UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE
ATOMIC SAFETY AND LICENSING BOARD

In the Matter of Boston Edison Company, et al. (Pilgrim Nuclear Generating Station Unit 2)	Docket No. 50-471

INTERVENOR COMMONWEALTH OF MASSACHUSETTS' PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW IN THE FORM OF A PARTIAL INITIAL DECISION

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INTRODUCTION

Pursuant to 10 CFR §2.754, the Commonwealth of Masschusetts hereby submits its Proposed Findings of Fact and Conclusions of Law in the form of a Partial Initial Decision, and requests that they be adopted by the Atomic Safety and Licensing Board in this proceeding.

As required by 10 CFR §2.754(c), the exact record reference relied upon is cited with respect to each proposed finding of fact herein, and each conclusion of law is accompanied by the authorities or reasoning which the Commonwealth believes support the conclusion requested.

As a preliminary matter, the Commonwealth notes that because this Board has yet to take testimony on the Commonwealth's contention relating to emergency planning, no cost/benefit balance can be struck pursuant to the requirements of the National Environmental Policy Act of 1969, 42 U.S.C. §§4321 et seq.*/ Accordingly, the Commonwealth has not submitted any findings of fact or conclusions of law on the cost/benefit issue.

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*/ As the NRC has acknowledged, "emergency planning advantages or disadvantages of particular sites [are] part of the NEPA cost/benefit analysis of alternate sites." Proposed Amendment to Appendix E, Supplementary Information, 43 FR 37474, Col. 1 (August 23, 1978).

In addition, the Commonwealth supports the Staff's position that findings of fact and conclusions of law on unresolved generic safety issues are equally inappropriate at this time. There are several such safety issues which are the subject of recent Board Notifications, I/E Bulletins and Three Mile Island Task Force investigations, and for all of these matters, the Staff intends to make further submissions.

RADIOLOGICAL HEALTH AND SAFETY MATTERS

I. FINANCIAL QUALIFICATIONS

1. On the issue of financial qualifications the Board admitted the following contention of the Commonwealth:

Commonwealth Contention 5

The Applicants are not financially qualified to design and construct the proposed facility.

A. Regulatory Standards

2. In an application for a construction permit, the applicant must show that the applicant "possesses the funds necessary to cover estimated construction costs and related fuel cycle costs or that the applicant has reasonable assurance of obtaining the necessary funds, or a combination of the two." 10 C.F.R. §50.33(f).

3. In examining the question of whether an applicant is financially qualified, the Nuclear Regulatory Commission (the Commission) and the Atomic Safety and Licensing Board (the Board) require no specific format and no specific types of information from Applicants which are established organizations. 10 C.F.R. Part 50, Appendix C.

4. In examining the question of whether an applicant is financially qualified, the Commission and the Board need in general "financial data and other related information that will demonstrate the financial qualifications of the applicant to

carry out the activities for which the permit or license is sought." 10 C.F.R. Part 50, Appendix C.

5. The regulatory standards of 10 C.F.R. §50.33 (f) and 10 C.F.R. Part 50, Appendix C are based upon and are authorized by the statutory language of 42 U.S.C. §2232(a), which provides in pertinent part that "each application. . . shall specifically state such information as the Commission, by rule or regulation, may determine to be necessary to decide such of the. . . financial qualifications of the applicant. . . as the Commission may deem appropriate for the license." 42 U.S.C. §2232(a).

6. In examining the question of whether an applicant is financially qualified, the Commission and the Board must make an "actual inquiry into the applicant['s] financial qualifications. It is not enough that the applicant is a regulated public utility." Public Service Company of New Hampshire, 7 N.R.C. 1, 18 (1978).

7. The Commission's and the Board's inquiry into the financial qualifications of an applicant is a safety-related inquiry, in that it is thought that an applicant's financial qualifications contribute in some fashion, directly or indirectly, to the applicant's ability to meet safety responsibilities. See Public Service Company of New Hampshire, 7 N.R.C. 1, 18 (1978); 33 Fed. Reg. 9704 (1968).

8. In examining the question of whether an applicant is financially qualified, the Commission and the Board require a "reasonable assurance" that the applicant will be able to obtain the necessary funds. Public Service Company of New Hampshire, 7 N.R.C. 1, 17-23 (1978).

B. Summary of the Parties' Presentations

1. The Applicant's Case

9. The Applicant presented its evidence on the financial qualifications issue through a panel of two witnesses: Mr. Ralph M. Kelmon, Boston Edison's Treasurer, who is also the head of the Treasury Organization of Boston Edison, and Mr. Thomas J. May, Boston Edison's Assistant Treasurer, who is also the head of the Financial Management Department within the Treasury Organization of Boston Edison. Mr. Kelmon's and Mr. May's prepared direct testimony is in the record following Tr. 9234, and their cross-examination is in the record at Tr. 9237-9390.

10. The Applicant also presented documentary evidence in support of its position, which primarily consisted of Amendment No. 8 to the License Application (Applicant's Ex. 1-DD) and Amendment No. 9 to the License Application (Applicant's Ex. 1-GG).

11. Additional evidence concerning the Applicant's position on financial qualifications is contained within a letter dated May 23, 1979 from Mr. R.M. Butler to Mr. Olan D.

Parr (Applicant's Ex. 1-FF) and earlier amendments to the License Application.

12. Mr. Kelmon and Mr. May testified that, in their opinion, there was "reasonable assurance" that the Applicant would be able to obtain the funds necessary to finance its portion of Pilgrim II. Prepared Direct Testimony of Mr. Kelmon and Mr. May, at 7-11, following Tr. 9234.

2. The Staff's Case

13. The Staff presented its evidence on the financial qualifications issue through Mr. Michael L. Karlowicz, Jr., a financial analyst employed by the Commission. Mr. Karlowicz's qualifications are contained in the record following Tr. 9513.

14. Mr. Karlowicz was the member of the Commission's Staff responsible for the preparation of the financial qualifications portion (at least as it related to Boston Edison Company) of the most recent supplement, Supplement No. 4, to the Staff's Safety Evaluation Report. The portions of Supplement 4 which relate specifically to Boston Edison's financial qualifications are page 20-1 and Appendix C, pages C-1 through C-15. Supplement No. 4 to the Staff's Safety Evaluation Report is in the record as Staff Ex. 50.

15. Mr. Karlowicz and the Commission Staff concluded that the applicants were "financially qualified" to build Pilgrim II. The Staff's review of this issue essentially reduced to an examination of "whether a reasonable financing

plan exists for raising the funds necessary to construct a nuclear power plant." Staff Ex. 50, at pp. 20-1, 20-2.

3. The Commonwealth's Case

16. The Commonwealth of Massachusetts presented its evidence on the financial qualifications issue through Mr. Paul F. Levy, who was the Deputy Director of the Massachusetts Energy Policy Office from 1974-1978, a Commissioner and then the Chairman of the Massachusetts Department of Public Utilities from 1978-1979, and who is currently the Director of the Department of Energy of the State of Arkansas. Mr. Levy's prepared direct testimony is in the record following Tr. 9434.

17. Mr. Levy's testimony was based in part upon three appendices, which were separately admitted as Commonwealth exhibits: Appendix 1, entitled Boston Edison Company, Pilgrim Unit II Financial Analysis of Comparative Studies, Treasury Organization, July 17, 1978 (Commonwealth Ex. 100); Appendix 2, entitled Boston Edison Company, Board of Directors Meeting, July 27, 1978, Report on Pilgrim II Project (Commonwealth Ex. 101); and Appendix 3, entitled Testimony of Ralph M. Kelmon, Boston Edison Company, Exhibit No. BE-100 (Commonwealth Ex. 102).

18. Mr. Levy testified that Boston Edison would have "extreme difficulty in financing [Pilgrim II]" if it maintained its current 59% ownership share. Prepared Direct Testimony of Mr. Levy, at 4, following Tr. 9434.

19. Mr. Levy also testified that Boston Edison will have increasing difficulty during the period of construction in issuing debt and equity, that Boston Edison is very dependent upon post-1985 earnings potential to attract current investors, that these post-1985 earnings are both uncertain and probably overstated, and that the only two potential options for improving the situtation would be a reduction of Boston Edison's ownership share in Pilgrim II or the allowance of construction work in progress in rate base (C.W.I.P.) by the Massachusetts Department of Public Utilities. Prepared Direct Testimony of Mr. Levy, at 4-13, following Tr. 9434.

20. Mr. Levy also testified on cross-examination that it was "possible" that Boston Edison could build Pilgrim II by extending its construction schedule, but that this would entail additional costs. Tr. 9482.

21. Mr. Levy also testified on cross-examination that several factors lead him to believe that Boston Edison would have difficulty in financing Pilgrim II: the percentage of earnings attributable to AFUDC; the dilution effect of selling equity at prices below book value; declining interest coverage ratios; and disinterest among institutional investors. Tr. 9469.

C. Findings of Fact and Conclusions of Law by the Board

1. Findings and Conclusions Relating to the Applicant's Presentation

22. The Board understands that questions such as the

issue of whether an applicant is financially qualified to construct a nuclear power plant cannot be conclusively proved by prospective evidence because such questions involve difficult evaluations of what will transpire in the future. The Board further understands that this particular issue is made even more difficult by the indeterminate nature of this issue itself. That is, whether "reasonable assurance" exists that funds will become available in the future is not only contingent upon future and possibly unforeseen events, but envisions a standard of proof somewhere between a standard requiring a showing of certainty that a financing plan will succeed and a standard requiring a showing of certainty that the plan will fail.

23. Because of the prospective nature of the facts being examined, and because of the difficulty of giving the "reasonable assurance" standard a precise definition, the Board is inclined to give great weight to its evaluation of the quality and credibility present or missing from the Applicant's presentation.

24. In this case, the Applicant's own documents severely undercut the conclusions reached by its own witnesses, Messrs. Kelmon and May. Commonwealth Ex. 102 was sworn testimony of Mr. Kelmon in the Applicant's current, pending rate case, D.P.U. 19991. Tr. 9276. Mr. Kelmon swore under oath that Commonwealth Ex. 102 was true in D.P.U. 19991 on May 2, 1979,

less than one month prior to this testimony before the Board on May 26, 1979. Tr. 9276. Mr. Kelmon reaffirmed before this Board that the material contained in Commonwealth Ex. 102 was true and accurate to the best of his knowledge and belief. Tr. 9276. However, Mr. Kelmon repeatedly disagreed with statements he made under oath in D.P.U. 19991 in Commonwealth Ex. 102 when he testified before the Board in this case. For example, Mr. Kelmon previously testified in D.P.U. 19991 that, "Financially, Boston Edison Company is not sound." Commonwealth Ex. 102, at p. 3. In this case, Mr. Kelmon disagreed with that statement. Tr. 9277. Similarly, Mr. Kelmon previously testified in D.P.U. 19991 that, "Overall, the financial health of the Company is poor." Commonwealth Ex. 102, at 5. In this case, Mr. Kelmon disagreed with that statement. Tr. 9277. Again, Mr. Kelmon testified in D.P.U. 19991 that, "The amount of bonds the company can issue has been extremely limited because of poor ratings and poor coverages." Commonwealth Ex. 102, p. 12. In this case, Mr. Kelmon disagreed with that statement. Tr. 9283. The Board finds that, in the three specific instances outlined in this paragraph, Mr. Kelmon testified one way under oath in D.P.U. 19991 on May 2, 1979, and testified in direct contradiction to that testimony in this case on May 26, 1979. The Board thus finds at least three instances where Mr. Kelmon has flatly contradicted himself under oath. The Board also finds that, in each of these three areas of conflict in Mr.

Kelmon's direct testimony, Mr. Kelmon's testimony went in the direction favorable to Boston Edison Company in each of the three areas in each of the two respective proceedings.

25. Numerous additional examples exist in the record in this case in which Mr. Kelmon's previous sworn testimony argues squarely against his conclusion in this case, even though it does not contradict (as a logical matter) his conclusions in this case. For example, although Mr. Kelmon's and Mr. May's prepared testimony gives no hint of the following points, and although their conclusion in this case is directly contrary, Mr. Kelmon admitted in this case that (referring to Boston Edison's allowed returns on common equity, earned returns on common equity, and earnings per share), "the financial deterioration from 1972 is quite evident." Tr. 9278; Commonwealth Ex. 102, p. 4. Similarly, Mr. Kelmon testified in this case that, "The Company [i.e., Boston Edison] ranges near the bottom in most financial industry wide comparisons." Tr. 9279; Commonwealth Ex. 102, p. 5. Again, Mr. Kelmon testified in this case that, "Because the company's [i.e., Boston Edison's] earnings and returns have not been adequate for several years now, the company's ability to raise capital has suffered an alarming deterioration." Tr. 9279; Commonwealth Ex. 102, p. 12. Mr. Kelmon testified in this case that, "The Company's [i.e., Boston Edison's] common stock has continuously sold below its book value for over five years." Tr. 9279;

Commonwealth Ex. 102, p. 12. Mr. Kelmon appeared to agree (although his testimony could conceivably be understood the other way) in this case that, "The company's [i.e. Boston Edison's] access to the common equity market has been all but cut off because of the depressed price of its stock." Tr. 9279-82; Commonwealth Ex. 102, p. 12. In any case, Mr. Kelmon had previously sworn both in this case (Tr. 9276) and in D.P.U. 19991 (Tr. 9276) that each of the five statements quoted in this paragraph were correct. See Commonwealth Ex. 102, pp. 4, 5, 12.

26. Reading through Commonwealth Ex. 102, the Board concludes that the Applicant has told a radically different story in a sworn evidentiary presentation to the Massachusetts D.P.U. than the Applicant presented to the Board in this case. Commonwealth Ex. 102; cf. Prepared Direct Testimony of Messrs. Kelmon and May, following Tr. 9234.

27. The Board finds that, in fact, "Financially, Boston Edison Company is not sound." Commonwealth Ex. 102, p. 3; cf. Tr. 9277.

28. The Board finds that, in fact, "Overall, the financial health of the company [i.e., Boston Edison] is poor." Commonwealth Ex. 102, p. 5; cf. Tr. 9277.

29. The Board finds that, in fact, "The amount of bonds the company [i.e., Boston Edison] can issue has been extremely limited because of poor ratings and poor coverages." Commonwealth Ex. 102, p. 12; cf. Tr. 9283.

30. The Board finds that, in fact, with respect to Boston Edison's allowed returns on common equity, earned returns on common equity, and earnings per share, "the financial deterioration since 1972 is quite evident." Commonwealth Ex. 102, p. 4; Tr. 9278.

31. The Board finds that, in fact, "the company [i.e., Boston Edison] ranges near the bottom in most financial industrywide comparison." Commonwealth Ex. 102, p. 5; Tr. 9279.

32. The Board finds that, in fact, "Because the company's [i.e., Boston Edison's] earnings and returns have not been adequate for several years now, the company's ability to raise capital has suffered an alarming deterioration." Commonwealth Ex. 102, p. 12; Tr. 9279.

33. The Board finds that, in fact, "the company's [i.e., Boston Edison's] common stock has continuously sold below its book value for over five years." Commonwealth Ex. 102, p. 12; Tr. 9279.

34. The Board finds that, in fact, "the company's [i.e., Boston Edison's] access to the common equity market has been all but cut off because of the depressed price of its stock." Commonwealth Ex. 102, p. 12; Tr. 9279-82.

35. Mr. Kelmon appeared to espouse a theory that flat, unqualified assertions of fact, contained in sworn testimony, could be true in the context of a rate case but not true in the context of a licensing proceeding. See, e.g., Tr. 9279-9284.

36. The Board categorically rejects the position of Mr. Kelmon and Boston Edison Company that flat, unqualified assertions of fact, contained in sworn testimony, are only true in the context of certain cases and can be not true in the context of other cases. To decide this issue any other way would reduce the regulatory process to a charade and would constitute an open invitation to future perjury.

37. The Board finds that Boston Edison's financial situation as a whole is accurately portrayed in Commonwealth Ex. 102, and that Boston Edison's financial situation as a whole is essentially ignored in the testimony of Messrs. Kelmon and May. Commonwealth Ex. 102; Prepared Direct Testimony of Messrs. Kelmon and May, following Tr. 9234.

38. The Board finds that lower Boston Edison ownership shares in Pilgrim II would substantially alleviate the financial problems involved in constructing Pilgrim II. The Board finds that Boston Edison's own internal memoranda are relatively candid and forthright on this point, and demonstrate that if Boston Edison's ownership share were to be reduced to the range of 30%-40%, the severe financial difficulties in constructing Pilgrim II would be alleviated. Commonwealth Ex. 100, 101.

39. The Board finds that, in fact, the most candid and unbiased document produced by Boston Edison that exists in this record specifically concludes correctly that Boston Edison's

management "can no longer recommend that we continue to license and construct Pilgrim II with a 59% ownership share." Commonwealth Ex. 101, p. 8.

40. The Board finds that, in fact, Boston Edison is not financially qualified to continue to own and construct a 59% ownership share in Pilgrim II. Commonwealth Ex. 101, p. 8.

41. The Board finds that the most recent cost estimates for the capital cost of Pilgrim II are uncertain. In this record alone, the following "most recent" capital cost estimates for Pilgrim II, all produced by the Applicant, exist: $1.895 billion (Commonwealth Exs. 103, 104, 105); $1.841 billion (Commonwealth Ex. 106); $2.0 billion (Commonwealth Ex. 101, p. 8; Commonwealth Ex. 100, p. 16); $1.95 billion (Commonwealth Ex. 100, p. 6); and $2.015 billion (Commonwealth Ex. 100, pp. 20, 27).

42. The Board finds that the capital cost estimates have escalated considerably faster than the general inflation rate. For example, the following table (taken from Commonwealth Exs. 104 and 105) shows the history of the four "formal" capital cost estimates for Pilgrim II.

Estimate	Date of Estimate	Total Capital Cost (including AFUDC)
Estimate #1	February, 1972	$0.402 billion
Estimate #2	April, 1973	$0.655 billion
Estimate #3	March, 1975	$1.221 billion
Estimate #4	January, 1979	$1.895 billion

This capital cost estimate history implies a growth rate in nominal (current, not deflated, dollars) of about 24.8% per year over seven years*/ which, although including the effects of inflation, still represents very substantial increases in real (deflated or constant) dollars. Commonwealth Exs. 104, 105.

43. The Board finds that there is no reason in this record to believe that this upward trend in capital cost will abate; accordingly, the Board finds that this upward trend in capital cost estimates will create additional difficulty in the financing of Pilgrim II.

2. Findings and Conclusions Relating to the Staff's Presentation

44. The Board finds that the Staff's evaluation of the Applicant's financial qualifications does not appear to constitute a truly independent assessment. It largely is comprised of a repetition of the Applicant's data, without any searching analysis. The Staff's unquestioning acceptance of the Applicant's data is perhaps best exemplified by the fact that the Staff repeated, supposedly as its own numbers, indenture coverage ratios which in fact were merely copied from the Applicant's submission. Staff Ex. 50, p. C-7. When the Applicant discovered an error in their indenture coverage ratios, and made the appropriate corrections (Tr. 9230-9233),

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*/ This number is calculated: $\left(\frac{1.895}{0.402}\right)^{1/7} = (4.71393)^{1/7} = 1.24795.$

the Staff simply adopted the same corrections (Tr. 9514-9515). The Board concludes that there is substantial doubt that the Staff has done more in this case than simply adopt the Applicant's data as accurate, and then adopt the Applicant's evaluation of that data.

45. The Board finds that the Staff's standard of review (whether Applicant have a "reasonable plan") is not precisely the same as the proper standard (whether "reasonable assurance" exists that funds can be obtained). Compare Staff Ex. 50, p. 20-1 and App. C. p. C-15; Tr. 9529; Tr. 9527; with Public Service Company of New Hampshire, 7 N.R.C. 1, 17-23 (1978); 10 C.F.R. §50.33(f).

46. The Board finds that the staff's presentation was not based upon close and detailed knowledge of the Applicant's financial data. For example, Mr. Karlowicz indicated that if he found an Applicant that had a "heavily imbalanced" capital structure, by which he meant 30% or less common equity as a percent of total capital, that would cause him concern in making an analysis of an applicant's financial qualifications. Tr. 9538-9539. At the time he made this statement, Mr. Karlowicz believed Boston Edison's common equity to be roughly 35-36% of total capital. Tr. 9539. Mr. Karlowicz appeared somewhat surprised to learn that Boston Edison's common equity as of 9/30/78 was about 31 1/2% of total capital (Tr. 9539) but then indicated that he did not see any problem with a 31 1/2%

common equity ratio (Tr. 9539-41). The Board finds that Mr. Karlowicz is unfamiliar with Boston Edison's actual financial position (Tr. 9539). The Board further finds that Mr. Karlowicz's assertion that a 30% common equity ratio is "heavily unbalanced" when he believed Boston Edison's ratio to be 35-36% (Tr. 9538-39) and his subsequent assertion that Boston Edison's common equity ratio of 31 1/2% is not heavily unbalanced but rather is "within the industry range" (Tr. 9540-41) is simply deceitful and unworthy of any expert witness.

47. The Board finds that the Staff invariably testifies that the Applicant in any licensing proceedings before the Atomic Safety and Licensing Board is financially qualified. Tr. 9524. Mr. Karlowicz testified that he was not aware of any example in the history of the N.R.C. in which a Staff witness had found an Applicant to be not financially qualified. Tr. 9524. Although this does not by itself show the Staff's analysis to be incorrect in this case or in any other case, this uniformity of performance and position by the Staff over the years does lead the Board to question the allegedly independent nature of the Staff's review. This is all the more the case when the Board considers that, in retrospect, some of these licensing proceedings have involved Applicants that, in hindsight, were not financially qualified. The attempted sell-down of Seabrook shares by Public Service Company of New Hampshire (Tr. 9534-9536) which followed hard on the heels of

an N.R.C. finding that Public Service of New Hampshire was financially qualified (Public Service Company of New Hampshire, 7 N.R.C. 1, 17-23 (1978)) leads this Board to question the accuracy and independence of the Staff's financial qualifications reviews in the past.

48. The Board finds that the Staff's presentation on financial qualifications is entitled to little or no evidentiary weight.

3. Findings and Conclusions Relating to the Commonwealth's Presentation

49. The Board finds that the evidentiary presentation of Mr. Levy on behalf of the Commonwealth is entitled to great evidentiary weight. The primary reasons for this determination are two-fold: first, Mr. Levy's experience as a neutral, impartial, and unbiased state regulator of the Applicant; and second, the fact that Mr. Levy relied heavily upon documents of the Applicant which explicitly supported his conclusions. The Board finds Commonwealth Exs. 100 and 101 (Appendices 1 and 2, respectively, to Mr. Levy's testimony) to be truthful, candid, and trustworthy evaluations of Boston Edison's financial position, produced by Boston Edison itself for internal use, which indicate that Boston Edison will have great difficulty in financing a 59% share of Pilgrim II and that Boston Edison should not go forward with a 59% ownership share. Commonwealth Ex. 101, p. 8. The Board similarly finds that Commonwealth Ex. 102 (Appendix 3 to Mr. Levy's testimony) to be sworn testimony

of Boston Edison's Treasurer, Mr. Kelmon, which accurately describes Boston Edison's present very grim financial situation.

