UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
BOSTON EDISON COMPANY, et al.	)	Docket No. 50-471
	)	
(Pilgrim Nuclear Generating Station, Unit 2)	)	

NUCLEAR REGULATORY COMMISSION STAFF'S PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW IN THE FORM OF A PARTIAL INITIAL DECISION

Barry H. Smith
Counsel for NRC Staff

November 20, 1979

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INTRODUCTION

Pursuant to 10 C.F.R. § 2.754, the Nuclear Regulatory Commission Staff (Staff) hereby submits Staff's Proposed Findings of Fact and Conclusions of Law in the form of a proposed Partial Initial Decision, and requests that they be adopted by the Atomic Safety and Licensing Board (the Board) in this proceeding.

As required by 10 C.F.R. § 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 Staff believes support the conclusion requested.

The Staff has indicated where it adopts the Applicants' or the Intervenor's proposed Findings. The Staff's decision not to adopt a Finding does not necessarily imply that the Staff rejects it.

I. Preliminary Statement

(1) The Staff adopts the Applicants' Findings in paragraphs Nos. 1 through 28.

(2) The Staff would modify Applicants' Finding in paragraph No. 29 as follows:

> A number of letters have been sent to the Applicants by the Staff notifying them of various requirements which have resulted from the investigations of the accident at Three Mile Island.[1/] The Commission has also issued policy statements concerning issues relating to the accident.[2/] In addition to these, the Staff has sent us a number of "Board Notifications (Notifications). These letters, statements

1/ Letter of October 10, 1979, To All Pending Construction Permit Applicants, Re: Followup Actions Resulting From The NRC Staff Reviews Regarding The Three Mile Island Unit 2 Accident from Domenic B. Vassallo, Acting Director, Division of Project Management; and letter of October 23, 1979 to Mr. R. M. Butler, Nuclear Projects Manager, Re: Emergency Preparedness Requirements--Pilgrim Nuclear Generating Station, Unit 2 from D. B. Vassallo, Acting Director, Division of Project Management.

2/ Suspension of 10 CFR § 2.764 and Statement of Policy on Conduct of Adjudicatory Proceedings (Modified Adjudicatory Procedure) (November 5, 1979, 44 Fed. Reg. ____).

of policy and Notifications are not a part of the decisional record. However, with respect to the Board notifications, the Board will examine any subsequent reports issued by the Staff on these matters and give the opportunity to the parties to move to reopen the record in this proceeding if such action is appropriate. In addition, the Board will endeavor to follow the Commission's direction as set forth below:

> In reaching their decisions the Board should interpret existing regulations and regulatory policies with due consideration to the implications for those regulations and policies of the Three Mile Island accident. In this regard it should be understood that as a result of analyses still under way the Commission may change its present regulations and regulatory policies in important respects and thus compliance with existing regulations may turn out to no longer warrant approval of a license application. As provided in paragraph 3 below, in addition to taking generic rulemaking actions, the Commission will be providing case-by-case guidance on changes in regulatory policies in conducting its reviews in adjudicatory proceedings. The Boards shall, in turn, apply these revised regulations and policies in cases then pending before them to the extent that they are applicable. The Commission expects the Licensing Boards to pay particular attention in their decisions to analyzing the evidence on those safety and environmental issues arising under applicable Commission regulations and policies which the Boards believe present serious, close questions and which the Boards believe may be crucial to whether a license should become effective before full appellate review is completed. Furthermore, the Boards should identify any aspects of the case which, in their judgment, present issues on which prompt Commission policy guidance is called for. The Boards may request the assistance of the parties in identifying such policy issues but, absent specific Commission directive, such policy issues shall not be the subject of discovery, examination, or cross-examination. (Modified Adjudicatory Proceedings.)

The Board will make its current findings based on the present record.

(3) The Staff adopts the Applicants' Findings in paragraphs Nos. 30 and 32.

II. Radiological Health and Safety Matters

A. General

(4) The Staff adopts the Applicants' Finding in paragraphs Nos. 33 and 34.

B. Facility Description

(5) The Staff adopts the Applicants' Findings in paragraphs Nos. 35 through 43.

(6) The Staff adopts Applicants' Finding in paragraph 44 with the following modification. The following footnote should be added.

> On April 2, 1979, the Staff notified the Board that it is evaluating new information relating to Combustion Engineering's flow blockage model for the Pilgrim Unit 2 Emergency Core Cooling System. Upon receipt of the Staff's review of this we will determine if the record should be reopened on this matter.

(7) The Staff adopts the Applicants' Findings in paragraphs 45 through 54.

(8) The Staff modifies Applicants' Finding in paragraph 55 as follows: The Staff concluded that the consequences of these accidents, were well within the guidelines of 10 C.F.R. Part 100, SER § 15.

A potential source of fission product leakage following a postulated loss-of-coolant accident is leakage from containment spray system or safety injection system components which will be located outside containment in the enclosure complex. The Staff at first did not accept the Applicants' system to mitigate the consequences. The Staff reevaluated its position and concluded that leakage from the sources in the engineered pump rooms, other than from valve packings and stems and pump seals, is so unlikely that it need not be considered. SER Supp. No. 3 § 15.6. The Board agrees with the Staff's conclusion and agrees that, even without giving credit for iodine filtration by the plug filter, the retention of iodine in the sump pump will be sufficiently high so that the offsite radiological consequences of leakage from the engineered safety feature system will be acceptable. SER Supp. No. 3, § 15.2.

(9) The Staff adopts the Applicants' Finding in paragraph 56 with the following modification:

> The Staff concluded that the Applicants have identified and will perform the development tests and analytical work necessary for verification of the design and safe operation of Pilgrim Unit 2 on a timely basis. (SER § 1.7.)

C. Steam Generator Tube Integrity

(10) The Staff adopts the Applicants' Findings in paragraphs Nos. 57 through 82.

(11) The Staff adopts the Applicants' Finding in paragraph No. 83 with the following modification:

> The word "construction" should be deleted in the last sentence.

D. Compliance with Appendix I

(12) The Staff and Intervenor Massachusetts Wildlife Federation (MWF) have agreed to submit joint findings of fact in this area. The Applicants will join in discussions concerning this area. These will be submitted by November 30, 1979.

E. Technical Qualifications

(13) The Staff adopts the Applicants' Findings in paragraphs Nos. 108 through 150.

(14) The Commonwealth has suggested that this Board follow the suggestion of the Licensing Board in Carolina Power & Light Company (Shearon Harris Nuclear Power Plant, Units 1, 2, 3 and 4), Supplemental Initial Decision (July 13, 1979), that a mandatory hearing be held at the operating license review stage to review the adequacy of Boston Edison's technical qualifications.

(15) We have reviewed the Shearon Harris opinion and we do not have the same doubts about Boston Edison's management capability nor do we see the same type of problems in this case as were present in Shearon Harris. For these reasons, the Board rejects the condition offered by the Commonwealth.

(16) If the Commonwealth of Massachusetts believes a hearing on this issue is necessary at the time an application is made for an operating license, it can request a hearing pursuant to 10 C.F.R. §§ 2.104(c) and 2.714.

(17) While the Board finds Boston Edison to have demonstrated the requisite qualifications to design and construct Pilgrim Unit 2, the Board cannot ignore the many statements concerning operator error in relationship to the TMI accident. (Investigation Into The March 28, 1979 Three Mile Island

Accident By Office of Inspection and Enforcement (NUREG-0600), TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations (NUREG-0578).) If a construction permit is ultimately issued to the Applicants, it is anticipated that qualifications to operate the plant will come under close scrutiny. It is for this reason that the Board will urge the Staff to carefully review, at the time, the qualifications of the personnel Boston Edison has chosen to operate the facility.

(18) While the Board will not impose the condition requested by the Commcnwealth, it does recognize the Commonwealth's present concern on this subject and, in the opinion of this Board, this issue alone would be a basis for the Commonwealth to intervene in the operating license hearing.

(19) The Staff adopts the Applicants' Findings in paragraphs Nos. 151 through 200.

(20) The Staff adopts the Applicants' Finding in paragraph No. 201 with the following modification:

The word "adequate" should be changed to "acceptable."

(21) The Staff adopts the Applicants' Findings in paragraphs Nos. 202 through 261.

F. Adequacy of Regulatory Staff Inspection Practices

(22) The Staff adopts the Applicants' Findings in paragraphs Nos. 262 through 270.

G. Generic Issues

(23) The Staff adopts the Applicants' Findings in paragraphs Nos. 271 through 275.

H. Financial Qualifications

(24) The Staff adopts the Applicants' Findings in paragraphs Nos. 276 and 277.

(25) The Staff adopts the Applicants' Finding in paragraph No. 278 with the following modification:

Change "10 C.F.R. § 20.33(f)" to "10 C.F.R. § 50.33(f)."

(26) The Staff adopts the Applicants' Findings in paragraphs Nos. 279 through 282.

(27) The Staff adopts the Applicants' Finding in paragraph No. 283 with the following modification:

On page 158, line 6, change "38%" to "39%."

(28) The Staff adopts the Applicants' Finding in paragraph No. 284 with the following modification:

On page 158, line 13, change "$6.7 million" to "$617 million."

(29) The Staff adopts the Applicants' Findings in paragraphs Nos. 285 and 286.

(30) The Staff adopts the Applicants' Findings in paragraphs Nos. 287 through 290.

(31) The Staff adopts the Applicants' Finding in paragraph No. 291 with the following modification:

Line 17, change "preferred" to "preferred stock."

(32) The Staff adopts the Applicants' Finding in paragraph No. 292.

(33) The Staff adopts the Applicants' Finding in paragraph No. 293 with the following modification:

Page 167, line 7, change "3-5" to "3-6."

(34) Mr. Levy's professional qualifications as an expert witness in the field of finance, particularly as to that for public utilities, is a close question. However, the Board allowed his testimony to be presented because of the general experience, albeit brief, that Mr. Levy had gained as Chairman of the Massachusetts Department of Public Utilities. (Tr. 9408-9434.) Because of this limited experience, we have given Mr. Levy's testimony very little weight.

(35) The Staff adopts the Applicants' Findings in paragraphs Nos. 294 through 301.

(36) The Commonwealth urges the Board to: (1) find that the Staff has not applied the reasonable assurance standard as directed by the Commission in Public Service Company of New Hampshire, et al. (Seabrook Station, Units 1 and 2), 7 NRC 1 (1978) (hereinafter Seabrook); and (2) find that the Staff did not independently assess the Applicants', specifically Boston Edison's, financial qualifications. (Commonwealth Findings, p. 17.) The Board rejects both of these positions. Our reasons are set forth below.

(37) The Commonwealth focuses on the following language of 10 C.F.R. § 50.33(f):

> If the application is for a construction permit, such information shall show that the Applicant possesses the funds . . . or that the Applicant has reasonable assurance of obtaining the necessary funds . . . . (emphasis supplied.)

(38) In Seabrook, supra, the Commission expressed its opinion of the interpretation of the "reasonable assurance standard" for financial qualifications as follows:

> The "reasonable assurance requirement of 10 C.F.R. § 50.33(f) does, however, contemplate actual inquiry into the Applicants' financial qualifications." It is not enough that the Applicants are a regulated public utility. On the other hand, given the history of the present rule and the relatively modest implementing requirements of Appendix C, a "reasonable assurance" does not mean a demonstration of near certainty that an applicant will never be pressed for funds in the

> course of construction. It does mean that the applicant must have a reasonable financing plan in the light of relevant circumstances. Seabrook, supra at 18. footnote omitted, emphasis supplied.)
>
> * * *
>
> [A] utility cannot provide more than a reasonable assurance that funds will be available through the course of a multi-year construction project. The number of variables - such as interest rates, the state of the stock and bond markets, the regulatory climate and the cost of fuel - that operate over the period required to construct a nuclear power plant make financial forecasting over a ten-year period uncertain. Seabrook, supra at 19.

(39) The Commission did not want the Staff to ignore that anticipated difficulties in raising funds are relevant to the reasonable assurance determination, but a showing of some potential difficulty would not necessarily preclude that determination, when all other factors were taken into account. (Seabrook, supra at 21.)

(40) The United States Court of Appeals for the First Circuit in NECNP v. NRC, 582 F.2d 87, at 93, recognized that an applicant's financial condition does not have to be "rosy" to meet the Commission's requirement for financial qualifications. Furthermore, the Court agreed that an Applicant must only demonstrate a reasonable assurance of obtaining the necessary funds, even if they must be obtained at a high cost. (Ibid. 93.)

(41) The Commission recognized, in Seabrook, that the history of the adoption of Appendix C indicates that the "reasonable assurance" requirement is not rigid and that it does not normally contemplate refined analyses

of an applicant's likely future ability to meet specific costs. The Commission furthermore noted in Seabrook that Appendix C makes clear that the "reasonable assurance" concept embodied in the regulation is more flexible than many of the Commission's safety criteria. (Seabrook, supra at 9, 10.)

(42) Based on the above, the Board concludes that a determination of the reasonableness of the financing plan, in light of relevant circumstances, is sufficient to meet the requirement of "reasonable assurance that funds can be obtained."

(43) In this proceeding, as discussed above, the Staff has fully met its burden in evaluating the financial condition and outlook of the Applicants and concluding that the they are financially qualified.

(44) The Commonwealth's assertion that the Staff's assessment of the Applicants' financial qualifications was not independent was deceitful is wholly without merit. (Commonwealth Findings at pp. 16, 18.)

(45) The Staff is critized by the Commonwealth because it relied on the Applicants' data. This information was requested by the Staff of the Applicants pursuant to 10 C.F.R. § 50.54(f) and Section IV of Appendix C to 10 C.F.R. Part 50. In meeting its burden of proof, the Applicants supplied the necessary financial information. There is nothing wrong with accepting such data unless there is some belief that it is untrue. No party has

demonstrated that the information supplied should not be relied upon. The Commonwealth witness based his case primarily on relatively old internal documents of the Applicants (Commonwealth Exhibits 100 and 101); however, he did not address either the information contained in SER Supplement No. 4 or other recent developments such as the Company's successful financing of $195 million of first mortgage bonds (Tr. 9539). Furthermore, we can find no assertion by Mr. Levy that the information relied upon by the Staff is inaccurate. In fact, it is not clear whether Mr. Levy even analyzed the Staff's review of the alternative financial plans submitted by Boston Edison. (Tr. 9481, 9485.) The most conservative of these showed Boston Edison's ability to finance the construction of Pilgrim Unit 2 upon receiving only 25% of its projected future rate increase requests. (Applicants' Exhibit 1-EE, 25% Plan).

(46) The important issue in the Staff's review is how the information is evaluated. It is clear from this record that the Staff did not merely accept the statements of the Applicants and perform a cursory evaluation. Instead, the Board finds that the Staff presentation is a detailed, objective, and well-documented review based upon substantial evidence from the record as a whole. As the reviewer, Mr. Karlowicz required alternative financing plans based on various rates of return which were considerably lower in magnitude than both those stated in the Applicants' (Boston Edison Company's) base plan and the Applicants' allowed rate of return. (SER Supp. No. 4 § C.2.1.)

(47) The Staff also closely examined relevant circumstances to Boston Edison's financial condition such as both historical and projected levels of internal cash generation, interest coverage and capital structure to determine whether all the elements of the financial plan, when looked at in their totality, represented a reasonable financing plan. (SER Supp. No. 4 §§ C.2.2, C.2.3, C.2.4.) Its detailed assessment has been discussed above. In addition, the Staff's financial analysis goes beyond the financing of the facility itself. It looks at the ability of the company to refund its maturing bonds and finance all of its capital requirements. (SER Supp. No. 4 § C.2.)

(48) The Commonwealth cites as an example of the lack of Staff review the fact that a correction was made to projected indenture coverage. The Staff probed the Applicants on the reason for this change, and Mr. Karlowicz gave his assessment of the impact of the change. (Tr. 1107; Applicants' Ex. 1-FF.) The Board does not find that bringing to the attention of the Board minor numerical and not judgmental errors which may have been found constitute adequate grounds for concluding that the Staff has not done its job. This is expecially true when one examines the extensive amount of material considered by the Staff on Boston Edison Company's financial qualifications. (SER Supp. No. 4, pp. 20-1, and A-1 to A-4.)

(49) An assertion is made by the Commonwealth that the Staff witness was surprised about the capital structure of Boston Edison Company and that

this "surprise" demonstrated that the Staff's witness was not familiar with Boston Edison's financial position. (Commonwealth Finding at p. 18.) First of all, the Staff's SER Supplement shows a 32.2% common equity component of capital structure. (SER Supp. No. 4 § C.2.4 at p. C-14.) Secondly, Boston Edison Company's annual report to its shareholders for the calendar year 1978 shows a 33% common equity component of capital structure. (Applicants Exhibit No. 1EE). This is very close to the response made by Mr. Karlowicz. (Tr. 9539.) When asked by the Commonwealth what the common equity of Boston Edison was as of May 29, 1979, Mr. Karlowicz responded by saying 35-36%. (Tr. 9539.) The Commonwealth has not demonstrated that, as of that date, that was not the correct figure. This is not a significant point to the Staff's review, except to show that the Commonwealth has mischaracterized the witness' response and a careful look at all the documents reveals that Mr. Karlowicz was very knowledgeable about the subject matter. (SER Supp. No. 4, Appendix C, Tr. 9578-9585.)

(50) To characterize Mr. Karlowicz' testimony as deceitful and unworthy is totally without any basis whatsoever. Mr. Karlowicz did not state, at any time in his testimony, that a utility could have a "heavily unbalanced" capital structure and still be within the industry range. (Tr. 9541.) Mr. Karlowicz indicated that a utility could be at the low end of a range, i.e., 30% common equity, which would be an item of concern, albeit one that should not be looked at in a vacuum. (Tr. 9539, 9541.) In fact, Mr. Karlowicz recognized that, at one time, Boston Edison did have a problem with its capital structure. (Tr. 9539.)

(51) Mr. Karlowicz's professional credentials encompass ten years of electric utility finance experience which includes responsibility for the finances of an investor-owned and federal regulatory responsibility. (Statement of Professional Qualifications following Tr. 9513.) The Board finds that Mr. Karlowicz is extremely qualified as an expert witness to speak about financial qualifications of public utilities and, in particular, has demonstrated a thorough knowledge of both this application and the required scope and substance of the Staff review as mandated by the Commission in Seabrook. (Tr. 9513, 9520, 9523, 9524.)

(52) The Commonwealth strongly suggests that, because Mr. Karlowicz could not recollect a Staff witness testifying that an applicant was not financially qualified, this casts doubt on the Staff's independence. (Commonwealth's Findings at p. 18.) The Board has fully explored the record and the Commonwealth's argument in search of a nexus between these two issues. We can find none. Moreover, we find the assertion inconsistent with Mr. Karlowicz' testimony which indicated that, in June of 1978, he could not find Boston Edison Company to be financially qualified to build Pilgrim 2. (Tr. 9533.)

(53) We do find that the Staff had doubts, at one time, about the financial qualifications of Boston Edison. (Tr. 9524, 9533; SER Supp. No. 4, Appendix C, § C.2.1.) It is these doubts that caused the Staff to require additional financial projections under most conservative assumptions and a substantial amount of additional financial information and, in the

opinion of this Board, conduct a very detailed analysis of the financial qualifications of Boston Edison to design and construct Pilgrim 2. (SER Supp. No. 4, Appendix C; Tr. 9525.)

(54) The Commonwealth also attacks the credibility of the Applicants' witness, Mr. Kelmon.

(55) Although there may be seeming conflicts to Mr. Kelmon's previous sworn testimony before the MDPU with that given in this proceeding, this Board finds that it does not contradict, as a logical matter, his conclusions presented in this case. The Board agrees with Mr. Karlowicz that Mr. Kelmon's earlier statements before the MDPU were based upon the Company's request to attain its allowed rate of return. The NRC's concern, on the other hand, is one of determining a company's ability to finance. If financing is obtainable, then the NRC's financial qualifications requirements will have been met. (Tr. 9534, 9544.)

