BEFORE THE

ARKANSAS PUBLIC SERVICE COMMISSION

IN THE MATTER OF THE PETITION OF ENTERGY ARKANSAS, INC. FOR A DECLARATORY ORDER APPROVING REPLACEMENT OF THE STEAM GENERATORS AT ARKANSAS NUCLEAR ONE, UNIT 2, AND FOR AN ORDER APPROVING NEW DEPRECIATION RATES THEREON	)	DOCKET NO. 98-065-U

DIRECT TESTIMONY

OF

DAVID A. SCHLISSEL

SCHLISSEL TECHNICAL CONSULTING, INC.

ON BEHALF OF THE

GENERAL STAFF OF THE

ARKANSAS PUBLIC SERVICE COMMISSION

October 1998

ENTERGY ARKANSAS, INC.
DOCKET NO. 98-065-U
PREPARED TESTIMONY OF DAVID A. SCHLISSEL

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 02478.

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

A. I am testifying on behalf of the General Staff of the Arkansas Public Service Commission.

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 24 states to prepare expert testimony and analyses on engineering and economic issues related to electric utilities. My clients have included the Staff of the California Public Utilities Commission, the Staff of the Arizona Corporation Commission, the Staff of

the Kansas State Corporation Commission, municipal utility systems in Massachusetts, New York, Texas, and North Carolina, and the Attorney General of the Commonwealth of Massachusetts.

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, Missouri, and Wisconsin and before an Atomic Safety & Licensing Board of the U.S. Nuclear Regulatory Commission.

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

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS DOCKET?

A. The General Staff of the Arkansas Public Service Commission retained Schlissel Technical Consulting, Inc. ("STC") to analyze issues related to Entergy's proposed replacement of the steam generators at the ANO Unit 2 Steam Generating Station. ("ANO 2") This testimony presents the results of my investigation of these engineering and economic issues.

Q. PLEASE EXPLAIN HOW YOU HAVE CONDUCTED YOUR INVESTIGATION OF ENTERGY'S PROPOSED REPLACEMENT OF THE STEAM GENERATORS AT ANO 2.

A. I have completed the following activities as part of this investigation:

- I have submitted one hundred and thirty seven (137) detailed interrogatories to Entergy and reviewed the more than twenty-five thousand pages of documents that the Company provided in response to these interrogatories. These documents included:
  - the findings of steam generator tube inspections at ANO 2
  - assessments of the root causes of steam generator tube corrosion
  - materials related to Entergy's efforts to address steam generator tube corrosion at ANO 2 including the minutes of Company task forces and committees
  - engineering and economic analyses of Entergy's options for addressing steam generator corrosion
  - materials related to Entergy's participation in steam generator-related industry groups and visits by ANO 2 engineers to other power plants
  - assessments of the likely future progress of steam generator tube degradation
  - economic studies of the optimum date for replacing the ANO 2 steam generators
  - materials related to the design and materials features of the replacement steam generators
  - materials related to the selection of the contractors for the ANO 2 Steam Generator Replacement Contract
  - materials related to the Company's efforts to preplan and prepare for the replacement of the ANO 2 steam generators

- I have met with the manager of Entergy's ANO-2 Steam Generator Replacement Project and with three other engineers who have been involved with the Company's efforts to address steam generator tube degradation at the plant and to study whether replacement was the most cost-effective alternative.

- I have reviewed the extensive correspondence between the U.S. Nuclear Regulatory Commission ("NRC") and Entergy concerning steam generator related corrosion issues and the results of periodic NRC inspections and evaluations of ANO 2.

- I have reviewed the nuclear industry experience concerning steam generator tube corrosion and the replacement of the steam generators at both domestic U.S. and foreign nuclear power plants.

- I have analyzed the economic studies presented in the testimony of Company witness Kenney and, with the assistance of the APSC General Staff, I have prepared sensitivity analyses using the Company's economic model.

Q. **HAVE YOU EVALUATED THE REPLACEMENT OF THE STEAM GENERATORS AT OTHER OPERATING NUCLEAR POWER PLANTS?**

A. Yes. I have evaluated the engineering and economic reasonableness of the proposed replacement of the steam generators at the Trojan, Indian Point Unit No. 2, and Point Beach Unit No. 2 nuclear power plants. I also have evaluated the reasonableness of Northeast Utilities' planning for and management of the replacement of the steam generators at the Millstone Unit No. 2 nuclear plant.

