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

In the Matter of **Docket No. 50-293 & 72-1044 LT**

Entergy Corporation

Pilgrim Nuclear Power Station

License Transfer Agreement Application

PILGRIM WATCH PETITION TO INTERVENE AND HEARING REQUEST

Pilgrim Watch requests a hearing and leave to intervene in the above captioned matter.

I. INTRODUCTION

As described in the Federal Register, 84, No. 21, January 31, 2019, the NRC is considering whether to approve the transfers of Renewed Facility Operating License No. DPR–35 for Pilgrim Nuclear Power Station (Pilgrim) and the general license for Pilgrim Independent Spent Fuel Storage Installation (ISFSI) from the current licensees to Holtec International and Holtec Decommissioning International, LLC.

In short, Energy Corporation wants to sell Pilgrim Nuclear Power Station ("Pilgrim") to Holtec International. As part of the transaction, Pilgrim's current licensed operator (Entergy Nuclear Operations, Inc., "ENOI") and owner (Entergy Nuclear Generation Company, "ENGC") of Pilgrim have filed a License Transfer Application ("LTA") asking that Entergy Nuclear Operations' license be transferred to Holtec Decommissioning International ("HDI), a newly formed subsidiary of Holtec International that will actually decommission Pilgrim. ENGC, Pilgrim's current licensed owner, will continue to exist and own Pilgrim after the transaction is completed, but it will be owned by Holtec International rather than Entergy Corporation and its name will be changed to Holtec Pilgrim. Both Holtec Pilgrim and HDI are (or will be) limited liability corporations; no other entity has any financial responsibility for Pilgrim's decommissioning.

Section 189(a) of the Atomic Energy Act is clear:

> "In *any proceeding* under this chapter, for the granting, suspending, revoking, *or amending of any license* or construction permit, o*r application to transfer control* …, the Commission *shall grant a hearing* upon the request of *any person whose interest may be affected by the proceeding*, and shall admit any such person as a party to such proceeding."

The LTA is a request to amend Pilgrim's current licenses, and to transfer of control of Pilgrim - from Entergy to Holtec. As discussed below, Pilgrim Watch's interests will be affected by this proceeding.

This being so, Section 189(a)(1)(A) of the AEA requires the Commission to grant Pilgrim Watch a hearing. A "transfer of control" triggers Pilgrim Watch's right to a hearing. (Amergen Energy Co., LLC (Three Mile Island Nuclear Station, Unit 1), CLI-05-25, 62 NRC 572, 573-74) This proceeding is directed amending ENOI's license to operate Pilgrim, and to transfer it to Holtec Decommissioning International. The License Transfer also seeks to transfer Pilgrim's Operating License from ENOI (owned by Entergy) to Holtec Decommissioning International.

10 CFR §2.309(a) is also clear: Pilgrim Watch's Petition and Request must be granted if the Licensing Board "determines that the requestor/petitioner has standing under the provisions of paragraph (d) of this section and has proposed at least one admissible contention that meets the requirements of paragraph (f) of this section."

Pilgrim Watch would not be surprised if Holtec, Entergy or the NRC Staff improperly sought to avoid granting Pilgrim Watch a hearing, likely citing to 10 C.F.R. § 2.1315 and 10 C.F.R. 51.22(c)(21). See LTA, p 20.

What those opposing a hearing would overlook in any such effort is that (1) an NRC regulation cannot override the plain command of Section 189(a) of the Atomic Energy Act; (2) the LTA asks for far more than simply "conform[ing] the [current] license to reflect the transfer action," and (3) under NEPA and NRC regulations the Commission cannot avoid requiring a new environmental assessment or environmental impact statement.

10 C.F.R. § 2.1315 only applies when a license amendment "does no more than conform the license to reflect the transfer action." That is far from the case here.

In particular, the proposed license amendment:

1. Requires the NRC to find that "Holtec Pilgrim LLC is financially qualified" and that Holtec Decommissioning International is both "technically and financially qualified" (Proposed Amended License, p. 1, subparagraphs c and d), a finding that would conveniently overlook that the only asset of Holtec Pilgrim and Holtec Decommissioning is Pilgrim's demonstrably insufficient Decommission Fund (see Contention 1, below) and that Holtec has never decommissioned a site (See transcript of NRC public meeting on January 15, 2019, ML19029A025):

    MS. CARPENTER (NDCAP): And my other question was: how many sites has Holtec decommissioned? And by that, I don't mean as a contractor. Excluding that, how many sites has Holtec decommissioned?

    MS. J. RUSSELL (Holtec): Holtec International has not decommissioned any sites.

2. Deletes the requirements that Pilgrim's owner "provide decommissioning funding assurance of no less than $396 million," provide a Provisional Trust fund in the amount of "$70 million," and "have access to a contingency fund of not less than fifty million dollars" (Proposed Amended License p. 4).
3. Deletes the requirement that the Decommissioning Trust agreement prohibit investments in the Pilgrim Owner's parent company. (Proposed Amended License, p. 5).

10 C.F.R. § 2.1315 does not apply here. These changes do far more "than confirm the license to reflect the transfer action." Contrary to Holtec's assertion, "the proposed license amendment does … involve … change[s] in … the requirements of the Licenses." See LTA, 20.

Even if this were not so, the Commission should determine that the generic determination of § 2.1315 should not apply here for all of the reasons set forth herein, including that the license transfer agreement raises significant questions with respect to safety hazards and whether the health and safety of the public will be affected.

10 C.F.R. § 51.22(c)(21) is similarly inapplicable. It could not be clearer that "upon the request of any interested person," such as Pilgrim Watch, the statement that in § 52.22(c) that "an environmental assessment or an environmental impact statement is not required" does not apply.

It is also clear that 10 C.F.R. § 52.22(c)(21) is directed to whether a new environmental assessment or environmental impact statement is required (See Contention 2), and <u>not</u> to whether Holtec Pilgrim and HDI are financially qualified.

Far from assuring that assuring that Holtec Pilgrim and HDI are "financially qualified" (LTA letter p.1, LTA p.17, LTA Enclosure 1, p. 2) and have financially adequate funds for decommissioning, the faulty and inaccurate assumptions in Holtec Pilgrim's and HDI's PSDAR and Decommissioning Cost Estimates show that neither is "financially qualified" and that neither has, or has access to, the funds decommissioning will require. This is particularly so because there is no updated or accurate environmental report and the environmental review required by NEPA has not been done.

There can be no doubt that affected parties like the Pilgrim Watch have hearing rights under the Atomic Energy Act. Neither can there be any doubt that license amendment requests such as those here are adjudications that also trigger hearing rights under 5 U.S.C. § 551(7) of the Administrative Procedure Act. Both of these laws require giving those whose interests would otherwise be ignored a meaningful opportunity to adjudicate the health, safety, and environmental matters that Pilgrim Watch raises here.

The NRC has long recognized that safety considerations, such as those involved here, are the heart of the rule that an entity to which a license is transferred must be financially qualified (Gulf States Utilities Co. (River Bend Station, Unit 1), LBP-95-10, 41 NRC 460, 473 (1995)); and as shown below, Holtec Pilgrim and HDI are not. Commission regulations, and common sense, correctly recognize that underfunding can affect plant safety.

In this proceeding the NRC must decide whether Holtec's "plan as proposed … will meet [its] financial qualifications regulations," and in doing so the NRC cannot avoid evaluating the "transferee's financial qualifications." Pacific Gas & Electric Co. (Diablo Canyon Nuclear Power Plant, Units 1 & 2), CLI-02-16, 55 NRC 317, 340 (2002). Where, as here, a petitioner such as Pilgrim Watch raises genuine issues about the accuracy or plausibility of an applicant's cost and revenue projections, the petitioner is entitled to a hearing. North Atlantic Energy Service Corp. (Seabrook Station, Unit 1), CLI-99-6, 49 NRC 201, 220-21 (1999).

As shown below, Pilgrim Watch is entitled to intervene because it (1) has standing and (2) pleads at least one valid contention. *Carolina Power and Light Co. and North Carolina Eastern Municipal Power Agency* (Shearon Harris Nuclear Power Plant, Units 1 and 2), LBP-82-119A, 16 NRC 2069, 2070 (1982).

A. Pilgrim Watch Has Standing

Pilgrim Watch meets the requirements of 10 C.F. R. § 2.309(d). Pilgrim Watch is a non-profit citizens' organization located at 148 Washington Street, Duxbury, Massachusetts 02332, and many of its members make their residences and places of occupation and recreation less than 10 miles from Pilgrim.

Pilgrim Watch has representational standing to intervene in this license proceeding, for several reasons.

One is that this Board found that Pilgrim Watch had standing in an earlier NRC proceeding, Pilgrim's license renewal (see Entergy Nuclear Generation Co. & Entergy Nuclear Operations, Inc. (Pilgrim Nuclear Power Station), Docket 50-93 LRA. As this Board said in *Georgia Power Co.*, 34 NRC 138, 141 (1991):

> The Commission has ruled that, under certain circumstances, even if a current proceeding is separate from an earlier proceeding, it will refuse to apply its rules of procedure in an overly formalistic manner by requiring that petitioners, who participated in the earlier proceeding, must again identify their interests to participate in the current proceeding.

See also Consumers Power Co. (Midland Plant, Units 1 and 2), 7 AEC 7, 12 (1974):

> We do not pause long to reject the licensee's argument that the request for hearing must be denied because the Sierra Club petitioners allegedly have failed to satisfy our procedural rules (10 CFR 2.714) governing intervention in this proceeding. …. We will not close our eyes to the fact that this proceeding, though separate from the earlier

> ones for some purposes, is merely another round in a continuing controversy as to whether the licensee can be reasonably expected to comply with our quality assurance regulations."

A second is that the Pilgrim Watch members that Pilgrim Watch represents in this proceeding[1] live within the 10-mile geographical zone that might be affected by a release of fission products into the environment during or after decommissioning. Pilgrim Watch is entitled to the presumption of injury-in-fact for persons residing within that zone (see Houston Lighting & Power Co. (South Texas Project, Units 1 & 2), LBP-79-10, 9 NRC 439, 443 (1979); Detroit Edison Co. (Enrico Fermi Atomic Power Plant, Unit 2), LBP-79-1, 9 NRC 73, 78 (1979); and Entergy Nuclear Generation Co. & Entergy Nuclear Operations, Inc. (Pilgrim Nuclear Power Station), LBP06-23, 64 NRC 257, 270 (2006)). That presumption is well-founded here.

The interests of Pilgrim Watch and its members extend to all aspects of Pilgrim's radiological decommissioning, spent nuclear fuel management, and site restoration. The proposed license transfer raises significant health, safety, environmental, and financial concerns for them.

Pilgrim Watch and its members will be at risk if there is a shortfall in the Decommissioning Fund that prevents the site from being fully decontaminated and restored. The radiological risk to their health and safety and to their environment if the site is not fully decontaminated before Pilgrim's license termination includes the threat of radiological contamination of land that will be released for public use, and of Cape Cod Bay and adjoining Plymouth, Duxbury and Kingston Bays and estuaries into which there will be radiological runoff, and potentially of their drinking water. Public health, safety and economic impact will result from actual/measured contamination

[1] (1) Rebecca Chin, 31 Deerpath Trail, North, Duxbury Massachusetts; (2) Molly Bartlett, Gurnet Road, Plymouth; (3, 4) Mary Elizabeth Lampert and James Blaine Lampert, both of 148 Washington Street, Duxbury, Massachusetts 02332 and (5) David O'Connell, Garden Street, Kingston Massachusetts. Declarations from each stating their interests and authorization for Pilgrim Watch to represent them are attached. (Exhibit 1)

above acceptable limits, and from the public's perceived or reasonably feared contamination irrespective of actual readings.

That risk is also financial to the Commonwealth— there is no guarantee that Massachusetts taxpayers, including Pilgrim Watch and its members, will not become the payers of last resort if the Decommissioning Trust Fund falls short.

Pilgrim Watch has an undisputable interest in ensuring that the owner of the Pilgrim site provides financial assurance that the site will be fully decontaminated, decommissioned, and restored, and spent fuel properly managed, all according to applicable federal, state, and local requirements. There is no such assurance, for the myriad reasons discussed below. If the NRC were to approve the LTA without first resolving the Petitioners' public safety, environmental and financial concerns, that approval would result in an unacceptable risk to the environment, and would jeopardize the health, safety, welfare, and economic interests of Pilgrim Watch and members of Pilgrim Watch who live, recreate, conduct business and own property within the areas likely to be impacted by the nuclear power station.

The information in the LTA itself shows that there is not sufficient money in the Decommissioning Trust Fund. The problem is exacerbated by the fact that Pilgrim will likely remain a repository for spent nuclear fuel for an indeterminable period of time, probably many decades into the future and perhaps indefinitely, after decommissioning itself is complete.

Pilgrim Watch also should be granted standing because its participation may reasonably be expected to assist in developing a sound record (See, 10 C.F.R. § 2.309 (e), as Pilgrim Watch has demonstrated by its participation in numerous NRC proceedings dating back to the 1980's. In recent years, NRC granted a hearing and admitted Pilgrim Watch as an intervenor in Docket 50-93 LRA, a license renewal proceeding that extended from 2006-2012. Pilgrim Watch members are Pilgrim Station's neighbors, and they can provide local insight that cannot be provided by the Applicant or other potential parties.

The standing requirements for Nuclear Regulatory Commission (NRC) adjudicatory proceedings derive from the Atomic Energy Act (AEA), which requires the NRC to provide a hearing "upon the request of any person whose interest may be affected by the proceeding." 42 U.S.C. 2239(a)(1)(A).

Pursuant to 10 C.F.R. § 2.309(f), Pilgrim Watch has standing and should be granted leave to intervene because it and its members' "interest[s] may be affected by the proceeding." Those interests will not be adequately represented in this action if Pilgrim Watch is denied intervention.

B. Pilgrim Watch's Contentions Meet the Requirements of 10 CFR. § 2.309 and are Admissible

As shown above, Pilgrim Watch is a "person whose interest may be affected by a proceeding and who desires to participate as a party." 10 C.F.R. § 2.309(a).

Pilgrim Watch's request for hearing is timely (10 CFR2.309(b)(1); it is submitted within twenty days of notice in the Federal Register.

Pilgrim Watch's Petition meets all of the requirements of 10 C.F.R. § 2.309(f). It "se[t]s forth with the particularly the contentions (Contention 1 and Contention 2) sought to be raised (10 C.F.R. § 2.309(f)(1) and for each contention provides and demonstrates what is required by 10 C.F.R. § 2.309(f)(1)(i-vi).

As required by Section 2.309(f)(i), the bases and facts of each contention provide specific statements of the issues of land and fact raised or controverted.

As required by Section 2.309(f)(ii), each contention provides a brief explanation of the bases for the contention.

10 CFR §2.309(f)(iii) requires that the Petitioner "demonstrate that the issue raised in the contention is within the scope of the proceeding." There can be no doubt that whether a licensee transferee is financially qualified (Contention 1), and whether the NRC can approve a license transfer without the environmental assessment and environmental impact statement requested by Pilgrim Watch and required by NEPA (Contention 2) are within the scope of this proceeding. The Atomic Energy Act and NRC regulations require the Commission to make an independent assessment regarding the proposed transfers in terms of regulatory requirements and the protection of public health and safety and the environment.

Pilgrim's Contention 1, that the applicant's license transfer does not provide the required assurance that Holtec Pilgrim and HDI have, or have access to, sufficient funds for decommissioning, is clearly within scope. In this license transfer proceeding, the NRC must evaluate the finances of Holtec Pilgrim and HDI and decide whether the LTA, as proposed, shows they meet NRC financial qualifications regulations. Pacific Gas & Electric Co. (Diablo Canyon Nuclear Power Plant, Units 1 & 2), CLI-02-16, 55 NRC 317, 340 (2002).

The NRC has long recognized that safety considerations, such as those involved here, are the heart of the rule that an entity to which a license is transferred must be financially qualified (Gulf States Utilities Co. (River Bend Station, Unit 1), LBP-95-10, 41 NRC 460, 473 (1995)); and as shown below, Holtec Pilgrim and HDI are not.

Pilgrim Watch submits that neither Holtec Pilgrim nor HDI has shown that there is "sufficient financial assurance" to avoid "significant adverse health, safety and environmental impacts." (NRC's questions and answers on decommissioning financial assurance, ML111950031)

Contention 2, that the LTA cannot be approved without an updated environmental report based on a thorough environmental assessment performed at the beginning of the decommissioning process as required by the National Environmental Policy Act and 10 CFR. §§ 51.20, 51.70 and 51.10, is plainly within scope also. The Atomic Energy Act and NRC regulations require the Commission to make an independent assessment regarding the proposed transfers in terms of regulatory requirements and the protection of public health and safety and the environment.

As required by 10 CFR §2.309(f)(iii), Pilgrim Watch has demonstrated that the scope of this proceeding encompasses the issues Pilgrim Watch's contentions raise, whether the proposed license transfer will meet NRC financial (Pacific Gas & Electric Co. (Diablo Canyon Nuclear Power Plant, Units 1 & 2), CLI-02-16, 55 NRC 317, 340 (2002) and environmental requirements.

Section 2.309(f)(iv) requires a petitioner to "demonstrate that the issue raised in the contention is material to the findings that the NRC must make" to approve the LTA. To approve the LTA, the NRC must find that Holtec Pilgrim and HDI are financially qualified. This issue is plainly material to both Contention 1 and Contention 2.

As shown in the Bases and Facts Supporting Contention 1, neither Holtec nor HDI is financially qualified and neither has provided assurance that they have, or have access to, the funds required for decommissioning.

To approve the LTA, the NRC must also decide whether the environmental impacts of decommissioning are bounded by: NUREG-0586, the GEIS (2002); NUREG-1496 (1997); NUREG-1437, Pilgrim's SEIS (2007); and NUREG-1437, GEIS for License Renewal of Nuclear Plants, June 2013.[2] This issue is material, and is raised in both Contentions 1 and 2. Pilgrim Watch contends that the old GEIS, SEIS, and other documents relied on do not bound either the costs of decommissioning or the potential environmental impact of decommissioning, as shown in the Bases and Facts Supporting Contentions 1 and 2. The findings that the NRC must make are clearly material to whether the LTA can be approved.

In short, Pilgrim Watch's contentions are material to the outcome of this proceeding. Both contentions impact whether the license transfer application should be granted or denied. *In the Matter of Dominion Nuclear Connecticut, Inc. (*Millstone Nuclear Power Station, Units 2 and 3) Docket Nos. 50-336-LR, 50-423-LR ASLBP No. 04-824-01-LR July 28, 2004, p. 7.

If, as Pilgrim Watch contends, the actual facts show that the information in the License Transfer Application is incomplete and misleading, and that the real facts do not ensure that adequate funds for decommissioning will be available when needed, the NRC cannot properly make the findings that it must make if it is to allow the proposed license transfer amendment. 10 CFR § 72.30(b). In this proceeding the NRC must decide whether "the plan as proposed … will meet [its] financial qualifications regulations," and in doing so the NRC cannot avoid evaluating the "transferee's financial qualifications." Pacific Gas & Electric Co. (Diablo Canyon Nuclear Power Plant, Units 1 & 2), CLI-02-16, 55 NRC 317, 340 (2002). Where, as here, a petitioner such as Pilgrim Watch raises genuine issues about the accuracy or plausibility of an applicant's cost and

[2] Holtec PSDAR, section 5.1)

revenue projections, the petitioner is entitled to a hearing. North Atlantic Energy Service Corp. (Seabrook Station, Unit 1), CLI-99-6, 49 NRC 201, 220-21 (1999).

Similarly, the NRC cannot properly make the necessary findings if, as Pilgrim Watch contends, the environmental impacts associated with the proposed decommissioning activities are not bounded by previous environmental impact statements. An accurate updated environmental analysis will show that decommissioning activities the LTA nowhere even considers in the LTA now are required, along with accompanying costs heretofore ignored by Holtec. 10 CFR §2.309(f)(1)(iv); 10 CFR §50.82(a)(4) (i).

As required by Section 2.309(f)(v), Pilgrim Watch's petition provides concise statements of the facts which support Pilgrim Watch's position and references to the specific sources and documents upon which it intends to rely in supports of its positions on the issues.

Section 2.309(f)(vi) requires that a petitioner provide sufficient information to show that a genuine dispute exists with the applicant/licensee on a material issue of law or fact. As required, the information set forth in Pilgrim Watch's petition and contentions includes references to specific portions of Holtec's LTA that Pilgrim Watch disputes and the supporting reasons for each dispute. The petition and contentions also identify numerous instances in which Pilgrim Watch believes that Holtec's application does not contain information on relevant matters required by law, and the supporting reasons for the Pilgrim Watch's belief.

Pilgrim Watch's petition meets the requirements of Section 2.309(f), and its contentions are admissible.[3] Pilgrim Watch is entitled to intervene because it (1) has standing and (2) pleads

[3] A Licensing Board should not address the merits of a contention when addressing admissibility. *Public Service Co. of New Hampshire* (Seabrook Station, Units 1 and 2), LBP-82-106, 16 NRC 1649, 1654 (1982). The basis for a contention may not be undercut, and the contention thereby excluded, through an attack on the credibility of the expert

at least one valid contention. *Carolina Power and Light Co. and North Carolina Eastern Municipal Power Agency* (Shearon Harris Nuclear Power Plant, Units 1 and 2), LBP-82-119A, 16 NRC 2069, 2070 (1982).

With respect to each contention, Pilgrim Watch specifically incorporates by reference, as if fully set forth such contention, all relevant bases, information, facts, sources, documents and other evidence stated with respect to any other contention. Pilgrim Watch also incorporates by reference all contentions, bases, information, facts, documents and other evidence included in the Massachusetts Attorney General's (AGO) filing in this proceeding.

II. CONTENTION 1

The Applicant's LTA does not provide the required financial assurance. It does not show that either HDI or Holtec Pilgrim is financially responsible, or that either has or has access to adequate funds for decommissioning. Neither does the LTA provide any reasonable assurance that Holtec Pilgrim and HDI have, or will have, the financial resources required to deal with environmental impacts that would place the public health, safety, and the environment at risk.

BASES[4]

1. As discussed in detail below the LTA and PSDAR that Entergy and Holtec have filed with the NRC are misleading and incomplete and are based on incorrect but important assumptions. They do not present the evidence that would be required for the NRC properly to conclude that there is the level of financial assurance required to meet the regulatory requirements

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who provided the basis for the contention. *Cleveland Electric Illuminating Co.* (Perry Nuclear Power Plant, Units 1 and 2), LBP-82-98, 16 NRC 1459, 1466 (1982).

[4] Consistent with 10 C.F.R. § 2.309(f)(1)(ii), the bases provided are not all the bases or all the details of the bases which support the contention, but merely "a brief explanation of the basis for the contention."

for the proposed license transfer and amendment. It is well established that Pilgrim Watch "may rely on alleged inaccuracies and omissions" to challenge a license amendment.[5]

2. The Atomic Energy Act (AEA) requires the NRC to ensure protection of public health, safety, and the environment (AEA, Sec.2(d)):

> The processing and utilization of source, byproduct, and special nuclear material must be regulated in the national interest and in order to provide for the common defense and security and to protect the health and safety of the public.

3. The NRC agrees that a shortfall in decommissioning funding would place public health, safety, and the environment at risk. Financial assurance is critical, and a licensee must ensure that sufficient funds are available throughout the decommissioning process:

> The NRC has a statutory duty to protect the public health and safety and the environment. The requirements for financial assurance were issued because *inadequate or untimely consideration of decommissioning, specifically in the areas of planning and financial assurance, could result in significant adverse health, safety and environmental impacts.* The requirements are based on extensive studies of the technology, safety, and costs of decommissioning (53 FR 24018). The NRC determined that there are significant radiation hazards associated with non-decommissioned nuclear reactors. The NRC also determined that the public health and safety can best be protected if its regulations require licensees to use methods which provide reasonable assurance that, at the time of termination of operations, adequate funds are available so that decommissioning can be carried out in a safe and timely manner and that lack of funds does not result in delays that may cause potential health and safety problems (53 FR 24018, 24033). *The purpose of financial assurance is* to provide a second line of defense, if the financial operations of the licensee are insufficient, by themselves, *to ensure that sufficient funds are available to carry out decommissioning (*63 FR 50465, 50473).[6]

[5] *In re Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc.*, Docket No. 50-271-LA-3, LBP-15-24, at 13 (Aug. 31, 2015), *vacated*, CLI-16-08.
[6] NRC, *Questions and Answers on Decommissioning Financial Assurance*, at 1 (ADAMS Accession No. ML111950031).

4. Holtec Pilgrim and Holtec Decommissioning International ("HDI") have not shown that they possess, or will be able to procure, the funds necessary to safely decommission the Pilgrim site. The lack of sufficient funds places Pilgrim Watch and its members, and neighboring citizens at risk that these proposed new licensees will deplete the Decommissioning Trust Fund before they have met their decommissioning obligations. Any shortfall in the Decommissioning Trust Fund would put Pilgrim Watch and its members, and indeed the entire Commonwealth of Massachusetts, at risk that the site will not be fully radiologically decontaminated.[7]

5. As explained in detail below, the limited assets of the proposed new licensees, Holtec Pilgrim and HDI, are insufficient to pay even the decommissioning costs outlined in the PSDAR and LTA, much less to cover any significant or unconsidered shortfalls resulting from likely costs that Holtec incurs before the entire site (including the ISFSI) is decommissioned and released.

6. The PSDAR and LTA do not contain the information to demonstrate reasonable assurance that sufficient funds are available to properly complete the decommissioning process. Neither do they show the detailed cost estimate for decommissioning, or an adequate contingency factor any identification of and justification for using the DCE's key assumptions, required by 10 C.F.R §72.30(b)

7. Holtec PSDAR and Decommissioning Cost Estimate provide essentially no margin for error. They admit that only $3 million (about one-third of one percent of the supposed current value of the DTF) will remain after the decommissioning work set forth in the PSDAR and LTA

[7] *Entergy*, LBP-15-24, at 22 ("As Vermont states, 'assuring adequate funds for a reactor owner to meet its decommissioning obligations is part of the bedrock on which NRC has built its judgment of reasonable assurance of adequate protection for the public health and safety and protection of the environment.").

have been completed; and, say that they expect to spend the entire Contingency Allowance accomplishing the work outlined in the PSDAR.

8. Holtec's PSDAR and DCE to not include the adequate contingency factor required by 10 CFR §72.30(b)(2)(ii). Holtec admits that its "The Contingency Allowance is … expected to be fully consumed." (PSDAR, Sec. 4.5)

9. The statements in the LTA and Entergy's covering letter make clear that the only reason that the two LLCs, HDI and Holtec Pilgrim, are supposedly financially qualified is that Holtec Pilgrim will own the DTF, and will be obligated to pay "HDI's costs arising out of or associated with HDI's operation and maintenance of Pilgrim in accordance with the NRC facility Licenses, which includes, without limitation, HDI's decommissioning costs and spent fuel management costs." (LTA, pg., 18.)

> "HDI will be financially qualified, because under the terms of its operating agreement, Holtec Pilgrim will be required to pay for HDI's costs of operation relating to Pilgrim, including decommissioning and spent fuel management costs" (LTA, pg., 17)
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> "HDI is financially qualified to be Pilgrim's decommissioning licensed operator, because under the terms of the Decommissioning Operator Services Agreement between Holtec Pilgrim and HDI, Holtec Pilgrim will be required to pay for HDI's costs of post-shutdown operation, including all decommissioning costs at Pilgrim." (Letter, pg. 3; LTA Enclosure 1, pg., 1)
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> "Thus, the existing decommissioning trust funds provide the appropriate basis for the financial qualifications of Holtec Pilgrim." (LTA Enclosure 1, pg., 16)

10. Nothing in the LTA or PSDAR suggests that any Entergy entity, or any Holtec entity except the two named Holtec LLCs, will have any financial responsibility for any of what the PSDAR calls the "licensed activities." There is no Parent Company Guarantee ("PCG"); and "the

NRC does not have the authority to require a parent company to pay for the decommissioning expenses of its subsidiary-licensee, except to the extent the parent may voluntarily provide a PCG" (see Questions and Answers on Decommissioning Financial Assurance, ML111950031**).**

11. At a meeting of the Nuclear Decommissioning Citizens Advisory Panel ("NDCAP") in Plymouth, Holtec made quite clear that it has no intention of agreeing to provide any such guarantee.

12. At a NDCAP meeting, Holtec also said that it expects to sue the DOE for reimbursement of costs that Holtec will incur for spent fuel management, and indicated that it would not agree to put whatever monies a Holtec entity might recover from DOE into the Pilgrim Decommissioning Trust Fund, despite the fact that Holtec expects the NRC to allow Holtec to use almost half of the total funds in the DTF for the very same spent fuel management costs that DOE might reimburse.

13. Even if Holtec, Holtec Pilgrim, and HDI did agree to use any recovery from DOE to reimburse the DTF for Pilgrim's spent fuel management costs, the NRC has consistently rejected licensee attempts to use such potential future recoveries from DOE to show financial assurance - for the simple reason that no recovery is guaranteed and the amount that might be recovered is uncertain. See, 10 C.F.R. § 50.75(e)(iii)(A) (chosen method of financial assurance must "guarantee that decommissioning costs will be paid").

13. The proposed license transfer and amendment are explicitly intertwined with Holtec Pilgrim's Post-Shutdown Decommissioning Activities Report (PSDAR), including cost estimates for decommissioning, spent fuel management, and site restoration, and also rely on Pilgrim's outdated, incomplete and inaccurate 2000 GEIS and 2006 SEIS.

14. Neither the costs nor the economic impacts of decommissioning are "bounded" by the 2000 GEIS and 2006 SEIS. A site assessment at the Pilgrim site would provide new and important showing that the 2000 GEIS and 2006 SEIS are outdated and that additional decommissioning costs are required to deal with Pilgrim's actual conditions.

15. NRC approval of the license transfer and amendment request would effectively approve the PSDAR and its financial and environmental analyses and assurance. The PSDAR is material to this proceeding "because it concerns the real-world consequences of approving the [license amendment request]."[8]

16. The proposed license transfer and PSDAR will inexorably lead to a shortfall in the amount of funding available to fully and safely decommission and radiologically decontaminate Pilgrim and to manage its spent nuclear fuel as long as it remains on-site. Any such shortfall could place public health, safety, and the environment at risk.

