MASS EFSC 83-24 #29

COMMONWEALTH OF MASSACHUSETTS
ENERGY FACILITIES SITING COUNCIL

RE: THE NEW ENGLAND ELECTRIC COMPANIES 1983 SUPPLEMENT TO THE SECOND LONG RANGE FORECAST OF ELECTRIC RESOURCES AND REQUIREMENTS

E.F.S.C. NO. 83-24

TESTIMONY OF PAUL CHERNICK ON BEHALF OF THE ATTORNEY GENERAL OF MASSACHUSETTS

FRANCIS X. BELLOTTI
ATTORNEY GENERAL

By: Richard Kanoff
Assistant Attorney General
Utilities Division
One Ashburton Place
Boston MA 02108
(617)-727-5112

November 14, 1983

Table of Contents

TESTIMONY OF PAUL CHERNICK

ON BEHALF OF THE ATTORNEY GENERAL

1 INTRODUCTION AND QUALIFICATIONS

Q: Mr. Chernick, would you state your name, occupation and business address?

A: My name is Paul L. Chernick. I am employed as a research associate by Analysis and Inference, Inc., 10 Post Office Square, Suite 970, Boston, Massachusetts.

Q: Mr. Chernick, would you please briefly summarize your professional education and experience?

A: I received a S.B. degree from the Massachusetts Institute of Technology in June, 1974 from the Civil Engineering Department, and a S.M. degree from Massachusetts Institute of Technology in February, 1978 in Technology and Policy. I have been elected to membership in the civil engineering honorary society Chi Epsilon, and the engineering honor society Tau Beta Pi, and to associate membership in the research honorary society Sigma Xi.

I was a Utility Analyst for the Massachusetts Attorney General for over three years, and was involved in numerous aspects of utility rate design, costing, load forecasting, and evaluation of power supply options. My work involved, among other things, utility load forecasts, supply plans, and nuclear cost projections.

In my current position, I have advised a variety of clients on utility matters. My resume is attached to this testimony as Attachment A.

Q: Mr. Chernick, have you testified previously in utility proceedings?

A: Yes. I have testified approximately twenty-five times on utility issues before such agencies as the Massachusetts Department of Public Utilities, the Texas Public Utilities Commission, the Illinois Commerce Commission, the New Mexico Public Service Commission, the District of Columbia Public Service Commission, the New Hampshire Public Utilities Commission, the Connecticut Department of Public Utility Control, and the Atomic Safety and Licensing Board of the U.S. Nuclear Regulatory Commission. A detailed list of my previous testimony is contained in my resume. Subjects I have testified on include cost allocation, rate design, long range energy and demand forecasts, costs of nuclear power, conservation costs and potential effectiveness, generation system reliability, fuel efficiency standards, and ratemaking for utility conservation programs.

I have previously filed testimony in six proceedings before the EFSC, of which five dealt with load forecasting and one concerned supply planning. Various aspects of supply planning have been covered in my testimony in several other cases; my testimony in New Mexico PSC 1794 specifically involved the cost justification for a transmission line.

Q: Have you authored any publications on utility issues?

A: Yes. Those publications are listed in my resume.

Q: What is the subject of your testimony?

A: I have been asked to review the existing justification for building the proposed Seabrook-Tewksbury 345 kV transmission line, of which NEPCO's proposed Amesbury-Tewksbury line is a part, in the near future, given the current status of the Seabrook plant and other relevant factors. I will not be discussing the environmental effects of the line or alternative designs for the line.

2 THE ORIGINAL JUSTIFICATION FOR THE SEABROOK-TEWKSBURY LINE

Q: How has the Seabrook-Tewksbury line been justified in the past?

A: The justification appears to be based on six points:

1. It is assumed that both Seabrook units will be completed in the near future.

2. Connecting the Seabrook plant to the grid would require three lines, each of over 1000 MW capacity, presumably to provide a spare line. The three interconnections were to be Seabrook-Newington, Seabrook-Scobie, and Seabrook-Tewksbury.

3. The Seabrook plant would require the reinforcement of the interconnection between Northern New England and Southern New England[1] by the addition of two lines of capacity exceeding 1000 MW. These lines were to be the aforementioned Seabrook-Tewksbury line and an additional Scobie-Tewksbury interconnection.

4. The Seabrook-Tewksbury line would be built before the

----

1. This interface is essentially Massachusetts' northern border.

Seabrook-Scobie-Tewksbury lines, and thus must be ready for Seabrook 1.

5. The alternative to the Seabrook-Tewksbury line would be an additional set of lines following the Seabrook-Scobie-Tewksbury route, which would be more expensive and require more new right of way.

6. In addition, the Seabrook-Tewksbury line would increase the power available in Northeastern Massachusetts through a new substation at Boxford, which would be needed soon in any case.

Q: Are the assumptions underlying these points still valid?

A: No. Several of them have been rendered obsolete by recent events:

1. Seabrook 1 is still over two years from commercial operation, and Seabrook 2 will not be in service until well into the 1990's, at the earliest. The second unit will almost certainly be cancelled.

2. Since Seabrook will not have more than one unit for many years, and will probably never have a second unit, the rationale for the third Seabrook interconnection no longer exists.

3. By the same reasoning, the North/South interface should

not require more than a single 1000-MW reinforcement for the foreseeable scope of the Seabrook plant.

4. The Seabrook-Scobie line is already in service.

5. The alternative to the Seabrook-Tewksbury line appears to be the shorter Scobie-Tewksbury line, largely along existing right of way.