50. The Board agrees with Mr. Levy that it is not certain that Boston Edison will be unable to finance a 59% ownership share of Pilgrim II, just as it also agrees with Mr. Levy that it is not certain that Boston Edison will not be able to finance its share of Pilgrim II. Tr. 9482-9483.

51. The Board agrees with Mr. Levy that Boston Edison will have "extreme difficulty" financing a 59% share of Pilgrim II. Prepared Direct Testimony of Mr. Levy, at 4, following Tr. 9234.

52. The Board finds that, although it is possible that Boston Edison will be able to finance a 59% share of Pilgrim II, no reasonable assurance exists that this will occur. Prepared Direct Testimony of Mr. Levy, at 4, following Tr. 9234; Commonwealth Exs. 100, 101, 102.

53. The Board finds that the Boston Edison Company is not "financially qualified" to construct and own a 59% share of Pilgrim II. Prepared Direct Testimony of Mr. Levy, at 4-13, following Tr. 9234; Commonwealth Exs. 100, 101, 102.

II. QUALITY ASSURANCE

54. Commonwealth Contention 10 states:

> The Applicants and their architect engineer, Bechtel Corporation, and nuclear steam system supplier, Combustion Engineering, are not technically qualified to engage in the proposed activities and cannot provide an adequate quality assurance program based on their previous records in similar ventures.

A. Legal Standards

55. Before issuing a construction permit, the Commission must find that the Applicant is technically qualified to design and construct a nuclear power plant. 42 U.S.C. §2232(a) and 10 C.F.R. §50.40(b). Each Applicant must include in its preliminary safety analysis report (PSAR) a "description of the quality assurance (QA) program to be applied to the design, fabrication, construction, and testing of the structures, systems, and components of the facility." 10 C.F.R. §50.34(a)(7). 10 C.F.R. Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," sets forth the specific requirements for quality assurance programs, including management and implementation. The description of the quality assurance program in the PSAR must include a discussion of how the applicable requirements of Appendix B will be satisfied. 10 C.F.R. §50(a)(7).

The Licensing Board must be "satisfied both that the QA (Quality Assurance) program is adequate on paper and that there

is, in fact, a reasonable assurance that the Applicant and its architect-engineer will carry out the program in accordance with its terms." Duquesne Light Company (Beaver Valley Power Station, Unit 2)("Beaver Valley"), ALAB-240, 8 AEC 829, 833 (Nov. 8, 1974) (quoting Consumers Power Co. (Midland Plant, Units 1 & 2)("Midland"),ALAB-106 RAI-73-3, 182, 184 (March 26, 1973).

56. The Commission has clarified the separate roles of the licensee and the Staff in quality assurance review. It is the duty of licensees to

> develop and implement reliable quality assurance programs which can assume the major burden of inspection. . . . [l]icensees bear an unavoidable and heavy responsibility for helping insure that nuclear power is utilized safely. Virginia Electric and Power Company (North Anna Power Station), CLI-76-22, 4 NRC 480, 486, 487 (1976); affirmed, Virginia Electric and Power Company v. U.S. Nuclear Regulatory Commission, 571 F.2d 1289 (4th Cir. 1978).

The Staff then "independently reviews designs and analyses, qualification documentation, and quality assurance programming of licenses to determine adequacy." Petition for Emergency and Remedial Action, ("U.C.S. Petition") CLI-78-6, 7 NRC 400, 426 (1978). It follows, therefore, that in order to "fulfill its regulatory obligations, NRC is dependent upon all of its licenses for accurate and timely information." Id. at 418.

57. The applicant has the burden of proving that it and the principal contractors, Bechtel Corporation and Combustion

Engineering, are technically qualified to design and construct Pilgrim Unit 2. 10 C.F.R. §2.732. The Applicant also has the burden of proving that it has provided an adequate quality assurance program and can implement that program to assure the health and safety of the public. Id. The Atomic Safety and Licensing Appeal Board has stated "the magnitude of the burden upon a litigant to whom the burden is assigned should be influenced by the gravity of the matter in controversy." Virginia Electric & Power Company (North Anna Power Station) ALAB-256, 1NRC 10, 17 n. 18. Quality assurance is an issue of major significance in the design and construction of a nuclear power plant; it requires a large burden of persuasion upon the Applicant. Carolina Power & Light Company (Shearon Harris Nuclear Power Plant, Units 1, 2, 3, and 4)("Shearon Harris"), Docket Nos. 50-400, 50-401, 50-402, and 50-403, Supplemental Initial Decision (July 13, 1979)

58. The past performance of the Applicant and the architect-engineer is an important factor in evaluating their ability to provide and implement an adequate quality assurance program. The Appeal Board has held that "performance of quality assurance activites at one facility is relevant in determining the likelihood of future satisfactory performance at another." Midland, supra at 21, citing Beaver Valley. Findings

B. The Evidence

59. The Commonwealth has submitted as exhibits several letters from the U.S. Atomic Energy Commission, Region I, to the applicant in connection with its QA program for Pilgrim Unit 1. These letters, each of which provides notice of violations and one of which requires the payment of a $12,000 fine, demonstrate a pattern of negligence on the part of the Applicant and its architect-engineer and constructor Bechtel in the important area of Quality Assurance. On several occasions, inspections have revealed that required auditing, reporting, record-keeping, or supervision by the Applicant and/or Bechtel was simply not being done. See Tr. at 3846-3847, 3847-3893, 4246-4341. (In the Safety Evaluation Report, for Pilgrim Unit 2 (SER), NUREG-75/054 (June 1975), the staff did not discuss the Applicant's or Bechtel's QA record for Pilgrim Unit 1, despite the record of problems with the QA programs demonstrated here by the Commonwealth and despite the fact that a November 1973 letter from the Midland Appeal Board to L. Manning Muntzing, AEC Director of Regulation, had severely criticized Bechtel's QA program at Midland Units 1 & 2. See Commonwealth Exhibit 2. The SER contained only a paper analysis of the QA proposals for Pilgrim Unit 2.) In response to the Commonwealth's exhibits, the Applicant indicated corrective action to be taken but generally provided no exculpatory reason for the failures. See Tr. at 3912-3919.

While the Applicant has argued that mistakes are unavoidable, these omissions are not the technical problems one would expect in the construction of any new facility. They are much more basic: they go to the Applicant's control of and response to those inevitable problems. While mistakes are inevitable, indeed because mistakes are inevitable, a system which allows those mistakes to remain hidden and uncorrected cannot be tolerated. In light of the poor record of the Applicant concerning quality assurance which was exposed during the hearings, this Board expected a heightened concern on the part of the Applicant and Staff to this important issue.

60. Since the conclusion of hearings on Quality Assurance on May 24, 1976, the activities of the Applicant and the Staff have continued to concern this Board. In U.C.S. Petition, the commission examined the Applicant's and Staff's review of the electrical connectors in Pilgrim Unit 1. The Commission was disturbed by the ineptitude displayed by both parties:

> The sequence of events in the Pilgrim case is not an acceptable model for regulatory or industry performance. Events moved from failure to identify connectors in use, to plant shutdown due to failure of connectors under test, and finally to replacement with splices. Because NRC is dependent upon information from licensees, the Commission is particularly concerned that at first apparently inaccurate information was forthcoming from the licensee and subsequently complete information was delayed well beyond the requested date for response. With respect to staff actions in the Pilgrim case, the delay in obtaining and reviewing the Pilgrim documentation was not satisfactory. U.C.S. Petition, supra at 418.

Particularly distressing was the Applicant's lack

> of detailed knowledge of the quality of installed plant equipment. Licensees must have this detailed understanding of their own plants in order to meet their obligations for public safety by ensuring a sound basis for making assessments of plant safety. Id. at 419.

The Commission ultimately ordered a comprehensive evaluation of the events at Pilgrim Unit 1.

61. The importance of the Applicant's Quality Assurance program is amplified by the critique of the Staff's oversight performance by the President's Commission on the accident at Three Mile Island:

> We find that the NRC is so preoccupied with the licensing of plants that it has not given primary consideration to overall safety issues. The Report of The President's Commission on the Accident at Three Mile Island, p. 51 (October 30, 1979).

62. Although the Applicant's initial QA program for Pilgrim Unit 2 was found in noncompliance with 10 CFR Part 50, Appendix B, the revised QA program has been inspected and approved by expert NRC regional personnel. We believe that more than paper assurances are required in this case. Without more critical scrutiny by the Staff of this important safety program, we cannot find that Boston Edison can provide a QA program in accordance with the requirements of the PSAR and 10 CFR Part 50, Appendix B and 42 U.S.C. §2232(a). Commonwealth Exhibit 7; Staff Witness Heishman at 6, following Tr. 4234.

63. In light of the Applicant's and architect-engineer's poor past and continuing record regarding quality assurance, the Board has great difficulty in finding that they have met their large burden in establishing a "reasonable assurance"

that they can carry out their respective QA programs in accordance with the written terms. The Commonwealth has documented a disturbing and continuing trend on the part of the Applicant and architect-engineer which prevents this Board from issuing an unconditional construction permit.

64. Until we receive further information from the Staff and the Applicant demonstration that Boston Edison has, in fact, corrected its poor performance record regarding quality assurance, we cannot issue an unconditional construction permit. Upon such demonstrations, we will consider issuance of a permit subject to the following:

(1) the Staff will undertake a particularly close scrutiny of the Applicant's and Bechtel's Quality Assurance program during construction; and

(2) a full adjudicatory hearing on the Applicant's and Bechtel's Quality Assurance programs will be held at the operating license stage. See Shearon Harris, supra.

III. NEED FOR POWER

65. The Board admitted the following "need for power contentions of the intervenors:

Commonwealth Contention 6 states:

The need for the electrical generating capacity of Pilgrim 2 has not been properly established because the Applicants have not developed a model adequately considering the effects of the following on demand:

(a) Voluntary curtailment of consumption of electricity by the public;

(b) Elasticity of demand;

(c) Peak Load pricing to flatten demand; and

(d) New standards for improved building insulation, heating, lighting and air conditioning.

Cleeton Contention H states:

Applicants and Staff have not adequately demonstrated the need for additional power in that the projected needs are inaccurate and conservation has not been seriously examined.

Ford Contention M states:

The Applicants have not adequately demonstrated the need for the Pilgrim 2 facility.

A. Regulatory Standards

66. The Atomic Safety and Licensing Appeal Board has held that a genuine need for the power projected to be produced by a nuclear generating facility must be shown in order to establish that there are genuine benefits to be gained from the project. The need for power can be properly thought of as representing the "benefits" side of the cost-benefit analysis

required by NEPA. Vermont Yankee Nuclear Power Corporation, ALAB-179, RAI-74-21 159 (1974).

67. The Atomic Safety and Licensing Appeal Board has specifically held:

> At the outset, inquiry must be made into whether there exists a genuine need for the electricity to be produced. This inquiry involves not only an analysis of existing generating capacity and of projections of expected growth, but also consideration of the possibility that measures to curtail consumption will be initiated. In this regard, appropriate attention must be given to energy conservation considerations, insofar as they affect the likelihood that predicted demand willl in fact occur. [Footnote omitted] At the same time, however, cognizance can be taken of the effect which a shortage of fossil fuel, or a need to divert that fuel to other uses, might have upon demand for non-fossil fueled generating sources. Vermont Yankee Nuclear Power Corporation, ALAB-179, RAI-74-21 159, 175 (1974).

68. The Atomic Safety and Licensing Appeal Board has also held that the "need for power" may be established by means of the so-called "substitution" theory, which purports to demonstrate that a particular nuclear generating facility is needed in order to substitute nuclear generation for fossil-fueled generation. Niagara Mohawk Power Corporation, ALAB-264, NRCI/4R 347, 353-354 (1975).

69. The employment of a "substitution" theory does not obviate the basic requirements established in Vermont Yankee, however, for a showing that the particular facility under review is needed, either for "reliability" (or "satisfaction of

demand") purposes or for "substitution" purposes. Public Service Company of New Hampshire, ALAB-422, 6 NRC 33, 99 (1977).

70. The Applicant has the burden of proof in demonstrating "need for power." Duke Power Company, ALAB-355, 4 NRC 397, 405 (1976); Energy Research and Development Administration, CLI-76-13, 4 NRC 67, 76-77 (1976).

B. Summary of the Parties' Presentations

1. The Applicant's Case

71. The Applicant's case on "need for power" was presented originally during the time period October, 1975-June, 1977. During this time period, the Applicant put on an original presentation in December, 1975 and an updated presentation in June, 1977. When the Atomic Safety and Licensing Board allowed the record on "need for power" to be supplemented upon motion of the Commonwealth, the Applicant made a third presentation on "need for power" in July, 1979.

72. The evidence received on this subject between October 1975 and June 1977 was fully briefed by the parties. See, Applicant's Proposed Finding No. 396, pp. 261-262. The Commonwealth incorporates by reference herein its proposed findings of fact and conclusion of law on this evidence corresponding to the Applicant's Request for a Limited Work Authorization, submitted to the Board August 12, 1977. (A copy of these findings pp. 2-21 is attached hereto for the convenience of the Board and parties as "Exhibit A".) This

prior evidence demonstrates a distinct trend of actual declining electricity needs for both the Boston Service Territory and the region covered by the New England Power Pool (NEPOOL), as well as the Applicant's inadequate demand forecasting.

73. The Applicant's third "need for power" presentation is the most recent and therefore by far the most relevant.

74. The Applicant presented its "need for power" testimony in July, 1979 through two panels of witnesses. Panel 1, dealing with demand and capacity projections and with "substitution" calculations, was comprised of Mr. Benjamin H. Weiner, Vice President-Power Supply Administration, Boston Edison Company; Mr. Philip A. Legrow, Generation Planning Engineer, Boston Edison Company; Mr. Donald V. Bourcier, Chief of Load Forecasting, New England Power Planning; and Mr. Arthur W. Barstow, Manager of Generation Planning, New England Power Planning. Panel 2, dealing with future oil prices, was comprised of Mr. F. Cort Turner, Mr. Nigel Godley, and Mr. David Hanna, all of Arthur D. Little Company. The prepared direct testimony of both of the Applicant's panels appears in the record following Tr. 10,430. The cross-examination of Applicant's Panel 1 appears at Tr. 10,753-10,946 and at Tr. 11,362-11,417. The cross-examination of Applicant's Panel 2 appears at Tr. 10,430-10,481.

75. The Applicant also offered three additional documentary exhibits: the 1979 NEPOOL "forecast", entitled "NEPOOL Forecast for New England, 1979-1989," dated March 1, 1979 (Applicant's Ex. 20A); the 1979 NEPOOL "report on the forecast," entitled "Report of the NEPOOL Load Forecasting Task Force on the NEPOOL Model-Based Forecast of New England Electric Energy and Peak Load, 1979-1989," dated March 1, 1979 (Applicant's Ex. 20B); and the "load and capacity report," entitled "New England Load and Capacity Report, 1978-1989," dated April 1, 1979 (Applicant's Ex. 20C).

76. The general thrust of the Applicant's testimony was that Pilgrim II is needed on a "reliability" or a "satisfaction of demand" basis by December, 1985, and that, even if Pilgrim II is not needed on a "reliability" or a "satisfaction of demand" basis until substantially later than December, 1985, the economics of the situation justify going forward with Pilgrim II on the current schedule upon a "substitution" theory. Prepared Direct Testimony of Applicant's Panel 1, at 9-24, and Ex. NP-33 through NP-43, following Tr. 10,430.

2. The Staff's Case

77. The Nuclear Regulatory Commission Staff first presented its evidentiary case on "need for power" in a presentation made in December, 1975 and in a supplemental presentation in June, 1977. Upon the Board's granting of a motion by the Commonwealth to supplement the record on the

"need for power" issue, the Staff made a third presentation in July, 1979.

78. Because of the passage of time, the Staff's third "need for power" presentation in July, 1979 is by far the most relevant to the Board's decision in this case.

79. The Staff presented its most recent "need for power" presentation through two witnesses, Dr. Sydney Feld and Dr. Wen S. Chern. Dr. Feld's prepared direct testimony appears in the record following Tr. 10,651. Dr. Chern did not file any prepared direct testimony. Dr. Feld's cross-examination appears at Tr. 10,506-10,648; Dr. Chern's cross-examination appears at Tr. 11,240-11,319, and Dr. Feld's and Dr. Chern's joint re-direct and re-cross appears at Tr. 11,320-11,345.

80. The Staff also offered as a documentary exhibit the "Oak Ridge Model," entitled "Regional Econometric Model for Forecasting Electricity Demand by Sector and by State, NUREG/CR-0250, ORNL/NUREG-49," as Staff Ex. 60.

81. The thrust of the Staff's case was that, upon a "reliability" or a "satisfaction of demand" basis, Pilgrim II under the most likely scenario is not needed until the 1988/89 power year, but that on a "substitution" basis, Pilgrim II should continue to be built on its current schedule. Prepared Direct Testimony of Dr. Feld, at 4-23, following Tr. 10,651.

3. The Office of Energy Resources' Case

82. The Office of Energy Resources presented its "need for power" case through two witnesses. Mr. John Buckley presented direct testimny on the subject of future oil prices, which appears in the record following Tr. 10,947, and his cross-examination appears at Tr. 10,372-10,426. Mr. Joseph Fitzpatrick presented non-expert (see Tr. 10,658) testimony on the subject of what he believes to be state energy policy in Massachusetts; his prepared direct testimony appears in the record following Tr. 10,947, and his cross-examination appears at Tr. 10,660-10,729.

4. The Commonwealth's Case

83. Like the Applicant and the Staff, the Commonwealth presented an original "need for power" evidentiary presentation during December, 1975. The Commonwealth presented its updated "need for power" case in July, 1979 through a panel of two witnesses, Mr. Paul L. Chernick and Ms. Susan C. Geller. Mr. Chernick's and Ms. Geller's prepared direct testimony appears in the record following Tr. 11,224 and their cross-examination appears at Tr. 10,969-11,201.

84. The thrust of the Commonwealth's "need for power" case was that, with respect to the "reliability" or "satisfaction of demand" issue, neither the NEPOOL model nor the Oak Ridge model was sufficiently competent to demonstrate any need for Pilgrim II, and , with respect to the

"substitution" issue, no proper cost/benefit analysis had been performed to justify construction of Pilgrim II in order to displace oil-fired generation. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 5-60, following Tr. 11,224.

C. Findings of Fact and Conclusions of Law by the Board

1. Findings and Conclusions Relating to the Applicant's Presentation

85. The Board finds that the Applicant has not presented a scintilla of evidence concerning Boston Edison's "need for power" in the future. Boston Edison never even offered its most recent energy and demand forecast into evidence. The Applicant limited itself to a discussion of New England's, not the Applicant's, future energy and demand projections. There is thus no evidence whatsoever in the record to justify a finding that Boston Edison, or this particular group of applicants, has any need for additional generating capacity in the future based upon a "reliability" or a "satisfaction of demand" justification. As witnesses Chernick and Geller point out, the NEPOOL forecast does not and cannot justify Boston Edison's being a lead participant in Pilgrim II. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 60, following Tr. 11,224.

86. The Board finds that Boston Edison has demonstrated no "need for power" specific to Boston Edison's or the applicant's service territories based upon a "reliability" or a "satisfaction of demand" theory.

87. The Board is not impressed with the Applicant's understanding of its own model (i.e., the NEPOOL model) or with the Applicant's general forecasting competence. Three examples will suffice to demonstrate the Board's concern in this area. First, questioning by the Applicant of the Commonwealth's witnesses disclosed that, not only was one of the Commonwealth's criticisms of the NEPOOL model correct (in discussing the residential module's miscellaneous use predictions) (see, Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 32, following Tr. 11,224), but that the Applicant and NEPOOL understood neither the Commonwealth's criticisms nor the actual workings of their own model. Tr. 11,028-11,035. It is hard to believe that the Applicant and NEPOOL truly understand their own model in light of the questioning at Tr. 11,028-11,035. Second, when faced with the Commonwealth's testimony that the NEPOOL model was subject to the "cross-sectional fallacy" in its modelling of migration (Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 17-19, following Tr. 11,224), the Applicant's questioning seemed to go forward on the premise that a "cross-sectional fallacy" was a figment of the witnesses' imagination, rather than a basic and well-documented potential problem in any area of modeling in the social sciences. Tr. 10,997. In other words, the Applicant's questioning here again indicated that, not only had the NEPOOL model been created without any

sensitivity to the problems of cross-level fallacies, but that, after the problem had been pointed out to the Applicant and to NEPOOL in written, sworn testimony, neither the Applicant nor NEPOOL was ever able to locate a basic reference text which would have explained this relatively simple matter. See, e.g., R. deNeufville and J.M. Stafford, Systems Analysis for Engineers and Managers, at 274-278 (New York: McGraw-Hill Book Company, 1971) (discussing the family of seven cross-level fallacies, one of which is the cross-sectional fallacy). Third, although NEPOOL and the Applicant had been warned in detail that their modelling of the impact of DOE efficiency standards on appliance use by refrigerators and freezers was erroneous (Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 31, following Tr. 11,224), the Applicant's questioning in this subject again indicated that Boston Edison and NEPOOL had never even understood the criticism, let alone corrected the error. Tr. 11,012-11,017.

88. The Board finds that neither the Applicant nor NEPOOL fully understands the workings of the NEPOOL model, and that the model was constructed without an understanding of some of the most basic modelling priciples. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 15-45, following Tr. 11,224.

89. The Board finds that the NEPOOL model has, since the initialization year (1970) and the calibration years

(1971-1976) overestimated the growth in New England peak energy. In fact, if the NEPOOL model continues to over-forecast New England peak growth to the same extent that it has in 1977 and 1978, peak demand can be expected to grow only 0.3% annually in New England to 16,019 MW in 1989. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 44-45, following Tr. 11,224. Peak growth rates were over-forecasted by 3.5% by the NEPOOL model in both 1977 and 1978, and the overall ten-year growth rate projected for 1979-1989 is 3.8%. Applicant's Ex. 20A, p. 6.