FACTS SUPPORTING CONTENTION 1

Fundamental facts underlying Contention 1 are that Holtec Pilgrim and HDI are not financially qualified, and that neither can provide the required financial assurance. The LTA makes clear that the only apparent asset of Holtec Pilgrim and HDI is Pilgrim's Decommissioning Trust Fund; nothing in the LTA indicates that either has, or has access to, any additional funds; and as shown below, there is not and will not be sufficient money in the Decommissioning Trust Fund to pay the costs that will be incurred during decommissioning.

[8] *Entergy*, LBP-15-24, at 41.

THE LTA DOES NOT ENSURE SUFFICIENT FUNDS FOR DECOMMISSIONING

As discussed in detail below, the LTA (and the PSDAR and DCE it includes) does not ensure that adequate funds for decommissioning will be available for at least the following reasons. Holtec makes incorrect assumptions and ignores significant facts each of which will result in additional costs, above and beyond the funds available for decommissioning. Although 10 CFR. §72.30 requires it to do so, Holtec has not justified key assumptions contained in the PSDAR and DCE.

Even if the NRC were to accept Holtec's assumptions, only 0.03% of the DTF will remain after decommissioning. The DTF will not be sufficient if any of Holtec's cost estimate assumptions are too low, or if Holtec Pilgrim and HDI incur any of the multitudinous additional costs that are not considered in the PSDAR or DCE.

Examples showing that many of Holtec's assumptions are wrong, that the DTF is not sufficient, and that Holtec Pilgrim and HDI are not financially responsible and have not provided financial assurance include the following:

A. Holtec's Cost Estimates incorrectly assume that Holtec's projected Contingency Allowance is sufficient
B. Holtec's assertion that there is sufficient money in the DTF incorrectly assumes that decommissioning costs will not rise faster than inflation
C. Holtec's estimated spent fuel management costs are based on the unlikely and unexplained assumption that DOE will remove all spent fuel by 2063.
D. Holtec's Cost estimates are based on the incorrect assumption that the Pilgrim site is essentially "clean."
E. Holtec's cost estimates incorrectly assume radiological occupational and public dose based on outdated documents.
F. Holtec's cost estimates incorrectly assumed incorrect socioeconomics costs of decommissioning.

G. Holtec’s cost estimate assumptions ignore the cost of managing Low Level Radioactive Waste
H. Holtec’s LTA ignores potential costs from fires in structures, systems and components containing radioactive and hazardous material.
I. Holtec’s DCE fails to consider costs likely to result from climate change impacts on the site.
J. Holtec cost estimates fail to consider that a significant shortfall in funds could occur if DOE requires repackaging of spent nuclear fuel into new containers approved by DOE for transportation.
K. Holtec fails adequately to consider delays in the work schedule leading to increased costs for overhead and project management.
L. Holtec’s cost estimates fail to consider pending state-law requirements that will decrease funds available for radiological decontamination
M. Holtec’s DCE fails to consider DTF funds that would not be available if NRC does not grant Holtec’s exemption request to use the DTF for spent fuel management costs and site remediation.
N. Holtec’s DCE fails to consider the economic consequences if the license exemption requests filed by Entergy may not be transferable to Holtec adding additional costs.
O. Holtec’s DCE fails to consider the likely adverse health impacts expected in special pathway receptor populations and for that matter in the general public
P. Holtec’s costs estimates ignore the costs of mitigating radiological accident(s)
Q. Holtec’s LTA Provides No Assurance that Holtec Pilgrim and HDI Will Have the Funds Necessary to Decommission the ISFSI.

Each of these is discussed in detail below.

A. Holtec’s Cost Estimates incorrectly assume that Holtec’s projected Contingency Allowance is Sufficient

10 CFR 72.30(b)(2)(ii) requires that “a decommissioning plan must contain … [a]n adequate contingency factor.” Holtec’s PSDAR and LTA do not do so.

According to Holtec's PSDAR, "a Contingency Allowance of 17 percent was determined to be reasonable for the Pilgrim decommissioning project [and] is incorporated into the estimate of License Termination, Spent Fuel Management and Site Restoration costs presented herein." (PSDAR, Sec. 4.5)

Seventeen percent of Holtec's estimated License Termination, Spent Fuel Management and Site Restoration costs is $237 million. However, Holtec admits that (PSDAR, Sec. 4.5) that its "Contingency Allowance is … expected to be fully consumed [and] does not account for inflation or escalation of the price of goods and services over the course of the project."

In other words, Holtec does not expect that any of the projected $237 million "contingency allowance" would be available to cover decommissioning costs that will increase faster than the rate of inflation, spent fuel management costs incurred after 2062, site restoration costs resulting from the fact that the Pilgrim site is not clean, or any of the other myriad costs that Holtec's DCE and PSDAR have essentially ignored.

By any realistic measure, Holtec's has no "rainy-day fund" or "decommissioning plan" that "contain[s] … [a]n adequate contingency factor," and does not provide financial assurance.

B. Holtec's Assertion that there is Sufficient Money in the DTF Incorrectly Assumes that Decommissioning Costs Will Not Rise Faster Than Inflation

In the PSDAR and LTA, Holtec Pilgrim and HDI assumed that the Decommissioning Trust Fund would grow at the rate of 2% more than inflation. Pilgrim Watch will not quarrel with this assumption.

However, they also assumed, incorrectly and with no apparent basis or justification as required by 10 CFR §72.30(b)(3), that decommissioning costs will <u>not</u> rise faster than inflation:

> “The decommissioning costs presented in this report are reported in 2018 dollars. Escalation of future decommissioning costs over the remaining decommissioning project life-cycle are excluded.” (PSDAR, p. 19; DCE, pp. 7, 18)

This assumption is simply wrong. Both the history of decommissioning costs and the NRC’s own statements show precisely the contrary – that *decommissioning costs will increase more than inflation.*

This one fact alone demonstrates that the Decommissioning Trust Fund does not, and will not, provide any basis for Holtec’s claim that “the existing decommissioning trust funds provide the appropriate basis for the financial qualifications of Holtec Pilgrim.” (LTA Enclosure 1, pg. 16)

The NRC’s own Questions and Answers on Decommissioning Financial Assurance specifically state that decommissioning costs will increase at a rate higher than the rate of inflation, and that over a period of only 20 years (40 years less than the 60 year period allowed for decommissioning) there will be 2.5 to 5.6 times increase in costs, i.e., *the annual increase in costs will be 5% to 9%* - much more than the average annual 3.7% rate of inflation:[9]

> “The NRC formulas represent the cost to decommission today, not in the future. *Due to rising costs, the future value of decommissioning will be much larger than the NRC formula calculated today.* For example, using the range of cost escalation rates based on NUREG - 1307, the increase in cost over a 20-year license renewal period would range from 2.5 to 5.6 times today’s estimated cost, not counting costs that are not included in the formula, such as soil contamination. *The rates of increase in decommissioning cost are higher than general inflation*.”

[9] Over the past 60 years, the average annual US rate of inflation has been about 3.7 percent. Over the last 10 years it has been about 1.55%; in 2018 it was 2.44%.

Callan Associates produces an annual analysis and report of decommissioning funds and costs. Its 2015 Nuclear Decommissioning Funding Study[10] said that "Total decommissioning cost estimates have risen 60% since 2008," an annual rate of about 6%, and that "2014 decommissioning cost estimates rose approximately 11% from the previous year." 2015 Nuclear Decommissioning Funding Study, p. 3.

Callan's "2018 Nuclear Decommissioning Funding Study"[11] reported that decommissioning costs increased by about 80% (from $55 billion to $89 billion, *an annual rate of about 5 percent)* from 2008 and 2017. Study, pp. 3, 9. During the same period, inflation was about 1.3% annually; in other words, decommissioning costs increased at a *rate of 3.7% over inflation*.[12]

In short, both the NRC statements and Callan's historical analysis are clear that there is no rational support for HDI's assumption that decommissioning costs will not increase faster than inflation. The only rational and factually supportable assumption would be that decommissioning costs will increase at an annual rate that is at least about 4% higher than the rate of annual inflation.[13]

The unavoidable conclusion is that essentially any "more than inflation" increase in decommissioning costs will wipe-out HDI's "left-over" $3 million. Any increase in

[10] https://www.callan.com/library/2015
[11] https://www.callan.com/library/2018
[12] It is important to note that Callan reported that total estimated decommissioning costs decreased about 2.5% in 2017. The decrease was attributed to the fact that a number of reactors had decided to decommission rapidly after shut-down (as Holtec plans for Pilgrim.) rather than waiting until the end of the NRC's permitted 60-year period (as reflected in Entergy's PSDAR). See https://www.powermag.com/data-shows-nuclear-plant-decommissioning-costs-falling/. This decrease is an overall number; and it does not reflect any decrease in a reactor's site- specific decommissioning costs.
[13] The NRC's predicted 5% to 9% increase in costs is 2.3% to 5.3%. more than the 3.7% inflation average, e.g., an average of about 3.3% more than average inflation and is 3.3% to 7.3% more than inflation over the past 10 years Callan's eight-year history reports an average increase in decommissioning costs of about 4.4% more than inflation.

decommissioning costs in the ranges that the NRC (5% to 9%) predicts, and Callan (5% to 6%) reports, would result in a hundreds of millions of dollars shortfall in the DTF.

For example, the HDI decommissioning cost estimate ("DCE"') required by 10 CFR §72.30(b)(2) projects accomplishing most decommissioning (what the PSDAR calls "License Termination") in six years – 2019-2024 – at a total 2018-dollar cost of about $577 million. Holtec projects accomplishing most site restoration in 5 years - 2021-2025 – at a cost, again in 2018 dollars, of about $39 million.

Based on Pilgrim Watch's calculations, if decommissioning costs were to increase at an annual rate of 4% more than inflation, a fair assumption based on NRC predictions and Callan Associates reports the 2018-dollar cost of decommissioning/license termination from 2019-2024 would increase to about $672 million, $95 million more than the DCE projection; and the 2018-dollar cost of site restoration from 2021-2025 would be about 47 million, $8 million more than the DCE allows.[14]

Holtec's projected spent fuel management cost estimates total a little more than $500 million, about $221 million in 2019-2021 and an average of about 6.7 million a year from then to 2063. If these costs were also to increase at an annual rate of 4% over inflation, Pilgrim Watch's calculations show that the cost of spent fuel management from 2019-2063 would increase to over $950 million, $450 million more than the DCE allows.

In sum, if decommissioning costs increase as the NRC and Callan say they will, at an annual rate of 4%, the cost of decommissioning Pilgrim will be about a billion dollars more than

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[14] Because HDI plans to decommission at the front end rather than almost 60 years after Pilgrim shuts down, its actual 2018-dollar costs of decommissioning are far less than Entergy's actual decommissioning costs would be.

Holtec projects, even if none of the other shortcomings in Holtec's assumptions discussed below are taken into account.

Pilgrim Watch does not doubt that others, based on different assumptions of periods of time or the annual increase in decommissioning costs, might make somewhat different assumptions. But the bottom line is clear – decommissioning costs will (as the NRC has said) increase faster than inflation, neither Holtec Pilgrim nor HDI has or will have access to sufficient assets, and neither Holtec nor HDI is financially responsible or has provided the necessary financial assurance.

Pilgrim Watch does not say that a decommissioning cost estimate must be precise. But for the NRC regulations and procedures to make any sense at all, a decommissioning cost estimate must be based on reasonable and justifiable assumptions. Holtec's assumption that decommissioning costs would not rise faster than inflation was not reasonable or justified. See 10 CFR 72.30(b)(3) that requires "Identification of and justification for using the key assumptions contained in the DCE."

For this reason alone, absent enforceable agreements by Holtec, Holtec and Holtec Pilgrim to provide significant additional financial assurance, such as a large Parent Company Guarantee (PCG) and agreement to put all recovery from the DOE into the DTF, the LTA cannot properly be granted.

C. Holtec's estimated spent fuel management costs are based on the unlikely and unexplained assumption that DOE will remove all spent fuel by 2063.

The spent fuel management costs projected in Holtec's PSDAR, DCE and LTA depend on Holtec's at least three unexplained and unlikely assumptions: that DOE will remove all spent fuel from the Pilgrim site by 2062. (Holtec PSDAR, pgs., 23 and 58), that Holtec will never have to repair or replace any failed casks or pads, and that Holtec will not to repackage spent nuclear fuel into new containers approved by DOE for transportation**.**

All of these assumptions are unjustified.

Holtec assumes "DOE will commence acceptance of PNPS's spent fuel in 2030 and, assuming a maximum rate of transfer described in the DOE Acceptance Priority Ranking & Annual Capacity Report (Reference 10), the spent fuel is projected to be fully removed the Pilgrim site in 2062, consistent with the current DOE spent fuel management and acceptance strategy (References 9 and 10)." DCE, p. 23.

Pilgrim Watch will assume *arguendo* that, once fuel transfer begins, it will proceed at "a maximum rate of transfer described in … Reference 10), and that removing spent fuel from Pilgrim will then take 32 years to accomplish.

But there is no reasonable basis for Holtec's assumption that "DOE will commence acceptance of PNPS's spent fuel in 2030;" that assumption is not justified by either of the two references upon which it rests. Reference 9 is concerned only with the rate of transfer to a site that has been constructed and is ready to accept spent nuclear fuel. The only Holtec reference that is concerned with when such a site might actually exist is Reference 10, DOE's January 2013 *Strategy for The Management and Disposal of Used Nuclear Fuel and High -Level Radioactive Waste*. ("DOE Strategy"). [15]

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15 https://www.energy.gov/sites/prod/files/Strategy%20for%20the%20Management%20and%20Disposal%20of%20Used%20Nuclear%20Fuel%20and%20High%20Level%20Radioactive%20Waste.pdf

Holtec ignores that the DOE strategy is simply "a framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing, and disposing of used nuclear fuel" (DOE Strategy, p. 1). It does even try to guess by when an interim or geologic repository might actually exist.

Holtec's assumption that "DOE will commence acceptance of PNPS's spent fuel in 2030 appears to rest on the DOE Strategy's statement that:

> With *appropriate authorizations from Congress*," "The Administration currently *plans to implement a program over the next 10 years* that:
>
> - Sites, designs and licenses, constructs and begins operations of a pilot interim storage facility by 2021 with an initial focus on accepting used nuclear fuel from shut-down reactor sites;
> - *Advances toward the siting and licensing of a larger interim storage facility to be available by 2025* that will have sufficient capacity to provide flexibility in the waste management system and allows for acceptance of enough used nuclear fuel to reduce expected government liabilities; and
> - *Makes demonstrable progress on the siting and characterization of repository sites* to facilitate the availability of a geologic repository by 2048.

The keys here are:

- "With appropriate authorizations from Congress"
  To Pilgrim Watch's knowledge there have been no such authorizations in the 6 years since the DOE Strategy was announced. None are mentioned in Holtec's LTA.

- "plans to implement a program over the next ten years"
  Six years have passed since the DOE Strategy was announced. To Pilgrim Watch's knowledge, no such plans have been implemented. None are mentioned in Holtec's LTA.

- Advances toward the siting and licensing of a larger interim storage facility to be available by 2025.
  To Pilgrim Watch's knowledge, the only "advances" are that Holtec's 2017 application, to construct and operate a consolidated interim storage facility in New

Mexico is pending before the NRC; and Interim Storage Partners' (ISP) application for a site in Andrews County Texas. There is nothing in Holtec's LTA to indicate that either of these facilities will be sited, licensed or available by 2025.

- "Makes demonstrable progress … to facilitate the availability of a geologic repository by 2048."
  Holtec's LTA mentions no such progress. The only "progress" of which Pilgrim Watch knows is that a number of bills relating to the storage of spent nuclear fuel have been introduced in Congress.

In short, the DOE Strategy is nothing more than a "plan" or "goal" for which "legislation is needed in the near term" (DOE Strategy, pp.13-14)

The fact that the Strategy provides no rational basis for Holtec's assumption that "DOE will commence acceptance of PNPS's spent fuel in 2030" is confirmed by later statements in the Strategy:

- Full implementation of this program will require legislation to enable the timely deployment of the system elements noted above. DOE Strategy. p. 2

- This Strategy provides a basis for the Administration to work with Congress. DOE Strategy. p. 4

- The Administration's goal is to have a repository sited by 2026; the site characterized, and the repository designed and licensed by 2042; and the repository constructed, and its operations started by 2048. DOE Strategy. p. 8

The unavoidable fact, that Holtec's LTA avoids, is that no one knows when there will be an interim or permanent repository for spent nuclear fuel ready and willing to accept Pilgrim's.

Congress has not passed enabling legislation. There is significant opposition to both Holtec's planned interim site in New Mexico and ISP's in West Texas. Yucca has made no progress; there are hundreds of contentions opposing it,[16] along with anticipated lawsuits along transportation routes- from cities, states, environmental groups, such as NIRS[17]

Nuclear waste may be stored at Pilgrim indefinitely, despite the unsupported assumption in the PSDAR (section 5.1) that it will leave the site beginning in 2030 and ending in 2062.

NRC's 2014 Continued Storage Rule discussed onsite storage for 100 years;[18] that would be until 3019 for Pilgrim, 57 years longer than Holtec presumed. Holtec's PSDAR (pp. 60-61) estimated on-going spent fuel storage costs at $ 7.2 million per year in 2018 dollars. Even if one were to assume that there would be no greater-than-inflation increase in those costs, those 57 additional years of spent fuel storage would add more than $380 million to Holtec's estimated cost. These additional costs far exceed the $3 million leftover in the DTF in Holtec's cost estimates.

Again, Holtec's LTA provides no explanation of its assumption that there will be no spent fuel on Pilgrim's site after 2062, or any financial assurance that Holtec will be able to pay reasonably expected spent fuel management expenses.

Holtec's LTA also makes the unexplained assumptions that Holtec will never have to repair or replace any failed casks or pads, and not will not have to repackage spent nuclear fuel into new containers approved by DOE for transportation**.** The PSDAR and DCE include no costs for repair or repackaging.

Regardless of when DOE may take title to Pilgrim's spent fuel, the dry casks will have to be repacked so that they can be transferred to either an interim or permanent repository. In addition, and both before and after 2062, Holtec will be responsible for repairing or replacing any

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16 http://www.state.nv.us/nucwaste/licensing/Contentions_NV.pdf.
17 Civilian Nuclear Waste Disposal, Congressional Research Service, Sept 6 2018. (https://fas.org/sgp/crs/misc/RL33461.pdf); www.NIRS.org
18 https://www.nrc.gov/waste/spent-fuel-storage/wcd.html

dry casks that might fail; and will be required to replace both the casks and ISFSI storage pad if spent fuel remains on site every 100 years. The first casks will be 100 years old less than 100 years from now.

Holtec will be required to continue paying ISFSI maintenance and security as long as spent fuel is on site, perhaps indefinitely. Also, the canisters may corrode and leak and are vulnerable to acts of malice, adding considerable costs for mitigation. (See discussion regarding severe accidents at pp. 66-80)

Spent Fuel Management is expensive. Holtec's LTA makes unwarranted assumptions about the likely costs, and for this additional reason fails to provide assurance that Holtec Pilgrim and HDI are financially responsible and will have the funds required for decommissioning.

D. Holtec's Cost estimates are based on the incorrect assumption that the Pilgrim site is essentially "Clean."

Holtec and the NRC appear to agree that an accurate cost estimate is necessary for a safe and timely plant decommissioning (NUREG-0586, Supplement 1, p. 68; DCE, p.55.)

But, at the time it filed its PSDAR and DCE, Holtec had not characterized the Pilgrim site, and had done essentially nothing to determine what contaminants are on the site or what it would cost to remove them.

Rather, Holtec admits that its cost estimates are based on nothing more than what appears to be an initial cursory "review of PNPS decommissioning records required by 10 CFR 50.75(g) records." Holtec says it will review of what it calls Entergy's "Historic Site Assessment (HSA)" sometime in the future:

> In the time leading up to, and immediately following, the equity sale/closure and license transfer, the following activities will be performed: … Review of the Historical Site Assessment (HSA) to support the identification, categorization, and quantification of radiological, regulated, and hazardous wastes in support of waste management planning." Holtec PSDAR pp 8-9

> "During Period 1, planning and preparing for the prompt decontamination and dismantlement of PNPS will begin by completing the following activities: … Conduct site characterization activities so that radiological, regulated, and hazardous wastes are identified, categorized, and quantified to support decommissioning and waste management planning." Holtec PSDAR, pp 10-11

> "In the time leading up to and immediately following the equity sale and license transfer, preparations for performance of decommissioning will include …. Facility characterization so that radiological, regulated, and hazardous wastes are identified, categorized and quantified to support decommissioning and waste management planning. DCE, p. 14

But the PSDAR and DCE make clear that Holtec prepared its cost estimates without having "conduct[ed] site characterization activities so that radiological, regulated, and hazardous wastes are identified, categorized, and quantified to support decommissioning and waste management planning." (PSDAR, pp 10-11) Even Holtec admits that site characterization must be completed as part of "planning and preparing for the prompt decontamination and dismantlement of PNPS," (PSDAR, pp 10-11) and that site characterization is essential for Holtec "to supplement plant historical knowledge and the PNPS" and further the identification, categorization, and quantification of radiological, regulated, and hazardous wastes." PSDAR, p. 11.

What this makes clear is at least four critical facts:

1. At the time it filed its PSDAR and DCE, Holtec simply did not know what radiological and hazardous waste now exist on Pilgrim's site.

2. Holtec's PSDAR and estimated costs are not based on the actual condition of the Pilgrim site.

3. Holtec's PSDAR does not, provide the "accurate decommissioning cost [that is] necessary for a safe and timely plant decommissioning." (NUREG-0586, supra.)

4. Holtec had no basis or justification for its assumption that there is "no significant contamination" on the Pilgrim site (DCE, p. 22).

Holtec quite properly does not attempt to justify its assumption that its PSDAR provided accurate cost estimates based on the Entergy HSA that Holtec had not reviewed when it filed its PSDAR and DCE. To the extent that Holtec might seek to justify its assumed PSDAR cost estimates based on "Pilgrim plant data and historical information obtained from Energy Nuclear Operations" (PSDAR summary, p. 7), that assumption would be similarly unjustified. The PSDAR is effectively silent as to what any such "data and historical information" might be and Holtec admits that the data and information both need to be supplemented by future site characterizations (PSDAR, p. 11) and confirmed (DCE, p. 22).

Holtec also could not properly assume that the site is "clean" based on a GEIS and SEIS that are old, incomplete, and inaccurate [19] The PSDAR and LTA provide no basis for concluding, as required by 10 CFR 50.82(a)(4) (i), that the environmental impacts associated with site-specific decommissioning activities are bounded by these old impact statements.

[19] The SEIS NUREG-1437, Supplement 29, Volume 1, Section 7.1, Decommissioning, concludes that "there are no impacts related to these issues beyond those discussed in the GEIS. For all of these issues, the staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted."

The PSDAR and LTA rely on the 2002 GEIS and Pilgrim's 2007 SEIS. The GEIS (2002) is a generic document and is outdated by 17 years. A site-specific environmental analysis is required since no two reactor sites and history are identical, but the SEIS (outdated by 12 years) was simply a review by NRC staff of documents provided by Entergy and involved no actual analysis by NRC of soil or liquid samples.[20]

The GEIS, SEIS and Holtec incorrectly assume that the Pilgrim site is essentially clean. However, and as discussed in detail below, the GEIS, SEIS, PSDAR and LTA ignore both old information regarding the reactor's history, and new and significant information since the GEIS and SEIS were published. Holtec's attempt to bound environmental impacts with the old GEIS and SEIS suggests that Holtec knows that that a new site assessment and environmental impact statement would show that the PSDAR and DCE do not include any rational or acceptable estimate of the costs of clean-up.

Whether by design, or because it does not know what contamination actually exists, Holtec's PSDAR made the unjustified apparent assumptions that Pilgrim's site was essentially clean, and that its PSDAR needed to provide only a "relatively small amount of the decommissioning cost … for the demolition of uncontaminated structures and restoration of the site. (p. 62). The only Site Restoration costs its PSDAR foresees "are those costs associated with conventional dismantling, demolition, and removal from the site of structures and systems after confirmation that radioactive contaminants have been removed. (p 19); an assumption again based absent information about the actual condition of the Pilgrim site.

[20] Audit of NRC's License Renewal Program (OIG-07-A-15), September 6, 2007

As shown below, it is clear that the limited information on which Holtec based its PSDAR estimates did not include important relevant facts and overlooked significant contamination.

The actual cost of decontaminating and restoring the Pilgrim site will be more, probably far more than Holtec has estimated. At Connecticut Yankee, for instance, previously undiscovered strontium-90 contributed to the actual cost of decommissioning Connecticut Yankee being *double* what had been estimated. During the decommissioning of Maine Yankee, the licensee encountered pockets of highly contaminated groundwater dammed up by existing structures, leading to cost increases. The Yankee Rowe site in Massachusetts incurred significant cost increases during decommissioning when PCBs were discovered in paint covering the steel from the vapor container that housed the nuclear reactor, as well as in sheathing on underground cables. Other plants have also ended up costing much more than what was estimated for decommissioning- Diablo Canyon 1&2, San Onofre 2&3.[21]

The NRC cannot properly conclude that the DTF provides financial assurance or that Holtec-Pilgrim or HDI are financially responsible. To do so, the NRC would have to ignore that Holtec's decommissioning cost estimates are based on unsupported assumptions, ignore the actual conditions of the Pilgrim site, accept that there will be no complete or accurate radiological and hazardous materials site investigation and characterization, and accept that there would be certainty regarding what is required or what it will cost to clean-up the site.

[21] *See, e.g.*, NRC, SECY-13-0105, at Summary Table, available at http://www.nrc.gov/reading-rm/doc-collections/commission/secys/2013/2013-0105scy.pdf (listing estimated costs under the NRC's minimum formula ranging from $438 million, counting the River Bend Station as one unit, to over $1 billion).

For Holtec to show that Holtec Pilgrim and HDI are financially responsible, and to provide the required financial assurance, it must conduct a new and complete site characterization, and submit a cost estimate based on the actual conditions at Pilgrim.

Examples of Radiological/ Hazardous Contamination[22]

Pilgrim Watch will not speculate what Entergy "knows," and may have told Holtec, about radiological and hazardous contamination. What is not speculative, and would be confirmed by a new site assessment, is that there is significant contamination at Pilgrim, that Holtec's assumption that the site is "clean" is not justified, and that the estimated costs in its PSDAR and DCE are inaccurate.

The LTA, PSDAR, DCE and GEIS and SEIS ignore that, over the years, Pilgrim has buried contaminated materials on site and has had many leaks and releases. Pilgrim opened with bad fuel and no off-gas treatment system; later it blew its filters prompting Mass Dept. Public Health to do a case-control study of adult leukemia testing the hypothesis that the closer you lived or worked at Pilgrim there would be an increase in leukemia. The hypothesis was confirmed.[23] Due to these leaks, many lethal radionuclides, including for example tritium, manganese54, cesium-137, Sr-90, I-131, cobalt-60, and neptunium[24] were found in the surface water, groundwater, and soils at Pilgrim at levels exceeding "background" levels.

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[22] These examples are discussed in more detail in the following documents: Jones River Watershed Association's Entergy's Legacy of Contamination at Pilgrim Nuclear Power Station Draft 3, section vi-vii, Exhibit 3; and, Pilgrim Watch Intervention Pilgrim License Renewal Application, Contention 1 filings, NRC Adams Electronic Hearing Docket.

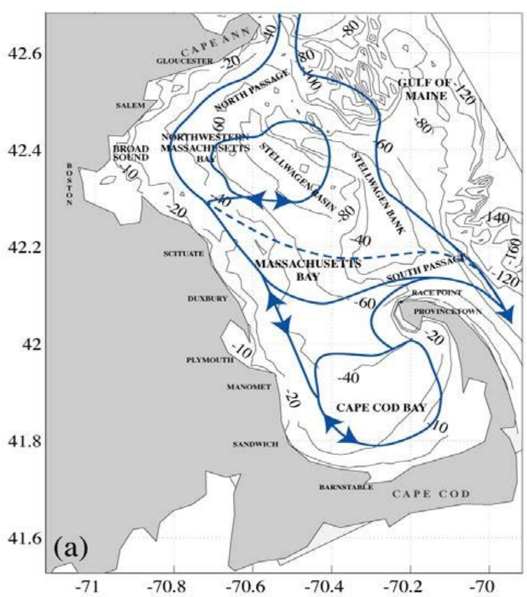
[23] *The Southeastern Massachusetts Health Study* [published in the *Archives of Environmental Health*, Vol. 51, p.266, July-August 1996 (Pilgrim Motion Request for Hearing and Motion to Intervene, May 2006, Exhibit F-2, NRC Adams, EHD, Pilgrim LR, Pleadings 2006)

[24] Neptunium releases into Cape Cod Bay reported by Stuart Shalat, who worked for the contractor doing the re-fueling in the 1980s. Stuart Shalat, Sc.D. Associate Professor Robert Wood Johnson Medical School, Exposure Science Division, Environmental and Occupational Health Sciences Institute

Holtec nowhere recognizes the existence of these contaminated materials, the costs of removing them, or the costs of remediating portions of the site that they have contaminated. None of the documents Holtec relied upon bound environmental impact.

Pilgrim is sited beside Cape Cod Bay. Due to the topography of the site, contaminants will leak into the Bay. Massachusetts and Cape Cod Bays are tidal. NUREG-1427, 2.2.5.1 Contaminants leaking into the bay during an incoming tide will be drawn into Plymouth, Duxbury and Kingston Bays, up the rivers, such as the Jones, Eel, and Bluefish Rivers and into estuaries; in the outgoing tide they will flow into and circulate around Cape Cod Bay and beyond.

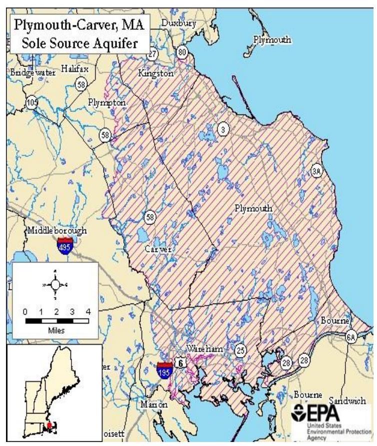
Currents will move the contamination. The figure below, provided by the Massachusetts Water Resources Authority,[25] show circulation in Massachusetts and Cape Cod Bays.