6. The Boxford substation has been deferred to at least 1992.

Q: What do you conclude from these facts?

A: The need for the Seabrook-Tewksbury line in this decade, given the changed circumstances listed above, has not been demonstrated.

3 THE SEABROOK-TEWKSBURY LINE AND SEABROOK 2

Q: Does the current status of Seabrook 2 represent a reasonable and prudent basis for commencing construction of the Seabrook-Tewksbury line?

A: No. Seabrook 2 will almost certainly be cancelled. Even if some currently unforeseen circumstance results in the eventual completion of the unit, it can not be expected to reach commercial operation before 1990.

Q: On what do you base your conclusions that Seabrook 2 will not operate in this decade, and that it is likely to be cancelled?

A: My starting point is the economic analysis of the Seabrook units which I have conducted and refined over the last four years. The most recent version of that analysis is presented in my testimony before the Connecticut Department of Public Utility Control in Docket 83-03-01, filed this June. That testimony, edited to incorporate the minor corrections presented in the hearing, accompanies the present testimony, as Attachment B.

Table 11 of Attachment B presents the results of eight methods for estimating the in-service dates of the Seabrook units. Even including several methods known to be biased on the optimistic (low) side, the average prediction for Seabrook 2 is March, 1991. The results based on Seabrook construction performance to date would predict commercial operation around 1993.

Table 26 of Attachment B presents optimistic estimates of the total levelized cost per kWh for each of the units. I find it very hard to believe that the levelized real cost of 10 cents/kWh for completing and operating Seabrook 2 can be the most cost-effective power supply option available to New England utilities. Furthermore, the price shock resulting from the commercial operation of Seabrook 1 can be expected to encourage a new round of conservation among the customers of the major owners, and to strain regulators' willingness to raise rates to finance further construction. Under those circumstances, it seems likely that the owners of Seabrook will have at least as much trouble financing the large remaining investment required for Seabrook 2 as they have had with financing the first unit.

In the light of these problems, the completion of that the second unit at Seabrook is highly doubtful, at best. Cancellation would hardly be surprising, since most of the units comparable to Seabrook 2 in terms of construction status have been cancelled, as have some units considerably more advanced than Seabrook 2.[2] But even if the unit were completed, it still would not have been reasonable to expect it to be commercial in this decade, given what was known in June.

Q: Have circumstances changed since June?

A: Yes. In the case in which the attached testimony was presented, the Connecticut Department of Public Utility Control ordered the Connecticut utilities (United Illuminating and Northeast Utilities) to "make every effort to disengage from Seabrook Unit No. 2," which contributed to the joint owners' decision to reduce construction to "the lowest feasible level" until Seabrook 1 is completed. Thus, the schedule and cost figures in my June testimony are out of date, and probably considerably optimistic.

My conclusion that cancellation is inevitable has become more widely accepted. The joint owners' resolution of September

----

2. See Table 9 of Attachment B for some examples. Since that table was compiled, Public Service of Indiana has announced that Marble Hill 2 (at 35% reported completion) will be delayed over two years, to late 1990, and that cancellation of both Marble Hill units is under consideration. Unit 1 is reported to be 55% complete. The cancellation (at least as a nuclear unit) of the 97% complete Zimmer unit also appears to be likely.

8, 1983 clearly contemplates cancellation (IR AG-8[3]) and NEES considers the probability of cancellation to exceed 50% (IR AG-11). Under these circumstances, the likelihood decreases of any extraordinary action by utilities or regulators to bail out Seabrook 2.

Q: How does the deferral or cancellation of Seabrook 2 affect the rationale for the Seabrook-Tewksbury line?

A: The determinations that the Seabrook plant would require three 1000-MW connections to the grid, and two reinforcements of the North/South interface, appear to rest on the assumption that Seabrook is a two-unit plant. At the least, both of these determinations must be re-examined in the light of changed circumstances. There is no evidence that the desirability of the Seabrook-Tewksbury line (as opposed to any other north/south interconnection) for a single-unit plant at Seabrook has ever been studied, let alone established.

Transmission planning is a complex process, dependent on the spatial and electrical characteristics of the existing and proposed facilities. However, a simple arithmetic analysis of power sources and flows would indicate that removing a

----

3. Except as noted, all responses to information requests refer to the initial sets of October 7, 1983.

1000-MW unit at Seabrook should allow for the deferral of a 1000-MW grid interconnection and of a 1000-MW connection across the North/South interface: the deferred facilities might well be the Seabrook-Tewksbury line.

Q: At this point, can any expenses or investments be justified on the basis that they are related to Seabrook 2?

A: I do not believe that the likelihood of completing Seabrook 2 is great enough to warrant any further investment on that basis.

4 THE SEABROOK-TEWKSBURY LINE WITHOUT SEABROOK 2

Q: What rationale might there be for building the Seabrook-Tewksbury line even if Seabrook 2 is never finished, or not completed for many years?

A: Some facilities may still be necessary to tie Seabrook 1 to the grid, to reinforce the North/South interconnection, and to serve load growth in northeastern Massachusetts.

Q: Is the Seabrook-Tewksbury line needed to interconnect Seabrook 1 to the grid?

A: Apparently not. Both of the other contemplated connections (Seabrook-Scobie and Seabrook-Newington) are in operation. Either of these lines can carry the full output of Seabrook 1. It would seem that two lines serving a single unit (a 100% reserve of transmission capacity) would be at least as secure as three lines serving two units (a 50% reserve). PSNH appears to agree with this assessment, as indicated in the first attachment to IR AG-9.