90. The Atomic Safety and Licensing Board finds that NEPOOL's forecasts have been declining rapidly in the last few years. The current (1979) long-range NEPOOL peak forecast entails a 3.81% compound growth rate. Tr. 10,767; Applicant's Ex. 20B, p. 5. The 1978 NEPOOL forecast was approximately 4.5%, the 1977 NEPOOL forecast was approximately 5.4%, and the 1976 NEPOOL forecast was approximately 5.6%. Tr. 10,768. In other words, even in the period which followed the Arab oil embargo by 2-5 years, NEPOOL peak forecasts have consistently drifted lower in each year.

91. The Atomic Safety and Licensing Board finds that Boston Edison's own forecasts have also been declining steadily over the last few years. Tr. 10,766.

92. The Atomic Safety and Licensing Board finds that there is a large discrepancy between the 1979 NEPOOL forecast

and the sum of the 1979 NEPOOL participants' forecasts. The Atomic Safety and Licensing Board finds that the NEPOOL forecast declined some 450 MW for the 1987/88 winter peak between the 1978 and 1979 NEPOOL forecasts. Tr. 10,813. However, the sum of the participants' forecasts declined over 2,000 MW between 1978 and 1979 (Tr. 10,814); indeed, one other participant's forecast alone declined by about 1200 Mw between 1978 and 1979 (Tr. 10,814-10,815) and Boston Edison's forecast declined over 200 MW (Tr. 10,812). The importance of this is that the 1978 participants' forecasts were summed (with adjustments for diversity and line losses) to achieve the 1978 NEPOOL forecast. Tr. 10,820-10,821. Since the adjustments for diversity were "close to zero" for the winter peak (Tr. 10,822) and since the 150 MW of line losses (Tr. 10,822) in the 1978 forecast would decrease if participants' forecasts decreased, a 1979 forecast prepared by the 1978 methodology would apparently be more than 2000 MW lower than NEPOOL's current 1979 forecast. Some serious question is raised, therefore, as to why the NEPOOL 1979 forecast exceeds the sum of the participants' forecasts by as much as it apparently does, and why the Board should consider the 1979 NePOOL forecast methodology so superior to previous NEPOOL methodology as to justify ignoring the NEPOOL participants' 1979 forecasts.

93. The Atomic Safety and Licensing Board finds that New England growth in both energy and peak has, in fact, been low

since the last pre-embargo data. For example, for New England's winter peak, the last pre-embargo figure was 13,548 MW in 1972/73, and the current winter peak was 15,111 MW in 1978/79. Tr. 10,780. This translates to approximately a 1.8% compound growth rate. Similarly, with respect to energy instead of peak, New England's total energy consumed was 76,202 GWH for 1973 and 82,800 GWH for 1978. Tr. 10,782. This translates to approximately a 1.7% compound growth rate.

94. The Atomic Safety and Licensing Board finds that there are a large number of very serious conceptual and computational errors in the NEPOOL forecast. For example, in the demographic submodule, the migration equations are improper in that they estimate migration using data <u>across</u> states rather than estimating coefficients over time for each state. This method is simply fallacious. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 17-19, following Tr. 11,224. Wages, although they are projected to decline, do not affect migration in the NEPOOL model, and neither do increases in college enrollments, because 1960-1970 uncorrected enrollment data are used; both appear to be serious oversights and both result in overestimates. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 18, following Tr. 11,224. The labor force participation ratios (LFPRs) are improperly estimated. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 20, following Tr. 11,224. Non-manufacturing

employment is improperly modelled. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 21, following Tr. 11,224. NEPOOL's cost index multipliers in the manufacturing employment sector appear to be incorrect. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 22-24, following Tr. 11,224. Transportation costs are measured incorrectly, and important taxes are ignored as costs while unimportant taxes are modelled. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 24-25, following Tr. 11,224. Energy costs are forecast using an atypical year, and the "Other Costs" category is modelled in a highly suspect manner. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 26, following Tr. 11,224. The transportation cost, energy cost, and other cost errors all favor New england and thus result in overestimates. NEPOOL's forecast handles projections in inconsistent manners from the ways they are treated by the forecasts that supplied the projections. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 27, following Tr. 11,224. Appliance saturations and penetrations, and appliance energy usages, are all modelled with a number of errors. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 27-32. Miscellaneous residential usage is conceptually and factually incorrect and contains unsubstantiated growth trends. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 32-34, following Tr. 11,224. The initialization of the appliancae

consumption data for 1970 by NEPOOL is highly suspect in that it overstates the size of the fastest-growing uses. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 35-36, following Tr. 11,224. The NEPOOL industrial submodule suffers from the following: a projection of the ratio of production to non-production employees that is done in such a complicated and counter-intuitive manner that NEPOOL even confused themselves as to what the model does; unsubstantiated projections of increasing man-hours per employee; arbitrary value added per man hour (VAMH) projections; unexplained and incomprehensible projections of KWH to dollar of value added ratios; and understaed price elasticities. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 36-40. The NEPOOL commercial submodule similarly mishandles price elasticities, mandated conservation, and saturation forecasts. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 40-43, following Tr. 11,224. The NEPOOL forecast as a whole contains extremely serious problems that transcend individual submodules such as improper elasticities, low electric price forecasts, and a complete failure to recognize the effects of reforms such as time-of-use rates, marginal cost pricing, fair back-up and purchased power rates for co-generation and self-generators, conservation programs, and load management programs. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 44, following Tr. 11,224.

95. The Atomic Safety and Licensing Board finds that the NEPOOL model is riddled with serious errors which were never explained by the Applicant or by NEPOOL. Accordingly, the Board gives no evidentiary weight to projections produced by the NEPOOL model. This conclusion is reinforced by the fact that both NEPOOL's and Boston Edison's projections are drifting downward, by the fact that the NEPOOL model overforecasts New England demand in 1976-1978, by the fact that growth in New England peak and energy consumption has been close to stagnant, and by the fact that the NEPOOL model forecasts more peak demand than the sum of its participants project individually.

96. The Atomic Safety and Licensing Board finds that the Applicant and NEPOOL make no allowance whatsoever in their load and capacity projections for the constributions to reliability made by transmission ties to other pools. Applicant's Ex. 20C, pp. 4-36. However, the transmission ties NEPOOL has with New York alone are equivalent to about 800 MW of firm capacity for reliability purposes. Tr. 11,380-11,381. The correct inclusion of this single factor in NEPOOL's Load and Capacity Report (Applicant's ex. 20C) would by itself equal the effective load carrying capacity of Pilgrim II. This results becaue, due to a nuclear power plant's size and outage rates, NEPOOL increases its own reserve margins by 2% for every immature nuclear power plant on line. Tr. 11,366; Tr. 10,755-760. In other words, when an 1150 MW nuclear power

plant is added to NEPOOL's available generation, NEPOOL simultaneously increases its reserve margins by 2%. Tr. 11,366; Tr. 10,755-10,760. As NEPOOL predicts a winter peak in 1985 of 21,502 MW (Applicant's Ex. 20A, p. 6), this implies that Pilgrim II coming on line will increase NEPOOL's required reserve margin by about 430 MW (i.e., 2% x 21,502 MW) and thus will only add about 720 MW (i.e., 1150 MW-430 MW) to NEPOOL's effective load-carrying capacity. A correction of NEPOOL's error in omitting the contribution of transmission ties to NEPOOL's reliability would thus by itself equal Pilgrim II's contribution to reliability.

97. Finally, the Board finds that NEPOOL has not even set capability responsibilities for its participants, including the Applicant, beyond the 1984/85 power year. Tr. 11,362-11,363. The Board also finds that NEPOOL has not set any required reserve margins beyond the 1984/85 power year. Tr. 10,758. Given this, it follows necessarily that NEPOOL cannot demonstrate any reliability requirements beyond the 1984/85 power year before actually setting objective capabilities for the participants and required reserve margins for the pool. As NEPOOL has intentionally done neither beyond 1984/85, NEPOOL has not shown any reliability requirements beyond 1984/85.

98. With respect to the Applicant's "substitution" case, the Board finds that it represents a confusing mixture of

irrelevant and incompatible calculations. The Applicant has employed a cost of equity capital in doing its "substitution" case of 13% (Tr. 11,788) while the Applicant has testified in its most recent rate case that its cost of equity capital is 15% or slightly above 15% (Tr. 10,788). The Applicant used a discount rate of 10.83%, which is the Applicant's own discount rate (Tr. 10,790), but which is not the ratepayers' discount rate (Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 50-54, following Tr. 11,224), although the Applicant appears to be estimating expenses as incurred by the ratepayers. The Applicant used a nuclear fuel cost escalation rate which appears quite optimistic in light of the history the Applicant has experienced in its supplier refusing to deliver on supply contracts. Tr. 10,793-10,795. The Applicant used a conservative total nuclear plant capital cost of $1.895 billion for Pilgrim II (Prepared Direct Testimony of Applicant's Panel 1, Ex. NP-43, following Tr. 10,430) when the capital cost estimate history of Pilgrim II has shown spectacular increases on the order of 25% per year in (nominal) dollars (Commonwealth Ex. 104, 105). Finally, the Applicant used very high real fossil fuel escalation rates of the A.D. Little Report (Prepared Direct Testimony of Applicant's Panel 1, Ex. NP-43, following Tr. 10,430), even though Mr. Buckley of Northeast Petroleum considered a constant oil price in real (deflated) dollars to be a more reasonable projection (Prepared Direct

Testimony of Mr. Buckley, at 6-7, following Tr. 10, 947; Tr. 10,377).

99. The Board also finds that the Applicant has not set out a conceptually correct cost/benefit analysis in its "substitution" case. A cost/benefit analysis must measure, on a consistent basis, the costs and benefits to the same class of people, whether they be a particular class of ratepayers, taxpayers, stockholders, or citizens. The Applicant has not done this, but rather has jumbled many different classes of costs and benefits together in a fashion calculated to understate the price of nuclear power. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 45-54, following Tr. 11,224. Worse, the Applicant hs satisfied itself with merely comparing the costs and benefits associated with various in-service dates for Pilgrim II, omitted consideration of other oil-saving options, and assumed that Pilgrim II would be built either in 1985 or in 1988. Prepared Direct Testimony of Applicant's Panel 1, Ex. NP-37 through NP-43, following Tr. 10,430. A cost/benefit analysis which assumes the ultimate conclusion is not relevant to a decision concerning the ultimate result.

100. The Board in general does not comment upon advocacy positions taken by contending parties in their requests for findings. The Board is reluctant to make such comments because it does not want to chill vigorous advocacy in future cases by

any party by singling out particular points for criticism. However, several points made by Boston Edison in their requested findings are so misleading, and so contradicted by the record, as to require comment.

101. First, Applicants take the Commonwealth's witnesses Chernick and Geller to task for not quantifying their criticisms of th NEPOOL and the ORNL models. Applicant's Requests for Findings No. 440, 444, 458, 467. This is not true. Chernick and Geller made two specific estimates of the effects of errors, where such estimates were possible. Worse, however, is the fact that this is a classic example of blaming the victim. Forecasts that are conceptually incorrect in their foundations simply cannot be corrected by a few cosmetic re-calculations of selected intermediate steps. For analogous reasons, one cannot "quantify" and thus "correct" the errors of forecasts done with a crystal ball or Tarot cards. The Commonwealth should not be blamed merely because NEPOOL and ORNL have produced incomprehensible and unreviewable forecasts. As previously noted, the burden is upon the Applicant, not upon the Commonwealth. See §57, supra.

102. Second, Applicants brush aside the ORNL's model's forecasting of declining profits with the bland assertion that the model was not designed to determine profit margins. Applicant's Requests for Findings, No. 461. The Board is not satisfied with this response, as it implies that the "need for

power" forecast by ORNL would only come to pass as a consequence of electric prices so low as to result in financial instability among New England utilities.

103. Third, Applicants assert that the ORNL model should be accepted because of the reputation of Dr. Chern and ORNL, and because of the testing and evaluation the model underwent. Applicant's Requests for Findings, No. 462. The Board would be more impressed with these qualifications and with this testing and evaluation if ORNL and Dr. Chern had noticed on their own the now uncontradicted fact that the ORNL model's central price equation is misspecified.

104. Fourth, the Applicant relies upon the substantial number of tests run on the ORNL model as proof of the model's dependability (Applicant's Requests for Findings, No. 462. This ignores the fact that the large number of "tests" claimed by Dr. Chern to have been run on the model were not even referred to, listed, or provided to the Commonwealth in response to explicit interrogatories (Commonwealth Interrogatory No. 19, 20 to Dr. Feld, Response dated 6/25/79 by Dr. Chern) and also ignores the fact that Dr. Chern's huge number of test runs indicate a brute force attempt to make data fit a bad model rather than the initial presence of a good model.

105. Fifth, Applicant indicates its own lack of understanding of econometrics when it points with pride to Dr.

Chern's estimated high potential for inter-fuel substitution in New England (Applicant's Requests for Findings, No. 459), apparently ignorant of the fact that Dr. Chern's alleged high potential for inter-fuel substitution in New England directly contradicts Dr. Chern's low long-run elasticities found for New England.

106. Sixth, the Applicant also frankly admits that it has not responded to the specific criticisms of the NEPOOL model made by the Commonwealth's witnesses Chernick and Geller. Applicant's Request for Findings, No. 440, 443. This is simply indicative of the Applicant's inability to respond on the merits to serious substantive criticisms. The Board is not persuaded that the Applicant did not have the time or space in its Requests for Findings; the Applicant devoted over 70 pages to the "Need for Power" issue yet satisfied themselves with only tangential and desultory criticisms of the testimony of Commonwealth witnesses Chernick and Geller. The Board finds that this is indicative of the Applicant's inability to respond substantively to serious forecasting issues raised in a substantive fashion.

2. Findings and Conclusions Relating to the Staff's Presentation

107. The Board finds that the Oak Ridge Model is not sufficiently trustworthy to justify Pilgrim II. The Board is especially mindful of the fact that the Commonwealth's presentation made some extremely serious statements about the

Oak Ridge Model, including the fact that the central price equation is incorrect for several reasons (Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 6-10, following Tr. 11,224), the fact that the model ignored residential gas prices (Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 12, following Tr. 11,224), and the fact that the Oak ridge model ignores mandated conservation and improved load factors (Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 13-14, following Tr. 11,224). None of these unequivocal statements of deficiencies in the Oak Ridge model were even challenged, let alone disproved or discredited, during the Staff's cross-examination.*/ Tr. 11,104-11,147.

108. The Board is not impressed with the Staff's knowledge of the specific details of Boston Edison, NEPOOL, or New England. For example, the Staff's questioning revealed that the Staff believed that NEPOOL's reliability calculations were only affected by winter peak. Tr. 11,119-11,121. This simply displays spectacular ignorance of the way NEPOOL works. Tr. 11,120-11,121; Tr. 11,369-11,378 (Mr. Barstow's discussion of the effect of non-winter peak loads on reliability).

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*/ If only two of the ORNL errors are corrected - mandated conservation and load factors - 1990/91 winter peak is 20,828 MW (Chernick/Geller, p. 14) x 0.92 (Chernick/Geller, p. 13) = 19,162 MW, producing a 36.3% reserve margin for NEPOOL without Pilgrim II or the NEPCO units. Correction of the arbitrary projection of falling prices and the low elasticities would further decrease the forecast.

109. The Board is not impressed by the way the Oak Ridge model manipulated price elasticities between the preliminary report and the final report on the Oak Ridge model. Tr. 11,260-11,272. The final Oak Ridge model used price elasticities that were lower than those reported in the literature and lower than those used in the preliminary report. Tr. 11,260-11,272.

110. The Board is not impressed with the way in which the Oak Ridge model handles gas prices. The Oak Ridge model did not select a gas price variable, despite an enormous number of attempts to make it do so, so the Oak Ridge modellers simply asserted that this proved that natural gas was unimportant in New England, rather than re-thinking their model. Staff Ex. 60, p. 5-3. In fact, when confronted with data which showed that, in energy equivalent terms, that natural gas is more important than electricity in New England, Dr. Chern admitted that he was not surprised. Tr. 11,241-11,251. This was despite the statements in the Oak Ridge model to the contrary (Staff Ex. 60, p. 5-3) and despite Dr. Chern's own previous sworn testimony that gas was "insignificant" compared to electricity in New England (Tr. 11,242). This type of apparent hedging on a very central fact is unworthy of the Nuclear Regulatory Commission Staff.

111. The Board is not impressed by the way the Oak Ridge model projects profits. Profits vary enormously, both over

time and between states; further, they decline uniformly over time. Tr. 11,260-11,261. The original model even predicted negative profits in some cases. Tr. 11,258. It is hard to believe that the Oak Ridge model is not somewhat pathological in this area, especially given the problems discussed previously with the price and profits equations. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, at 6-10, following Tr. 11,224.

112. The Staff's "substitution" analysis suffers from similar weaknesses described above relating to the Applilcant's "substitution" analysis; see §§84-85, supra. The Board makes similar findings with respect to the Staff's "substitution" case. A few examples will suffice. The Staff uses the Applicant's current $1.895 billion Pilgrim II capital cost estimate as the Staff's "high" cost case, despite the fact that the Applicant's capital cost estimates for Pilgrim II are drifting upwards rapidly. Prepared Direct Testimony of Dr. Feld, at 17-19, following Tr. 10,651; cf. Commonwealth Ex. 104, 105. The Staff's analysis assumed that Pilgrim II would be built, and merely compared oil savings between two different in-service dates for Pilgrim II. The Staff did not perform any cost-benefit analysis whatsoever which involves not building Pilgrim II at all as an option. Prepared Direct Testimony of Dr. Feld, at 10-15, following Tr. 10,651. A cost/benefit analysis which assumes the result is not useful in determining whether or not the result itself is appropriate.

3. Findings and Conclusions Relating to the Office of Energy Resources Presentation.

113. The Atomic Safety and Licensing Board adopts the conclusions of Mr. Buckley that the price of fuel oil in nominal dollars will grow with inflation generally and thus will remain constant in real (deflated) dollar terms. Prepared Direct Testimony of Mr. Buckley, at 6-7, following Tr. 10,947; Tr. 10,377.

114. The Atomic Safety and Licensing Board accepts the Office of Energy Resource's stipulation that Mr. Fitzpatrick was not and is not an expert witness. Tr. 10,658-10,659. Accordingly, the Board makes no findings based upon Mr. Fitzpatrick's proffered calculations.

115. The Atomic Safety and Licensing Board is not impressed with Mr. Fitzpatrick's candor and forthrightness. Although Mr. Fitzpatrick testified that he believed state policy to be to reduce oil consumption, Mr. Fitzpatrick refused to admit that in fact he had taken a contrary position before the Energy Regulatory Administration of the U.S. Department of Energy with respect to an MMWEC facility until he had been asked three times and finally asked by the Chairman. Tr. 10,671-10,673. Similarly, Mr. Fitzpatrick refused to say whether a state agency, of which he testified he had been the head, still existed (Tr. 10,660-10,665), apparently to hinder the admission for the truth of the matters contained therein of a document produced by that office. See Tr. 10,695-10,705.

4. Findings and Conclusions Relating to the Commonwealth's Presentation

116. The Atomic Safety and Licensing Board adopts in whole the testimony of the Commonwealth's witnesses. Prepared Direct Testimony of Mr. Chernick and Ms. Geller, passim, following Tr. 11,224. The Board concludes from these two witnesses' lengthy cross-examination that they both understood the forecasting models in issue better than the proponents of the respective models and that they have correctly evaluated the weaknesses of the NEPOOL and the Oak Ridge models. The Board finds both Mr. Chernick and Ms. Geller to be competent and candid in their responses to cross-examination.

117. The Board finds that, in fact, upon a "satisfaction of demand" or "reliability" theory, the Commonwealth has conclusively shown that neither the Applicant nor the Staff has met the Applicant's burden of proof on the "need for power" issue. Both the Applicant's and the Staff's "reliability" cases are completely without weight.

118. The Board finds that sufficient errors, biases, conceptual mismatches and irrelevancies have been identified in the Applicant's and Staff's "substitution" arguments to cause the Board to reject the "substitution" analyses. This finding relies heavily upon the limited nature of the cost/benefit analyses done by the Applicant and the Staff; in both cases, the construction of Pilgrim 2 was assumed, and the only "analysis" compared two different in-service dates.

119. The Board finds that no convincing "need for power" has been demonstrated, either by the Applicant or by the Staff.

IV. ALTERNATE ENERGY SOURCES

120. Commonwealth Contention #3 is as follows:

> "The Applicants and the Staff have not given adequate or accurate consideraion to solar power, wind power, the use of fossil fuels, the high-temperature gas-cooled reactor or the burning of solid waste [see Tr. 832] as alternate source of power."

121. The National Environmental Policy Act, 42 U.S.C. §4321 et seq. and the regulations promulgated by the Nuclear Regulatory Commission under the authority of that statute, 10 CFR §50.20(a)(3) impose an obligation on the agency to explore alternatives to a proposed project such as Pilgrim 2, and to assess their environmental impact. This mandate has been interpreted to mean that these alternatives are to be explored to the fullest extent possible. Calvert Cliffs Coordinating Committee v. AED, 449 F.2d 1109 (1971).

122. To demonstrate that its proposed project is the superior solution to the problem of generating electricity to serve the needs of the Boston Edison customers, the Applicants must show that there is a need for the electricity, that its environmental costs do not outweigh its electricity generating benefits.

123. The question of alternative sources of electrical energy along with the question of the need for power go to the heart of this controversy. If the power is not needed, Pilgrim 2 should not be built; if the needed energy can be supplied in an environmentally preferable way, Pilgrim 2 should not be built. Because Contention 3 goes to the heart of this

controversy, the burden of the proof on the Applicants should be correspondingly high. "[T]he magnitude of the burden of persuasion placed on a litigant should be influenced by the gravity of the matter in controversy." Virginia Electric Power Co. (North Anna Power Station Units 1, 2, 3 and 4) ALAB-256 (January 27, 1975) fn. 18.

124. As discussed above, the Applicants have not demonstrated that there is a need for an 1180 MW nuclear power plant. Even if the Board were to find that additional capacity is needed, the combination of alternatives of coal, solar, and the burning of solid waste can supply that need at an economically competitive price and with less impact to the environment.

125. The Commonwealth introduced evidence on the energy potential of solid waste resource recovery through Mr. Alden E. Cousins, Director of the Mass. Bureau of Solid Waste Disposal. (POst Tr. 5411.) This Bureau is engaged in the process of land acquisition and contracting to promote this technology.

126. The burning of solid waste to create steam which generates electricity is economically and technically feasible as shown by the fact that

(a) such plants already exist in Switzerland. (Tr. 1459)

(b) a steam generating plant built by Universal Oil Products already exists in Harrisburg, Pa. (Tr. 5438)

(c) experts Vetrano and Cousins agree that such systems are technologically feasible and economic. (Vetrano Testimony, Post Tr. 1409 at 33; Cousins Testimony, Post Tr. 5411 at 2)

127. A plant burning 1200 TPD of trash and generating steam from it currently exists in Saugus, Massachusetts. (Tr. 5463). Universal Oil Products plans a plant to be operational in Haverhill, Massachusetts in 1979 which will burn 3000 TPD of mixed solid waste and generate 60 MW of power. (Cousins Test., pp. 1-2).