(56) The Board questioned the witness as to whether he had any examples of situations which would lead him to determine that an applicant was not financially qualified. Mr. Karlowicz gave the following examples, which would give rise to serious problems in finding an applicant financially qualified: (1) a negative cash flow for an ascertained period; (2) heavily unbalanced capital structure; (3) indenture coverage of 1.0 for a sustained period of time; and (4) a common stock dividend cut or omission. (Tr. 9530, 9538, 9578.)

(57) Despite Mr. Levy's raising the spectra of potential difficulties which the Applicants may meet in financing the construction of Pilgrim Unit 2, including regulatory reasons, he has offered no real evidence to show that the necessary rate increases required by the company to finance Pilgrim 2 construction will not be forthcoming. (Tr. 9418, 9434.) Our review of his testimony shows the thrust of his presentation to be conjecture of potential difficulty. As acknowledged by the Commission, the mere showing of potential difficulty will not preclude a determination of financial qualification, all other relevant factors being taken into account. (Seabrook, supra at 21.)

(58) The Board agrees with the Staff that, when dealing with this subject matter, no one item can be looked at in total isolation. (Tr. 9579.) However, the Board is confident that the Staff gives appropriate weight to the relevant circumstances when evaluating whether the Applicants have presented a reasonable financing plan.

(59) The Board finds that the Staff's review of the financial qualifications of the Applicants represents an independent and objective evaluation, and that its determinations are based on a sound and thorough analysis. (SER Supp. No. 4, Appendix C.)

I. Common Defense and Security

(60) The Staff adopts the Applicants' Finding in paragraph No. 302.

III. Environmental Matters

A. General

(61) The Staff adopts the Applicants' Finding in paragraphs Nos. 303-305.

B. Impacts of Construction

(62) The Staff adopts the Applicants' Findings in paragraph No. 306.

(63) There are no historical, cultural, archaeological or architectural resources which will be affected by construction of Pilgrim Unit No. 2 (FES § 2.3.2).

(64) The construction water requirements will be supplied by the Town of Plymouth. This will not affect the planned local water supply (FES at

4-2). The construction of Unit 2 will not have an effect on the quality of surface run-off water or groundwater used by others (FES at 4-2). Therefore, the Board finds that there will be no adverse effect on groundwater due to construction.

(65) The Staff adopts the Applicants' Finding in paragraph 307 with the following addition:

> Dredged spoils material will be barged to an off shore disposal area in accordance with U. S. Army Corps of Engineers regulations (FES § 4.2). Surplus material will be disposed of in any existing borrow area in accordance with State Department of Natural Resources and Department of Public Works specifications (FES § 4.2). These procedures have been committed to by the Applicant (FES § 4.5). The Board finds that the action will avoid unnecessary adverse environmental impacts from dredging activities.

(66) The major expected adverse terrestrial ecology effects are those associated with long-term loss of biological productivity through the removal of forest community acreages (FES § 4.3.1). However, the construction activities are not expected to result in the elimination of any existing population of plants or animals (FES § 4.3.1).

(67) The existing transmission corridor from the site, which was established for Unit 1, will be used for Unit 2 (FES § 3.7). The transmission line for Unit 2 will utilize existing towers (FES § 13.7.2.1). The construction of the transmission lines will have a minimal impact on the land in the vicinity of the facility and along the transmission corridor. The Staff recommends the condition that the transmission corridor be replanted with a vegetative screen (FES § 4.5.2).

(68) The Staff adopts the Applicants' Findings in paragraphs Nos. 308, 309, and 310.

(69) The Applicant has proposed several measures to limit the adverse effect of construction of the Pilgrim facility (FES at 4-5, 4-6). The Staff has evaluated these measures and has concluded that, if combined with Staff recommendations, they are adequate to assure that adverse environmental impact from the construction of Pilgrim 2 will be at the minimum practicable level. The Applicants' proposed commitments and the Staff's recommendations will be included as conditions of the construction permit for Pilgrim Unit 2; the conditions are discussed in the following paragraphs.

(70) The Applicants will be required to take the necessary mitigating actions (including those summarized in § 4.6.1 and 4.6.2 of the FES) during construction of the plant and associates transmission lines to avoid unnecessary adverse environmental impacts from construction activities (FES p. v).

(71) Moreover, the Applicants will be required to establish a control program which shall include written procedures and instructions to control all construction activities as prescribed in the FES and will provide for periodic management audits to determine the adequacy of implementation of environmental conditions. Boston Edison Company will be required to maintain sufficient records to furnish evidence of compliance with all of the environmental conditions in the FES (Id.).

(72) Before engaging in a construction activity not evaluated by the Commission, the Applicants will be required to prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not evaluated, or that is significantly greater than that evaluated in the Final Environmental Statement, the Applicant shall provide a written evaluation of such activities and obtain prior approval of the Director of the Office of Nuclear Reactor Regulation to engage in these activities.

(73) If unexpected harmful effects or evidence of serious damage are detected during facility construction, the Applicant will be required to provide to the Staff an acceptable analysis of the problem and a plan of action to eliminate or significantly reduce the harmful effects of damage.

(74) The Staff adopts the Applicants' Findings in paragraph No. 311.

C. Impacts of Operation

(75) The Staff adopts the Applicants' Findings in paragraphs No. 312 and 313 with the addition of the following sentence to the Finding in paragraph 313:

> The recreational use of waters in the vicinity of the site will not be affected by the operation of the proposed Pilgrim Unit 2 (FES § 5.2.3).

(76) The operation of Pilgrim Unit 2 is not expected to adversely affect commercial fishing near the site during the winter months and it will not affect offshore fishing during the summer (FES § 5.2.4). During plant operation there is the possibility that the thermal discharge will cause a 14% loss of the local Irish Moss harvest. The Staff reviewed the available information and concluded that the reduction may be due to a natural phenomenon rather than the impact of plant operation (FES § 5.4.2.2.7). The Board concurs with the Staff's conclusion that the impart of plant operation on Irish Moss harvesting is obscured by natural fluctuations occurring in the vicinity of the plant. (Tr. 10,010.)

(77) The Staff accepts the Applicants' Finding in paragraph 314 with the following modification:

> The FES reference should include FES § 5.4.2.2.5. The following sentences should also be inserted.

The Applicants will be required by their 402 NPDES permit to design and construct a barrier as near to the terminal end of the discharge canal as good engineering practice will allow so as to at all times prevent fish entry into the canal. (Applicants' NPDES Permit, hereinafter Staff Ex. 18c, Part III.) The Applicants will be required to take additional precautions if the physical barrier is not successful (Staff Ex. 18c, 6 Part III).

The Staff considered the placement of a barrier a positive solution to the gas bubble disease (FES § 9.31).

(78) The Staff calculated the radiological impact on man. This includes a determination of the radiation dose commitments to individuals, populations and occupational radiation exposure[3/] (FES § 5.3 following Tr. 7828). The Board has reviewed the Staff's methodology in assessing the environmental impacts due to radiation and finds them to be reasonable.

(79) The annual individual dose commitments resulting from routine operation of the plant are a small fraction of the dose limits specified in 10 C.F.R. Part 20. The population dose commitments are small fractions of the dose from natural environmental radioactivity (FES § 5.3.1.6 following

3/ Tables 3.4 and 3.5 which were utilized in assessing the radiological impacts were modified by Staff witness Weller following Tr. 6482 at p. 8 and following Tr. 7659 at unnumbered p. 5.

Tr. 7828). The Board finds that there will be no significant radiological impact on man from the routine operation of the Pilgrim Unit 2.

(80) The Staff adopts the Applicants' Findings in paragraphs Nos. 315 and 316.

D. Environmental Monitoring

(81) The Staff adopts the Applicants' Findings in paragraphs Nos. 317 through 320.

E. Alternative Cooling System Designs

(82) The Staff adopts the Applicants' Findings in paragraphs Nos. 321 through 327.

F. Uranium Fuel Cycle

(83) The Staff adopts the Applicants' Findings in paragraphs Nos. 328 through 330.

G. Alternative Sites

(84) The Staff adopts Applicants' Findings in paragraphs Nos. 331 through 341.

(85) The Staff found some deficiencies in the 1974 study, including the updated material. However, no area contained a serious enough flaw to eliminate the consideration of the site or to believe that the study was not adequate. (FSFES, pp. 3-2, 3-7; Staff Supplemental Testimony Relating to Alternate Sites, pp. 4-13 following Tr. 9852, hereinafter Supplemental Testimony.) If the Staff believed additional information was required, a request was made to the Applicants to provide it or the Staff independently sought it out. (FSFES at 4-2.)

(86) The Staff adopts the Applicants' Finding in paragraph No. 341 with the following modification:

Line 8, change "10" to "9".

(87) The Staff adopts Applicants' Findings Nos. 342 through 354.

(88) The Staff adopts Applicants' Finding in paragraph No. 355 with the following modification:

> The Board finds that the analysis and evaluation undertaken by the Staff fully complies with NEPA and the guidance offered by the Commission, Seabrook, CLI-77-8, supra; and the Appeal Board in Seabrook, ALAB-471, supra; and Boston Edison, ALAB-479, supra. Compliance was obtained by the Staff taking a "hard look" at specific sites, both within and without the relevant region of interest which represent a genuine set of alternatives to the Rocky Point site.

(89) The Staff adopts the Applicants' Findings in paragraphs Nos. 356 through 359.

(90) The Staff adopts the Applicants' Finding in paragraph No. 360 with the following modification:

Page 223, line 5, change "inferior" to "not preferable".

(91) The Staff adopts the Applicants' Finding in paragraph No. 361.

(92) The Commonwealth asserts that the Staff's review was flawed because it did not employ the "redundancy criteria," i.e., eliminate sites which have similar characteristics. (FSFES § 5.4.) The Board agrees with the Staff that, while this criteria reduces the number of sites for comparison, it does not affect the quality or completeness of the review. (FSFES § 5.4.)

(93) The Staff adopts the Applicants' Proposed Findings in paragraphs Nos. 362. through 364.

(94) The Staff adopts the Applicants' Finding in paragraph No. 363 with the following modifications:

(95) The Staff adopts the Applicants' Finding in para. No. 363 with modification as follows:

The applicants submitted data in their 1974 siting study estimating the population around each of the candidate alternative sites analyzed in the study. The Staff found the 1974 study deficient because it did not include population projections or transient populations for any of the alternative sites. The Applicants provided additional information in a May 30, 1978 response to questions posed by the Staff. This updated submittal included population projections and estimates of seasonal residents. The Staff criticized the 1978 submittal because it did not include estimates of daily recreational visitors and tourists. However, the staff stated that the inclusion of these daily transients, when weighted to account for their occupancy on an annual basis, would not alter the population distributions to the extent that the conclusions of the Staff's review would be affected (FSFES at p. 3-5).

In order to check the population data submitted by the Applicants for the candidate alternative sites and the Rocky Point site, the Staff independently compared the Applicants 1970 population data base with 1970 Bureau of the Census data and found that the Applicants' values were in close agreement with the Census data (FSFES para. 3.3.3). The Staff also compared the Applicants' population projections with projections prepared by the Federal Government for Bureau of

Economic Analysis Area 4, an area that covers southeastern New Hampshire, eastern Massachusetts, and Rhode Island. This comparison showed that the Applicants projected population growth rate for the area within 48 km of each of the alternative sites and the Rocky Point site exceeds the projected regional growth rate made by the Federal Government (FSFES para. 3.3.3). The Staff concluded that the population data in the 1978 submittal and in the Pilgrim Unit 2 licensing documents were reasonable representations of the population distributions for the candidate alternative sites and the proposed Rocky Point site (FSFES at p. 5-9).

The data in the PSAR and the FES for the Pilgrim Unit 2 site, which the Staff utilized during its construction permit review, included detailed data on permanent residents, seasonal residents and tourists visiting the historical sites in Plymouth. FSFES at 5-8. The Applicants' 1978 estimates of population at Pilgrim were based on reconnaissance-level information and were not intended to supersede the detailed information previously provided in the PSAR and FES for Pilgrim Unit 2. Staff population and projected population figures for the area surrounding the Rocky Point site are found in Table I of the Final Supplement of the FES. FSFES

at 4-4. These figures demonstrate that the population surrounding the Rocky Point site does not exceed the "trip levels" of Reg. Guide 4.7. See para. 364 infra. For example, in 1985, the population density out to 48 km is projected at 169 persons per km^2, and in 2020, the projection is 349 persons per km^2. FSFEW at 4-4. These projections are less than the trip levels of 310 persons per km^2 at the beginning of plant operation and 620 persons per km^2 over the life of the plant as set forth in Regulatory Guide 4.7. Staff witness Kantor updated these projections further at the hearings held on August 27, 1979. Staff Exh. 66. This witness testified that although the updated figures in Exhibit 66 depict density factors that are slightly higher than the ones shown in Table 1 of the FSFES, the differences are not "significant enough to change any of our conclusions in the FES." Tr. 11,449.

(96) The Staff adopts the Applicants' Findings in paragraph No. 364.

(97) An important factor in assessing the reasonableness of the Staff approach to demography in the alternative site review is the recognition that an accident is no more likely to occur in the summer than in the winter or in the day or night. (FSFES § 5.23.) To assume for purpose of the NEPA review that an accident will only occur at the height of the tourist season

rather than assuming that it will happen during some period of time during the year is not realistic. Of course, the Staff does take into account maximum population density when dealing with emergency planning. (Rebuttal Testimony of F. Kantor and L. Soffer following Tr. 1107, Tr. 11,671, hearinafter Kantor and Soffer Testimony.)

(98) Dr. Herr asserts that knowing the maximum popluation for each sector would be useful to determine risk. However, Dr. Herr does not define how he perceives risk. (Tr. 11,669.) In fact, he uses it in a different meaning throughout his testimony. (Tr. 11,670.) The Board perceives risk as a measure of probability times consequences. (F. Kantor and L. Soffer Testimony at pp. 7-10.) It is with this perspective that the Board has examined the Staff's methodology relating to demography.

(99) The Board would possibly agree with Dr. Herr's suggestion if a site presented some unique feature that required a level of study beyond the gathering of reconnaissance level information. This is not present in this proceeding.

(100) The Staff adopts the Applicants' Findings in paragraphs Nos. 365 through 370.

(101) The Staff adopts the Applicants' Findings contained in paragraphs 371 and 372 with the following modification: The last sentence should be deleted and substituted with the following:

> While the Commission did not change its present policy, it did request the Staff to submit recommendations concerning the Annex to Appendix D and provide the following:
>
> 2. In the interim, pending completion of the 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. Offshore, slip. op. at 10.

(102) The Board has not received from the Staff any notification that this case requires such an analysis. This is not surprising since the Staff set forth its opinion in the response to the Commonwealth's comments on the FSFES that it did not believe such an analysis is required. (FSFES at § 5.23.)

(103) The Board, in reviewing this record, agrees with the Staff that there is nothing in this record which would indicate the need for a consideration of the environmental consequences of a Class 9 accident. Of course, if the Commission decides to undertake the consideration of Class 9 accidents, it may very well require the reopening of this record. However, until such time, the Board finds that the Staff is under no duty to consider the environmental consequences of a Class 9 accident to fulfill the requirements of NEPA in this case.

(104) The Staff believes the Board should reject Applicants' Proposed Finding in paragraph 373 and substitute the following:

> The proposed amendment to Appendix E to 10 C.F.R. Part 50, Fed. Reg. 37473 (August 23, 1978), states that the advantages and disadvantages with respect to emergency planning at alternative sites may be considered in the cost benefit analysis. The Staff has undertaken an analysis of alternative sites which would identify "any potential emergency planning advantages or disadvantages of particular sites." (Kantor and Soffer Testimony at p. 7. The Board believes that under the circumstances of this case a comparison of emergency planning will be useful.

(105) The Staff adopts Applicants' Findings in paragraphs Nos. 374 and 375.

(106) The Staff adopts Applicants' Finding in paragraph No. 376 with the following modifications:

page 238, line 6, should read as follows:

> . . . near the site, staff witness Masnik testified that a recent modeling effort predicted a 2-3% reduction in population . . . .

Page 238, line 9, reference should be Tr. 10311-12.

Page 238, footnote, the reference should be Tr. 9893-9895.

(107) In assessing the alternative sites, the Staff and Applicants utilized reconnaissance-level information. That is, information available in open literature, published or unpublished reports, existing records, authoritative sources or information that can be obtained by brief field surveys performed by recognized experts. It does not include information that must be obtained by detailed onsite monitoring programs or studies. (FSFES, p. 4)

(108) The specific areas that were examined for each environmental parameter at each site are discussed below.

(109) The Staff reviewed the potential impact on the aquatic ecology and water quality with respect to construction activities, intake and discharge effects.

(110) For construction impacts, the Staff examined (1) onsite stream diversions or alterations; (2) changes in site runoff during site development; (3) right of way or water pipeline development; and (4) siltation due to dredging for barge facilities, intake/discharge structures, and pipelines. (FSFES pp. 4-10, 4-21, 4-31, 4-39, 4-47, 4-56.) The primary impacts reviewed for intake effects were those associated with impingement or entrainment. With respect to discharge effects during operation, primary attention was given to those impacts associated with thermal loading, cold shock, discharge of biocides and other compounds, discharge of water differing in

quality from the receiving waters, physical changes in the receiving water near the discharge, including scouring of the bottom and shoreline and gas bubble disease (GBD) induced mortality.

(111) The Staff also reviewed, where applicable, the use of once-through cooling systems and closed cycle.

(112) The Staff looked at the water availability (hydrology) for plant operation at each site. (FSFES pp. 4-13, 17, 26, 35, 43, 51, 59.)

(113) With respect to terrestrial ecology and land use, the Staff reviewed the following areas: dedicated areas, forests, wildlife habitats, farmlands, wet lands, flood plains, and transmission lines. (FSFES pp. 4-18, 26, 27, 35, 36, 44, 52, 59.)

(114) The following areas were explored in the area of socioeconomic impact: (1) displacement of residences, industrial and commercial establishments; (2) destruction of onsite historic or natural features listed in the national or state registers; (3) items of local historical interest; (4) onsite recreation or scenic areas listed in the state outdoor recreation plan; (5) archaeological sites; (6) traffic impacts; (7) labor shed; and (8) visual impacts. (FSFES pp. 4-17, 18, 26, 35, 44, 52, 59.)

(115) The Staff examined the potential impact on the safe operation of a nuclear plant of the industrial, transportation, and military facilities, i.e., external hazards, in the vicinity of the alternative sites.

(116) The Staff also reviewed the demography surrounding each site.

(117) The Staff adopts the Applicants' Finding in paragraph No. 377 with the following modifications:

Page 239, line 18, should read ". . . preferable and possibly superior."

Page 241, line 14 and 15 should read ". . . estimated to be comparable or possibly greater than those. . . ."

(118) The Staff adopts Applicants' Findings in paragraphs Nos. 378 and 379.

(119) The Staff adopts Applicants' Finding in paragraph No. 380 with the following modification:

Page 243, the last sentence on the page should read:

With respect to the effects of the water intake structure on aquatic biota, the Staff concluded that, although the proposed use of closed-cycle cooling at both sites 19 and 20 would substantially reduce mortality related to the entrainment and impingement, the apparently high biological importance of the northern portion of Buzzards Bay on both the Buzzards Bay and Cape Cod Bay fishery may result in the determination that even closed-cycle cooling in this region would still result in significant adverse impacts to the fishery. (FSFES § 4.8.1.)

Page 244, strike the remainder of the sentence beginning on page 243.

The Staff also concluded that there would be more displacements at these sites than at Rocky Point. FSFES, § 4.8.6.

(120) The Staff adopts Applicants' Findings in paragraphs Nos. 381 through 387.

(121) The Staff was correct in not ranking the sites with respect to their relative merits. It did compare the degree of impact for each factor to the proposed site. (FSFES § 4-16, Table 11.)

(122) The Staff adopts the Applicants' Proposed Findings Nos. 388 through 392.