Q: Is the Seabrook-Tewksbury line needed to reinforce the North/South interconnection?

A: It is possible that some reinforcement is required to allow excess generation in Maine, New Hampshire, and New Brunswick to serve loads in southern New England. Particularly in the summer, low running-cost hydro, coal, and nuclear power to the north of the interface may exceed local loads by more than the capacity of existing transmission lines connecting them to southern New England. This does not appear to be a problem currently, but may be in the future, especially once Seabrook 1 becomes operational.

This concern is discussed in the responses to the second sets of information requests. It is only in the last week that NEES has presented any analyses explicitly addressing the need for interface reinforcement if only one unit is completed at Seabrook. These studies (in IR AG-2, and in the NEPLAN letter attached to IR Costello-2) indicate that under some circumstances[4] some northern generation would be "locked in", unavailable for economic dispatch to the south. But the potential need for reinforcing the interface does not necessarily translate into the need for the Seabrook-Tewksbury line.

Again, simple arithmetic analysis indicates that, if the

----

4. Optimistic assumptions regarding nuclear maintenance schedules tend to overstate this effect.

Seabrook-Tewksbury and the Scobie-Tewksbury lines, each with a 1200 MW normal rating, were sufficient reinforcement for the two-unit Seabrook case, either of them should suffice for the one-unit Seabrook case. This is borne out by the magnitude of the locked-in generation shown in IR Costello-2 (the NEPLAN letter), which is no more than 1250 MW, even when all northern generation is available. Either of the two lines would essentially eliminate the bottleneck.

Q: Has NEES presented any evidence that it is cost-effective to build any new north/south interconnection to unlock the northern generation?

A: A couple of studies related to this issue were provided in response to discovery. A study of a <u>second</u> interconnection following the in-service date of Seabrook 2[5] indicates that the line would save only $2-3 million in 1987 with a 600 MW connection to Hydro Quebec, no new northern generation past Seabrook 2, and oil at $8.41/MMBTU, or about $52/barrel. Recent high-sulfur oil prices have been about $27.25/barrel; oil prices would have to escalate at about 17.5% annually to reach even the low end of the range assumed in the study. If the results for a second new interconnection with two Seabrook units can be extrapolated to a first interconnection

----

5. "Fuel Savings Resulting from Installation of the Scobie-Tewksbury 345 kV Transmission Line (1987-1990)", NEPOOL Planning Committee, January, 1982 (IR Costello-2, Set 2).

with only one Seabrook unit, this indicates that it is rather speculative to assume that the savings will cover the $5 million annual levelized carrying costs over the first decade (even for a relatively inexpensive $19.6 million line).

A second study (the October 5, 1983, NEPLAN letter attached to IR Costello-2, Set 2) produces much higher savings estimates for the first new interconnection with Seabrook 1 and the HQ purchase: the expected savings are $16 million in 1987. It is difficult to interpret these results, for two reasons. First, no oil price forecast is provided; as demonstrated above, oil prices are crucial inputs to these analyses. Second, all of the attachments to that letter, describing the computer runs, indicate that the Scobie-Sandy Pond 345 kV line is assumed to be out of service. This is a major north/south interconnection, with a normal summer rating of 1222 MW. Obviously, a new interconnection would be more valuable if an existing connection were out of service for an entire year, but it is not clear what else this study demonstrates.

Q: If only one of the two interconnections to Tewksbury (from Seabrook or from Scobie) is to be built at this time, do you have any opinion as to which one should be constructed?

A: There is very little information available on which the two lines can be compared, but what I have seen certainly favors the Scobie line. The Scobie-Tewksbury line is shorter,[6] appears to run primarily along existing right of way,[7] and is estimated to be considerably less expensive. The current estimate for the Seabrook-Tewksbury line is $29.5 million in March, 1985 (IR AG-7, Set 2), while the previously mentioned January 1982 NEPOOL report on "Fuel Savings" estimates that the Scobie-Tewksbury line would cost $19.6 million in 1986[8]. As Table 1 demonstrates, the difference between these two costs are even larger when the estimates are expressed on a more consistent basis[9]. Overall, the data which NEES has offered in support of the Seabrook-Tewksbury line suggests that the Scobie-Tewksbury line would be the preferred alternative.

Q: Is there any indication that the Seabrook-Tewksbury line is required in the near future for delivering power to northeastern Massachusetts?

----

6. 24.7 miles versus 46.5 miles, from Section V of the NEPOOL forecast.

7. See the attachments to the letter of November 29, 1974, in IR AG-6.

8. See page C-1.

9. The December 1982 report on "A-C Transmission Reinforcements" by T.H. Patel, indicates that additional investment may be necessary to retain 230 kV lines along the same right-of-way; it is not clear how Patel's figures relate to those in the earlier NEES report.

A: No. That power would be delivered through the Boxford substation (see Exhibit S-4 in IR AG-1), which is now scheduled for 1992 in the forecast (Table 22) and is not listed at all in the NEPLAN 345 kV system diagram through 1992 (provided in response to intervenor Costello's IR-5B). Whether that substation is needed, and when, depends on local load growth and on the extent to which the Mystic and Salem stations and decentralized energy sources (such as cogeneration, small hydro and refuse-fired generation) can satisfy local loads.