In addition, I have examined steam generator-related design and materials issues in a number of other investigations of nuclear power plant construction projects and operating facilities.

Q. PLEASE SUMMARIZE YOUR CONCLUSIONS.

A. Based on the information that I have reviewed and the economic sensitivity studies that I have prepared, I agree with the Company that it is necessary to replace the steam generators at ANO 2 and that replacement appears to be the least cost option at this time.

Q. WHAT WERE THE ROOT CAUSES OF THE STEAM GENERATOR TUBE PROBLEMS THAT HAVE BEEN EXPERIENCED AT ANO 2?

A. The root cause of the tube degradation experienced at ANO 2 was the susceptibility of the materials used in the existing steam generators to corrosion when exposed to the operating environment in the steam generators. In particular, the Alloy 600 material used for the steam generator tubes has been shown to be extremely susceptible to a variety of degradation mechanisms including denting, stress corrosion cracking, and intergranular attack.

Q. WERE THE MATERIALS USED IN THE ORIGINAL ANO 2 STEAM GENERATORS TYPICAL OF THE TYPES OF MATERIALS USED IN STEAM GENERATORS BUILT IN THE 1970'S?

A. Yes. The materials used in the ANO 2 steam generators, including the Alloy 600 material used for the steam generator tubes, were typical of the materials used in nuclear power plants of ANO 2's vintage.

Q. WHO DESIGNED THE ORIGINAL ANO 2 STEAM GENERATORS?

A. The original steam generators were included in ANO 2's Nuclear Steam Supply System ("NSSS") which was designed and supplied to the Company by Combustion Engineering.

Q. HAVE ANY UTILITIES SUED COMBUSTION OVER PROBLEMS EXPERIENCED BY STEAM GENERATORS?

A. Yes. Florida Power & Light Corporation sued Combustion Engineering in 1995, saying that the steam generators at the St. Lucie Unit 1 nuclear plant had lasted only one-half as long as Combustion Engineering had promised. The two parties reached a confidential settlement in March, 1997.

Q. HAS ENTERGY SUED COMBUSTION ENGINEERING OVER THE PROBLEMS EXPERIENCED BY THE ANO 2 STEAM GENERATORS?

A. No. I have been informed that the Company has reached a settlement with Combustion Engineering in lieu of litigation. However, the General Staff has not yet been informed of the terms of that settlement but it is possible that any compensation that the Company may have received from

Combustion Engineering could have ratemaking implications which are beyond the scope of this docket.

Q. HAS THE STEAM GENERATOR TUBE-RELATED CORROSION THAT HAS BEEN EXPERIENCED AT ANO 2 BEEN TYPICAL OF THE CORROSION EXPERIENCED AT OTHER OPERATING NUCLEAR POWER PLANTS?

A. Yes. Essentially all of the operating nuclear power plants in the U.S. have experienced some degree of steam generator tube corrosion. However, the specific degradation mechanisms experienced and the number of tubes with defects have varied significantly from plant to plant.

Q. WHICH OPERATING POWER PLANTS IN THE U.S. HAVE HAD STEAM GENERATORS DESIGNED BY COMBUSTION ENGINEERING?

A. The following nuclear plants have had steam generators that were originally supplied as part of NSSS systems from Combustion Engineering – ANO 2, Calvert Cliffs, Fort Calhoun, Maine Yankee, Millstone Unit 2, Palisades, Palo Verde Units 1, 2, and 3, San Onofre Units 2 and 3, St. Lucie Units 1 and 2 and Waterford Unit 3.

Q. HAVE THE SPECIFIC STEAM GENERATOR TUBE CORROSION MECHANISMS THAT HAVE BEEN EXPERIENCED AT ANO 2

BEEN TYPICAL OF THE MECHANISMS THAT HAVE AFFECTED THESE OTHER NUCLEAR PLANTS WITH COMBUSTION ENGINEERING DESIGNED STEAM GENERATORS?

A. Yes. The corrosion mechanisms that have been experienced at ANO 2 are typical of the mechanisms that have degraded the steam generator tubes at other plants with Combustion Engineering designed steam generators. For example, the denting of steam generator tubes at the tube support plates that affected ANO 2 during the early to mid-1980's, also was experienced at the Calvert Cliffs, St. Lucie 1 and Fort Calhoun nuclear plants. Similarly, the outer diameter stress corrosion cracking/intergranular attack at the top of the tube sheet and the tube support plates that has affected ANO 2 since the early 1990's has been reported as a problem at Calvert Cliffs, St. Lucie Unit 1, Maine Yankee, and Fort Calhoun.

