REPORT TO THE PUBLIC POLICY GROUP CONCERNING FUTURE TROJAN NUCLEAR PLANT OPERATING PERFORMANCE AND COSTS

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I. BACKGROUND

Schlissel Engineering Associates was retained by the Portland General Electric Company (PGE) on behalf of the Public Policy Group to review the reasonableness of the projected levels of future Trojan capacity factors, operating and maintenance (O&M) costs, capital additions expenditures, and steam generator replacement costs used in PGE's Least Cost Plan analyses. This Report presents the results of this review.

As part of this review, I have submitted requests for information to PGE concerning the economic and engineering bases for its projected Trojan costs and operating performance and reviewed the documents provided by the Company in response to those requests. The documents provided by PGE included the correspondence between PGE and the U.S. Nuclear Regulatory Commission (NRC) concerning steam generator-related issues at Trojan, the Bechtel Power Corporation Trojan Steam Generator Replacement Feasibility Study, and some limited information on budgeted O&M and capital additions expenditure items.

I have also examined the documents related to Trojan which are contained in the U.S. Nuclear Regulatory Commission's (NRC) public docket files. These documents included NRC Inspection Reports, the periodic NRC SALP Reports in which the NRC evaluates the performance of Trojan and PGE in a number of functional areas and correspondence from PGE related to these inspections and evaluations.

I have also investigated the problems which have led to steam generator replacements at operating nuclear power plants. I have further studied in detail the engineering of the steam generator replacements at a number of power plants and the costs and schedule durations of those replacements.

Finally, I have made an engineering analysis of the factors which in the past have affected performance and led to increases in O&M costs and capital expenditures at operating nuclear power plants and which can be expected to do so in the future.

Unfortunately, PGE was unable to provide any studies or analyses which formed the basis for its projected Trojan capacity factors, O&M costs and capital additions expenditures. The Company also indicated that it had not performed, and therefore could not provide, (a) any engineering analyses related to current or anticipated regulatory trends which may affect future Trojan performance or operating costs or (b) any studies which examined or evaluated the potential impact of the aging of Trojan's systems, structures or components on future plant performance or costs.

Moreover, the Company was unwilling to provide several categories of documents which would have been useful in my review. These documents included evaluations of Trojan and PGE by the nuclear industry's Institute of Nuclear Power Operations (INPO), materials related to meetings of the

Nuclear Oversight Committee of the PGE Board of Directors, and evaluations, assessments or critiques of operations, activities or outages of the Trojan Nuclear Plant and/or the Company's Nuclear Division.

II. SUMMARY OF FINDINGS

The main findings of this review are as follows:

1. PGE currently projects that the replacement of Trojan's four steam generators will cost between $145 million and $215 million, in 1993 dollars, and require an outage of approximately four months. The $185 million to $215 million high end of this range is consistent with the actual and planned costs of other steam generator replacements. The Company's projected four month outage duration is optimistic. Steam generator replacements at other nuclear power plants have required longer plant outages.

2. Trojan began commercial operations on May 20, 1976. Through the end of March 1992, i.e., the first sixteen years of its service life, the Unit had achieved less than a fifty two percent cumulative lifetime capacity factor. However, in its Least Cost Plan, PGE now projects that starting in 1993, Trojan will achieve dramatically

higher capacity factors, with seventy one percent being the "most likely" annual capacity factor, according to PGE.

3. There is no evidence to support PGE's claim that Trojan will achieve 71 percent capacity factors over the remaining years of its projected service life. In fact, available evidence, including Trojan's actual performance, the capacity factors achieved by comparable nuclear power plants, and the potential impacts of steam generator tube degradation and the aging of plant systems, structures, and components and structures, shows that the Company's capacity factor projections are unreasonably optimistic.

4. The Company's Least Cost Plan should instead assume that future Trojan annual capacity factors will fall within the range of 47 to 67 percent, with 57 percent being the "base case" or "most likely" figure. This 57 percent "base case" capacity factor would allow for a moderate improvement in Trojan's operating performance while the 67 and 47 percent figures would reflect the Unit's performance under optimistic and moderately pessimistic scenarios.

5. Trojan-related O&M expenditures increased between 1977 and 1991 at an average annual growth rate of 13.1 percent above the general rate of inflation.

6. However, PGE projects that Trojan-related O&M expenditures will decrease, in real terms, by approximately 10 percent between 1991 and 1998.

7. Consequently, the Company predicts that O&M expenditures at Trojan will decrease, in real terms, at the same time that the Unit's performance will increase dramatically. This is simply unreasonable given Trojan's operating history.

8. Trojan-related O&M expenditures can reasonably be expected to increase at several percentage points above the rate of inflation for the remaining years of the Unit's projected service life.

9. Trojan-related capital additions expenditures increased between 1977 and 1991 at an average annual growth rate of 3.4 percent above the general rate of inflation.

10. Although these capital additions expenditures decreased between the peak year of 1989 and 1991,

it is reasonable to expect that future Trojan-related capital additions expenditures will increase, on average, at several percentage points above the rate of inflation as a result of future regulatory activity and plant aging.

11. Consequently, the Company's Least Cost Plan should assume that future Trojan O&M expenditures will start at the Company's $140 million upper bound figure for 1993 and increase, on average, at annual rates of two to four percent above the rate of inflation for the remainder of Trojan's service life. The Least Cost Plan should also assume that future Trojan capital additions expenditures will start at the Company's $21 million figure for 1993 and increase, on average, at annual rates of two to four percent above the rate of inflation for the remainder of Trojan's service life.

The remainder of this Report will be organized as follows. Section III will examine the Company's cost and schedule estimates for the 1996 replacement of Trojan's four steam generators. Sections IV and V will then examine the reasonableness of PGE's projected future Trojan capacity factors, O&M costs and capital additions expenditures.

III. STEAM GENERATOR REPLACEMENT ISSUES

Steam generators are used in Pressurized Water Reactor nuclear power plants (PWRs) like Trojan to produce the steam that is used to drive the nuclear power plant's main turbine-generator and produce electricity. Heated primary reactor coolant flows inside the steam generator in approximately 3,500 small diameter tubes while a separate secondary system coolant flows around the outside of the tubes. Heat is transferred from the heated primary system coolant to the secondary system coolant. The secondary system steam which is produced in the steam generator is then used to produce electricity in the main turbine-generator.

Steam generators in operating PWRs have experienced a wide variety of forms of tube and other component degradation and corrosion. At many plants, steam generator tube corrosion and degradation have led to substantial power plant outages and increased inspection and repair costs. The problems were sufficiently severe at the Surry, Turkey Point, Point Beach Unit 1, Robinson Unit 2, Palisades, Cook Unit 2 and Indian Point Unit 3 plants that the utilities have replaced the steam generators. Other utilities are currently planning or evaluating the need for, and the economics of, the replacement of the steam generators.

Prior to 1991, Trojan had experienced relatively less steam generator tube degradation and corrosion than other operating PWRs. PGE has argued that this is partly attributable to the fact that starting in the early 1980's it began to implement a aggressive steam generator maintenance program which included such measures as the implementation of the steam generator water chemistry guidelines proposed by the Electric Power Research Institute (EPRI) and the removal of copper bearing alloys from equipment in the plant's secondary system.

However, extensive microcracking of steam generator tubes was unexpectedly discovered during Trojan's 1991 refueling outage. The discovery of this cracking led to expanded steam generator tube inspections, root cause analyses, and the plugging or sleeving of a substantial number of steam generator tubes.

The Company has identified the root causes of this unanticipated steam generator tube cracking as phenomena known as intergranular attack and outer diameter stress corrosion cracking. The microcracks were found in the locations where the tubes intersected the tube support plates within the steam generators.

PGE has received a Technical Specifications Amendment from the NRC which allows Trojan to operate for the current fuel cycle with an enhanced leak detection limits. Additional steam generator tube inspections will be conducted during Trojan's next refueling outage, at which time PGE will evaluate whether the problem has been arrested or controlled.

Although PGE is currently investigating secondary system water chemistry changes which its hopes will arrest the initiation and growth of the microcracks, the Company has begun to develop contingency plans for the possible replacement of the steam generators in 1996. Thus far, the Company has hired Bechtel Power Corporation to prepare a "Trojan Nuclear Plant Steam Generator Replacement Feasibility Study for Portland General Electric Company." On the basis of this Feasibility Study, the Company currently projects that the replacement of Trojan's four steam generators will cost between $145 million and $215 million, in 1993 dollars, and require an outage of approximately four months.

The higher end of this cost range is consistent with the costs of the recent replacement of the steam generators at the Indian Point 3 nuclear plant and with the current estimates for the costs of replacing the steam generators at the Millstone 2 and Indian Point 2 nuclear plants. For example, Northeast Utilities currently projects that the 1992 replacement of Millstone 2's steam generators will cost approximately $200 million, in 1992 dollars.

Similarly, Consolidated Edison Company of New York has estimated that the replacement of the steam generators for the Indian Point 2 nuclear plant from Westinghouse will cost $127 million, in 1990 dollars, excluding the cost of the new steam generators which the utility had already purchased from Westinghouse in 1987 at a cost of approximately $37 million.