Interestingly, NEES' presentation on this topic in DPU 19559, et al., (Exhibit S-4 in IR AG-1) shows no power being produced at Salem Harbor, or at the older Mystic units; the simulation presented is apparently a base-load case, indicating that any future northeastern Massachusetts supply problem may involve economic dispatch constraints, rather than reliability. Since Salem Harbor is now burning coal, over 300 MW of base-load power is available in the area which was to be served by the Boxford substation. In addition, NEPOOL load forecasts have declined dramatically since that exhibit was prepared. In 1979, for NEPOOL forecast a 1989/90 peak of 24120 MW; today, that projection is for 17640 MW, or a 76% decrease in expected growth from last winter's 15619 peak. Thus, the economic justification for new power supply to any NEPOOL sub-area, and to this area in particular, may be much less than was anticipated in previous analyses.

The schedule for the Boxford substation indicates that the Seabrook-Tewksbury line (or any other reinforcement) is not needed for northeastern Massachusetts in this decade. Again, there is no evidence that the line would ever be needed, given recent changes in circumstances, including reduced load forecasts, Salem coal conversion, and Seabrook 2's delay or cancellation. Indeed, NEES indicates (IR AG-8, Set 2) that it has no analytical support for even the 1992 in-service date.

Q: Is there currently any indication that this line will be required or economically justified in the foreseeable future?

A: NEES does not seem to be able to provide any such indication at this time. Certainly, no need for the line was demonstrated in the response to IR AG-9, or to IR AG-2 in the second set (which specifically requested any reasons for preferring the Seabrook line over a Scobie-Tewksbury line).

Q: What action would be appropriate for the Council to take at this time with respect to the Amesbury-Tewksbury line?

A: It is my understanding that the original approval of this line included the condition that the line was to be constructed on a schedule consistent with the construction of the Seabrook plant. I believe that it would be sufficient to clarify this condition to reflect events which were not contemplated at the time of the original approval. For example, the clarification might specify that, pending further determinations, the construction of the line shall not commence until Seabrook 2 is at least 50% complete and scheduled for fuel loading within two years.

Q: Does this conclude your testimony?

A: Yes.

Line #	Description	($ million)
[1]	Scobie-Tewksbury cost estimate	$19.555
[2]	Remove 10% inflation from 1981	$12.689
[3]	Add back 7% inflation	$17.249
[4]	Seabrook-Tewksbury cost estimate	$29.500
[5]	Inflate to 1986	$31.211
[6]	Advantage of Scobie-Tewksbury over Seabrook-Tewksbury	$13.962

Table 1: Comparison of Cost Estimates for Scobie-Tewksbury and Seabrook-Tewksbury Transmission Lines.

Notes:

1. From "Fuel Savings Resulting from Installation of the Scobie-Tewksbury 345 kV Transmission Line (1987-1990)" NEPOOL, January 1982, p. C-1. Early 1986$.
2. From 1981 direct costs of $11.57 and inflation of $6.28, equivalent years of inflation is:
   $\ln\{(11.57 + 6.26) / 11.57\} / \ln\{1.1\} =$ 4.54
3. At this point, 7% seems more reasonable than 10% inflation from 1981-1986. The same inflation assumptions should be used for both estimates.
4. From IR AG-7, Set 2. March 1985$.
5. Ten months of inflation at 7%, to early 1986.
6. [5] - [3]

#29 R

COMMONWEALTH OF MASSACHUSETTS
ENERGY FACILITIES SITING COUNCIL

RE: THE NEW ENGLAND ELECTRIC COMPANIES 1983 SUPPLEMENT TO THE SECOND LONG RANGE FORECAST OF ELECTRIC RESOURCES AND REQUIREMENTS	E.F.S.C. NO. 83-24

REBUTTAL TESTIMONY OF PAUL CHERNICK ON BEHALF OF THE ATTORNEY GENERAL OF MASSACHUSETTS

FRANCIS X. BELLOTTI
ATTORNEY GENERAL

By: Richard Kanoff
Assistant Attorney General
Utilities Division
One Ashburton Place
Boston MA 02108
(617)-727-5112

February 2, 1984

Table of Contents

2 LOCKED-IN GENERATION

Q: Please describe NEES' case regarding the locked-in generation argument.

A: First, Mr. Bigelow acknowledged that, once built, the Scobie-Tewksbury line would relieve the locked-in generation problem as well the Seabrook-Amesbury-Tewksbury line would. He asserted, however, that NEES' delay in pursuing the licensing of the Scobie-Tewksbury line pushed the earliest in-service date for that line back past NEES' anticipated commercial operation date for Seabrook 1. If this is the case, some locked-in generation penalty can be expected from selecting the Scobie-Tewksbury line over the Seabrook-Amesbury-Tewksbury line. Finally, Mr. Bigelow sponsored two NEPLAN studies of potential locked-in generation, and computed the magnitude of the economic penalty in the event that the line is not available until late 1988.

Q: On what assumptions or inputs is NEES' locked-in generation dependent?

A: The magnitude of the penalties depend on

- the most likely commercial operation date for Seabrook 1,

- the earliest possible in-service date for the Scobie-Tewksbury line,
- existing transfer limits,
- the availability of northern New England nuclear plants, and
- projected fuel prices.

Q: Which of these assumptions will you discuss?

A: I will discuss the two latter issues, nuclear availability and fuel prices.

2.1 Northern Nuclear Availability

Q: How does the availability of the northern nuclear units affect the level of the penalty from locked-in generation?