25 Physical and Biological Oceanography of Massachusetts, Wendy Leo, Rocky Geyer, Mike Mickelson http://www.mwra.state.ma.us/harbor/enquad/pdf/ms-085_04.pdf

The dispersion of discharges also varies seasonally. From information available, it is reasonable to predict that currents, winds and tides would spread contaminants around Cape Cod Bay, into Massachusetts Bay and eventually south down the outside arm of Cape Cod, impacting also rivers, streams, and other waterways that are connected to the larger bodies of water. The impact, actual or perceived, would significantly affect public safety, the marine ecology and economy.

Also, Pilgrim's site is above the Plymouth-Carver Aquifer, the second largest aquifer in the state that provides drinking water to several towns and supports many natural resources.



Historic poor management, releases and contamination ignored

As stated, Pilgrim opened in 1972 with bad fuel and no off-gas treatment system, a technology that attempts to reduce the radioactivity of gasses that are removed from the radioactive steam that turns the turbine in the condenser. It did not install the off-gas system until 1977. This prompted Mass Dept. Public Health (MDPH) to do a case-control study of adult leukemia testing the hypothesis that the closer you lived or worked at Pilgrim there would be an increase in leukemia. The hypothesis was confirmed.[26]

MDPH in its introduction to its study said that, "Pilgrim which began operations in 1972**,** had a history of emissions during the 1970's that were above EPA guidelines as a result of a fuel rod problem." [27] Due to the leaks, many lethal and long-lived radionuclides were identified. For example, neptunium (2.14 million years) was reported by Dr. Stuart Shalat who worked as a contractor at Pilgrim and now at Rutgers University.[28]

Subsequently Pilgrim blew its filters in 1982, prompting authorities to send suited personnel into neighboring communities to take samples. The Annual Radiological Environmental Reports indicate considerable offsite contamination. If there was offsite contamination, the only reasonable assumption is that there was contamination onsite also.

For example, the Pilgrim Nuclear Power Station Environmental Radiation Monitoring Program Report No. 15 January 1 through December 31, 1982 - Issued April 1983 Boston Edison Co. (Exhibit 3) shows the results from testing various media offsite for radionuclides. As an example, the milk sampling report on page 30. says that:

> Milk samples were collected at two locations during 1982- Kings Residence (Station 22-12 miles W), and Whitman (Station 21- 21 miles NW)

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[26] The Southeastern Massachusetts Health Study published in the Archives of Environmental Health, Vol. 51, p.266, July-August 1996

[27] The Southeastern Massachusetts Health Study 1978-1986 Martha Morris, Robert Knorr Principal Investigators Exec Summary, Background, pg.,1

Cs-137: Kings Residence in late June concentrations 1,000,000 times in excess of concentration expected (The contamination level of the June 11, 1982 spent resin incident was up to 100,000 dpm/100 cm2.)

Gamma isotopic analysis identified primarily long-lived radionuclides including Cs 137 and the Whipple farm (1.5 mi -SSW); lettuce 31.9 pCi/kg and Cs-137 concentrations > 1,000,000 times what would be expected at both locations.

Boston Edison, Pilgrim's previous owner, attributed the high readings to the cow's pregnancy; Tufts University Veterinary School explained cows delivered calves not cesium.

Other media sampled show similarly high readings. NRC Inspection Reports from June-July 1982 document and confirm the releases of resin.[29]

Due to these and subsequent releases discussed below, many lethal radionuclides were found in the surface water, groundwater, and soils at Pilgrim at levels exceeding "background" levels. These releases prompted additional health studies that were published in the 1980's thru 2004 showing radiation linked diseases in communities near Pilgrim. (See Pilgrim Watch Motion to Intervene Pilgrim LRA, Contention 5, (5.3.3) and Exhibits F-2-F-4, Adams Library, Accession NO. ML061630125.)

All of this is "overlooked" in Holtec's LTA, PSDAR and DCE and in Entergy's old GEIS and SEIS. The LTA cannot properly be approved until Holtec has conducted a new site assessment "to further the identification, categorization, and quantification of radiological,

[29] **NRC Inspection Reports June-July 1982:** June 11, 1982 Preliminary Notification of Event Or Unusual Occurrence -PNO-1-82-42 Subject: release of Resin; June 11, 1982: Licensee Event Report June 9, 1982;June 14, 1982: Preliminary Notification of Event or Unusual Occurrence-PNO-1-82-42A Subject: release of spent resin update; July 7, 1982: Inspection Report by NRC of PNPS dated July 7, 1982;July 8, 1982: NRC Memo: Generic Implications of the Release of Spent Resin (Available NRC Adams, microfische).

regulated, and hazardous wastes" (PSDAR 2.4.2, p. 11), as included in its PSDAR and DCE the costs or removing all wastes and contamination on site and has provided assurance that it has the financial ability to do so.

Contamination onsite is exacerbated by Pilgrim's long history of mismanagement[30]

From 1986- 1989, Pilgrim shut down due to a series of mechanical failures. (*US nuclear plants in the 21st century: The risk of a lifetime*. Report by the Union of Concerned Scientists, David Lochbaum, May 2004.) In May 1986, The NRC identified Pilgrim as one of the most unsafe facilities in the U.S. (*Pilgrim on list of worst -run nuclear plants,* Boston Globe, A Pertman, May 23, 1986.)

In January of 1988, a 5,000 cubic yard pile of dirt containing radioactive cesium-134, cesium-137, and cobalt-60 was found in a parking lot near the reactor. (*Radioactivity was detected in dirt pile near Pilgrim*, Boston Globe, L. Tye, January 21, 1988)

In February 2014, the NRC identified Pilgrim as one of the nine worst performing nuclear reactors in the U.S. In September 2015, Pilgrim was moved to NRC's lowest safety ranking (Category 4), joining 2 other Entergy reactors. (http://www.nrc.gov/info-finder/reactors/pilg/special-oversight.html) December 2016, Special Inspection:[31] NRC unintentionally "leaked" an email containing NRC report covering the November 28 - December 8 inspection. Written by Donald Jackson, the lead inspector, this report included a long list of

[30] Pilgrim Chronology 1967- 2015, https://jonesriver.org/legal/pilgrim-chronology-1967-2015/ Exhibit 4
[31] http://www.capecodtimes.com/news/20161206/nrc-email-pilgrim-plant-overwhelmed

flaws at the plant that were observed during the initial week of the inspection. In the email, Donald Jackson, said that, "***"The plant seems overwhelmed just trying to run the station."***

The list of Pilgrim failures mentioned in the email were:

- failure of plant workers to follow established industry procedures,
- broken equipment that never gets properly fixed,
- lack of required expertise among plant experts,
- failure of some staff to understand their roles and responsibilities, and
- a team of employees who appear to be struggling with keeping the nuclear plant running.
- We are observing current indications of a safety culture problem that a bunch of talking probably won't fix."

The report suggests that Pilgrim was a "plant (that) seems overwhelmed just trying to run the station," increasing the probability of leaks that will require cleanup and more money than anticipated. Pilgrim remains in the lowest safety ranking in 2019.

Contamination resulting from Buried Pipes and Tanks

Pilgrim's buried pipes and tanks are made of materials that corrode - concrete, carbon steel, stainless steel, titanium and external coatings and wraps are susceptible to age-related and environmental degradation.[32] The pipes and tanks are old and subject to age-related degradation.[33] Some of the pipes and tanks contain industrial process, radionuclides in

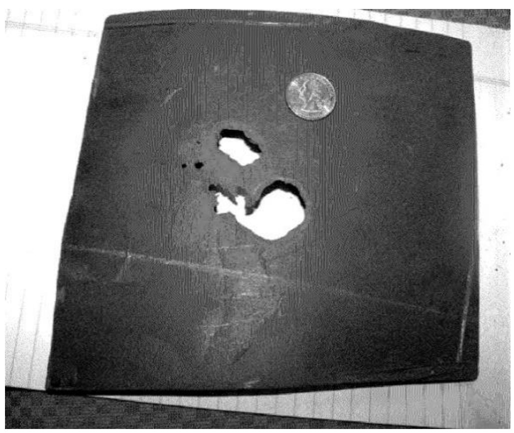
[32] See for full discussion buried pipes and tanks, Pilgrim Watch was admitted to Pilgrim's License Renewal Proceeding and filed Contention 1, *The Aging Management Plan Does Not Adequately Inspect and Monitor for Leaks in All Systems And Components That May Contain Radioactively Contaminated Water*. We refer the ASLB to the file, especially Pilgrim Watch Post Hearing Findings of Fact and Conclusion of Law, June 9.2008, Docket 50-293

[33] Pilgrim Watch Post-Hearing Findings of Fact Conclusions of Law, June 9, 2008,11

wastewater and embedded in the pipe/tank. Degradation of these components can lead to leaks of toxic materials into groundwater and soils.

According to Entergy during the LRA proceeding, all of Pilgrim's underground pipes are within 10 feet of the surface, which is well within reach of groundwater and salt water flooding.[34]

The photograph below shows a hole in one of Pilgrim's buried SSW discharge pipes.[35] There is every reason to assume that it is not the only one.



There has been no adequate program for inspecting buried pipes and tanks. NEI's Buried Piping/Underground Piping and Tanks Integrity Initiative, that began in 2009, is voluntary. The NRC's monitoring programs are not only voluntary; they are also inadequate. They are based on inaccurate assumptions about corrosion and an insufficient inspection regime. Rather than requiring a comprehensive approach to deal with leaks of radioactive materials from buried pipes and tanks, the NRC has allowed Pilgrim to take piecemeal approach by conducting

[34] Ibid,
[35] Pilgrim License Renewal Application Proceeding, Entergy submissions, PillR0045779-Pill R00457

physical inspections only in those rare instances when pipes are dug out for other purposes and by only fixing sections of failed pipe.

These voluntary processes have allowed leaks and spills to go unnoticed,[36] and are incapable of identifying failures in, or ensuring the integrity of, decades-old piping systems.[37]

Holes such as that shown above leak, and neither Holtec nor the NRC can properly assume that it is the only one. Holtec must be required to conduct a new site assessment to determine the extent of leakage,, i.e., so that " radiological, regulated, and hazardous wastes are identified, categorized and quantified to support decommissioning and waste management planning "(CDE, p. 14), and to include in its PSDAR and DCE the costs of removing contamination around buried pipes and tanks and a showing that the DTF has sufficient funds to do so.

Tritium and Other Radionuclides in Groundwater[38]

The Pilgrim Tritium in Groundwater Program has shown significant radioactive contamination (tritium, cesium-137, cobalt-60, manganese-54) in Pilgrim's soil. Neither this contamination nor the cost of removing it, is mentioned in Holtec's PSDAR or DCE.

Prior to 2007, Pilgrim had no groundwater monitoring program. What had leaked into and contaminated the site is unknown; but what was found when wells were put into place in 2007 strongly suggests perhaps considerable prior leakage.[39]

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[36] Ibid, 55-59
[37] Ibid, 37
[38] https://www.mass.gov/lists/environmental-monitoring-data-for-tritium-in-groundwater-at-pilgrim-nuclear-power-station; https://jonesriver.org/pilgrim-contamination/ ; and see Attachment 2 for a full report.
[39] Only four wells were installed in 2007.

Since 2007, Entergy's own groundwater well tests, and MDPH's analysis of split samples, have confirmed Pilgrim is leaking radionuclides and contaminating the soil and groundwater. Entergy's tests have shown levels ranging from non-detect levels to as high as 70,000 piC/L.[40] EPA's standard for tritium in drinking water is 20,000 piC/L; California's goal is 400 piC/L. Every year since 2007 there has been at least one well with levels well above the upper limit of normal background levels. In all but 2 years, there was at least one well above Mass DPH's screening level of 3,000 piC/L and 3 years with at least one well above EPA's safe drinking water standard of 20,000 piC/L.

By April 2012 an underground line leading to the discharge canal had separated. The leak was accidently discovered when tritiated water was found coming out of an electrical junction box inside the facility.[41] Five months later, groundwater tests results showed high tritium levels (4,882-5,307 pCi/L), in one of the wells and this was suspected to be related to the separated underground line. [42] Soil sampling was done, and preliminary results showed tritium, cobalt-60, and cesium-137 at levels above normal (1,150 picocuries per kilogram (pCi/kg) of cobalt-60 and 2,490 pCi/kg of cesium-137). [43]

By January 2014 – nine months after the leak was originally discovered – excessive levels of tritium (69,000-70,000 pCi/L), the highest in Pilgrim's recorded history, were detected near a basin that collects radiologically contaminated water and ultimately sends it to Cape Cod

[M] Mass MDPH Pilgrim Nuclear Power Station (PNPS) tritium in groundwater monitoring wells, January 2014
[41] Mass MDPH Pilgrim Nuclear Power Station (PNPS) tritium in groundwater monitoring wells, May 2013
[42] Mass MDPH Pilgrim Nuclear Power Station (PNPS) tritium in groundwater monitoring wells, Sept 2013
[43] Split sample testing at MDPH

Bay. Entergy and Mass DPH continued their investigations, unsure of the sources of leakage, and performed no cleanup.[44]

More than a year later, Pilgrim's newest groundwater wells continued to show elevated levels of tritium and final soil testing results show levels of tritium, manganese-54, cesium-137, and cobalt-60 at various depths near the separated underground line above typical background levels.[45]

According to Mass DPH in its August 2014, November 2014, and May 2015 Groundwater Monitoring Reports, tritium levels continued to trend higher in some of Pilgrim's wells and radionuclides (e.g., Cobalt-60 and Cesium-137) were still being found in soils on the site. The November report describes new samples showing high levels of tritium in air conditioning condensate at the facility (3,500-4,000 piC/L).

In addition to the contaminating spills described above, at least five other historic spill events that have been reported on the Pilgrim site since 1976. [46] For instance, in 1988 there was a spill of low-level radioactive waste water. The radioactively contaminated liquid waste was discovered inside a process building and had leaked outside the building. An estimated 2,300 gallons of contaminated water spilled, and 200 gallons leaked outside the building from under a door. About 2,500 square feet of asphalt and 600 cubic feet of sand and gravel were contaminated. [47]

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[44] Mass DPH. Pilgrim Nuclear Power Station (PNPS): tritium in groundwater monitoring wells. Jan. 2014.
[45] Mass DPH. Pilgrim Nuclear Power Station (PNPS): tritium in groundwater monitoring wells. May 2014.
[46] Mass DPH. Pilgrim Nuclear Power Station (PNPS): tritium in groundwater monitoring wells. Aug 2014.
[47] Mass DPH. 1988. Investigation of Radioactive Spill at Pilgrim on November 16, 1988. Prepared by Radiation Control Program.

Soil samples obtained in 2014 as part of a larger tritium leak investigation showed high levels of manganese-54, cesium-137, and cobalt-60 at various depths near a separated underground line above typical background level.[48]

For the non-drinking water reporting standards for cobalt-60 (5.27 years half-life), cesium-137 (30.17 years half-life), and manganese-54 (312 days half-life), see Table4. For drinking water, EPA's MCL for these radionuclides is 4 mrem per year. For cesium-137, the level found in Pilgrim's soil was 38x more than the reporting standard. For cobalt-60, the level found in Pilgrim's soil was more than 8x the reporting standard.

Table 4. EPA's maximum contaminant level (MCL), non-drinking water reporting standards, and the average concentration assumed to yield 4 mrem per year for select radionuclides

Radionuclide	EPA's MCL for Drinking Water	Non-Drinking Water Reporting Standards (Entergy/NRC)[73]	Average Concentration assumed to yield 4 mrem/year
Tritium	4 mrem/year	30,000 piC/L	20,000 piC/L
Manganese-54	4 mrem/year	1,000 piC/L	300 piC/L
Cesium-137	4 mrem/year	50 piC/L	200 piC/L
Cobalt-60	4 mrem/year	300 piC/L	100 piC/L

[48] *Ibid*. at 67

Absent a new and complete site assessment, there is no certainty of the sources of Pilgrim's leaks. Likely candidates include leaks from the Condenser Bay Area, seismic gaps, a crack in the Torus Floor, materials and soil from subsequent construction left on site, and age-related degradation. Extreme temperatures and storms, salt water and air, corrosive chemicals, and intense radiation most likely have caused components to thin and crack, compromising the structural integrity of the facility and underground/buried pipes.[49]

During the past 12 years in which the licensee has known about the leaks, nothing has been done to clean up the soil. The cost of removing all on-site radioactive tritium and other radioactive materials that have been released into the soil must be included in Holtec's LTA, PSDAR and CDE. They have not been.

Once again, Holtec must be required to conduct a new site assessment to determine the extent of leakage, i.e., so that "radiological, regulated, and hazardous wastes are identified, categorized and quantified to support decommissioning and waste management planning. (DCE, p. 14) Unless it does so, it will not be able to include in its PSDAR and DCE an accurate estimate of the costs of removing contamination around buried pipes and tanks, to show that the DTF has sufficient funds without which there can be no financial assurance, or to show that Holtec Pilgrim and HDI are financially responsible.

[49] Pilgrim Watch, Contention 1, The Aging Management Plan Does Not Adequately Inspect and Monitor for Leaks in All Systems and Components That May Contain Radioactively Contaminated Water; Pilgrim Watch Post Hearing Findings of Fact and Conclusion of Law, June 9.2008, Docket 50-293, NRC Adams, ML 081650345

Stormwater Drains and Electrical Vaults[50]

Pilgrim has twenty-five electrical vaults on site. The vaults and other sources of untreated water are pumped out to four stormwater drains and directly into Cape Cod Bay. Over the past twenty-five years, Pilgrim's storm drains were supposed to be tested twice per year for pollutants, oil, grease, total suspended solids, as required by EPA. But Entergy failed to conduct sampling over roughly the past 10 years, according to the EPA.[51] Sampling has only occurred three times since January 2009, and only three of the four storm drains were tested. There is also a fifth "miscellaneous" storm that has never been tested, apparently because it is inaccessible.

When storm drain sampling was done (from 1998-2007), certain parameters were exceeded on many occasions.[52] Initial sampling by EPA from only seven vaults found total suspended solids, cyanide, phenols, phthalates, PCBs, antimony, iron, copper, zinc, lead, nickel, cadmium, hexavalent chromium. Lead, copper, and zinc exceeded marine water quality criteria.

Monitoring results from standing water in storm water manholes, junction boxes, and electrical duct banks show radioactive materials at tritium levels as high as 1,500 pCi/L in some storm water manholes and up to 4,500 pCi/L in some electrical duct bank manholes. [53] Even though these levels may be low in relation to the excessive levels in the groundwater, they still exceed the background level of 5-25 piC/L for surface water and 6-13 piC/L for groundwater.

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[50] https://jonesriver.org/getfile/ccbw/2012/10/RAD-REPORT_2017.07.18_VS3.pdf (Attachment 3)

[51] EPA's 2016 Draft Authorization to Discharge under the National Pollution Discharge Elimination System (Fact Sheet)

[52] page 31 of EPA's 2016 Draft Authorization to Discharge under the National Pollution Discharge Elimination System (Fact Sheet)

[53] Ibid, at 22

Unless and until Holtec performs a new and complete site analysis, the actual extent of drain and vault radioactivity and the costs or removing it will not be known

Holtec reliance on Entergy's environmental radiological monitoring data

Holtec says that "PNPS will continue to comply with the Offsite Dose Calculation Manual, Radiological Environmental Monitoring Program, and the Groundwater Protection Initiative Program during decommissioning (LTA, 1.4 Additional Considerations). The reports are not reliable, according to NRC's own task force, likely raising costs during decommissioning and negatively impacting public health.

The NRC's Groundwater Contamination (Tritium) at Nuclear Plants Task Force Final Report, September 1, 2006[54] identified "that *under the existing regulatory requirements* the potential exists for unplanned and unmonitored releases of radioactive liquids to migrate offsite into the public domain undetected." (LLTF Executive Summary ii)

Section 3.1.4 of the LLTF recommended that the following regarding the Radiological Environmental Monitoring Program.

- The radiation detection capabilities specified in the Buried Tanks and Pipes Monitoring Program (BTP) are the 1970's state-of-the-art for routine environmental measurements in laboratories. More sensitive radiation detection capability exists today, but there is no regulatory requirement for the plants to have this equipment. The guidance primarily focuses on gamma isotopic analysis of environmental material and on tritium in water

[54] NRC's Groundwater Contamination (tritium) at Nuclear Plants Task Force Final Report, September 1, 2006; https://www.nrc.gov/docs/ML0626/ML062650312.pdf

samples. There are minimal requirements for analyzing environmental samples for beta- and alpha -emitting radionuclides. P.18

- The regulatory guidance provides built in flexibility in the scope of the REMP. It …allows licensees to reduce the scope of and frequency of the sampling program, without the NRC approval, on historical data...if a licensee's environmental samples have not detected licensed radioactive material in several years, then the licensee typically reduces the scope and sample frequency of the associated environmental pathway. NRC inspections have observed reductions in the scope and frequency of licensee programs… p.19

The Task Force concluded (Conclusions 3.2.1.3):

- (2) The radiological effluent and environmental monitoring program requirements and guidance largely reflect radioactive waste streams that were typically from nuclear plant operation in the 1970's. The issues that were important then, i.e. principal gamma emitters giving the significant dose, while still important today, have been joined by new issues. Today, as a result of better fuel performance, and improved radioactive source terms reduction programs, a new radioactive waste stream has evolved. The new liquid radioactive source terms are made up of a lower fraction of gamma emitting radionuclides and a higher fraction of weak beta emitters. The NRC program has not evolved with the changes in technology and industry programs
- (3) The REMP has allowed licensees significant flexibility to make changes to their programs without NRC prior approval. The historical trend has been to reduce the scope of the program. There is no guidance on when the program needs to be expanded.

Its Recommendations:

(1) The NRC should revise the radiological effluent and environmental monitoring program requirements and guidance consistent with current industry standards and commercially available radiation detection technology.

(2) Guidance for the REMP should be revised to limit the amount of flexibility in its conduct. Guidance is needed on when the program, based on data or environmental conditions, should be expanded.

(6) The NRC should require adequate assurance that spills and leaks

will be detected before radionuclides migrate offsite via an unmonitored pathway.

The LLTF stated further in its Executive Summary ii that, …relatively low leakage rates may not be detected by plant operators, even over an extended period of time."

Hazardous Waste Dumping[55]

Numerous sources have reported that drums of hazardous waste were buried on the Pilgrim site in the 1980s and/or 1990s.[93] Barrels of chemical waste were reportedly shipped from New Jersey were buried along Power House Road (Pilgrim's access road) and then over-planted with evergreen trees.

[55] https://jonesriver.org/getfile/ccbw/2012/10/RAD-REPORT_2017.07.18_VS3.pdf (Attachment 3)

This contamination was the subject of public comments to the NRC in 2007.[56] These comments are reported in Pilgrim's "Generic Environmental Impact Statement for License Renewal:" "The public, NRC officials and Entergy staff also are well aware of burials off the Access Road." The NRC responded to this comment by saying that the comment was noted and would be kept on file to "ensure that these types of areas will be identified during plant decommissioning." Now is the time to identify "these types of areas," and to provide the costs of remediation.

In October 2015, community members filed a formal "Chapter 21E"[57] report to MassDEP about these hazardous materials. The Chapter 21E report triggers regulations that requires the agency to investigate and report its findings to the public. MassDEP followed up a year later saying that without more evidence, such as samples showing contamination, or pictures of stuff being buried, there is nothing more the agency could do.

[56] Bramhall W. October 2013 Pilgrim Coalition Newsletter. <http://archive.constantcontact.com/fs159/1109945140723/archive/1115182751860.html> Accessed 11/24/2015

[57] 21E is a classification given to hazardous material disposal sites by MassDEP.

There may be additional waste buried that requires investigation. Holtec must conduct the necessary investigations, and its decommissioning costs must include whatever is required to make the site clean.

E. Holtec's cost estimates incorrectly assume radiological occupational and public dose based on outdated documents.

Holtec used the 2002 GEIS to base its decision on radiological impacts to the public and workers. (Holtec PSDAR 5.1.8) The outdated GEIS in turn ***used risk coefficients per unit dose recommended*** by the International Commission on Radiological Protection (ICRP) issued in 1991- **28 years ago**.

Holtec's assumed dose ignored new and significant information. The National Academies BEIR VII report (2006),[58] the most recent report from the National Academies, found far greater health impacts than the 1991 ICRP. BEIR VII found mortality rates for women from exposure to radiation were 37.5 % higher than a BEIR 1990 report and that the impact of allowable radiation standards on workers was twice that estimated in 1991. Allowable dose during decommissioning must be reduced to reflect BEIR VII, new and significant information supported by the Commonwealth, which will inevitably result in an increase in Holtec's estimated decommissioning costs.

BEIR VII lifetime risk model predicts that approximately **1 person in 100 would be expected to develop cancer (solid cancer or leukemia) from a dose of 0.1 Sv [10,000 millirem] above background**" (BEIR VII, p. 8) shows the risk from a lifetime (70 year) exposure to various

[58] https://www.nap.edu/catalog/11340/health-risks-from-exposure-to-low-levels-of-ionizing-radiation

levels of radiation. Exposure to 25 millirem/year equates to a lifetime cancer risk of 175/100,000; whereas a 10 millirem/year equates to a lifetime cancer risk of 70/100,000-a significant difference when considering that EPA permits only 1 in 100,000.

EPA's and DEP's risk level goal for a **mixture of chemicals** is a lifetime cancer incidence risk of **1 in one hundred thousand (1/100,000).** DEP's risk level goal for **one chemical** is lifetime cancer incidence risk of **1 in a million (1/1,000,000)**

Lifetime Cancer Risk estimates based on BEIR VII are much higher. The Table below, based on BEIR VII's conclusion that "the BEIR VII lifetime risk model predicts that approximately **1 person in 100 would be expected to develop cancer (solid cancer or leukemia) from a dose of 0.1 Sv [10,000 millirem] above background**" (BEIR VII, p. 8) shows the risk from a lifetime (70 year) exposure to various levels of radiation.

BEIR VII explains that "Because of limitations in the data used to develop risk models, risk estimates are uncertain, and estimates that are a factor of two or three larger or smaller cannot be excluded."

Exposure-millirem/year	**Lifetime Cancer Incidence Risk**	**Cleanup Standards**
10 millirem/year	70/100,000 (0.7/1,000)	Current Massachusetts Limit for Unrestricted Use for its licensees; requested limit to Holtec
25 millirem/year	175/100,000 (1.75/1,000)	NRC Limit for Unrestricted Use site
100 millirem/year	700/100,000 (7/1,000)	NRC & Mass. Limit for Restricted Use site
500 millirem/year	3,500/100,000 (35/1,000)	

Cancer Incidence Risk resulting from whole body exposure is about <u>2 times mortality risk</u>	**Reproductive disorders** occur at lower levels of radiation exposure than cancer

F. Holtec's cost estimates incorrectly assumed incorrect socioeconomics costs of decommissioning.

Holtec's PSDAR (5.1.12) acknowledged that decommissioning PNPS is expected to result in negative socioeconomic impacts. But it relied on outdated 2002 GEIS findings.

A 2015 University of Massachusetts-Amherst study, commissioned by Plymouth and ignored by Holtec, found that the economic impact on Plymouth alone would be almost $500 million, and that there would be a more than $100 million impact on the rest of the region:[59]

<u>Pilgrim Station in 2014 Direct Impacts</u>

$440 Million Wholesale value of electricity produced
586 - Pilgrim Station workforce
$77 Million Wages and benefits for plant workforce
$60 Million Spending for goods and services in southeastern Massachusetts
$17.4 Million State and local taxes and other payments
$300K Charitable giving by Entergy and Pilgrim Station

<u>Secondary Impacts</u>

$105 Million Additional economic output attributable to Pilgrim Station
589 - Additional jobs created by Pilgrim Station
$30 Million Wages and benefits paid by additional jobs

<u>Town of Plymouth Impacts</u>

190 - Pilgrim Station employees living in Plymouth
$24.9 Million Wages and benefits paid to plant employees
$58.5 Million Value of real estate owned by plant employees
$10.3 Million Municipal revenue from Pilgrim Station
$950K Municipal revenue from employee property tax payments
$23K - $61K Municipal revenue from biennial refueling outages

[59] The Pilgrim Nuclear Power Station Study: A Socio-Economic Analysis and Closure Transition Guide Book Jonathan G. Cooper, University of Massachusetts – Amherst, April 2015 (https://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1080&context=larp_ms_projects)

Regional Impacts

> Pilgrim Station's operation stimulates additional economic activity in Plymouth and Barnstable counties. The in-region spending by both Pilgrim Station vendors and plant employees creates an additional $105 million in regional economic output.
>
> Nuclear power plant employment is stable and well-compensated, enabling employees to attain home ownership.

Additional socioeconomic impacts include that that Radiological Emergency Planning contributions from the licensee to towns and the state will drop despite the fact that the risk is not eliminated. MEMA's Nuclear Preparedness 2016 budget with costs assessed to licensees of operating reactors in the Commonwealth was $482,901.[60] Towns in Pilgrim's emergency planning zone negotiate funding with Entergy. 2016 receipts ranged from $85,000/yr. to $295,000/yr. plus monies for training and equipment. If the towns do not continue to receive funds, training and equipment, they will be unable to provide the protection that their community needs, deserves and that they want to provide. Pending legislation in the state legislature would require that the licensee fund post shutdown emergency planning expenses.

Also, actual or perceived contamination in Cape Cod Bay and surrounding waterways will have regional impact on coastal economies. For example, on commercial seafood, marine transportation, coastal tourism and recreation, marine science and technology, marine-related construction and infrastructure, and real estate.

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[60] Massachusetts Emergency Management 2016 Nuclear Preparedness Budget $482,910 (2015 spending $ 447,176) costs assessed on operating reactor licensees in the Commonwealth http://www.mass.gov/bb/h1/fy16h1/brec_16/act_16/h88000100.htm

G. Holtec's cost estimate assumptions ignore the cost of managing Low Level Radioactive Waste

In addition to spent nuclear fuel, Class A, B and C Radioactive Waste (LLRW) is also stored at Pilgrim, some of it in containers along the shoreline. Pilgrim's LLRW, for example, includes the control rods, resins, sludge, filters, and will include the entire nuclear power reactor when it is eventually dismantled,[61] and is another potential source of contamination onsite and to Cape Cod Bay resulting in significant increased costs.