128. The Haverhill plant is technically feasible because it will use the reliable and technologically proven waterwall incinerator which has been in use since 1964 to generate steam. (Tr. 5440, 5441, 5495, 5496.) The technology of generating electricity from steam is proven and reliable. (Tr. 5441) Furthermore, the technology is economically feasible. (Tr. 5473)

129. By 1982, the combined generating power of the Saugus and Haverhill plants, plus a proposed plant west of Boston, is 145 MW. (Cousins Test., p. 7.) The Commonwealth of Massachusetts is strongly committed to promoting this technology. (Neely Test., p. 17.) Boston Edson has considered the purchase of steam from such plants located in eastern Massachusetts (Tr. 5 445, 5494).

130. There is more than enough solid waste generated in Massachusetts to supply fuel for the Saugus, Haverhill and West Boston plants. (Tr. 5482, 5483, 5487, 5488.) Studies by Raytheon and Arthur D. Little estimate that about 470 MW of power could be generated from solid waste in Massachusetts alone. (Tr. 5444.)

131. Simultaneous burning of solid waste and generation of electricity is a sound environmental alternative because

(a) it doesn't involve use of additional resources since the fuel is waste.
(Tr. 1438)

(b) it generates needed power. (Tr. 1438).

(c) it reduces use of expensive and environmentally unsound landfills.
(Cousins Test., pp. 4-5)

132. The Haverhill plant is an environmentally sound alternative source of energy because

(a) it will not result in environmentally unsound thermal discharges into the Merrimack River. (Cousins Test., p. 6)

(b) it will have environmentally acceptable levels of sulfur emissions. (Tr. 5453, 5454)

(c) the burning will result in high quality residue which is commercially marketable and therefore will not have to be disposed of in a landfill. (Tr. 5458, 5459, 5460)

133. Environmental and economic conditions will cause these solid waste burning facilities to be built because

(a) cost of waste disposal is increasing.
(Tr. 5492)

(b) air pollution control regulations are forcing municipal incinerators to close.
(Tr. 5492)

(c) land for landfills is becoming more expensive and scarce.
(Tr. 5492)

134. It is the unanimous conclusion of witnesses on all sides that because of its environmental and energy benefits the simultaneous burning of solid waste and generation of energy should be encouraged. (Tr. 1366; Vetrano Test., Post Tr. 1409 at 36; Tr. 1441-1443 5410.)

1516 289

135. Three parties introduced evidence on the feasibility and economics of certain applications of solar power in New England. (Applicant's Testimony on Alternative Energy Sources, Post Tr. 955; Staff Witness Vetrano, Post Tr. 1409, and Commonmwealth witness Converse, Admitted Tr. 1540.) It should be stated at the outset that the Commonwealth does not contend that central station electric generation from solar power is feasible in New England at this time. Professor Converse, Professor of Engineering at Dartmouth, with practical experience in the field, testified for the Commonwealth that solar heating of space and water is technically feasible and economically competitive. (Converse Test., p. 7)

136. Both Applicants' witness White and Commonwealth's witness Converse agree that solar heating of homes and hot water is technologically feasible. (Tr. 1360; Converse Test. p. 7; Tr. 1584, 1587.) There are solar units in operation in New England at the present time. (Tr. 1412, Tr. 1549)

137. Because backup storage systems can be used, the New England climate is not necessarily a drawback to the use of solar heating. (Tr. 1580)

138. Solar panels are presently available through the Gardener Research catalogue. (Tr. 1588) Support services, although not universal, are presently available to service and repair solar heating and hotwater units. (Tr. 1620)

139. Because of rising fuel costs, the Staff's estimates that solar heating systems will become economically competitive with conventional heating systems in 1985-1990, based on a

comparison of projected solar costs with 1972 conventional heating costs, is an invalid comparison. (Vetrano Test., p. 14 contains this comparison. Tr. 1421 confirms he used 1972 prices, Tr. 1612) Also, estimates that cost of solar panels must come down to $2-4 (Vetrano $2.10-2.20 in 1980, Tr. 1422) per square foot installed are invalid because they do not take into account the dramatic rise in conventional fuel prices. (Tr. 1612)

140. The capital costs of solar heating systems are expected to decrease (Converse Test., p. 6). Increased ERDA funding will further advance solar technology. (Tr. 1392)

141. The cost of the solar space heating system in the DeVries building in New Hampshire, monitored by Professor Converse, was $5 per square foot installed in 1974. (Tr. 1564) Between January 1, 1975 and end of that heating season, DeVries Building received 40% of its heat from solar heating unit. (Tr. 1556) Based on his detailed observation of the DeVries Building and computer simultations, Professor Converse concludes that 50-70% of home heating needs could be supplied by solar heating. (Tr. 1557, 1591)

142. Forty percent of all energy used in New England goes for space heating. Therefore, the use of solar energy for space heating can result in a substantial reduction both in the demand for imported fuels and for nuclear power. (Converse Test., p. 1; Tr. 1605) Solar energy involves essentially no environmental degradation and is being promoted by the government. (Converse Test., p. 4)

143. Of the more conventional sources of power which are reasonable alternatives to Pilgrim Unit 2, coal is the most likely alternative. (Applicant's Testimony on Alternate Energy Source Post Tr. 955, p. 28) A great deal of attention was given in these proceedings, both in the fall of 1975 and in June 1977 to the coal versus nuclear issues. In the latest session, the Applicant offered "updated" testimony on the economic comparison of the two fuel sources (Post Tr. 8207), which the Commonwealth rebutted with testimony showing that the 70% expected capacity factor claimed by the Applicants for Pilgrim 2, and at the heart of their economic comparison, is unreasonable based on a statistical analysis of the performance of all U.S. nuclear power plants to date. (Testimony of Nancy A. Boxer, Post Tr. 8587)

144. To set the background, it is established that a coal-fired plant has the following advantages:

(a) its source of fuel, coal, is free from foreign influence and is abundant;

(b) the extraction and use of coal to generate electric power has an advanced technology. (Vetrano Test., Post Tr. 1409, pp. 15-16)

145. There are 217 billion tons of demonstrable and economically recoverable reserves of coal in the United States. The annual coal production (as of the time of the Applicant's Direct Testmony in 1975 was 600 million tons. There are sufficient coal reserves to take care of the fuel needs of a coal-fired alternative to Pilgrim 2. (Applicant's Test., Post Tr. 955, pp. 35-36)

146. In 1975, Applicants calculated the capital cost of a coal-fired alternative to Pilgrim 2 to be 15% less than the capital cost of Pilgrim 2. (Id. at 32.) This is the figure generally accepted throughout the industry. (Tr. 8140)

147. In its original testimony, the Applicant made an analysis of coal versus nuclear based on ranges of assumptions concerning capital, fuel and operating costs for each, and on a range of capacity factors. Many of these were challenged by the intervenors. However, the Applicant took an entirely different approach in its Supplemental Testimony. This time, it relied on an Edison Power Research Institute (EPRI) financed report on coal capital costs to fix a figure for purposes of the comparison. It assumed a 70% capacity factor for Pilgrim.

148. Most significantly, the Applicant's witness, Mr. Gerber, accepted the premise that coal capital costs would be 100% of nuclear and, based on that premise, he actually analyzed only the fuel costs of the two options. His calculation that nuclear has a small cost advantage of 1.69 miles per Kwh over coal is based only on fuel costs. (Tr. 8109, 8111, 8138)

149. The EPRI-financed study on coal capital costs offered by the Applicant (Post Tr. 8207) was done by the Bechtel corporation. That report is the first portion of a two-part study examining the total generation costs of coal and nuclear plants. Another consultant, United Engineers and Constructors, is in the process of writing the second portion of the study -- the portion that will deal with nuclear capital

costs. That crucial portion of the study is not yet completed. (Tr. 8230-8240) Until EPRI releases United Engineers and Constructors' portion of the study, dealing with nuclear capital costs, it is a misuse of the Bechtel-authored portion to argue that it demonstrates that coal and nuclear capital costs will be identical in the 1980's. The Bechtel-authored portion only gives half of the story, at best.

150. The Staff offered evidence strongly supportive of the proposition that coal capital costs will be around 85% or less of nuclear costs. (Nash Supplemental Testimony, Post Tr. 8304, Table 1 at p. 3.) The Staff presented the results of various studies comparing coal and nuclear costs. Only studies which dealt with both options were included. (Tr. 8316) The most recent study done by United Engineers and Constructors in December 1976, for power plants to be operational in 1986, concluded that coal capital costs would be 79% of nuclear costs. (Id.) There were four studies listed for plants operational in the 1980's. The average of the results were that coal capital costs will be 84% of nuclear capital costs. (Id.) Given this evidence, it is not appropriate to give credence to the Applicant's position that coal and nuclear capital costs are equivalent.

151. We have other substantial doubts about the applicability of the EPRI report to this proceeding. The report assumed that two 500 MW coal plants would be built, although its own figures indicate that capital costs would be

lower for one 1000 MW unit. (Tr. 8213-8316) The Applicant's analysis did not attempt to identify the optimum size of a coal plant that might actually be built. (Tr. 8220)

152. Since it is established that coal capital costs will be about 85% of nuclear capital costs, the fundamental premise upon which Mr. Gerber based his analysis is faulty. Only by inflating the capital costs for coal can nuclear power gain an economic advantage. If coal capital costs are held at reasonable levels, and a 10.8 m/kwh is used for nuclear fuel costs (which is "a more reasonable number to use"), coal has the economic edge. (Applicant's Test. Post Tr. 7927 at 28; Tr. 8105-8107)

153. Finally, the cost of electricity is extremely dependent on the reliability of power plants. A ten percentage point change in the capacity factor of a nuclear plant, for example, leads to a 12% increase in the cost of a Kwh. (Lee-Levy Test. "The Economics of Nuclear Power: A New England Perspective", Post Tr. 4962 at 35) Therefore, comparison of the total generating costs of coal and nuclear is heavily dependent on the assumptions made regarding expected capacity factor. Capacity factor is relatively more significant for nuclear plants, which have higher fixed costs but lower fuel costs than equivalent fossil plants. Traditionally, the nuclear industry has over-estimated the reliability of nuclear plants, projecting capacity factors in the 70-80% range. (Commonwealth Exhibit #16, "Nuclear Plant Performance/Update," p. 1; Lee-Levy Test., 16-20, 36-37)

154. In this case, the Applicant projected the expected capacity factor for Pilgrim Unit 2, in 1988, to be 70%. (Applicant's Test., Post Tr. 8207, p. 7) All of the calculations in the Applicant's Supplemental Testimony are based on this projection. The Commonwealth established through its witnesses and through cross-examination, that this reduction is wholly unjustifiable and that Pilgrim 2 is much more likely to have a capacity factor in the 45%-55% range.

155. The Commowealth presented three pieces of evidence bearing on the question. Dr. Gordon MacDonald of Dartmouth College, a noted authority on energy and environmental issues and a former member of the President's Council on Environmental Quality, performed a statistical analysis of the capacity factors of baseload nuclear and coal plants. (Post Tr. 5690)

156. The Applicant extensively cross-examined Doctor MacDonald. In view of this, it is important to note that Doctor MacDonald did not purport to precisely predict what any one nuclear will achieve in any one year; such an attempt by anyone would be unrealistic. His testimony was offered as a guide drawn from the real experience of how capacity factors of nuclear and coal-fired plants have compared in the past. Much of the cross-examination went to the size of the data base. The relatively small data base is due to the small number of nuclear plants in operation. (Tr. 6295, 6320)

157. Doctor MacDonald's projections are useful guides to aid the board in its decision on the validity of applicants' projected capacity factors because:

(a) the model is best method of projection given limited data available. (Tr. 5740, 6317)

(b) the model is constructed in the following sequence which assures that the model evolved from the data and not that the data was contorted through a deceptive model:

(1) the data is collected first.

(2) an analysis of the data is performed to determine what the important variables are.

(3) the important variables affecting cumulative capacity factors of coal plants are, design power and years of operation.

(4) a model is constructed which represents the observed relationship among the e variables. (Tr. 5766-5767, 5776)

The actual post data and relationships among variables determine the signs in the model, not vice versa (Tr. 6256)

158. Doctor MacDonald's model quantifies this observed relationship based on actual performance of coal-fired plants;

1. increase in size of coal-fired plant causes cumulative capacity factors to decline.

2. the cumulative capacity factor rises as coal-fired pants operate longer.

3. the date a coal plant went into service has no effect no the size of its cumulative capacity factor. (Tr. 5767)

159. Historical data shows that coal-fired plants have higher cumulative capacity factors than nuclear plants, therefore the generating costs of coal plants are lower than nuclear. (Revised Table 5, June 30, 1976 letter updating

MacDonald's April 1, 1976 testimony.) The expected cumulative capacity factors and the lower capital costs for coal-fired plans make coal-fired plants preferable to nuclear plants. (Tr. 6282)

160. Doctor MacDonald's testimony was fully confirmed and extended by the Commonwealth's witness, Ms. Nancy A. Boxer, a economist and co-author of "Nuclear Plant Performance/Update: Data Through Dec. 31, 1976," published by the Council on Economic Priorities. (Boxer Test. Post Tr. 8587; Commonwealth Ex. 16.) Ms. Boxer's statistical analysis of nuclear plant capacity factors is based on the operating records of all United States nuclear plants through the year 1976. It thus increases substantially the data base available to Doctor MacDonald.

161. The statistical analysis employed by Ms. Boxer involved the use of multiple regression to estimate the simultaneous effects of several independent variables -- size, age, vintage, duplicate status, prototype status, and fuel system cost -- on the dependent variable, capacity factor, for a given unit year. Multiple regression analysis is the methodology accepted by most economists and other scientists interested in determining the simultaneous influence of several factors on a variable, in order to determine correlation between factors, to enable inferences of causation, and to predict the future. (Boxer Test., p. 5)

162. Boxer's analysis showed that only the effects of size of plant and age are statistically significant to capacity factor at the 95% confidence level. Every MW increase in size correlates with a decline in capacity factor of almost 4 percentage points. (Boxer Test., p. 8)

163. Boxer's equations and a detailed explanation of her statistical analysis are included in her testimony. (Post Tr. 8587) The model reflects reasonable expectations for capacity factors derived from actual, statistically significant trends, and demonstrates that one would expect the average 1150 MW PWR operational in 1984 to achieve a capacity factor of 47.75% in 1988. (Boxer Test., p. 11; Tr. 8644, 8739) In order to be conservative, Ms. Boxer considered that some improvement might result from learning in the industry. It is her opinion, therefore, that Pilgrim 2 may be expected to achieve a capacity factor in the range of 45%-55% in the year 1988, its fourth year of commercial operation. (Boxer Test., p. 14) It can be noted here that BECo's only other nuclear plant -- Pilgrim Unit 1 -- has also performed far below its owners' expectations. At the end of 1986, Pilgrim 1 had a cumulative capacity factor after 4 years of operation of 47%, and a capacity factor in 1976 alone of 41.1%. (Comm. Ex. 16, Table 2.3, pp. 6-7)

164. It should also be noted that Ms. Boxer's projections fit very well with the range of assumptions made in the Lee-Levy testimony, "The Economics of Nuclear Power; A New England Perspective." Post Tr. 4962:

". . . [T]he reliability of a nuclear plant determines its competitive advantage or disadvantage over a coal plant. . . . A nuclear plant costing $1000/Kw will have a 13% lower generating cost than a coal pant supplied with $48 coal if the former has a capacity factor of 70%. With a 60% capacity factor it will produce electricity at 40% greater cost than the coal plant."
(Id. at 35-36)

165. Even if one uses the Applicant's assumptions, varying only the capiatal cost of coal to assume that it is 83% of nuclear, the nuclear plant must achieve a 54% capacity factor to break even with coal. (Tr. 8288) This is at the top of the range predicted by Ms. Boxer and substantially better than the performance of Pilgrim 1.

166. We find that the Applicant's claims of a 70% capacity factor of Pilgrim 2 have no justification in past experience or reasonable expectation. They are highly optimistic and self-serving. (Tr. 8739)

167. Based on the foregiong, the Board finds that, using reasonable assumptions, Pilgrim 2 will be more expensive than a comparable baseload coal plant.

168. We do not believe that the amendent to the F.D.E.S. offered by the Staff through Doctor Gotchy, can serve as a basis for rejecting the coal alternative on health grounds. (Gotchy Test., Post Tr. 8358) First, as discussed above, the Staff explicitly represented that Doctor Gotchy's testimony was not offered in response to the contentions of the parties on alternative energy sources and would not be relied on for that purpose. Secondly, Doctor Gotchy readily admitted the extreme

uncertainties in his work. For example, Doctor Gotchy offered a range for additional public disease due to the coal fuel cycle of 3 to 100, in contrast to comparable figures from the Ford Foundation of from 2 to 25. (Tr. 8361-8363) Also, while recognizing that the implementation of federal laws will substantially reduce sickness among coal miners, his current estimates did not take that factor into account. (Tr. 8379-8380) Most importantly, Doctor Gotchy's conclusion was that the public risk associated with both fuel cycles was so small as to be insignificant in comparison to all other human risks. (Tr. 8383-8384) It would be inappropriate to discount coal's advantages based on this evidence.

169. The Applicant has consistently overestimated the purported advantages of nuclear power. They have failed to account for the dramatic escalation in the capital cost of Pilgrim 2.

170. The Applicant has also been overly sanguine about the availability and cost of uranium to fuel Pilgrim 2.

WASH - 1535, the proposed Final Environmental Statement, Liquid Fast Metal Breeder Reactor Program, Vol. 1 Dec. 1974, U.S. Atomic Energy Commission §1.1.4.2, "availability of Uranium Resources" estimates 1990 needs of a 2.4 million tons of uranium. (Tr. 1188) WASH - 1535 foresees shortages of uranium after 1990 unless new uranium discovered. (Tr. 1190)

171. The Applicant cites no facts on which to base its conclusion that there will be recycling of nuclear fuel. (Applicant's Test. Post Tr. 955, p. 45) At present, there can

be no such reasonable expectation. In estimating cost of fuel, Applicants assumed use of mixed oxide fuel and breeder reactors. (Tr. 6311) This is another wholly unjustifiable assumption, given President Carter's recent actions indefinitely deferring recycling and the Clinch River Breeder Project. Deferring recycling of nuclear fuel will result in increased costs to Pilgrim 2.

172. Based upon the foregoing, the Board finds that coal-fired power plants are a presently existing and reasonable alternative to Pilgrim 2 which can supply all the power needed by the Applicants at a cost less than that for Pilgrim Unit 2 and that any environmental problems with coal-fired plants have been identified and have presently existing technological solutions (Tr. 1291-1292, 6325) but Applicants have inflated the cost of a coal-fired alternative thereby failing to explore that alternative to the fullest extent possible.

173. The Board finds further that the Applicants have underestimated both the economic and environmental costs of Pilgrim 2 by factoring into their analyses conjectures of unrealistically high capacity factors and unrealistically favorable nuclear fuel costs; they have assumed the continued existence of a regulatory climate which will encourage the growth of the nuclear fuel industry and the recycling of nuclear fuel; this analysis has prevented them and the Staff from exploring alternatives to the fullest extent possible.

V. ALTERNATIVE SITES

A. The Methodology and Analysis

Since the initiation of this proceeding, the Commonwealth has vigorously pursued two contentions asserting that the Staff and Applicant have not given adequate consideration to alternative sites:

Commonwealth Contention 4

> The Applicants and the Staff have not given adequate consideration to underground siting, offshore siting and inland siting using closed-cycle cooling systems, as alternative types of sites.

Commonwealth Contention 12s

> Neither the Applicants nor Staff have adequately considered the alternative of locating the proposed plant at a site more suitable from a population density and environmental standpoint.

173. The need to analyze alternative sites arises from the Commission's obligations under the National Environmental Policy Act 42 U.S.C. §4321 et seq. The Licensing of a nuclear power plant is a "major federal action" which requires the Commission to examine to the fullest extent possible reasonable alternatives to the applicant's proposal. See, 42 U.S.C. §§4332(2)(c) and 4332(2)(E). The Commission has recognized that consideration of alternative sites is the "linchpin" of the environmental analysis for a proposed nuclear plant. Public Service Company of New Hampshire (Seabrook Station, Units 1 and 2) CLI 77-8, 5 NRC 503, 522 (1977)("Seabrook") citing Monroe County Conservation Society, Inc. v. Volpe, 427 F.2d 693, 697-698 (2nd Cir. 1972).

174. The standard by which the Board decides whether to reject or modify a utility's application is "whether an alternative site is obviously superior to the site which the applicant has proposed" Seabrook, 5 NRC at 530. This standard assumes and does not distract from the staff's independent obligation to conduct a thorough, well reasoned and detailed analysis and comparison of alternative sites. Boston Edison Company (Pilgrim Nuclear Generating Station, Unit 2, ALAB 479, 7 NRC 774, 779 (1978)("Pilgrim"); Seabrook, supra 5 NRC at 530.

175. In November 1977, this Board denied Boston Edison's request for a limited work authorization. Pilgrim, LBP-77-6, 6 NRC 839 (1977). After carefully reviewing the evidence and testimony of the applicant and the staff, the Board concluded that the Staff's evaluation of alternative sites did not satisfy NEPA requirements. The Applicant and the Staff appealed our partial initial decision, which the Appeal Board subsequently affirmed in May 1978. ALAB-479, 7 NRC 774 (1978).

176. In so ruling, the Appeal Board specifically rejected the Staff's generalized review and inadequate investigatory techniques for screening and evaluating alternative sites. ALAB-479, 7 NRC at 791. The Appeal Board identified many examples in the Staff's analysis which were not only lacking in specificity of detail, but sorely wanting in well-reasoned analysis. 7 NRC at 782-791. The Board upheld our determination that the Applicant's evidence, which we reviewed

with scrutiny, did not cure the deficiencies in the Staff's review. 7 NRC at 792-794.

177. With respect to Applicant's review, another Appeal Board decision Seabrook provides further guidance. In ALAB-471, the Appeal Board admonished the Staff to view Applicant's statements regarding alternative to its proposed site with the same "dispassionate and skeptical eye" as it does with safety matters." Seabrook, ALAB-471, 7 NRC 471, 505 (1978). The staff should be wary of broad and unsupported assumptions which favor an applicant's site. NEPA requires the staff to do more than list possible disadvantages to a particular site without any indication of their gravity or relative weight. It is precisely this rigorous analysis expected of the staff which justifies application of the obviously superior test at the end of that analysis. Seabrook, CLI-77-8, 5 NRC at 530.