A: As I understand the explanations offered in support of Exh. ROB-9 and ROB-10, generator availability is handled in three ways. First, all outages for all units other than the northern nuclear units (Maine Yankee, Vermont Yankee, Pt. Lepreau, and Seabrook) are treated in the production costing model, ECOPEN, as deterministic reductions in the capacity available by region. NEES has never specified exactly how the amounts and types of unavailable generation were determined. Second, ECOPEN is run for each season with no northern nuclear outages, or with a particular generator out for a seven-week refueling. The results of these runs, added up for the number of weeks in each season with and without a northern refueling, produce the "gross penalty" figures reported in Exh. ROB-9 and ROB-10. Third, the probability of the gross penalty actually occurring is calculated as the probability that all the northern nuclear units not on maintenance are available, as shown in the attachments to the response to IR AG 3-8. Mr. Bigelow referred to this last step as using the ECOPEN penalty only 40% of the time, but in Ex. ROB-10 the adjustment is more like 52% - 58%, and even in Ex. ROB-9 it is as high as 47%.

Q: Are the allowances for outages, other than northern nuclear units, appropriate?

A: As I noted, NEES has never really explained the origin of these figures, nor how it determined division of the outages between various plants or types of capacity, such as northern coal and northern oil. Therefore, I have not (and could not have) reviewed the assumptions. These specifics will have an effect on the magnitude of the penalty, but should not change the general pattern: there will be times when economic northern generation exceeds northern demand.

NEES does make some very peculiar assumptions in these studies. THe first such assumption is that 860 MW of northern capacity is out of service at all times, regardless of whether a nuclear unit is on maintenance or not. For example, when Vermont Yankee (500 MW) is refueling, only 360 MW of northern fossil generation is out of service. This is equivalent to assuming that nuclear outages decrease the amount of fossil outages on an equal MW basis. This is partly true for maintenance, but of course a nuclear refueling in no way precludes a forced outage of a fossil plant. Second, northern nuclear outages are assumed to specifically eliminate coal outages; any remaining outages during a nuclear refueling are oil units.[2] This is obviously not the case. Third, when coal is allowed to be out of service at all, only 114 MW, exactly the size of Merrimac 1 and about the size of the Schiller or Mason coal facilities, is taken out; if Merrimac 2 (330 MW) is ever out of service, it must be in the winter, which is the only season for which NEES does not provide an ECOPEN run. Any unit can break down any time, and while it is possible that Merrimac 2 would be scheduled for maintenance in the winter, that does not seem particularly likely. Fourth, even if 114 MW of northern coal were out every week except for the 14 weeks assumed for northern refueling, including the entire winter, the capacity factor of the 688 MW of northern coal would be about 88%,

----

2. Mr. Bigelow erroneously states that a portion of the fossil outages are assigned to coal, even when a nuclear plant is on maintenance.

which is implausibly high. At a more realistic 65% capacity factor, an average of 241 MW of capacity would be out every week; if coal outages are somehow prevented during nuclear refuelings, the other weeks must average 330 MW of northern coal outages. NEES' use of only a third this much coal outage is highly unrealistic. In short, the results of NEES' treatment of non-nuclear northern outages are so strange that it is almost certain to be incorrect. It is clear, however, that NEES overstates northern coal availability and that this error will overstate the extnet of the locked-in generation and thus the economic penalty.

Q: Is the treatment of northern nuclear refueling significant and appropriate?

A: The size of the penalties (or conversely, the savings from having a line in place in time) are quite sensitive to the timing of maintenance outages. NEES' studies indicate that refueling of any of the northern nuclear units[3] substantially reduces the penalties. For example, Exh. ROB-10 indicates that if Seabrook were to refuel in the summer, the annual penalty is reduced by about a third.

There are two substantial problems with the modeling of

----

3. None of this refueling discussion really applies to Pt. Lepreau, since the CANDU HWR's do not have to be shut down for refueling.

northern nuclear refuelings. First, the studies allow only 7 weeks of refueling in every 18 months. A seven week refueling is very short, although not unprecedented. NEPOOL's own studies[4] report an average of 9.5 weeks of overhaul annually, and recommend the use of 8.5 weeks for planning purposes. These NEPLAN studies clearly recognize that the six-week target outage durations used by NEPEX to encourage quick overhauls are unrealistic for planning. The use of different refueling periods by different NEPOOL bodies does not appear to represent any disagreement about appropriate expectations, as Mr. Bigelow indicated on cross-examination, but simply the difference in the objectives of the two groups.

Second, the studies assume that northern nuclear units will refuel only in spring and fall, and specifically never in the summer. This has the effect of considerably increasing the penalty, since a nuclear refueling in the summer would reduce northern generation just when the transfer limit is most constrained. NEES justifies this assumption by arguing that

----

4. The original analysis is laid out in A RELIABILITY EVALUATION OF MAINTENANCE REQUIREMENTS AND EXTERNAL TIE BENEFITS FOR NEW ENGLAND, NEPOOL Planning Committee, July 1979. The SUMMARY OF GENERATION TASK FORCE LONG RANGE STUDY ASSUMPTIONS, NEPLAN and GTF, March 1982, reports that this value was "Approved by the NEPOOL Executive Committee for use in planning studies, September 1979" and acknowledges that the projections "assume substantial improvements over actual experience will be made in the future".

the economic penalty of having a nuclear unit unavailable in the summer is so great that none would ever be refueled in that season (see IR AG 3-9).