The figure below shows the shoreline location of Entergy's storage of LLRW. It shows that Pilgrim has about 20-30 white storage containers located approximately 30 feet away from the coastal bank. It will be susceptible to the impacts of climate change-sea level rise, storm surges, flooding. According to the NRC, only one of these containers currently contains Greater-than-Class- C waste, the most toxic type of LLRW, and the others are presently empty. We assume they will be filled during decommissioning.

[61] High-Level Dollars Low-Level Sense, Arjun Makhijani, A Report of The Institute for Energy and Environmental Research, 1992

In the photograph, the white containers are for Low Level Radioactive Waste. To the right of the storage area is the LLRW building that compress materials to store or for shipment.

The LLRW waste will remain on the Pilgrim site, like the high-level radioactive waste, until an offsite repository accepts Pilgrim's LLRW. Massachusetts does not belong to any compacts.

For Class B and C radioactive waste Holtec's PSDAR (at 13) says that "an import petition will be filed with the Texas Compact Commission to gain approval for disposal of out of compact waste at the Waste Control Specialists (WCS) facility in Texas." Acceptance may well be more expensive than to compact members, and timely acceptance is not guaranteed to non-compact members. Potential higher fees and prolonged onsite storage are not factored into Holtec's cost estimates. Huge amounts of Class A, B and C radioactive waste will result during the decommissioning process, and likely more of these storage containers pictured will be used.

H. Holtec's LTA ignores potential costs from fires in structures, systems and components containing radioactive and hazardous material.

During decommissioning, there is a serious concern about fire protection for the structures, systems, and components containing radioactive and hazardous materials in storage. Capabilities to monitor for and respond to these kinds of toxic emergencies are not addressed by Holtec. Fire in a building would result in increase in mixed waste adding to cost and also impact worker and potentially public health. Holtec's cost estimates should include the cost of an adequate study to locating sites where potential masses of contaminated material susceptible to ignition might accumulate during decommissioning and the costs of forestalling a fire by removing or limiting heat, oxygen, and/or fuel. Also, Holtec's cost estimates should include costs for training and equipment for offsite fire personnel that are counted on in an emergency.

I . Holtec's DCE fails to consider costs likely to result from climate change impacts on the site.

Holtec's DCE, and its contingency allowance, similarly do not take into account any estimates of increased costs resulting from climate change. The documents that Holtec relied upon do not even mention climate change.

New and significant information, ignored by Holtec, show that climate change impacts on the site are likely to decrease Holtec's capability to cleanup and to cause delay in work schedule, increacing costs.[62]

Based on current levels of greenhouse gas prediction, the UN Intergovernmental Panel on Climate Change (IPCC) 2018 Report[63] shows sea levels will rise more rapidly; severe storms will occur more frequently, coinciding with high tides and exceptional wave heights; rising groundwater tables, and floods more severe. The National Geographic (December 16, 2015) identified Pilgrim among the 13 nuclear reactors impacted by sea-level rise and predicted that, "if significant protective measures were not taken, these sites could be threatened."[64]

As climate change impacts get worse and decommissioning commences in 2019 storm drains and stormwater testing (discussed above) will become even more critical, as these outlets could become further conduits for pollution into Cape Cod Bay. Increased flooding and storm

[62] See for an overview of climate change impacts on Pilgrim that includes a critique of Entergy's flood hazard evaluation report (AREVA Report) by Florida-based Coastal Risk Consulting (CRC), Analysis of AREVA Flood Hazard Re-Evaluation Report: Pilgrim Nuclear Power Station, Plymouth, MA ("CRC Report") https://jonesriver.org/ecology/climate/

[63] https://research.un.org/en/climate-change/reports

[64] http://news.nationalgeographic.com/energy/2015/12/151215-as-sea-levels-rise-are-coastal-nuclear-plants-ready/

intensity, sea level rise, and rising groundwater tables could increasingly flush contaminates present in groundwater and soil into Cape Cod Bay.

The numerous negative impacts resulting from climate change not considered by Holtec that would likely increase decommissioning costs include:

- Increased flooding and storm surge resulting from climate change is likely to cause corrosion of underground piping, tanks and structures and subsequent leakage. And corrosion and potential leakage of the Greater-than-Class-C waste and low-level waste containers located close to Cape Cod Bay.
- Radiological and hazardous waste contamination, if not cleaned up quickly, will be washed out into Cape Cod Bay unable to be retrieved.
- Severe storms and flooding can result in loss of offsite power and potential damage to the diesel generators located by the bay. The spent fuel pool requires electricity to operate its safety systems. In Fukushima extreme weather conditions at the site prevented workers to perform necessary mitigating actions. Severe storms and flooding could present conditions at Pilgrim so that workers could not perform their jobs.

Once again, Holtec's DCE does not include any estimates of the costs of removing these contaminants; and these costs are not included in Holtec's contingency allowance.

J. Holtec cost estimates fail to consider that a significant shortfall in funds could occur if DOE requires repackaging of spent nuclear fuel into new containers approved by DOE for transportation.

The U.S. Government Accountability Office reported in 2014: "per DOE, under provisions of the standard contract, the agency does not consider spent nuclear fuel in canisters to be an acceptable form for waste it will receive. This may require utilities to remove the spent nuclear fuel already packaged in dry storage canisters". [U.S. Government Accountability Office, Spent Nuclear Fuel Management: Outreach Needed to Help Gain Public Acceptance for Federal Activities That Address Liability, GAO-15.141, October 2014, P. 30.[65]

Repackaging spent fuel so that it can be transported off-site will be expensive, but that cost has been ignored by Holtec.[66]

According to Task Order 12: Standardized Transportation, Aging, and Disposal Canister Feasibility Study, Option 3 (1 PWR/1 BWR/13.1/U) it will cost $34,311,000,000 to repackage 140,000 MT; the per ton cost is $245,078.00.[67]

A BWR assembly has an average weight of 281 Kg, and thus, the per assembly cost is ~$68,887.00. At the Pilgrim station, repackaging could add $261,770,600 to the predisposal costs, not included in D&D funds or Holtec's estimates. Moreover, DOE 's Standard Contract under the Nuclear Waste Policy Act requires reactor operators to pay for this additional expense from the NWPA fund. This per-assembly cost above is based on one large centralized repackaging facility handling the entire projected SNF inventory. If reactor operators have to establish repackaging

[65] http://www.gao.gov/assets/670/666454.pdf]
[66] Robert Alvarez analysis for Pilgrim 2018, https://ips-dc.org/ips-authors/robert-alvarez/
[67] https://curie.ornl.gov/system/files/documents/not%20yet%20assigned/STAD_Canister_Feasibility_Study_AREVA_Final_1.pdf (p-5-2)

infrastructures at decommissioned or closed reactors, the lack repackaging becomes an even more expensive proposition.

K. Holtec fails adequately to consider delays in the work schedule leading to increased costs for overhead and project management.

Cleaning up previously unknown radiological or nonradiological contamination will delay the work schedule escalating costs. There inevitably will be other delays as there always are in large projects. HDI is new to decommissioning.

L. Holtec's cost estimates fail to consider pending state-law requirements that will decrease funds available for radiological decontamination.

There are a number of now-pending Massachusetts laws and regulations that, if passed or adopted, they would result in additional costs to Holtec and reduce the funds available for decommissioning.

- **Radiological Cleanup Standard:** The Massachusetts of Public Health issued a MEMO requesting that the licensee agree to a <10/ml/rem/yr. and < 4 ml/rem/yr. for drinking water sources from all pathways. Holtec's PSDAR says that they are considering singing the MEMO. If Holtec does not agree, Massachusetts is considering a regulation that, after decommissioning is complete and the NRC has released the site, would require the site to meet this lower standard. State Legislation filed 01/19 by Senator deMacedo (S. 183579) and Representative Muratore (HD 1752) includes a < 10 ml/rem/yr. standard and less than 4ml/rem yr. for drinking water pathways.
- **Pending state-law requirements for funding offsite emergency planning and MDPH's Environmental:** H.181704, filed by Representatives Cutler and LaNatra require a licensee to fund offsite emergency planning post shutdown.

H183826 filed by Representatives Meschino and Cutler requiring an increase in funding for MDPH monitoring.

- **Pending state- law requiring a $25 million annual fee to establish a Postclosure Trust Fund:** SD 598 Senator Patrick O'Connor.

M. Holtec's DCE fails to consider DTF funds that would not be available if NRC does not grant Holtec's exemption request to use the DTF for spent fuel management costs and site remediation.

HDI submitted a request to NRC to allow the DTF to be used for spent fuel management and site restoration costs; and asked NRC to approve the request by the time of the transfer. (Enclosure 2, LTA) If approved, it would divert hundreds of millions of dollars from the Decommissioning Fund for non-decommissioning uses, and greatly increase the chances of a shortfall in the Decommissioning Fund that could leave the site radiologically contaminated.

Entergy has requested additional exemptions. Any licensee amendment request granted to Entergy would have been based on Entergy's, not Holtec's, analyses when the request was submitted and would not apply to Holtec. Holtec likely will file similar license amendment request(s) and would be subject to a hearing because the request is directly related and intertwined with the LTA.

N. Holtec's DCE fails to consider the economic consequences if the license exemption requests filed by Entergy may not be transferable to Holtec adding additional costs.

Entergy has requested additional exemptions. Any licensee amendment request granted to Entergy would have been based on Entergy's, not Holtec's, analyses when the request was submitted and would not apply to Holtec. Again, Holtec must file its own license amendment request(s) and would be subject to a hearing because the request is directly related and intertwined with the LTA.

O. **Holtec's DCE fails to consider the likely adverse health impacts expected in special pathway receptor populations and for that matter in the general public**

Holtec's unfounded reliance on Entergy's old environmental monitoring reports is the basis for its conclusions regarding environmental justice. The PSDAR says that, "Potential impacts to minority and low-income populations would mostly consist of radiological effects. Based on the radiological environmental monitoring program data from PNPS, the SEIS determined that the radiation and radioactivity in the environmental media monitored around the plant have been well within applicable regulatory limits. As a result, the SEIS found that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations (i.e., minority and or low-income populations) in the region as a result of subsistence consumption of water, local food, fish, and wildlife." (LTA, 5.1.13 Environmental Justice)

As discussed in the foregoing at pp. 47-49, the NRC's Groundwater Contamination (tritium) at Nuclear Plants Task Force Final Report, September 1, 2006[68] identified "that *under the existing regulatory requirements* the potential exists for unplanned and unmonitored releases of radioactive liquids to migrate offsite into the public domain undetected." (LLTF Executive Summary ii)

[68] NRC's Groundwater Contamination (tritium) at Nuclear Plants Task Force Final Report, September 1, 2006; https://www.nrc.gov/docs/ML0626/ML062650312.pdf

P. Holtec's costs estimates ignore the costs of mitigating radiological accident(s)

Radiological accidents are neither remote, speculative nor worst case scenarios; instead they are reasonably foreseeable. HDI (PSDAR, 5.19) concludes that the impacts of PNPS decommissioning on radiological accidents are small and are bounded by the previously issued GEIS.

NRC staff concluded in the SEIS that "there are no impacts of severe accidents beyond those discussed in the GEIS." (SEIS 5.1.2).

Both the GEIS and the SEIS concluded the risk from severe accidents is small. They improperly ignore vulnerability and the impact of a spent fuel pool accident or ISFI accident on decommissioning costs and public safety and environment.

However, as we show, the spent fuel pool and dry casks are vulnerable and the potential consequences huge. Therefore, the potential of a radiological incident must be properly analyzed and then Holtec set monies aside for potential mitigation.

The GEIS and SEIS, that Holtec relied upon, do not bound environmental impacts or radiological accidents, for at least the following reasons.

- The GEIS was published in 2002 and is outdated. [69] For example, the BEIR VII Report and the University of Massachusetts Socio-Economic Impact Report had not yet been published, and many of the examples of radiological/hazardous contamination had yet to occur.
- The GEIS was also flawed. In assessing offsite related accidents, the GEIS only considered: seismic events, aircraft crashes (not small aircraft, that pose the more realistic and serious

[69] Comments on The US Nuclear Regulatory Commission's Waste Confidence Generic Environmental Impact Statement, Dr. Gordon Thompson, December 19, 2013.

threat), tornadoes with high winds; and fuel related accidents-fuel drops and loss of water, ignoring the greatest danger the partial loss water in the spent fuel pool.

- The GEIS and SEIS both ignore the escalating terrorist threat with US infrastructure, including nuclear reactors as targets. Both predate awareness of an increased threat from cyber-attacks,[70] drones, and electromagnetic attacks.[71] For example, while reactor safety systems are more or less isolated from an outside cyberattack, a hack knocking out the electrical grid system would shut down power to all reactor safety systems. On-site emergency power generators are then vulnerable to insider and armed assault seeking to cause a meltdown. Loss of electric grid may disenable security cameras.
- The GEIS and SEIS incorrectly assert that the environmental impact of accident-induced or attack-induced pool fires is SMALL. That assertion is incorrect. The environmental impact is LARGE due to the large inventory of radionuclides in the pool.
- Perhaps because Pilgrim's ISFSI did not yet exist, the GEIS and SEIS totally ignore ISFSI radiological accidents. The casks are vulnerable to attack and releases from cracks caused by age, corrosion, manufacturing defects. Each cask contains a huge amount of radioactivity and each cask contains >1/2 the Cesium-137 released at Chernobyl. The environmental impact is LARGE.
- Emergency plans are insufficient now during operations; and will be far less sufficient when funding is reduced and then completely cut to offsite departments- MEMA, local EPZ towns

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[70] December 15, 2017, NRC issues license amendment to Pilgrim to change the implementation date for cyber security *upgrades from December 15, 2017 to December 31, 2020 – after Pilgrim is closed**.***

[71] ***Electromagnetic Defense Task Force*** (***EDTF***): ***2018 Report***. (Source: US Air Force's Air University; issued Nov 28, ***2018***). From 20–22 August ***2018***, Air University Website, LeMay Papers http://www.defense-aerospace.com/articles-view/release/3/198020/report-highlights-gaps-in-us-electro_magnetic-capabilities,

and host communities. For example, the sirens are coming down and recent disasters have demonstrated cell and standard phones cannot be relied upon.

- Also, the GEIS and SEIS use an inappropriate arithmetic definition of radiological risk, probability times consequences. Holtec's and the GEIS' environmental impact determination with respect to severe accidents, is a risk assessment - the product of the probability and the consequences of an accident. This means that a high consequence low-probability events, like a severe accident, will result in a small impact determination, because the probability is determined to be low so no matter how severe the consequences they will be trivialized.
- The risk and consequences are considered low because NRC had not in 2002, or now, conducted the comprehensive empirical and analytic inquiry needed to thoroughly understand probability and consequences; they inappropriately assume that the risk environment remains static; and both rely on false assumptions and ignore "inconvenient truths."

Spent Fuel Pool Accidents Ignored by the GEIS, SEIS and Holtec - Examples

Fuel Handling Accidents: Accidents can and do happen, even with single-proof cranes. For example at Vermont Yankee (May 2008)[72] the brakes on the crane didn't function properly and it almost dropped a load of high-level radioactive waste during the first removal of spent fuel assemblies from the spent fuel pool into a cask for dry cask storage outside of the plant. According to reports at the time, the brakes on the crane did not respond properly because its electrical relays were "out of adjustment." The cask came within 1½ inches of the floor, when the operator wanted it to stop four inches above the floor. Another mishap or near-miss failure with a single-proof crane

[72] https://www.reformer.com/stories/nrc-reviews-vy-safety-system-after-crane-failure,65923

occurred at Palisades March 18, 2006 attirbutable to worker error[73]. Human error, either in operations or manufacturing, is not considered, as it needs to be, in the GEIS, SEIS or by Holtec.

Canister Drop in the pool: If a cask is dropped in the pool and the pool floor is breached, there are many safety-related components located on the floors below the spent fuel pool which could be disabled that could simultaneously initiate an accident and disable accident mitigation equipment. If a hole is punched in the pool floor or walls and water is lost simply to the top of the assemblies, a pool fire will likely follow.

A canister drop can lead to a crack in the canister- especially a concern with HBU fuel. Each canister contains over ½ the Cesium-137 released at Chernobyl.

Causes of Spent Fuel Pool Cooling Water Loss. There are many potential causes of "a significant draw-down of the spent fuel pool." Water could be lost from a spent-fuel pool through leakage, boiling, siphoning, pumping, displacement by objects falling into the pool, or overturning of the pool. These modes of water loss could arise from events, alone or in combination, that include: (i) acts of malice by persons within or outside the plant boundary; (ii) an aircraft impact; (iii) an earthquake; (iv) dropping of a fuel cask; (v) accidental fires or explosions.[74]

Partial drain-down: The GEIS did not recognize different consequences of both a full drain-down and a partial drain-down. This is an important omission because total drainage of the pool is not the most severe case of water loss. In a partial drain-down the presence of residual water would block air convection, e.g., by blocking air flow beneath the racks.[75] Previously, in

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[73] https://www.nirs.org/press/03-20-2006/

[74] Environmental Impacts of Storing Spent Fuel and High-Level Waste from Commercial Nuclear Reactors: A Critique of NRC's Nuclear Waste Confidence Decision and Environmental Impact Determination, Gordon Thompson, February 6, 2009; Comments on the US Nuclear Regulatory Commission's Draft Consequence Study of a Beyond Design Basis Earthquake Affecting Spent Fuel Pool for a US Mark 1 Boiling Water Reactor, Gordon Thompson, August 1, 2013

[75] http://www.environmental-defense-institute.org/publications/Cover.Ltr.Thompson.NRC.SNF.Short.pdf

filings made during a 2002 license-amendment proceeding, NRC staff assumed that a fire would be inevitable if the water fell to the top of the racks.

Pool Fire Ignition Time: NRC Staff and industry today incorrectly claim that that it would take, a minimum of 10 hours for the fuel in a boiling water reactor aged 10 months or in a PWR for 16 months to heat to zirconium ignition temperature; and that the 10- hour period "allows for the licensee to take onsite mitigation measures or, if necessary, for offsite authorities to take appropriate response actions using an all-hazards approach emergency management plan."

NRC staff assumes that the minimum delay time for SNF ignition can be calculated by further assuming that an SNF assembly is perfectly insulated thermally. The NRC analysis provides no basis for assuming these assumptions are correct.

A 10-hour minimum delay time for BWR SNF aged 10 months is potentially plausible. But that is not the whole story. For example, an attack scenario could cause partial drain-down and a local radiation field precluding access; and a fuel handling accident during transfer from pool to dry casks - such as a cask drop.

Mitigation. Contrary to NRC's and Holtec's current estimate, 10 hours is not a guaranteed enough time to put out a spent fuel fire. An attack scenario could rapidly cause partial drain-down and result in a local radiation field that precludes access to the fire. There is no basis for assuming that a site's Flex program to provide supplemental water will be sufficient. For example, Pilgrim Watch and the Union of Concerned Scientists showed that Pilgrim's Flex plan to provide supplemental water had little to no probability of working, especially in severe storm conditions.[76]

[76] Presentation to NRC: Status of Fukushima Lessons, Union of Concerned Scientists, David Lochbaum, July 31, 2014, https://www.nrc.gov/reading-rm/doc-collections/commission/slides/2014/20140731/lochbaum-20140731.pdf

Evacuation. Ten hours is not enough time for offsite authorities to take appropriate response actions using an all-hazards approach emergency management plan. NRC's emergency preparedness recommendation, option EP-2, essentially eliminates offsite emergency preparedness at Level 2 (pool storage) and Level 3 (ISFI storage). In addition, the notification requirement to State and Local Governmental is changed from 15 minutes to 60 minutes; and public alert and notification systems and Evacuation Time Estimates (even with a significant population change) are not required. As early as Level 2, challenging drills and exercises involving hostile action said not to be warranted, and ORO participation in radiological drills and exercises would no longer be required. Even with offsite emergency plans in place during operations, a timely (less than 10 hour) evacuation is not possible[77]; therefore, absent offsite preparedness there is no way that 10-hours would allow offsite authorities to evacuate the population.

ISFSI Accidents the GEIS, SEIS and Holtec Ignore - Examples

Holtec assumes that, "No contamination or activation of the ISFSI pads is assumed. As such, only verification surveys are included for the pad in the decommissioning estimate." (PSDAR, pg.,25) They do not consider, as they should, something going wrong.

Causes of a Dry Cask Canister Rupture. Holtec ignores the potential of a dry cask canister rupture. Casks, although safer than spent fuel pool storage, are vulnerable to attack,

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; Pilgrim Watch Comment (11.16.2014) Waterways Application, No. W14-414, Cape Cod Bay, Plymouth, Plymouth County, Ch 91 Application of Entergy Nuclear Operations, Inc. Pilgrim Nuclear Power Station; Pilgrim Watch Comment NRC, January 30, 2014

[77] Pilgrim Watch's 2.206 Petition To Modify, Suspend, Or Take Any Other Action To The Operating License Of Pilgrim Station Until The NRC Can Assure Emergency Preparedness Plans Are In Place To Provide Reasonable Assurance Public Health & Safety Are Protected In The Event Of A Radiological Emergency (19.30.2013);Pilgrim Watch's September 3, 2014 Supplement To Its August 30, 2013 2.206 Petition To Modify, Suspend, Or Take Any Other Action To The Operating License Of Pilgrim Station Until The NRC Can Assure Emergency Preparedness Plans Are In Place To Provide Reasonable Assurance Public Health & Safety Are Protected In The Event Of A Radiological Emergency (09.03.2014) https://www.nrc.gov/docs/ML1433/ML14338A180.pdf

described below.[78]

Vulnerability Pools and ISFSI to Acts of Malice

Reactors make ideal targets for outside or inside attackers for the simple reasons that they contain large amounts of radioactivity that could create severe impacts, and their defense is "light" in a military sense. The design of GE BWR Mark I reactors like Pilgrim makes those reactors highly vulnerable to attack because their spent fuel pools are in the top floor of the reactor, outside primary containment with a light roof structure overhead. In addition, Pilgrim's spent fuel when removed from inside the reactor is placed in thin-walled dry casks. The casks are stacked vertically out in the open making them vulnerable to attack. Each cask contains about ½ the Cesium-137 released during the Chernobyl accident.

The ISFSI is in the process of being moved to higher ground. But it will be very close to a public road, Rocky Hill Road. There is no plan to place the ISFSI in a reinforced building, surround it with earthen berms (a dirt cheap solution) or erect a blast shield. The ISFSI as it now sits with the canisters lined up vertically is described as "Candlepin bowling for terrorists."

The following table, prepared by Dr. Gordon Thompson for the Massachusetts Attorney General,[79] summarizes available means of attack. It shows that nuclear power plants are vulnerable.

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[78] Environmental Impacts of Storing Spent Fuel and High-Level Waste from Commercial Nuclear Reactors: A Critique of NRC's Nuclear Waste Confidence Decision and Environmental Impact Determination, Gordon Thompson, February 6, 2009 (https://www.nrc.gov/docs/ML1001/ML100150145.pdf); Comments on the US Nuclear Regulatory Commission's Draft Consequence Study of a Beyond Design Basis Earthquake Affecting Spent Fuel Pool for a US Mark 1 Boiling Water Reactor, Gordon Thompson, August 1, 2013 (https://www.nrc.gov/docs/ML1401/ML14016A068.pdf)

[79] The Massachusetts Attorney General's Request for a Hearing and Petition for Leave to Intervene With respect to Entergy Nuclear Operations Inc.'s Application for Renewal of the Pilgrim Nuclear Power Plants Operating License and Petition for Backfit Order Requiring New Design features to Protect Against Spent Fuel Pool Accidents, Docket

Mode of Attack	CHARACTERISTICS	PRESENT DEFENSE
Commando-style by land	• Could involve heavy weapons/sophisticated tactics • Attack requiring substantial planning and resources	Alarms, fences, lightly-armed guards, with offsite backup
Commando-style by water	• Could involve heavy weapons/sophisticated tactics • Could target intake canal • Attack may be planned to coordinate with a land attack	500 yard no entry zone – marked by buoys – simply, "no trespassing" signs Periodic Coast Guard surveillance by boat or plane
Land-vehicle bomb	• Readily obtainable • Highly destructive if detonated at target	Vehicle barriers at entry points to Protected Area
Anti-tank missile	• Readily obtainable • Highly destructive at point of impact	None if missile is launched from offsite
Commercial aircraft	• More difficult to obtain than pre-9/11 • Can destroy larger, softer targets	None
Explosive-laden smaller aircraft	• Readily attainable • Can destroy smaller, harder targets	None

Dr. Gordon Thompson also analyzed the impact of a shaped charge as one potential instrument of attack.[30] The analysis shows that the cylindrical wall of the canister is about 1/2 inch (1.3 m) thick, and could be readily penetrated by available weapons. The spent fuel

No. 50-293, May 26, 2006 includes a Report to The Massachusetts Attorney General On The Vulnerability of Pilgrim's Spent Fuel Pool - Risks and Risk-Reducing Options Associated with Pool Storage of Spent Nuclear Fuel at the Pilgrim and Vermont Yankee Nuclear Power Plants, Gordon Thompson, May 25, 2006 (Risks and Risk-Reducing Options Associated with Pool Storage of Spent Nuclear Fuel at the Pilgrim and Vermont Yankee Nuclear Power Plants, Gordon Thompson, May 25, 2006. (https://www.nrc.gov/docs/ML1001/ML100150145.pdf)

[30] Gordon R. Thompson, *Environmental Impacts of storing Spent Nuclear Fuel and High- Level Waste from Commercial Nuclear Reactors: A Critique of NRC's Waste Confidence Decision and Environmental Impact Determination* (Cambridge, Massachusetts: Institute for Resource and Security Studies, 6 February 2009). Tables also in Declaration of 1 August 2013 by Gordon R. Thompson: Comments on the US Nuclear Regulatory Commission's Draft Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a US Mark I Boiling Water Reactor

assemblies inside the canister are long, narrow tubes made of zirconium alloy, inside of which uranium oxide fuel pellets are stacked. The walls of the tubes (the fuel cladding) are about 0.023 inch (0.6 mm) thick. Zirconium is a flammable metal.

Table 7-7: Performance of US Army Shaped Charges, M3 and M2A3

Target Material	Indicator	Type of Shaped Charge	
		M3	**M2A3**
Reinforced concrete	Maximum wall thickness that can be perforated	60 in	36 in
	Depth of penetration in thick walls	60 in	30 in
	Diameter of hole	• 5 in at entrance • 2 in minimum	• 3.5 in at entrance • 2 in minimum
	Depth of hole with second charge placed over first hole	84 in	45 in
Armor plate	Perforation	At least 20 in	12 in
	Average diameter of hole	2.5 in	1.5 in

Notes: (a) Data are from: Army, 1967, pp 13-15 and page 100. (b) The M2A3 charge has a mass of 12 lb, a maximum diameter of 7 in, and a total length of 15 in including the standoff ring. (c) The M3 charge has a mass of 30 lb, a maximum diameter of 9 in, a charge length of 15.5 in, and a standoff pedestal 15 in long.

Table 7-8: Types of Atmospheric Release from a Spent-Fuel-Storage Module at an ISFSI as a Result of a Potential Attack

Type of Event	Module Behavior	Relevant Instruments and Modes of Attack	Characteristics of Atmospheric Release
Type I: Vaporization	• Entire module is vaporized	• Module is within the fireball of a nuclear-weapon explosion	• Radioactive content of module is lofted into the atmosphere and amplifies fallout
Type II: Rupture and Dispersal (Large)	• MPC and overpack are broken open • Fuel is dislodged from MPC and broken apart • Some ignition of zircaloy fuel cladding may occur, without sustained combustion	• Aerial bombing • Artillery, rockets, etc. • Effects of blast etc. outside the fireball of a nuclear weapon explosion	• Solid pieces of various sizes are scattered in vicinity • Gases and small particles form an aerial plume that travels downwind • Some release of volatile species (esp. cesium-137) if incendiary effects occur
Type III: Rupture and Dispersal (Small)	• MPC and overpack are ruptured but retain basic shape • Fuel is damaged but most rods retain basic shape • No combustion inside MPC	• Vehicle bomb • Impact by commercial aircraft • Perforation by shaped charge	• Scattering and plume formation as for Type II event, but involving smaller amounts of material • Little release of volatile species
Type IV: Rupture and Combustion	• MPC is ruptured, allowing air ingress and egress • Zircaloy fuel cladding is ignited and combustion propagates within the MPC	• Missiles with tandem warheads • Close-up use of shaped charges and incendiary devices • Thermic lance • Removal of overpack lid	• Scattering and plume formation as for Type III event • Substantial release of volatile species, exceeding amounts for Type II release

One scenario for an atmospheric release from a dry cask would involve mechanically creating a comparatively small hole in the canister. This could be the result, for example, of the air blast produced by a nearby explosion, or by the impact of an aircraft or missile. If the force was sufficient to puncture the canister, it would also shake the spent fuel assemblies and damage their cladding. A hole with an equivalent diameter of 2.3 mm would release radioactive gases and particles and result in an inhalation dose (CEDE) of 6.3 rem to a person 900 m downwind from the release. Most of that dose would be attributable to release of two-millionths (1.9E-06) of the MPC's inventory of radioisotopes in the "fines" category.

Another scenario for an atmospheric release would involve the creation of one or more holes in a canister, with a size and position that allows ingress and egress of air. In addition, this scenario would involve the ignition of incendiary material inside the canister, causing ignition and sustained burning of the zirconium alloy cladding of the spent fuel. Heat produced by burning of the cladding would release volatile radioactive material to the atmosphere. Heat from combustion of cladding would be ample to raise the temperature of adjacent fuel pellets to well above the boiling point of cesium.

Potential for Release from a Cask and Consequences: Dr. Thompson observed that a cask is not robust in terms of its ability to withstand penetration by weapons that are available to sub-national groups. A typical cask would contain 1.3 MCi of cesium-137, about half the total amount of cesium-137 released during the Chernobyl reactor accident of 1986. Most of the offsite radiation exposure from the Chernobyl accident was due to cesium-137. Thus, a fire inside an ISFSI module, as described in the preceding paragraph, could cause significant radiological harm.[80]

Casks may corrode and leak – especially over a long period of onsite storage

Casks may remain onsite indefinitely subjected at Pilgrim, for example, to salt induced stress corrosion cracking and threatened by sea level rise. The thin (0.5") stainless steel canisters crack may crack within 30 years. No current technology exists to inspect, repair, or replace cracked canisters. With limited monitoring, we will only know after the fact that a cask has leaked radiation. [81] NRC's Mark Lombard stated that there is no technology to find cracks or judge its depth in Holtec Casks[82]. (October 6, 2015) Dr. Kris Singh said that it is not feasible to repair Holtec's steel canisters. (October 14, 2014).[83] Mitigation will be costly. The $3 million excess in the fund after decommissioning estimated by Holtec will be totally insufficient.