(123) The Staff substitutes the following for Applicants' Finding No. 393: The Applicants provided information concerning the estimated economic cost which would result if the Pilgrim project were to be moved to one of the thirteen alternative sites evaluated by the Staff. This material was submitted by letter of August 18, 1978, App. Ex. 15, letter from Butler to Regan, Attachment entitled "Realistic Appraisal of Schedule and Cost Impact of Locating Pilgrim 2 at Alternative Sites Instead of Pilgrim Station." The Board believes this information is important. However, the Board agrees with the Staff that

this type of information is to be factored into the alternative site analysis only if the Staff determines there is an environmentally superior site. (Tr. 10,185.) The alternative site analysis should be primarily based on environmental considerations of the sites within the Region of Interest. The economic considerations should only come into play if an environmentally superior site is found and a decision must be made whether to move the plant to the alternative. At this point, a cost benefit analysis can be made as to whether the environmentally superior site remains an "obviously superior" site.

(124) The Staff would substitute the following for Applicants' Finding No. 394:

> Since the Board does not find any of the alternative sites "obviously superior" to the proposed site, it is not necessary to determine if construction of Pilgrim Unit 2 at the Pilgrim site will be substantially more economical than construction at any of the alternative sites.

Board's Assessment of the Commonwealth's Position

(125) The Commonwealth proposes that the Board find the following: (1) the Staff's methodology to screen site is unreasonable; (2) the Region

of Interest (ROI) is not valid; (3) the Staff did not evaluate a genuine slate of alternative sites; (4) the Staff erroneously applied the "obviously superior" standard; and (5) the Staff did not give appropriate consideration to demography. (Commonwealth's Proposed Findings at pp. 81, 91, 98, 101, 103.) The Board rejects these proposed findings. Our reasons are set forth below.

(126) The Board has carefully reviewed this record in order to address the concerns of the Commonwealth. The only evidence that the Commonwealth has presented on the issue of alternative sites is on the subject of demography. During this entire proceeding, the Commonwealth has not suggested one site that is preferable or potentially superior to the proposed site. We are grateful to the Commonwealth's original persistance in this matter which led the Staff to take the "hard look" at specific alternative sites; however, now that specific sites are identified, all that the Commonwealth has done is to continue to criticize the Staff review. With all the resources of the Commonwealth, including the Massachusetts Energy Facilities Siting Council, the Board believes that the Attorney General could place something tangible before the Board. Seacoast Anti-Pollution League v. NRC, 598 F.2d 1221 at 1231 (1st Cir. 1979).

(127) The Commonwealth believes that the Staff's criteria for site selection and comparison is not consistent and it would be better to follow the procedures suggested by the Commonwealth. (Commonwealth Findings,

p. 77.) The Board is not certain what procedures the Commonwealth is referring to. If it is the so-called "redundancy criteria," the Board has addressed this above. (See para. 92.) It is true that there is some logic to this criteria, but it need not be applied to every case.

(128) The Commission set forth in its Seabrook opinion the basic elements of a review by the Staff. Seabrook, supra at 523-525. The Board finds that these procedures have been fully implemented in this proceeding. The Staff requested additional information from the Applicants, went on site visits and gathered and independently assessed information. (FSFES § 1.4, Supplemental Testimony pp. 1-5). In addition the Staff formally circulated the Draft Supplement to the Final Environmental Statement.

(129) The Commonwealth criticizes the Staff for giving "extensive lip service to the site screening terms and process advanced by the Commonwealth . . . ." (Commonwealth Findings at p. 77.) Again, the Staff is unnecessarily criticized by the Commonwealth for doing its job. The Staff is required by NEPA and its own regulations (10 C.F.R. § 51.25) to respond to responsible comments. If the Staff ignored the Commonwealth's comments, we are sure that the Intervenor Commonwealth would be arguing that the Staff had not complied with NEPA. The Board finds the Staff's good faith attempt to respond to the comments made by the Attorney General is in full accordance with NEPA and not mere "lip service."

(130) Rather than paying "lip service" to the Commonwealth, the Staff articulated in its response its reasons for believing that the sites they reviewed were environmentally diverse and genuine.

(131) Environmental diversity is obtained by examining the major water bodies and associated terrestial resources within the ROI. (FSFES § 5.6; Supplemental Testimony at 1 p. 14.) The site is genuine if it is potentially licensable. (FSFES § 5.6). The Board finds that this is a reasonable approach to an alternative site review. Particularly in light of the fact that a major consideration in siting any power plant is the availability of water.

(132) In the instant case, the Staff looked at sites located near rivers, lake/reservoirs, ocean/bay, and ground and municipal supplies. (Supplemental Testimony at pp. 14-16.) The Staff also examined sites which were diverse with respect to aquatic biology, terrestrial ecology, water quality, population density, socioeconomic factors, geology, and meteorology. (Supplemental Testimony at p. 17.) Although this type of diversity is not always obtained, it is present in the alternative sites examined by the Staff in this case.

(133) The Commonwealth claims that the sites selected by the Applicants and accepted by the Staff were "straw men." (Commonwealth Findings at 78.) The Commonwealth urges to reject the slate of sites offered because the Staff did not probe enough into the reasons for deferral of other sites.

(134) It is not incumbent upon the Staff to endlessly explore whether one of the deferred sites could also be among the best available. This would be contra to the admonition of the court in Seacoast. (See Applicants' Finding in para. 354.)

(135) In the instant case, the Board believes that the Staff did not merely accept the deferred status of certain sites. An analysis was made of the reasons offered and those reasons properly accepted by the Staff. (FSFES § 4-1.)

(136) The examples offered by the Commonwealth to support its position that the Staff should have probed deeper into the Applicants' reasons for deferral of certain sites are not persuasive. (Commonwealth Findings No. 185.) To begin with the Applicant had other reasons to defer sites other than water and land availability, e.g., seismicity, residential development. (FSFES § 3.2.) Also it is incorrect that the Staff did not examine the pipeline at sites 19 and 20. These were examined at length. (FSFES § 4.8.1.)

(137) The Board is also cognizant that the information on these sites were available to the Commonwealth since 1975, and no evidence has been offered to show why one of these sites should be looked at more thoroughly.

(138) Even if one of the sites examined by the Staff was eventually rejected, this does not mean the entire review should be rejected. Especially when, as one examines more closely the attributes of the site, the more

adverse impacts are likely to be discovered. Seabrook, CLI-77-8, supra at 529.

(139) The Commonwealth urges the Board to ignore the Applicants' information updating the 1974 siting study. (Commonwealth's Finding No. 183.) The Board does not agree with Commonwealth that the Applicants' witness on this subject did not have the requisite knowledge to support the information. In addition, the Commonwealth has not shown that any of the information was flawed or inaccurate. In addition, the Staff performed extensive updating of this information to obtain an independent basis for a review. (Supplemental Testimony pp. 1-11, FSFES §§ 1, 3, and 6. The Board finds the Staff properly relied on the information which is submitted as part of this docket.

(140) The Commonwealth urges the Board to find the Staff review inadequate because it accepted the Applicants' Region of Interest (ROI). In fact, the Staff did not accept the Applicants' original ROI. As discussed above, the Staff believed the ROI should be expanded to include all of Massachusetts. (FSFES § 4.) While the Staff was satisfied that it had an acceptable ROI, it included in its review sites outside of Massachusetts.

(141) In the Commonwealth's discussion of the legal opinions of lawyers in the states adjacent to Massachusetts it neglected to mention that it agreed by stipulation to the admissibility of these letters.[4/] (Tr. 10,350,

4/ See July 17, 1979 letter of transmittal from Barry H. Smith to Board.

10,351, 10,332.) The Board has independently reviewed the statutes and rendered our interpretation. (See para. 84.) We agree with the language of the stipulation that these views of these particular counsel should be given additional weight because they are familiar with the statutes and regulations relating to siting of nuclear power plants in their respective jurisdictions.

(142) The Board finds that Massachusetts is a reasonable ROI. Since the Staff went outside the ROI, for reasons the Board concurs in, it makes very little difference in this proceeding whether the ROI is Massachusetts or New England.

(143) The Commonwealth's position is that the ROI in this case would not be significant if there was a genuine slate of sites. (Commonwealth Findings, No. 201.)

(144) To support its position the Commonwealth argues that the particular sites on the Merrimack examined by the Staff should have been eliminated because of the possible need for flow augmentation, and the competing consumptive uses of the River. No one has asserted that river flow augmentation could not be accomplished or that the competing uses of the water would preclude the construction of a power plant. (FSFES §§4.4.5, 5.18, 5.20.) In fact, one may argue that these problems would effect any site on the Merrimack chosen for a nuclear power plant. The Board believes that, if the

Staff would have eliminated the Merrimack for consideration of any sites, the Commonwealth would argue that the Staff arbitrarily eliminated a major resource area.

(145) As discussed above, the Board does conclude that sites 1, 2 and 2A are potentially licensable.

(146) The Commonwealth asserts that the rejection of sites, e.g., the Deerfield River, demonstrates that the Staff's review is inadequate. Again, the Board reiterates its agreement with the Staff and the courts that an endless search for sites is not necessary or productive. (Seacoast, supra; FSFES § 5.8.) First of all, the Staff properly concluded that the Deerfield River, a tributary of the Connecticut River, did not offer any diversity over the Connecticut River. Also, the Staff, by reviewing the Montague site, was able to examine a site on the Connecticut River which had undergone extensive analysis. (FSFES § 5.15, § 5.16.) Furthermore, the Staff examined the Maramos site, also located on the Connecticut River, in the Montague environmental review and it was not found to be superior to that site. (FSFES § 5.17.)

(147) With respect to aquatic impacts at sites 19 and 20, the Staff determined that there may be a significant impact to the fishery, not that there "would" be, as stated by the Commonwealth. (FSFES §§ 4.3.1, 5.2.2.) It is unfortunate that the Commonwealth did not carefully review the Staff's assessment of Sites 19 and 20. The Staff was careful to state that further detailed studies, beyond reconnaissance level, would be needed to determine

the potential on impact and what mitigation would be needed. (FSFES § 5.2.2.) As stated above, the Board finds no reason to conclude that these sites are not potentially licensable.

(148) With respect to the potential aircraft hazard from Otis Air Force Base, the Staff recognized that further study may be necessary to determine the design basis for the plant. (FSFES § 4.8.4.1.) The fact that an aircraft crash might become a design base event does not preclude the site from consideration.

(149) The shipping hazard at Site 20 was also addressed by the Staff and found not, based on a preliminary judgment, to be a problem. (FSFES § 4.8.4.2.) Again, if such an accident had to be a design basis event, it would not make it unacceptable for licensing.

(150) With respect to the Montague site, the Commonwealth urges us to find a discrepancy in the Staff approach between this site and the sites on the Merrimack. (Commonwealth Findings No. 202.) The Commonwealth claims that the Staff did not count the presence of shortnose sturgeon as a defect against the Montague site, but did against the Merrimack sites. Again, the Commonwealth has misstated the facts.

(151) The fact is that the Staff, when making a comparison between the Merrimack sites and Rocky Point as they now exist, did not assume the presence of the shortnose sturgeon. (FSFES § 4.4.1.) However, the Staff did make a

comparison of these sites assuming that all of the efforts to improve the conditions in the Merrimack were successful and the presence of the short-nose sturgeon is established. Based on these assumptions the Staff concluded that the Rocky Point site may be considered environmentally preferable. (FSFES § 4.4.1.)

(152) The Commonwealth's position concerning the Montague site is further eroded by its failure to read the entire record and its misunderstanding of how the Section 7 of the Endangered Species Act, 16 U.S.C. § 1531 et seq operates. The Commonwealth argues that the Staff only relied on the Northeast Utilities 316 demonstration document for its conclusion on the short-nose sturgeon. This is in error, the Staff relied on other documents. (Tr. 10,251-10,252.) In addition only the National Marine Fisheries Service can make the determination as to whether an intake structure in the Holyoke Pool would endanger the continued existence of the species. (Section 7 of the Endangered Species Act, supra.) Finally, there is an alternative available to place the intake structure, i.e., Turners Pool. (FSFES §§ 4.12.1, 5.15.)

(153) Another problem raised by the Commonwealth with the Staff's review is that the it did not assess the impact of transmission at the alternative sites lines in sufficient detail. (Commonwealth Finding No. 211.) The Board finds that the Staff's approach was entirely reasonable. It is not necessary to attempt to analyze impacts such as transmission lines when it is known

that the proposed site has minimal impacts. (FES § 3.7.2.) Of course, if an alternative site was very close to becoming superior to the proposed site, it may, at that point, be necessary to measure the impacts of transmission lines from the proposed alternative. This is not necessary in the instant case.

(154) The final argument of the Commonwealth is that the Staff improperly applied the obviously superior test. We disagree.

(155) The Commonwealth is in error when it asserts that the Staff applied the "obviously superior" test to each impact category. (Commonwealth Finding No. 206.) It is clear to the Board that the Staff determined whether a particular impact at the alternative site was superior, equal, or inferior, to the same impact at Rocky Point. (FSFES § 4.15.) After making these individual comparisons, the Staff then applied its collective judgment to determine if the comparison of the various environmental factors led the Staff to conclude that one or more sites were obviously superior to the proposed site. (FSFES § 4.15.) The Board believes that the Staff's approach allows a decisionmaker to assess the advantages and disadvantages of all the alternatives.

(156) The Staff finds that this is a reasonable approach and clearly identifies the Staff's assessment of the degree of impact that each category represents. The Board recognizes that the conclusion is based on the judgment of the Staff and we find that the Staff's conclusion is based on a thorough analysis of the environmental impacts at each of the sites.

(157) The Board does not understand the Commonwealth's argument that the Pilgrim site is given an advantage because the impacts, particularly aquatic, have been found to be negligible. (Commonwealth's findings No. 207.) It is important to recognize that the Staff did not merely assume that the aquatic impacts would be negligible. These conclusions are based on a number of studies and the actual operating experience at Pilgrim Unit 1. (FES § 5.4.2, FSFES § 4.1, Tr. 9949, 10,227, 10,275.)

(158) The Board believes that if the proposed site had been determined to have significant impacts in one or more categories and an alternative appeared to be superior in one or more categories, then the alternative may become obviously superior. In the instant case, the Board cannot find that any site is obviously superior to the proposed site.

(159) The Board is confused by the Commonwealth's proposed findings on the subject of demography. The Board understood that the parties had agreed not to discuss emergency planning for the purpose of this Partial Initial Decision.[5/] This was reiterated in the Commonwealth's proposed findings. (Commonwealth Findings at p. 1.) However, the Commonwealth's findings are replete with references to emergency planning. (Commonwealth's Findings at pp. 111, 113, 114, 117, 120, 124, 128.) The Board also chose to restrict the hearing on this matter to demography and not emergency planning. (Tr. 11,609

5/ Letter of Barry H. Smith, NRC Staff Counsel, to the Board, September 13, 1979.

and 11,610.) For these reasons, we have not considered any of the arguments offered by the Commonwealth concerning emergency planning.

(160) On the subject of demography, the Commonwealth urges the Board to require the Staff to (1) determine the consequences of a Class 9 accident at the Rocky Point site, and (2) ignore the population figures provided by the Staff and Applicants. The Board finds that neither of these positions is acceptable nor warranted. Our reasons are set forth below.

(161) The consideration of Class 9 accidents is discussed above. (See para. 100-103.) We now only reiterate what we said above--this Board cannot consider Class 9 accidents unless directed to do so by the Commission.

(162) The Commonwealth believes that the Staff's effort to provide up-to-date information is a sign that the data in general is inaccurate. Ironically, at the time the new information was introduced, counsel for Commonwealth only had an objection as to timeliness and he welcomed the new data. (Tr. 11,448.)

(163) The ERT study is not in evidence, although it is anticipated that it will be introduced by the Applicants at the time the issue of emergency planning is heard. (Tr. 11,473.) Therefore, it is difficult for the Board to give any weight to the numbers; however, since no one has challenged the numbers,we can compare them to the numbers given in the FES.

(164) Our review reveals that the numbers are not dramatically different than those given before. Since the Staff has asserted, and there is no evidence to the contrary, that its conclusions are not changed, the Board does not find this information in any way detracts from the Staff's review. (Tr. 11,449.) In fact, we are grateful to the Staff in its endeavor to bring to the attention of the Board the most recent information that is available.

(165) The Commonwealth believes that the Staff practice of not obtaining figures on daily transients between five and thirty miles is indefensible and that the Staff ignored transients between zero and two miles. This, according to the Commonwealth, is in violation of the Appeal Board's admonition in Seabrook, 7 NRC 471, supra.

(166) As discussed above, the Staff did take into account visitors to the Plymouth historic sites. (FSFES § 15.23 at pp. 5-9.) The Staff properly chose to ignore daily visitors at the Pilgrim recreation and visitor center. (Tr. 11,503.) We agree, when weighted, that these individuals would not be significant. (Tr. 11,502.)

(167) The Staff has taken into account seasonal and tourist transients within five miles of the plant. (FSFES § 4.2, 5.23.) In Seabrook, the Appeal Board was cautioned against ignoring "nearby concentrations of transient populations" when comparing alternative sites. (Seabrook, 7 NRC 71, supra at 510.) The Staff has not ignored the major sources of transient population at Rocky Point, i.e., seasonal and tourist transients. (FSFES §§ 5.23, 3.3.3, 4.2.)

(168) Although the siting of a plant is considered under Part 100, we find it incumbent upon ourselves to clarify one issue. Siting a nuclear power plant away from densely populated areas is an important factor in protecting the public health and safety, it is not the only element. The concept of defense in depth, which includes siting, is employed to ensure that the public health and safety is protected. (Rebuttal Testimony F. Kantor and L. Soffer at pp. 1, 2.)

(169) The Commonwealth suggests that the Board should reject the Staff's concept of weighting and including water area in calculating average population density. We have discussed our reasons for objections to this above; however, we will reiterate again that, for the purposes of an alternative site analysis, this is an entirely acceptable practice. (Rebuttal Testimony of E. Kantor and L. Soffer Testimony pp. 4-6.)

(170) To accept Professor Herr's hypothesis that, for an alternative site review, the maximum concentrations of population in a sector must be considered regardless of the time or season is not realistic and leads to absurd results. (Tr. 11,702, Rebuttal Testimony of F. Kantor and L. Soffer at 8.)

(171) Finally, the Board rejects the Commonwealth's position that the Staff's "factor of two" population density comparison is not a valid estimate of residual risk. The Board agrees that this is a crude indicator of

risk, but it is based on a reasonable analysis by the Staff. (FSFES Appendix B, § 5.23.)

(172) This factor of two is based on the results of an early site review (Perryman risk analysis), and experience gained in the use of the concequence model (CRAC). (FSFES § 5.2.3., Appendix B) From these studies, the Staff has been able to conclude that population density differences of at least two or more would be required before significant differences in residual risks could reasonably be expected. (FSFES § 5.2.3.) The Staff also judged that close in population densities should be given greater weight. (FSFES § 5.23.) We believe this is a reasonable method for determining residual risk without doing the "Class 9" analysis.

(173) The Commonwealth relies heavily on a Staff paper (SECY-137) for support for a Class 9 analysis at the proposed site. The Commission has not taken action on this paper or any other that this Board is aware of that would indicate the Staff should perform an analysis of the environmental consequences of a Class 9 accident. (Tr. 11,536.) The Staff may propose such an analysis, but it cannot be considered without Commission approval. Offshore, supra.

(174) The Commonwealth urges the Board to find the Montague site preferable to Rocky Point with respect to residual risk. Commonwealth Finding

at p. 127.[6/] The Commonwealth concentrates its analysis on the fact that this site does not have transients, it is inland, and, as one goes further away from the site, the factor of two is met in some rings. The Board does not find that the Staff has rigidly applied its test. (Tr. 11,569.) We do find that it is acceptable to apply judgment to the significance of population densities at various population rings. (Tr. 11,569.) The Board also cannot neglect the fact that, in general, the meteorology at an inland site in New England is not quite as good as a coastal site. (FSFES Appendix B.) Finally, even if the Board would assume that Montague is preferable from a population standpoint, and we do not, this would not cause us to change our opinion that, taking all factors into consideration, it is "obviously superior" to Rocky Point.

H. Need for Power

(175) The NRC Staff adopts the Applicants' Findings in paragraphs Nos. 395 and 396.