In fact, northern nuclear units do refuel in the summer. Two of the first seven refuelings of Vermont Yankee were in the summer, as were three of Maine Yankee's first five refuelings.[5] Even with only the two northern nuclear units in service, one of them refueled every summer from 1974 (the first year either one refueled) to 1978.

The addition of Seabrook 1 can only increase the frequency of northern nuclear refueling. First, the existence of a larger number of nuclear units[6] will require more refuelings in the summer and winter. If a nuclear unit had to be refueled in the summer, it would seem to be more sensible to refuel one of the northern ones, rather than one of the southern ones, which would be closer to the seasonal load centers. Similarly, it would reasonable to expect NEPEX to avoid winter refuelings in the north, although Maine Yankee once refueled in the dead of winter. Furthermore, it would be PSNH, as the operator of Seabrook, which would ask NEPEX for

----

5. This tabulation is based on data through 1981 for Vermont Yankee and 1980 for Maine Yankee.

6. Seabrook 1 and Millstone 3 will bring the New England total to nine.

a Seabrook refueling date, which would then have to be reconciled with the other requests for scheduled maintenance. Since PSNH's summer loads are comparable to or below its spring and fall loads, summer would be an excellent time for refueling from the operator's point of view.

Detailed discussions of the seasonal economics of nuclear refueling are really of only limited relevence in any case. Nuclear units are generally refueled at an appropriate time in the fuel life (which is determined by capacity factor and is therefore random) and are often refueled when they are out for other extensive maintenance, repair, or inspection (also random processes). In any case, there is no justification for neglecting summer refuelings in the locked-in generation analysis.

Q: Is the treatment of forced outages at northern nuclear units reasonable?

A: Not as a whole. While the forced outage rate (FOR) for Pt. Lepreau is reasonable, the FOR's for Maine Yankee, Vermont Yankee, and Seabrook are much too low. In Table 1, I calculate the FOR which, combined with NEES' maintenance outage allowance of 7 weeks in 18 months, produces the observed mature[7] capacity factors of Maine Yankee and Vermont Yankee. I also display there the FOR which would produce the first-year capacity factor for Seabrook projected in Attachment A to my direct testimony.[8] Finally, Table 1 also shows the probability of all the units not on maintenance being available. The probabilities derived from realistic capacity factors are as little as half those used in ROB-9 and ROB-10.

It is interesting to note that the FOR for Seabrook in ROB-10 assumes that Seabrook will be in operation in 1984, and that it will therefore be considerably matured by 1987. Therefore, while Exh. ROB-9 assumes a Seabrook FOR of 40.8%, Exh. ROB-10 assumes a Seabrook FOR of only 26.4%. Thus, while EXh. ROB-14 purports to assume that Seabrook will enter service in 1986, it is actually based in part on a study (ROB-10) which assumes a 1984 in-service date. Even if NEPLAN's very optimistic capacity factor projections somehow turned out to be correct, NEPLAN would not expect Seabrook to achieve a 67% capacity factor in its first full year of operation; yet this

----

7. I defined maturity as starting in the fifth full year of operation, consistent with NEPOOL projections and historical experience.

8. NEES is not projecting that Seabrook would refuel before 1988. NEPLAN assumes a nuclear maintenance outage in every year except the first (1986 for Seabrook), so again NEES and NEPLAN assumptions are not consistent.

is the 1987 capacity factor implicitly projected by NEES in the development of Exh. ROB-14. Of course, it would be more appropriate to use a capacity factor closer to 50%.

2.2 Fuel Price Projections

Q: Are the fuel price projections used in ROB-9 and ROB-10 appropriate and reasonable?

A: No. The oil and coal price forecasts used in ROB-9 and ROB-10 (specified on page 28 of Mr. Bigelow's testimony) are inconsistent with NEES' current price projections (provided in IR AG 3-11). Table 2 displays the prices assumed for oil and coal in the ECOPEN studies, in NEES' current projections, and the difference between the two sets of estimates. Table 2 also shows the cost differential between coal and oil in the various price projections. Mr. Bigelow has indicated that the ECOPEN savings with an additional north-south line result primarily from the displacement of southern oil with northern coal. This coal-oil cost differential is about 30% to 50% lower in NEES' current price projections than it is in the inputs to the ECOPEN runs.

Mr. Bigelow is certainly correct in arguing that fuel prices are subject to much uncertainty. Recent experience has demonstrated that this uncertainty exists on the down-side as well as the upside. It is extraordinarily inappropriate and inconsistent for NEES to be using one set of fuel prices to evaluate rate design, conservation programs, and oil back-out investments, while using a higher set of prices to justify the choice of the Seabrook-Amesbury-Tewksbury line over the Scobie-Tewksbury line, on the basis of energy conservation and oil displacement.

Furthermore, NEES' current oil price forecasts are now over a year old. In contrast, those 12/82 revisions replaced a previous forecast made only three months earlier. It is not clear how often NEES checks and revises its forecasts, but if Mr. Bigelow is correct that oil prices have fallen considerably in the last six months, it would appear to be time for a revision.

Q: Have you calculated the sensitivity of the results in ROB-9 and ROB-10 to the availability and fuel price assumptions?

A: Yes. In Table 3, I display the gross savings from ROB-9, calculate net savings at the FOR's from Table 2, and adjust the results to NEES' current fuel price forecast. The penalties are calculated for refuelings in spring and fall, and again for refuelings in summer and fall. I did not bother to include the spring period, since Mr. Bigelow uses the results from ROB-9 only for 1984 and 1985, and even he does not expect Seabrook 1 to be in service in the spring of 1985. Table 4 repeats these calculations for ROB-10.

unrealistic and/or inconsistent with NEES' best estimates. The effect of these inappropriate assumptions is to greatly overstate the magnitude of the economic penalties from locked-in generation.