High Burnup Fuel (HBU)

Pilgrim has approximately 35% HBU; yet the NRC is just starting a test to see whether the casks can handle it, with results not in until 2027. Robert Alvarez (https://www.ips-dc.org/ips-authors/robert-alvarez/) explains the problems in doing so:

> Research shows that under high-burnup conditions, fuel rod cladding may not be relied upon as a key barrier to prevent the escape of radioactivity, especially during prolonged storage in the "dry casks."

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[80] Ibid; and also see: Assessing risks of potential malicious actions at commercial nuclear facilities: the case of a proposed independent spent fuel storage installation at the diablo canyon site, Gordon Thompson, June 27, 2007 (https://www.nrc.gov/docs/ML1001/ML100150145.pdf)

[81] San Onofre Dry Cask Storage Issues analyses at: https://sanonofresafety.files.wordpress.com/2011/11/drycaskstorageissues2014-09-23.pdf

[82] (https://www.youtube.com/watch?v=QtFs9u5Z2CA&t=17s)

[83] (https://www.youtube.com/watch?v=QtFs9u5Z2CA&t=17s)

High-burnup waste reduces the fuel cladding thickness and a hydrogen-based rust forms on the zirconium metal used for the cladding, which can cause the cladding to become brittle and fail- a costly event.

- In addition, under high-burnup conditions, increased pressure between the uranium fuel pellets in a fuel assembly and the inner wall of the cladding that encloses them causes the cladding to thin and elongate.
- And the same research has shown that high burnup fuel temperatures make the used fuel more vulnerable to damage from handling and transport; cladding can fail when used fuel assemblies are removed from cooling pools, when they are vacuum dried, and when they are placed in storage canisters.
- High burnup spent nuclear fuel is proving to be an impediment to the safe storage and disposal of spent nuclear fuel. For more than a decade, evidence of the negative impacts on fuel cladding and pellets from high burnup has increased, while resolution of these problems remains elusive.
- NRC Meeting Presentation Slides Dry Storage & Transportation of High Burnup, 9/6/18 meeting, slides 14 & 15: NRC said that storage and transportation of HBU is safe, providing no technical bases, for 60 years – no guarantee for longer storage when fuel may still be onsite.

Consequences of a spent fuel pool fire or cask rupture.

The GEIS, SEIS and Holtec minimize the potential consequences of a spent fuel pool fire or a cask rupture. The amount of radiation released likely would far exceed the EPA's one rem release limit, and the resulting off-site damage to property and health would be unimaginable.

Pilgrim's pool contains approximately 70 million curies.[84] Much of the damage from a pool fire or dry cask failure would be caused by the release of Cesium-137. To make the risk meaningful, it is useful to compare the inventory of Cs-137 in Pilgrim's pool and core with the amount of Cs-137 released at Chernobyl.[85] Chernobyl - 2,403,000 curies Cs-137; Pilgrim's pool - more than 44,000,000 curies Cs-137; Pilgrim's Core - 5,130,000 curies Cs-137. Each cask contains more than half the total amount of Cs-137 released at Chernobyl

Studies of the consequences of a spent fuel pool fire show huge, potential consequences, ignored by Holtec and the documents Holtec relies on.

- 2016 Princeton Study: A major Spent Fuel Pool fire could contaminate as much as 100,000 square kilometers of land (38,610 square miles) and force the evacuation of millions.[86]
- 2013 NRC Study: A severe spent fuel pool accident would render an area larger than Massachusetts uninhabitable for decades and displace more than 4 million people.[87]
- 2006 Massachusetts Attorney General Study: $488 Billion dollars, 24,000 cancers, hundreds of miles uninhabitable[88]

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[84] Spent Nuclear Pools in the US: Reducing the Deadly Risks of Storage, Robert Alvarez, IPS, May 2011, pg., 14

[85] See 2012 GAO Report: GAO -12-797, Spent Nuclear Fuel: Accumulating Quantities at Commercial Reactors Present Storage and Other Challenges, http://www.gao.gov/assets/600/593745.pdf.

[86] Frank N. von Hippel, Michael Schoeppner, "Reducing the Danger from Fires in Spent Fuel Pools," Science & Global Security 24, no.3 (2016): 141-173 http://scienceandglobalsecurity.org/archive/sgs24vonhippel.pdf;Richard Stone, "Spent fuel fire on U.S. soil could dwarf impact of Fukushima," *Science*, May 24, 2016. (NRC variable at: http://www.sciencemag.org/news/2016/05/spent-fuel-fire-us-soil-could-dwarf-impact-fukushima

[87] Consequence Study of a Beyond Design-Basis Earthquake Affecting the Spent Fuel Pool for A U.S. Mark I Boiling Water Reactor (October 2013) at 232 (Table 62) and 162 (table 33), Adams Accession NO ML13256A342)

[88] The Massachusetts Attorney General's Request for a Hearing and Petition for Leave to Intervene With respect to Entergy Nuclear Operations Inc.'s Application for Renewal of the Pilgrim Nuclear Power Plants Operating License and Petition for Backfit Order Requiring New Design features to Protect Against Spent Fuel Pool Accidents, Docket No. 50-293, May 26, 2006 includes a Report to The Massachusetts Attorney General On The Potential Consequences Of A Spent Fuel Pool Fire At The Pilgrim Or Vermont Yankee Nuclear Plant, Jan Beyea, PhD., May 25, 2006 (NRC RC Electronic Hearing Docket, Pilgrim 50-293-LR, 2—6 pleadings, MAAGO 05/26 (ML061640065) & Beyea (ML061640329)

Dry Cask: A typical cask would contain 1.3 MCi of cesium-137, about half the total amount of Cesium-137 released during the Chernobyl reactor accident of 1986. Most of the offsite radiation exposure from the Chernobyl accident was due to Cesium-137. Thus, a fire inside an ISFSI module from a terrorist attack or significant rupture of the cask could cause significant radiological harm[89] and huge expense.

These facts cannot be ignored. The documents that Holtec relies upon, are outdated and factually incorrect. They do not bound environmental impact. Even today, NRC is ignoring both the vulnerability and severe consequences of spent fuel pools and cask storage. Site Specific analysis of spent fuel incidents are required before approval of the LTA. Funds for mitigation after a spent fuel accident must be included in cost estimates.

Q. Holtec's LTA Provides No Assurance that Holtec Pilgrim and HDI Will Have the Funds Necessary to Decommission the ISFSI.

Holtec says that ongoing ISFSI operations will continue until 9/7/2063 (DCE 17) and the ISFSI will be decommissioned in 2063 (DCE 16). Holtec's estimated cost of decommissioning the ISFSI, in 2018 dollars will be about $4.2 million.[90] DCE, pp 66, 70. In making this estimate, Holtec again incorrectly assumes that decommissioning costs will not increase more than inflation. It also assumes, with no apparent basis particularly since ISFSI decommissioning will not happen until at least 54 years from now, that there will be "no contamination or activation of the ISFSI pads." DCE, pg. 25.

[89] Environmental Impacts of Storing Spent Fuel and High-Level Waste from Commercial Nuclear Reactors: A Critique of NRC's Nuclear Waste Confidence Decision and Environmental Impact Determination, Gordon Thompson, February 6, 2009; Comments on the US Nuclear Regulatory Commission's Draft Consequence Study of a Beyond Design Basis Earthquake Affecting Spent Fuel Pool for a US Mark 1 Boiling Water Reactor, Gordon Thompson, August 1, 2013, pg., 30

[90] Holtec admits that its estimated $4.2 million cost assumes that there will be "no contamination or activation of the ISFSI pads." DCE, pg. 25

An important question, not answered in Holtec's LTA, is where the funds to pay ISFSI decommissioning costs will come from.

Holtec's LTA is clear that its $1.134 billion estimated cost is the cost to decommission the site, safeguard the spent fuel *until it can be transferred to the DOE* and restore the impacted area of the site." (PSDAR, p. 18; DCE, pg. 8). The Schedule of "planned decommissioning activities" in Section 2.0 of the PSDAR, (PSDAR, pg. 5) includes "Ongoing ISFSI Operations" but not ISFSI decommissioning. (PSDAR, pg. 8)

Holtec's Cash Flow Analysis (DCE, pp. 61.62) does not include the costs of decommissioning the ISFSI, and the $3.6 million that Holtec expects to be "left over" is not enough. This is particularly clear when the likely increase in decommissioning costs is taken into account.

Pilgrim Watch's calculations show that the actual cost of decommissioning the ISFSI at the earliest point in time assumed by Holtec (2063), will be about $24 million if decommissioning costs between now and then increase at a rate 4% more than inflation, and would be about $6.5 million even if the decommissioning cost increase was only 1% more than inflation.

In the overall picture, a 6.5 to $24 million shortfall in the funds that must be available for ISFSI decommissioning is relatively small.

But this shortfall, together with the at least 16 other incorrect assumptions and ignored significant facts discussed above, each of which will result in additional costs above and beyond the funds available for decommissioning, show that Contention 1 is not only admissible but is also correct.

The existing decommissioning trust funds do not provide a basis upon which the NRC could properly find the required financial assurance. Holtec Pilgrim and HDI are not financially responsible. The LTA should be denied.

III. CONTENTION 2

THE LICENSE TRANSFER AND AMENDMENT REQUEST DOES NOT INCLUDE THE ENVIRONMENTAL REPORT REQUIRED BY 10 CFR 51.53(d), AND HAS NOT UNDERGONE THE ENVIRONMENTAL REVIEW REQUIRED BY THE NATIONAL ENVIRONMENTAL POLICY ACT

BASES

1. PW specifically incorporates by reference, as if fully set forth here, all facts supporting Contention 2 and all Bases for and Facts Supporting Contention 1.

2. The National Environmental Policy Act (NEPA) requires that a NEPA analysis be performed.

The NRC responsibilities under NEPA are triggered by the fact that a federal agency "has actual power to control the project." *Ross v. Fed. Highway Admin.*, 162 F.3d 1046, 1051 (10th Cir. 1998). The NRC clearly has "actual power to control" the requested license transfer.

"[P]ermitting [Holtec] to decommission the facility" requires NEPA review. *Citizens Awareness Network, Inc. v. Nuclear Regulatory Comm'n*, 59 F.3d 284, 293 (1st Cir. 1995). "[R]egardless of the label the [Nuclear Regulatory] Commission places on its decision," the NRC "cannot t skirt NEPA or other statutory commands by essentially exempting a licensee from regulatory compliance, and then simply labelling its decision 'mere oversight' rather than a major federal action. To do so is manifestly arbitrary and capricious." *Id.*

3. NRC requires environmental impact statements for major federal actions. Approval of Holtec's proposal as a whole would constitute a major federal action.

NEPA requires federal agencies to prepare an Environmental Impact Statement for every "major federal action significantly affecting the quality of the human environment." 42 U.S.C 4332(2)(c); accord 10 C.F.R. 51.20 (a)(1). As discussed above with respect to Contention 1, and as shown in the Facts Supporting Contention 2 below, Holtec's actions will affect the quality of the environment.

40 C.F.R. § 1508.18 defines *major* federal actions as "actions with effects that *may* be major and which *are potentially subject to Federal control and responsibility*," including "[a]pproval of specific projects" or other instances where regulatory approval is necessary to a licensee's actions." The LTA has effects that "may be major," is potentially subject to [NRC] control. The LTA also requires "regulatory approval."

The D.C. Circuit Court of Appeals has held that a federal action is involved, "whenever an agency makes a decision which permits action by other parties which will affect the quality of the environment." *Scientists' Inst. for Pub. Info., Inc. v. Atomic Energy Comm'n*, 481 F.2d 1079, 1088 (D.C. Cir. 1973). Consistently, the 9th Circuit has held that because the NRC has "mandatory obligation to review" Holtec's plans, the NRC's "failure to disapprove" of those plans would constitutes "major federal action" triggering NEPA review. *Ramsey v. Kantor*, 96 F.3d 434, 445 (9th Cir. 1996).

4. A NEPA review is required if there is a potential environmental impact.

The mere "possibility of a problem" requires the NRC "to evaluate seriously the risk" that this problem will occur, and what environmental consequences would ensue in those circumstances. *Id.*, U.S.C. § 4332(2)(C); *see also, e.g.*, *Blue Mountains*, 161 F.3d at 1211.

Even if the proposed license transfer might not have any environmental impacts, the *possibility* of significant environmental impacts precludes a FONSI and triggers the need for an Environmental Impact Statement.

NEPA explicitly requires an Environmental Impact Statement if an action has "effects that *may be* major and which are *potentially* subject to Federal control and responsibility." C.F.R. § 1508.18. (emphasis added). A "potential" significant effect suffices. *San Luis Obisco Mothers for Peace,* 449 F.3d at 1030. "[W]hen the determination that a significant impact will or will not result from the proposed action is a close call, an [environmental impact statement] should be prepared." *National Audubon Soc. v. Hoffman*, 132 F.3d 7, 13 (2d. Cir. 1997) (reversing a decision by the U.S. Forest Service not to prepare an environmental impact statement because the Forest Service failed to consider the possible effects of the challenged action). Agencies should "err in favor of preparation of an environmental impact statement." *Id*. at 18.

An environmental impact statement is required if the agency's review shows a "substantial possibility" that the project or action "may have a significant impact on the environment." *Id*. at 18. It is only when the NRC's action "*will not* have a significant effect on the human environment" that an environmental impact statement is not required. *Id*. at 13.

5. <u>NEPA requires a comprehensive environmental review.</u>

The NRC is required to take a "hard look" at the potential environmental consequences of Holtec's proposed action. *Baltimore Gas & Elec. Co. v. Natural Res. Def. Council, Inc.*, 462 U.S. 87, 97 (1983). The required NEPA analysis must be comprehensive and address all "potential environmental effects," unless those effects are so unlikely as to be "remote and highly speculative." *San Luis Obispo Mothers for Peace v. NRC*, 449 F.3d 1016, 1030 (9th Cir. 2006).

"Ignoring possible environmental consequences will not suffice." *Found. on Econ. Trends v. Heckler*, 756 F.2d 143, 154 (D.C. Cir. 1985).

The potential effects of Pilgrim decommissioning (including operation of the ISFSI during the many years before it might be decommissioned) are neither remote or highly speculative; and they cannot be ignored.

6. <u>NRC regulations require an environmental impact statement.</u>

Under 10 C.F.R. §§ 51.53(d), every applicant for a

> "license amendment approving a license termination plan or decommissioning plan … shall submit with its application a separate document, entitled 'Supplement to Applicant's Environmental Report—Post Operating License Stage,' which will update 'Applicant's Environmental Report—Operating License Stage,' as appropriate, to reflect any new information or significant environmental change associated with the applicant's proposed decommissioning activities or with the applicant's proposed activities with respect to the planned storage of spent fuel."

Since the LTA also seeks to transfer Pilgrim's ISFSI and to operate the ISFSI after PNPS is decommissioned, an environmental impact statement is also required by 10 C.F.R. §§ 51.20 requires an environmental impact since the "license pursuant to part 72 of this chapter" would then be "for the storage of spent fuel in an independent spent fuel storage installation (ISFSI) at a site not occupied by a nuclear power reactor."

7. <u>An environmental analysis is an important part of the NRC's review.</u>

An Environmental Assessment helps an agency determine whether the proposed action is significant enough to require preparation of an Environmental Impact Statement. *Marsh v. Or. Natural Resources Council*, 490 U.S. 360, 371 (1989).

The NRC has recognized the value of a comprehensive NEPA analysis: "While NEPA does not require agencies to select particular options, it is intended to foster both informed decision-making and informed public participation, and thus to ensure that the agency does not act upon incomplete information, only to regret its decision after it is too late to correct." *In re Duke Energy Corporation (McGuire Nuclear Station, Units 1 and 2; Catawba Nuclear Station, Units and 2*), CLI-02-17, 56 N.R.C. 1, 10 (2002).

An environmental impact statement "insures the integrity of the agency process by forcing it to face those stubborn, difficult to answer objections without ignoring them or sweeping them under the rug" and serves as an "environmental full disclosure law so that the public can weigh a project's benefits against its environmental costs." *National Audubon Soc.*, 132 F.3d at 12 (citing *Sierra Club v. United States Army Corps of Eng'rs*, 772 F.2d 1043, 1049 (2d. Cir. 1985)). The procedures of NEPA serve a "vital purpose" that "can be achieved only if the prescribed procedures are faithfully followed." *Lathan v. Brinegar*, 506 F.2d 677, 693 (9th Cir.1974).

8. <u>The NRC cannot issue a Finding of No Significant Impact (FONSI) without first evaluating all the evidence.</u>

The NRC can issue a FONSI only if it reasonably determines, based on an evaluation of all the evidence, that its action "will not have a significant effect on the human environment." (40 C.F.R. § 1508.13) A FONSI must include "a convincing statement of reasons to explain why a project's impacts are insignificant. *Blue Mountains Biodiversity Project v. Blackwood*, 161 F.3d 1208, 1212 (9th Cir. 1998). S*ee also Citizens Against Toxic Sprays, Inc. v. Bergland*, 428 F. Supp. 908, 927 (D. Or. 1977) ("No subject to be covered by an [environmental impact statement] can be more important than the potential effects of a federal [action] upon the health of human beings [and the environment]."); *Maryland-Nat'l Capital Park & Planning Comm'n v. U.S. Postal*

Service, 487 F.2d 1029, 1039-40 (D.C. Cir. 1973) (agency must consider "genuine issues as to health" before deciding whether to prepare an environmental impact statement). If the agency determines that a full environmental impact statement is not necessary, the agency must then prepare a FONSI "sufficiently explaining why the proposed action will not have a significant environmental impact." 40 C.F.R. § 1501.4; *id.* § 1508.14; *New York v. NRC I*, 681 F.3d 471, 477 (D.C. Cir. 2012).

As shown in this Petition, the proposed LTA will have a significant impact.

9. <u>The generic determination of 10 CFR § 2.1315 does not apply</u>.

Holtec seems to contend that no environmental assessment is required because of "the generic determination in 10 CFR 2.1315(a). According to Holtec, this "generic determination applies [because] the proposed conforming license amendment … does no more than conform the License to reflect the proposed transfer discussion." LTA, p. 20.

As shown at pages 3-4 above, this is simply not so. The proposed license amendment:

> Requires the NRC to find that "Holtec Pilgrim LLC is financially qualified" and that Holtec Decommissioning International is both "technically and financially qualified" (Proposed Amended License, p. 1, subparagraphs c and d), a finding that would have to overlook that the only asset of Holtec Pilgrim and Holtec Decommissioning International is Pilgrim's demonstrably insufficient Decommission Fund (see Contention 1, below) and that as a Holtec representative (Ms. Joy Russell) said ay an NDCAP meeting . Holtec itself has never decommissioned a site.
>
> > MS. J. RUSSELL (Holtec): Holtec International has not decommissioned any sites.

a. Deletes the requirements that Pilgrim's owner "provide decommissioning funding assurance of no less than $396 million," provide a Provisional Trust fund in the amount of "$70 million," and "have access to a contingency fund of not less than fifty million dollars" (Proposed Amended License p. 4). Particularly given the inadequacy of the Decommissioning Trust Fund, this is a significant change.

b. Deletes the requirement that the Decommissioning Trust agreement prohibit investments in the Pilgrim Owner's parent company. (Proposed Amended License, p. 5).

Because of these requested changes, the generic determination of §2.1315 does not apply. In addition, the clear import of § 2.1315 is that when, as here, the requested amendment does far more than conform than conform the license, the NRC must consider both "significant safety hazards considerations" and "whether the health and safety of the public will be significantly affected", as required by NEPA.

Finally, and contrary to fact, even if the requested amendment did "no more than confirm the license to reflect the transfer action, the Commission should (as provided in § 2.1315(a), determine that its generic determination not apply here for all of the reasons set forth herein, including those set forth below:

a. The license transfer agreement raises significant questions with respect to safety hazards and whether the health and safety of the public will be affected.

b. Pilgrim has a long history of bad fuel, blown filters, leaks, releases, buried hazardous materials, and mismanagement (see pp. 36-51, above)

c. Neither Holtec nor the NRC knows what contamination exists at the PNPS site.

d. Holtec has not conducted a site analysis.

e. Holtec has not yet reviewed what it calls Entergy's "Historic Site Assessment," a review that Holtec admits is needed "to support the identification, categorization, and quantification of radiological, regulated, and hazardous wastes in support of waste management planning." Holtec PSDAR pp 8-9

f. Holtec has made only an initial cursory "review of PNPS decommissioning records required by 10 CFR 50.75(g) records.

g. Holtec admits that a new site assessment is necessary so that "radiological, regulated, and hazardous wastes are identified, categorized and quantified to support decommissioning and waste management planning.".

h. NRC's Lessons Learned Task Force identified "that *under the existing regulatory requirements* the potential exists for unplanned and unmonitored releases of radioactive liquids to migrate offsite into the public domain undetected;" and and recommended revising the regulations. See pp. 103-104, above).

i. The NRC has noted burials of hazardous waste, saying that "these types of areas will be identified during plant decommissioning" but to date has not done so. See pp. 53-54 above.

10. <u>The categorical exclusion of 10 CFR § 51.22 does not apply.</u>

In its LTA, Holtec also says (LTA, pg. 10) that

> "The requested consent to transfer licensed owner and operator authority for Pilgrim is exempt from environmental review because it falls within the categorical exclusion contained in 10 CFR 51.22(c)(21) for which neither an Environmental Assessment nor an Environmental Impact Statement is required."

Holtec is again incorrect. 10 CFR § 51.22(b) could not be clearer. "[A]n environmental impact statement is not required" *"[e]xcept … upon the request of any interested person*." Pilgrim Watch is an "interested person, and it" has requested "an Environmental Assessment [and] an Environmental Impact Report."

Beyond that, in the "special circumstances" that exist at PNPS (See pp.88-89, above), the Commission should determine that an environmental assessment or environmental impact statement is required.

Finally, Holtec's apparent suggestion no environmental assessment or environmental impact statement are ever required for any "Approvals of direct or indirect transfers of any license issued by NRC or any associated amendments of license required to reflect the approval of a direct or indirect transfer of an NRC license" (10 CFR § 51.22 (c)(21)) goes much too far. 10 CFR § 51.22 (a) says that some categories of licensing and regulatory actions are "eligible for categorical exclusion," but neither the Atomic Energy Act, NEPA, nor the NRC's exhaustive regulations directed to licensing or licensing transfers can countenance a conclusion that no "amendments of license required to reflect the approval of a direct or indirect transfer of an NRC license," no matter how flawed, have any environmental effect and are automatically excluded from any environmental review.

11. The environmental impacts are not "bounded" by previous environmental impact statements.

Holtec says that it "has concluded that the environmental impacts associated with planned PNPS site specific decommissioning activities are less than and bounded by the previously issued environmental impact statements."

What Holtec "has concluded" is, once again, wrong. The "previously issued environmental impact statements" do not and cannot bound numerous environmental impacts associated with Holtec's decommissioning plan because they are neither completely nor accurately discussed in "the previously issued environmental impact statements, much less environmental impacts resulting from events that occurred after the previous EIS's were issued, or for some other reason were not considered at all.

Holtec's PSDAR reviews some environmental impacts of decommissioning (pgs., 20-35). But Holtec fails to show potential environmental impacts that would result from Holtec *not* performing a thorough and proper site assessment at the beginning of the decommissioning process. Such an up-front site assessment is required for Holtec to properly cleanup the site, to provide a valid cost estimate, and to assure the money will be there to do the job needed to protect public health and safety.

As shown in this Petition, the "previously issued environmental impact statements" were inadequate.

12. <u>The lack of sufficient decommissioning funds increases the need for an environmental impact statement.</u>

Neither Holtec Pilgrim nor HDI is financially responsible, neither has or has access to any funds other than the DTF, and the DTF does not and will not have sufficient funds for decommissioning.

The NRC agrees that a shortfall in decommissioning funding would place public health, safety, and the environment at risk.

> The requirements for financial assurance were issued because *inadequate or untimely consideration of decommissioning, specifically in the areas of planning and financial assurance, could result in significant adverse health, safety and environmental impacts. … The purpose of financial assurance is* to provide a second line of defense, if the financial operations of the licensee are insufficient, by themselves, *to ensure that sufficient funds are available to carry out decommissioning (*63 FR 50465, 50473). NRC *Questions and Answers on Decommissioning Financial Assurance*, at 1 (ADAMS Accession No. ML111950031, italics added).

Absent a complete and accurate environmental impact statement, neither the NRC nor anyone else will know what needs to be done to completely and safely decommission Pilgrim and protect the public health and safety, or what is needed to provide real financial assurance.

FACTS SUPPORTING CONTENTION 2[91]

Pilgrim Watch specifically incorporates, as if fully set forth here, the Bases of Contention 1, the Facts Supporting Contention 1, and the Bases of Contention 2.

As shown above, NEPA and NRC Regulations require an environmental impact statement. The actual facts here make clear that prior environmental statements do not include, and that neither Holtec nor the NRC knows, the actual conditions at the Pilgrim site.

Other facts supporting at least one of Contention 1 and Contention 2 include the following.

Pilgrim is located on the shore of Cape Cod Bay; in a densely populated neighborhood; on top of the Plymouth-Carver Aquifer; and it is in America's Hometown, a national tourist location. Its location puts a premium on an early site assessment and NEPA analysis

.

1. Pilgrim is sited beside Cape Cod Bay. Due to the topography of the site, contaminants will leak into the Bay.
2. Massachusetts and Cape Cod Bays are tidal. NUREG-1427, 2.2.5.1.
3. Contaminants leaking into the bay during an incoming tide will be drawn into Plymouth, Duxbury and Kingston Bays, up the rivers, such as the Jones, Eel, and Bluefish Rivers and into estuaries; in the outgoing tide they will flow into and circulate around Cape Cod Bay and beyond.
4. Climate change is causing sea level rise, increases in the number and severity of storms, and flooding. This will result in contaminants left onsite washing out to Cape Cod Bay and adjacent waters; and hasten corrosion by exposure to salt and moisture of buried pipes, tanks and structures left in the ground that contain radiological or hazardous material. Low Level

[91] Many of the facts set forth below here also support Contention 1 and should be considered in connection with Contention 1.

Radioactive Waste is stored about 30 feet from Cape Cod Bay, Holtec's LTA does not adequately consider and analyze this. An early site assessment and NEPA must analyze the impact of climate change on the site.

5. Holtec's LTA and previous environmental impact statements do not adequately consider the possibility of site-specific impacts resulting from the plant's close proximity to residential neighborhoods (and potential airborne asbestos and lead contamination, as well as potential impacts from a radiological incident or radiological dispersion during demolition work and disruption of soils).
6. Pilgrim's site is above the Plymouth-Carver Aquifer, the second largest aquifer in Massachusetts, that provides drinking water to several towns and supports many natural resources.

Neither Holtec nor the NRC knows what contamination exists at the Pilgrim site.

7. Holtec has not conducted a site analysis.
8. Holtec has not yet reviewed what it calls Entergy's "Historic Site Assessment." (HSA)
9. Holtec admits a review of the HSA is needed "to support the identification, categorization, and quantification of radiological, regulated, and hazardous wastes in support of waste management planning." Holtec PSDAR pp 8-9.
10. Holtec has made only an initial cursory "review of PNPS decommissioning records required by 10 CFR 50.75(g) records.
11. Holtec admits that a new site assessment is necessary so that "radiological, regulated, and hazardous wastes are identified, categorized and quantified to support decommissioning and waste management planning. " (CDE, p. 14).

12. Previously issued environmental impact statements do not and cannot bound numerous environmental impacts associated with Holtec's decommissioning plan that are either incompletely and inaccurately discussed in the previously issued environmental impact statements or are not considered by them at all.
13. A site assessment at the Pilgrim site would provide new and important information that is not included in previously issued environmental impact statements, and that would show that previously issued environmental impact statements are outdated and incomplete.
14. NEPA explicitly requires an Environmental Impact Statement if an action such as a license transfer has "effects that *may be* major and which are *potentially* subject to Federal control and responsibility."

Specific facts and impacts that Holtec and previous environmental impacts have not adequately considered, the effects of which "may be major and which are potentially subject to Federal control and responsibility."

15. Holtec says its estimates are based on nothing more than what appears to be an initial cursory "review of PNPS decommissioning records required by 10 CFR 50.75(g) records." Holtec says it will review of what it calls Entergy's "Historic Site Assessment (HSA)" sometime in the future (PSDAR, 8-9)
16. Holtec has no basis to justify its assumption that there is "no significant contamination" on the Pilgrim site. (DCE, p.2)
17. The GEIS, SEIS and Holtec incorrectly assume that the Pilgrim site is essentially clean. However, GEIS, SEIS, PSDAR and LTA ignore both old information regarding the reactor's history, and new and significant information since the GEIS and SEIS were published. These

documents do not bound environmental impacts. A new site assessment and NEPA are required.

18. An early site assessment and NEPA analysis will prevent the unexpected expenses experienced at other sites.

19. An updated site analysis or environmental impact statement would show that actual decommissioning costs, particularly removal of contamination and site restoration, may be far greater than Holtec's current LTA estimates, and prevent what happened at other sites from happening here. This is illustrated by the facts that:

    a. At Connecticut Yankee, previously undiscovered strontium-90 contributed to the actual cost of decommissioning Connecticut Yankee being double what had been estimated.

    b. During the decommissioning of Maine Yankee, the licensee encountered pockets of highly contaminated groundwater dammed up by existing structures, leading to cost increases.

    c. The Yankee Rowe site in Massachusetts incurred significant cost increases during decommissioning when PCBs were discovered in paint covering the steel from the vapor container that housed the nuclear reactor, as well as in sheathing on underground cables.

Other plants such as Diablo Canyon 1&2, and San Onofre 2&3 have ended up costing much more than what was estimated for decommissioning.