Q. **HAS TUBE CORROSION LED TO THE REPLACEMENT OF THE STEAM GENERATORS AT OTHER OPERATING NUCLEAR POWER PLANTS IN THE U.S.?**

A. Yes. As shown on Table STC-1 below, steam generator tube corrosion has led to the replacement of the steam generators at twenty-one nuclear power plants in the U.S. and at many foreign plants. Steam generators also are

currently being replaced at Commonwealth Edison Company's Braidwood Station in Illinois.

TABLE STC-1
DURATIONS OF DOMESTIC U.S.
STEAM GENERATOR REPLACEMENT OUTAGES

Plant	Year Replacement Completed	Duration of Replacement Outage
Surry 2	1980	260 days
Surry 1	1981	200 days
Turkey Point 3	1982	217 days
Turkey Point 4	1983	150 days
Point Beach 1	1984	118 days
Robinson 2	1984	130 days
Cook 2	1989	175 days
Indian Point 3	1989	140 days
Palisades	1991	121 days
Millstone 2	1993	228 days
North Anna 1	1993	96 days
Summer 1	1994	99 days
North Anna 2	1995	68 days
Ginna	1996	70 days
Catawba 1	1996	115 days
Salem 1	1997	Unquantified[1]

[1] The replacement of the Salem Unit 1 steam generators was performed as part of a 2-3 year outage during which the utility

McGuire 1	1997	94 days
St. Lucie 1	1997	79 days
Point Beach 2	1997	Unquantified[2]
McGuire 2	1997	77 days
Byron 1	1998	105 days
Braidwood 1	1998	ongoing

Q. HAVE STEAM GENERATORS DESIGNED BY COMBUSTION ENGINEERING BEEN REPLACED AT ANY POWER PLANTS?

A. Yes. The steam generators have been replaced at the Palisades, Millstone Unit 2 and St. Lucie Unit 1 nuclear plants, all of which had Combustion Engineering designed steam generators. Replacement steam generators also have been ordered for the Calvert Cliffs and Palo Verde plants.

addressed significant management, programmatic, and hardware deficiencies. Thus, it is not possible to identify a separate duration for the steam generator replacement outage.

[2] The replacement of the steam generators at Point Beach Unit 2 was performed at the beginning of a ten-month outage during which the utility addressed serious concerns that had been raised by the U.S. Nuclear Regulatory Commission. Thus, it is not possible to identify a separate duration for the steam generator replacement outage.

Q. HAVE STEAM GENERATOR RELATED PROBLEMS LED TO THE RETIREMENTS OF ANY OPERATING NUCLEAR POWER PLANTS?

A. Yes. The cost of addressing steam generator corrosion issues was a major factor in the decisions to retire the Maine Yankee, San Onofre Unit 1, and Trojan nuclear plants.

Q. DO YOU AGREE WITH THE CONCLUSION OF COMPANY WITNESS DOUGHTY THAT ENTERGY RESPONDED REASONABLY TO ANO 2 STEAM GENERATOR CORROSION ISSUES?

A. Yes. The extensive documentation that I have reviewed shows that, overall, the Company responded to steam generator corrosion issues appropriately. In particular, the Company created a Steam Generator Task Force in 1981 and a Steam Generator Integrity Committee in 1985 to monitor the performance of the steam generators and to investigate potential corrective actions for corrosion issues. These organizations identified and evaluated potential remedies for steam generator tube corrosion, including a number of plant modifications and changes to plant water chemistry that were ultimately implemented by management.

The Company also regularly incorporated lessons learned from the experiences of other utilities in addressing steam generator corrosion issues. As part of this effort, Company representatives attended the Electric Power Research Institute's ("EPRI") conferences on steam generator issues and participated in industry organizations such as the Combustion Engineering Owners Group Steam Generator Task Force and the EPRI Steam Generator Strategic Management Group. In addition, Company engineers regularly reviewed steam generator-related issuances from the NRC and the Institute of Nuclear Power Operations ("INPO") for information applicable to ANO 2.

Q. IS THERE ANY EVIDENCE THAT THE STEAM GENERATOR TUBE DEGRADATION AT ANO 2 WAS MADE MORE SEVERE DUE TO THE COMPANY'S OPERATIONAL PRACTICES?