3 LOSS COMPARISON

3.1 Load Levels

Q: What are the critical considerations in the modeling of line losses from the alternative lines?

A: Line losses in this case are dependent on

- the load levels modeled,
- the spatial (and hence seasonal) distribution of load modeled,
- the generation patterns modeled,
- Seabrook availability assumed,
- the assumed covariance between the availability of Seabrook and that of HQ power, and
- the physical configuration of the lines.

Q: Are the choices of load levels appropriate?

A: They certainly do not represent typical load levels. Mr. Bigelow indicates (IR Costello 3-7, part f) that cases 1, 2, and 4 represent 90% of 1987 summer peak, and that case 3 represents 55% of 1987 summer peak. Weighting the 4 cases equally, as one might do before determining how they are to be actually used, produces an 81% load factor based on summer peak; since NEPOOL summer peak is about 93% of winter, this is equivalent to a 75.4% LF on winter peak. NEPOOL's LF is about 63%, and it is not projected to change significantly in this century.

In fact, case 3 (the only 55% case) is actually used for only 9-17% of the hours in Mr. Bigelow's calculation of average losses, depending on the year and the assumed inservice date for Seabrook[9]. In the evaluation performed with the Seabrook capacity factor I project, case 3 is not used at all. As a result, the implicit load factor is even higher than 81%; it is as high as 87% for 1988 with a realistic Seabrook in-service date, and 90% for the realistic capacity factor evaluation.

Normally, one would expect that lower (more realistic) loads would produce lower losses, which would in turn produce a smaller loss differential between the two transmission lines under consideration. However, Mr. Bigelow indicates that his 90% load assumption is conservative, in that lower loads would produce larger loadings on these particular lines.

----

9. Case 3 represents the situation in which Seabrook is operating and HQ is not. Other peculiarities in the treatment of this situation will be discussed below.

only summer load patterns would tend to overstate the flows and hence the losses. In the winter, in particular, much more of Seabrook's output would be consumed in New Hampshire and Maine, and less would be flowing into Tewksbury.

Q: Did the loss runs actually use the load patterns Mr. Bigelow described?

A: No, at least not in case 3. While Mr. Bigelow described the case 3 load as 55% of 1987 summer peak, the microfiche[11] clearly indicates that the load pattern was actually 45% of 1982 winter peak as projected in NEPOOL Load and Capacity Report dated January of 1977 (and hence representing the 1976 forecasts of the individual utilites).

Table 5 compares the distribution of load between the various load areas in case 3 and in the other three cases. As can be seen in that table, the total load in case 3 is 55% of NEPOOL projected 1987 summer peak. However, the individual company or area loads are not proportional to the same area loads in the 90% cases. Case 3 therefore does not represent the 1987 summer load distributions which NEPOOL now expects to occur; in fact, it does not represent any situation which NEPOOL expects to ever occur. The 1976 projections used in case 3 included some very unrealistic company forecasts, including

----

11. This was the only case not provided in hard copy.

NEES', which greatly overstated the growth of some areas relative to the pool.

Therefore, NEES' case is based in part on assuming, contrary to fact and contrary to NEES' official projections, that load forecasts from 1976 for 1982 are representative of 1987 load patterns. It is not clear why Mr. Bigelow chose to use this data, or why he chose to represent it as 1987 summer load data.

Q: Would case 3 represent a typical off-peak load pattern, if the loads were redistributed by load area?

A: Not really. Case 3 assumes that all 1600 MW of pumped storage hydro is pumping. This situation undoubtedly arises from time to time, but the pumped hydro facilites actually spend only about 10% - 12% of the year pumping. If only 90% and 55% loads are modeled, the 55% loads must represent about a third of the year in order to produce NEPOOL's load factor (based on summer peak) of about 68%. Hence, only about a third of the off-peak period would involve heavy pumping loads.

3.2 Generation Patterns

Q: Are the generation patterns assumed in the loss studies reasonable and appropriate?

situation. First, both Newington and Wyman 4 are shown as running at full power; even Ex. ROB-10 does not show them as being on at 50%, or in the case of Newington, even at 75% load. For 1980-82, Wyman 4 had an average capacity factor of about 23%. I do not have as much data on Newington, but in 1980 it operated at a 47% capacity factor. Both of these figures pre-date recent and planned coal conversions, and of course Seabrook and Millstone operation; as a result, the capacity factors for Wyman and Newington are likely to be lower in the late 1980's than in the beginning of the decade. Even at their historical capacity factors, however, it would fairly unusual to find either unit operating at 55% load. Second, Mt. Tom is not generating; this may be due to a failure to recognize the coal conversion at this plant,[12] or due to an intentional outage. If the latter is the case, generation out of service appears to be concentrated in the south, since Milestone 3 is the only other major unit I have identified as being out of service in this run.

It is somewhat perplexing that NEES has bothered to model the effects of load and generation patterns outside of the

----

12. Recall that the load data is over seven years old for this run; the generator characteristics may also be similarly dated.

13. The load flow model includes plants as far away as Illinois and Alabama, not just portions of the New York and New Brunswick systems, as Mr. Bigelow indicated at one point on the stand.

region,[13] which Mr. Bigelow says have "absolutely no" effect on transmission flows in New England, but does not model even simple variations in regional load and generation patterns. Even the ECOPEN runs for locked-in generation were run for 8 load levels for each of the seasonal load patterns, and with a few variations in dispatch (through modeling of northern nuclear maintenance.)