(176) The Staff adopts the Applicants' Finding in paragraph No. 397 with the following modification:

Line 9 should read as follows:

> . . . second motion (which was supported by the NRC Staff) was granted and the Applicants . . .

6/ The Board is not certain of the Commonwealth's position with respect to this site because earlier in its finding we were urged to reject this site because of the presence of the shortnose sturgeon.

(177) The Staff would modify the Applicants' Finding in paragraph No. 398 to read as follows:

> As a result of the time intervals since the commencement of evidentiary hearings and consequent deferrals in the scheduled in-service date of the unit as well as changes in circumstances affecting anticipated electricity demand, the Applicants and Staff have, in effect, made three separate presentations relating to the need for Pilgrim 2. The first such presentations were made in 1975 and were based upon the then current NEPOOL load and capacity projection dated April 1, 1975 and supported a projected 1982 in-service date. The second set of presentations were made in 1977 and were based upon the then current NEPOOL load and capacity projections dated January 1, 1977 and supported a projected 1984 in-service date. The final presentations were made in July and August of 1979 and were based upon NEPOOL load and capacity projections issued on April 1, 1979, as well as an independent Staff forecast and an analysis of the effect of earlier operation of Pilgrim 2 upon the use and cost of oil-fired generation. These analyses supported a projected in-service date of December, 1985.

(178) The Staff adopts Applicants' Findings in paragraphs Nos. 399 through 405.

(179) The Staff would delete the phrase "no small" in line 4 of Applicants' Finding in paragraph No. 406.

(180) The Staff would delete the word "particularly" in line 1 of Applicants' Finding in paragraph No. 407 and insert the phrase "planning by" following the word "affect" in line 2.

(181) The Staff adopts the Applicants' Findings in paragraphs Nos. 408 through 410.

(182) The Staff would modify the Applicants' Finding in paragraph No. 411 to read as follows:

> The Applicants' presentation relating to the need for Pilgrim Unit 2 involves three bases. The first such basis is to provide adequate generating capacity to meet the forecasted power needs in New England, including a sufficient reserve margin to assure adequate reliability levels. The second is economic, in that significant cost savings will accrue to New England electricity consumers from the installation of Pilgrim Unit 2 as scheduled, even if forecasted growth rates do not materialize and the Unit is not required for reliability reasons until a later date. The third is the reduction in dependence on (imported) oil for electrical generation and the furtherance thereby of national, regional and statewide

energy policies and goals. (Applicants' witness Weiner, p. 3, following Tr. 10,430.) The NRC Staff developed an independent analysis of these three factors as well, preparing a forecast of power needs to determine when the facility will likely be needed for reliability reasons and an analysis of the economic and oil consumption consequences of earlier compared to later in-service dates for the facility.

(183) The Staff would modify line 1 of Applicants' Finding in paragraph No. 412 to read as follows:

The Applicants' analysis of the need for Pilgrim Unit 2 is based . . . .

(184) The Staff adopts Applicants' Findings in paragraphs Nos. 413 through 417.

(185) The Staff would modify Applicants' Finding in paragraph No. 419 in the following manner:

In line 1, the word "Given" should be changed to "Based on."
In line 4, the phrase "Under that analysis," should precede "delays."

(186) The Staff adopts Applicants' Findings in paragraphs Nos. 422 through 423.

(187) The Staff would modify the last line in Applicants' Finding in paragraph No. 424 to read as follows:

> . . . schedule, noting that it is, in fact, unlikely that service could actually begin on that date. (Staff witness Feld, pp. 7-10, following Tr. 10,651.)

(188) The Staff adopts Applicants' Findings in paragraphs 425 through 427, 429 through 430, 434 through 438.

(189) The Staff adopts Applicants' Finding in paragraph No. 439 only through line 10.

(190) The Staff would modify Applicants' Finding in paragraph No. 440 to read as follows:

> The witnesses also raised a number of alleged modeling errors in various sectors of the model, not all of which can possibly be dealt with herein. We have chosen not to deal directly with each and every criticism. This is in part because of the scattershot nature of the criticisms and the failure of the witnesses to document or otherwise quantify the effect of many of their criticisms in terms of the forecast results. In addition, we conclude that the overall effect of the criticisms is to increase the uncertainty associated with the

NEPOOL forecast, but that the totality of the criticisms give us little guidance regarding an alternative perspective upon growth of electricity demand in New England.

(191) The Staff would modify Applicants' Finding in paragraph No. 441 as follows:

Insert the word "necessarily" between "not" and "based" in line 11.

Add the following at the end of the paragraph:

It is also unclear that the potential existence of this fallacy implies the direction of the error that would result. (Tr. 11,109-11,110.)

(192) The Staff would modify Applicants' Finding in paragraph No. 442 to read as follows:

Certain other errors raised by the witnesses in their prepared testimony may have resulted from a failure to solicit from NEPOOL the supporting documentation or reasoning. An example of the latter was Mr. Chernick's admitted failure to request data of NEPOOL which would permit investigation of his "cross-sectional fallacy" argument. (Tr. 11,001-02.) The existence of the general problem was acknowledged by witness Chernick on cross-examination. (Tr. 11,039-40.)

(193) The Staff would modify the Applicants' Finding in paragraph No. 443 in the following manner:

In line 4, delete the phrase "sort of questions as" and substitute the phrase "problems of documentation which." In line 6, delete the word "score" and substitute the word "dispute."

(194) The Staff would modify the Applicants' Finding in paragraph No. 444 in the following manner:

In line 2, delete the phrase "assiduously avoided any" and substitute "offered little."

Delete the second sentence.

In line 8, delete the word "many" and substitute the phrase "the majority."

(195) The Staff adopts the Applicants' Finding in paragraph No. 445.

(196) The Staff would modify the Applicants' Finding in paragraph No. 446 to read as follows:

On further examination of Commonwealth witness Chernick concerning his one percent forecast, the witness indicated that he had a 95% level of confidence that the actual growth rate would lie

between minus 0.5% and plus 2.5%. (Tr. 11,192-11,193.) The witness described his methodology as "entirely subjective." (Tr. 11,193.) The use of "confidence intervals" therefore appears wholly unrelated to the ordinary statistical meaning of those terms. Given the contentions of the Commonwealth regarding alleged methodological errors in the Applicants' forecasts as well as the testimony presented by other Commonwealth witnesses on adequate and defensible forecast methodology, the Commonwealth could hardly expect that much weight be given to a "forecast" such as that offered by Mr. Chernick.

(197) The Staff adopts the Applicants' Findings in paragraphs Nos. 447 through 450.

(198) The Staff would add the following sentence to the Applicants' Finding in paragraph No. 451:

> It does appear to us that this area increases the uncertainty of the forecasts, especially in later years.

(199) The Staff adopts the Applicants' Finding in paragraph No. 452.

(200) The Staff would modify Applicants' Finding in paragraph No. 453 as follows:

In lines 4 and 5, delete the phrase "however, this was based upon several good reasons, including" and substitute ". This was based on . . . ."

(201) The Staff adopts the Applicants' Finding in paragraph No. 454.

(202) The Staff would modify the Applicants' Finding in paragraph No. 455 as follows:

In line 1, delete "Furthermore, it is likely that" and substitute "Peak load pricing would, in all likelihood, reduce peak demand. (Tr. 11,322.)"

Add "not necessarily" at the end of line 1. Delete the word "not" from line 2.

(203) The Staff adopts the Applicants' Finding in paragraph No. 456.

(204) The Staff would modify the Applicants' Finding in paragraph No. 457 as follows:

In lines 16 and 17, delete the phrase "in a number of conferences and professional journals."

(205) The Staff would modify Applicant's Finding in paragraph No. 458 so that lines 15 and 16 should be stated as follows:

difficult to examine and evaluate many of the criticisms because of the absence of some quantification of the effect on the forecast.

(206) The Staff adopts Applicants' Findings in paragraphs Nos. 459 and 460.

(207) The Staff would add the following to the Applicants' Finding in paragraph No. 461:

> The projection of profits is dependent upon the assumptions regarding costs. The effect of profit as a component of price is essentially unimportant to the model. The estimation of cost, which is based on an extensive data base, is the primary determinant of price and the calculation of profits is essentially a residual of the model, which is influenced by demand and cost, but which does not itself materially affect the forecast. (Tr. 11,258-64; 11,285-86.) The Commonwealth's charges that the price equation is "misspecified" (e.g., Commonwealth's Proposed Findings Nos. 102, 103, 111) ignores this important analysis.

(208) The Staff would modify the Applicants' Finding in paragraph No. 462 by deleting the first sentence and substituting the following:

> The only attempt we have seen to quantify the criticisms of the ORNL model is presented in Commonwealth Proposed Finding No. 107, at note *, allegedly illustrating the effects of ignoring mandated conservation and improved load factors. This calculation was developed without any attempt by the

Commonwealth to follow up with Dr. Chern's responses to Commonwealth interrogatories on this subject, and, in addition, ignores the fact that the Staff's forecast utilizes a mechanism to capture forecast uncertainty (i.e., varying price of electricity) which provides an estimate over a range, all of which the Staff feels to be reasonable. (Testimony of Dr. Feld, p. 7, following Tr. 10,651.)

(209) The Staff adopts Applicants' Findings in paragraphs Nos. 463 through 456.

(210) The Commonwealth proposes a finding that "staff believed that NEPOOL's reliability calculations were only affected by winter peak." (No. 108.) We are apparently asked to base this conclusion upon two questions posed by Staff counsel during cross-examination. There is not one scintilla of evidence that Staff analysts fail to understand the manner in which reliability is calculated and the Commonwealth's assertion that the questioning "displays spectacular ignorance of the way NEPOOL works" is, we believe, based on a misperception of the cross-examination and is, in any event, a wholly unwarranted extrapolation from the cited questioning.

(211) The Staff would modify the Applicants' Findings in paragraph No. 467 as follows:

In line 12, delete the word "ideological" and substitute the word "methodological."

(212) The Staff would add the following to the Applicants' Finding in paragraph No. 468.

The Board finds that the Staff's method of deriving a range of forecast values is more helpful in capturing the inherent uncertainty of forcasting.

(213) The Staff would modify the Applicants' Finding in paragraph 470 as follows:

At the end of line 11, add "it would not be imprudent to establish"

In line 12, delete "is" and insert "as"

(214) The Staff adopts the Applicants' Findings in paragraphs Nos. 471 through 480.

(215) The Staff would modify the Applicants' Finding in paragraph No. 481 as follows:

In line 4, the phrase "(in the non-statistical sense)" should follow the word "uncertainty."

(216) The Staff adopts in the Applicants' Findings in paragraphs Nos. 482 through 494.

(217) The Staff would modify the Applicants' Finding in paragraph No. 495 as follows:

In line 2, delete "admitted" and substitute "stated."

(218) The Staff adopts the Applicants' Findings in paragraphs Nos. 497 through 501.

(219) The Staff would modify the Applicants' Finding in paragraph No. 502 as follows:

In line 2, the phrase "all other things being equal" should be inserted after the word "escalation."

(220) The Staff adopts the Applicants' Finding in paragraph No. 503.

(221) The Staff would modify the Applicants' Finding in paragraph No. 504 by altering the last three lines so that they read as follows:

Tr. 10,651, Tr. 11,320-321; the Staff also explained that its handling of O & M costs makes its selection of escalation rates for these costs reasonable. Tr. 10,629. The O & M component is not a deciding factor in any of the analyses. Staff witness Feld, p. 22, following Tr. 10,651.

(222) The Staff would modify the Applicants' Finding in paragraph No. 505 as follows:

In line 13, the phrase "in the manner suggested by the Commonwealth" should be inserted between "rates" and "would."

In line 15, the following sentence should be inserted before the citation to Tr. 10,551:

> "This is principally true because of the interaction between the nominal component of the discount rate and the rate of escalation selected to reflect inflation in costs elsewhere in the analysis."

(223) The Staff would modify the Applicants' Finding in paragraph No. 506 as follows:

Delete the phrase: "Aside from the ideological purity which would be achieved by such a refinement" in lines 4-6.

(224) The Staff adopts the Applicants' Finding in paragraph No. 507.

(225) The Staff adopts the Applicants' Finding in paragraph No. 508 and would add the following:

The Commonwealth also criticizes the comparative analysis offered by the Applicant and by the Staff apparently on the grounds that it fails to compare a number of other "oil-saving options." This criticism misperceives the nature of

the analysis, which is limited to the question whether Pilgrim 2 should be constructed sooner than otherwise needed for reliability purposes and does not analyze whether Pilgrim 2 should be constructed even if never needed for reliability purposes. There is also no indication that the other "oil saving" options are mutually exclusive with construction of Pilgrim 2 or that the capital utilized for Pilgrim 2 would go to such options. Tr. 11,131.

(226) The Staff adopts the Applicants' Finding in paragraph No. 509 with the deletion, in line 2, of the word "highly."

(227)The Staff adopts the Applicants' Finding in paragraph Nos. 510 through 515 and 517.

(228) The Staff would modify the Applicants' Finding in paragraph No. 518 as follows:

In lines 11 and 12, delete "We find further assurance in making such finding from" and substitute "especially in light of"

(229) The Staff would modify the Applicants' Finding in paragraph No. 519 as follows:

In the last line, add "likely" between "would" and "be."

(230) The Staff adopts the Applicants' Findings in paragraphs Nos. 520 and 521.

I. Alternative Energy Sources

(231) The Staff adopts Applicants' Findings in paragraphs Nos. 522 and 523.

(232) The Staff discussed alternative energy sources in the FES. (FES, § 9.1.2.) This discussion was supplemented by Witnesses Vetrano, Nash and Fisher (Staff Witness Vetrano following Tr. 1409, hereinafter Vetrano; and Staff Witnesses Nash and Fisher following Tr. 8304, hereinafter Nash and Fisher).

Wind Power

(233) Wind power, which has been used in the past, was considered by the Staff. The primary problem associated with wind power is its limitation to small power ratings. (Vetrano, p. 29.) In order to produce the power that would come from the proposed Pilgrim plant, at least 2,000 windmills off-shore or 10,000 on-shore would probably be needed. This would constitute a severe land use problem if placed on shore. (Vetrano, p. 30.) There are also problems with storage capacity and higher cost, including transmission cost. (Vetrano, p. 30.) While there appears to be a potential for use of

wind power, it is not for the scale of transmission or production of power anticipated from the proposed Pilgrim Unit No. 2. Based on the foregoing, the Board does not find the use of wind power to be a reasonable alternative to the proposed Pilgrim Unit 2.

High Temperature Gas-Cooled Reactor

(234) The high temperature gas-cooled reactor was investigated by the Staff. (Vetrano, p. 25.) A 330 megawatt operating plant exists; however, the feasibility of an 1180 megawatt plant has not been demonstrated.

(235) The high temperature gas-cooled reactor (HTGR) requires less cooling water and is more efficient. The HTGR also reduced uranium requirements, although there is no evidence that the uranium supply for Pilgrim Unit No. 2 is in jeopardy. (Vetrano, p. 26.) Another advantage is that less space is required for storage, although the LWR needs only 0.10 acre per year for fuel storage. (Vetrano, p. 27.)

(236) While there may be a slight advantage of a HTGR over the proposed LWR, since the impact of Pilgrim Unit No. 2 is minor and neither plant would have a significant permanent environmental impact, there is not a significant difference between the two. A decision to build an HTGR at this time, assuming it would be available, would cause an unwarranted delay, increased cost and design changes. (Vetrano, p. 28.) The Board finds that the HTGR

does not assure any significant environmental or economic benefits such that it should be considered a viable alternative to the proposed Pilgrim plant, especially in light of the fact that there are no operating HTGR plants of the size of the proposed Pilgrim Unit No. 2.

Solid Waste

(237) There have been experiments using municipal waste which have been referenced in the Staff's and Applicants' testimony. (Vetrano, p. 33.) In St. Louis, where use of municipal waste is found to be economical, it provides only 5% of the system's electrical requirements. (Vetrano, p. 35.) There is no question that the burning of trash provides an environmental benefit.

(238) The Staff adopts the Applicants' Finding in paragraph No. 574.

(239) The Board agrees with the Staff that municipal waste-produced electricity should be used, probably by burning the waste along with coal in existing generating plants, but it cannot at this point be used as a substitute for conventional power generation. (Vetrano, p. 36.)

(240) The Staff testimony also discussed pyrolysis and hydrogenation. These are processes for converting garbage and animal waste into oil. Although these may become alternatives, they need more research and they

could not supply the needed power that would be produced by the proposed Pilgrim Unit No. 2. (Vetrano, p. 37.)

(241) The Staff's testimony also discussed anaerobic digestion. This is the process whereby garbage is broken down into methane. The technologies are available; however, the problems are with low yield of the gas, low heat and high cost of production. (Vetrano, p. 38.) In addition, there is a problem with the fact that the sources of garbage are too widely dispersed, which carries concomitant problems of difficulty of transport and necessity of being near the point of manufacturing as well as large pumping cost. (Vetrano, p. 39.) The Staff estimates that such a process could only save approximately 30 watts per person per year. (Vetrano, p. 39.)

(242) The Staff adopts the Applicants' Finding in paragraph No. 575.

Other Sources

(243) Coal gasification is a technology which is available. However, it is not economic in comparison with other forms of burning fuels directly. (Vetrano, p. 24, 25.)

(244) The utilization of the ocean for temperature differentials is not a feasible alternative to Pilgrim because there are requirements for differences in ocean temperature in order to produce electrical power. There

are few places in the world where such a generation plant could be established. Such places would be in the Gulf stream, but not off New England. (Applicants' testimony, p. 82, following Tr. 955; Vetrano, p. 40.) While use of ocean thermal gradients is technically feasible, it is not very efficient and requires large amounts of water. This form of energy production also has extensive problems with transmission of electricity from the point of generation to the point of use. (Vetrano, p. 41.) The economic feasibility is in doubt with an estimated total cost of 37 and 50 mills per kilowatt hour for a 100 MWe system, which is not comparable to that produced by coal or nuclear and may be underestimated. There may also be an unacceptable impact on aquatic life because of problems with entrainment and discharging the fish at different temperature levels. (Vetrano, p. 43.)

(245) Another potential alternative is the use of geothermal power. However, there are no known geothermal resources in New England. Thus, geothermal energy cannot be considered as an alternative to Pilgrim Unit 2. (FES § 9.1.2.1.)

Solar Energy

(246) The Staff discussed the various means by which solar energy could be utilized for the production of energy as a substitute for the proposed Pilgrim Unit No. 2. Each of the efforts utilizing solar energy has problems relating to technology, cost, environmental consequences, geographic and engineering problems. (Vetrano, pp. 3 through 14.)

(247) The demonstration of production of steam through use of solar energy have failed. There are problems of availability of periods of adequate sunshine, the storage of the electrical energy until needed, and general problems of scaling up from demonstration to actual operational units. (Vetrano, p. 3.) The cost would now be at least four times that of a nuclear or fossil plant. (Vetrano, p. 4.) The government is only now about to fund a 100 megawatt plant which would be operational by the mid-1980's. (Vetrano, p. 3.) These problems do not make utilization of solar energy for electric generation a reasonable alternative to the proposed nuclear power plant.

(248) Photovoltaic cells are not reliable. They are costly and require large amounts of land. (Vetrano, pp. 4-5.) A central power station using photovoltaic cells would encounter problems with storage and cost as well as means of preventing cell degradation. (Vetrano, p. 5.) Photovoltaic cells are not a reasonable alternative to the proposed Pilgrim Unit No. 2.

(249) The Staff provided extensive testimony on the use of solar systems for purposes of home heating and cooling. The development of major subcomponents is not at the point where they are economically and technologically feasible. The following problems exist: (1) the cost and design of collectors; (2) absorption for purposes of refrigeration; (3) geographic differences which would influence the amount of sunlight available; (4) engineering problems, such as integrating the solar system into the home with

access for maintenance and repairs; (5) angle of inclination; (6) heat mode; and (7) meteorology. (Vetrano, pp. 6, 9, 10.)