178. We recognize that the scope of an alternative site search is not "self defining", but rather depends on the facts and circumstances of each case. ALAB-479, 7 NRC at 779.*/ In determining whether the Staff has taken a "hard look" at alternative sites the second time around, we are mindful that the Commonwealth has consistently stressed a grave

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*/ Vermont Yankee Nuclear Power Corp. v. NRDC, 435 U.S. 519, 551 (1978).

concern about the high population densities surrounding the Rocky Point site.*/ While population density is one among other factors to be considered in an alternative site analysis, it has special environmental and safety significance. From a safety standpoint, high population densities and unique site characteristics can operate to restrict or preclude timely evacuation. From an environmental perspective, densely populated areas have a higher residual risk from the consequences of a major reactor accident. See, Section IV(B) Demography, infra.

179. Subsequent to the Appeal Board's decision in ALAB-479, the Staff undertook a closer look at the Applicant's 1974 draft Siting Study, which had been previously presented in this proceeding in summary form. Post Tr. 1685; Tr. 9725-9729. The Rocky Point site was not considered in this study which was limited in geographic scope to eastern Massachusetts. The Staff concluded that the Applicant's site selection process had produced a slate of candidate sites which were "potentially licensable" and "among the best that reasonably could have been found "within the identified "region of interest." FSFES, (vii), §2. While accepting the Applicant's justification for limiting its study to eastern Massachusetts, the Staff concluded that this limitation was

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*/ See FSFES, A-7-A-30, FES. A-8-A-9; See also comments of the Department of the Interior FSFES A-31.

arbitrary, and consideration should have been given to the "resource area" of the Connecticut River, the largest fresh water source in the Commonwealth FSES (vii), §2, §4.

To supplement this major deficiency the 1974 siting study, the Staff chose the Montague site as representative of this resource area to compare to Rocky Point. FSFES (viii). The Staff also examined Seabrook and Millstone, in alleged response to ALAB-479, not withstanding its belief that these sites were not reasonable alternatives to Rocky Point "because of problems involving siting outside of Massachusetts". FSFES, §4, see §3.

180. Thus, the final slate of candidate sites brought forward by the Staff for detailed comparison with Rocky Point included three nearly contiguous sites on the Merrimack River (sites 1, 2, and 2A); three coastal sites, one cluster of 4 sites on Cape Cod Bay in Plymouth (the site 18 Complex); two on Buzzard Bay (Sites 19 and 20); and Montague, Seabrook and Millstone. The Staff concluded, after reviewing data for these sites that none of the candidate sites was obviously superior to Rocky Point. FSFES, at 4-60.

181. The Commonwealth contends, by way of its extensive comments on the Draft Supplement and cross examination, that the Staff failed to employ any uniform or consistent criteria to its selection of candidate sites and its comparison of those

sites to Rocky Point.*/ The Commonwealth points to various methodological criteria for site selection and comparison which apparently has evolved within the NRC in recent years. If such criteria had been applied by the Staff in this case, the Commonwealth argues the Staff would not have accepted the Applicant's slate of candidate alternate sites, and would have selected more geuiene alternatives to Rocky Point from areas in the Connecticut River and in New Hamphsire or Connecticut. FSFES, A-17/A-16.

182. There is a certain appealing logic to the site screening process which the Commonwealth describes, for it appears to be designed to produce leading candidates for final comparison with the proposed site. See, Seabrook, CLI-78-14, 7 NRC 952, 956 (1978); CLI-77-8, 5 NRC at 530 n.30 (1977). The Staff expressly disavows any current regulatory requirements which impose a particular site selection methodology on applicants or review criteria for the staff. FSFES §§4, 5.5-5.19. We note however, that both the Applicant and Staff pay extensive lip service to the site screening terms and process advanced by the Commonwealth in its comment in all of their subsequent evidence.*/

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*/ The Commonwealth also asserts that the Staff did not give proper consideration and weight to population density in its alternative site analysis. FSFES, A-16/A-30.

*/ See App. Direct Testimony, Post Tr. 9608; App. Ex. 16; Staff Suppl. Testimony, Post Tr. 9852.

183. We hesitate to probe the site selection methodology of the Applicant because we believe the question we must determine under NEPA is whether the Staff's analysis was reasonable. Seabrook, CLI-77-8; 5 NRC 503.*/ On the other hand, we must assure ourselves that the Staff's review produced a slate of realistic alternatives sites and not just "straw men" to be stuck down in the comparison with Rocky Point. In this case, the Staff accepted the Applicant's slate of sites without investigating the quality of that slate. Instead, the staff examined the methodology employed by the applicant to determine its reasonableness. Tr. 9777-9778; see discussions Tr. 9759-9778. Perforce, we are compelled to examine, at least briefly, the Applicant's information upon which the staff relied.

184. First, the Applicant's 1974 Siting Study, App. Ex. 14, is the same study presented in previous hearings on this matter. Post. Tr. 1678, Tr. 9729. This draft study looked only at Eastern Massachusetts in terms of Boston Edison's

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*/ While we admitted the Applicant's siting study and 1978 updates into evidence, we feel we cannot give much weight to this information and analysis. This is true, in large part, because the sponsoring witness for the study, Mr. Griffin, knew very little about the methodolgy and assumptions employed in the siting, let alone details. Tr. 9638-9844. While he was apparently a "principal investigator" in the study, he appears to have participated only in general environmental subject areas, on which he had no particular expertise. App. Direct, Post Tr. 9608 at 2; Tr. 9682-9696. His "supervison and control" of the Applicant's 1978 submissions to the Staff appears to have been administrative at best. App. Ex. 15, Post Tr. 9676.

general needs through the year 2000, and did not investigate western Massachusetts or other New England states. The Rocky Point site was never passed through the screening process used in the study, but was excluded on the assumption that the site already housed three nuclear units. Tr. 9722-9728; Tr. 9841 - 9143. It is clear, therefore, that Rocky Point was not selected on the basis of its superiority to the sites analyzed in this study.

185. The study screened resource areas, within eastern Massachusetts, defined by major water bodies, for two large basedload units. (fossil or nuclear). General attention was given to both engineering (cost) and environmental concerns. Tr. 9745-9746, App. Ex. 14 (A). The screening criteria for nuclear sites were primary water and land availability for 3000-4000 MW (2-3 units). App. Ex. 14 (A), II-2; Staff Supp. Testimony, Post Tr. 9852 at 14. Demography was considered, but no apparent threshold for popular densities was used. Tr. 9754-9788.*/ No

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*/ The Siting Study indicates that cumulative population density were calculated, using a then proposed AEC population guideline of less than 30,000 persons within 5 miles, 500,000 within 20 miles at 2 million within 2 miles. Transients and seasonals were not considered. The low popular zone requirements of 10 CFR 100 were also used. These criteria were not strictly used as deferred criteria. App. Ex. 15, letter May 30, 1978, Q: 312.1. For example, the North Shore costal and estuarine sites were deferred because of high population and ecological impact considerations, while the alternative sites (1, 2, 2A) were selected as preferred sites even though they exceeded the population criteria. Tr. 9811-9819.

specific or uniform deferral criteria were employed in the selection of the candidate sites other than generalized problems associated with the 12 deferred nuclear sites. See. App. Ex. 15, May 30, 1979, Q: 340.11 and App. Ex. 14(c) Table VI-1. For example, four potential sites on the Merrimack River estuary were rejected because they were too small for two large nuclear units, in too close proximity to the Seabrook Station, and were judged to have potential adverse impact on acquatic biota even with a closed cycle cooling.*/ Four of the deferred sites were offshore sites, the technology for which is not sufficiently advanced. Id. The four remaining sites deferred were all located on Buzzards Bay. Sites 21 and 21B in Mattapoisett were allegedly deferred because of some nearby residential homes and the shallowness of Buzzards Bay, which was judged to require several miles length of intake and discharge pipeline. App. Ex. 15, May 30, 1978, Q:340.11 at 9-10. */ Sites 22 and 23, located in the Town of Dartmouth on the western end of Buzzards Bay, were deferred because of nearby residential developments and "water source problem". Id. Table VI-1. Site 22, like candidate

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*/ We note that candidate sites 18 and 19 share these same characterstics in relation to Pilgrim Unit 1, with similar potential adverse impacts on the ecology of Buzzards Bay FSFES §4.7.

*/ The Applicant's candidate sites 19 and 20, also on Buzzards Bay are also located in shallow water, although the need for pipelines at these sites was never addressed by the Staff or Applicant. See Com. Ex. 110, Tr. 10, 113.

Sites 19 and 20, has coastal flood plains; Site 23, like candidate Site 1, is located about 2 miles from Buzzards Bay requiring extensive pipeline. Id. at 10; FSFES §4.7; Tr. 10,093-10,095.

186. We consider the asserted reasons for deferring these nuclear sites because of the Staff's assertion that the candidate sites selected by the Applicant were "among the best that could reasonably be found" within the Applicant's limited region of interest. FSFES 55.6. Considering the flow augmentation and population problems associated with the Merrimack candidate sites (1, 2 and 2A), and the ecological and potential site suitability problems with the Buzzards Bay sites (19 and 20), we believe that the Staff should have, but did not, probe sufficiently the Applicant's reasons for deferral of other potential nuclear sites. See FSFES, A-12 - A-16. We find that those reasons were superficial, and did not provide a rational basis for making a reasoned choice among these alternatives. Pilgrim, ALAB-479, 7 NRC at 779-781.

188. The Staff accepted the Applicant's justifications for limiting the geographic of its siting study to eastern Massachusetts, with exception of the Connecticut River in Western Massachusetts.*/ Based on documentation

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*/ The Applicant's reason for not investigating the western part of the state was because of transmission distances to Boston Edison's service territory. FSFES, at 4-1.

provided by the Applicant, the Staff identified six key consideration which limited the scope of the 1974 siting study, only three of which were environmentally defined (demography, land requirements, and cooling water availability). FSFES, at 3-1. The other three factors were based on state and service territory boundaries and general regional power objectives.

188. We have searched the Applicant's submissions to the staff on this matter, and can find no evidence that the Applicant considered any of the referenced environmental factors in limiting its region of interest to eastern Massachusetts App. Ex. 15, letters of April 13, 1978 and August 2, 1978. The point is not that the Applicant is required to have considered these factors under NEPA, but that the Staff asserts that something was done which was not done. Pilgrim, ALAB-479, 7 NRC at 781. We turn to the actual reasons advanced by the Applicant and accepted by the Staff to substantiate the limited region of interest.

189. The Applicant claims that one key factor limiting the geographic scope or "region of interest" of its 1974 siting study was the purported legal, regulatory and policital obstacles of siting a plant outside Massachusetts. This factor, along with others can bear on the need and reasonableness of exploring alternative sites outside of an applicant's service territory or state. See Seabrook CLI-77-8,

5 NRC 503 at 539-41 (1977); ALAB-471, 7 NRC 477, 486-87 491-493 Ct. N. Indiana Public Service co. (Baily Generating Station, Nuclear 1) ALAB 224, 8 AEC 244, 268 (1974).*/

190. In response to questions posed by the Staff concerning the limited geographic scope of the 1974 siting study, the Applicant submitted information on the apparent "institutional barriers" which Boston Edison might encounter in siting Pilgrim 2 in a sister New England state. This information was supplied to the Staff in two letters (included in App. Ex. 15).

191. The letter of April 13, 1978 letter (Attachment 1, at 7-8 and Attachment 2, Section III) was prepared by Applicant's witness Griffin, or someone under his "supervision and control" (Tr. 9644, 9650-53 9706-9711). Attachment I and Attachment 2 Section III, discuss the potential political and public resistence to a Boston Edison sponsored plant in another state because of the "public perception" that the host state would not receive any benefits of the power generated by the plant.

Upon cross examination, it became readily apparent that this assertion had no basis in reality. (Tr. 9699-9705.) Whatever people's perceptions of where power might be exported or imported, the truth of the matter is that Pilgrim 2 is a

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*/ In Baily , the Appeal Board acknowledged that under special circumstances, NEPA would require a search for acceptable sites outside an applicant's territory, particularly in densely populated regions. See Seabrook, CLI-78-14, 7 NRC 952, 976-977 (Bradford, concurring).

NEPOOL unit, and the power generated from this unit wherever it is located will be transmitted to the whole New England region. Tr. 9702-9705; of Seabrook CLI 78-41, NRC 952, 976; ALAB-471, 7 NPC at 491.

Attachment 2 section III of the April 13 posits similar attitudinal and legal obstacles to out of state siting, which allegedly justify limiting Boston Edison's site search to Massachusetts. While interesting, we give this evidence little weight, as it was not prepared by the Applicant's sponsoring witness Griffin, whose "supervision" over the preparation of this document was administrative at best. Tr. 9706-9711.

192. The Applicant's second letter of August 2, 1978 contains the legal opinions of lawyers in the states adjacent to Massachusetts (App. Ex. 15). These opinion letters, solicited by Boston Edison, discuss the various statutes of Connecticut, Rhode Island, Vermont and New Hampshire which BECO, as a lead applicant, would encounter if it constructed and operated a nuclear plant in these sister New England states. While the Applicant's solicitation letter was never introduced with this package, it is apparent from the letters that the authors were asked to address their opinions to a situation assuming a 1973 and 1978 time frame, and transmission conditions whereby most of the power generated by the plant would be exported out-of-state. This latter assumption does not comport with our understanding of how the NEPOOL grid

operates. See pp. 83-84, supra; Tr. 9702-9705, App. Ex. 15, letter of August 18, 1978, Attach. 3. We believe that this erroneous assumption unduly influenced the speculations of out of state counsel with respect to the potential hostile perception of their respective regulatory officials.

193. There was substantial dispute among the parties as to the admissibility and weight to be accorded these unsworn legal opinions by the Board (Tr. 9859-9878; Tr. 9916-9920; Tr. 10,315-10,325). The Staff would have us rely on the "experience" of these out-of-state counsel as experts on how the law of their states should be interpreted. The Staff prevails upon us to do so, in part, because the Staff itself relied upon the fact that these counsel practiced in the states about which their opinions speak. The Commonwealth and the Cleetons objected strenuously to the introduction of the opinions for that purpose, arguing that opinion testimony on matters of domestic law was totally inappropriate, and that it was the sole function of the Board to interpret the law applicable to the issues in this case. Id.

194. We agree with the Intervenors that the Licensing Board, in its quasi-judicial capacity, has the sole duty to find and interpret the law. See McCormick, Evidence Sec. 335, 2d Ed. (1972). The best evidence on the law is the statute

itself.*/ Accordingly, we give little weight to these legal opinions, as we have taken official notice of the statutes of neighbor New England states, which the Applicant believes are relevant. See App. Ex. 18, Tr. 10,353; 10 CFR §2.743(i).*/

195. The question remains whether the Staff was justified in accepting the Applicant's reasons for limiting the geographic scope of its siting study based on the potential licensing difficulties posed by the laws of sister states. First, we observe that the 1974 Siting Study itself does not appear to have ever considered any other region of New England other than eastern Massachusetts for its site search. The Applicant's and Staff's reliance on potential legal obstacles to out-of-state siting is more accurately a post hoc justification for the limited geographic scope of a study performed before consideration of "legal and institutional barriers" were ever suggested as limiting factors on an

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*/ Expert testimony on matters of domestic law has been routinely excluded in federal courts. See Consolidated Water Power and Paper Co. v. Bowks, 150 F.2d 960, 962 (5th Cir. 1941); NLRB v. Whittier Mills Co., et al, 123 F.2d 725 (5th Cir. 1941); Strickland v. Humble Oil and Refining Co., 140 F.2d. 83, 86 (5th Cir. 1944), cert. denied 223 U.S. 712 ren. den. 223 U.S. 812.

*/ With respect to the Staff's concerns, we note that do not control what materials the Staff may choose to rely in discharging its NEPA duty to evaluate alternative sites.

alternate site search by the Commission. FSFES, §3; see Seabrook, CLI-77-8, 7 NRC at 540; Pilgrim ALAB-479, 7 NRC at 784-85.

196. With the exception of Maine, we do not believe the statutes of the remaining four New England states pose unusual or insurmountable "legal barriers" to siting Pilgrim 2 outside of Massachusetts. Two obstacles effectively preclude Boston Edison from siting n the State of Maine. The first relates to BECo's Indenture of Trust and First Mortgage, issued in 1940, representing $500 million of the Company's long term debt financing, which precludes issuance of bonds for a generating facility in a state not adjoining Massachusetts. App. Ex. 15, letter of April 13, 1978, Attach 2. While this assertion alone would not be sufficient to exclude Maine from consideration, Maine law does require Maine utility companies to own a majority interest in any facility constructed in the state. Under the present ownership agreement, Maine utilities own less than 3% of Pilgrim 2.

The corporate and siting statutes of the other state appear to present the same burdens of licensing approvals for a domestic utility as for a foreign utility applicant.*/

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*/ We do not agree with the Applicant that Connecticut laws Section 16-246c(a) totally deprives a foreign utility of eminent domain powers. A foreign utility appears to gain the right of eminent domain if it obtains a certificate of compatibility from the Power Facility Evacuation Council Conn. Laws, Section 16-50.

The one exception is potentially Rhode Island, the laws of which require part ownership of a domestic utility in a plant built in that state. Rhode Island G.L. §39-20-4. This statute merely requires a fractional percentage of ownership by a domestic Rhode Island utilty, or domestic affiliate of a foreign utility owner. New England Power Company, of which Narrangansett Electric Co. of Providence, Rhode Island is a wholly owned affiliate, owns 11.16% of Pilgrim 2. If rearrangements in ownership were required to site Pilgrim 2 in Rhode Island, it appears to be minimal indeed. In New Hampshire, there appears to be no unusual difficulties to siting by an out-of-state lead applicant. In apparent recognition of integrated and interdependent electric systems in New England, the New Hampshire legislature enacted its "NEPOOL Act," RSA 374-A (effective June 24, 1975), expressly authorizing foreign utilities to participate in electric generating plants in the state, even as lead applicants. App. Ex. 18.

197. The significance of these alleged "legal obstacles" depends, in part, on other factors such as system reliabiilty, transmission losses and regional power planning in addition to environmenal considerations all of which bear on the appropriate scope of the region of interest. Indeed, the Staff and Applicant claim these other factors influenced their

selection of alternative sites to Pilgrim 2. FSFES, §§ 2 and 3. From a system reliability and transmission standpoint, the Applicant's own studies indicate that the location of Rocky Point is certainly not the best location for a NEPOOL nuclear unit. In fact, all of the alternative sites, with the exception of Seabrook, have considerable energy savings advantages over the Rocky Point site for the New Englad electric system. App. Ex. 15 (Staff Ex. 52) letter August 18, 1978, Attachment 3, Table 2; Tr., 9736-9745. The Montague site, in eastern Massachusetts, and sites in eastern Connecticut and coastal Rhode Island, in fact, have significant transmission advantages over Rocky Point. The Applicant's own witness admitted that the location of Rocky Point for Pilgrim 2 was never selected based on concepts of proximity to load centers of Boston Edison, the service territories of other participants or system reliability. Tr. 9730-9733.

198. With respect to regional planning needs of NEPOOL, the NEPOOL Planning Committee in 1970 apparently considered eastern Massachusetts to be a "desirable location for a baseload unit to meet New England Power needs". See App. Ex. 15, letter August 11, 1978, Attachment 2. NEPOOL does not do siting studies for the participant, but considers only general load characteristics (Tr. 2141-2143). It appears from the scant record on NEPOOL planning requirements that the NEPOOL plan provides that if a utility serves a particular load center,

that utility should be encour ed to satisfy its portion of NEPOOL demand by building a new plant near that load center. App. Ex. 15, letter of April 13, 1978, Attachment 1, at 4. Applicant's w.tness Griffin explained that this plan in connection with Pilgrim 2 means that the "Generation Task Force set up some general criteria for trying to demonstrate that we conform to those criteria" (Tr. 9649).*/

199. While the concepts of load center, system reliability and transmission losses appear reasonable siting consideration in the abstract, the analysis alternative sites to Pilgrim 2, a unit which is proposed to serve New England power needs, is a very real question to be addressed. The Applicant simply cannot have it both ways; it cannot claim the urgency to site Pilgrim 2 at Rocky Point for load center and system reliability reasons for purposes of the alternative sites review, and then attempt to justify the need to build the unit solely on power needs in other portions of New England. See Comm. witnesses Chernick and Geller, Post Tr. 11,224 at 60).

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*/ Applicant's witness Griffin demonstrated little personal understanding of the Boston Edison's load center needs or those of the NEPOOL transmission system although he claims to have prepared Applicant's information on the subject (Tr. 9719-9721; 9732-9739).

200. We find that the Applicant's evidence bearing on its decision to limit the geographic scope of its study to eastern Massachusetts totally inadequate, and the Staff reliance on this generalized information unwarranted. See FSFES §3. As Appeal Board has noted:

> It is a well settled rule that when a party has relevant evidence within his control which he fails to produce, that failure gives rise to the inference that the evidence is unfavorable to him Internat'l Union (UAW) v. NLRB, 459 F 1329, 1336 (D.C. Cir. 1972). Applying that rule here, we think it reasonable to infer that the evidence put forth by the Applicants and the Staff reflected at the very most that could be said in favor of their position on the issue of propriety of rejecting generically . . . New England sites, i.e., that were there any additional favorable evidence, it would have been produced. Seabrook, ALAB 471 at 498.

201. These deficiencies in the Staff's evaluation of the Applicant's siting study would not be that significant if, in fact, the state of candidate sites represented a realistic range of genuine environmentives to Rocky Point. By the term "genuine", the Staff means "potentially licensible". FSFES, §5.6. An impact which would render a site not "potentially licensible" would, according to the Staff, be one that could not be mitigated, i.e., irreversible, a "serious environmental defect". Tr. 10,016-10,024. There appears, however, to be no rational distinction in the Staff application of this criteria in the screening or final comparison of sites.