Pilgrim's History of Spills, Leaks, Mismanagement - Requires Site Assessment & NEPA[92]

20. Pilgrim opened with bad fuel and no off-gas treatment system

21. Later Pilgrim blew its filters in June 1982.

22. Operating with bad fuel and blowing its filters, prompted Mass Dept. Public Health to do a case-control study of adult leukemia testing the hypothesis that the closer you lived or worked at Pilgrim there would be an increase in leukemia. The hypothesis was confirmed.[93]

23. Due to these leaks, many lethal radionuclides, including for example tritium, manganese54, cesium-137, Sr-90, I-131, cobalt-60, and neptunium[94] were found in the surface water, groundwater, and soils at Pilgrim at levels exceeding "background" levels.

24. The Annual Radiological Environmental Reports (see especially the 1983 report following the June 1982 releases) indicate considerable offsite contamination, some media having >1000 times Cs-137 of what would be expected.

25. These releases prompted additional health studies that were published in the 1980's thru 2004 showing radiation linked diseases in communities near Pilgrim. (See Pilgrim Watch Motion to Intervene Pilgrim LRA, Contention 5, (5.3.3) and Exhibits F-2-F-4, Adams Library, Accession NO. ML061630125.)

26. Knowing that there was offsite contamination, the only reasonable assumption is that there is contamination onsite also. This requires a site assessment and NEPA analysis, not yet done.

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[92] Pilgrim Chronology 1967- 2015, https://jonesriver.org/legal/pilgrim-chronology-1967-2015/ Exhibit 4

[93] *The Southeastern Massachusetts Health Study* [published in the *Archives of Environmental Health*, Vol. 51, p.266, July-August 1996 (Pilgrim Motion Request for Hearing and Motion to Intervene, May 2006, Exhibit F-2, NRC Adams, EHD, Pilgrim LR, Pleadings 2006)

[94] Neptunium releases into Cape Cod Bay reported by Stuart Shalat, who worked for the contractor doing the re-fueling in the 1980s. Stuart Shalat, Sc.D. Associate Professor Robert Wood Johnson Medical School, Exposure Science Division, Environmental and Occupational Health Sciences Institute

27. Contamination onsite is exacerbated by Pilgrim's long history of mismanagement.[95]

28. Pilgrim was shut down from 1986-1989 due to a series of failures

29. January 21, 1988, a 5,000 cubic yard pile of dirt containing radioactive cesium-134, cesium-137, and cobalt-60 was found in a parking lot near the reactor. (*Radioactivity was detected in dirt pile near Pilgrim*, Boston Globe, L. Tye, January 21, 1988).

30. February 2014: NRC identified Pilgrim as one of the nine worst performing nuclear reactors in the U.S.

31. In September 2015, Pilgrim was moved to NRC's lowest safety ranking (Category 4), joining two other Entergy reactors. (http://www.nrc.gov/info-finder/reactors/pilg/special-oversight.html) Pilgrim remains in the lowest safety ranking in 2019.

32. December 2016, Special Inspection[96]**:** NRC unintentionally "leaked" an email containing NRC report covering the November 28 - December 8 inspection. Written by Donald Jackson, the lead inspector, this report included a long list of flaws at the plant that were observed during the initial week of the inspection. In the email, Donald Jackson, said that, "***"The plant seems overwhelmed just trying to run the station."***

33. The list of Pilgrim failures mentioned in the leaked email were: failure of plant workers to follow established industry procedures; broken equipment that never gets properly fixed; lack of required expertise among plant experts; failure of some staff to understand their roles and responsibilities; a team of employees who appear to be struggling with keeping the nuclear

[95] Pilgrim Chronology 1967- 2015, https://jonesriver.org/legal/pilgrim-chronology-1967-2015/ Exhibit 4

[96] http://www.capecodtimes.com/news/20161206/nrc-email-pilgrim-plant-overwhelmed

plant running; and NRC inspectors are observing current indications of a safety culture problem that a bunch of talking probably won't fix."

34. A "plant (that) seems overwhelmed just trying to run the station" increases the probability of leaks.
35. All of these facts, and those below, require a site assessment and NEPA analysis.

Contamination resulting from Buried Pipes and Tanks

36. Pilgrim's buried pipes and tanks are made of materials that corrode - concrete, carbon steel, stainless steel, titanium and external coatings and wraps are susceptible to age-related and environmental degradation.[97]
37. The pipes and tanks are old and subject to age-related degradation.[98] Most were put in place in the 60's.
38. Some of the pipes and tanks contain industrial process, radionuclides in wastewater and embedded in the pipe/tank.
39. Degradation of these components can lead to leaks of toxic materials into groundwater and soils. A site analysis and NEPA is required.
40. There has been no adequate program for inspecting buried pipes and tanks.
41. NEI's Buried Piping/Underground Piping and Tanks Integrity Initiative, that began in 2009, is voluntary and inadequate. These voluntary processes have allowed leaks and spills to go unnoticed.[99]

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[97] See for full discussion buried pipes and tanks, Pilgrim Watch was admitted to Pilgrim's License Renewal Proceeding and filed Contention 1, *The Aging Management Plan Does Not Adequately Inspect and Monitor for Leaks in All Systems And Components That May Contain Radioactively Contaminated Water*. We refer the ASLB to the file, especially Pilgrim Watch Post Hearing Findings of Fact and Conclusion of Law, June 9.2008, Docket 50-293

[98] Pilgrim Watch Post-Hearing Findings of Fact Conclusions of Law, June 9, 2008,11

[99] Ibid 55-59

Tritium and Other Radionuclides in Groundwater[100]

42. The Pilgrim Tritium in Groundwater Program has shown significant radioactive contamination (tritium, cesium-137, cobalt-60, manganese-54) in Pilgrim's soil.

43. Prior to 2007, Pilgrim had no groundwater monitoring program. What had leaked into and contaminated the site is unknown; but what was found when wells were put into place in 2007 strongly suggests perhaps considerable prior leakage

44. Since 2007, Entergy's own groundwater well tests, and MDPH's analysis of split samples, have confirmed Pilgrim is leaking radionuclides and contaminating the soil and groundwater. Entergy's tests have shown levels ranging from non-detect levels to as high as 70,000 piC/L.[101] 20,000 is the EPA limit; California's goal is 400.

45. In all but 2 years, there was at least one well above Mass DPH's screening level of 3,000 piC/L and 3 years with at least one well above EPA's safe drinking water standard of 20,000 piC/L.

46. April 2012 an underground line leading to the discharge canal had separated. The leak was accidently discovered when tritiated water was found coming out of an electrical junction box inside the facility.[102]

47. Five months later, groundwater tests results showed high tritium levels (4,882-5,307 pCi/L), in one of the wells and this was suspected to be related to the separated underground line. [103]

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[100] https://www.mass.gov/lists/environmental-monitoring-data-for-tritium-in-groundwater-at-pilgrim-nuclear-power-station; https://jonesriver.org/pilgrim-contamination/ ; and see Attachment 3 for a full report.
[M] Mass MDPH Pilgrim Nuclear Power Station (PNPS) tritium in groundwater monitoring wells, January 2014
[102] Mass MDPH Pilgrim Nuclear Power Station (PNPS) tritium in groundwater monitoring wells, May 2013
[103] Mass MDPH Pilgrim Nuclear Power Station (PNPS) tritium in groundwater monitoring wells, Sept 2013

48. Soil sampling was done, and preliminary results showed tritium, cobalt-60, and cesium-137 at levels above normal (1,150 picocuries per kilogram (pCi/kg) of cobalt-60 and 2,490 pCi/kg of cesium-137). [104]

49. By January 2014 – nine months after the leak was originally discovered – excessive levels of tritium (69,000-70,000 pCi/L), the highest in Pilgrim's recorded history, were detected near a basin that collects radiologically contaminated water and ultimately sends it to Cape Cod Bay.

50. Entergy and Mass DPH continued their investigations, unsure of the sources of leakage, and performed no cleanup.[105]

51. More than a year later, Pilgrim's newest groundwater wells continued to show elevated levels of tritium and final soil testing results show levels of tritium, manganese-54, cesium-137, and cobalt-60 at various depths near the separated underground line above typical background levels.[106]

52. In addition to the contaminating spills described above, at least five other historic spill events that have been reported on the Pilgrim site since 1976. [107]

53. Tritium moves quickly in the soil; other radionuclides more slowly. Therefore, if the monitoring wells show only tritium it does not prove that other radionuclides, perhaps with longer half-lives, may be upstream.

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[104] Split sample testing at MDPH

[105] Mass DPH. Pilgrim Nuclear Power Station (PNPS): tritium in groundwater monitoring wells. Jan. 2014.

[106] Mass DPH. Pilgrim Nuclear Power Station (PNPS): tritium in groundwater monitoring wells. May 2014.

[107] Mass DPH. Pilgrim Nuclear Power Station (PNPS): tritium in groundwater monitoring wells. Aug 2014.

54. In 1988 there was a spill of low-level radioactive waste water. The radioactively contaminated liquid waste was discovered inside a process building and had leaked outside the building. An estimated 2,300 gallons of contaminated water spilled, and 200 gallons leaked outside the building from under a door. About 2,500 square feet of asphalt and 600 cubic feet of sand and gravel were contaminated.[108]

55. Absent a new and complete site assessment, there is no certainty of the sources of Pilgrim's leaks.

56. Likely candidates include leaks from the Condenser Bay Area, seismic gaps, a crack in the Torus Floor, materials and soil from subsequent construction left on site, and age-related degradation.

57. Extreme temperatures and storms, salt water and air, corrosive chemicals, and intense radiation most likely have caused components to thin and crack, compromising the structural integrity of the facility and underground/buried pipes.[109]

58. During the past 12 years in which the licensee has known about the leaks, nothing has been done to clean up the soil. A site and NEPA is needed.

Stormwater Drains and Electrical Vaults[110]

59. When storm drain sampling was done (from 1998-2007), certain parameters were exceeded on many occasions.[111]

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[108] Mass DPH. 1988. Investigation of Radioactive Spill at Pilgrim on November 16, 1988. Prepared by Radiation Control Program.

[109] Pilgrim Watch, Contention 1, The Aging Management Plan Does Not Adequately Inspect and Monitor for Leaks in All Systems and Components That May Contain Radioactively Contaminated Water; Pilgrim Watch Post Hearing Findings of Fact and Conclusion of Law, June 9.2008, Docket 50-293, NRC Adams, ML 081650345

[110] https://jonesriver.org/getfile/ccbw/2012/10/RAD-REPORT_2017.07.18_VS3.pdf (Attachment 3)

[111] page 31 of EPA's 2016 Draft Authorization to Discharge under the National Pollution Discharge Elimination System (Fact Sheet)

60. Initial sampling by EPA from only seven vaults found total suspended solids, cyanide, phenols, phthalates, PCBs, antimony, iron, copper, zinc, lead, nickel, cadmium, hexavalent chromium. Lead, copper, and zinc exceeded marine water quality criteria.

61. Monitoring results from standing water in storm water manholes, junction boxes, and electrical duct banks show radioactive materials at tritium levels as high as 1,500 pCi/L in some storm water manholes and up to 4,500 pCi/L in some electrical duct bank manholes.

Holtec reliance on Entergy's environmental radiological monitoring data

62. Holtec says that "PNPS will continue to comply with the Offsite Dose Calculation Manual, Radiological Environmental Monitoring Program, and the Groundwater Protection Initiative Program during decommissioning (LTA, 1.4 Additional Considerations). The reports are not reliable, according to NRC's own task force, likely negatively impacting public health.

63. The NRC's Groundwater Contamination (Tritium) at Nuclear Plants Task Force Final Report, September 1, 2006[112] identified "that *under the existing regulatory requirements* the potential exists for unplanned and unmonitored releases of radioactive liquids to migrate offsite into the public domain undetected." (LLTF Executive Summary ii)

64. The LLFT recommended for example: (1) The NRC should revise the radiological effluent and environmental monitoring program requirements and guidance consistent with current industry standards and commercially available radiation detection technology. (2) Guidance for the REMP should be revised to limit the amount of flexibility in its conduct. Guidance is needed on when the program, based on data or environmental conditions, should be expanded. (6) The

[112] NRC's Groundwater Contamination (tritium) at Nuclear Plants Task Force Final Report, September 1, 2006; https://www.nrc.gov/docs/ML0626/ML062650312.pdf

NRC should require adequate assurance that spills and leaks will be detected before radionuclides migrate offsite via an unmonitored pathway.

65. The LLTF stated further in its Executive Summary ii that, …relatively low leakage rates may not be detected by plant operators, even over an extended period of time."

66. We cannot rely on a review of monitoring reports. An actual site assessment and NEPA analysis are required.

Hazardous Waste Dumping

67. Drums of hazardous waste were buried on the Pilgrim site in the 1980s and/or 1990s. Holtec's LTA does not adequately consider them.

68. The NRC has noted burials of hazardous waste, saying that "these types of areas will be identified during decommissioning." Holtec's LTA does not adequately consider them, a site and NEPA assessment must.

Climate Change Impacts on The Site.

69. Based on current levels of greenhouse gas prediction, the UN Intergovernmental Panel on Climate Change (IPCC) 2018 Report[113] shows sea levels will rise more rapidly; severe storms will occur more frequently, coinciding with high tides and exceptional wave heights; rising groundwater tables, and floods more severe. The National Geographic (December 16, 2015) identified Pilgrim among the 13 nuclear reactors impacted by sea-level rise and predicted that, "if significant protective measures were not taken, these sites could be threatened."[114]

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[113] https://research.un.org/en/climate-change/reports

[114] http://news.nationalgeographic.com/energy/2015/12/151215-as-sea-levels-rise-are-coastal-nuclear-plants-ready/

70. As climate change impacts get worse and decommissioning commences in 2019 storm drains and stormwater testing (discussed above) will become even more critical, as these outlets could become further conduits for pollution into Cape Cod Bay. Increased flooding and storm intensity, sea level rise, and rising groundwater tables could increasingly flush contaminates present in groundwater and soil into Cape Cod Bay.

71. Numerous negative impacts resulting from climate change that need analysis:

- Increased flooding and storm surge resulting from climate change is likely to cause corrosion of underground piping, tanks and structures and subsequent leakage. And corrosion and potential leakage of the Greater-than-Class-C waste and low-level waste containers located close to Cape Cod Bay.
- Radiological and hazardous waste contamination, if not cleaned up quickly, will be washed out into Cape Cod Bay unable to be retrieved.
- Severe storms and flooding can result in loss of offsite power and potential damage to the diesel generators located by the bay. The spent fuel pool requires electricity to operate its safety systems. In Fukushima extreme weather conditions at the site prevented workers to perform necessary mitigating actions. Severe storms and flooding could present conditions at Pilgrim so that workers could not perform their jobs.

Flooding

72. Flooding risk needs analysis because it can result in contaminants washing out into Cape Cod Bay; and contribute to corrosion of buried components and consequent release of hazardous material.

73. In 2012, the Nuclear Regulatory Commission (NRC) requested information from all U.S. nuclear reactors, including PNPS, to support its review of the Fukushima Daiichi nuclear

accident (NRC, 2012). Part of this request addressed flood and seismic hazards at reactor sites.

74. In March 2015, Entergy provided the NRC with a Flood Hazard Re-Evaluation Report prepared by AREVA, Inc. (AREVA, 2015). In September 2015, Jones River Watershed Association (JRWA) commissioned Coastal Risk Consulting, LLC (CRC) to provide an expert analysis of the methodologies and conclusions presented in the AREVA Flood Hazard Re-Evaluation Report. (Exhibit 5)

75. Post shutdown, having a detailed and robust flood assessment for PNPS is important. It will provide the basis for good planning and management for the site leading up to and throughout decommissioning, which will help curb flooding risks and ultimately protect public safety, environmental health, and the economic well-being of the area.

76. The following key points are presented and explained in this report:

    - Local Intense Precipitation is shown in the AREVA Report to be a primary hazard of concern that could inundate the site by as much as 2.5 feet of rainwater (AREVA p. 29). However, the AREVA analysis underestimates this risk by using outdated precipitation data and not considering future climatic conditions, which are projected to increase precipitation amounts during heavy rainfall events.

    - While the storm surge analysis was robust, sea level rise over the next 50 years was understated by relying primarily on historic rates of sea level rise. This approach produces only 0.46 feet of sea level rise by 2065. However, the National Oceanographic and Atmospheric Association (NOAA) estimates sea level rise of 3.05 feet by 2065.

- Groundwater, subsidence, and erosion are not considered in the analysis, further underestimating the risks to PNPS, particularly when analyzing the combined effects of extreme storm events.
- In addition to storm surge, other factors and mechanisms such as high tide and wave setup dramatically compound flooding. The main flaw in the Combined Flooding section of the AREVA Report relates to the limitations of the term "combined." Of the five combined event scenarios provided in the NRC guidance document, NUREG/CR-7046, Appendix H, only one is deemed appropriate for PNPS. This conclusion disregards a wide range of possibilities for analysis with the available.

77. The attached CRC's analysis of the Area report is valuable although it was prepared on a low budget and it too needs to be updated. Climate change impacts are moving quickly. A site assessment and NEPA analysis are required to model flooding impacts based on the most current data.

Low-Level Radioactive Waste (LLRW)

78. Pilgrim's LLRW, for example, includes the control rods, resins, sludge, filters, and will include the entire nuclear power reactor when it is eventually dismantled,[115] and is another potential source of contamination onsite and to Cape Cod Bay resulting in significant increased costs.
79. The waste is stored about 30 feet from Cape Cod bay.
80. The shoreline location makes it susceptible to climate change impacts; hence, a site and NEPA analysis is required.

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[115] High-Level Dollars Low-Level Sense, Arjun Makhijani, A Report of The Institute for Energy and Environmental Research, 1992

81. The LLRW waste will remain on the Pilgrim site, like the high-level radioactive waste, until an offsite repository accepts Pilgrim's LLRW. Massachusetts does not belong to any compacts.

Radiological Occupational and Public Dose Based on Outdated Documents- not protective public and worker health.

82. Holtec used the 2002 GEIS to base its decision on radiological impacts to the public and workers. (Holtec PSDAR 5.1.8) The outdated GEIS in turn ***used risk coefficients per unit dose recommended*** by the International Commission on Radiological Protection (ICRP) issued in 1991- **28 years ago**.

83. Holtec's assumed dose ignored new and significant information. The National Academies BEIR VII report (2006),[116] the most recent report from the National Academies, found far greater health impacts than the 1991 ICRP.

84. BEIR VII found mortality rates for women from exposure to radiation were 37.5 % higher than a BEIR 1990 report and that the impact of allowable radiation standards on workers was twice that estimated in 1991.

85. Allowable dose during decommissioning must be reduced to reflect BEIR VII, new and significant information supported by the Commonwealth,

86. BEIR VII lifetime risk model predicts that approximately **1 person in 100 would be expected to develop cancer (solid cancer or leukemia) from a dose of 0.1 Sv [10,000 millirem] above background**" (BEIR VII, p. 8) shows the risk from a lifetime (70 year) exposure to various levels of radiation. Exposure to 25 millirem/year equates to a lifetime cancer risk of

[116] https://www.nap.edu/catalog/11340/health-risks-from-exposure-to-low-levels-of-ionizing-radiation

175/100,000; whereas a 10 millirem/year equates to a lifetime cancer risk of 70/100,000-a significant difference when considering that EPA permits only 1 in 100,000.

Likely Adverse Health Impacts Expected in Special Pathway Receptor Populations and In the General Public

87. Holtec's PSDAR said: "Potential impacts to minority and low-income populations would mostly consist of radiological effects. Based on the radiological environmental monitoring program data from PNPS, the SEIS determined that the radiation and radioactivity in the environmental media monitored around the plant have been well within applicable regulatory limits. As a result, the SEIS found that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations (i.e., minority and or low-income populations) in the region as a result of subsistence consumption of water, local food, fish, and wildlife." (LTA, 5.1.13 Environmental Justice)
88. Discussed in the foregoing, the NRC's Groundwater Contamination (tritium) at Nuclear Plants Task Force Final Report, September 1, 2006[117] identified "that *under the existing regulatory requirements* the potential exists for unplanned and unmonitored releases of radioactive liquids to migrate offsite into the public domain undetected," (LLFT Executive Summary ii), showing the SEIS does not bound the environmental impacts and that a site assessment and NEPA analysis are required.

[117] NRC's Groundwater Contamination (tritium) at Nuclear Plants Task Force Final Report, September 1, 2006; https://www.nrc.gov/docs/ML0626/ML062650312.pdf

Spent Fuel Unlikely to Leave Site by 2062

89. Holtec assumes "DOE will commence acceptance of PNPS's spent fuel in 2030 and, assuming a maximum rate of transfer described in the DOE Acceptance Priority Ranking & Annual Capacity Report (Reference 10), the spent fuel is projected to be fully removed the Pilgrim site in 2062, consistent with the current DOE spent fuel management and acceptance strategy (References 9 and 10)." DCE, p. 23.78.

90. DOE's January 2013 *Strategy for The Management and Disposal of Used Nuclear Fuel and High -Level Radioactive Waste*. ("DOE Strategy"). [118] is simply "a framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing, and disposing of used nuclear fuel" (DOE Strategy, p. 1). It does even try to guess by when an interim or geologic repository might actually exist.

91. DOE qualifies its statement by saying, "With *appropriate authorizations from Congress*," Holtec does not, but should. There has been no enabling legislation in Congress.

92. There is significant opposition to both Holtec's planned interim site in New Mexico and ISP's in West Texas. Yucca has made no progress; there are hundreds of contentions opposing it,[119] along with anticipated lawsuits along transportation routes- from cities, states, environmental groups, such as NIRS[120]

93. Nuclear waste may be stored indefinitely. A site assessment and NEPA need to analyze this likelihood**.**

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118 https://www.energy.gov/sites/prod/files/Strategy%20for%20the%20Management%20and%20Disposal%20of%20Used%20Nuclear%20Fuel%20and%20High%20Level%20Radioactive%20Waste.pdf

119 http://www.state.nv.us/nucwaste/licensing/Contentions_NV.pdf.

120 Civilian Nuclear Waste Disposal, Congressional Research Service, Sept 6 2018. (https://fas.org/sgp/crs/misc/RL33461.pdf); www.NIRS.org

94. NRC's 2014 Continued Storage Rule discussed onsite storage for 100 years[121] that would be until 3019 for Pilgrim, 57 years longer than Holtec presumed; or indefinitely.

Radiological Accidents

95. Radiological accidents are neither remote, speculative nor worst case scenarios; instead they are reasonably foreseeable.

96. HDI (PSDAR, 5.19) concludes that the impacts of PNPS decommissioning on radiological accidents are small and are bounded by the previously issued outdated GEIS. NRC staff concluded in the SEIS that "there are no impacts of severe accidents beyond those discussed in the GEIS." (SEIS 5.1.2). Showing the SEIS does not bound the environmental impact, discussed below.

97. The GEIS was published in 2002 and is outdated. [122] For example, the BEIR VII Report was not published

98. The GEIS was also flawed. In assessing offsite related accidents, the GEIS only considered: seismic events, aircraft crashes (not small aircraft, that pose the more realistic and serious threat), tornadoes with high winds; and fuel related accidents-fuel drops and loss of water, ignoring the greatest danger the partial loss water in the spent fuel pool.

99. The GEIS and SEIS both ignore the escalating terrorist threat with US infrastructure, including nuclear reactors as targets. Both predate awareness of an increased threat from cyber-attacks,[123]

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[121] https://www.nrc.gov/waste/spent-fuel-storage/wcd.html

[122] Comments on The US Nuclear Regulatory Commission's Waste Confidence Generic Environmental Impact Statement, Dr. Gordon Thompson, December 19, 2013.

[123] December 15, 2017, NRC issues license amendment to Pilgrim to change the implementation date for cyber security *upgrades from December 15, 2017 to December 31, 2020 – after Pilgrim is closed**.***

drones, and electromagnetic attacks.[124] For example, while reactor safety systems are more or less isolated from an outside cyberattack, a hack knocking out the electrical grid system would shut down power to all reactor safety systems. On-site emergency power generators are then vulnerable to insider and armed assault seeking to cause a meltdown. Loss of electric grid may disenable security cameras.

100. The GEIS and SEIS incorrectly assert that the environmental impact of accident-induced or attack-induced pool fires is SMALL. That assertion is incorrect. The environmental impact is LARGE due to the large inventory of radionuclides in the pool.

101. Perhaps because Pilgrim's ISFSI did not yet exist, the GEIS and SEIS totally ignore ISFSI radiological accidents. The casks are vulnerable to attack and releases from cracks caused by age, corrosion, manufacturing defects. Each cask contains a huge amount of radioactivity and each cask contains >1/2 the Cesium-137 released at Chernobyl. The environmental impact is LARGE.

102. The GEIS and SEIS use an inappropriate arithmetic definition of radiological risk, probability times consequences. Holtec's and the GEIS' environmental impact determination with respect to severe accidents, is a risk assessment - the product of the probability and the consequences of an accident. This means that a high consequence low-probability events, like a severe accident, will result in a small impact determination, because the probability is determined to be low so no matter how severe the consequences they will be trivialized.

103. The incomplete and outdated GEIS and SEIS themselves make clear that a site assessment and NEPA analysis are required.

[124] ***Electromagnetic Defense Task Force*** (***EDTF***): ***2018 Report***. (Source: US Air Force's Air University; issued Nov 28, ***2018***). From 20–22 August ***2018***, Air University Website, LeMay Papers http://www.defense-aerospace.com/articles-view/release/3/198020/report-highlights-gaps-in-us-electro_magnetic-capabilities,

Spent Fuel Pool Accidents Ignored by the GEIS, SEIS and Holtec - Examples

104. **Fuel Handling Accidents**: Accidents can and do happen, even with single-proof cranes. For example at Vermont Yankee (May 2008)[125] . Another mishap or near-miss failure with a single-proof crane occurred at Palisades March 18, 2006 attirbutable to worker error[126]. Human error, either in operations or manufacturing, is not considered, as it needs to be, in the GEIS, SEIS or by Holtec

105. Canister Drop in Pool: If a cask is dropped in the pool and the pool floor is breached, there are many safety-related components located on the floors below the spent fuel pool which could be disabled that could simultaneously initiate an accident and disable accident mitigation equipment. If a hole is punched in the pool floor or walls and water is lost simply to the top of the assemblies, a pool fire will likely follow.

106. A canister drop can lead to a crack in the canister- especially a concern with HBU fuel. Each canister contains over ½ the Cesium-137 released at Chernobyl.

107. **Partial drain-down**: The GEIS did not recognize different consequences of both a full drain-down and a partial drain-down. This is an important omission because total drainage of the pool is not the most severe case of water loss. In a partial drain-down the presence of residual water would block air convection, e.g., by blocking air flow beneath the racks.[127] Previously, in filings made during a 2002 license-amendment proceeding, NRC staff assumed that a fire would be inevitable if the water fell to the top of the racks.

108. Pool Fire Ignition: A 10-hour minimum delay time for BWR SNF aged 10 months, as assumed by Holtec, is potentially plausible. But that is not the whole story. For example, an

[125] https://www.reformer.com/stories/nrc-reviews-vy-safety-system-after-crane-failure,65923
[126] https://www.nirs.org/press/03-20-2006/
[127] http://www.environmental-defense-institute.org/publications/Cover.Ltr.Thompson.NRC.SNF.Short.pdf

attack scenario could cause partial drain-down and a local radiation field precluding access; and a fuel handling accident during transfer from pool to dry casks - such as a cask drop.

109. Mitigation: Contrary to NRC's and Holtec's current estimate, 10 hours is not a guaranteed enough time to put out a spent fuel fire. An attack scenario could rapidly cause partial drain-down and result in a local radiation field that precludes access to the fire. There is no basis for assuming that a site's Flex program to provide supplemental water will be sufficient.

110. These must be considered in a new site assessment and NEPA analysis.

ISFI Accidents the GEIS, SEIS and Holtec Ignore

111. Holtec assumes that, "No contamination or activation of the ISFSI pads is assumed. As such, only verification surveys are included for the pad in the decommissioning estimate." (PSDAR, pg.,25). Holtec does not consider, as a site assessment and NEPA analysis should, something going wrong- acts of malice or leak from a crack. A new site assessment and NEA analysis is required.

Vulnerability Pools and ISFSI to Acts of Malice

112. Reactors make ideal targets for outside or inside attackers for the simple reasons that they contain large amounts of radioactivity that could create severe impacts, and their defense is "light" in a military sense.

113. The threat against nuclear power plants is real. According to the 9/11 Commission report, the Sept. 11, 2001 terrorists initially considered attacking a nuclear power reactor.[128] According to a new report "Protecting U.S. Nuclear Facilities from Terrorist Attack: Re-

[128]http://www.resilience.org/stories/2004-07-25/911-report-reveals-al-qaeda-ringleader-contemplated-ny-area-nuclear-power-plant-p

assessing the Current 'Design Basis Threat' Approach,"[129] prepared under a contract for the Pentagon by the Nuclear Proliferation Prevention Project (NPPP) at the University of Texas at Austin's LBJ School of Public Affairs finds that none of the 104 commercial nuclear power reactors in the United States is protected against a maximum credible terrorist attack, such as the one perpetrated on September 11, 2001, nor against airplane attacks, nor even against readily available weapons such as rocket propelled grenades and 50-caliber sniper rifles.

114. The design of GE BWR Mark I reactors like Pilgrim makes those reactors highly vulnerable to attack because their spent fuel pools are in the top floor of the reactor, outside primary containment with a light roof structure overhead

115. Pilgrim's spent fuel when removed from inside the reactor is placed in thin-walled dry casks. The casks are stacked vertically out in the open making them vulnerable to attack. Each cask contains about ½ the Cesium-137 released during the Chernobyl accident.

116. Pilgrim's spent fuel when removed from inside the reactor is placed in thin-walled dry casks. The casks are stacked vertically out in the open making them vulnerable to attack. Each cask contains about ½ the Cesium-137 released during the Chernobyl accident.