(250) It is clear that solar units may become economical if the price of collectors goes down, especially in light of the fact that the price of oil and gas may rise faster than the general price levels. (Vetrano, p. 13.) The Staff, in fact, recognizes that the solar unit for heating will be available as an economic option in the time period of 1985 through 1990. (Vetrano, p. 14.) While solar systems can be bu' . today, there is uncertainty as to how effective they can be and what would be their actual cost. (Vetrano, p. 11.) There is evidence that basic research is still needed for solar home heating. (Applicants' witness White, p. 77 following Tr. 955.) In the time period of 1982, 1% of New England's electric power needs could be replaced by solar power, although, in the period 1990 to 2000, solar could be a partial alternative to nuclear power. (Applicants' witness, p. 80 following Tr. 955.)

(251) The Staff adopts the Applicants' Findings in paragraphs Nos. 565 through 568.

Fossil Fuels

(252) The Staff eliminated the use of natural gas as a viable alternative for production of electricity since the evidence is that it will not be available for long-term purposes. (Vetrano, p. 15.)

(253) The Staff also considered oil as an alternative, but its rising cost and the lack of an adequate and reliable supply, along with the announced national goal of reducing reliance on oil as a source for long-term use, essentially rule out its consideration as a viable alternative. (Vetrano, p. 15.)

Coal

(254) Dr. Fisher and Dr. Nash, who are suitably qualified, were the Staff's witnesses on the economic comparison of the nuclear and coal option. Dr. Fisher was involved with preparing the NRC cost calculations of the nuclear fuel cost and his testimony was limited to those areas. (Tr. 8300.)

(255) In 1977, the Staff reviewed the estimated cost of power generation by the proposed Pilgrim Nuclear Power Station Unit 2, found in the FES § 9.1.2.4 and the testimony of James Vetrano relating to alternative energy sources presented on October 23, 1975 following Tr. 1409, and compared this with the next best alternative which the Staff concluded continued to be a coal-fired plant. The Board finds that the only feasible alternative to compare the nuclear option with is a coal-fired plant. (Nash and Fisher, p. 1.)

(256) While the Staff's 1977 cost estimates were higher than their earlier estimates, their analysis continues to support the earlier conclusion

that the nuclear option is substantially less costly than the coal alternative. (Nash and Fisher, pp. 1, 25.) The NRC Staff CONCEPT code, which is used to estimate capital costs for coal and nuclear, has been revised with respect to estimating capital costs for pressurized water reactors. (Nash and Fisher, p. 1.) The Staff, using the CONCEPT code, concluded that the proposed Pilgrim Unit 2 will cost approximately $1245 million in 1984 dollars with a unit cost of $1055/Kw. (Nash and Fisher, p. 1.) The Applicants have concluded that the capital cost for the proposed Pilgrim Unit 2 plant will be $1521 million. (Applicants' witness Maroni, p. 8 following Tr. 8207.)

(257) The capital cost of coal was also updated by the Staff. Since the CONCEPT code has not been updated for coal plants, the Staff reviewed cost estimates from representatives of architect-engineering firms for the purpose of determining what the cost of coal-fired plants will be. (Nash, p. 3.) The Staff did not include in their review of cost estimates the Coal-Fired Power Plant Capital Cost Estimates prepared by the Bechtel Power Corporation, San Francisco, California, for the Electric Power Research Institute. (Applicants' Ex. SP-8 following Tr. 8207.) The Board accepts the Staff's review of coal cost as sufficient to compare the capital cost of coal with nuclear. If the Bechtel costs are reasonable, the Staff's costs become more conservative since Bechtel is projecting almost equal capital costs for a coal plant and an equivalent nuclear plant built in the northeastern portion of the United States. (Applicants' Ex. SP-8 following Tr. 8207.)

(258) A reasonable capital cost of a coal-fired facility, based on the Staff's review, is 85% of the cost of a nuclear plant. (Nash and Fisher, p. 41.) The Staff's comparison assumes no additional seismic considerations for the coal plant. The estimated capital cost of a coal plant is approximately $897/KW. (Nash and Fisher, p. 4.)

(259) The Staff also presented a review of the operation and maintenance costs for a nuclear power and coal facility utilizing a computer code (OMCST) which was not available at the time Mr. Vetrano had presented his testimony. (Nash, p. 4.) Based on this analysis, the Board finds that operation and maintenance cost for the nuclear option is less than the coal alternative over a range of capacity factors from 50% to 70%.

(260) The Staff reviewed the fuel costs for both nuclear fuel and coal based on the best available information. (Nash and Fisher, p. 5.) For the nuclear fuel cycle the Staff looked at the cost assuming recycling of plutonium and enriched uranium as well as no recycling. The Applicants and the Staff used as the base case a no-recycle alternative. (Nash and Fisher, p. 5; Applicants' testimony, p. 21 following Tr. 8207.) The Board finds that a reasonable estimate of the cost of the nuclear fuel was presented by the Staff. (Nash and Fisher, p. 5.) In predicting uranium prices, the Staff used forecasts based on cost of production in mining and milling and demand as indicated by the forecast of operating nuclear power plants. (Nash, p. 6; Table 4.) The Staff relied primarily on documents prepared by

the Energy Research and Development Administration, the agency responsible for development of such cost estimates. The Staff further included in forward costs the recovery costs, since this reflects new mine/new mill complexes which will likely be needed. (Nash and Fisher, p. 7.) The Staff assumed 0.3% assay enrichment of mill tails. Since it is likely a lower assay will be used in the future, uranium requirements, and therefore the cost, may be overstated. (Nash and Fisher, p. 9.) The cost of conversion of U_3O_8 to UF6 was determined by looking at commercial contracts. (Nash and Fisher, p. 9.) For enrichment, the cost was derived by looking at private cost studies and an ERDA announcement of fees for enrichment services. (Nash and Fisher, p. 10.) For UO_2 fabrication costs, the Staff reviewed industry publications which indicate a possible decline in price due to increased experience, improved plant utilization and competition. (Nash and Fisher, p. 11.) For reprocessing, the cost of spent fuel storage would include one-year storage of spent fuel. For no reprocessing, the Staff looked at spent fuel storage assuming the use of high density racks which allow for 4 to 6 annual discharges. (Nash and Fisher, p. 11.) Such a system will cost approximately $2 million. A new central system to store all spent fuel will cost approximately $2 million (Nash and Fisher, p. 12; and testimony of Staff witness Miller, p. 3 following Tr. 4778), which translates to a cost of $5/kg/HM year for storage. (Nash, p. 12.) The Staff did an extensive review of publications to obtain an estimate of the cost of transporting spent fuel and arrived at a cost of $15/kg/HM reflecting the costs of a special train, cask charges, and freight. (Nash and Fisher, pp. 12 and 13.)

(261) The Board has reviewed the Staff's cost estimates for reprocessing, storage and transporting plutonium and the cost of mixed-oxide fuel and we find that the Staff used reasonable estimates. (Nash and Fisher, pp. 14, 15.)

(262) The Board finds that the cost estimates discussed above are derived from reliable sources of information and represent a valid estimate of what the fuel cost of the nuclear fuel cycle will be. The fact that similar sources were used in the uncompleted GESMO proceeding does not affect the validity of their independent use in this proceeding. (Tr. 8311.)

(263) The Staff presented a reasonable estimate of the cost of disposal of high level waste by calculating the costs of transportation, amortized cost of shielded casks, cladding and associated hardware, packaging of transuranic waste and low-level beta-gamma waste, and the Federal repository change. These costs are calculated by the Staff to be $50/kg, taking into account unforeseen costs of waste disposal. (Nash and Fisher, pp. 15, 16; Table 6, p. 17.) The total cost of waste disposal without recycling was conservatively estimated to be $100/kg. (Nash and Fisher, p. 18.)

(264) The 30-year levelized nuclear fuel cycle cost for the recycle case is 9.22 mills/kwh. (Nash and Fisher, p. 21.) The 30-year levelized cost for nuclear fuel cycle cost for the no recycle case is 11.53 mills/kwh.

(Nash and Fisher, p. 21.) The Staff utilized Federal Power Commission documents to arrive at a coal price of $35 per ton which is equivalent to 29.4 mills per kilowatt hour. (Nash and Fisher, p. 23.) It is very difficult to calculate the cost of coal in New England due to the variability and the lack of data on coal cost in New England. (Nash and Fisher, pp. 22, 23; Applicants' witness, p. 55 following Tr. 7927, and p. 34 following Tr. 955.) The Staff took into account the cost of stockpiling coal for a three-month period. (Nash and Fisher, p. 23.) These costs were calculated over a 50%-70% range of capacity factors. (Nash and Fisher, p. 23.)

(265) The Staff updated the information found in the FES § 10.2.4 relating to decommissioning costs. Using a report from the Atomic Industrial Forum, Inc. and their own expertise, the Staff arrived at a range of decommissioning costs for a pressurized water reactor of $2.3 million (1975 dollars) for mothballing to $20.3 million (1975 dollars) for prompt removal/dismantling. The Staff used appropriate escalation rates and discount rates to calculate a reasonable cost for mothballing to be 0.039 mills/kwh and 0.138 mills/kwh for prompt removal/dismantling. (Nash and Fisher, p. 24, Table 12.)

(266) Upon reviewing the Staff's estimates of costs across the range of capacity factors, the Board concludes that the nuclear option is less costly than coal. The Pilgrim plant with high seismic design and no recycle is expected to cost about 56.9 M/kw hours on a 30-year levelized basis. The more likely case, which is a low cost seismic design and no recycle, is

expected to cost about 53 M/kw hours levelized cost. The coal alternative is expected to cost 68.7 M/kw hours levelized. Over a 30-year period, the low cost seismic design would be a cost savings of nearly $550 million in 1984 present value terms and the high cost seismic design would be a savings of slightly over $410 million in 1984 present value terms. (Nash and Fisher, p. 26, Table 13; FES § 10.4; Staff Ex. 13 following Tr. 8308.)

(267) The Staff's comparison of costs between the nuclear and coal alternative assume each is operating at 60% capacity. The estimates of capacity factors have been rigorously contested in this proceeding. The Applicants utilize an estimated 70% capacity factor; the Staff assumes 60% capacity for its primary cost comparison, but compares cost over a range of 50% to 70%. (Appicants' witness, p. 7 following Tr. 8207; Nash, p. 27 following Tr. 3110; Nash and Fisher, p. 26; Staff Ex. 13, following Tr. 8308.) The Commonwealth's three witnesses, relating to the economics of nuclear generating vis-a-vis the coal alternative, relied heavily on attacking the capacity factor of nuclear generation. (The Economics of Nuclear Power: A New England Perspective, following Tr. 4962, hereinafter Lee Report; Commonwealth witness MacDonald following Tr. 5690, hereinafter MacDonald; and Commonwealth witness Boxer, following Tr. 8587, hereinafter Boxer.)

(268) The Staff calculated the capacity factors of nuclear power plants from 1973 to July 1975 using the relative frequency and frequency distribution of capacity factors for operating nuclear plants in the United States.

Nash following Tr. 3110, Table 8.) This confirmed the Staff's assumption that the capacity factors for nuclear power plants is in the range of 55% to 65%. (Tr. 3113.) The Staff calculated the 10-year average capacity for 894 fossil units in the United States to be 68.8%. (Nash, p. 27 following Tr. 3110.)

(269) The Lee Report is general in nature, and the report concludes that it is reasonable for a utility to choose nuclear as a form of energy production; that a light water reactor can solve short term energy problems; and that there will be sufficient fuel for the proposed Pilgrim Unit 2. (Tr. 5024, 5030, 5031.) The report gives scenarios dependant upon assumption of a particular capacity factor at one or the other energy sources. (Lee Report at 38.) Read together, the scenarios demonstrate that it is not unreasonable to choose the nuclear alternative in New England.

(270) The Staff adopts the Applicants' Findings in paragraphs Nos. 537 through 540.

(271) The Lee Report concludes that the cost of the nuclear plants will be increased by safety problems. (Lee Report, p. 11.) Mr. Lee did not talk to any NRC officials about these problems, nor did he have any specific dollar cost estimates for correction of the problems. (Tr. 5025, 5026.) Mr. Levy agrees that there are technological problems with both coal and nuclear power generation and that the safety issues involved with a nuclear

plant do not always result in expenditure of funds. (Tr. 5068, 5070.) Commonwealth Witnesses Lee and Levy did not provide any cost estimates for coal, nor did they offer any evidence that the cost estimates used by the Staff and Applicants are unreasonable. (Lee, Tr. 5034, 5041, 5042.) Both men also recognized that there are environmental costs associated with coal; however, they could not tell the Board how these costs would affect the price of coal. (Tr. 5034.)

(272) The Staff adopts the Applicants' Findings in paragraphs Nos. 204 through 212.

(273) Commonwealth Witness Dr. MacDonald used the variables of age and size because he felt they would be the variables of greater significance. (Tr. 6287.) Under cross-examination, he acknowledged that other variables, such as the architect-engineer employed by the utility, may be important. (Tr. 6288, 6289, 6290.)

(274) Dr. MacDonald believes that there are enough uncertainties in his data that it can be used to accurately predict how a plant will operate. (Tr. 6292, 6293, 6294, 6295.) In fact, there is so much uncertainty in his prediction that the Pilgrim Unit 2 capacity factor could easily be 80%. (Tr. 6299.)

(275) While Dr. MacDonald refers to the problems of large plants (MacDonald, p. 9), he also believes that many problems will be resolved as more experience is gained. (Tr. 6298.) Dr. MacDonald refers in his testimony to the cost increase due to safety and environmental concerns (MacDonald, p. 5); however, by his own admission, Dr. MacDonald is basing this prediction purely on speculation. (Tr. 6301, 6302.)

(276) The Staff adopts Applicants' Finding in paragraph No. 212.

(277) The Commonwealth presented the testimony of Ms. Nancy Boxer which provided a statistical prediction of the capacity factor of Pilgrim 2 in 1988. Ms. Boxer had performed a multiple regression analysis using age and size as independent variables. Using a multiple regression equation to predict capacity factor for a 1000 MW pressurized water reactor in its fourth year of commercial operation, she predicted a capacity factor of 47.75% for Pilgrim 2 in 1988.

(278) At the 95% confidence level identified by Ms. Boxer as "generally accepted" by statisticians and econometricians (Tr. 8706), the interval within which her equations predict the 1988 Pilgrim capacity factor to be ranges from 17.6% to 77.9%. (Letter from Ellyn R. Weiss to Board dated August 1, 1977 transmitting Submission of Nancy A. Boxer, Witness.) This interval is so wide as to render the statistical prediction of extremely limited utility since it contains virtually any reasonable prediction.

(279) The raw data from which Ms. Boxer's regression equations are derived consisted of a measurement of capacity factors for all unit years of commercial nuclear power plant operation. However, these data report capacity factor as simply the percentage of design electric rating output which is represented by actual net output. (Boxer at 5-6.) Since design electric rating does not account for license-imposed or cooling-system deratings (Tr. 8679-8682), these data understate capacity factor because the plant operating at full capacity will be reported by the data to be operating at less than full capacity.

(280) The derived multiple regression equations utilize age and size as imputs from which the prediction is derived. (Boxer, Ex. E.) However, these variables explain only 20% of the total variability in capacity factor within the data set, i.e., the R^2 is approximately .2. (Id., Tr. 8682, 8693.) Since 80% of the variability is unexplained by Ms. Boxer's equations, one of several other variables (which may, of course, be either favorable or unfavorable with respect to Pilgrim 2) could have substantially more effect on future Pilgrim 2 capacity factors than do size or age. (See generally Tr. 8686-8692; 8703-8704.) Ms. Boxer did assign a speculative 7% capacity factor increase estimate to account for "learning" in the nuclear industry. (Boxer, p. 14, Tr. 8736.) However, she demonstrated no specific knowledge about industry training or related programs (Tr. 8730-8735), and apparently has no precise explanation for the additional figure chosen. In light of the limited utility of age and size as predictors of capacity factor, i.e.,

their ability to explain only 20% of the variability, we are reluctant to attach much credibility even to the prediction of approximately 17% to 78% as the range within which Pilgrim 2's 1988 capacity factor would be expected to fall.

(281) In light of the foregoing, we find that Ms. Boxer's statistical prediction of capacity factor gives us no persuasive reason to reject the Staff's utilization of 50%, 60% and 70% predicted capacity factor in their analysis or to reject the Applicants' utilization of a 70% predicted capacity factor.

(282) The Staff recognized the difficulty of attempting to compare fossil units capacity factors with nuclear units, using statistical techniques similar to those employed by the Commonwealth witnesses, when there is such a small data base for nuclear power generation. The Staff also recognized that nuclear and coal plant capacity factor could be a function of such variables as plant size, age, type, manufacture or location. The Staff believed that a prediction of the plant capacity solely on these variables would result in a very wide statistical variation due to the small sample size. (Nash, pp. 26, 27 following Tr. 3110.) The Board agrees with the Staff's assessment. After reviewing the Commonwealth's witness, we find that the Staff's assumption of a 60% capacity factor for coal and nuclear, when comparing the cost of each alternative, is reasonable.

Health Effects of Coal and Nuclear Alternatives

(283) The NRC Staff presented an analysis of the health effects associated with the coal and nuclear fuel cycle alternative. In making his evaluation, Staff Witness Dr. R. L. Gotchy, a well-qualified health physicist (Tr. 6494), considered the entire fuel cycle associated with each alternative. For coal, the cycle consists of mining, processing, fuel transportation, power generation, and waste disposal. The nuclear fuel cycle includes mining, milling, uranium enrichment, fuel preparation, fuel transportation, power generation, irradiated fuel transportation and reprocessing, and waste disposal. (Supplement to Pilgrim Unit 2 FES Regarding Health Effects Attributable to Coal and Nuclear Fuel Cycle Alternatives by Dr. R. L. Gotchy, Tr. following 8358, hereinafter Alternative Health Effects Supplement.)

(284) For each 0.8 gigawatt-year (a 1000 megawatt plant operating at a conservatively high 80% capacity factor for a year), the Staff estimates 1.1 to 5.4 associated deaths and 17-24 injuries and diseases. (Alternative Health Effects Supplement, p. 3.) The bulk of this total (0.62 to 4.9 deaths) is attributable to coal-fueled power used in the nuclear fuel cycle for uranium enrichment, auxiliary reactor systems, and the like. (Id.) The Staff estimates a range of 15 to 120 mortalities per 0.8 GWy for the coal fuel cycle, with an additional 57 to 210 per 0.8 GWy disease and injury estimate (morbidity). (Id., p. 5.) There is considerable uncertainty associated with these estimates (Tr. 8502-8535) which Dr. Gotchy estimates to be about

an order of magnitude for the uranium fuel cycle and about two orders of magnitude for the coal fuel cycle. (Alternative Health Effects Supplement, p. 1, Tr. 8502, 8503.)

(285) The Staff's estimates may overstate the relative nuclear fuel cycle effects because of the conservatism which underlies the generic evaluations upon which the estimates are based. (Alternative Health Effects Supplement, p. 3.) In addition, the failure to estimate important health effects from coal power generation beyond a 50-mile radius from the plant understates the effects from coal. (Tr. 8370, 8466-67, 8478-79.) The primary sources of uncertainty in the estimates of nuclear fuel cycle effects derive from the uncertainties in dose calculation modeling, reliance on conservative meteorological and population density assumptions (Tr. 8527-8530), and conversion of dose rates to health effects (Tr. 8531). Uncertainty in the estimates of coal fuel cycle effects derives partially from the paucity and inadequacy of available epidemiological studies (Alternative Health Effects Supplement, p. 5), and the focus of such studies on sulfur dioxide emissions to the exclusion of effects from nitrous oxides and synergism among emissions. (Tr. 8523-24.) In addition, there are uncertainties with a prediction of effects in light of recent federal programs and regulations as well as national changes in the amount and source of coal utilized. (Tr. 8507, 8510-11, 8513, 8515, 8517, 8519.) It should be noted, however, that the impact of transportation of coal is based on firm statistics and is alone greater than the estimate of all effects from the nuclear fuel cycle

assuming an all nuclear economy, i.e., nuclear energy to operate the nuclear fuel cycle. (Alternative Health Effects Supplement, p. 11.)