A. No. I have seen no evidence that suggests that Entergy's operational practices made the steam generator tube corrosion at ANO 2 more severe.

Q. WERE THERE ANY REASONABLE ACTIONS THAT ENTERGY COULD HAVE TAKEN THAT WOULD HAVE ENABLED THE COMPANY TO AVOID STEAM GENERATOR TUBE CORROSION?

A. No. Given the experience of other operating nuclear power plants of a similar vintage, both in the U.S. and abroad, it was almost inevitable that ANO 2 would experience significant steam generator tube corrosion.

Q. HAS THE NRC EXPRESSED ANY SERIOUS CONCERNS ABOUT THE ACTIONS TAKEN BY ENTERGY CONCERNING THE STEAM GENERATORS AT ANO 2?

A. NRC evaluations of Entergy's steam generator practices at ANO 2 generally have been positive except for negative findings in 1992 and 1996 which were limited to deficiencies in the Company's tube inspection programs.

Q. WHEN DID THE COMPANY START TO ANALYZE WHETHER IT MIGHT NEED TO REPLACE THE ANO 2 STEAM GENERATORS?

A. The Company first began in 1992 to find large numbers of tubes with axial cracks at the tube support plates and/or circumferential cracks at the top of the tube sheet. It appears that the discovery of these cracks led the Company to seriously consider that the ANO 2 steam generators might have to be replaced.

Q. DID THE COMPANY USE A REASONABLE DECISION-MAKING PROCESS TO REACH THE CONCLUSION THAT THE ANO 2 STEAM GENERATORS SHOULD BE REPLACED?

A. Yes. The Company conducted several detailed engineering and economic analyses during the years 1993 through 1996 that formed the basis for the decision to replace the ANO 2 steam generators during the unit's year 2000 refueling outage. These studies, which were assisted by experienced consulting firms, used a steam generator strategic model which examined likely future steam generator tube degradation rates at ANO 2 and a wide variety of alternative repair or replacement scenarios.

Q. PLEASE DESCRIBE THE ALTERNATIVE REPAIR AND REPLACEMENT SCENARIOS CONSIDERED BY THE COMPANY IN THESE ENGINEERING AND ECONOMIC ANALYSES.

A. The Company's 1993 analyses investigated the following questions:

- Will the Company need to replace the steam generators? If so, will the replacements last until 2038?
- How much will the Company spend on repair or replacement? And when?
- What should the Company do now? What actions can be deferred?
- Is there any way to avoid replacement? If so, under what conditions, and how likely are they?

To answer these questions, the studies looked at a broad range of alternative repair and replacement options, including:

- different repair methods – plugging, sleeving and preventive sleeving.

- different plant primary system operating temperatures between 590 and 607 degrees.

- the optimal date(s) for steam generator replacement.

- whether to seek NRC permission to use Alternative Plugging Criteria for the axial cracks at the tube support plates.

- whether to restore previously plugged tubes to service.[3]

The 1993 studies also considered a number of related Operating Enhancements which included replacing the ANO 2 condenser and Moisture Separator Reheater, increasing the thermal power of the plant, and chemical cleaning of the steam generators.

Q. WHAT WERE THE PRIMARY CONCLUSIONS OF THE COMPANY'S 1993 STUDIES?

A. The primary conclusion of the 1993 Company studies was that the steam generators should be replaced in the 2000-2003 time frame because replacement could not be avoided unless the steam generator tube degradation rate turned "optimistic." The studies also concluded that the

[3] The options considered by the Company are listed on a page from the 1993 studies which is included as Exhibit DAS-2.

Company should replace the ANO 2 condenser and perform the primary side power uprating with the steam generator replacement and that the Moisture Separator Reheater should be replaced as soon as possible. The studies further found that, in the years prior to replacement, the Company should maintain the primary system hot leg water temperature at 599 degrees and, where possible, insert sleeves to repair tube defects.

Q. IN SUBSEQUENT YEARS DID THE COMPANY REEVALUATE THE NEED TO REPLACE THE ANO 2 STEAM GENERATORS?

A. Yes. The Company reexamined the options for addressing steam generator corrosion in subsequent years, including whether replacement of the steam generators was the most economic alternative. These studies looked at changed circumstances, including revised predictions of the likely future course of steam generator tube degradation that reflected the discovery of additional tube cracks during the years 1994 and 1995.