If these Millstone 2 and Indian Point 2 estimates are escalated to 1993 dollars, they fall within the $185 million to $215 million high end of PGE's estimated range for the cost of replacing Trojan's steam generators.

The Bechtel Trojan Steam Generator Feasibility Study also concluded that the most likely duration of the steam generator replacement outage would be in the range of 120 to 130 days. This estimated outage duration is somewhat optimistic in that replacement of the four steam generators at the Indian Point 3 nuclear power plant required a four and a half month outage from early February through the end of June 1989. Moreover, as shown on Table 1, below, other plants have required steam generator replacement outages of longer than 4 months.

TABLE 1
STEAM GENERATOR REPLACEMENT
OUTAGE DURATIONS

Unit	Year of Replacement Outage	Duration of Replacement Outage
Surry 1	1980/81	10 months
Surry 2	1979/80	16 months
Turkey Point 3	1981	6 months
Turkey Point 4	1982/83	6 months
Robinson 2	1984	5 months
D.C. Cook 2	1988/89	6 months
Indian Point 3	1989	4.5 months
Palisades	1990/91	6 months

In addition, Consolidated Edison has estimated that the replacement of the four steam generators at the Indian Point 2 nuclear plant might require an outage of up to six months. The replacement "Model F" steam generators that have been installed in the Surry, Turkey Point, Point Beach, Palisades, Robinson, Cook and Indian Point 3 plants, and that may be installed in Trojan, have a number of design and materials features which improve their resistance to the forms of tube and component degradation and corrosion experienced by earlier steam generators. For example, to reduce the potential for the denting of steam generator tubes, the Model F steam generators employ a more open tube support plate structure and use new materials for the tube support plates (ferritic stainless steel instead of carbon steel). Newer Model F steam generators also contain tubes fabricated from a material known as Inconel 690 in place of the tubes fabricated from Inconel 600 which were included in earlier vintage steam generators.

According to the Bechtel Steam Generator Replacement Feasibility Study, PGE is considering purchasing previously owned Model F steam generators that were installed, but never used, in the cancelled Seabrook 2 nuclear power plant. Although the cost of these previously owned replacement steam generators may be less than the cost of new steam generators from Westinghouse or another vendor, there are several factors which must be considered by the Company prior to making a decision as to which option to pursue.

First, Bechtel estimates that the cost of removing these steam generators from the Seabrook 2 plant would be approximately $4.24 million, in 1992 dollars. This cost must be factored into the economic comparison.

Second, the conditions under which the steam generators have been maintained at Seabrook 2 must also be considered. It is possible that Seabrook 2 steam generators may have been exposed to a potentially corrosive environment for perhaps as long as ten years.

Third, according to the Seabrook Final Safety Analysis Report filed with the U.S. Nuclear Regulatory Commission, the tubes in the Seabrook 2 steam generators were fabricated from thermally treated Inconel 600. As noted above, problems with the corrosion of Inconel 600 steam generator tubes have led many utilities and vendors to employ more corrosion resistant Inconel 690 tubes in recent replacement steam generators. For example, the new steam generators installed in such plants as Cook 2 and Indian Point 3, and scheduled to be installed in Millstone 2 in 1992, contain tubes fabricated from Inconel 690. The use of the previously owned Seabrook 2 steam generators, with tubes fabricated from Inconel 600, may increase the potential for future steam generator-related problems, inspections and repairs at Trojan.

Moreover, it must be recognized that the installation of Model F steam generators, even those with tubes from Inconel 690, does not guarantee that Trojan will be free of steam generator-related problems and outages. Many of the forms of steam generator tube and component degradation and corrosion experienced by the original generation of steam generators only developed after years of operating time. Consequently, the possibility that currently unexpected and unanticipated problems will develop after the installation of the replacement of the steam generators at Trojan cannot be completely ruled out eventhough plants like Surry Units 1 and 2 and Turkey Point Units 3 and 4 have operated with replacement steam generators for up to twelve years with little or no steam generator-related problems. For example, an official at the Wolf Creek Nuclear Plant, which began operations in September 1985 with a Model F steam generator, has been quoted in Nucleonics Week as acknowledging that:

> Frankly, we're not sure our steam generators can last for 40 years, seeing what others have experienced.

Finally, the replacement of Trojan's steam generators is currently being considered as a contingency for 1996. However, the discovery of additional steam generator deterioration could force PGE to advance the installation of the replacement steam generators.

For example, unexpected steam generator tube deterioration has recently led Virginia Power to accelerate the installation of the replacement steam generators at North Anna Unit 1 from 1995 to January 1993. Similarly, in 1989, South Carolina Electric & Gas Company believed that the replacement of the steam generators at the Summer Nuclear Plant might not be required until the end of this decade, if not later. Since then, the planned date of the replacement of the Summer steam generators has been advanced twice due to accelerated tube corrosion, first to 1996 and then to 1994.

IV. CAPACITY FACTORS

PGE projects that starting in 1993 annual Trojan capacity factors will be within the range of sixty to eighty percent, with seventy one percent being the "most likely" capacity factor.[1] Unfortunately, as was noted earlier in this Report, the Company was unable to provide any studies or analyses which formed the basis for this claim that Trojan's future performance will be dramatically better than it past has been.

In fact, the following evidence supports the conclusion that the Company's projection of a seventy one percent "most likely" annual capacity factor for Trojan over the plant's remaining service life is unreasonably optimistic:

1. The performance of Trojan over the first sixteen years of its operating life.

2. The operating performance of comparable nuclear power plants.

3. Steam Generator Issues including the possibility of further steam generator tube related problems

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1 PGE predicts a 71 percent "most likely" capacity factor for Trojan for all of the remaining years of its service life except for 1996 when the steam generators would be replaced. The Company projects a 58 percent capacity factor for that year.

prior to the replacement of the steam generators in 1996 and the capacity factors achieved by PWRs following steam generator replacement outages.

4. The potential impact of the aging of Trojan's equipment, components, and structures.

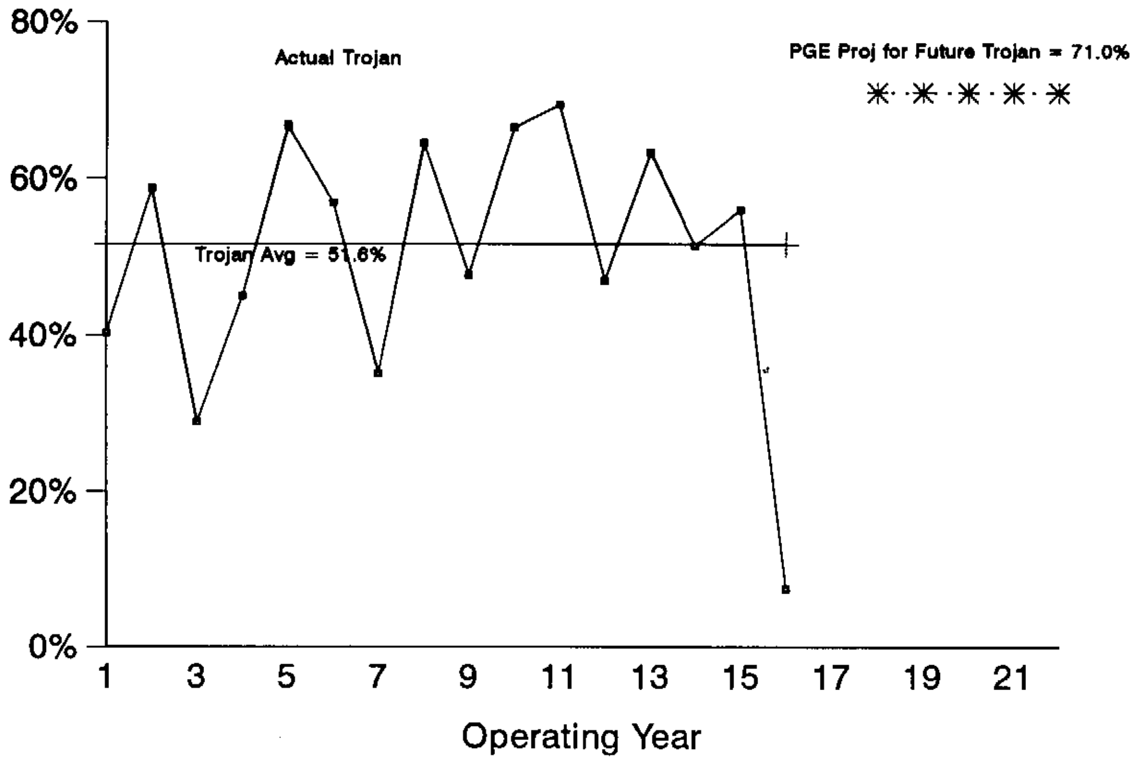
Each of these factors will be addressed in turn.

A. Trojan's Operating History

The Trojan Nuclear Plant began commercial operations on May 20, 1976. Through the end of March 1992, i.e., the first 16 years of its projected service life, Trojan achieved only a 51.6 cumulative capacity factor. This figure is approximately 19 percentage points below the 71 percent capacity factor which PGE now projects will be the Unit's "most likely" performance over the remaining years of its projected service life.