202. For example, the Staff asserts that the need for flow augmentation for the three Merrimack River sites does not detract from the licensibility of those sites. FSFES, §5.19-5.20. This conclusion was reached notwithstanding the acute competition for water and land uses immediately upstream of Sites 1, 2, 2A. While the Staff estimated that an augmentation reservoir of about 50 acres, 100 feet deep would be required to provide sufficient water for a single nuclear unit, the Staff failed to even investigate whether land immediately upstream or downstream would be available for such an impoundment. Tr. 10,082-10,091. Without further documentation, the Staff concluded, nonetheless, that the flow augmentation could be provided at these sites on a "cost beneficial basis". FSFES, §5-19.*/

The Deerfield River, however, was rejected by the Staff as a viable resource area because flow augmentation of same type would be required. FEFES, §5.15. The Staff investigation of the feasibility of flow augmentation on the Deerfield, a fully regulated river, was cursory at _____

*/ There appears to be no basis in the FSFES for this conclusion. See FSFES, at 4-13 and 4-17.

best.*/ Certainly, verification of this point was within easy reach of the Staff but it simply was not explored. Seabrook, ALAB-471, 7NRC at 493-498; Pilgrim, ALAB-479, 7NRC at 790.*/

Another example of the Staff's inconsistent application of criteria is its analysis of Sites 19 and 20 on Buzzard's Bay. The Staff concluded that even with closed cycle cooling for both of these sites, the intake and discharge effects of a single nuclear unit would cause a "significant adverse impact to the fishery". FSFES, at 4-31. In response to criticism of the Commonwealth that identification of this serious environmental defect should have triggered elimination of these sites from the candidate slate, the Staff opined that "even if the [acquatic] impacts are not mitigatible, this is not a criteria for rejection or elimination, but is a reason for finding that these sites are not preferable to Rocky

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*/ The Staff did not even attempt to substantiate its documentation from the Mass. Energy Facilities Siting Council on this point. FSFES, §5.15, Appendix D, Tr. 10,162-166.

*/ The NRC Staff conclusion in the FES for NEP 1 and 2 (Charlestown) was that Bear Swamp on the Deerfield River was a suitable site for two nuclear units with flow augmentation. This is not surprising as the Deerfield is a fully regulated river. Tr. 10,165-10,166.

Point. FSFES, §5.22 at 5-6.*/

203. Indeed, this response and these examples only illustrate how the Staff applied certain screening criteria to suit its convenience. When the selection of the Staff's slate of candidate sites was questioned, the Staff would attempt to minimize the significance of any environmental defects. In other instances, the same type of defect was used to screen out other potential sites from consideration, or was weighed heavily against a candidate site in the final comparison with Rocky Point. See FSFES, §§4.4, 4.6, 4.11.

204. The staff treatment of the shortnose sturgeon, an endangered species on the Connecticut River, further illustrates this point. The Commonwealth criticized the Staff's selection of Montague as the most representative site for the Connecticut River Resource area, because of the presence of this landlocked species in the Holyoke Pool, where the intake and discharge structure of a proposed unit would be located. FSFES, A-13. The Commonwealth noted, as had the Staff, that the U.S. Department of Commerce, National Marine Fisheries Service (NMFS) and the U.S. Environmental Protection Agency had made a preliminary determination that construction

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*/ The staff also identified substantial site suitability questions with respect to the proximity of these sites to Cape Cod Canal and Otis Air Force Base. FSFES, §4.8.4. Indeed, Site 19 is right next to the Canal and Site 20 less than 4 km from the shipping canal. Id.; see also Comm. Ex. 109. The Staff elected to treat this fatal defect as a disadvantage to the site, rather than cause for dropping it from the candidate slate of sites.

and operation of the two proposed Montague units would have a "probable impact" on this species. FSFES, at 4-49, A-5, A-13.*/ The Staff concluded, in apparent disregard of the opinions of these sister agencies with primary jurisdiction over these matters, that no dectable impact to this population of shortnose sturgeons will occur. FSFES, at 4-49. This conclusion was based on Northeast Utilities 316 demonstration document, which EPA had rejected. Tr. 10,298-10,300. Notwithstanding this probable adverse impact on these species and the implications of the legal duties which necessarily follow, the Staff explained that "in any event" it did not count the presence of the shortnose sturgeon as a defect against the Montague site.*/ In contrast, for the Merrimack sites the Staff weighed the potential and yet unsubstantiated presence of shortnose sturgeons in that river as a disadvantage which would render Rocky Point environmentally superior. FSFES, §4.4.1.

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*/ The determination by NMFS was made at EPA's and NRC's request for a biological opinion, pursuant to Section 7 Endangered Species Act, 16 U.S.C. §1531 et seq. NMFS determined that biological opinion could not be issued because of insufficient data. See Comm. Ex. 110. EPA rejected the intake location because of the potential adverse impacts on the shortnose sturgeon and other resident species in the Pool, and advised that Applicant to provide more information for an alternative intake location upstream. See Comm. Ex. 111. The Staff never responded to NMFS's comments regarding the Staff's opposite conclusion.

*/ See, NECNP v. NRC, 582 F.2d 87, 93-96 (1st Cir. 1978); Nebraska v. Rural Electrification Administration, 12 ERC 1156, (D. Neb. 1978); Seabrook, supra, 15 NRC at 543; TVA (Hartsville Nuclear Plant), ALAB-463, 7 NRC 341 (1978).

205. We find that the Staff's manipulation of its purported screening criteria was arbitrary and does not permit the reasoned choice of alternative which NEPA requires. Pilgrim, ALAB-479, 7 NRC at 783.

206. This lack of consistent or rational analysis by the Staff is most strikingly evident in its comparison of candidate sites to Rocky Point. It should now be clear that the "obviously superior" test is something which is applied at the end of the alternative site analysis, and not before; "[in] other words . . . it comes into play after alternatives have been identified and their solvent features explored." ALAB-479 at 785.

What the Staff did in this case was to apply the obviously superior test to each impact category during its analysis of each candidate site. Each discrete environmental impact for an alternative site was individually compared to the corresponding impact at Rocky Point, and the obviously superior test applied. All impacts at Rocky Point were assumed to be "negligible", or "acceptable", or "not significant", which represented the Staff's final conclusions for the site.*/ The result, not surprisingly, was that all potential advantages at the alternative sites were discounted by application of this standard, seriatim. See FSFES, Table II.

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*/ See Comments of Dept. of Commerce, FSFES at A-5, and the Staff's conclusory response FSFES §5.1.

A site characteristic which was identified as "preferable" was quickly discarded because it alone was not superior to Rocky Point.

207. A few examples serve to illustrate how the Staff's analysis operates. Aquatic impacts at each site were individually compared to aquatic impacts anticipated for Rocky Point, and found not obviously superior. For example, at Seabrook the Staff concludes that incremental entrainment/entrapment losses caused by a third unit at this site will not be significant with either one through a closed cycle cooling system. This would appear to be an advantage for Seabrook. But no, this advantage is discounted because the corresponding impacts at Rocky Point is judged to be "negligible":

> Whether or not the Seabrook site with either closed cycle or once through cooling is judged to be environmentally superior to the Rocky Point once through site is dependent upon, however, the anticipated impingement/entrapment related impacts to the fishery at the Rocky Point site. Since the anticipated impacts to the fishery at the Rocky Point site is negligible, it is concluded that the Seabrook site is environmentally preferable, primarily due to the design and placement of the intake structure, but not environmentally superior to the Rocky Point site with respect to the impact of impingement/entrapment losses on the nearby fishery, FSFES, at 4-56, see also Comments of U.S. Dept. of Commerce at A-5.

208. Similarly, with respect to discharge and thermal effects at Seabrook, which the Staff found acceptable with a once through unit and preferable to Pilgrim with closed-cycle cooling, the Staff concluded the same impacts at Rocky Point were negligible or could be controlled by mitigative devices. FSFES, at 4-58. When the same impacts were assessed at Montague and Millstone, the Staff concluded that a closed cycle unit at these sites would be environmentally preferable, but not superior to Rocky Point. FSFES, at 4-5, 4-41, See also Sites 18, at 4-23, Sites 1,2,2A at 4-11.

209. The Staff's analysis of terrestial land use and socioeconomic impacts provide more examples of the Staff's disaggregated application of the obviously superior standard. Montague is described as having "mixed cutover/burned forest", 10 ha of "prime farmland" which were believed to be unsuitable for general crops, and an occasional transient bald eagle or osprey. FSFES, at 4-44. In assessing the impacts on these resources, the Staff concludes that a single plant would preempt the use of a larger area of forest and wildlife habitat than it would at Rocky Point site. FSFES, at 4-51. The Staff notes further that "because there is more important farmland onsite [at Montague] than at Rocky Point, the Rocky Point is preferable for this factor. The two other sites are equivalent for all other factors." Id. This conclusion totally fails to evaluate the extent of the "destruction" involved at the

Montague site. First, the preemption of an unspecified amount of "cutover/burned" trees can hardly be said to be a significant disadvantage, and there is no basis for concluding an actual wildlife habitat will be usurped just because the Staff observes that the site is best suited for use as a woodland or wildlife habitat. FSFES, at 4-44 and 4-55. Furthermore, it is an overstatement to claim that the existence of 10 ha of prime farmland on the Montague site renders it less preferable to Rocky Point, when the staff itself concluded that the farmland is unsuitable for general crops without irrigation. Id.*/

210. Similarly, the Staff concludes that the socioeconomic impacts at the Montague site make it less preferable to Rocky Point in terms of unusual impacts of cooling towers and traffic impacts. FSFES, at 4-52. In contrast to the bifurcated comparison used in alternate site analysis, the socioeconomic factors assessed for Rocky Point in the FES were considered together and judged to be primarily beneficial, especially in terms of the tax advantages to Plymouth. See, Pilgrim 2, FES at 4-5 and 5-41. No such countervailing benefits are included in the consideration of socioeconomic impacts for Montague or for any other candidate site. Furthermore, the negative visual impact of natural draft cooling towers at Montague assumes that other less obtrusive

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*/ The Staff's conclusion with respect to these impacts is contrary to those reached earlier by the Staff in the Montague FES, NUREG-0084 (February, 1977), §§4.2.4 and 5.1.1.

closed cycle cooling systems such as mechanical draft towers, could not be used to mitigate this impact. See, Seabrook, ALAB-471, 7 NRC at 504-508.*/

211. Finally, transmission lines are assumed to be a negative impact at all candidate sites, except Montague, Site 2A and Millstone. FSFES, Table 11. No analysis of transmission line impacts is discussed in the Final Supplement. Tr. 10,096. On cross-examination, the Staff feebly explained this purported assessment was based solely on the Applicant's analysis of how many acres would be required for new transmission lines at each site. All sites that required any new lines were given negative ratings based on the assumption that Pilgrim requires no additional transmission lines. Tr. 10,095-10,098. This assessment is simply inadequate. Not every transmission line will necessarily preempt significant farmland or parkland in New England. Pilgrim, ALAB-479, 7 NRC at 786-787. In addition, the impact of transmission lines at Pilgrim is not nonexistent. FES, §5.1.2.*/

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*/ Cooling towers at Millstone, Sites 1, 2 and 2A, Site 18, Seabrook and Sites 19 and 20 are similarly concluded by the Staff to have a "visual intrusion" on the area and thus a negative impact; we hardly need to emphasize what the Appeal Board in Seabrook has stressed already -- that tower types can vary and the aesthetic and meterological impacts will differ at each location. ALAB-471, 7 NRC at 506-507.

*/ With respect to transmission lines, we note that the Staff ignores the energy savings advantages of the candidate sites over Rocky Point. App. Ex. 15, August 18, 1978, Attachment 3.

212. It is clear that the Staff has misapplied the obviously superior standard in this case. By segmenting its comparison of alternative sites to Rocky Point, impact by impact in tortured juxtaposition, it effectively precluded any final composite judgment on the relative merits of a candidate site to the proposed site. This is not how the test is to be applied. ALAB-479, 7 NRC at 784-785; Seabrook, ALAB-471, 7 NRC at 501 n.38. Cf. United States v. Spock, 416 F.2d 165, 181-182 (1st Cir. 1969).*/

213. It is not that the Staff's analysis is wanting in detail; the length of the FSFES attests to this truth. These details, however, were manipulated at every turn to favor the Rocky Point site. The Staff's presentation makes it impossible to evaluate the net advantages and disadvantages of a candidate site which then can be compared to the proposed site. Noting the imprecision inherrent in the assessment of the many diverse factors relevant to a study of the site, the Commission fashioned the obviously superior test to deal with the _____

*/ In the Spock case, the Court reversed a conviction where the jury had been given special questions of fact to be answered before reaching a general verdict. The court noted "[t]here is no easier way to reach, and perhaps force, a verdict of guilty than to approach it step by step. . . . By a progression of questions, each of which seems to require an answer unfavorable to the defendant, a reluctant juror may be led to vote for a conviction which, in the large, he would have resisted." U.S. v. Spock, supra at 182. This case offers an analogy to the predastored conclusion finessed by the Staff here.

difficulties of comparing sites. Seabrook, CLI-77-8, 7 NRC at 528. The test, of course, was never intended to be applied strictly to each and every characteristic of the site, but rather as a final judgment after the features of each alternative site were explored.

214. Based on the foregoing, the Board finds that neither the Applicant nor the Staff have presented a reasoned and thoughtful analysis of alternative sites which permit a conclusion that there is no obviously superior site to Rocky Point. The Board finds specifically that the Staff has not satisfied the requirements of NEPA for a dispassionate and rational analysis of genuine alternative sites. See ALAB-479.

B. Demography

215. It has been long-standing NRC policy to require the siting of nuclear power reactors away from densely populated areas. See Reg. Guide 4.7, pg. 9, 16; Statement of Considerations, 10 CFR Part 100, 27 FR 3509 (April 12, 1962); "Commission Action Paper," SECY 78-137 (March 7, 1978), introduced as Commonwealth Exhibit 112 at Tr. 11,539 ["SECY 78-137"]. Because some risk of a serious radiological accident will remain even after all reasonably attainable safety features are built into the design of a proposed nuclear reactor, careful scrutiny of the size, distribution and evacuability of the population surrounding that reactor has emerged as the NRC's primary means of protecting the public against the consequences of such catastrophic accidents . SECY 78-137 at 1; 10 CFR §100.10.

216. To a considerable extent, the NRC's remote siting policy finds expression in the site suitability criteria of 10 CFR Part 100.*/ It is also effectuated, however, through the comparison of alternative sites under the cost/benefit

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*/ See, e.g., 10 CFR §§1[illegible]3(b) and 100.11(a)(2), which require the applicant to establish a low population zone (LPZ) around the proposed site and define such an area as that containing residents, "the total number and density of which are such that there is a reasonable probability that appropriate protective measures could be taken in their behalf in the event of a serious accident." 10 CFR §100.11(a)(3) contains the additional requirement that no "population center" larger than 25,000 persons may be closer to the reactor site than one and one-third times the distance from that site to outer boundary of the LPZ.

analysis mandated by NEPA. See SECY 78-137 at 2; Proposed Amendment to Appendix E, Supplementary Information, 43 FR 37474, Col. 1 (August 23, 1978); Public Service Company of New Hampshire (Seabrook Stations, Units 1 and 2), ALAB-471, 7 NRC 477, 93 (1978) ["Seabrook"]; Report of the Siting Policy Task Force, NUREG-0625 at 4,9. In the Newbold Island proceedings, for example, the Staff's FES concluded that a particular alternative site was more desireable than the proposed site from an environmental standpoint and that the "principal factor leading to this conclusion is the fact that the population density at the Newbold site is significantly larger than at the [alternative] location." SECY-137 at 2 and Enclosure A.

217. As part of its Pilgrim 2 alternative sites analysis, therefore, the Staff was obliged to carefully study the population surrounding Rocky Point and the other candidate sites. Indeed, because of the undeniable public health and safety implications of reactor siting, this Board is not inclined to treat demography as just one more undifferentiated factor in the NEPA balancing process; it is a paramount public safety consideration that must be accorded far more weight than most of the other environmental concerns addressed by the Staff in its FSFES. As the Commission noted in Public Service Company of New Hampshire (Seabrook Station, Units 1 & 2), 5 NRC 507, 527 (1977), "NEPA does not require . . . an unbalanced weighting of environmental over other factors such as economic considerations or the possible health and safety advantages of

particular locations."*/ The need for differential weighting, of course, hardly needs justification: "public safety is the first, last, and a permanent consideration in any decision on the issuance of a construction permit or a license to operate a nuclear facility." Petition for Emergency and Remedial Action, CLI-78-6, 7 NRC 400, 404 (1978), citing Power Reactor Development Corp. v. International Union of Electrical Radio and Machine Workers, 367 U.S. 396, 404 (1961).

218. It is important to note at the very outset that in seeking to assess the off-site consequences of accidental releases of radioactivity, the Staff has quite properly concerned itself with the entire spectrum of reactor accidents, up to and including Class 9 events. Tr. 11,457-8. This latter category of accident has been defined as involving "sequences of postulated successive failures more severe that those postulated for establishing the design basis for protective systems and engineered safety systems." Proposed Annex to Appendix D, 10 CFR Part 50 ["Proposed Annex"]. In other words, a Class 9 accident is one that is beyond the design basis of the plant, typified by a substantial release of radioactivity either through core-melt or breach of containment. Tr. 11,458.

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*/ In that same proceeding the Commission concluded it would be proper to include sunk costs in the cost-benefit analysis mandated by NEPA, at least to the extent that purely environmental impacts were being considered. Protection of the public, however, was decidedly a different matter: "Under the Atomic Energy Act, 42 U.S.C. 2011 et seq., our responsibility to protect the public health and safety is such that we may not consider to any extent any investment that an applicant has made in a facility when we are passing on the safety of the plant" 5 NRC at 535, fn. 36.

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220. While the Staff acknowledged that in analyzing surrounding population densities its purpose was to gauge the impact of all classes of accidents, including Class 9, it has declined in this case to perform what has come to be called a Class 9 accident analysis. FSFES at 5-7, 5-8. Such a study involves detailed examination of a host of variables such as population density and distribution, meteorology, topology and sheltering and evacuation capabilities, and has been done before by the Staff, most notably during its review of the Perryman application. Tr. 11,520, 541; SECY 78-137, pg 6. While the present status of Staff policy is unclear, it appears that the Staff has committed itself to perform a Class 9 analysis wherever population densities in the area surrounding the proposed site exceed certain "trip-levels". Tr. 11,535-37; SECY 78-137.

221. The Staff's use of its trip-levels in this case will be discussed in some detail below. As a preliminary matter, the Board must deal with the Staff's rather disingenuous assertion that in spite of the commitment it made in SECY 78-137 to perform an in-depth study of the consequences of a Class 9 accident whenever high population densities are encountered, it is nevertheless prevented from doing so under the Proposed Annex to Appendix D of 10 CFR Part 50. This document was issued by the AEC for public comment over seven yeas ago, has since been treated as an "interim" statement of policy and theoretically is still under consideration by the NRC. See Offshore Power Systems (Floating Nuclear Power Plants), Docket No. STN 50-437, Slip Opinion at 1-2 (September 14,1979) ["OPS"].

222. The Proposed Annex divided all radiological accidents into nine classes, and with respect to accidents of the ninth class held that the probability of their occurrence was so remote that the alternative sites analysis required under NEPA need not address the consequences of such events. Proposed Annex, pg. 1. On a number of occasions in the past the Staff has cited te annex in refusing to look at Class 9 accident consequences, a position that has been upheld on the ground that "NEPA does not require consideration of environmental effects not shown to have some reasonable likelihood of occurring." Duke Power Company (Catawba Nuclear Station, Units 1 and 2), ALAB-355, 4 NRC 397, 416 (1976).

223. For a number of reasons, however, the proscription against consideration of Class 9 accidents contained in the Proposed Annex has lost most of its force and effect. First, it can hardly be maintained any longer that Class 9 events are so remote in likelihood that they need not be considered. To the contrary, in another proceeding relating to the Salem nuclear power plant*/ the Staff has acknowledged that the accident at Three Mile Island was a Class 9 event, and the Staff in this case has so informed the Board. Tr. 11,436. To the extent that earlier case law upheld the Staff's refusal to undertake Class 9 consequence studies on the basis of the fact that such events could not happen, it clearly is no longer controlling.

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*/ Public Service Electric and Gas Co. (Salem Nuclear Generating Station, Unit 1), NRC Docket No. 50-272.

224. Second, we note that in the Perryman early site review the Staff concluded that the population surrounding the proposed site was sufficiently high to call for a Class 9 analysis, in spite of the explicit language of the Proposed Annex. SECY 78-137 at pg. 5-6. Based on the methodology developed in the 1972 Reactor Safety Study, the Staff concluded that Perryman would have to be rejected in favor of an alternative site that demonstrated a significantly reduced threat to the surrounding population in the event of a serious reactor accident. Id. at 6 and Enclosure D.

225. Furthermore, as we noted above, in SECY 78-137 the Staff has proposed disregarding the Annex's ban on Class 9 accident assessments under NEPA whenever the area surrounding a proposed site demonstrates a relatively high population density. Rather, "assessment of the relative differences in Class 9 accident risks should be included as one element of the site comparisons." SECY 78-137, pg. 1. As with the Perryman review, the Staff's concern is "not based on a uniquely high probability of accident but rather on unique circumstances which increase the potential consequences and thus the overall risk." Id., pg. 4. According to SECY 78-137, whatever prior case law has had to say about the necessity under NEPA to perform such an evaluation in the face of the Staff's refusal to do so, "this does not preclude the Staff from going beyond the strict requirements of the law when it will assist in performing its NEPA review." Id., pg. 5.

226. Finally, in OPS the Commission itself upheld a Class 9 analysis performed by the Staff for floating nuclear plants. Although its reasoning holds little relevance for the instant proceedings, we note that the Commission did decline "to express any views on the question of environmental consideration of Class 9 accidents at land-based reactors" and announced its intention to "complete the rulemaking begun by the Annex and to re-examine Commission policy in this area." OPS, slip opinion at 9. In furtherance of that re-examination, the Commission instructed the Staff to:

> 1. Provide us with its recommendations on how the interim guidance of the Annex might be modified, on an interim basis and until the rulemaking on this subject is completed, to reflect developments since 1971 and to accord more fully with current Staff policy in this area; and
>
> 2. In the interim, pending completion of rulemaking on this subject, bring to our attention, any individual cases in which it believes the environmental consequences of Class 9 accidents should be considered.

Id. at 9-10.

227. By inviting the Staff's recommendation for interim guidance based on developments since issuance of the Proposed Annex and on current Staff policy, the Commission has at least implicitly accepted the Staff's position that under certain circumstances the Proposed Annex should not operate as a bar to in-depth analysis, under NEPA, of the consequences of Class 9 accidents. Accordingly, the Board holds that where high population densities, irregular population distributions or other unique site characteristics indicate a substantially

increased threat to the public in the event of a major radiological accident, a Class 9 accident analysis is not only permissible but mandatory as part of the Staff's alternative sites review. We now turn to the question of whether the Staff's review in this case was sufficient to identify the need for such an analysis.