Q. WHAT WERE THE CONCLUSIONS OF THESE SUBSEQUENT COMPANY REEXAMINATIONS OF WHETHER TO REPLACE THE ANO 2 STEAM GENERATORS?

A. As shown in Exhibit JFK-2 of Entergy witness Kenney, the Company's subsequent economic studies continued to show that replacement of the

steam generators was cost-effective and should be planned for the years 2001-2003.

Q. DO YOU AGREE WITH THE ENTERGY CONCLUSION THAT THE ANO 2 STEAM GENERATORS WILL HAVE TO BE REPLACED IN THE YEAR 2000?

A. Yes. Entergy's recent engineering analyses show that the NRC-approved tube plugging limit of 30 percent for ANO 2 will be reached during the unit's refueling outage in the year 2000, assuming pessimistic (i.e., high) tube degradation rates. The Company's studies also show that the unit will be near its NRC-approved 30 percent steam generator tube plugging limit during that outage even if the tubes only degrade at the optimistic (i.e., lower) rate.

Q. DO YOU BELIEVE IT IS APPROPRIATE TO ASSUME PESSIMISTIC TUBE DEGRADATION RATES WHEN SCHEDULING THE REPLACEMENT OF THE STEAM GENERATORS?

A. Yes. There could be significant cost consequences if the Company delays the planned steam generator replacement to a subsequent ANO 2 outage based on optimistic tube degradation rates and then is forced to plug a larger than expected number of tubes during the year 2000 outage. Under those circumstances, Entergy probably would be required to maintain ANO 2 shut

down until the replacement steam generators had arrived and all pre-outage planning and preparations had been completed. Such an outage could last months, if not longer. The unavailability of ANO 2 for such an extended period would lead to higher replacement power costs for both the Company and its ratepayers.

An internal Company memorandum likened planning the date for replacing the ANO 2 steam generators based on optimistic degradation rates to "running out of gas as you roll into the gas station" and noted that this was a "very risky scenario especially if the consequences were great (i.e., unable to start up after the 2001 outage)." The memorandum also noted that such a strategy provided "no hedge against the variability in the degradation projections." I agree.

Q. DO YOU AGREE WITH THE CONCLUSION OF COMPANY WITNESS DOUGHTY THAT THE SELECTION OF BECHTEL TO REMOVE THE ORIGINAL STEAM GENERATORS AND INSTALL THE NEW STEAM GENERATORS WAS CONSISTENT WITH INDUSTRY PRACTICE?

A. Yes. The selection of Bechtel was a reasonable choice. Bechtel has had extensive experience in managing and conducting the replacement of steam generators at operating nuclear power plants. In fact, at the time that

Entergy chose the contractors for the ANO 2 steam generator replacement project, Bechtel had served as the primary contractor on 11 of the 16 domestic U.S. steam generator replacements that had been completed through 1996. Bechtel has also served as the primary contractor on all four of the steam generator replacements which have required temporary cuts to be made in the plant's containment building to remove the original steam generators and to install the replacement equipment. Such a temporary cut in the containment will be required to replace ANO 2's steam generators.

In addition, Bechtel had been the architect engineer/constructor for ANO 2 and had provided support engineering services for the unit in recent years.

Q. DO YOU AGREE WITH THE CONCLUSION OF COMPANY WITNESS DOUGHTY THAT THE SELECTION OF WESTINGHOUSE TO MANUFACTURE THE ANO 2 REPLACEMENT STEAM GENERATORS WAS CONSISTENT WITH INDUSTRY PRACTICE?

A. Yes. Westinghouse has designed and manufactured the replacement steam generators for twelve domestic nuclear power plants.

Q. DO YOU HAVE ANY OBSERVATIONS ON THE PROCESS THE COMPANY USED TO SELECT BECHTEL AND WESTINGHOUSE?

A. Yes. The documents provided by Entergy during discovery reveal that the Company implemented a very thorough process for selecting the contractors for the manufacture and installation of the ANO 2 replacement steam generators. This process included the submission of Requests for Proposals to potential bidders; the review of proposals; the acceptance of rebids; the review by an ANO 2 Replacement Steam Generator Bid Evaluation Core Team; meetings with and presentations by bidders; input from ANO Bid Evaluation Team Specialty Area Members; and the review of additional information provided in response to bid related questions. The Company also created a Vendor Evaluation Team which visited other steam generator replacement outages and the fabrication facilities of each of the bidders to design and supply the replacement steam generators.