Figure 1 below presents the annual capacity factors achieved by Trojan since it began commercial operations in May 1976. This Figure reveals that Trojan has **never** achieved a 71 percent capacity factor, not even for a single operating year. In fact, the Unit has only come close to a 71 percent capacity factor in its 11th operating year when it achieved a 69.4 percent capacity factor and has only exceeded a 60 percent capacity in five of its operating years.

FIGURE 1
TROJAN CAPACITY FACTORS



Consequently, there is no evidence in Trojan's operating history to support the conclusion that it will achieve 71 percent capacity factors over the remaining years of its projected service life.

B. The Operating Performance of Comparable Nuclear Power Plants

Figure 2 below compares Trojan's lifetime 51.6 percent capacity factor with the capacity factors achieved through the end of March 1992 by 27 other medium and large PWRs which are of the same vintage as Trojan, i.e., began commercial operations prior to the accident at the Three Mile Island Nuclear Power Plant in March of 1979. These are the plants which have designs similar to Trojan and which have been operated in essentially the same regulatory and technical environments as Trojan. Each of these plants has a Nuclear Steam Supply System (NSSS) designed by one of the three PWR vendors, i.e., Westinghouse, Babcock & Wilcox, or Combustion Engineering.

FIGURE 2
LIFETIME CAPACITY FACTORS
THROUGH MARCH 31, 1992
TROJAN AND
ALL COMPARABLE PWRS

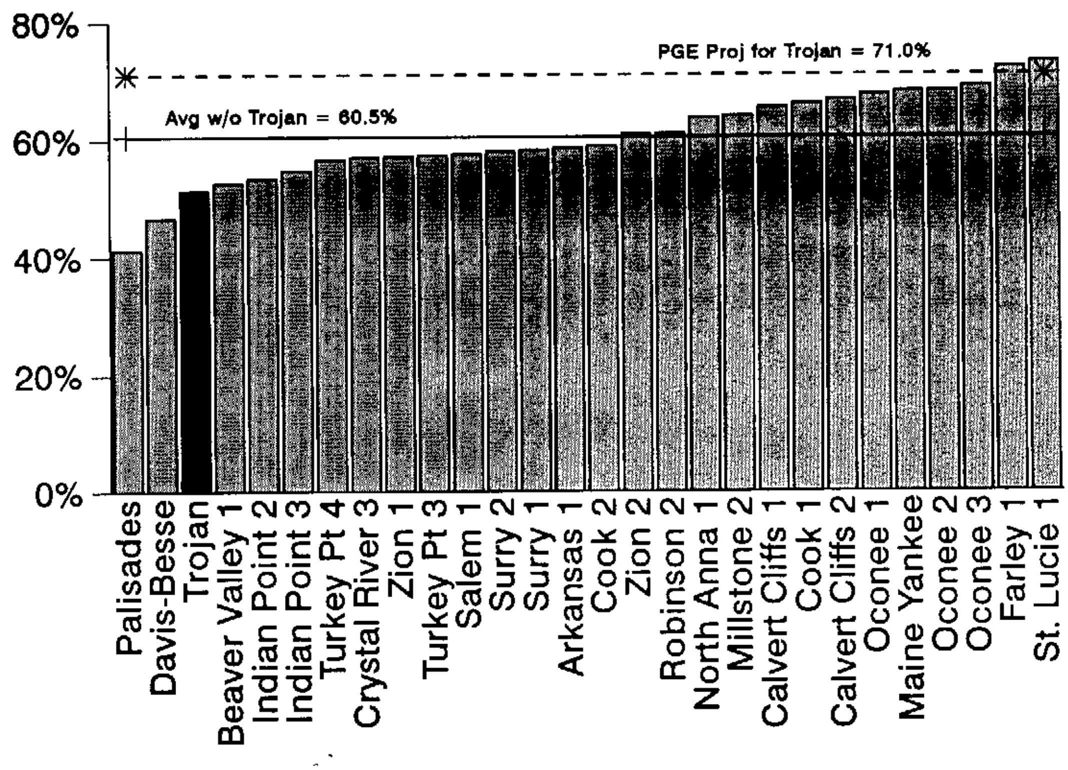


Figure 2 reveals that only two of the 27 comparable PWRs have achieved lifetime capacity factors at or above the 71 percent figure which PGE projects as "most likely" for Trojan's future performance. Moreover, the average lifetime capacity factor of this comparison group was only 60.5 percent while the median lifetime capacity factor was 59 percent. Interestingly, Figure 2 also reveals that (a) Trojan's lifetime operating performance has been significantly below the industry average and (b) only two PWRs had lower lifetime capacity factors than Trojan.

Figure 3 makes the same comparison of lifetime capacity factors as Figure 2 except that the comparison group is limited to those similar vintage PWRs which, like Trojan, have Nuclear Steam Supply Systems designed by Westinghouse. These are actually the plants with the designs most similar to that of Trojan.

FIGURE 3
LIFETIME CAPACITY FACTORS
THROUGH MARCH 31, 1992
TROJAN AND
COMPARABLE WESTINGHOUSE PWRS

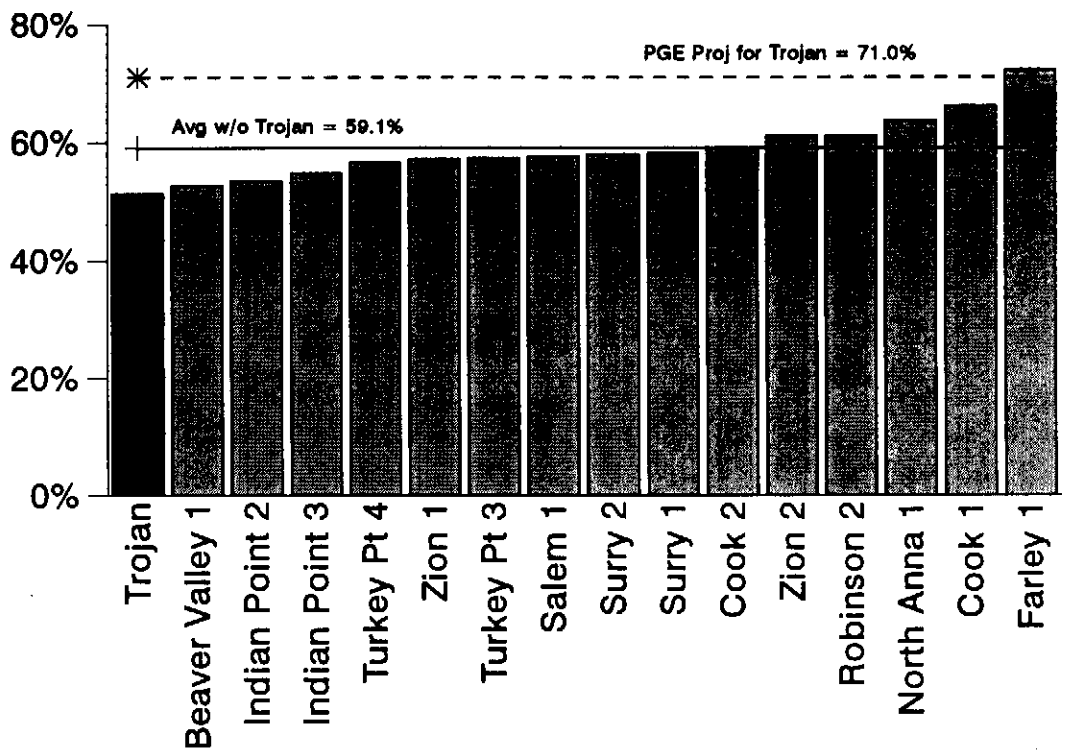
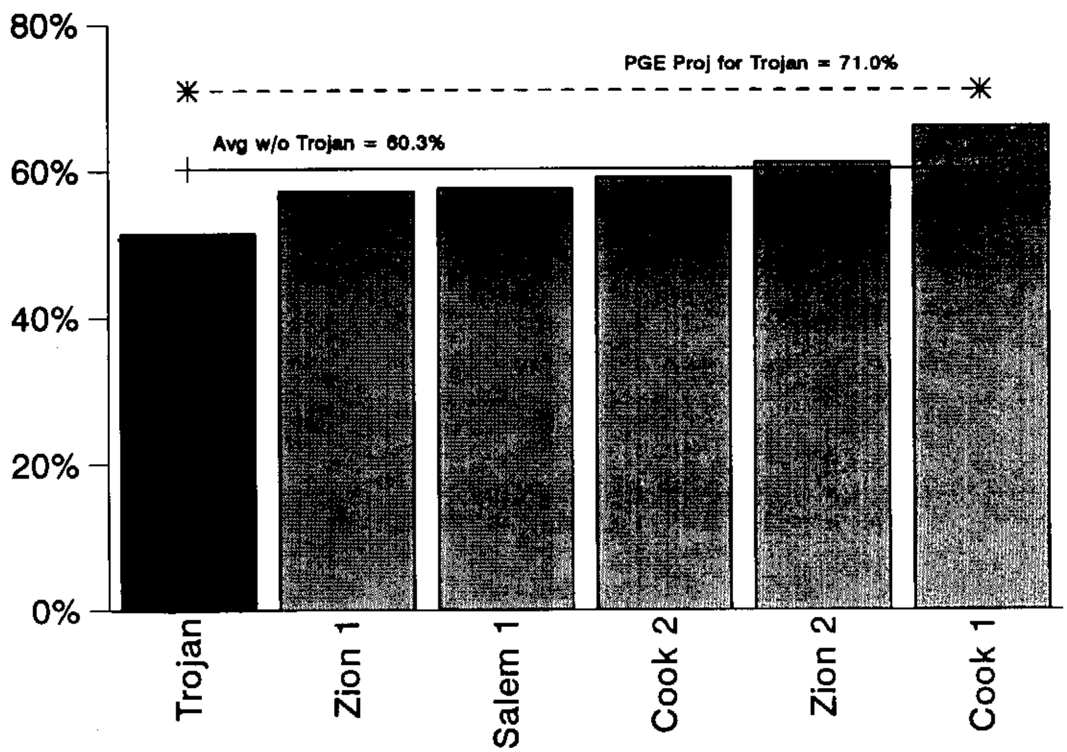