(286) In light of the foregoing, we find that the expected adverse health effects of coal power generation are several times the expected effects from nuclear power generation. Despite the uncertainties of such analysis, a reasonable basis is provided for concluding that nuclear-fueled generation is considerably less harmful than coal-fueled generation in the area of adverse health effects. However, it should be emphasized that the increased risk of health effects for either fuel cycle attributable to a 1000 megawatt plant represents a very small incremental risk to the average individual in the public. (Alternative Health Effects Supplement, p. 12.)

(287) Upon reviewing the testimony of the Applicants and the Staff, the FES and the updated portions of the FES, we find that the Staff has considered the reasonable alternatives to Pilgrim Unit No. 2. The Board finds that, when considering the economic and environmental costs of the coal alternative, the nuclear alternative is a reasonable alternative.

J. Environmental Impact of Routine Releases of Radioactive Materials

(288) The Cleetons introduced the direct testimony of Dr. Arthur Tamplin, Dr. Rosalie Bertell and Dr. Helen Caldicott on the subject of low level radiation and its alleged health impacts upon certain members of a population.

(Testimony of Dr. Bertell following Tr. p. 7044, hereinafter Bertell; Dr. Arthur Tamplin following Tr. p. 6959-A, hereinafter Tamplin; and Dr. Caldicott following Tr. p. 7150, hereinafter Caldicott.) None of the Cleeton witnesses presented any evidence that the Cleetons are at any greater risk than any other member of the population from the routine doses of radiation caused by the operation of the proposed Pilgrim Unit 2 plant.

(289) This Board did not permit adjudication of the issue of the general health effects of low level radiation. See Vermont Yankee Nuclear Power Corp. (Vermont Yankee Nuclear Power Station) ALAB-179, 7 AEC 159 (February 1974). As stated in our April Order, Contention E was admitted to allow the Cleetons an opportunity to demonstrate that they would be adversely affected by the routine operations of the proposed plant. If the Cleetons' position was correct, then this Board would have to weigh those adverse impacts into the cost-benefit analysis and determine whether those costs, i.e., health impacts on the Cleetons and their family, would tip the cost-benefit balance against the project or in favor of an alternative.

(290) The Staff adopts the Applicants' Findings in paragraph Nos. 586-596.

(291) The Staff presented testimony by Dr. Reginald Gotchy, a qualified senior radiobiologist for the Staff (Tr. 6509, 6510, 6513, 6514, 6508, and Professional Qualifications following Tr. 6494), on the incremental risk to the Cleetons stemming from the routine operation of the proposed Pilgrim 2

plant. (Testimony of Dr. Gotchy following Tr. p. 6494, and corrected testimony pp. 3 through 7, following p. 7654, hereinafter Gotchy.)

(292) While the Cleetons' witnesses do not agree with all of the assumptions Dr. Gotchy used, they do not dispute the accuracy of the assessment given those assumptions. (Tr. 7119 and 7007.) Dr. Gotchy used acceptable models to determine the doses to a maximally exposed individual. (Gotchy p. 2, following Tr. 6494; Tr. 6497, 6744, 6528.) The assumptions used by Dr. Gotchy were reasonable and very conservative, especially in light of the fact that it is unlikely that an individual would grow all of his own vegetables, rely exclusively on a goat to provide milk and eat exclusively of the shell fish and fin fish from the proposed outfall area. (Gotchy p. 2, following Tr. 6494, and p. 3 following Tr. 7654.)

(293) Assuming 30 years of operation of the plant, Dr. Gotchy determined that the critical organ would be the total body since the dose to the total body would outweigh any risk to any single organ. (Gotchy p. 3.) He calculated a total body dose commitment of 3.6 mrem/yr. throughout the life of the plant, which is conservative since it expresses the dose to a child. (Gotchy p. 3.)

(294) Using the annual dose commitment of 3.6 mrem/yr., Dr. Gotchy estimated the risk of mortality for 30 years of operation from the proposed plant. (Gotchy, p. 4.) He used "The Effect on Population of Exposure to

Low Levels of Ionizing Radiation - Report of the Advisory Committee on the Biological Effects of Ionizing Radiation, Divisions of Medical Sciences, National Academy of Sciences, National Research Council," otherwise known as the BEIR report, to obtain risk estimators, as did other witnesses. The BEIR report reviewed data concerning radiological effects accumulated from previous experiments with radiation, covering the known effects of various quantitites of radiation. It is one of the most authoritative sources of data on the biological effects of radiation. (Gotchy, Tr. 6534; Tamplin, Tr. 6962; and Bertell, p. 2.) The intervenor's witnesses, although they accept the fact that the BEIR report is an authoritative source, believe that recent information would change some of the risk assessment. (Tamplin, Tr. 6963; Bertell, Tr. 7106.) Dr. Gotchy recognized that new data has come to light; however, in his opinion, such research would not change the risk estimators in the view of a majority of the experts. (Gotchy, Tr. 6534, 6663, 6685.)

(295) Using the BEIR report, Dr. Gotchy determined that the added lifetime risk of cancer mortality per person per rem would be 1.35×10^{-4} and the added risk of all genetic defects is 2.6×10^{-4} per person/rem. (Gotchy, p. 4.)

(296) Using the risk estimators obtained from the BEIR report, Dr. Gotchy calculated the lifetime risk of cancer mortality for an infant born when Pilgrim Unit 2 would begin operating by first calculating that the cancer

risk from background radiation in the United States is approximately 2.89 x 10^3 deaths per year. He then calculated the lifetime risk from cancer to be 17%. (Gotchy, p. 5.) Therefore, background radiation accounts for .823 percent of the total cancer death rate. (Gotchy, p. 5; Tamplin, Tr. 6975.) The cancer risk from background radiation would be 0.0014. In other words, for every 714 persons dying, 122 deaths would be due to cancer and one of these deaths might be due to background radiation. (Gotchy, p. 5.) The increase in total body dose commitment from Pilgrim Unit 2 would be 0.0151. If one assumes a linear dose effect relationship, the lifetime risk of dying of cancer to an individual, who was an infant at the time Pilgrim Unit 2 commenced operation, would be 0.00142.

(297) In other words, there would be about one chance in 703 of dying of cancer induced by background radiation plus the postulated maximum dose to a hypothetical individual from 30 years of operation of Pilgrim Unit 2. (Gotchy, p. 5.) The added incremental risk is 2.1 x 10^{-5} or one chance in 47,000 that the person living on the site would contract cancer due to the proposed operation of Pilgrim Unit 2. Since the Cleetons live in Franklin, Massachusetts, which is approximately 40 miles from the site, the risk to the Cleetons would be orders of magnitude lower. (Gotchy, p. 5.) We find these calculations to be reasonable.

(298) The Staff adopts the Applicants' Finding in paragraph No. 599.

(299) The Board examined not only the potential risk to the Cleetons but also the incremental risk from operation of Pilgrim 2 to the population within 50 miles of the plant, which we believe is a realistic assessment of the risk. (Question of Dr. Cole, Tr. 6719.) The incremental risk to the average individual within 50 miles of the proposed plant is 8.3×10^{-10} or one chance in 550 million that such a person would contract cancer due to the proposed operation of the Pilgrim Unit 2 plant. (Gotchy Staff Ex. 8, Affidavit of Dr. Gotchy, p. 5 following Tr. 7820.) The Board accepts the calculations performed by Dr. Gotchy to determine the incremental risk to the population within 50 miles of the plant.

(300) The Staff recognizes that the dose calculations contain some uncertainties, which the Staff believes to be in the range of about an order of magnitude. (Tr. 6624, 6625.) The Staff has taken reasonable steps to compensate for these uncertainties by utilizing a conservative approach. (Tr. 6521, 6526, 6625, 6645, 6630.) For example, the Staff integrates the dose not only for the 30 year life of the plant but continues to take into account the dose for 50 years beyond the life of the plant in order to assure taking into account the entire life of an individual. (Tr. 6524, 6535.) Any uncertainties, therefore, do not inherently undermine the conclusions which they reach.

(301) Mrs. Cleeton contends that the fact that she has some prior exposure to X-rays would make her more susceptible to low level radiation from

routine operations of the proposed plant. Dr. Gotchy pointed out that X-rays may predispose her to cancer; however, the incremental risks from Pilgrim Unit 2 do not change that risk. (Tr. 6745.) Under the linear dose rate hypothesis, when one is looking at the health effects, previous dose rate does not matter. There will be the same incremental effect for the entire population. (Tr. 6728, 6742.)

(302) The Cleetons introduced the direct testimony of Dr. Arthur Tamplin. (Cleeton witness Tamplin following Tr. 6959-A, hereinafter Tamplin.) Over objection by the Applicants, the Board admitted Dr. Tamplin's testimony insofar as it dealt with low level radiation, but reserved judgment as to the weight we would give to it. (Tr. 6959.) It became apparent that the Tamplin testimony did not directly address the Cleetons' Contention. (Tr. 7012, 7013.) Dr. Tamplin gave no basis for believing that some persons may be more susceptible than others to low level radiation. Further, he does not know whether the Cleetons would be in that group even if such a group existed. (Tr. 6969.) Therefore, this Board gives little weight to Dr. Tamplin's testimony.

(303) Dr. Tamplin does not disagree with Dr. Gotchy's conclusions, except for the risk estimators utilized, and he could not tell us what would constitute an unreasonable risk to the Cleetons. (Tr. 7007, 7012, 7013.)

(304) Dr. Tamplin believes that the risk of contracting cancer from low level radiation should be increased by a factor of 10 (Tamplin, p. 6, Tr. 6965), and the genetic effects should be increased by a factor of 4. (Tamplin, p. 4.) Dr. Tamplin also believes that some persons may be more susceptible to radiation than others. A person who is susceptible could have the risk increased by 10 to 100 times. (Tr. 6966.) The Cleetons may be in this group, but he does not know. (Tamplin, Tr. 6969.)

(305) Even if we should accept Dr. Tamplin's estimate of risk and the fact that a susceptible group of persons exists in the population (and there is no evidence in this record to support such a proposition), the risk to the Cleetons is still not unreasonable. (Tr. 6974.)

(306) Dr. Bertell stated that the purpose of her testimony was to set forth the scientific evidence that the Cleeton family (and Mrs. Cleeton in particular) will be exposed to an unreasonable risk. (Bertell, p. 1.) Dr. Bertell posits that there is an unreasonable risk from the proposed operation of Pilgrim Unit 2 because there is no monitoring of health effects from radiation. (Bertell, Tr. 7101, pp. 1 and 3.) Dr. Bertell believes that using predictive models as the Staff and Applicants have done is not enough and that the public health cannot be protected without a monitoring program to confirm the predictions. (Tr. 7096, 7097.) Therefore, she believes it is an unreasonable risk to build the proposed Pilgrim Unit 2 plant. (Bertell, Tr. 7059, 7065, 7073, 7074, 7083, 7108, 7114.) Whether

health monitoring is feasible, given the number of variables involved, seems very unlikely. At any rate, Dr. Bertell's preference for such monitoring does not give us any reason to reject the proposed plant. Dr. Bertell also believes that there are persons in the society who are more susceptible to the effects of radiation than others; she does not accept the averaging concept used by the Staff to determine health effects. (Bertell, pp. 2 and 3.)

(307) The Board has reviewed Dr. Bertell's testimony and her responses on cross-examination. Our review shows that she does not know what type of reactor the proposed Pilgrim Unit 2 plant will be. (Tr. 7051.) She does not know about the radiological monitoring that will be done at the Pilgrim plant; she has not read the environmental report, the SER or the FES. (Tr. 7055-56.) In fact, she admits that she does not know anything about the proposed Pilgrim Unit 2 plant. (Tr. 7059.) She also knows very little about the Cleeton family except that she has been told Mrs. Cleeton had tuberculosis and has had X-rays and that there is a history of cancer in Mrs. Cleeton's family. (Tr. 7073.)

(308) The Staff adopts the Applicants' Finding in paragraph No. 605.

(309) Cleetons' witness Dr. Caldicott is a physician who has no background in engineering or statistics. She has done no research relating to low level radiation. The Board finds that since Dr. Caldicott has some

limited experience with radiation, she could be qualified to speak to the subject, but that no great weight should be given to her testimony. (Tr. 7143-A, 7143-B.)

(310) Dr. Caldicott believes that Mrs. Cleeton would face great risk if exposed to any additional radiation and that her grandchildren (along with all children) are also in great danger if exposed to any additional radiation. (Testimony of Dr. Caldicott, Tr. following 7150 as limited; Tr. 7144-45, 7147 at page 2 and Tr. 7182.) Dr. Caldicott apparently believes that any additional increase in radiation is totally unacceptable and therefore unreasonable risk. (Caldicott, p. 2.) Dr. Caldicott does not know what dose an individual will receive, but believes that any increase in the dose would be unacceptably harmful. (Tr. 7154 and 7155.) When asked to give a quantified estimate of risk to the Cleetons, she testified that she could not do so. (Tr. 7180.)

(311) The Staff adopts the Applicants' Finding in paragraph 609.

(312) This Board cannot accept Dr. Caldicott's admonitions without knowing what she believes the risk to be from routine emissions from the proposed Pilgrim Unit 2. We are required by statute to balance the costs and the benefits and determine whether or not the costs (including environmental risks) are so great that they outweigh any benefits. Dr. Caldicott did not give us any evidence to show that Mrs. Cleeton is more susceptible than the

general population, nor what risk to such a person would be. Absent such a showing, we cannot give weight to her testimony in this proceeding.

(313) The Board has examined the evidence of the Staff, the Applicant and the intervenors. The Staff and the Applicant attempted to determine what the risk would be to Mrs. Cleeton and her family. Mrs. Cleeton has attempted to show that she and her family would be subject to an unreasonable risk if Pilgrim Unit 2 is constructed. However, her witnesses did not make a showing of unreasonable risk in general from routine operation of Pilgrim 2 nor of unreasonable risk to the Cleetons in particular. The Staff, using what all witnesses recognize as the most authoritative document estimating risk of biological effects from radiation, have shown that the incremental risk of contracting cancer from the proposed Pilgrim Unit 2 is negligible.

(314) The Board finds that the routine discharge of radioactive materials and/or attendant routine doses of radiation caused by the proposed operation of Pilgrim Unit 2 do not constitute an unreasonable threat to the health and safety of the Cleeton family. Upon examining Chapter 5 of the FES and the testimony presented by Dr. Gotchy, the Board finds that neither the Cleeton family nor the general population is subject to an unreasonable risk from the operation of the proposed Pilgrim 2 Plant. (FES, Ch. 5; Tr. following 7819; Staff Ex. 11B.)

K. Transportation Risks

(315) The Staff adopts the Applicants' Findings in paragraphs Nos. 613 and 614 with the following addition to the latter:

> The Staff presented testimony of Robert F. Barker, who, in his position with the NRC Staff, is responsible for standards development relating to transportation of byproduct and source material and under whose direction WASH-1238 was prepared. (Educational and Professional Qualifications of Robert F. Barker, Tr. following 2275.)

(316) The Staff adopts the Applicants' Findings in paragraphs Nos. 615 and 616 with the following addition to the latter:

> Mr. Barker provided a detailed analysis of the transportation regulations which form the basis of the conclusions of WASH-1238 with respect to the level of risk of radiological exposure due to transportation accidents. These include design and quality assurance in packaging, surface radiation level limits, limits on the number of packages and packing configurations, and imposition of a duty to monitor for loose radiation and to provide accurate labeling. These regulations are issued by the Department of Transportation (49 C.F.R. Parts 173, 174, 175, 177, 178) and implemented by NRC regulation (10 C.F.R. Part 71) and inspection. All of these regulations apply to the proposed Pilgrim Unit 2. (Staff Witness Barker, pp. 4-12, Tr. following 2537; Tr. 2288.)

(317) The Staff adopts the Applicants' Finding in paragraph No. 617.

(318) The Staff substitutes the following proposed finding for Applicants' proposed finding in paragraph No. 618:

> The Board finds that the transportation risks from accidents specified in Summary Table S-4 of 10 C.F.R. § 51.20(g) and set forth in Table 7.3 of the Final Environmental Statement Relating to Construction of Pilgrim Unit 2 at page 7-7 are applicable to define transportation risks associated with operation of Pilgrim Unit 2.

L. Risk of Theft and Sabotage

(319) The Board admitted Commonwealth Contention 9 which avers that the Applicants and Staff overstate the advantage of the nuclear option as opposed to alternative methods of electrical generation by understating the risk of theft and sabotage attendant on nuclear generation, the costs of which, if considered in the cost-benefit analysis for Pilgrim 2, would cause the overall costs of the facility to outweigh its benefits. (Board Memorandum and Order, February 18, 1975, pp. 607.)

(320) Based upon 10 C.F.R. § 50.13 and the Appeal Board decisions interpreting it [Long Island Lighting Co. (Shoreham Station), ALAB-156, 6 AEC 831, 851 (1973); Potomac Electric and Power Co. (Douglas Point Station,

Units 1 and 2), ALAB-218, 8 AEC 78, 81 n. 7 (1974); Consolidated Edison Co. of New York, Inc. (Indian Point Station, Unit 2) ALAB-197R, 7 AEC 826 (1974)], no evidence was taken on the risks and costs associated with armed acts of force against the plant itself. In addition, we are governed by Appeal Board holdings which preclude consideration of detailed security plans at the Construction Permit stage. Consolidated Edison Co. of New York, supra. Accordingly, we have taken evidence on this contention which relates to costs associated with acts of theft and sabotage during transportation of nuclear materials to and from the plant and evidence which relates to the general security plan for Pilgrim 2 and the costs associated therewith.

(321) The Staff presented the testimony of Robert Barker on theft and sabotage during transportation (Tr. following 2275, hereinafter Barker on Theft and Sabotage) and, by affidavit, the testimony of Donald Kasun and Vernon Hodge on theft and sabotage (Tr. following 8459, hereinafter Kasun and Hodge), together with the document Calculations of Radiological Consequences from Sabotage of Shipping Casks for Spent Fuel and High-Level Wastes, NUREG-0194 (hereinafter NUREG-0194). In addition, the Staff presented the testimony of John Sears on theft and sabotage at the plant. (Tr. following 2210, hereinafter Sears.) The Applicant presented the testimony of Walton Rodger and Lawrence Low on theft and sabotage during transportation. (Tr. following 2024, hereinafter Rodger and Low.) The Commonwealth presented the testimony of George Rathjens. (Tr. following 4380 as limited by Board ruling at Tr. 3286-3297, hereinafter Rathjens.)

(322) In assessing the risks of theft and sabotage during transportation of fuel to, and spent fuel and high-level waste from, Pilgrim 2, we have considered both the likelihood or probability of such events and the consequences which could attend such events.

(323) With respect to probability, we find that such events are extremely unlikely. In addition to legal deterrents to such actions (Barker on Theft and Sabotage, p. 9; Rodger and Low, p. 9), the extreme difficulty of such acts is likely to deter would-be thefts and saboteurs. This difficulty stems from the fact that successful execution of theft requires special heavy equipment (Barker on Theft and Sabotage, p. 6; Tr. 2118, 4399), and that any attempt to extract valuable nuclear material requires massive and sophisticated separation and processing equipment (Tr. 2118), since the shipped material would be very low in enrichment. (Barker on Theft and Sabotage, p. 4; Rathjens, p. 6, Tr. 2460.) Further, discovery of the theft is extremely likely (Barker on Theft and Sabotage, p. 9; Roger and Low, p. 14), perhaps utilizing special radiological aerial surveillance. (Tr. 2115, 2121.) A saboteur intent upon breaching the shipping casks (which are not only extremely heavy, but built to rigorous standards) (Barker on Theft and Sabotage, pp. 6, 8; Kasun and Hodge, p. 3; Rodger and Low, pp. 12, 13; Affidavit of C. Vernon Hodge in Response to Board Questions, Tr. following 8459, pp. 4, 5; Tr. 2044, 2503) might do so with a shaped explosive charge (Kasun and Hodge, p. 2; Tr. 2067). However, there are numerous easier targets for saboteurs, such as liquified natural gas, biological and chemical

toxics, and the like (Barker on Theft and Sabotage, p. 9; Tr. 2029, 2501, 4406). Further, the threat of radiological release lacks the immediacy of such other threats. (Rodger and Low, p. 15; Tr. 2068.) In 30 years of experience with the transportation of radioactive wastes and spent fuel, no such acts of theft or sabotage have occurred. (Rodger and Low, p. 9; Barker on Theft and Sabotage, pp. 3, 4; Tr. 2103-04.) Based upon the foregoing, we conclude that the probability of theft and sabotage of nuclear materials transported to and from Pilgrim 2 is extremely low.