3.3 Seabrook Availability

Q: Is NEES' projection of Seabrook availability reasonable?

A: No. As I noted in connection with the locked-in generation analysis, NEES' expectation for Seabrook generation is rather inflated. Reducing Seabrook's output to a more realistic value for its early years, in the 47% to 52% range, yields losses about 20% lower than those shown in Exh. ROB-14. With a realistic capacity factor, as opposed to NEES' assumptions, about 1000 to 1800 hours/year are shifted from Seabrook-on conditions (losses of 7.48 to 9.28 MW) to Seabrook-off conditions (losses of about 2 MW). The sensitivity of losses to Seabrook capacity factors is demonstrated in Table 6, which recalculates the average losses, given NEES' methodology and other assumptions, including the NEES estimates of losses for each of their case, but with a realistic 47% immature capacity factor for Seabrook. Table 6 also calculates the average losses for a mature capacity factor of 54.3%.

3.4 Covariance of Seabrook and HQ

Q: Does NEES properly treat the coincidence of Seabrook availability and HQ availability?

A: No. Seabrook will become unavailable at random, day or night, in any season. It is my understanding that HQ power will be available whenever HQ has power to spare, which would tend to be concentrated in the spring and summer. There is no reason to assume, as NEES does, that HQ will only be available when Seabrook is available.

3.5 Physical Configurations

Q: What physical configuration issues do you consider to be open?

A: Basically, I am unwilling to accept NEES' assurances regarding the appropriateness of the design for either line, including the size of the conductors, and whether the Seabrook-Scobie-Tewksbury line is attached to the Scobie bus. Given the shortcomings in NEES' approach to other issues in this case, I would recommend that the Council require NEES to justify its choices in these issues.

3.6 Conclusions on the Loss Study

Q: What do you conclude from your review of NEES' loss study?

A: There are three points I would emphasize. First, if the loss differential is anywhere near the magnitude NEES projects, the Seabrook-Amesbury-Tewksbury line is preferable to the Scobie-Tewksbury line. Second, the losses may be sensitive to a large number of variables, most of which NEES has not examined. Third, NEES' justifications for its specific assumptions are quite weak.

4 CONCLUSIONS AND RECOMMENDATIONS

Q: Given the numerous problems you have identified in NEES' new case, can you conclude whether the Seabrook-Amesbury-Tewksbury line is preferable to the Scobie-Tewksbury line?

A: No. Table 7 repeats the calculations in Exh. ROB-14, with the more reasonable inputs from my re-analysis of the locked-in generation penalty.[14] As can be seen in that table, the locked-in generation penalty for the Scobie-Tewksbury line on NEES' schedule is approximately the same size as the difference in NEES' reported construction costs for the lines; the inservice dates of both Seabrook and the Scobie-Tewksbury line are hence crucial to determining the relative benefits, as is the refinement of the ECOPEN runs to reflect more appropriate refueling schedules, durations, and fuel costs. Even using NEES estimates of MW losses by case, and using NEES nuclear refuelings in the ECOPEN runs, Table 7 indicates that Scobie-Tewksbury is the preferred line if it can be in place by the spring of 1988, and if (as seems quite likely) Seabrook is not in service before the autumn of 1986.

----

14. Exhibit ROB-13, NEES' alternative comparison of total benefits and costs, assumes a Seabrook inservice date which is now essentially impossible, and which even NEES does not believe, and may therefore be ignored.

However, depending on the assumptions regarding locked-in generation, NEES' estimates of the differential losses between the two lines may be enough to outweigh the construction cost savings of the Scobie-Tewksbury line. Thus, the shortcomings of NEES' loss study, discussed in the preceding section, must be resolved before a choice can be made between the lines.

Q: How would you recommend that the Council proceed under these circumstances?

A: I would recommend that the Council:

1. specifically withdraw the original approval of the Seabrook-Amesbury-Tewksbury line, because the conditions on which it was based have failed to materialize;

2. deny current reapproval of the Seabrook-Amesbury-Tewksbury line at this line, because NEES' new case is fatally deficient, and because NEES' presentation in this case makes reliance on its conclusions unfounded;

3. order NEES to proceed with all critical-path licensing activities for the Scobie-Tewksbury line on an expeditious basis;

4. determine that NEES' planning process for the Scobie-

Tewksbury line and the Seabrook-Amesbury-Tewksbury line was deficient for the reasons set forth in sections 2 and 3 of this testimony; and

5. invite NEES to submit a complete case for the Seabrook-Amesbury-Tewksbury line at the earliest possible time, with the understanding that the Council will consider NEES' filing on the most expeditious basis consistent with legal requirements and opportunity for public involvement.

Q: Do you anticipate that preparation and presentation of an appropriate case, and Council review and action on it, would interfere with construction of the Seabrook-Amesbury-Tewksbury line prior to the in-service date of Seabrook 1?

A: No, I do not. At this point, there are some thirty months remaining before even NEES expects Seabrook to enter service. NEES expects the construction of the Seabrook-Amesbury-Tewksbury line, once approved, to take only 14 months. If there is a good reason to build the Seabrook-Amesbury-Tewksbury line, as opposed to the Scobie-Tewksbury line, NEES should be able to explain that reason to the Council in 16 months.

Q: Does this conclude your rebuttal testimony?

A: Yes.