Figure 3 reveals that only a single Westinghouse designed PWR, Farley Unit 1, has achieved a lifetime capacity factor through the end of March 1992 which was at or above the 71 percent capacity factor which PGE predicts as "most likely" for Trojan's future performance. In fact, the comparison group of 15 Westinghouse PWRs have achieved an average lifetime capacity factor of only 59 percent, with a median lifetime capacity factor of only 58 percent.

Both of these comparison groups include medium (i.e., over 693 megawatt) and large (i.e., over 1,000 megawatt) sized nuclear power plants. Figure 4 below, however, limits the comparison group to the five large PWRs which are of the same vintage as Trojan. This comparison reveals that none of the large PWRs which began commercial operations prior to March 1979 has achieved a lifetime capacity factor of 71 percent or higher. In fact, the average lifetime capacity factor achieved by this group through the end of March 1992 was only 60 percent and the median capacity factor was only 59 percent.

FIGURE 4
LIFETIME CAPACITY FACTORS
THROUGH MARCH 31, 1992
TROJAN AND
COMPARABLE LARGE PWRS



The lifetime capacity factor data shown on Figures 2, 3, and 4 are important in that they represent the units' sustained performance over significant periods of time. They offer insights into long-term performance rather than focusing on shorter-term trends. However, I have also analyzed the recent operating performance of comparable PWRs to determine whether that recent performance might justify PGE's use of a 71 percent "most likely" future capacity factor for Trojan. The results of these analyses are shown on Figures 5, 6, and 7 below.

FIGURE 5
CAPACITY FACTORS
1983 THROUGH 1991
TROJAN AND
ALL COMPARABLE PWRS

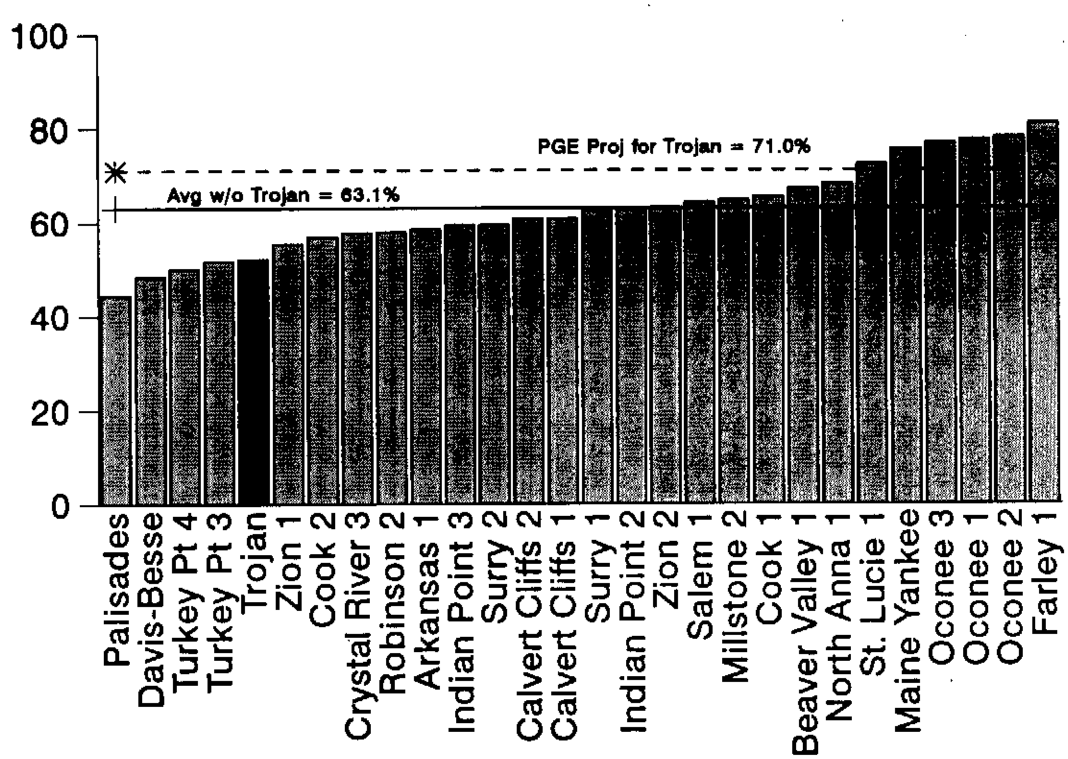


Figure 5 shows that only 6 of the 27 units in the PWR comparison group, or less than 1/4 of the comparison group, achieved capacity factors of 71 percent or higher over the nine year period 1983 through 1991. In fact, as many of the comparable plants achieved capacity factors of 55 percent or lower during this recent 9 year period as achieved capacity factors of 71 percent or higher.

Figure 5 also shows that the entire 27 plant comparison group achieved only an average 63.1 percent capacity factor over this nine year period, with a median capacity factor of only 62.4 percent.

Figure 6 below examines the capacity factors achieved during the years 1983 through 1991 by the 15 medium and large PWRs of the same vintage as Trojan which have Westinghouse-designed Nuclear Steam Supply Systems.

FIGURE 6
CAPACITY FACTORS
1983 THROUGH 1991
TROJAN AND
COMPARABLE WESTINGHOUSE PWRS

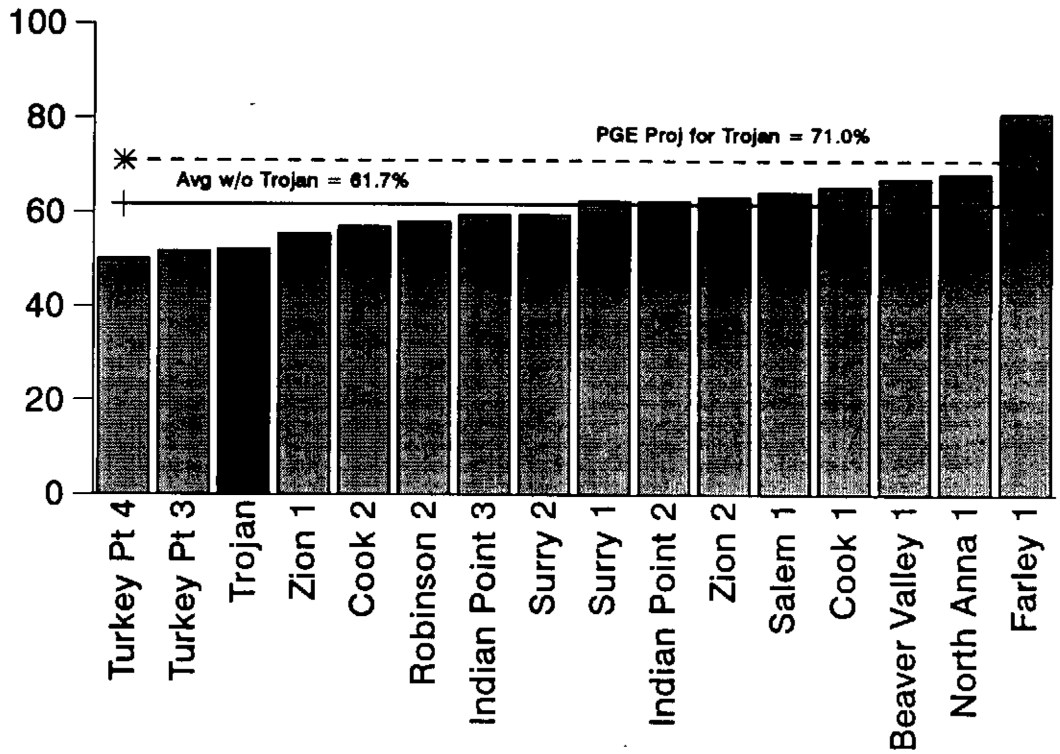
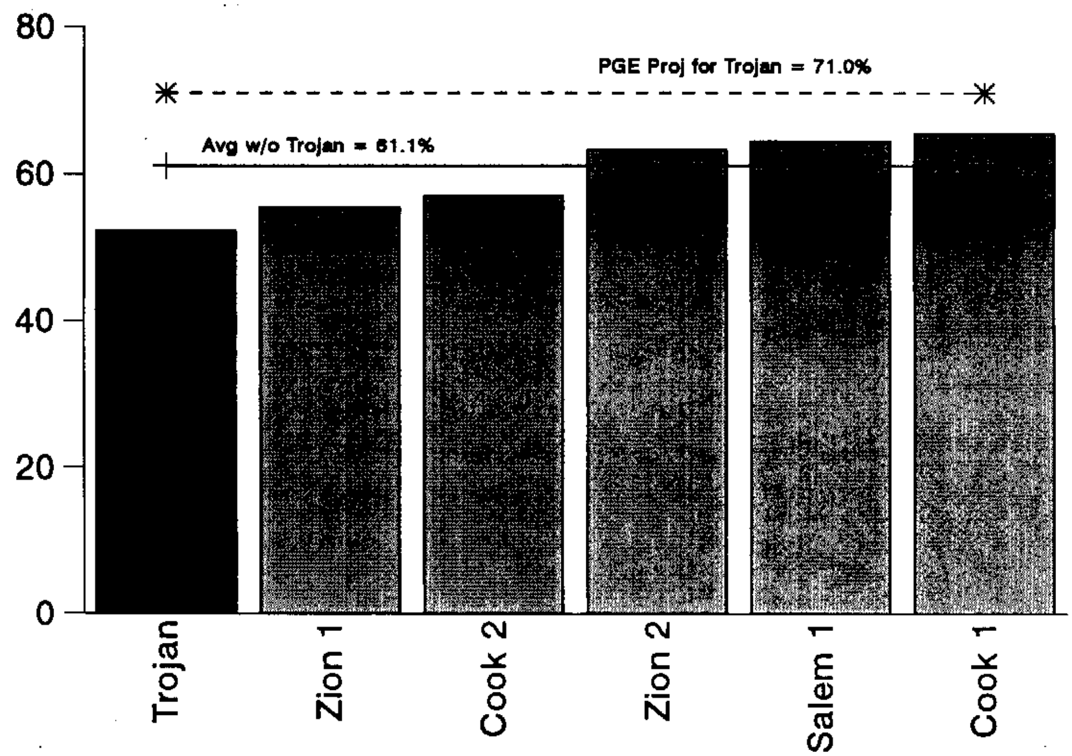