1 1 7 . Dr. Gordon Thompson also analyzed the impact of a shaped charge as one potential instrument of attack.[30] The analysis shows that the cylindrical wall of the canister is about 1/2 inch (1.3 m) thick, and could be readily penetrated by available weapons. The spent fuel

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[129] http://sites.utexas.edu/nppp/files/2013/08/NPPP-working-paper-1-2013-Aug-15.pdf

[30] Gordon R. Thompson, *Environmental Impacts of storing Spent Nuclear Fuel and High- Level Waste from Commercial Nuclear Reactors: A Critique of NRC's Waste Confidence Decision and Environmental Impact Determination* (Cambridge, Massachusetts: Institute for Resource and Security Studies, 6 February 2009). Tables also in Declaration of 1 August 2013 by Gordon R. Thompson: Comments on the US Nuclear Regulatory Commission's Draft Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a US Mark I Boiling Water Reactor

assemblies inside the canister are long, narrow tubes made of zirconium alloy, inside of which uranium oxide fuel pellets are stacked. The walls of the tubes (the fuel cladding) are about 0.023 inch (0.6 mm) thick. Zirconium is a flammable metal.

118. **Table 7-7: Performance of US Army Shaped Charges, M3 and M2A3**

119.

Target Material	Indicator	Type of Shaped Charge	
		M3	M2A3
Reinforced concrete	Maximum wall thickness that can be perforated	60 in	36 in
	Depth of penetration in thick walls	60 in	30 in
	Diameter of hole	• 5 in at entrance • 2 in minimum	• 3.5 in at entrance • 2 in minimum
	Depth of hole with second charge placed over first hole	84 in	45 in
Armor plate	Perforation	At least 20 in	12 in
	Average diameter of hole	2.5 in	1.5 in

Notes: (a) Data are from: Army, 1967, pp 13-15 and page 100. (b) The M2A3 charge has a mass of 12 lb, a maximum diameter of 7 in, and a total length of 15 in including the standoff ring. (c) The M3 charge has a mass of 30 lb, a maximum diameter of 9 in, a charge length of 15.5 in, and a standoff pedestal 15 in long.

120. **Table 7-8: Types of Atmospheric Release from a Spent-Fuel-Storage Module at an ISFSI as a Result of a Potential Attack**

Type of Event	Module Behavior	Relevant Instruments and Modes of Attack	Characteristics of Atmospheric Release
Type I: Vaporization	• Entire module is vaporized	• Module is within the fireball of a nuclear-weapon explosion	• Radioactive content of module is lofted into the atmosphere and amplifies fallout

Type II: Rupture and Dispersal (Large)	• MPC and overpack are broken open • Fuel is dislodged from MPC and broken apart • Some ignition of zircaloy fuel cladding may occur, without sustained combustion	• Aerial bombing • Artillery, rockets, etc. • Effects of blast etc. outside the fireball of a nuclear weapon explosion	• Solid pieces of various sizes are scattered in vicinity • Gases and small particles form an aerial plume that travels downwind • Some release of volatile species (esp. cesium-137) if incendiary effects occur
Type III: Rupture and Dispersal (Small)	• MPC and overpack are ruptured but retain basic shape • Fuel is damaged but most rods retain basic shape • No combustion inside MPC	• Vehicle bomb • Impact by commercial aircraft • Perforation by shaped charge	• Scattering and plume formation as for Type II event, but involving smaller amounts of material • Little release of volatile species
Type IV: Rupture and Combustion	• MPC is ruptured, allowing air ingress and egress • Zircaloy fuel cladding is ignited and combustion propagates within the MPC	• Missiles with tandem warheads • Close-up use of shaped charges and incendiary devices • Thermic lance • Removal of overpack lid	• Scattering and plume formation as for Type III event • Substantial release of volatile species, exceeding amounts for Type II release

121. **Types of Atmospheric Release from a Spent-Fuel-Storage Module at an ISFSI as a Result of a Potential Attack**

- One scenario for an atmospheric release from a dry cask would involve mechanically creating a comparatively small hole in the canister. This could be the result, for example, of the air blast produced by a nearby explosion, or by the impact of an aircraft or missile. If the force was sufficient to puncture the canister, it would also shake the spent fuel assemblies and damage their cladding. A hole with an equivalent diameter of 2.3 mm would release radioactive gases and particles and result in an inhalation dose (CEDE) of 6.3 rem to a person 900 m downwind from the release. Most of that dose would be attributable to release of two-millionths (1.9E-06) of the MPC's inventory of radioisotopes in the "fines" category.

- Another scenario for an atmospheric release would involve the creation of one or more holes in a canister, with a size and position that allows ingress and egress of air. In addition, this scenario would involve the ignition of incendiary material inside the canister, causing ignition and sustained burning of the zirconium alloy cladding of the spent fuel. Heat produced by burning of the cladding would release volatile radioactive material to the atmosphere. Heat from combustion of cladding would be ample to raise the temperature of adjacent fuel pellets to well above the boiling point of cesium.

122. Pilgrim's ISFI is being moved to higher ground to a location very close to Rocky Hill Road, a public thoroughfare. Most of the vegetation was removed to the street. A site and NEPA analysis should analyze its vulnerability.

Casks may corrode and leak – especially over a long period of onsite storage

123. Casks may remain onsite indefinitely subjected at Pilgrim, for example, to salt induced stress corrosion cracking and threatened by sea level rise. The thin (0.5") stainless steel canisters crack may crack within 30 years. No current technology exists to inspect, repair, or replace cracked canisters. With limited monitoring, we will only know after the fact that a cask has leaked radiation. [130]

124. NRC's Mark Lombard stated that there is no technology to find cracks or judge its depth in Holtec Casks[131]. (October 6, 2015)

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[130] San Onofre Dry Cask Storage Issues analyses at: https://sanonofresafety.files.wordpress.com/2011/11/drycaskstorageissues2014-09-23.pdf
[131] (https://www.youtube.com/watch?v=QtFs9u5Z2CA&t=17s)

125. Dr. Kris Singh said that it is not feasible to repair Holtec's steel canisters. (October 14, 2014).[132]

126. Holtec provides no information on Pilgrim's cask warranty. From San Onofre we understand a cask is guaranteed for manufacturing defects for 25 years and no warranty for corrosion.

High Burnup Fuel (HBU)

127. Pilgrim has approximately 35% HBU; yet the NRC is just starting a test to see whether the casks can handle it, with results not in until 2027

128. NRC Meeting Presentation Slides Dry Storage & Transportation of High Burnup, 9/6/18 meeting, slides 14 & 15: NRC said that storage and transportation of HBU is safe, providing no technical bases, for 60 years – no guarantee for longer storage when fuel may still be onsite.

Consequences of a spent fuel pool fire or cask rupture.

129. The GEIS, SEIS and Holtec minimize the potential consequences of a spent fuel pool fire or a cask rupture. The amount of radiation released likely would far exceed the EPA's one rem release limit,

130. Studies of the consequences of a spent fuel pool fire show huge, potential consequences, ignored by Holtec and the documents Holtec relies on.

- 2016 Princeton Study: A major Spent Fuel Pool fire could contaminate as much as 100,000 square kilometers of land (38,610 square miles) and force the evacuation of millions.[133]

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[132] (https://www.youtube.com/watch?v=QtFs9u5Z2CA&t=17s)

[133] Frank N. von Hippel, Michael Schoeppner, "Reducing the Danger from Fires in Spent Fuel Pools," Science & Global Security 24, no.3 (2016): 141-173 http://scienceandglobalsecurity.org/archive/sgs24vonhippel.pdf;Richard Stone, "Spent fuel fire on U.S. soil could dwarf impact of Fukushima," *Science,* May 24, 2016. (NRC variable at: http://www.sciencemag.org/news/2016/05/spent-fuel-fire-us-soil-could-dwarf-impact-fukushima

- 2013 NRC Study: A severe spent fuel pool accident would render an area larger than Massachusetts uninhabitable for decades and displace more than 4 million people.[134]
- 2006 Massachusetts Attorney General Study: $488 Billion dollars, 24,000 cancers, hundreds of miles uninhabitable[135]

131. Dry Cask: A typical cask would contain 1.3 MCi of cesium-137, about half the total amount of Cesium-137 released during the Chernobyl reactor accident of 1986. Most of the offsite radiation exposure from the Chernobyl accident was due to Cesium-137. Thus, a fire inside an ISFSI module from a terrorist attack or significant rupture of the cask could cause significant radiological harm[136] and huge expense.

132. The documents that Holtec relies upon, are outdated and factually incorrect. They do not bound environmental impact.

Holtec's LTA and previous environmental impact statements ignore potential costs from fires in structures, systems and components containing radioactive and hazardous material.

133. There is a serious concern about fire protection for the structures, systems, and components containing radioactive and hazardous materials in storage. Capabilities to monitor for and

[134] Consequence Study of a Beyond Design-Basis Earthquake Affecting the Spent Fuel Pool for A U.S. Mark I Boiling Water Reactor (October 2013) at 232 (Table 62) and 162 (table 33), Adams Accession NO ML13256A342)

[135] The Massachusetts Attorney General's Request for a Hearing and Petition for Leave to Intervene With respect to Entergy Nuclear Operations Inc.'s Application for Renewal of the Pilgrim Nuclear Power Plants Operating License and Petition for Backfit Order Requiring New Design features to Protect Against Spent Fuel Pool Accidents, Docket No. 50-293, May 26, 2006 includes a Report to The Massachusetts Attorney General On The Potential Consequences Of A Spent Fuel Pool Fire At The Pilgrim Or Vermont Yankee Nuclear Plant, Jan Beyea, PhD., May 25, 2006 (NRC RC Electronic Hearing Docket, Pilgrim 50-293-LR, 2—6 pleadings, MAAGO 05/26 (ML061640065) & Beyea (ML061640329)

[136] Environmental Impacts of Storing Spent Fuel and High-Level Waste from Commercial Nuclear Reactors: A Critique of NRC's Nuclear Waste Confidence Decision and Environmental Impact Determination, Gordon Thompson, February 6, 2009; Comments on the US Nuclear Regulatory Commission's Draft Consequence Study of a Beyond Design Basis Earthquake Affecting Spent Fuel Pool
for a US Mark 1 Boiling Water Reactor, Gordon Thompson, August 1, 2013, pg., 30

respond to these kinds of toxic emergencies are not addressed by Holtec. Fire in a building would result in increase in mixed waste impacting worker and public health.

Without a new Site assessment & NEPA analysis, we cannot determine what contamination needs remediation and measures must be taken to mitigate future contamination

134. Contrary to Holtec's apparent assumptions, the Pilgrim site is not "clean."

135. Holtec's previous environmental impact statements do not adequately consider the generation and storage of non-radiological contaminants both as currently existing and created during decommissioning of PPS and the continued operation and decommissioning of the ISFSI.

136. Holtec's previous environmental impact statements do not adequately consider the existence of unidentified or inadequately identified, characterized or quantified, radiological and non-radiological contamination.

137. Holtec's previous environmental impact statements do not adequately consider known and unknown contamination at Pilgrim resulting from previously identified tritium and other leaks, buried hazardous waste, opening with bad fuel and no filtration and blowing its filters in 1982.

138. Holtec's previous environmental impact statements do not adequately considered the possibility of site-specific impacts resulting from the plant's close proximity to residential neighborhoods (and potential airborne asbestos and lead contamination, as well as potential impacts from a radiological incident)

139. Holtec has provided no identification, characterization and quantification of species that may become listed as endangered or threatened in the next 100 or more years;

140. Climate change is expected to cause sea level rise and increases in the number and severity of storms and flooding. Holtec's previous environmental impact statements do not adequately consider this.

141. Holtec’s previous environmental impact statements do not adequately consider the unique environmental and economic impacts related to the length of indefinite spent fuel storage.

142. Holtec’s previous environmental impact statements do not adequately consider likely adverse health impacts expected in special pathway receptor populations and for that matter in the general public

143. Holtec’s LTA incorrectly assumed and concluded that the environmental impacts associated with planned PNPS site specific decommissioning activities are bounded by the previously issued environmental impact statement.” (Holtec PSDAR, 5.1)

144. Holtec’s assumed radiological occupational and public dose are based on outdated documents, and are inaccurate

145. Holtec’s LTA and previous environmental impact statements do not adequately consider potential radiological incidents at the site, including environmental impacts from the storage of spent nuclear fuel in both the pool and on the ISFSI that also includes impacts resulting from the possibility of terrorist attack.

146. Holtec’s LTA and previous environmental impact statements do not adequately consider potential environmental effects of continued storage of spent nuclear fuel, including the possibility of indefinite storage onsite and the possibility of a terrorist attack on stored spent nuclear fuel.

147. Holtec’s LTA and previous environmental impact statements do not adequately consider the possibility of accidents during transfers of spent nuclear fuel from the spent fuel pool to dry casks and from old dry casks to new dry casks or transfer have not been adequately considered

148. Holtec's previous environmental impact statements ignore potential costs from fires in structures, systems and components containing radioactive and hazardous material.

149. The license transfer agreement raises significant questions with respect to safety hazards and whether the health and safety of the public will be affected.

150. The LTA has environmental effects that may be major and are subject to NRC control.

A lack of sufficient funds to carry out decommissioning could result in significant adverse health, safety and environmental impacts, and would increase the need for an updated site assessment and environmental impact statement.

151. The NRC agrees that a shortfall in decommissioning funding would place public health, safety, and the environment at risk.

152. An updated site assessment and environmental impact statement is essential to reduce risks to the public health, safety and the environment.

153. An updated site assessment and environmental impact statement must consider both current and future conditions at Pilgrim, and whether Holtec Pilgrim and HDI are financially capable of dealing with potential adverse health, safety and environmental impact.

154. An updated site assessment and environmental impact statement must also consider the reasons that PNPS is now, and at least since September of 2015 has been, in the NRC's lowest category of operating reactors, Category 4.

155. An updated site assessment and environmental impact statement would show and confirm that Holtec has not adequately considered the potential environmental impacts of decommissioning, or the costs of mitigating the potential impacts that an updated site assessment and environmental impact would show.

156. An updated site assessment and environmental impact statement would show and confirm that the funds in Pilgrim's Decommissioning Trust Fund, or otherwise available to Holtec-Pilgrim and HDI are not sufficient to mitigate the potential health, safety and environmental impacts of decommissioning.

157. An updated site assessment and environmental impact would show and confirm potential costs that the Decommissioning Funding Cash Flow Analysis in Holtec's CDE does not take into account.

158. An updated site assessment and environmental impact would show and confirm that costs reflected in Holtec's LTA and Cash Flow Analysis rest on incorrect assumptions.

An updated site analysis or environmental impact statement would show and confirm that decommissioning costs will rise faster than inflation.

159. An updated LTA and site assessment and environmental impact statement would show and confirm that the Decommissioning Funding Cash Flow Analysis in Holtec's CDE incorrectly assumes that decommissioning costs will not increase faster than inflation.

160. An updated LTA and site assessment and environmental impact statement would show and confirm that the rates of increase in decommissioning cost are, and will be, higher than general inflation.

161. An updated LTA and site assessment and environmental impact statement would show and confirm that, as the NRC (NRC Questions and Answers on Decommissioning Financial Assurance) has found:

    d. The NRC formulas represent the cost to decommission today, not in the future. Id.

e. Due to rising costs, the future value of decommissioning will be much larger than the NRC formula calculated today.

f. Using the range of cost escalation rates based on NUREG - 1307, the increase in cost over a 20-year license renewal period would range from 2.5 to 5.6 times today's estimated cost, not counting costs that are not included in the formula, such as soil contamination.

g. The rates of increase in decommissioning cost are higher than general inflation.

162. An updated LTA and site assessment and environmental impact statement would show and confirm that the NRC findings that increases in decommissioning costs are higher than inflation:

h. As shown by Callan's 2015 Nuclear Decommissioning Funding Study, total decommissioning cost estimates rose 60% between 2008 and 2014. Callan, 2015 Report; and rose approximately 11% from the previous year.

i. As shown by Callan's 2018 Nuclear Decommissioning Funding Study, decommissioning costs increased at an annual rate of about 5.8 percent between 2008 and 2016, and total estimated decommissioning costs for all U.S. reactors has increased from $55.1 billion in 2008 to 88.1 billion in 2017 – i.e., by about 60% over the ten-year period.

An updated site analysis or environmental impact statement would show and confirm that Holtec Pilgrim and HDI do not have sufficient assets.

163. An updated LTA and site assessment and environmental impact statement would show and confirm that the only significant asset of Holtec Pilgrim and HDI is the Pilgrim Decommissioning Trust Fund.

164. An updated site analysis or environmental impact statement would show and confirm that the assets of Holtec Pilgrim and HDI are insufficient to cover costs of dealing with the environmental impacts

165. An updated site analysis or environmental impact statement would show and confirm that the assets of Holtec Pilgrim and HDI are insufficient to pay the decommissioning costs outlined in Holtec's LTA. For example,

166. An updated updated site analysis or environmental impact statement would show and confirm that the Pilgrim Decommissioning Trust Fund does not provide an appropriate basis to show that Holtec Pilgrim and HDI are financially qualified to accomplish the decommissioning or avoid placing the place public health, safety, and the environment at risk. For example:

- No Holtec entity except Holtec Pilgrim and HDI has any financial responsibility.
- There is no Parent Company Guarantee.
- Neither Holtec Pilgrim nor HDI has agreed to put any monies recovered from DOE into the Decommissioning Trust Fund.
- Because Pilgrim is "merchant plant" ratepayers cannot be required.to pay post-closure costs that Holtec Pilgrim and HDI have insufficient assets to pay.

167. An updated site analysis or environmental impact statement would show and confirm that the neither Holtec Pilgrim nor HDI is financially responsible.

168. An updated site analysis or environmental impact statement would show and confirm that Holtec's projected contingency allowance is not sufficient.

An updated site analysis or environmental impact statement would show and confirm that Holtec has not considered potential significant costs

169. An updated site analysis or environmental impact statement would show and confirm that Holtec's cost estimates ignore the cost of managing Low Level Radioactive Waste or its environmental impact.

170. An updated site analysis or environmental impact statement would show and confirm that Holtec's estimates do not consider costs likely to result from climate change impacts on the site, or the environmental impacts of climate change.

171. An updated site analysis or environmental impact statement would show and confirm that Holtec's costs estimates ignore both the environmental impacts of radiological accidents and the costs of mitigating radiological accidents.

172. An updated site analysis or environmental impact statement would show and confirm that Holtec's estimates do not consider ignore both potential costs from fires in structures, systems and components containing radioactive and hazardous material, and their related costs.

173. An updated site analysis or environmental impact statement would show and confirm that Holtec's cost estimates do not adequately increased costs for overhead and project management. resulting from consider delays in the work schedule.

174. An updated site analysis or environmental impact statement would show and confirm that Holtec's costs estimates do not include the funds that will be required for dealing with environmental impacts.

175. An updated site analysis or environmental impact statement would show and confirm that neither the economic impacts of decommissioning nor their resulting costs are "bounded" by the previously filed environmental impact statements.

176. An updated site analysis or environmental impact statement would show and confirm that it is unlikely that DOE will remove all spent fuel from the Pilgrim site by 2063. Holtec has not provided a sufficient or satisfactory basis for its assumption that DOE will do so.

177. An updated site analysis or environmental impact statement would show and confirm that nuclear waste may be stored at Pilgrim indefinitely.

178. An updated site analysis or environmental impact statement would show and confirm that Holtec's cost estimates do not consider costs of spent fuel management after 2063.

179. An updated site analysis or environmental impact statement would show and confirm that Holtec's cost estimates do not consider costs of maintaining security at the site after 2063.

180. An updated site analysis or environmental impact statement would show and confirm that Holtec will be required to continue paying ISFSI maintenance and security as long as spent fuel is on site.

181. An updated site analysis or environmental impact statement would show and confirm that Holtec's cost estimates do not consider the lack of funding for the construction of a Dry Fuel Transfer Station to move spent fuel into new dry casks, or for the purchase of new casks and labor and material costs to transfer spent nuclear fuel into new casks.

182. An updated site analysis or environmental impact statement would show and confirm that Pilgrim's the dry casks of spent nuclear fuel will have to be repacked before they can be

183. An updated site analysis or environmental impact statement would show and confirm that Holtec's assumed socioeconomics costs of decommissioning are outdated and incorrect.

184. An updated LTA and site analysis or environmental impact statement would show and confirm that Holtec's cost estimates do not consider pending state-law requirements that will decrease funds available for radiological decontamination.

185. An updated LTA and site analysis or environmental impact statement would show and confirm that Holtec's cost estimates do not consider DTF funds that would not be available if NRC does not grant Holtec's exemption request to use the DTF for spent fuel management costs and site remediation.

186. An updated LTA and site analysis or environmental impact statement would show and confirm that pending Massachusetts state-law requirements would decrease funds available for radiological decontamination.

187. An updated LTA and site analysis or environmental impact statement would show and confirm that exemption requests filed by Entergy may not be transferable to Holtec.

188. An updated site analysis or environmental impact statement would show and confirm that the proposed license transfer and PSDAR will lead to a shortfall in the amount of funding available to fully and safely decommission and radiologically decontaminate Pilgrim and manage its spent nuclear fuel. Any such shortfall could place public health, safety, and the environment at risk.

189. An updated site analysis or environmental impact statement would show and confirm that Holtec Pilgrim's and HDI's lack of sufficient decommissioning funds increases the need for such an updated site analysis and environmental impact statement.

190. The proposed license amendment does not simply confirm Pilgrim's current licenses.

191. The proposed license amendment requires the NRC to find that "Holtec Pilgrim LLC is financially qualified" and that Holtec Decommissioning International is both "technically and financially qualified."

192. The proposed license amendment deletes the requirements that Pilgrim's owner "provide decommissioning funding assurance of no less than $396 million," provide a Provisional Trust fund in the amount of "$70 million," and "have access to a contingency fund of not less than fifty million dollars."

193. The proposed license agreement deletes the requirement that the Decommissioning Trust agreement prohibit investments in the Pilgrim Owner's parent company.

The License Transfer Application cannot be approved until:

1. Holtec has conducted a new and comprehensive site assessment;
2. Holtec has submitted the Supplement to Applicant's Environmental Report required by 10 CFR 51.53(d);
3. The updated and accurate environmental report and the environmental review required by NEPA and NRC regulations have been completed,
4. Holtec has revised and updated its application to reflect the actual conditions at Pilgrim, and revised its PSDAR and DCE decommissioning estimates to reflect these conditions and the required environmental reports.

IV. ADOPTED CONTENTIONS

Pilgrim Watch adopts, and incorporates by reference, the Massachusetts Attorney General's Contentions in this proceeding together with all of the Attorney General's supporting bases and evidence. Should the Attorney General, for any reason, not proceed with any of her contentions Pilgrim Watch requests to take the contentions forward.

V. CONCLUSION

For the reasons stated, Pilgrim Watch should be granted standing, its Contentions should be admitted, and Holtec's License Transfer Application should be denied.

Respectfully submitted on February 20, 2019,

(Electronically signed)

Mary Lampert
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James B. Lampert
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<u>EXHIBITS</u>

Exhibit 1: Declarations (5)

Exhibit 2: Entergy's Legacy of Contamination at Pilgrim Nuclear Power Station

Exhibit 3: Pilgrim Nuclear Power Station Environmental Radiological Monitoring Report, November 15, 1983

Exhibit 4: Chronology of Events Pilgrim Nuclear Power Station, 1960-2015

Exhibit 5: Analysis of AREVA Flood Hazard Re-Evaluation Report Pilgrim Nuclear Power Station Plymouth, MA, CRC Consulting

EXHIBIT 1

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

In the Matter of	**Docket No. 50-293 & 73-1044 LT**
Entergy Corporation	
Pilgrim Nuclear Power Station	
License Transfer Agreement Application	

DECLARATION OF Mary Lampert

1. My name is Mary Lampert, director of Pilgrim Watch.
2. I live at 148 Washington Street, Duxbury Massachusetts. My house is approximately 6 miles from Pilgrim Station, across Duxbury and Plymouth Bays. I can see the reactor from my property.
3. The value of our property depends on the cleanliness of the environment and therefore we are concerned that there will not be sufficient funds to properly clean up the Pilgrim site. If, for example, the press later reports that there is runoff into the Bay or that the licensee is cutting corners, it would devalue my property, our chief financial asset. It is a valuable piece of property. We are retired so our assets are important.
4. My family and I enjoy the outdoors- especially the beaches in Duxbury, Kingston, Plymouth and Cape Cod Bay - all within sight of Pilgrim Station. Our three grown children and three, soon to be four, grandchildren visit in the summers to go to the beach, take the boat around the bays. We want to assure that they are safe. Young children are most susceptible to radiation exposure.
5. We try to purchase locally caught fish and shellfish and, in the summer local produce. We want to believe that it is safe. The NRC must require a thorough and early site assessment and NEPA analysis. Previous environmental assessments are outdated and incomplete.
6. Unless there is a proper site assessment at the start it will not be possible to determine whether Holtec International has enough money to do a proper job. I am concerned that Holtec International will run short of money and abandon the site leaving taxpayers, such as myself, to pay to complete the decommissioning.

7. We have lived in Duxbury over thirty years and are active in the community. We care about the town- our neighbors and fellow citizen's health and safety. Therefore, we are working to assure that decommissioning is done right and Holtec has sufficient money to do the job.
8. If NRC provides Pilgrim Watch with a hearing in this case, it will be able to present evidence showing the need for NRC to require modifying the proposed license transfer to address the concerns raised. This would serve to provide reasonable assurance that my family's health and safety and value of our property will be best protected. No other party that we know of is requesting intervention that has lived in the area for over 30 years; and has represented a public interest group before the Commission in roughly that number of years. Over that time, we have accumulated a considerable amount of information and contacts within the industry.

I declare, under penalty of perjury, that the foregoing statements are true and correct.

Signed this day February 20, 2019.

Mary Lampert (signed electronically)

148 Washington Street, Duxbury MA 02332

Tel 781.934.0389

Email: mary.lampert@comcast.net

EXHIBIT 1

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

In the Matter of — Docket No. 50-293 & 73-1044 LT

Entergy Corporation

Pilgrim Nuclear Power Station

License Transfer Agreement Application

DECLARATION OF JAMES B. LAMPERT

1. My name is James B. Lampert.

2. I am a member of Pilgrim Watch.

3. I now live, and since 1986 have lived, at 148 Washington Street, Duxbury Massachusetts, approximately 6 miles across open water from Pilgrim Nuclear Power Station (PNPS). I can see PNPS from my house.

4. The cleanliness of the environment affects the value of the house and property on which I live; our property depends on the cleanliness of the environment. If Holtec does not completely and properly decommission, or if there is a public perception to that effect, that would reduce the value of my house and property.

5. I enjoy, and make considerable use of, the outdoors- especially the beaches in Duxbury, and Kingston, Plymouth and Cape Cod Bays. I have owned a boat for more than 30 years and want to be assured that the beaches and bays are safe and free from radiological run-off from PNPS.

6. Unless there is a proper site assessment at the start it will not be possible to determine whether Holtec International has enough money to do a proper job. I am

concerned that Holtec International will run short of money and abandon the site leaving taxpayers, such as myself, to pay to complete the decommissioning.

7. We have lived in Duxbury over thirty years and are active in the community. I care about my, my family's and our neighbors and fellow citizen's health and safety.

8. If NRC provides Pilgrim Watch with a hearing in this case, I expect to present evidence showing that the Holtec's decommissioning cost estimates are inaccurate, and that an assessment of actual conditions at PNPS must be made, and that a new or supplemental environmental impact statement is necessary. I also expect that that I would be able to provide significant information that other intervenors likely would not.

9. I attended the Nuclear Decommissioning Citizen Advisory Panel (NDCAP) meetings referred to in the Pilgrim Watch Petition to Intervene and Hearing Request (Petition). At those meetings, I understood representatives of Holtec to say that Holtec itself has not decommissioned any nuclear reactor sites, that Holtec would not agree to be responsible for and pay any decommissioning costs that Holtec Pilgrim and Holtec Decommissioning Inc could not pay from the Pilgrim Decommissioning Trust Fund, that Holtec expected to sue the Department of Entergy (DOE) for reimbursement of costs that Holtec incurred for spent fuel management, and that Holtec would not agree to put any funds recovered from DOE into the Pilgrim Decommissioning Trust Fund.

10. I made the calculations discussed in the Petition relating to what decommissioning costs would likely be if the costs of decommissioning increased at an annual rate of 4%, or 1%, more that inflation. I am a graduate of Massachusetts Institute of Technology. I used calculators available on the Internet to make these calculations and believe that the calculations are correct.

I declare, under pains and penalty of perjury, that the foregoing statements are true and correct.

Signed this day February 20, 2019.

James B. Lampert es B. Lampert

148 Washington Street, Duxbury MA 02332

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EXHIBIT 1

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

In the Matter of **Docket No. 50-293 & 73-1044 LT**

Entergy Corporation

Pilgrim Nuclear Power Station

License Transfer Agreement Application

DECLARATION OF Molly Bartlett

1. My name is Molly Bartlett. I live at 1 Government Way, Gurnet Point, Plymouth, Massachusetts. I also own property at 226 Warren Avenue, Plymouth, Massachusetts. Both of these properties are less than 3 miles from Pilgrim Station.
2. The value of our property depends on the cleanliness of the environment and therefore we are concerned that there will be sufficient funds to properly clean up the Pilgrim site. If, for example, the press later reports that there is runoff into the Bay or that the licensee is cutting corners, it would devalue my property, our chief financial asset.
3. My family and I enjoy our natural environment- especially the beaches and Duxbury, Kingston, Plymouth and Cape Cod Bay - all within sight of Pilgrim Station. Additionally, we enjoy locally caught fish and shellfish and local produce. The cleanliness of our environment is of prime importance to our family's health. The NRC must require a thorough and early site assessment. Previous environmental assessments are outdated and incomplete. Unless there is a proper site assessment at the start it will not be possible to determine whether Holtec International has enough money to do a proper job.
4. Also, I am concerned that Holtec International will run short of money and abandon the site leaving taxpayers, such as myself, to pay to complete the decommissioning.
5. If NRC provides Pilgrim Watch with a hearing in this case, it will be able to present evidence showing the need for NRC to require modifying the proposed license transfer to address the concerns raised. This would serve to provide reasonable assurance that my family's health and safety and value of our property will be best protected.
6. I am a member of Pilgrim Watch and I have authorized Pilgrim Watch to represent me in this licensing Transfer proceeding.

I declare, under penalty of perjury, that the foregoing statements are true and correct.

Signed this day February 13, 2019.