228. The Staff has acknowledged that in comparing alternative sites it utilized population density data as its primary indicator of residual risk, i.e. that risk to the surrounding population that remains even after all practicable steps have been taken to design and construct the safest possible power reactor. Tr. 11,456-59. Indeed, to the extent that the off-site consequences of a radiological accident have been considered at all, it is only through analysis of population density:

> . . . an assessment of the Pilgrim site and the alternative sites has been made in the DS FES, which compared the relative differences in accident consequences, for accidents including Class 9 events. This review, based upon reconnnaissance-level information, has used the population and population density in the vicinity of a site as a measures of the relative magnitude of potential consequences, and the Staff has determined whether there are sites that have significantly lower accident consequences than the Rocky Point site.
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> FSFES at pp. 5-7.*/

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*/ At one point a Staff witness testified that meteorology was also considered, Tr. 11,462, but the FSES itself acknowledges that such data was available for only some of the sites. See FSFES at pp. 5-8. Under such circumstances, the Board must conclude that the Staff's comparison of sites with respect to accident consequences was based on population density figures only.

229. "The litmus which the courts apply - and which we must perforce use - is whether the environmental consequences of each reasonable alternative have been accorded a 'hard look'", Boston Edison Company (Pilgrim Nuclear Generating Station, Unit 2), ALAB-479, 7 NRC 774, 779 (1978). This Board questions whether any "hard look" at accident consequences can be said to have occurred when only population density data was used, without regard to other critical and readily available threshold indicators such as road capacity, population distribution, local topography and rudimentary wind direction data, an issue that will be discussed in greater detail below.

230. Our first concern, however, lies with the Staff's misuse of the meager data that it did gather. Its methodology totally obscured significant differences between the Rocky Point and the alternative sites, making it impossible to conclude that some or all of the alternatives do not offer substantially reduced risks in the event of a radiological accident. Before granting a construction permit this Board must satisfy itself that none of the alternative sites is "obviously superior" to the proposed site, and with such a demanding standard it becomes all the more critical that differences between the sites be sharply delineated. The Staff's demographic assumptions and methodology, however, have had just the opposite effect, that of understating population figures and obscuring the risk potential of the area surrounding the Rocky Point site.

231. As a preliminary matter, the accuracy of the population data utilized by the Staff is open to serious and disquieting question. In preparing the FSFES, the Staff relied on the Applicant's Environmental Report (ER), its Preliminary Safety Analysis Report (PSAR) and a 1974 siting study commissioned by the Applicant, as updated by additional data submitted in 1978. Tr. 11,465-66; FSFES at 3-4, 3-5. Just prior to the evidentiary hearing on demography, however, the Staff received an additional study from the Applicant ["ERT study"] which revealed that the company's earlier submissions understated certain categories of population. TR. 11,446. According to the ER, for example, there were 452 seasonal residents living within one mile of the Rocky Point site, while the ERT study indicated that there were 1,361, or three times as many. Tr. 11,505-6. When asked if he could account for this discrepancy, the Staff witness acknowledged that the ERT study used different occupancy factors and was "a much more thorough and systematic review." Tr. 11,506-7.

232. The Board finds the discrepancies between the Applicant's earlier submissions and the ERT study troubling for two reasons. First, as the Staff has acknowledged, "differences in close-in population should be given greater weight than corresponding differences in population density at greater distances." FSFES at B-2. Clearly, the population within one mile of the proposed reactor should have been of critical concern, and indeed is entirely within the confines of the LPZ. Its underestimation by a factor of three can't help but

call into question the thoroughness with which the Staff undertook to investigate the entire matter of population density.

233. Second, the ERT study only looked at population within five miles of the Rocky Point site. Tr. 11,453. Within that area it revealed that seasonal population figures were three times greater than what the Staff had originally believed, and since the area of concern under Reg. Guide 4.7 extends out to thirty miles from the site, the Board questions whether other critical discrepancies might not still remain undiscovered.

234. In addition, while the Staff concluded that there were no significant concentrations of tourists within two miles of the site, Tr. 11,502, the ERT study for that same area in 1990 indicates a peak tourist figure of 2469. Tr. 11,480. According the Staff, such people are "negligible", for their length of stay in the area is small. Tr. 11,480-82. Such reasoning is open to serious question, however, for it ignores the fact that if an accident were to occur during the summer months these tourists will indeed be there and in fact will be well within the LPZ, people who already put a severe strain on Plymouth's traffic flow capacity and who will have had no prior instruction in emergency measures or homes in which to shelter

themselves.*/ Commonwealth's witness Herr at 6, following Tr. 11,612.

235. Similarly, the Staff has acknowledged that it did not bother to gather figures for daily transients between five and thirty miles from the site, Tr. 11,504-5, although that area includes Provincetown and most of Cape Cod, a prime tourist attraction every summer. Tr. 11,505. Since more than one million tourists visit the town of Plymouth alone every year, Tr. 11,471, we find it indefensible that the Staff chose toignore transients between zero and two miles from the site, and again between five and thirty miles. Indeed, the Staff's practice of ignoring transients has already been condemned once before, in Seabrook:

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*/ In Southern California Edison Company, (San Onofre Nuclear Generating Station, Units 2 and 3) ALAB-248, 8 AEC 957, 62 (1974) the Appeal Board had little trouble concluding that daily visitors posed significant emergency planning problems within the LPZ, and would have to be taken into account in satisfying the siting criteria set forth in 10 CFR Part 100:

> To be sure, Part 100 refers expressly only to the need to protect "residents" within the low populatin zone. But we are aware of no basis for concluding that the Commission intended that term to be given a narrow, literal construction, which would exclude consideration of the safety of large numbers of transients regularly present within the low populaton zone. The need to protect such visitors is just as great as the need to protect permanent residents; if anything, greater steps will need to be taken to protect the visitors, who are likely to be relatively unfamiliar with the surrounding area and who will not have homes in which to take shelter. We thus decline to read the word "residents" as expressing a Commission intention to protect permanent residents but to ignore the safety of visitors. (emphasis added)

> To highlight the essential arbitrariness of the Staff's treatment of comparative population densitites, we note that the Staff ignored Seabrook's concentration of transients. The density figures it used on remand to compare the population at Seabrook with that at other sites include only permanent population. . . . By ignoring transients, it gave Seabrook (where transients are a major factor) an unfair advantage in comparison to sites where transients are of lesser significance. Seabrook at 510, fn. 63. (emphasis supplied)

We see no reason why the Appeal Board's criticism of the Staff in Seabrook is not equally applicable here; if anything, the Staff's action is all the more reprehensible in this case, where it had already been put on notice that transients were not to be ignored.

236. The Staff has acknowledged that population density, by itself, is at best a "crude indicator of risk", and that an accurate assessment of the consequences of a radiological accident can only be obtained by investigating a host of other variables. Tr. 11,520; 11,572-74. As noted above, such an in-depth study has come to be called a Class 9 analysis, and the trigger for performing it is now found in Reg. Guide 4.7: if projected population density within a thirty-mile radius of a potential site exceeds 500 persons per square mile at the time of initial operation or 1,000 persons per square mile at its retirement, then "special attention should be given to the consideration of alternative sites with lower population densities." FSFES, B-1. In SECY 78-137, the Staff proposed that among other things, "special attention" would include performing a Class 9 analysis for each of the candidate sites,

but the Commission has yet to take any action on this proposal. Tr. 11,536-7.

237. While we have concluded that other unique site characteristics might also serve as a triggering device, the Staff is cleary warranted in its position that the population density surrounding a proposed site might in some circumstances be so high as to require a close look at all sites to determine how each would fare in the event of a Class 9 accident. See, generally, SECY 78-137. If population density is to be used as an indicator of risk and the Staff's exclusive triggering device for determining whether a Class 9 analysis is warranted as part of the NEPA review process, however, the work done by the Staff on the Pilgrim 2 application contains certain assumptions and omissions that cannot help but compromise the reliability of this factor.*/

238. In arriving at average population densities for the area surrounding the Rocky Point site, the Staff employed weighting factors of 1.0 for permanent residents and 0.25 for seasonal residents. Tr. 11,469-71. As noted above, the Staff testified that transients between zero and two miles and five and thirty miles were not considered at all, because the Staff concluded that when weighted these figures would be

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*/ In the following discussion, we have in a large extent relied on the observations of Professor Phillip B. Herr, introduced by the Commonwealth as a witness at Tr.11,589.

negligible.*/ Tr. 11,480-82.

239. Perhaps such weighting assumptions would hold true for a region experiencing moderate seasonal fluctuations in population, but when an area is as profoundly effected by tourists and summer residents as is that surrounding the Rocky Point site, the use of weighted population density as an exclusive threshold indicator of residual risk is highly questionable. Commonwealth witness Herr at 6, following Tr. 11,612; Tr. 11,660-62. To the extent that the licensing process is concerned with the consequences of serious reactor accidents, it is illusory to obscure the crowded conditions that occur every summer in the Plymouth area by ignoring transients or averaging their inflow over the course of an entire year. Id.

240. According to extrapolations made by a Staff witness from the ERT study, for example, within two miles of the site the maximum daily population in 1985 will be 10,700 persons. Tr. 11,513-14. The Staff's weighting technique reduces this figure to 3,943, Tr. 11,515, but if a major accident at the Rocky Point site during the summer were to necessitate emergency measures for that two mile zone, all of which is well within the LPZ, there would be 10,700 individuals requiring information, evacuation and/or sheltering, not 3,943.

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*/ For reasons that the Staff did not explain, tourists and daytrippers were considered for that area between 2 and 5 miles from the site, where they were weighted by a factor of 0.0033. Tr. 11,470; FSFES at 5-9.

241. Similarly, in 1990 the maximum daily population within two miles of the plant is projected to be 12,121 persons. Tr. 11,479. This includes 4,393 permanent residents, 5,259 summer residents and 2,469 daily transients. Tr. 11,479-82. Under the Staff's weighting system, the 5,259 summer residents were reduced to 1,315, and the daily visitors were not counted at all because they were deemed to be "negligible." Tr. 11,480-82. In comparing Pilgrim 2 to the other sites, therefore, a peak population of 12,121 was reduced to 5,708, once again grossly understating the magnitude of risk should an accident occur in the summertime. Tr. 11,655-57.

242. The Staff's weighting system becomes all the more incomprehensible when one considers that it was not uniformly applied. Only at Pilgrim and the coastal sites (Nos. 18-20, Seabrook and Millstone) did the Staff differentiate between population categories and weight seasonal residents, Tr. 11,516; for all of the inland sites, no such calculations were performed. In addition, there is certainly no dispute that the area surrounding the Rocky Point site experiences far greater than normal incursions of seasonal residents and tourists, but since the Staff's weighting method has the effect of concealing the magnitude of such population fluctuations, this critical aspect of the Rocky Point situation is totally factored out of the Staff's analysis of comparative populations. Tr. 11,658-59.

243. The Staff's review of population at Rocky Point and its alternative sites is further compromised by its insistence that water area be included when calculating average population densities. The 53 municipalities which are within 30 miles of the Rocky Point site have a projected 1985 population of 981,000 persons in the winter, 1,395,000 in the summer and a land area of 1,256 square miles. Commonwealth witness Herr at 7, following Tr. 11,612. This means a winter density of 780 persons per square mile of land area, a summer density (with summer-only population "discounted" at 100/365) of 870 persons per square mile, and an actual summertime population (seasonal plus year-round) of 1,110 persons per square mile. Id. at 7.

244. These figures, which were derived by Commonwealth witness Herr by focusing exclusively on land area surrounding the site, are far more revealing than the Staff's in reflecting the actual population density of the area in question and in providing insight into how Rocky Point would fare in comparison with the other sites in the event of a major radiological accident. As with its treatment of seasonal residents and tourists, the Staff's inclusion of water area when calculating population density has effect of vastly deflating Rocky Point's figures and making it appear far more desirable in comparison to the inland sites than is actually the case.

Finally, it should be noted that in comparing population densities the Staff has chosen to ignore sectoral

information, Tr. 11,581, information that would otherwise indicate where significant concentrations of population exist within each radial ring. Tr. 11,655-56; 11,662-63. This is particularly troubling in light of the fact that the population surrounding the Rocky Point site is extraordinarily uneven by radial sector. Commonwealth witness Herr at 12, following Tr. 11,612. Nearly one half of the cumulative permanent population within thirty miles of the site is concentrated in the northwest and west-northwest sectors. Id. at 14; PSAR, Table 2.1-8. Even without consideration of seasonal residents, the northwest sector alone is projected to have a 1990 cumulative population of 330,000 persons living within thirty miles of the site, PSAR, Table 2.1-8, and thus a density of 1,858 persons per square mile. Id.

245. By 2020, there will be nearly 700,000 persons living in this sector, at an average density of 3,737 persons per square mile. Id. at 17. In other words, in the event of a major radioactive release under wind conditions blowing to the northwest, emergency measures will have to be taken to protect an area with a population density of 1,858 persons per square mile in the year 1990 and 3,737 in the year 2020. In comparing Rocky Point with the other candidate sites, however, population density at thirty miles was found by the Staff to be only 438 in 1985 and 908 in 2020. FSFES, Table 1.

246. Similarly, the peculiar configuration of the Rocky Point site is such that a southeasterly plume trajectory would carry an accidental release along a coastal corridor densely populated in the summertime. Commonwealth witness Herr at 28, following Tr. 11,612. In 1975, the south-southeast sector alone contained a summertime population of nearly 9,000 persons within five miles of the Rocky Point site, a density of 1,800 persons per square. Id.; PSAR Tables 2.1-2a and 2.1-8. We also note that Priscilla Beach, Whitehorse Beach and Manomet Heights have a summer residence of some 7,000 persons, all of whom are within a narrow arc and less than two miles from the Rocky Point site.*/ Commonwealth witness Herr at 28, following Tr. 11,612. The fact that this high density is "balanced" by lower densities at other seasons and in other sectors does nothing to diminish the magnitude of the problem of exposure if a major accident occurs at an unfavorable season under unfavorable wind conditions.

247. This Board is cognizant of the fact that the Staff's temporal weighting of seasonal and daily transients, its inclusion of the waters off Rocky Point in calculating average population densitites and its refusal to consider the vast disparties in population densities between one sector and

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*/ According to the Commonwealth's testimony, only two narrow two-lane roads provide that area with egress to Route 3A. Any accident, breakdown or construction obstruction would seriously impair the ability of this road network to accommodate emergency demand. Commonwealth witness Herr at 28, 31, following Tr. 11,612.

another are all permitted, either explicitly or implicitly, by the provisions of Reg. Guide 4.7. The Reg. Guide itself, however, is no more than a Staff position paper, never having been promulgated by the Commission as a regulation, Tr. 11, 528, and hence is not binding on this Board. See Seabrook , 7 NRC at 509-10 and cases cited.*/ We conclude that the Staff's use of population density is a necessary first step in assessing the relative impact of major reactor accidents at each of the candidate sites, but are also constrained to hold that the Staff's failure to refine its analysis to include the above-mentioned variables amounts to an impermissible gamble that a serious radiological accident will not occur at a time when wind direction is favorable and the area surrounding Rocky Point is not inundated with summer residents and tourists. As Professor Herr observed, average population density figures are clearly relevant and necessary in comparing alternative sites, but so too are extremes in population fluctuation. Tr. 11,660-62. This is especially true in an area such as that surrounding the Pilgrim 2 site, where the town of Plymouth alone attracts over a million tourists a year, Tr. 11,471, and

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*/ In Seabrook, the Appeals Board criticized the Staff for using Reg. Guide 4.7's "trip levels" to disqualify alternative sites that otherwise met the siting criteria set forth in 10 CFR Part 100. We do not interpret the Board as saying that if Pilgrim 2 meets the requirements of 10 CFR Part 100, no analysis can be undertaken under NEPA to determine if some other site might not be far more preferable from the point of view of reducing the consequences of a Class 9 accident.

which by 1975 was already experiencing an inflow of 25,000 seasonal residents every summer, all within five miles of the site. PSAR Table 2.1-2a

248. We are equally convinced by Professor Herr's argument that in comparing Pilgrim 2 with the inland sites the Staff seriously erred in refusing to take into account the fact that eight of the sixteen sectors radiating out from the Pilgrim 2 site are over water, PSAR Figure 2.1-6, so that average population was once again diluted and those inland sites made to look far less desirable from a population density standpoint than they actually are. Commonwealth witness Herr at 8, following Tr. 11,612. It may very well be that a coastal site is to be preferred in that specific instance where it can be demonstrated that prevailing winds are offshore and hence will transport radioactive material away from population centers. The Staff's inclusion of water area in calculating average population density is a gross oversimplification of this principle, however, and cannot be tolerated.

249. Given the Staff's inattention to the unique demographic characteristics of the Rocky Point site, the Board finds all the more troubling its use of the so-called Factor of Two. As noted above, the Staff has admitted with commendable candor that "the population density of a site is a relatively crude measure of the residual risk associated with the accidental release of radioactivity" FSFES at B-1. As the Staff acknowledged, the actual consequences of a major accident

will depend on many factors, including population density and distribution, meteorogical and topological conditions, the rate at which persons can be evacuated from the area of impact, access to travel routes, the shielding factor to be found in the area's residences and other site-specific characteristics. Tr. 11,572-4; FSFES at B-1.

250. Under such circumstance, and given the Staff's obligation to analyse the residual risk to the public posed by major radiological accidents, one would expect that the Staff would have under undertaken to refine its analysis, perhaps by incorporating the population fluctuations and distributions noted above, perhaps by utilitizing reconnaissance-level data with respect to meteorology, transportation networks, etc.; there is clearly much more that can be done to sharpen the Class 9 triggering device without coming even close to the complexities of the Class 9 analysis itself.

251. The Staff, however, has apparently done just the opposite. It has further diluted whatever accuracy its "crude indicator of risk" could be said to have by requiring that in order for the difference in population densities between two sites to be considered "significant", the alternative site must have a population density which is at least a factor of two lower than the primary site at distances out to 30 miles. Tr. 11,559-60; FSFES at B-2.

252. The Staff, in effect, has first adopted an admittedly imprecise measure of residual risk, and then rendered it totally dysfunctional by refusing to respond to that indicator unless extreme differences in population density are present. If there are differences between the sites such that one or more of the alternatives may provide greater protection to the public in the event of a reactor accident, desensitizing the "crude indicator" by the factor of two ensures that these differences will never receive the attention they truly warrant. This is clearly not the "hard look" mandated by NEPA; the Staff's function is not to mask critical differences between sites, but to uncover them. If population density is too crude an indicator of risk, then the solution is not to make it all the more so by use of the factor of two test. Rather, the indicator itself must be upgraded.

253. An examination of the Montague population figures as compared to those of Rocky Point provides graphic proof of all the infirmities in the Staff's methodology. First, Montague does not have a significant seasonal or transient population, Tr. 11,517, so that its population density figures accurately reflect population density throughout the year. The Rocky Point figures, on the other hand, are weighted averages, and effectively conceal the fact that during the summer much higher concentrations of people can be found throughout the area around the site.

254. Second, Montague is an inland site, so that its population figures reflect actual land-mass living density. In contrast, for Rocky Point the population density figures have been cut roughly in half by the Staff's inclusion of water area in its averaging calculations.

255. Having thus obscured the true situation with respect to population density at Rocky Point vis-a-vis Montague, the Staff then further undermines whatever comparison could be made by requiring that differences between the sites are not to be considered significant unless Montague is found to be twice as populous as Rocky Point. Indeed, comparison of the Montague figures (found at FSFES, pg. 4-48) and the Rocky Point figures (found at FSFES, pg. 4-4, as modified by Staff Exhibit 66) indicate that the Staff is apparently requiring that before an alternative site be considered more preferable than the proposed site it must have a population density that is a factor of two lower at each radial distance out to thirty miles.

256. In the year 2020, for example, the Montague site will have lower population densitites at every distance out to thirty miles except for the 3-4 mile radial ring. FSFES at 4-4, 4-48. Between zero and one mile from the sites, Rocky

Point's population density is five times that of Montague's (320 people/mi^2 vs. 61 people/mi^2),*/ while it is four times greater at zero to ten miles (735 vs. 169), zero to twenty miles (761 vs. 183) and zero to thirty miles (908 vs. 234). Id. Finally, Rocky Point's density figures are in greater than Montague's for the zero to two, zero to three and zero to five mile ring, although concededly not by the factor of two required by the Staff. Id.

257. All of the above-cited figures would appear to indicate that Montague is a more preferable site than Rocky Point, at least from the standpoint of residual risk.**/ The Staff has concluded otherwise, FSFES at 4-51, apparently because the Rocky Point population densities do not exceed those of Montague by a factor of two at every radial distance. See, generally, Tr. 11,563-70. Because of fortuitous differences in population density at a handful of the radial rings, therefore, the factor of two is not totally met, and the population

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*/ This figure is all the more troubling in light of the Staff's own position that "differences in close-in population density should be given greater weight than corresponding differences in population at greater distances" FSFES at B-2.

**/ A similar demonstration can be made for the year 1985, although the Montague figures are higher at more of the radial rings than they are for the year 2020. FSFES at 4-4, 4-48.