Figure 6 shows that only one of the fifteen plants in the Westinghouse PWR comparison group achieved a capacity factor at or above 71 percent over the nine year period 1983 through 1991. Figure 6 also shows that the Westinghouse PWR comparison group achieved only an average 61.7 percent capacity factor over this nine year period, with a median capacity factor of 62.4 percent. Figure 7, below, reveals that none of the large PWRs of the same vintage as Trojan achieved a capacity factor of 71 percent or higher over the nine year period 1983 through 1991.

FIGURE 7
CAPACITY FACTORS
1983 THROUGH 1991
TROJAN AND
COMPARABLE LARGE PWRS



I have also analyzed the operating performance of these PWR comparison groups over the recent six year period, 1986 through 1991. The results of these analyses are essentially the same as the results of the nine year analyses shown on Figures 5, 6, and 7 above.

Although PGE has no study, analyses or reports which have evaluated the extent to which steam generator tube degradation has affected Trojan's capacity factor, the

Company has stated that if Trojan had not required extended steam generator inspection and repair efforts, its 1989, 1990, and 1991 outages would have been completed on schedule and its capacity factor would have been "at or above the industry average." However, those PWRs which are comparable in design and vintage to Trojan achieved, on average, only a 62.8 percent capacity factor during the three years 1989 through 1991 This is far below the 71 percent "most likely" capacity factor which PGE projects Trojan will start to achieve in 1993.

Consequently, neither the lifetime or the recent capacity factors of the PWRs comparable in design and vintage to Trojan support the use of a 71 percent capacity factor for Trojan in the Least Cost Plan.

C. Steam Generator Issues

PGE projects that Trojan will achieve 71 annual capacity factors both in the years 1993 through 1995, i.e., before the steam generator replacement, and in 1997 and later years after the steam generator replacement. The following evidence argues against the reasonableness of those projections.

1. Prior to 1996 Steam Generator Replacement

The actual duration of Trojan's 1989 refueling outage was 53 days longer than the planned duration. The actual duration of Trojan's 1990 refueling outage was 38 days longer than the planned duration. Similarly, the actual duration of the Unit's 1991 refueling outage was 240 days longer than the outage's planned duration.

The Company has stated that these outages were extended beyond their planned durations by the need to perform expanded steam generator inspections and repairs. The correspondence between PGE and the NRC and the general history of steam generator problems at Trojan and other PWRs suggests that future Trojan outages in 1993, 1994, and 1995, i.e., the outages prior to the planned replacement of the steam generators in 1996, could also be extended by the discovery of further tube cracking, or by the discovery of additional and currently unanticipated corrosion or degradation. Moreover, as noted earlier, the discovery of such further deterioration in the condition of the steam generators could accelerate the date of the steam generator replacements. Either of these developments would lower the capacity factors achieved by Trojan during 1993, 1994, or 1995. Consequently, the Company's projection of 71 percent capacity factors for Trojan in each of these years is overly optimistic in that it does not allow for the discovery of any further steam generator deterioration.

2. After the 1996 Steam Generator Replacement

Table 2 below presents the capacity factors achieved before and after steam generator replacements by the 8 medium and large PWRs which have replaced their steam generators.

TABLE 2
PWR CAPACITY FACTORS
BEFORE AND AFTER
STEAM GENERATOR REPLACEMENTS

Unit	Capacity Factor Before Replacement	Capacity Factor After Replacement
Surry 1	55.3	64.0
Surry 2	61.6	64.3
Turkey Point 3	63.1	57.2
Turkey Point 4	65.8	50.8
Robinson 2	62.4	67.6
D.C. Cook 2	59.8	71.0
Indian Point 3	50.9	79.5
Palisades	40.2	76.9

This Table shows that the only 3 plants which have achieved capacity factors of 71 percent or higher after steam generator replacements are Indian Point 3, Cook 2 and Palisades. Significantly, these are the three units which have most recently replaced their steam generators. In fact, as of the end of March 1992, the Palisades plant had been operating for only a single year following the end of its steam generator replacement outage. For this reason, the 76.9 percent capacity factor achieved by Palisades during this single year does not provide any significant evidence as to how that plant, or Trojan, will perform over a longer period of time.

Similarly, as of March 1992, the Indian Point 3 and the Cook 2 plants had only been operating with replacement steam generators for approximately three years. For this reason, the 79.5 percent and 71 percent capacity factors achieved by these units over this relatively short period of time also provide little insight into how well those units, or Trojan, will operate over a longer period of years.

In fact, the operating performance of the other five medium or large PWRs which have replaced steam generators demonstrates that each unit achieved higher capacity factors during their first three years of operations with the replacement steam generators than they did in subsequent years. This evidence is presented in Table 2 below:

TABLE 3
PWR CAPACITY FACTORS
FIRST THREE YEARS AFTER
STEAM GENERATOR REPLACEMENTS
COMPARED TO SUBSEQUENT YEARS

Unit	Capacity Factor First Three Years After Replacement	Capacity Factors Years Four and Later After Replacement
Surry 1	65.8	63.3
Surry 2	76.0	60.2
Turkey Point 3	78.1	48.2
Turkey Point 4	61.3	45.4
Robinson 2	79.9	58.8

The operating performance of each of these PWRs was higher during its first three years of operations with the replacement steam generators than in the following years. Furthermore, in each instance, except Surry 1, the capacity factor <u>declined significantly</u> after the Unit had been operating for three years with the replacement steam generators. For example, Turkey Point 3 achieved a 78.1 percent capacity factor during the first three years of operation following its steam generator replacement outage.

However, the Unit's capacity factor declined to 48.2 percent during the subsequent seven years of operations through March 31, 1992.

The point of this analysis is not to argue that the replacement steam generators are themselves defective. Indeed, there is no evidence that the replacement steam generators have caused any significant problems at Surry, Turkey Point or Robinson. What has been happening at these plants is that other factors, such as managerial or technical problems, or the impact of the aging of plant systems, structures and components, have offset and eventually overwhelmed any improvement in performance gained from the steam generator replacements. The net result has been a decrease in plant performance over the longer term. In fact, as shown on Table 2 above, the overall capacity factors achieved by Turkey Point Units 3 and 4 in all years after the installation of replacement steam generators have been 5.9 percent and 15 percent lower than the capacity factors achieved by the units prior to the replacements. The capacity factors achieved by the Surry and Robinson PWRs have only been between 2.7 and 8.7 percent higher after the replacement of their steam generators.

Thus, the installation of replacement steam generators can be expected to offset further declines in a nuclear power plant's operating performance but cannot, by itself, be expected to improve Trojan's capacity factor to 71 percent over the long term.