(324) When the probability of an event is extremely low, the costs associated with the event will be low even if the consequences are quite high. The Staff's analysis of the consequences of the worst credible breach reveals that only about one early death and 38 latent cancer fatalities would be expected where the population density is 100 persons per square mile. (Kasun and Hodge, pp. 3, 4; NUREG-0194.) Therefore, the consequences of such an event are themselves relatively low. Commonwealth witness Rathjens stated that a larger radioactive release might be possible in the event of an extremely high temperature sustained fire (Tr. 4393, 4419), but offered no analysis or explanation that leads us to conclude that to be a credible event. The Staff concludes that a massive rupture of a spent fuel cask is essentially impossible. (Kasun and Hodge, pp. 4, 5.)

(325) The Staff adopts Intervenor Commonwealth's Finding in paragraph No. 270.

(326) In view of these developments, the Board does not feel it can rule on this contention based on the present state of the record. It is the Board's understanding that the Staff will supplement the record on this subject and the parties will have the opportunity to cross-examine if they believe it to be necessary. (See Letter dated January 25, 1979 from B. Smith, Counsel for NRC Staff to Board.)

(327) In our limited consideration of theft and sabotage at the plant, we have considered the risks associated with such acts by employees or other unarmed persons as well as the general cost of security to avoid such acts. The security utilized at nuclear plants is sufficient that both Staff's witness Sears (who evalutes the security systems of plants, Tr. following 2210), and Commonwealth's witness Rathjens (a distinguished political scientist with expertise in the area of diversion of nuclear materials) testified that the likelihood of significant theft or sabotage at the plant by unarmed persons is very low. (Sears, pp. 1-3; Rathjens, pp. 120, 123, 124, 126; Tr. 2212, 2256, 2266, 2267, 2269, 2770, 4384-5, 4389-90, 4402.) Irradiated fuel (which is the only nuclear material present which is classified as special nuclear material (10 C.F.R. § 70.3; Sears, p. 1), is present only within three protective shells, each of which has controls and barriers. (Sears, p. 2.) In light of the special handling and equipment required (Sears, p. 2), and the general difficulty of making weapons from irradiated fuel (Tr. 4409-4412), as well as the availability of easier ways of obtaining a nuclear weapon (Id.), the risk of theft of special nuclear material from

the plant is extremely low. While disgruntled employees might succeed in disabling a nuclear plant, this risk is not unique to nuclear generating facilities and there is no evidence that the associated costs would differ. (Tr. 4422-3; 4426-7.) In light of the foregoing, we find that the risk of theft and sabotage by unarmed persons at Pilgrim 2 is extremely small and that the associated cost is negligible.

(328) The Staff's witness Sears testified that an estimated cost for security under the old regulations was $250,000 capital outlay and $200,000 annual operating costs. (Sears, p. 4., Tr. 2246.) New regulations will raise this cost. (Sears, Tr. 2267.) However, we find that the reasonable probable cost of the Pilgrim Unit 2 security program (even assuming a conservative factor of 5 greater than Mr. Sears' estimate of costs under the old regulations) is small relative to the overall cost of the facility and would not, taken in conjunction with all other costs, render nuclear generation less desirable than any alternative.

(329) Since this testimony was presented the Commission has adopted new regulations pertaining to the physical protection of the licensed activities in nuclear power reactors against industrial sabotage. (10 C.F.R. § 173.55.) Once these regulations are fully implemented, the Board finds that the risk will be even less than described above.

M. Effect of Unavailability of Reprocessing and Waste Disposal Facilities on Costs and Environmental Assessment

(330) The Staff adopts the Applicants' Finding in paragraph No. 632.

(331) The Staff's analysis of the impact on the availability of fuel for Pilgrim Unit 2 assumed that there will be no reprocessing. (Nash, p. 1 following Tr. 4770.) To obtain an estimate of the availability of fuel, the Staff estimated the number of operating reactors, reactors under construction and planned reactors, which amounted to a total of 236 committed reactors. (Nash, p. 2, 3.) Assuming plant operation at 70% capacity, the total fuel requirements during the Pilgrim 2 lifetime for the 236 committed reactors is 1,455,000 tons of U_3O_8 assuming no reprocessing. If uranium recycle is assumed, the total uranium requirement is approximately 1,240,000 tons; the requirement is 1,110,000 tons of U_3O_8 if plutonium recycle is assumed. (Nash, p. 2, 3.) The Board has reviewed the sources utilized by the Staff and concurs with the Staff estimates of the total uranium requirements for the 236 committed reactors.

(332) The Staff, using figures from the Energy Research and Development Administration (predecessor to the Department of Energy), estimated, in updated testimony filed June 24, 1977, the amount of uranium available. (Nash and Fisher pp. 6, 7 following Tr. 8304.) The Board finds that it is reasonable to rely on the estimates supplied by ERDA, which is the government agency responsible for uranium resource assessment. (Nash and Fisher,

p. 6.) Reserves of uranium are defined as those with the highest assurance of magnitude and availability. Probable potential resources are those projected by favorable trends and largely delineated by drilling data within productive uranium districts. (Nash, p. 4.) Using the estimates obtained from ERDA, 840,000 tons of uranium are available in reserve and 1.09 million additional tons are available in probable potential reserve. (Nash and Fisher, p. 7.) The Staff estimated reasonable costs of uranium to assess the available uranium. (Nash, p. 7; Nash and Fisher, p. 6, 7.) The Board finds that, with either a delay in reprocessing or no reprocessing during the life of the proposed Pilgrim 2, sufficient uranium is available to provide fuel during the life of the plant.

(333) The Staff introduced the testimony of James Miller, who is qualified to discuss the cost of increased spent fuel storage capacity. (Staff witness Miller following Tr. 4778, hereinafter Miller; Professional Qualifications, following Tr. 4778, 4781.)

(334) The currently proposed spent fuel storage pool for Pilgrim Unit 2 is designed to accommodate spent fuel for five years (Miller, p. 3), and could be expanded to accommodate spent fuel for 10 years by using methods such as high density racks. (Miller, p. 3; Nash and Fisher, p. 11 following Tr. 8034.) The cost of this expansion would be approximately $700,000. (Miller, p. 3.) If there is no reprocessing during the lifetime of Pilgrim

Unit 2, the Applicants could build an on-site storage capacity at an approximate cost of $20 million. This would be a worst-case situation. (Miller, p. 3; Nash and Fisher, p. 12 following Tr. 8034.) Another feasible option is less expensive off-site storage. (Miller, p. 4.)

(335) The Staff adopts the Applicants' Finding in paragraph No. 637 with the following modification:

> The Staff estimated that the cost of the no recycle option would amount to 2.3 mills/Kwh. (Nash, p. 21 following Tr. 8304.)

(336) The Board has reviewed the additional cost if reprocessing is delayed or deferred for the life of the proposed plant. The Board finds that the costs incurred do not shift the cost-benefit balance in favor of alternative forms of power generation.

(337) The Staff introduced the testimony of Dr. Michael Parsont, who is qualified to address the environmental impact of increased spent fuel storage necessitated by a delay in reprocessing of the fuel. (Staff witness Parsont following Tr. 4906, hereinafter Parsont; Professional Qualifications following Tr. 4906, Tr. 4909-4413.) The Staff calculated the dose from the fuel elements and the fuel pool by using the Applicants' design for the fuel assemblies and the assumption that the fuel pools are filled to a depth of 26 feet at all times (Parsont, pp. 1, 2 following Tr. 4906), and by using

computer codes which have been verified by actual measurements. (Id., Tr. 4937-38.) The calculation, for conservatism, assumed a person was three feet above the pool. The Staff conservatively estimated the dose rate above the fuel elements to be 9×10^{-8} mrem/hr. (Parsont, p. 2.) The dose rate from the fuel pool water is estimated to be 1.8 mrem/hr. (Parsont, p. 2.)

(338) The environmental impact from 1.8 mrem/hr. radiation level, assuming for conservatism that the nearest resident is 1900 feet above the fuel pool, would be a received dose of less than 0.02 mrem/yr., which is insignificant when compared to the natural background radiation of 100 mrem/yr. (Parsont, p. 3.) The environmental impact would continue to be insignificant even if the fuel pools were expanded. (Parsont, p. 3.) The Applicants' calculations confirm the Staff's assessment that the environmental impact is not significant. (Applicants' testimony, pp. 8, 10, 11 following Tr. 4692.)

(339) The Staff calculations are based on a number of conservative assumptions which tend to make any actual environmental impact to the Cleetons, who reside 40 miles from the plant, even more remote. (Parsont, pp. 2, 3, Tr. 4946.) This becomes more evident when one considers that the dose from a diagnostic X-ray is 1700 times that from the fuel pool storage. (Tr. 4947.)

(340) The Board finds, based on calculations of dose from the fuel elements and fuel pool storage, that there will not be a significant increase in the radiological impact due to longer storage of spent fuel at the proposed Pilgrim Unit 2 site.

N. Environmental Impact of Postulated Accidents

(341) The Staff adopts the Applicants' Findings in paragraphs Nos. 648 and 649 with the following modification:

In the first sentence, the word "realistically" should be placed before "estimated exposures."

O. Compliance with Federal Water Pollution Control Act

(342) The Staff adopts the Applicants' Finding in paragraph No. 650.

(343) The Board has reviewed the 401 certification and recognizes that an appeal has been taken on the tentative decision and that a final decision has not been entered by the State. (Tr. 9968.) However, this Board is bound to accept the Commonwealth's certification since it has not exercised its authority to stay its certification. (30A Mass. Ann. Laws, § 14(3).)

IV. Site Suitability Matters

A. Geography

(344) The Staff adopts the Applicants Findings in paragraph No. 651.

B. Exclusion Area

(345) The Staff adopts the Applicants Finding in paragraph No. 652 with the addition of the following to the footnote.

> Upon receipt of the Staff's evaluation, the Board will assess whether this matter should be reopened.

C. Population Density

(346) The Staff adopts the Applicants Finding in paragraph No. 653.

D. Low Population Zone

(347) The Staff adopts the Applicants Findings in paragraph Nos. 654 and 655.

(348) The Staff's decision to include as a population center contiguous communuties rather than a single political entity was not lightly arrived at. The Staff did not merely look at the total projected population. It took into account the population density of various segments of Plymouth and compared those densities to other cities in Massachusetts and New England with populations between 25,000 and 50,000 persons. (SER Supp. No. 3 § 2.1.3.)

(349) The Staff also examined land use plans within certain Census Enumeration Districts. (SER Supp. No. 3 § 2.1.3.) One other test applied was locating various institutions which might be expected to be in and around a population center. (SER Supp. No. 3 § 2.1.3.)

(350) Based on the above the Staff found that: 1) there is a significantly lower population density for Census Enumeration District No. 1198 than for central Plymouth; (2) there is no significant development within large parts of the District; and (3) not all of Census Enumeration District No. 1198 should be included as a part of the population center. It did conclude that the portion of the census district which adjoins central Plymouth should be included as a part of the population center and that the population center should include certain institutions, including a nursing home. (SER No. 3 § 2.1.3.)

(351) The Board strongly approves of the Staff's approach in this case in determining the population center. Its methodology and assumptions are reasonable and fully consistent with the admonition in 10 C.F.R. § 100.11(a)(3) that political boundaries are not controlling in determining population centers.

(352) The Staff adopts Applicants' Findings in paragraph No. 656 with the following modification.

The words "assuming, without deciding" be deleted.

(353) The Board finds that the Staff requirement that the Applicants commit to periodically monitor for, and report to the Staff, any significant change in land usage controls, zoning and population in Census Enumeration District No. 1198 is reasonable. (SER Supp. Nos. 3 and 4.) The Applicant has accepted this commitment.

E. Nearly Industrial, Transportation and Military Facilities

(354) The Staff adopts the Applicants' Finding in paragraph No. 654.

F. Aircraft Hazards

(355) The Staff adopts the Applicants' Findings in paragraphs Nos. 658 and 659 (pages 414-417).

G. Hydrology

(356) The Staff adopts the Applicants' Findings in paragraphs Nos. 660 through 667.

(357) The Staff conducted an independent evaluation of the hydrologic engineering factors at the site. The Board finds that: (1) there are no unique hydrologically-related phenomena related to the water supply system; and (2) the potential for ground water and surface water contamination would have no effect on nearby wells.

(358) The Staff adopts Applicants' Findings in paragraph No. 668.[6/]

H. Meterology

(359) The Staff adopts the Applicants' Findings in paragraph No. 669 through 672.

I. Geology and Seismology

(360) Appendix A to Part 100 sets forth the criteria describing the nature of the investigations required to obtain the geologic and seismic data necessary to determine site suitability and provide reasonable assurance that Pilgrim Unit 2 can be constructed and operated at Rocky Point without undue risk to the public. It also describes the procedures for determining the quantitative vibratory ground motion design basis at the Rocky Point site due to earthquakes and requires information on which to base a decision as to whether Pilgrim Unit 2 need be designed to withstand the effects of surface faulting. (Part II to Appendix A, of 10 C.F.R. Part 100.)

6/ By letter of July 5, 1979 from Barry H. Smith, Counsel for NRC Staff, we were informed of a report on break-water damage at the Pilgrim Unit No. 1. Since this breakwater will be used by the proposed Unit 2, the report was relevant to our consideration in this case. The report indicated that the Applicants have committed to submit the final design analysis for the Unit 2 intake structure for review and approval by the Staff. We agree with the Staff that this review should take place at the operating stage review and it does not change any conclusions regarding the breakwater. (SER § 2.4.2.)

(361) The Board has reviewed the Applicants' submittal on this subject and the Staff's determinations concerning the required investigations and establishment of the design basis earthquake. (PSAR § 2.5 and Appendices; SER Suppl. No. 3 and No. 4, 2.5.) The results of our review are set forth below.

(362) The Staff adopts the Applicants' Proposed Finding in paragraph No. 673.

(363) The Board has undertaken a detailed review of whether there has been compliance with Appendix A to Part 100.

(364) Part IV(a) of Appendix A requires certain investigations to be carried out by the Applicants. These investigations are discussed below.

(365) Part IV(a)(1) requires a determination of the lithologic, stratigraphic, hydrologic, and structural geologic conditions of the site and the region surrounding the site, including its geologic history. These matters are discussed by the Staff in the SER. (SER §§ 2.5.1, 2.5.2.) The hydrologic investigations and the Staff's review of this information are found in § 2.4.2 of the SER.

(366) The next required investigation is described in Part IV(a)(2) of Appendix A. This section requires an identification and evaluation of tectonic provinces underlying the site and the region surrounding the site.

The Appendix cautions the Applicants and Staff to consider the possible effects caused by man's activities, e.g., drilling activities.

(367) The Staff examined the results of the Applicants' investigation and, employing its own body of expertise, concluded that there were no tectonic structures underlying the site or any possible effects caused by man's activities. (SER § 2.5.1, 2.5.2.)

(368) The next investigation is a determination of the static and dynamic engineering properties of the material underlying the site. (Part IV(a)(4).)

(369) The Staff would substitute the following for the Applicants' Finding in paragraph No. 674:

> The Applicants have investigated the subsurface materials underlying the proposed Pilgrim 2 facility by having a total of 61 borings drilled into the subsurface and by excavating two test pits below foundation level. The purpose of the Applicants' extensive investigation program was to:
>
> (1) make a determination of subsurface materials and stratification;
> (2) measure the degree of compactness of the in-site soils;
> (3) recover representative undisturbed and bulk samples for field and laboratory testing in order to establish static and dynamic engineering properties of the in-site soils; and

(4) evaluate the previous stress history of the foundation soils. (SER Supp. No. 3 § 2.6.1.)

(370) These investigations have shown that foundation soils consist predominantly of about 90 feet of dense, poorly-graded to well-graded sands and gravelly sands. The upper 20 to 30 feet consist of glacial sandy till with layers of silt, silty clay, and sandy clay. Stratified sandy glacial outwash, ranging in thickness from 60 to 80 feet, is the main bearing stratum at the site and overlies bedrock. Bedrock consists of competent igneous rocks, known as the Dedham granodiorite, and the bedrock surface under the foundation area lies between 58 and 80 feet below MSL. (PSAR, §§ 2.4.1.3.1, 2.5.1.3.3.1, 2.5.1.3.3.2, Site Suitability Report, at 8 following Tr. 7466; SER Supp. No. 3 § 2.6.1.)

(371) Part IV(e)(5) requires a listing of all historically reported earthquakes which have affected or which could reasonably be expected to have affected the site. The Applicants are expected to give specific information concerning these earthquakes. Because earthquakes are reported in terms of various parameters, e.g., magnitude, intensity at given location, it may be necessary to estimate the data by the use of appropriate empirical relationships.

(372) Although New England has one of the longest records of historical earthquakes, the Pilgrim site is located in an area which has relatively little seismic activity. (SER Supp. 3 § 2.5.5.)

(373) The largest earthquakes which occurred within 50 miles of the site were an intensity V-VI (MM) earthquake in 1847, an intensity VII-VIII (MM) in 1817, and an intensity VI (MM) in 1744. (SER Suppl. No. 3 § 2.5.5.) The Applicants' determination of location for the 1744 and 1847 earthquakes are different than those published in "Earthquake History of the United States." These differences are accountable by the fact that the Applicants were able to find more complete historical accounts of the earthquakes which enabled them to more accurately identify their location. (SER Supp. No. 3 § 2.5.5.)

(374) During the course of the review, the location of an earthquake of 1628, which was apparently felt strongly near the proposed site, was investigated by the Applicants. (SER Supp. No. 3 § 2.5.5.) Despite the sparse data concerning this earthquake, the Applicants were able to postulate the location by comparing its effects with a later earthquake. (SER Supp. No. 3 § 2.5.5.) We agree with the Staff that the Applicants' postulated position is reasonable. Other earthquakes located in the New England-Piedmont tectonic province were also identified by the Applicants and reviewed by the Staff. (SER Supp. § 2.5.5.)

(375) The next step in the required investigations is to correlate the epicenters or locations of highest intensity of the previously identified reported earthquakes, where possible, with tectonic structures, any part of which is located within 200 miles of the Pilgrim site. If epicenters or locations of highest intensity cannot be reasonably correlated with a tectonic

structure, then it must be identified with tectonic provinces, any part of which is located within 200 miles of the site. See Part IV(a)(6) of Appendix A. This part of the investigation required a lenghthy period of time, and required careful analysis by both the Staff and Applicants. (SER § 2.5; SER Supp. No. 3, §§ 2.5, 2.5.3, 2.5.4, 2.5.5.) The Board will address this issue in its discussion of the determination of the design basis for vibrating ground motion.

(376) Part IV(a)(7) and (8) to Appendix A concern investigation of faults and surface faulting. The nearest map fault is about 17 miles southwest of the site, and there is the possibility of faulting existing about 10 miles north of the site in the vicinity of Marshfield, Massachusetts. (SER Supp. No. 3, § 2.5.2.) There are no faults identified near the site. (SER Supp. No. 3, §2.5.2.)

(377) In determining whether these faults are capable, the Board and Staff are guided by the definition found in Part III(g) of Appendix A. This definition gives a number of characteristics of a capable fault. However, these characteristics are not binding when a site, such as Pilgrim, is in the Eastern region of the United States. In this situation, the structural association of a fault with geologic structural features which are geologically old (at least pre-Quaternary) shall, in the absence of conflicting evidence, demonstrate that the fault is not a capable fault within the definition of Appendix A. The Board agrees with the Staff that, given the age

of faults and the lack of conflicting evidence, these faults are not capable within the definition of Appendix A. (SER Supp. No. 3 §§ 2.5.1, 2.5.2; PSAR § 2.5.1.2.3.)