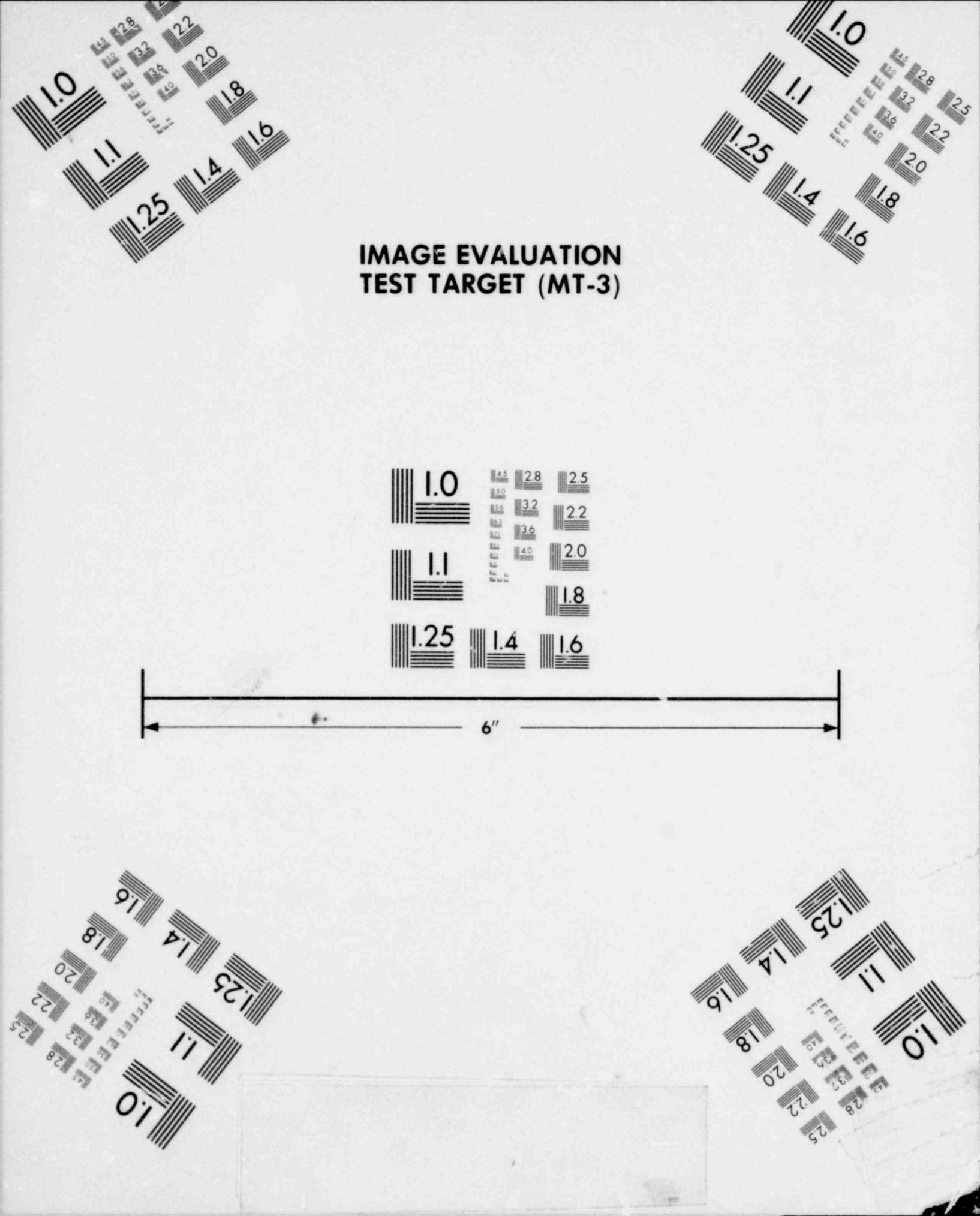
density differences between the two sites are deemed by the Staff to be insignificant. This Board cannot accept such reasoning, based on population density averages that obscure far more than they reveal and a factor of two that finds no support in either logic or precedent.

258. All of what the Board has had to say thus far about the Staff's demographic analysis has been in response to the Commonwealth's contention that the population density of the area surrounding the Rocky Point site is too high to allow the siting of a nuclear power plant there, or that at the very least a Class 9 analysis of all sites should have been performed by the Staff before Rocky Point was determined to be an acceptable site. For the reasons set forth above, the Board is inclined to agree with the Commonwealth.

259. In addition, the Commonweath has alleged that the transportation network serving the area around Rocky Point site will pose significant problems if evacuation should become necessary, especially when viewed in light of the large numbers of tourists and day trippers that visit the Plymouth area and Cape Cod during the summer. See Comments of the Commonwealth of Massachusetts on the Draft Supplement to the Final Environmental Statement for Pilgrim Unit 2, pp. 45-47; Tr. 11,673; 11,696. This problem in itself, the Commonwealth contends, should have been sufficient to trigger a thorough

study of the consequences of a Class 9 accident at Rocky Point and its alternative sites, and at the August 28, 1979 evidentiary hearing it proferred extensive written testimony on this issue. See testimony of Commonwealth witness Herr at 20-31, following Tr. 11,612.

260. The Board decided to defer cross-examination on the above-described testimony until it took up the matter of emergency planning. Tr. 11,609-612. Since those hearing have yet to be conducted, we cannot at this time make a determination as to the merits of the commonwealth's allegation. Accordingly, we must defer final decision on the NEPA-related issue of demography until such time as the forthcoming evidentiary hearings on emergency planning are concluded.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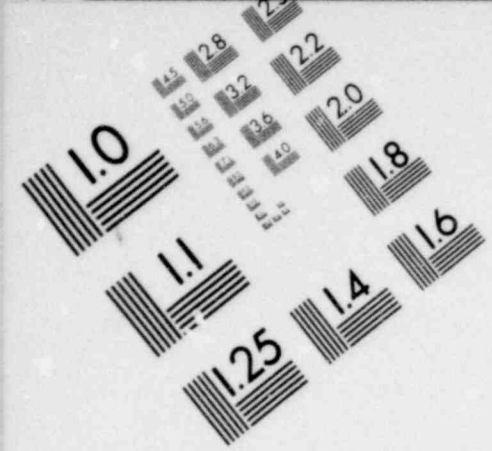

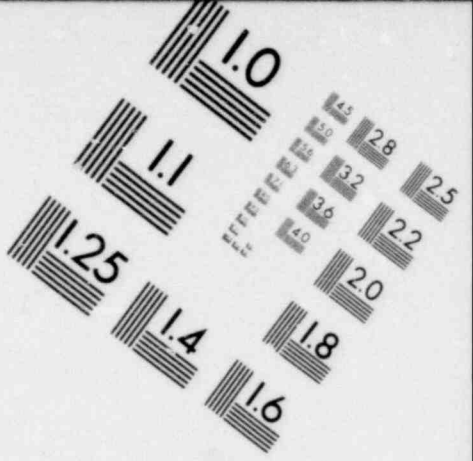

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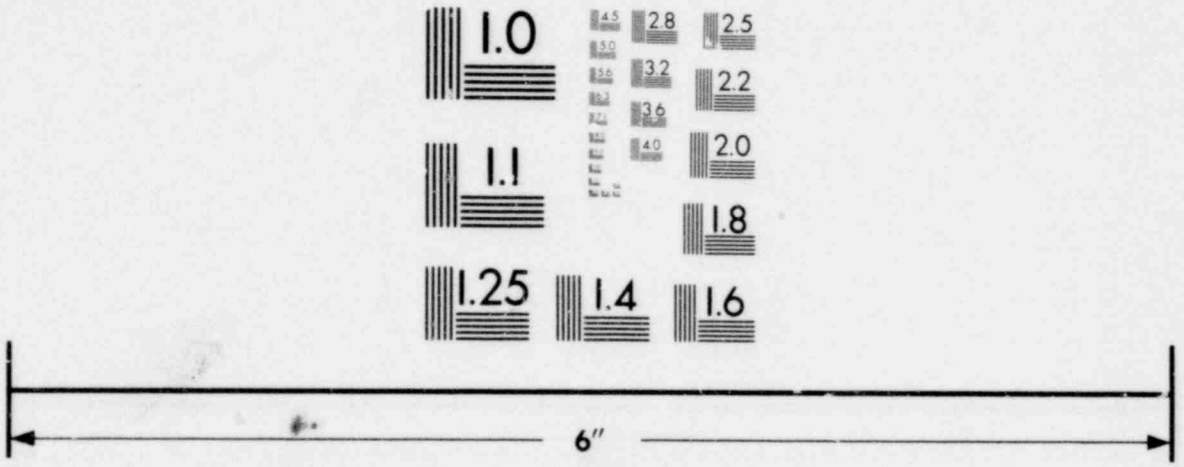

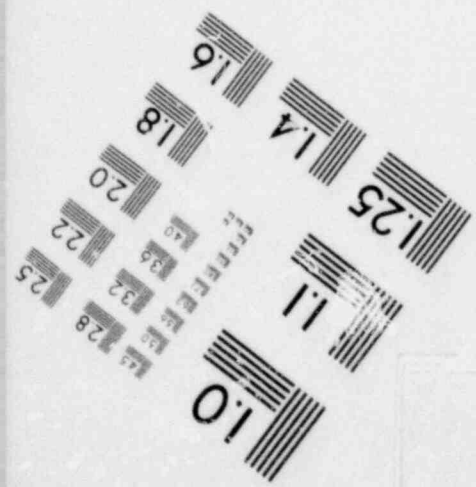

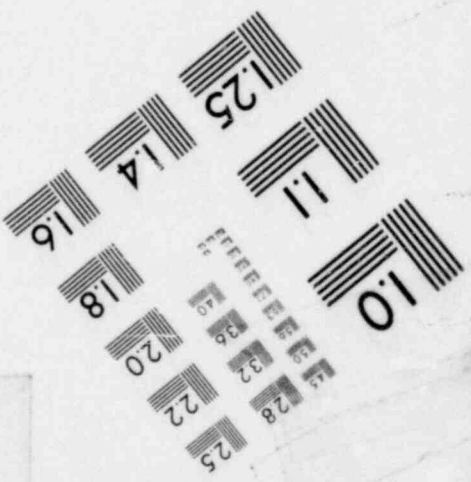

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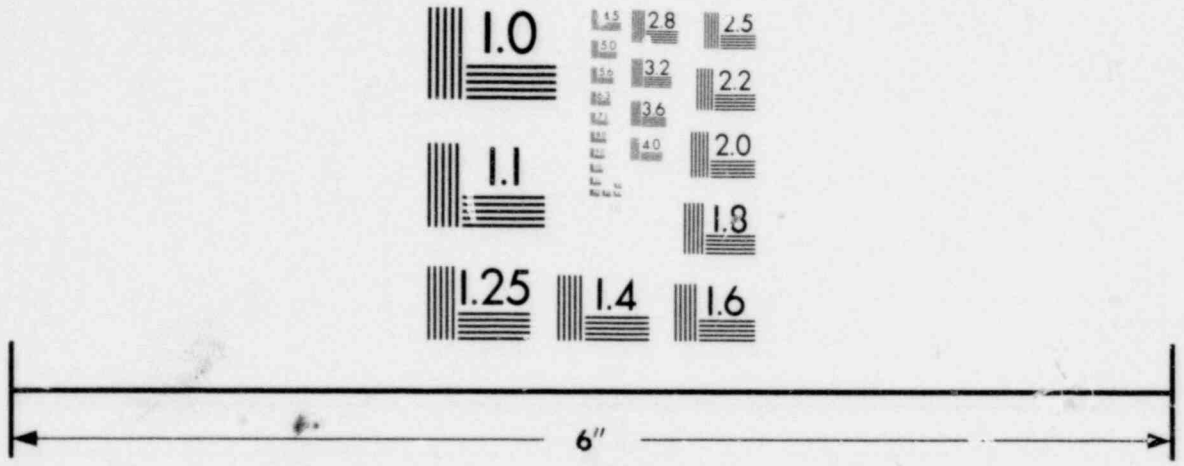

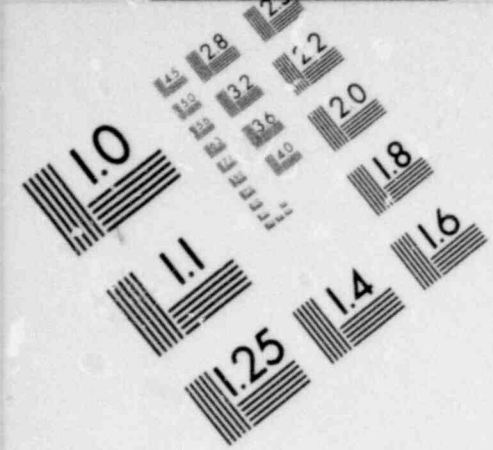

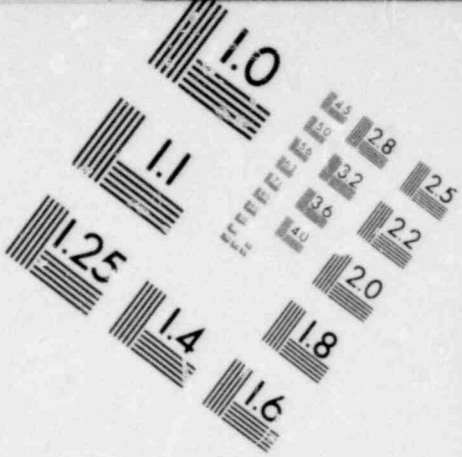

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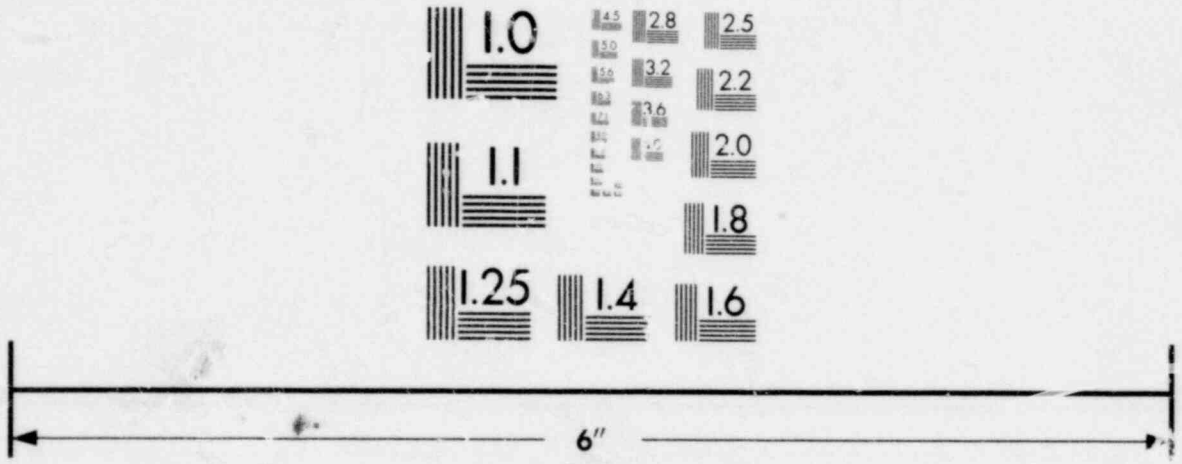

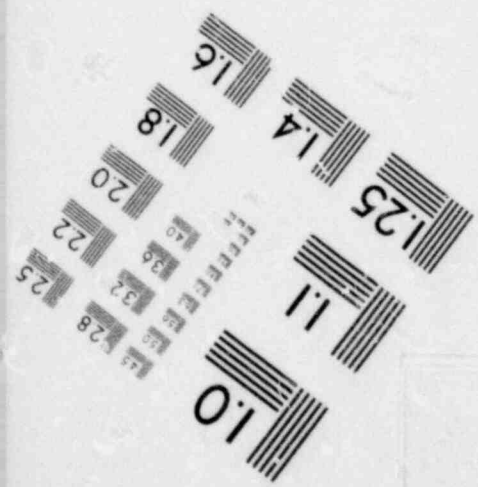

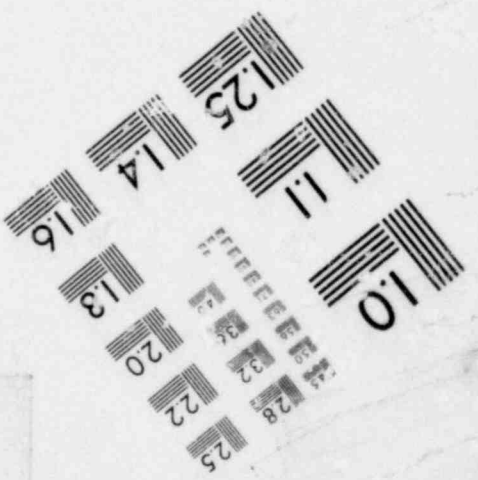

VI. THE RISK OF THEFT AND SABOTAGE

261. The Board admitted into controversy the following contention of the Commonwealth relating to the risks of theft and sabotage.*/

Commonwealth Contention 9

> The Applicants and the staff overstate the advantage of the nuclear option as opposed to alternative methods electrical generation by understaing the risk of theft and Sabotage attendant on nuclear generation, the cost of which, if considered in the cost-benefit analysis for Pilgrim 2 would cause the overall costs of the facility to outweigh its benefits.

262. The Commonwealth offered the testimony of Professor George Rathjens of MIT on the issue of security at nuclear power plants. (Post Tr. 4380) This testimony, consisting of portions of the Report of the Massachusetts Nuclear Safety Commission, chaired by Doctor Rathjens, was offered in support of the Commonwealth's Contention 9, that the advantages of nuclear power vis-a-vis the alternatives has been overstated by failure to fully consider the risk of theft and sabotage. Doctor Rathjens has wide experience in the evaluation of technologies for the U.S. Defense Department, the President's Office of Science and Technology and the U.S. Arms Control and Disarmament Agency, to give some examples. Resume, Post Tr. 4380.

263. On the objections of the Applicant and Staff, the Board struck all of Doctor Rathjens' testimony dealing with anything beyond the threat of an "insider" action, on the

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*/ Board Memorandum and Order (February 18, 1975) at 6-7.

theory that operators of nuclear power plants are not required to take measures to protect against serious or terrorist attack from the outside. See Applicant's Proposed Finding No. 621.

264. The subsequent action of the Commission in promulgating new Regulation 73.55 belies this assertion. Licensees for nuclear plants are now required to establish onsite physical protection systems and a security organization which will provide protection against "a determined violent external assault, attack by stealth, or deceptive actions, of several persons," including armed invaders with military training. (10 CFR 73.55(a)(1). This is the definition of a "terrorist."

265. Professor Rathjens' testimony was improperly stricken. The magnitude of the risks of theft and sabotage and of the costs necessary to guard against such actions, are costs of nuclear power which must be considered under NEPA just as are the costs associated with radioactive waste disposal. N.R.D.C. v. N.R.C. 547 F.2d 633 (D. C. Cir. 1976)

266. Professor Rathjens testified that a very small number of knowledgeable people could bring about a "melt-down" in a nuclear power plant and cause a breach of the containment with a consequent release of radioactivity to the environment. Furthermore, they could select a time when meteorological conditions would produce maximum damage. Thus, what might be extremely unlikely to occur as an accident be one of the more likely consequences of sabotage performed by determined and knowledgeable terrorists. Rathjens Test., Post Tr. 4380, pp. 4-5, 124. Furthermore, the vulnerability of a reactor, the

scale of potential damage and the public sensitivity to radiation, make nuclear plants attractive targets. Id.

267. Professor Rathjens testified further that the threat of attack by heavily armed groups should be a serious consideration in planning for future reactors and that substantial upgrading in security at existing facilities is required. Id. at 126-127.

268. Neither the Staff nor the Applicant ever responded to these facts.

269. The Staff and the Applicant maintain that the Board should limit its consideration of Commonwealth's Contention 9, as an environmental issue, to the risks of theft and sabotage to nuclear materials in transit to and from the plant. In support of this limitation on the contention, the Staff and Applicant presented testimony which purports to demonstrate the minimal risks associated with the potential for sabotage and other terrorist activities in the transportation of spent fuels and radioactive waste to and from nuclear power plants.*/

270. In support of this assertion the Staff and Applicant witnesses relied almost exclusively on previous NRC studies which estimated the probability of occurrences and potential consequences of transportation accidents and the health effects of radiological releases in a non-urban area resulting from a

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*/ See Applicant's Proposed Findings, par. 622-631.

high-explosive assault on spent fuel cases.*/

270. Recent events preclude us from accepting the Staff and Applicant's arguments. By letter dated January 25, 1979, counsel for the staff forwarded to the Board and parties certain Commission reports and a copy new study by Sandia Laboratories (SAND 77-1927) entitled "Transport of Radionuclides in Urban Environs: A Working Draft Assessment," which appears to assess sabotage of spent fuel in urban areas of high population denity. By letter dated March 5, 1979 Staff counsel advised the Board that it was aware of a classified document containing information potentially relevant to the issue of sabotage of spent nuclear fuel. A copy of the transmittal memorandum for this document was attached, indicating potential relevance to this proceeding.**/

271. On June 15, 1979, the Commission promulgated an interim final rule, 10 CRF §73.37, which established immediately effective safequards requirements for all spent fuel shipments. (44 FR 34466). The Commission's stated reason for this emergency measure was based on its evaluation of the Sandia study, NUREG 77-1927, which suggests that "sabotage of

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*/ See WASH-1238, Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, and NUREG 75/138 Supp. 1 to WASH 1238; and "Calculations from Sabotage of Shipping Costs for Spent Fuel and High Level Wastes", NUREG 0194; (February 1977). Staff witness Barker, Tr. 2275 ff.; Affidavit of Kasun and Hodge Tr.8459 ff.; Applicant Witnesses Rodger and Low Tr. 2024 ff.

**/ See Memorandum of January 22, 1977, from T.F. Carter Jr. to Director and Chief Counsel, Hearing Division, OELD, attached to letter of March 25, 1979 from B.H. South, Counsel for NRC Staff to the Board. The Staff advised us that it would forward its assessment of this new information. To date, we have heard nothing further from the staff on this matter.

spent fuel shipments has the potential for producing serious radiological consequences in area of high population density." The Commission specifically cited previous studies, relied upon the Staff and Applicant in this proceeding, which in light of the Sandia Study no longer appeared to accurately assess the risks of theft and sabotage in high population areas. Id. The Commission's action raises substantial doubt on the continued validity and reasonableness of the Staff reliance on these previous studies, particularly when Pilgrim 2 is proposed to be located in an urban area of extremely high population denity.

272. In view of these developments, the Board does not feel it can rule on this contention based on the present state of the record. The Board finds that the Commonwealth has raised substantial questions concerning the risks of theft and sabotage inherent in nuclear power, and that the staff has a yet unmet obligation under NEPA to meet and resolve these questions Aeshilman v. NRC, 547 F.2d 622. (D.C. Cir. 1976); reversed on other grounds, sub nom Vermont Yankee Nuclear Power Corp. v. NRDC, 435 U.S. 519 (1978).*/ Accordingly, we direct the Staff and Applicant to supplement its testimony on this matter in forthcoming hearings. See Pilgrim ALAB-479, 7 NR Cat. 793.

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*/ In this regard, we note that the Commonwealth has alerted the Staff to its concern with the Staff's evaluation of the new theft and sabotage documents. See letter March 29, 1979, L. Burt, A.A.G. to B.H. Smith.

CONCLUSION OF LAW

The Board has carefully considered all the evidence presented by the parties. Based on our review of the record as it has been thus far developed, we conclude as follows:

A. The evidence has not established that the Applicants are financially qualified to design and construct the proposed facility.

B. The evidence has not established that the Applicants are technically qualified to design and construct the proposed facility with respect to their quality assurance program.

C. The environmental review conducted by the Staff pursuant to NEPA and 10 CFR Part 51 has been inadequate on the issues of need for power, alternative energy sources, alternative sites and the risk of theft and sabotage.

D. The requirements of Section 102(2)(c) and (e) of NEPA and 10 CFR Part 51 have not been complied within this proceeding, nor can a final cost/benefit analysis for this project be made on the basis of the record at this time.

E. As to the issue of site suitability, the Board can not determine whether the site for Pilgrim Unit 2 is a suitable site for a nuclear power reactor of the general type and size proposed, and accordingly defers resolution of this matter until the completion of hearings on emergency planning.

IT IS SO ORDERED

THE ATOMIC SAFETY AND
LICENSING BOARD

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Date:

Respectfully submitted,

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