D. The Potential Impact of the Aging of Plant Systems, Structures and Components on Operating Performance

Trojan has been in commercial service for approximately 16 years. As discussed earlier, the Unit has achieved a 51.6 lifetime capacity factor over that period. PGE's projection that the Unit's operating performance will increase dramatically over the remaining years of its service life is counter-intuitive in that most equipment becomes less reliable as it ages.

In fact, it is widely accepted that aging will be a serious problem for the equipment, components, and structures of nuclear power plants. For example, NUREG-1144, Rev. 2, issued by the U.S. NRC in June 1991, reported on the NRC's "Nuclear Plant Aging Research Program Plan." In explaining the need for such a Research Program Plan, NUREG-1144 noted 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 aging process, and the limited experience with prolonged operation of these power plants. (page 1.5)

NUREG-1144, Rev. 2, also reported 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.

But even if a serious accident does not occur, 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 PWR, in a 1982 proceeding before the New York State Public Service Commission noted that:

> As this plant [i.e., Ginna] gets 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.

Unfortunately, the oldest medium or large size PWR has been operating for just over 21 years. Thus, there is no evidence concerning what will happen to the reliability and availability of these large nuclear power plants over the second halves of their projected service lives. However, a study by the Electric Power Research Institute reveals that the equivalent availability of fossil plants deteriorates at an accelerating rate with age. This study found that equivalent availability factors for fossil plants improved initially with age, but then declined to 5 to 15 percentage points below design levels by age 28.

By the end of March 1992, Trojan had operated for 15 full years and ten months of its 16th year. In order to evaluate the reasonableness of the Company's assumption that Trojan's performance will improve as it ages, I have analyzed the capacity factors achieved by PWRs comparable to Trojan after they reached 15 years of age. The results of these analyses are shown on Figures 8 and 9 below.

FIGURE 8
CAPACITY FACTORS
AFTER AGE 15
ALL COMPARABLE PWRS

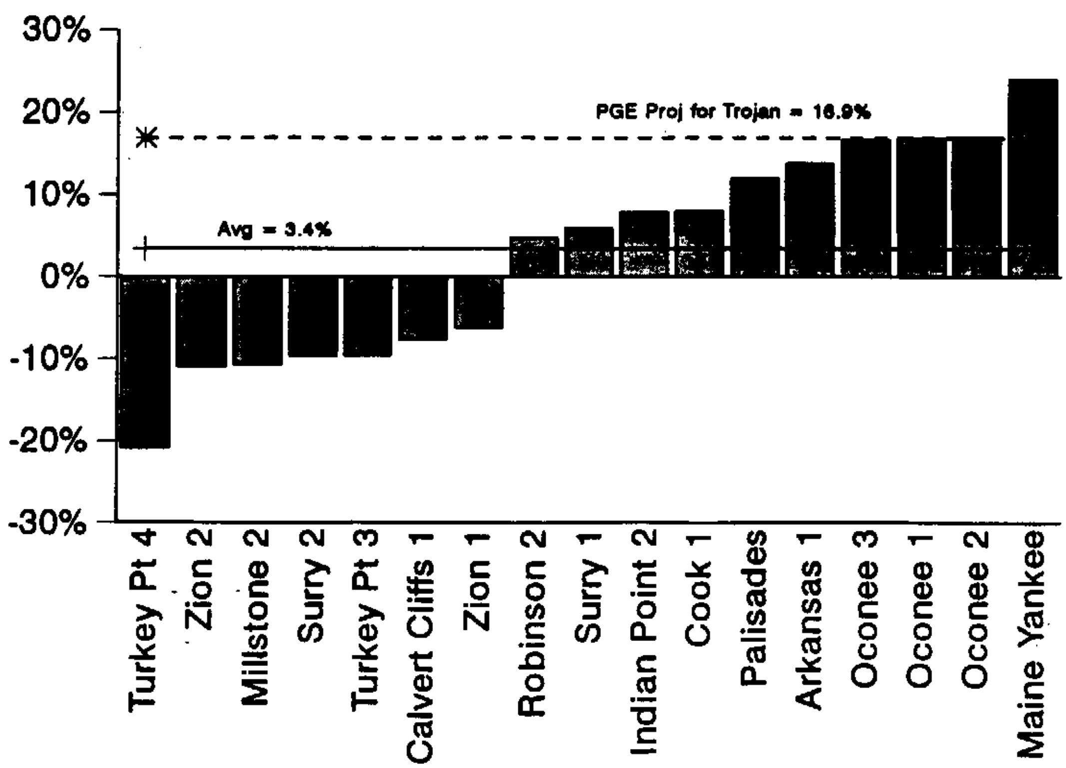


Figure 8 shows that the capacity factors of seven of the 17 units in the overall PWR comparison group which have operated for longer than 15 years decreased after the plant reached 15 years of age. Although the capacity factors of 10 of the comparison plants increased after they had operated for 15 years, only four of these 10 plants, or less than 1/4 of the total group of 17 units, had their capacity factors improve by the 16.9 percentage points by which PGE projects Trojan's capacity factor will improve.[2] Significantly, all four of these plants, Maine Yankee and the three Oconee Units, also had the highest capacity factors of the comparison group during their first 15 years of commercial operations. In addition, as shown on Figure 9 below, none of these four units are Westinghouse-designed plants.

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2 This 16.9 percentage point figure represents the difference between the cumulative 54.1 percent capacity factor achieved during the first fifteen years of Trojan's operations and the 71 percent "most likely" capacity factor which PGE projects for Trojan's future performance.

FIGURE 9
CAPACITY FACTORS
AFTER AGE 15
COMPARABLE WESTINGHOUSE PWRS

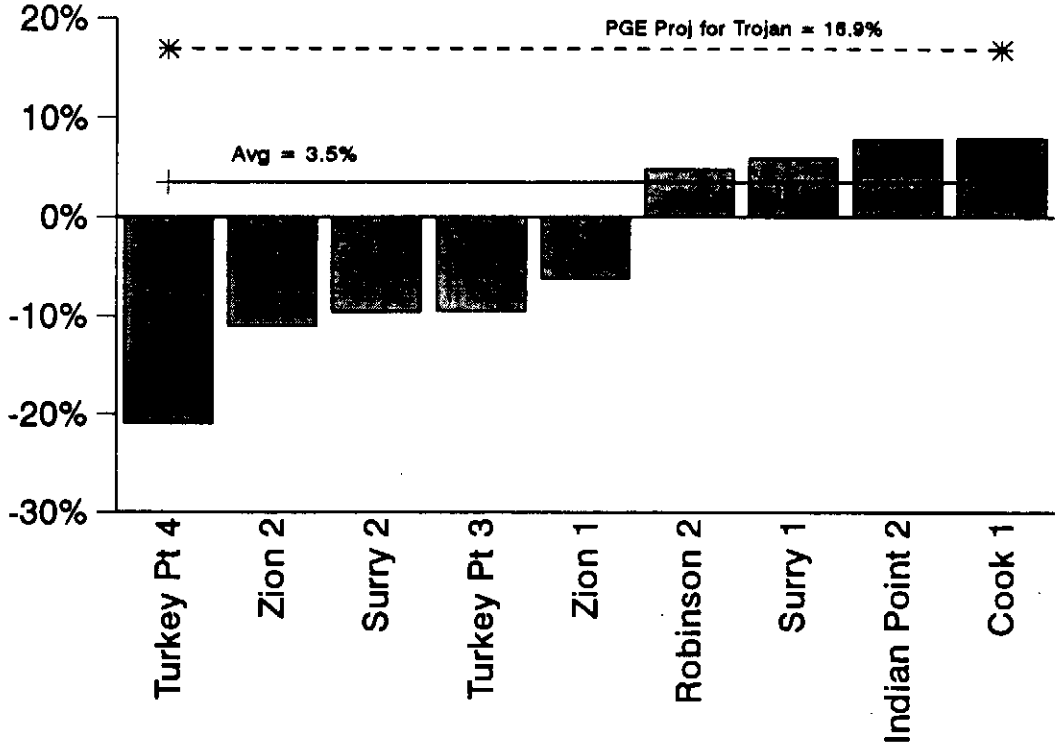


Figure 9 presents the same data as Figure 8 except that the comparison group is limited to those similar vintage PWRs which, like Trojan, have Nuclear Steam Supply Systems designed by Westinghouse. This Figure shows that the capacity factors of four of the nine comparison Westinghouse PWRs which have operated for longer than 15 years have decreased since the units reached 15 years of age. In addition, none of the comparison Westinghouse PWRs have had their capacity factors improve after age 15 by the 16.9 percentage point improvement which PGE projects for Trojan in the future.

Finally, the oldest medium or large PWR has only been operating for approximately twenty one years. Consequently, there is no evidence to support the Company's claim that Trojan will maintain a 71 percent "most likely" capacity factor through its later operating years. In fact, as I have described, it would be more reasonable to assume that the capacity will deteriorate as Trojan ages.