Q. DO THE MATERIALS AND DESIGN FEATURES OF THE REPLACEMENT STEAM GENERATOR ADDRESS THE STEAM GENERATOR CORROSION MECHANISMS THAT HAVE DEGRADED THE ORIGINAL ANO 2 STEAM GENERATORS?

A. Yes. Many design and materials improvements have been incorporated in the replacement steam generators to be installed at ANO 2 to minimize their susceptibility to the corrosion mechanisms that have affected the original steam generators. Most significantly, the replacement steam generators will

use Alloy 690 tubes. This material offers a superior resistance to corrosion in steam generator operating environments. The replacement steam generators also will use stainless steel for tube support plates. This will enhance their resistance to the denting suffered by the carbon steel tube support plates in the original steam generators.

Q. WHAT HAS BEEN THE OPERATING PERFORMANCE OF OTHER REPLACEMENT STEAM GENERATORS WITH ALLOY 690 TUBES?

A. Replacement steam generators with Alloy 690 tubes have been in service since March 1989. During this 9.5 year period, there have been no reports of any Alloy 690 tubes that have been plugged due to in-service degradation. The only defects in tubes manufactured from Alloy 690 have been caused by damage during maintenance operations.

Q. WHAT IS THE PROJECTED SERVICE LIFE FOR THE REPLACEMENT STEAM GENERATORS?

A. Entergy's Steam Generator Replacement Specifications require that the cumulative full power operating life of the replacement steam generators to be provided by Westinghouse be forty years.

Q. WHAT IMPACT WILL THE REPLACEMENT OF THE ANO 2 STEAM GENERATORS HAVE ON THE POSSIBILITY OF EXTENDING THE UNIT'S OPERATING LIFE?

A. The installation of the replacement steam generators will enhance the Company's ability to extend the operating life of ANO 2 beyond the unit's currently scheduled retirement in 2018.

Q. DO YOU HAVE ANY OBSERVATIONS CONCERNING THE COMPANY'S EFFORTS TO PREPLAN THE REPLACEMENT OF THE ANO 2 STEAM GENERATORS?

A. Yes. It appears that the Company is taking reasonable steps to preplan the steam generator replacement. In addition to selecting Bechtel and Westinghouse, Entergy has retained ABB-Combustion Engineering, the designer of the ANO 2 nuclear steam supply system, to provide licensing support and safety analyses. The Company also appears to be making reasonable efforts to monitor the work of these project contractors. These efforts include the placement of a full-time on-site representative at the ENSA facility in Spain where the replacement steam generators are being fabricated.

The documentation that I have reviewed shows that the Company also is making an extensive effort to learn from the experiences of the steam generator replacements at other nuclear power plants. In addition to retaining Bechtel and other contractors with significant experience in replacing steam generators, Company engineers have visited the replacement

outages at the St. Lucie Unit 1, Ginna, Catawba Unit 1, Byron, Braidwood, and Point Beach Unit 2 plants. The Company also has participated in the industry Steam Generator Replacement Group.

Q. IS THE COMPANY'S PROJECTED 70 TO 75 DAY DURATION FOR THE ANO 2 STEAM GENERATOR REPLACEMENT OUTAGE CONSISTENT WITH THE DURATIONS OF THE STEAM GENERATOR REPLACEMENT OUTAGES AT OTHER NUCLEAR POWER PLANTS?

A. Yes. The Company's projected outage is consistent with the durations of recent steam generator replacement outages which are shown on Table STC-1 earlier in my testimony.

Q. IS THE COMPANY'S PROJECTED COST FOR THE REMOVAL OF THE ORIGINAL STEAM GENERATORS AND THE INSTALLATION OF THE REPLACEMENT STEAM GENERATORS CONSISTENT WITH THE COST OF STEAM GENERATOR REPLACEMENTS AT OTHER NUCLEAR POWER PLANTS?

A. Yes. Entergy's projected cost for the ANO 2 steam generator replacement is based on detailed cost estimates and contracts with project contractors and is within the $100 to $200 million range that recent steam generator replacements have cost.

Q. HAVE YOU FOUND ANY WEAKNESSES IN THE ENTERGY 1998 ECONOMIC ANALYSIS PRESENTED BY COMPANY WITNESS KENNEY?

A. Yes. The Company fails to present any sensitivity studies which examine the economics of replacing the steam generators.