(378) The Board finds no evidence of surface faulting; therefore, no further consideration of this was necessary by the Staff or Applicants. (SER Supp. No. 3 §§ 2.5.1, 2.5.2.)

(379) The Staff's extensive review of the information submitted by the Applicants was supplemented by several visits to the site and its environs. The Staff also conferred with local geologists, Applicants' consultants, and with its advisors, the U. S. Geological Survey (USGS). The evaluation by the USGS is found in Appendix B to SER Supplement No. 3. (SER Supp. No. 3 § 1.2.5.)

(380) The Board finds that the investigations required by Part IV of Appendix A were fully complied with by the Applicants and carefully reviewed by the Staff.

(381) With the information obtained from the investigations a determination of the design basis for Vibratory Ground Motion must be made. (Part V to Appendix A.) Vibratory ground motion will be referred to as "g" value which is defined as that acceleration used to anchor the zero period end of Reg. Guide 1.60 response spectra. Before the "g" value is determined, the Safe Shutdown Earthquake must be established. Part III(c) of Appendix A.

(382) An important aspect in determining the SSE is the association of historically reported earthquakes with a tectonic province or a tectonic structure. A "tectonic province" is "a region of the North American continent characterized by a relative consistency of the geologic structural features contained therein." (Part III(b) of Appendix A.) The definition of a "tectonic structure" is a large-scale dislocation or distortion within the earth's crust. Its extent is measured in miles. (Part III(i) of Appendix A.) With this definition in mind, the Board has evaluated whether the proper Safe Shutdown Earthquake (SSE) has been determined and if the appropriate "g" value has been arrived at by the Staff and Applicants.

(383) There are three approaches to determining the "g" value. The first is to take those historic earthquakes of greatest magnitude or intensity which have been associated with tectonic structures and assume that the epicenters are situated at the point on the structure closest to the site. The rules provide that the magnitude or intensity may be larger than that of the maximum earthquakes historically recorded. (Section V(a)(1)(i) of Appendix A.) The second approach is employed when the epicenter or locations of highest intensity of earthquakes cannot be associated with a tectonic structure but they can be identified with tectonic provices in which the site is located. In this case, the "g" value will be determined assuming that these earthquakes occur at the site. (Section V(a)(1)(ii).) The third approach involves the situation where the epicenters or locations of the highest intensity of historically reported earthquakes cannot be reasonably related

to a tectonic structure, but are identified with tectonic provinces in which the site is not located. In this case, the "g" value should be determined assuming the epicenter or locations of highest intensity of these earthquakes are at the closest point to the site on the boundary of the tectonic province. (Section V(a)(1)(iii) of Appendix A.)

(384) The determination of whether the identified earthquakes are associated with tectonic structures or tectonic provinces and the location of these tectonic structures or provinces caused the extensive investigations and review by the Staff in this case. The positions of the Applicants and Staff, as well as the Board's position, are set forth below. (SER Supp. No. 3 §§ 2.5.3, 2.5.4.)

(385) Besides those earthquakes known within 50 miles of the site, the Staff examined those which occurred within the different regions of the New England-Piedmont tectonic province. These earthquakes lie within one of the several zones of relatively high seismic activity for the region. (SER Supp. No. 3 § 2.5.5; Supp. Testimony of T. Bennett, R. Jackson and J. Kane on the Safe Shutdown Earthquake, following Tr. 8945 (hereinafter SSE Testimony).)

(386) The largest historical earthquake within these zones is near Cape Ann, Massachusetts in 1755, intensity VIII.[7/] The location of this earthquake is in a zone extending from Boston-Cape Ann, Massachusetts area northward and westward. (SER Supp. No. 3, § 2.5.5.)

7/ All intensities described are on the Modified Mercalli Scale.

(387) The proximity of the site to the source of the Cape Ann earthquake had to be decided in order to establish the "g" value. (SSE Test. at p. 2.)

(388) Three alternative hypotheses for associating earthquakes near Cape Ann with geological structures were considered in the course of the Staff's review. They are as follows:

> The hypothesis favored by the NRC staff was that the Cape Ann earthquake can reasonably be associated with the northwest-trending zone of structures represented by relatively young intrusive bodies and the high earthquake activity itself (SER Supp. No. 3, §§ 2.5.4, 2.5.5; SSE Testimony at p. 3).
>
> The hypothesis favored by the applicants was that the Cape Ann earthquake and other large earthquakes in New England were associated with faults near specific intrusive bodies within the northwest-trending zone (SER No. 3 §§ 2.5.4, 2.5.5; SSE Testimony at p. 3).
>
> The hypothesis favored by the U. S. Geological Survey was that the Cape Ann earthquake could reasonably be associated with a northeast-trending zone of deformation represented by the high concentration of Paleozoic faulting in the Cape Ann vicinity (SER Supp. No. 3 § 2.5.5, Appendix B; SSE Testimony at 3).

(389) The Staff did not embrace the USGS hyopthesis because there is no clear association of earthquake activity for the New England region. (SSE Test. at p. 4; SER Supp. No. 3 § 2.5.4.)

(390) The Staff did not believe there was enough geologic and seismic data to accept the licensee's theory as basis for licensing a nuclear power plant. (SER Supp. No. 3 § 2.5.4.)

(391) The basis for the Staff hypothesis is that there is a general spatial correlation of seismicity with the White Mountain Plutons which are the youngest significant deformation features in New England. (SER Supp. § 2.5.4; SSE Testimony at p. 4.)

(392) The Staff was also able to establish that earthquakes in zones B and C did not occur near the site. (SER Supp. No. 3 § 2.5.5, pp. 2-14.)

(393) The Staff also recognized that there were reported earthquakes in New England outside of these zones; however, none exceeded an intensity VII (MM). (SER Supp. No. 3, § 2.5.5. at pp. 2-13.)

(394) The critical problem was establishing the minimum distance between the Pilgrim site and the structure associated with the earthquake activity in Zone A and with the zone of intrusion in that area. (SER Supp. No. 3, § 2.5.5 at pp. 2-14.) The Applicants provided extensive data in order to establish this distance, including a comprehensive aeromagnetic map. (SER Supp. No. 3 § 2.5.5 at pp. 2-14.)

(395) From the information provided by the Applicants, the Staff determined that neither the high earthquake activity in what has been referred to as Zone A, nor the zone of intrusive bodies (plutons), with which the historical seismicity can be specially associated, extend south of the northeast-trending fault zone which bounds the north side of the Boston Basin. (SER Supp. No. 3 § 2.5.5 at pp. 2-15; 2.5.4 at pp. 2-11.) Therefore, the Staff concluded that the Cape Ann earthquake should not be assumed to be closer than 35 miles to the Pilgrim site. (SER Supp. No. 3 § 2.5.5 at pp. 2-15.)

(396) The Board finds that the Staff's hypothesis is reasonable in light of the existing knowledge about geology and seismology. The Board agrees with the Staff that, whether its hypothesis or that of its advisor, USGS, is used, the Cape Ann earthquake would not be assumed to be closer than about 35 miles from the site. (SSE Testimony at p. 4; SER Supp. No. 3, Appendix B.)

(397) Using a standard eastern intensity-attenuation curve indicates that an earthquake of maximum intensity VIII (MM) would produce an intensity of no greater than VII at a distance of 35 miles. (SER Supp. No. 3, § 2.5.6.) Because there is no historical earthquake greater than intensity VII within the New England-Piedmont tectonic province and those outside are small or too far away, the Board agrees that the SSE of intensity VII (MM) is conservative and in accordance with Section V(1) of Appendix A to Part 100. (T. 8994, 8995, 8999.)

(398) To establish the ground motion expected at the Pilgrim site from the postulated earthquake of intensity VII, the Staff utilized the data relating to intensity and acceleration levels developed by Neumon and Trifunic and Brady. The trend of the means of the peak acceleration values corresponding to intensity VII is 0.13g. (SER Supp. No. 3 § 2.5.6; SSE Testimony at p. 5.)

(399) Because of the stiff soil at the Pilgrim site it is possible that the vibratory ground motion at this site could be amplified. (SER Supp. No. 3 § 2.5.6 at pp. 2-16; SSE Test. at 9041.) Based on studies conducted by the Staff and others, the Staff concluded that a design acceleration larger than 0.13g established should be used. (SER Supp. No. 3 § 2.5.6 at pp. 2-16; SSE Test. at pp. 5, 6.)

(400) Based on the consideration of (1) the seismic wave transmissions at the Pilgrim site; (2) the effects of site conditions on the levels and response spectra for strong motion; and (3) the potential for earthquake occurrence in the site region, the Staff correctly concluded that the response spectra in Reg. Guide 1.60, scaled to 0.20g at the ground surface, should adequately represent the effects of potential earthquakes. (SER Supp. No. 3 § 2.5.6 at pp. 2-16.)

(401) In summary, the Board finds that:

(a) The site is in the New England-Piedmont tectonic province (SER Supp. No. 3 § 2.5.3).

(b) The largest historical earthquake in the province is the intensity VIII[8/] near Cape Ann in 1755 (SER Supp. No. 3 § 2.5.5).

(c) The 1755 earthquake was associated with a zone of structures and is assumed to occur no closer than 35 miles from the site (SER Supp. No. 3 §§ 2.5.4, 2.5.5, 2.5.6).

(d) The intensity at the site from the postulated occurrence of the safe shutdown earthquake is VII (SER Supp. No. 3 § 2.5.6).

(e) The mean acceleration corresponding to intensity VII is 0.13g based on the Trifunac-Brady relationship (SER Supp. No. 3 § 2.5.6).

(f) Soil conditions at the Pilgrim site are expected to amplify the ground motion so that a value above the mean is appropriate (SER Supp. No. 3 § 2.5.6).

8/ All intensities described are on the Modified Mercalli scale.

(g) An acceleration level of 0.20g at free-field ground surface is considered appropriate for the safe shutdown earthquake (SER Supp. No. 3, § 2.5.6).

(402) In accordance with section V(1)(a)(iv) and section VI of Appendix A, the Staff considered the effects of liquefaction, and reached a conclusion based on various studies and an independent analysis of data that there is an adequate margin against liquefaction for ground accelerations up to 0.25g. (SER Supp. No. 3 § 2.6.2.)

(403) The Staff also considered, in accordance with Section V(2) of Appendix A, the stability of slope and concluded that the slopes will be stable under anticipated conditions. (SER Supp. No. 3 § 2.6.2 at pp. 2-19.) The Board agrees with the Staff's conclusion.

(404) As required by Section V(3) of Appendix A, the Staff considered the effects of the SSE and the properties underlying the site on the cooling water supply. The Staff concluded that appropriate consideration was given to it. (SER Supp. No. 3 § 2.6.1 at pp. 2-17, 18.)

(405) Once the SSE is established and the corresponding vibratory ground motion, a "g" value for an Operating Basis Earthquake (OBE) must be established. The Staff found an acceleration level of 0.1g for an OBE acceptable. The basis for this is that this is consistent with Reg. Guide 1.60 and the fact that

the probability of the OBE occurring during the life of this plant is low. (SER Supp. No. 4 § 2.5.6.)

(406) The Board finds that the Applicant and Staff have met the requirements of Appendix A to Part 100. We also find that the Staff has demonstrated a reasonable understanding of the site and the regional geology and seismology and the Board agrees that this site is suitable for the proposed Pilgrim Unit 2.

V. Unavoidable Adverse Environmental Effects

(407) The Staff has assessed the unavoidable adverse environmental effects from the proposed operation of Pilgrim Unit 2. The Board concurs with the Staff's conclusions that land will not be available for alternative productive uses during the life of the plant, water discharged into the canal will be of lower quality than the water withdrawn from the Bay, and there will at times be gases in the water in concentrations sufficient to become a supersaturation condition. (FES § 10.1.1.)

(408) Thermal and chemical discharges from routine operation of the proposed Pilgrim Unit 2 are not expected to have an adverse effect on the biota of Cape Cod Bay; however, there will be some entrainment and impingement losses. The Staff has assessed these losses and concluded that the recuperative capacity of Cape Cod Bay is sufficient to make the losses insignificant. (FES §§ 5.4.2.1.3, 10.1.2.) The Board concurs with the Staff's conclusion.

(409) During the routine operation of Unit 2, there will be insignificant amounts of radioactivity which will be released to the environment. (FES § 5.3 following Tr. 7828.)

VI. Relationships Between Local Short-Term Use of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

(410) There are competing interests for all of coastal areas (FES § 10.2); however, the proposed site is better suited for utilization for power generation than the other competing uses. The proposed plant is, therefore, consistent with long-term objectives for coastal zone management. (FES § 10.2.) The Board agrees with the Staff that dedication of man's resources at the proposed site for Pilgrim Unit 2 is consistent with the balancing of short-term and long-term objectives for the use of the environment.

VII. Irreversible and Irretrievable Commitments of Resources

(411) In considering irreversible and irretrievable commitments of resources, the Staff identified material and nonmaterial resources. (FES § 10.3.2.) Since the organisms that will be lost due to the construction and operation of Pilgrim Unit 2 represent an insignificant fraction of the total Bay ecosystem, the Board concurs in the Staff's judgment that the losses are not irreversible or irretrievable resource commitments. (FES § 10.3.3.)

(412) The materials used in the construction of Pilgrim Unit 2 are almost entirely of the depletable category of resources. The uranium that will be consumed in the form of fuel by Pilgrim Unit 2 represents an irretrievable commitment of a resource. (FES § 10.3.4.) The Staff has considered this commitment of a resource assuming no recycling of uranium or plutonium. (FES § 10.3.4.) The Staff considered other materials that would be consumed during the operation of Pilgrim Unit 2 and found the consumption of those materials to have a negligible effect on their total resources. (FES § 10.3.4.) The Board concurs with the Staff assessment of the irretrievable commitment of material resources to be consumed by Pilgrim Unit 2.

VIII. Cost-Benefit Analysis

(413) The Board finds that the principal economic and environmental costs of construction and operation of the facility, based on the existing record are summarized as follows:

a. The costs of construction of the facility will be approximately 2,037.5 million.

b. The plant, along with Unit 1, will occupy about 45 acres for all station facilities. Approximately 49 acres will be disturbed during construction (See Section II A, supra).

c. There will be 38 miles of transmission line corridor (FES, Table 10.4).

d. There will be a nonconsumptive use of water of 1700 cfs for condenser cooling and 78 cfs for service water (both salt). The consumptive use will be 30 million gallons/yr. of freshwater (FES, Table 10-4).

e. The thermal effects on the water will be the condenser cooling water heated 22°F above intake temperature (Units 1 and 2), and about four acres of the Bay may be heated 10°F above normal Bay temperature (FES, Table 10-4).

f. The Staff adopts the Applicants' Findings in paragraphs 681d and e, with the following modification to 681e: There will be an additional radiological impact of an occupational radiation exposure of about 500 man-rem/yr. There may be an individual dose of 0.05 man-rem/yr possible dose to the thyroid from ingestion of fish and invertebrates living near the discharge channel and 2.5 man-rem/yr possible dose to the thyroid at the nearest site boundary from gaseous effluents (FES, Table 10-4 following Tr. 8803 See Section III C.

g. The ecological impact on aquatic life will be that some weak swimming organisms will be impinged or entrapped in the intake

structure. The passage of spores, eggs, larvae, small fish, and other planktonic forms through the condenser circuit could cause a loss of up to 15% of these forms of aquatic life within one square mile of Pilgrim Unit 2 (FES, Table 10-3 see Section III B, supra). The discharge of heated waters will attract schools of Pollock and Menhaden. The operation of Pilgrim Unit 2 increases the degree of nitrogen saturation of the circulating water, thereby creating the possibility of causing gas bubble disease in fish living in the channel. At times, the thermal plume may sink to the bottom of the Bay and raise the temperature of bottom living benthos by about 5°F over an area of three to four acres. During dredging and construction operations, it is expected that about 3.5% of the total area resource of Irish moss will be destroyed (FES, Table 10-4 see Section III B, supra).

h. The ecological impact on terrestrial life will be that about 47 acres now devoted to a forest community will be converted to nonbiological uses (FES, Table 10-4; Staff Exs. 16, 17 following Tr. 8542). Also, transmission corridors will be kept permanently clear of brush by the application of herbicides (FES, Table 10-4).

i. The social impact will be transmission corridors which will present a visually displeasing effect at road crossings until screening plantings are established. The construction noise at the

nearest residence could be as high as 75dB and traffic on local roads will increase by 1000 round trips per day (FES, Table 10-4).

(414) The Staff adopts the Applicants' Findings in paragraphs 682(a) and (c) with the following modification:

FES, Table 10-1, should be a reference in Finding 682C.

(415) The Staff rejects the Applicants' Finding in paragraph No. 383 and would substitute the following:

Because the Staff will be submitting new information pertaining to the issue of theft and sabotage, the Board cannot at this time make the final cost benefit balance.

(416) The Staff rejects Applicants' Finding in paragraph No. 684 and would substitute the following:

Further, independently considering the final balance among conflicting environmental factors set out in the record of this proceeding as of the date of this Partial Initial Decision the Board cannot find at this time that the appropriate action to be taken is to authorize the granting of the construction permit subject to further orders and directives of the Commission.

IX. Conclusions of Law

(417) The Staff adopts the Applicants' Finding in paragraph 685 with the following modification:

F. Add the following footnote:

Subject to such further findings as are warranted on the Supplemental Testimony concerning the issue of theft and sabotage.

X. Order

(418) The Staff adopts the Order proposed by the Applicants.

Respectfully submitted,

Barry H Smith

Barry H. Smith
Counsel for NRC Staff

Barry H Smith for

Marcia E. Mulkey
Counsel for NRC Staff

Dated at Bethesda, Maryland
this 20th day of November, 1979.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
BOSTON EDISON COMPANY, et al.	)	Docket No. 50-471
	)	
(Pilgrim Nuclear Generating Station, Unit 2)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "NUCLEAR REGULATORY COMMISSION STAFF'S PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW IN THE FORM OF A PARTIAL INITIAL DECISION" in the above-captioned proceeding have been served on the following by deposit in the United States mail, first class or, as indicated by an asterisk, through deposit in the Nuclear Regulatory Commission's internal mail system, this 20th day of November, 1979.

Andrew C. Goodhope, Esq.
3320 Estelle Terrace
Wheaton, Maryland 20906

Dr. A. Dixon Callihan
Union Carbide Corporation
P. O. Box Y
Oak Ridge, Tennessee 37830

*Dr. Richard F. Cole
Atomic Safety and Licensing Board
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

George H. Lewald, Esq.
Ropes & Gray
225 Franklin Street
Boston, Massachusetts 02110

Dale G. Stoodley, Esq.
Boston Edison Company
800 Boylston Street
Boston, Massachusetts 02199

Henry Herrmann, Esq.
Room 1045
50 Congress Street
Boston, Massachusetts 02108

Mr. and Mrs Alan R. Cleeton
22 Mackintosh Street
Franklin, Massachusetts 02038

The Board of Selectmen
Town of Plymouth
Plymouth, Massachusetts 02360

William S. Abbott, Esq.
50 Congress Street, Suite 925
Boston, Massachusetts 02109

Michael B. Meyer
Assistant Attorney General
Utilities Division
Public Protection Bureau
One Ashburton Place
19th Floor
Boston, Massachusetts 02108

*Atomic Safety and Licensing
Appeal Board
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

*Atomic Safety and Licensing
Board Panel
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Mr. Lester B. Smith
Director of Conservation
Massachusetts Wildlife Federation
P.O. Box 343
Natick, MA 01761

Francis S. Wright, Esq.
Stephen M. Leonard, Esq.
Assistant Attorneys General
Environmental Protection Division
Public Protection Bureau
One Ashburton Place, 19th Floor
Boston, Massachussetts 02108

Patrick J. Kenny, Esq.
General Counsel
Massachusetts Governor's Office
of Energy Resources
73 Tremont Street
Boston, Massachusetts 02108

*Docketing and Service Section
Office of the Secretary
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Laurie Burt, Esq.
Assistant Attorney General
Commonwealth of Massachusetts
Environmental Protection Division
One Ashburton Place, 19th Floor
Boston, Massachusetts 02108

Barry H. Smith
Barry H. Smith
Counsel for NRC Staff

1533 226