E. Conclusion

In conclusion, none of the above evidence supports the Company's projection that the operating performance of the Trojan Nuclear Plant will, in future years, improve to a 71 percent "most likely" capacity factor. Instead, the Unit can, at best, be expected to improve its performance by several percentage points as a result of the improvement programs adopted by management starting in late 1989 and by the planned replacement of its steam generators in 1996. For this reason, the Company's Least Cost Plan should instead assume that future Trojan annual capacity factors will fall within the range of 47 to 67 percent, with 57 percent being the "base case" or "most likely" figure. This 57 percent "base case" capacity factor would allow for a moderate improvement in Trojan's operating performance while the 67 and 47 percent figures would reflect the Unit's performance under optimistic and moderately pessimistic scenarios.

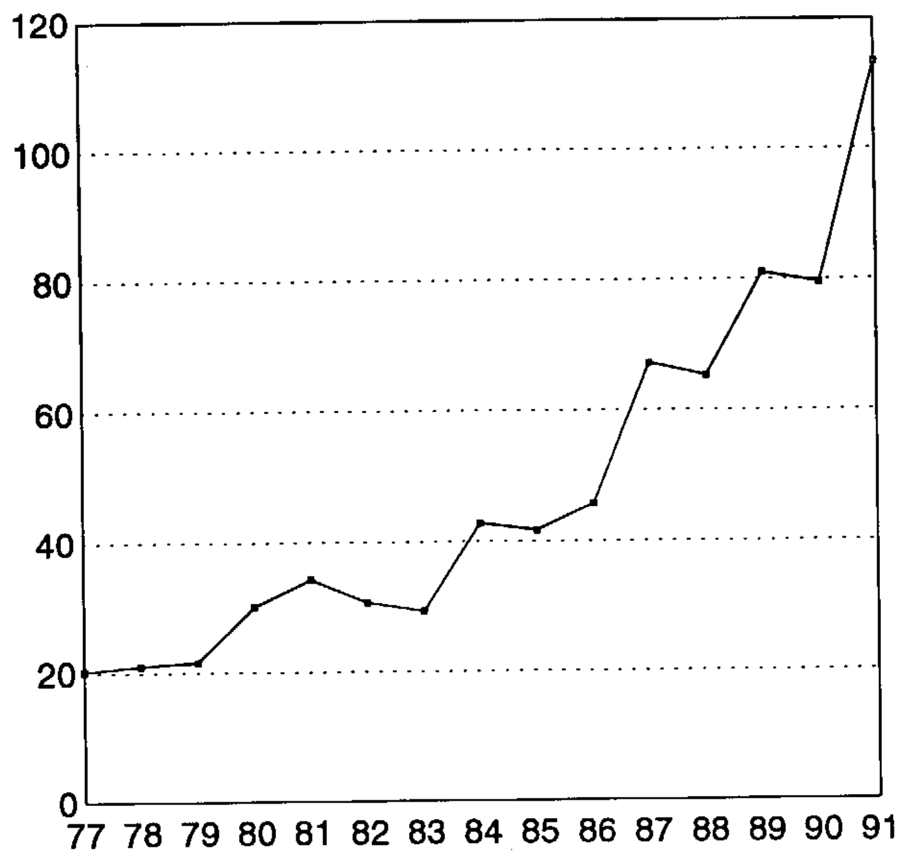
These projected capacity factors are close to those proposed for the San Onofre 1 plant by the staff of the California Public Utilities Commission's Division of Ratepayer Advocates in a proceeding investigating the cost-effectiveness of the unit's continued operation. In that proceeding, Southern California Edison had projected that the San Onofre 1 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. The CPUC's Division of Ratepayer Advocates (DRA) recommended that the unit's historical 56.4 percent capacity factor be used instead of the Company's "unreasonably optimistic" capacity factors:

> Based on all of the above information, DRA concludes that SCE's use of 60%, 70% and 80% capacity factors is unreasonably optimistic and overstates the likely benefits of operating SONGS 1. DRA recommends that .... a [capacity factor] of 56.4% be used to evaluate SONGS 1, and that a [capacity factor] of 44% also be considered to take into account the potential for additional prolonged outages that may occur due to increasing NRC requirements or SONGS 1 specific problems related to its unique conditions. DRA suggests that no weight be given 80% [capacity factor] scenarios, and that the 70% scenarios only be considered as an optimistic, upper bound. (page 10, September 25, 1991 Report in Investigation 89-07-004)

V. O&M AND CAPITAL ADDITIONS EXPENDITURES

PGE's annual expenditures for operating and maintaining (O&M) Trojan were approximately $13.6 million in 1977, the plant's first full year of commercial operation. However, these expenditures have increased since 1977, reaching $155.1 million in 1991. Figure 10 below shows the inflation adjusted growth in the Company's non-fuel O&M expenses related to Trojan. These expenditures have increased over 5.5 fold, in real terms, between 1977 and 1991. This corresponds to an average annual growth rate of 13.1 percent above the general rate of inflation.

FIGURE 10
ACTUAL TROJAN
O&M EXPENDITURES
(in millions of 1982 dollars)



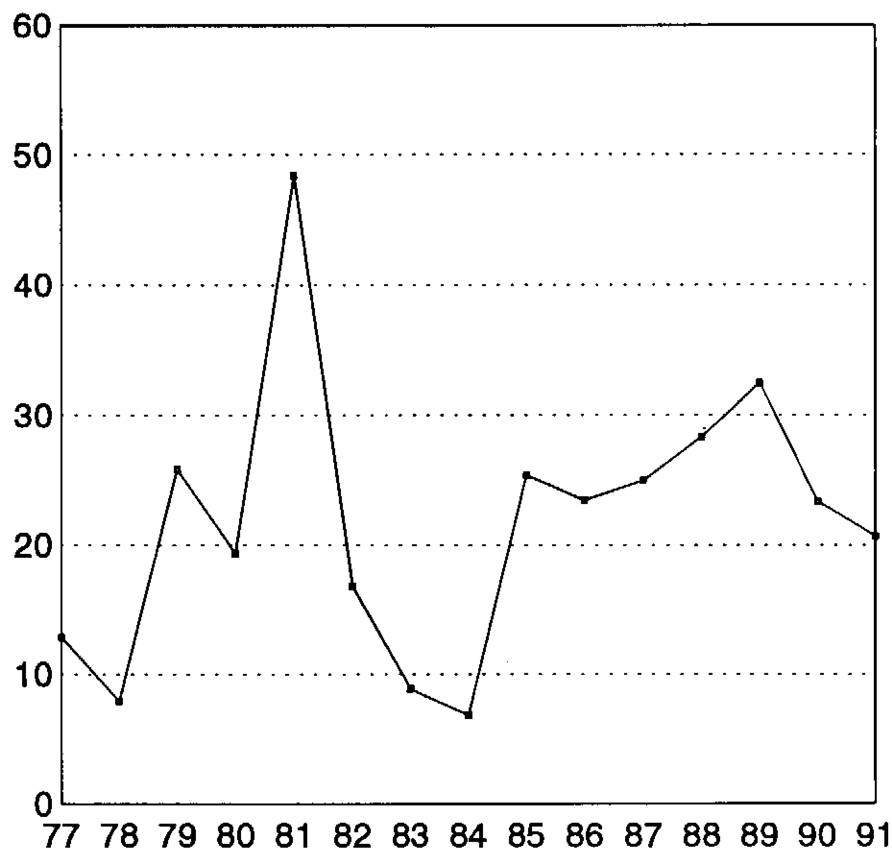
However, despite this history of real growth in O&M expenditures, PGE projects in its Least Cost Plan that O&M expenditures will decrease by approximately 10 percent, in real terms, over the period 1991 through 1998 and then increase slightly, in real terms, thereafter. The Company's projections of real decreases in future Trojan O&M expenditures over the years 1991 through 1998 are thus in dramatic contrast to the 13.1 percent average annual real growth experienced in these expenditures since 1977. The Company's projections of real decreases in future Trojan O&M expenditures are also in stark contrast to the real growth in O&M expenditures of 20 percent per year experienced by the Company between 1986 and 1991.

As noted in Section IV above, PGE is projecting that starting in 1993 Trojan's annual capacity factors will increase to 71 percent from the cumulative 51.6 percent figure the plant has achieved over its first sixteen years of commercial operations. Remarkably, this means that the Company is projecting that Trojan's performance will improve dramatically at the same time that Trojan-related O&M expenditures will be substantially reduced. As I will explain in the remainder of this Section, this is an unreasonable assumption.

PGE's annual capital additions expenditures for Trojan have increased from $8.7 million in 1977 to $41.0 million in 1989, $30.7 million in 1990, and $28.3 million in 1991. Figure 11 below shows the inflation adjusted growth in the

Company's capital additions expenditures at Trojan between 1977 and 1991. These expenditures increased over sixty percent, in real terms, over that period. This corresponds to an average annual growth rate of 3.4 percent above the general rate of inflation. The real growth rate was even higher over more recent period 1984 through 1991, when capital additions expenditures grew by approximately seventeen percent per year above the rate of inflation.

FIGURE 11
ACTUAL TROJAN
CAPITAL ADDITIONS EXPENDITURES
(in millions of 1982 dollars)



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.

In fact, 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. (Quoted in 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)

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 Trojan rather than the decreases the Company would project. However, this slackening should mean that future rates of growth in these expenditures will be below the double digit real growth experienced in O&M expenditures between 1977 and 1991.