Q. HAVE YOU PREPARED ANY SENSITIVITY STUDIES TO EXAMINE THE ECONOMICS OF REPLACING THE ANO 2 STEAM GENERATORS IF YOU ASSUME THAT THE COMPANY'S PROJECTIONS FOR FUTURE ANO 2 OPERATING PERFORMANCE AND COSTS ARE NOT MET?

A. Yes. Using the Company's economic model, and with the assistance of the APSC General Staff, I have prepared sensitivity scenarios which assume 84.5 percent, 78.7 percent, and 71.7 percent for the three-year rolling average capacity factors for ANO 2 following the completion of the steam generator replacement outage. I also have prepared sensitivity scenarios which assume that future ANO 2 O&M costs after the steam generators are replaced will be 10 percent higher than the Company's Base Case figures.

Q. ON WHAT BASIS DID YOU DECIDE TO PREPARE SENSITIVITY SCENARIOS FOR THREE-YEAR ROLLING AVERAGE CAPACITY FACTORS OF 84.5 PERCENT, 78.7 PERCENT AND 71.7 PERCENT?

A. ANO 2 achieved a 78.7 percent capacity factor during the ten-year period 1988-1997 and an 84.5 percent capacity factor during the five- year period 1993-1997. ANO 2's cumulative lifetime capacity factor through the end of 1997 was 71.7 percent.

Q. WHAT WERE THE RESULTS OF YOUR SENSITIVITY STUDIES?

A. The results of my sensitivity studies are shown on Table STC-2 below. All of these studies use the Company's base case assumptions except for the changed capacity factors and O&M costs:

TABLE STC-2
Sensitivity Scenarios
Net Present Value Benefit of
Replacing the ANO 2 Steam Generators
Versus No Replacement

Scenario			
Future Market Price of Power	Future ANO 2 Capacity Factor	Future ANO 2 O&M Costs	NPV Benefit of Replacement ($1000)
High	84.5 percent	Base Case	
High	78.7 percent	Base Case	
High	71.7 percent	Base Case	
Low	84.5 percent	Base Case	
Low	78.7 percent	Base Case	
Low	71.7 percent	Base Case	
High	Base Case	+10 percent	
High	84.5 percent	+10 percent	
High	78.7 percent	+10 percent	
High	71.7 percent	+10 percent	
Low	Base Case	+10 percent	
Low	84.5 percent	+10 percent	
Low	78.7 percent	+10 percent	
Low	71.7 percent	+10 percent	

TABLE STC-3
Aging Sensitivity Scenarios
Net Present Value Benefit of

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Q. HAVE YOU PREPARED ANY OTHER SENSITIVITY STUDIES?

A. Yes. I have prepared a number of scenarios to examine what would happen if ANO 2's future operating performance declines dramatically and if the unit's O&M costs increase significantly after the unit reaches the age of 30.

I assumed for these scenarios that ANO 2 achieves the Company's Base Case capacity factor and O&M projections through the year 2009. I then assumed that the unit's three-year rolling capacity factor would drop to 60 percent and O&M costs would increase by 20 percent for the remaining 9 years of its operating life. Although operating performance and O&M expenditures would probably change more gradually as a plant ages, these scenarios provide dramatic examples of what could happen.

Q. WHAT WERE THE RESULTS OF THESE AGING SCENARIOS?

A. The results of these scenarios are shown on Table STC-3 below:

TABLE STC-3
Aging Sensitivity Scenarios
Net Present Value Benefit of
Replacing the ANO 2 Steam Generators
Versus No Replacement

Scenario		
Future Market Price of Power	Future ANO 2 Capacity Factor	NPV Benefit of Replacement ($1000)
High		
High		
Low		
Low		

These scenarios show that replacement of the ANO 2 steam generators would remain the lowest cost option even if you assume that aging will adversely impact the unit's performance and costs.

Q. WHAT IS YOUR OVERALL CONCLUSION REGARDING ENTERGY'S PROPOSAL TO REPLACE THE STEAM GENERATORS AT ANO 2?

A. Based on the information I have reviewed and the sensitivity studies that I have prepared, I agree with the Company that it is necessary to replace the steam generators at ANO 2 and that replacement appears to be the least cost option at this time.

Q. DOES THIS COMPLETE YOUR TESTIMONY?

A. Yes.