Studies by the U.S. Department of Energy and by various nuclear industry organizations have revealed that expanded and enhanced NRC regulation has been a major factor driving increased O&M and capital additions expenditures. A review of the current regulatory environment reveals that there is no reason to expect that the current level of regulatory activity will diminish in the future. In fact, representatives of nuclear utilities have recently 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.

Moreover, as noted in an October 1991 paper by Dr. James G, Hewlett, it is reasonable to expect that 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.

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 Trojan. 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 requirement that all plants, including Trojan perform individual plant severe accident analyses to identify all important accident risks.

* The NRC's concern over the need to root out fraudulent and substandard parts.

The issues and initiatives will result in increased O&M and capital additions expenditures at operating nuclear power plants like Trojan. However, 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 recent article in Nucleonics Week has quoted a representative of Yankee Atomic Power Company as saying 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 article in the March 1991 issue of Power Engineering, reported that an INPO representative had 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.

The same article also quoted James Taylor, the NRC's Executive Director of Operations, as telling the 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."

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. As reported in the February 6, 1992 issue of Nucleonics Week:

> ... Selin explained that, while a utility experiencing financial difficulties should not have its operating licenses immediately revoked and its power plants shut down, he is concerned about "the long term implications that inadequate cash flows can have."
>
> 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."

Similarly, at an NRC session held on February 5, 1992, Dr. Thomas Murley, Director of the NRC's Office of Nuclear

Reactor Regulation, was asked what characteristics of those plants which are generally seen as good performers "are clearly different from those that you see in the problem plants?" Dr. Murley's answer was that:

> ... I think a characteristic of the plants that have high performance are management attention from the very top, starting from the board of directors and the CEO and the president of the company. They set the tone for the safety -- what I've come to call the "safety culture at the plant. **And that tone is don't cut corners. Do it right the first time. Put the resources in to operate the plant well**, have depth of high talent management throughout the plant, and those sorts of things. That's my experience of a common thread for the well-run plants. (Emphasis added)

PGE froze Nuclear Department employee levels in late 1989. In addition, the Company has stated its intention to reduce the number of outside contractors employed on Trojan-related activities in order to decrease O&M expenditures, in real terms, over the years 1993 through 1998.

Northeast Utilities, which operates the Haddam Neck and the three Millstone nuclear units offers an example of a utility which has recently gotten into serious trouble with the NRC as a result of trying to reduce expenditures by reducing personnel and contractor resources.

Through the late 1980's the Millstone nuclear power plants operated by Northeast Utilities were all good performers, achieving, for example, a cumulative 78 percent capacity factor over the three year period 1988-1990. The utility also received very high ratings from the NRC.

Then in 1988 and 1989, Northeast Utilities adopted a program to minimize operating costs. By 1990, the staffing levels at NU's four plants had been reduced by approximately 10 percent and the outside contractor population had been significantly decreased.

Starting in 1990, the NRC issued approximately $500,000 in fines against Millstone. In addition, Millstone experienced numerous unit outages attributable to such avoidable problems as the failure of unit 1 operators to pass their requalification exams, secondary-side pipe breaks in units 2 and 3 attributable to erosion-corrosion, and the fouling of circulating water intake structures. The utility also was hit with hundreds of safety allegations made by Millstone employees and with charges that management had harassed some whistleblowers.

The capacity factors of the three Millstone Units declined dramatically to a 30.4 percent capacity factor for Unit 1 in 1991, a 51. 8 percent capacity factor for Unit 2, and a 28.1 percent capacity factor for Unit 3. In fact, the combined capacity factor of the three units fell to 36.8 percent in 1991, or more than 41 percentage points lower than the 78 percent combined capacity the three units achieved in the three previous years.

In response to these declines in performance, Northeast Utilities adopted a $50 million, five-year program to fix the problems that had plagued Millstone. This program included the addition of approximately 200 personnel to the Company's nuclear organization. Then in June 1992, the utility announced that it was again increasing the annual O&M budgets for the Millstone and Haddam Neck plants by up to 12 percent and that it would add another 250 new positions to its nuclear organization during the next two years to support operations at all of its nuclear plants. As explained in the June 11, 1992 issue of Nucleonics Week:

> In addition, NU said, annual budgets - which were increased last October by $10 million - will rise by as much as another $20 million annually during the next few years, representing an 6% - 12% increase in nuclear expenditures. NU's announcement of new hires and outlays is part of the utility's so-called "performance enhancement program." (PEP) NU initiated the PEP as part of its company-wide effort to reverse Millstone's declining performance and to address NRC's growing concerns about NU's ability to run Millstone while, at the same time, acquiring Seabrook. NU has concluded that cost management problems caused Millstone's performance slide.

Consequently, what had been adopted as a program to reduce personnel costs and contractor expenditures ended up as a planned increase of 450 personnel to reverse the declining performance of the utility's nuclear plants.

The NRC has also cited numerous other utilities for failing to provide the resources needed to adequately operate and maintain nuclear units. Examples of other utilities cited by the NRC include Boston Edison (Pilgrim Nuclear Station) and the New York Power Authority (the Fitzpatrick nuclear plant)

In fact, the NRC cited PGE in late 1988 for failing to provide sufficient resources to address and resolve problems at Trojan. For example, the December 1988 Report of the NRC's Maintenance Team Inspection at Trojan concluded that:

> The maintenance process for Trojan has been improved and reflects continuing organizational and program improvements; it currently appears adequate, but could be further strengthened. The program reflects a recent dedication of resources to address long-standing, industry recognized issues; **however, progress to date generally reflects an allocation of insufficient resources in the past....."** (Emphasis added)

Similarly, the major concerns highlighted during the Maintenance Team Inspection included the findings that management had failed to provide sufficient resources to address unexpected issues concurrently with planned work and that there was:

> insufficient depth of engineering and plant resources to address safety and regulatory issues in a timely manner. Delays were noted relative to both self-identified program weaknesses and industry and NRC identified generic safety concerns.

The ratings given by the NRC to Trojan consistently declined over the period 1985 through 1989. Starting in late 1989 PGE adopted a substantial number of Trojan-related improvement programs to improve its NRC ratings.

For example, the Company has implemented a Nuclear Division Improvement Plan which included improvements in the Corrective Action Program, the initiation of a Maintenance Improvement Plan, and the establishment of an Engineering

Excellence Program. Other programs implemented by PGE in recent years have included:

* A Fire Protection Improvement Program

* A Preventive Maintenance Improvement Program

* A Procedure Improvement Program

* A Service Water Surveillance Program

* A Maintenance Training Program

Although the correspondence between the Company and the NRC indicates that progress has been made in the implementation of many of these programs, that same correspondence also highlights the fact that additional work remains to be done. For example, during the two most recent NRC SALP evaluations, Trojan has received Category 3 ratings, the lowest possible ratings, in the functional area of Maintenance/Surveillance. The same evaluations have also noted problems in the Engineering/Technical Support functional area and stressed that a common theme in all of the functional areas evaluated was the need to strengthen Trojan's root cause analysis program. In fact, the NRC was concerned that events at Trojan "recurred prior to being fully resolved."

Similarly, the NRC's 1991 Inspection of Trojan's Fire Protection Program concluded that:

> Fire protection has been a topic of concern at Trojan for several years. Trojan fire protection was found to be deficient during the initial Appendix R team inspection in August 1983, and deficiencies were again noted during a followup team inspection in October 1988. The additional deficiencies noted during this most recent team inspection appear to confirm a pattern of inadequate Trojan management attention to the fire protection area, as well as an apparent lack of resolve to correct the root cause of these recurring deficiencies.

Substantial expenditures will have to be made in future years to address and resolve these concerns and to ensure that the progress made by the Trojan improvement programs is not lost. In addition, future O&M and capital additions expenditures will be required at Trojan in response to issues currently outstanding before the NRC and INPO and in response to new issues that will be identified as a result of operational experience or research activities. For these reasons, it is simply not reasonable to expect that O&M expenditures will decrease by 10 percent, in real terms, over the years 1991 through 1998 and that capital additions expenditures will experience no real growth over the same period.

Moreover, additional work will be required, as Trojan ages, to repair or replace degraded systems, structures and components. This additional work will require increased O&M and capital additions expenditures. For example, an official at Carolina Power & Light Company acknowledged in 1991 that the utility's older nuclear plants, Brunswick and Robinson, had cost more to run "because of their ages." This same

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Similarly, a January 1988 study of the material condition of 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. (Volume I, page 3-1 of the "Oyster Creek Nuclear Generating Station Material Condition Study Phase II," dated January 1988)

For these reasons, I have concluded that the Company's Least Cost Plan should assume that future Trojan O&M expenditures will start at the Company's $140 million upper bound figure for 1993 and increase, on average, at annual rates of two to four percent above the rate of inflation for the remainder of Trojan's service life. The Least Cost Plan should also assume that future Trojan capital additions expenditures will start at the Company's $21 million figure for 1993 and increase, on average, at annual rates of two to four percent above the rate of inflation for the remainder of

Trojan's service life.