Signature:

Name: Molly Bartlett

Address: 41 Beacon Street, #5, Boston, MA 02108 and 1 Government Way, Gurnet Point, Plymouth MA

Phone Number: 617-888-2744

EXHIBIT 1

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

In the Matter of

Docket No. 50-293 & 73-1044 LT

Entergy Corporation

Pilgrim Nuclear Power Station

License Transfer Agreement Application

DECLARATION OF Rebecca J. Chin

1. My name is Rebecca J. Chin. I live at 31 Deerpath Trail North, Duxbury, MA. My residence is within the Emergency planning Zone for Pilgrim Station.
2. The value of our property depends on the cleanliness of the environment and therefore we are concerned that there will be sufficient funds to properly clean up the Pilgrim site. If, for example, the press later reports that there is runoff into the Bay or that the licensee is cutting comers, it would devalue my property, our chief financial asset.
3. My family, including my married sons, and grandchildren, all residents of Duxbury and I enjoy our natural environment- especially the beaches and Duxbury, Kingston, Plymouth and Cape Cod Bay - all within sight of Pilgrim Station. Additionally, we enjoy locally caught fish and shellfish and local produce. The cleanliness of our environment is of prime importance to our family's health. The NRC must require a thorough and early site assessment. Previous environmental assessments are outdated and incomplete. Unless there is a proper site assessment at the start it will not be possible to determine whether Holtec International has enough money to do a proper job.
4. Also, I am concerned that Holtec International will run short of money and abandon the site leaving taxpayers, such as myself. to pay to complete the decommissioning.
5. If NRC provides Pilgrim Watch with a hearing in this case, it will be able to present evidence showing the need for NRC to require modifying the proposed license transfer to address the concerns raised. This would serve to provide reasonable assurance that my family's health and safety and value of our property will be best protected.
6. I am a member of Pilgrim Watch and I have authorized Pilgrim Watch to represent me in this licensing Transfer proceeding.

I declare, under penalty of perjury, that the foregoing statements are true and correct.

Signed this day February 8, 2019.

Signature Rebecca J. Chin

Name: Rebecca J. Chin

Address: 31 Deerpath Trail North, Duxbury, MA 02332

Phone Number: 781-837-0009

EXHIBIT 1

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

In the Matter of | Docket No. 50-293 & 73-1044 LT

Entergy Corporation

Pilgrim Nuclear Power Station

License Transfer Application

DECLARATION OF: David O'Connell

My name is David O'Connell, my family and I reside at 7 Center St., Kingston, MA which is approximately 7 miles from Plymouth Nuclear Power Station.

I feel privileged to have lived in this area for the last 42 years. Thirty- seven in Duxbury (about the same distance from Pilgrim) and the last 6 in Kingston. The physical beauty of where we live could not be better. Over the years we have enjoyed the beaches, sailing, lobstering and fishing the waters of Duxbury, Kingston, Plymouth and Cape Cod Bays. All of which are in close proximity to the Pilgrim Station.

After attending a recent presentation by representative of Entergy, Holtec and the NRC at Hotel 1620 in Plymouth, I left, not, feeling at all reassured that there was a well- conceived plan for decommissioning and restoration of the Pilgrim Station site.

I think it naive to suggest there will be enough funds to cover the cost decommissioning, site restoration and safety maintenance well into the future. To depend on financial markets to provide sufficient increases in worth to the decommissioning fund is unrealistic. Will there be enough funding to cover the cost of the possible degradation or some natural occurrence (sea rise for example) that compromises the waste containment system, if not, one then has to assume it falls on the tax payers to cover the cost?

Site assessment needs to be reevaluated and updated. Sea rise was barely addressed. Should a fault develop in the waste containment system which causes a flow of contaminated material into Cape Cod Bay, please be reminded that ocean currents are swift and far reaching. Think of the Gulf of Maine, Buzzards Bay, Long Island Sound and on and on.

NRC needs to provide Pilgrim Watch a hearing allowing it to show evidence as to why NRC should modify the proposed license transfer.

Please give your utmost consideration to the physical and financial health of my family and the tens of thousands who will be negatively affected by improper decision making.

As a member of Pilgrim Watch I have authorized Pilgrim to represent me in the license transfer proceedings.

I declare, under penalty of perjury, that the foregoing statements are true and correct.
Signed the day of February 15, 2019

David O'Connell
7 Center Street
Kingston, MA 02364
(617) 694-3918

<u>Exhibit 2</u>

Entergy's Legacy of Contamination at Pilgrim Nuclear Power Station, Cape Cod Bay Watch, July 2017

RAD-REPORT_2017.
07.18_VS3.pdf

Exhibit 3

Pilgrim Nuclear Power Station Environmental Radiological Monitoring Report, November 15, 1983, Boston Edison Company

PNPS REMP 1982
8305160136.pdf

Exhibit 4

Chronology of Events Pilgrim Nuclear Power Station, 1960-2015, Jones River Landing

PDF

CCBW-Time-Line_20
15.10.01_updated1.p

Exhibit 5

Analysis of AREVA Flood Hazard Re-Evaluation Report Pilgrim Nuclear Power Station Plymouth, MA, CRC Consulting

CRC-PNPS-Analysis-
Report_Dec2015_FIN

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of **Docket No. 50-293 & 72-1044 LT**

Entergy Corporation

Pilgrim Nuclear Power Station

License Transfer Agreement Application

CERTIFICATE OF SERVICE

Pursuant to 10 C.F.R. § 2.305, I certify that copies of PW's Petition for Leave to Intervene and Hearing Request have been served upon the Electronic Information Exchange, the NRC's e-filing system, in the above-captioned proceeding, on February 20, 2019.

Signed (electronically) by

Mary Lampert
Pilgrim Watch, director
148 Washington Street
Duxbury, MA 02332
Tel. 781.934.0389
Email: mary.lampert@comcast.net

DRAFT 3

Entergy's Legacy of Contamination at Pilgrim Nuclear Power Station

Cape Cod Bay Watch
A Program of the Jones River Watershed Association
55 Landing Road, Kingston, MA 02360
www.capecodbaywatch.org

July 2017

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Acronyms

µGy	Microgray
ALARA	As Low As Reasonably Achievable
BEIR VII	Seventh Biological Effects of Ionizing Radiation (National Academies of Science 2005 report)
Cr(VI)	Hexavalent chromium
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Agency
Gpd	gallons per day
H-3	Tritium
IARC	International Agency for Research on Cancer
ISFSI	Independent Spent Fuel Storage Installation
JRWA	Jones River Watershed Association
LLRW	low-level radioactive waste
LTR	License Termination Rule
MassDEP	Massachusetts Department of Environmental Protection
MassDPH	Massachusetts Department of Public Health
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MEMA	Massachusetts Emergency Management Agency
MERL	Massachusetts Environmental Radiation Lab
mg/L	Milligram/Liter
mGy	Milligray
MOU	Memorandum of Understanding
Mrem	Millirem
NEI	Nuclear Energy Institute
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	National Oceanic and Atmospheric Administration’s National Marine Fisheries Service
NRC	Nuclear Regulatory Commission
PCA	Plymouth-Carver Aquifer
pCi/L	picocuries per liter
PSDAR	Post Shutdown Decommissioning Activities Report
Rd	Rad
REMP	Radiological Environmental Monitoring Report

Executive Summary

Entergy's Pilgrim Nuclear Power Station is sited on the shore of Cape Cod Bay and above the Plymouth-Carver Sole Source Aquifer. Pilgrim has been releasing radioactive materials and other contaminants deliberately and accidentally into groundwater, surface water, and soils since it began generating electricity in 1972. Leaks of tritium have been documented since voluntary monitoring began in 2007 and leaks are still ongoing today. This report summarizes radiological contamination at Pilgrim, from both routine releases and accidental leaks.

Entergy announced that Pilgrim will shut down no later than May 31 2019, and is planning to refuel one last time in spring 2017. The Nuclear Regulatory Commission will allow Entergy to choose from a variety of strategies for decommissioning. The most common strategy is long-term "SAFSTOR," a process that would allow Entergy defer full decommissioning and cleanup of Pilgrim for up to 60-years. Under SAFSTOR, ongoing leaks and environmental contamination may not be fully addressed for 60 years. Contamination is currently migrating toward Cape Cod Bay and it will continue to do so. Pilgrim's location directly on the shoreline makes it increasingly vulnerable to climate change and sea level rise impacts, meaning more challenges for site cleanup and flushing of contaminants into the surrounding environment. With closure imminent, it is more important than ever to understand the extent of Pilgrim's environmental contamination. An independent site assessment and decontamination plan that goes beyond the inadequate NRC standards is needed. Along with radioactive contamination, cleanup plans should include Pilgrim's wastewater treatment plant leaching field and the reported chemical waste dumping site on the property. Regulators and elected officials need to step up oversight and ensure that the cleanup schedule is accelerated and decontamination is not postponed for 60 years. Pilgrim's buildings and structures are expected to be rubblized, but these should not be allowed to be buried on site where coastal impacts could continue to leach contaminants into Cape Cod Bay. Concrete remains should be tested for a wide range of pollutants and disposed of in an appropriate and safe manner that protects people and the environment.

Additionally, Entergy has built a dry cask storage facility very close to the shoreline and sea level, where large concrete "dry casks" will house highly toxic nuclear waste indefinitely on site. This precariously located storage area is currently within reach of rising tides, coastal storms, and saltwater degradation – creating a potential source of further radioactive waste contamination, long after Pilgrim shuts down. It is essential that this nuclear waste dry cask storage facility be made more robust, moved to a higher elevation farther away from Cape Cod Bay and securely protected from natural and man-made hazards, including acts of terror, until it can be shipped offsite. Although the Department of Energy is working to develop "interim and long-term

storage" for radioactive waste, none exist today. This hazardous material may remain in Plymouth for decades to thousands of years.

The legacy that Pilgrim leaves behind is one of stranded nuclear waste and radioactive contamination that will, at best, be managed but likely never completely cleaned up. In order to achieve the best result, it is critical that regulators and our elected officials ensure transparency and public participation in all phases of environmental cleanup at Pilgrim.

I. Introduction

Radioactive discharges from Pilgrim pose a regional threat to environmental quality, human health and the health of Cape Cod Bay's ecosystem. Discharges of radioactive tritium into groundwater pose a threat to Plymouth's sole-source aquifer and Cape Cod Bay's water quality and ecosystems." – Association to Preserve Cape Cod Position Statement, 2014.

This report documents ongoing radiological contamination of the environment by Entergy Nuclear Generation Company's[1] (Entergy) Pilgrim Nuclear Power Station (Pilgrim) in Plymouth, Massachusetts. It also identifies issues to be addressed during the facility's decommissioning, set to begin in May 2019. While Pilgrim discharges a variety of pollutants into the surface waters of Cape Cod Bay, groundwater, soil and air, this report focuses on Entergy's radioactive discharges. These discharges are part of routine operations and from unlicensed spills, leaks, and accidents, which have contaminated groundwater and soils at the site and are flowing into Cape Cod Bay.

Pilgrim has operated for 44 years, affecting the health of people and the environment of the region. Pilgrim's discharge of radioactive materials should cease and permits allowing for such discharges should be terminated. During decommissioning, heightened monitoring of potential radiological contamination from demolishing structures and rubblization or burying of contaminated concrete is needed. This is especially true as stormwater runoff is likely to increase as flooding increases and sea levels and groundwater levels rise as a result of global warming. Existing yard drains could increasingly become conduits for pollution into Cape Cod Bay. An accelerated time schedule should be set for the decommissioning process and a robust monitoring program will be a critical to direct a thorough cleanup of the site.

There are two kinds of radioactive materials: naturally-existing background radiation and man-made radiation not found in nature, such as iodine-131, cesium-137, cesium-134, colbalt-60, and manganese-54. Tritium, a radioactive isotope of hydrogen, is generated both naturally in the atmosphere and by nuclear reactions that are brought about through man-made processes. Exposure to man-made radiation, like Pilgrim's, can cause damage to the human body, including harmful genetic mutations, cancers, benign tumors, cataracts, birth defects, and reproductive, immune and endocrine system disorders. These impacts can affect humans as well as plants and wildlife.

Known lethal radionuclides being discharged to the environment intentionally and accidentally by Pilgrim include tritium, manganese-54, cesium-137, and cobalt-60. There are several reports showing "footprints" of radiation-linked diseases in communities near Pilgrim.[2]

The National Academies of Science published a report in 2005 about health effects of low levels of ionizing radiation.[3] The report, called BEIR VII (seventh Biological Effects of Ionizing Radiation), found that there is no safe level of radiation and even very low doses can cause cancer and other, non-cancer effects such as heart disease. Exposure to radioactivity over time, no matter how little, increases cancer risk, according to the World Health Organization's International Agency for Research on Cancer (IARC).[4] The conclusion is simple: no amount of radiation is safe.

Furthermore, the ecological health of flora and fauna has been completely ignored. While Entergy is required to conduct some sampling of radioactive materials in certain plants and fish around Pilgrim, this is only done to determine whether concentrations are safe for people who might be exposed by consuming contaminated food or water. There is no evaluation of harm to plant and animals themselves. There have been no assessments of the cumulative impacts from more than forty years of radiological emissions on local flora and fauna, including reproductive impacts or genetic changes.

This report also covers:

- Plans for long-term storage of high-level radioactive waste (spent nuclear fuel) at Pilgrim;
- current unsafe storage of so-called "low level radioactive waste" on site;
- issues with Pilgrim's industrial wastewater treatment facility;
- and reported "midnight dumping" of pollutants on the Pilgrim property.

State and federal governments have failed to provide a comprehensive overview of the issues that need to be addressed, and so the job has been largely left to citizen activists. We have made every effort to ensure that the information in this draft report is accurate and up-to-date, and welcome any comments and feedback at info@capecodbaywatch.org.

II. Pilgrim: Background and History

Entergy's Pilgrim plant is a Mark I "boiling water reactor" made by General Electric. This is the same design as the nuclear reactors that melted down during Japan's Fukushima Dai-ichi nuclear disaster in 2011.

Pilgrim is a merchant plant that has the capacity to produce up to 690 megawatts of electricity, which it sells to the New England electric grid, or ISO-New England. Boston Edison began construction of Pilgrim in 1967 and operations began in 1972 after the predecessor to the U.S. Nuclear Regulatory Commission (NRC), the Atomic Energy Commission, issued Boston Edison an operating license. The license was transferred to Entergy when it purchased Pilgrim in 1999.

Pilgrim has operated continuously since 1972, except for a long-term shutdown from April 1986 to January 1989 caused by a series of mechanical failures and a multitude of short-term emergency shutdowns, or SCRAMS, over the decades.[5]

Pilgrim is one of the worst performing commercial nuclear reactors in the U.S. In 1982, the NRC penalized Boston Edison $550,000 for violating regulations. In 1986, Pilgrim was ranked as one of the most unsafe reactors in the U.S., out of approximately 100 plants. Despite Pilgrim's deteriorated condition and poor safety record, in 2012 the NRC extended Pilgrim's operating license until 2032. The next year, in 2013, the NRC downgraded Pilgrim again due to operating failures and ranked it among one of the 22 worst performing reactors. Pilgrim was then placed under heightened federal oversight, which still continues today. In 2014, the NRC again downgraded Pilgrim's status to one of the 10 worst performing reactors. By 2015, Pilgrim was degraded yet again to a "Category IV" plant by the NRC – placing it in the bottom two performing plants in the nation. This most recent downgrade was based on numerous forced shutdowns and equipment failures, and is just one step away from mandatory shutdown by federal regulators. Only one other plant is currently in Category IV: Arkansas Nuclear. Like Pilgrim, this is an Entergy-owned facility.

In October 2015, Entergy announced that Pilgrim will close no later than May 31, 2019. Entergy could choose the "SAFSTOR" method of decommissioning, which will be a critical time when motoring environmental impacts and risks should be diligently pursued (see Section VII for more about decommissioning).

Since the closure announcement, Pilgrim has continued to be plagued by numerous equipment malfunctions and shutdowns. In 2016 alone, Pilgrim has experienced problems including ocean water too warm to provide required cooling, valve malfunctions in the condenser, a hydrogen leak in the turbine building, and falsified fire-watch reporting. The plant was shut down for nearly two weeks in September 2016 for a series of mishaps.

To top it off, Entergy recently requested to delay implementation of critical safety upgrades at Pilgrim until December 2019 – more than two years after the NRC's deadline for compliance, and about six months after Pilgrim's scheduled closure. After the Fukushima nuclear disaster in 2011, and because Pilgrim is the same design as the Fukushima reactors, the NRC recommended a series of safety upgrades, including installation of "hardened containment vents." These vents would help prevent radioactive release to the local environment if an accident were to occur. It was known before Pilgrim started operations in 1972 that its Mark I design was flawed and the containment structure was too small. The hardened vents are intended to overcome this design flaw. In late September, a Massachusetts Delegation, including Senators Markey and Warren and a long list of congressional representatives called on the NRC to reject Entergy's extension request. The issue is still pending.

Despite heightened NRC oversight triggered by the 2015 Category IV ranking, delayed safety upgrades, and continued mechanical problems and unplanned shutdowns, Pilgrim continues to operate. The NRC is currently carrying out the first of two intensive site inspections (Dec. 2016 and Jan. 2017) to review Pilgrim's status relative to these past problems. The twenty-person inspection team will be reviewing the plant's physical state and staff performance.

It is time for the NRC to shut Pilgrim down and begin decommissioning now, rather than allow it to shut down on its own accord in 2019.

1. LOCATION AND COASTAL IMPACTS

Pilgrim is located on the shore of Cape Cod Bay in Plymouth, Massachusetts, close to sea level. The coastal zone in which Pilgrim sits is subject to many coastal hazards, specifically those associated with sea level rise, flooding, storm surge and nor'easters (Figure 1).[6]

Entergy's property in Plymouth consists of approximately 1,700 acres of land,[7] ranging from sea level to nearly 300 feet above mean sea level.[8] It consists of about one mile of ocean frontage on Cape Cod Bay. Since 1970, Cape Cod Bay has been designated as an Ocean Sanctuary by the State of Massachusetts and is supposed to be protected from any activity that alters or endangers its ecology.[9]

Some of Pilgrim's critical infrastructure is located in Cape Cod Bay itself, including its cooling water intake structure, discharge channel, and jetties (Figure 2). The reactor building structure and foundation reach more than 30-40 feet below ground.[10]

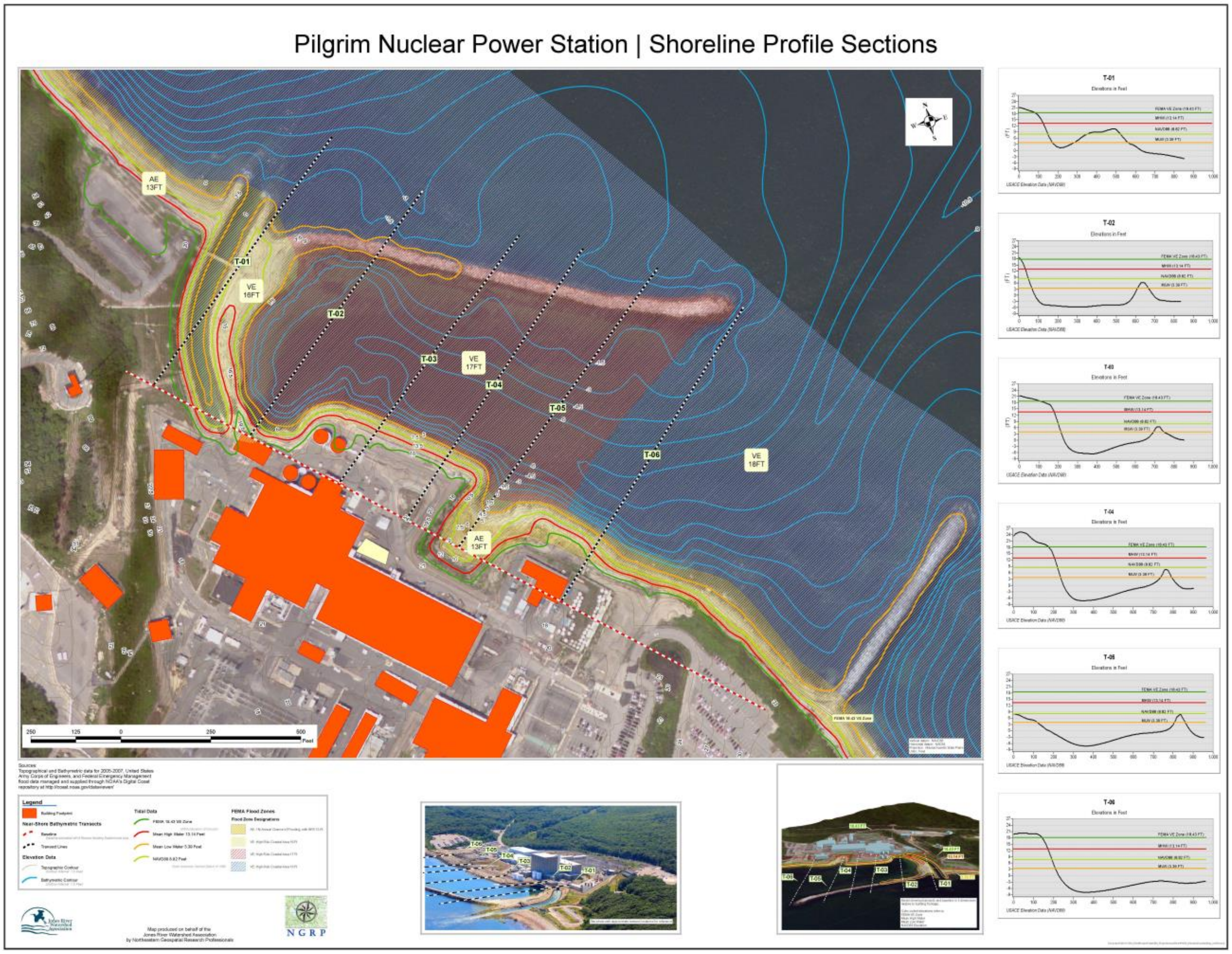

Figure 1. One of several maps developed by NGRP and JRWA as part of an elevation analysis of the Pilgrim Site. This map in particular shows that several surveyed locations reported by Entergy do not match current modeled elevation data, and that the protective jetty at the top of the map could be over-washed in several locations.

In order to maintain these structures, Pilgrim performs periodic maintenance and dredging in the waters of Cape Cod Bay – a public trust resource. After the 9/11 terrorist attacks in New York and Washington, Pilgrim was permitted to exclude public access to an area around its boundary, eventually set at 500 yards.[11] These activities impact the Ocean Sanctuary as well as the use of public "tidelands" under Massachusetts law.

Pilgrim is sited above the Plymouth-Carver Sole Source Aquifer (PCA).[12] The PCA is the second largest aquifer in Massachusetts and provides drinking water to seven towns.[13] The PCA was designated as a "sole source" drinking water aquifer by the U.S. Environmental Protection Agency (EPA) in 1990 at the request of the Massachusetts Department of Environmental Protection (MassDEP) under the Federal Safe Drinking Water Act. The coarse-grained soil, sand and gravel glacial outwash deposits that comprise the PCA are highly permeable and more susceptible to infiltration and migration of contaminates than less permeable soils. A number of private wells are located near Pilgrim, as are agricultural lands. Although some limited radiation monitoring has been performed in years past, these efforts have been reduced.

Given that Pilgrim will shut down by May 31, 2019, it is more important than ever to fully understand the risks associated with coastal hazards. Pilgrim's nuclear waste storage areas are currently located close to the shoreline. These areas are vulnerable to storm surge, rising sea levels, flooding, salt water degradation, and other coastal risks – raising concerns about potential accidents, leaks, and impacts to the health of Cape Cod Bay (see Section VI for more about waste storage).

Figure 2. Pilgrim Nuclear Power Station, showing jetties, cooling water intake canal (center), and discharge channel (right). (Photo: Marc Costa/CCS/Light Hawk)

Coastal impacts could also undermine successful remediation of contaminants on the site. Pilgrim has been releasing radioactive materials and other contaminants deliberately and accidentally into groundwater, surface water, and soils since it began operating in 1972. As sea levels increase, so do adjacent groundwater elevations. Contamination present on Pilgrim's site will, no doubt, continue to migrate toward Cape Cod Bay even after Pilgrim stops generating power (see Section VII for more about decommissioning).

III. RADIOLOGICAL STANDARDS AND LIMITS

The harmful impacts of extremely hazardous, radiation-releasing isotopes to the public and environment have not been adequately addressed by federal, state or local officials. Federal and state agencies are responsible for protecting public health and the environment from Pilgrim's radioactive emissions, yet risk and dose limits of the wide array of contaminants leave doubt that the limits are actually protective, given the high incidence of cancers and blood disease in the local region.

Various terms like "risk standards" and "dose limits" are used in order to deflect public concern about the toxic effects of Pilgrim's man-made radioactive emissions that have been released into the environment on an ongoing basis since 1972. These so-called limits are just measures of how much lethal radioactive material Entergy is allowed to discharge into our air, water and soils. If Pilgrim had never started operating, we would have only background levels[14] - or what would be expected to be found in the area if there were no additional man-made sources of contamination.

Various terms like "risk standards" and "dose limits" are used in order to deflect public concern about the toxic effects of Pilgrim's man-made radioactive emissions that have been released into the environment on an ongoing basis since 1972.

There is no "safe dose" of manmade radiation.

Radionuclide emissions are assessed in terms of dose limits (for drinking water and generic overall dose), concentration risk standards depending on the radionuclide (for drinking water), and reporting standards that vary depending on the radionuclide (for non-drinking water).

For the dose limit approach, the unit rem is used. Rem measures the damage done to living tissue. One rem equals 1,000 millirem (mrem). According to the NRC, the radiation dose received in one year by the average American from natural and man-made sources is about 620 mrem.[15] Others – including the U.S. Department of Energy and the Health Physics Society – report the average person receives about 300-369 mrem per year.[16]

The unit curie is different than the unit rem in that it describes the radioactivity of a substance. A picocurie is one trillionth of a curie. This unit can be used when measuring radioactive concentration if expressed as the total amount of radioactivity per unit volume (for example, picocurie per liter (pCi/L). To put the units rem and curie in perspective, an estimated 200 pCi/L of cesium-137 yields a dose of about 4 mrem per year. This relationship will change depending on the radionuclide in question (Table 4).

The NRC has adopted ALARA (as low as reasonably achievable) as a radiation safety principle for minimizing doses and releases of radioactive gas and liquid effluents.[17] For liquid effluents, such as tritiated water, the ALARA annual objective requires that a release must not result in a dose greater than 3 mrem to the whole body or 10 mrem to any organ for members of the public. The

NRC has established a generic dose limit of 100 mrem in one year to members of the public based on the impact from all sources of radioactive effluents combined (gas and liquid).

The NRC also has reporting levels for various radioactivity concentrations in environmental samples at Pilgrim (Figure 4). For instance, the non-drinking water reporting standard for tritium (H-3) is 30,000 picocuries per liter (pCi/L). The NRC also requires Entergy to report results of their Radiological Environmental Monitoring Program (REMP) reports on an annual basis, which summarizes Pilgrim's radioactive releases.

Nuclear facilities are also supposed to comply with EPA's 1979 radiation standard[18] that limits the annual dose to a member of the public to less than or equal to 25 mrem to the total body or organs.[19] The NRC incorporated these EPA standards into its regulations in 1981.

Table 1. Reporting levels for various radionuclides at Pilgrim. (Source: Table 3.5-4, Pilgrim Nuclear Offsite Dose Calculation Manual)

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Analysis	Water pCi/L	Airborne Particulate or Gases pCi/m^3	Fish pCi/kg, wet	Milk pCi/L	Food Products pCi/kg, wet
H-3	30,000 [(1)]	--	--	--	--
Mn-54	1,000	--	30,000	--	--
Fe-59	400	--	10,000	--	--
Co-58	1,000	--	30,000	--	--
Co-60	300	--	10,000	--	--
Zn-65	300	--	20,000	--	--
Zr-95	400	--	--	--	--
Nb-95	400	--	--	--	--
I-131	20 [(1)]	0.9	--	3	100
Cs-134	30	10	1,000	60	1,000
Cs-137	50	20	2,000	70	2,000
Ba-140	200	--	--	300	--
La-140	200	--	--	300	--

[(1)] Value adjusted for fact that no drinking water pathway exists at Pilgrim Station.

The National Academies of Science published the BEIR VII report in 2005 about health effects of low levels of ionizing radiation.[20] The report found that there is no safe level of radiation and even very low doses can cause cancer and other, non-cancer effects such as heart disease. The

NRC's allowable dose limit for the public is 100 mrem per year. The BEIR VII report estimates that this level, over a 70-year timeframe, will result in approximately one in 100 people developing cancer and one fatal case occurring.[21]

… there is no safe level of radiation and even very low doses can cause cancer and other, non-cancer effects such as heart disease.

To address the BEIR VII findings, EPA identified levels of radionuclides, such as tritium, in drinking water that would cause no adverse health effects, called Maximum Contaminant Level Goals (MCLG). These goals, focused solely on public health, are zero. Unfortunately, these goals are not enforceable. EPA has also set enforceable regulations for drinking water, called Maximum Contaminant Levels (MCL). These levels increased when costs and benefits of the goals were considered (as opposed to public health only). For beta particles (e.g., tritium, idodine-129, strontium-90, cesium-237), EPA's MCL is 4 mrem per year. For tritium, EPA estimates that the average concentration assumed to yield 4 mrem per year is 20,000 pCi/L (Table 4).

As for the state, the Massachusetts Department of Public Health (MassDPH) has established a screening level of 3,000 pCi/L for tritium in groundwater, meaning further investigation is undertaken if tritium levels are detected in excess of this level at Pilgrim.[22]

Regulators like the NRC, EPA and MassDPH often downplay the presence of tritium in groundwater at Pilgrim. In particular, MassDPH asserts that since no one is drinking water from Pilgrim's wells, everything is fine. MassDPH uses EPA's drinking water limit of 20,000 pCi/L to justify Pilgrim's unlawful, unpermitted leaks and discharges of radionuclides into the PCA as "safe."[23] This is not an adequate defense for allowing Entergy to continue to contaminate the groundwater with radionuclides as it has been doing on an ongoing basis since at least 2007. No level of groundwater contamination is acceptable, regardless of whether or not anyone is directly drinking the water from Pilgrim's wells. The PCA is a resource that belongs to everyone; it is not Entergy's to contaminate. In addition, Entergy has failed to adequately assess the groundwater flow direction and residents with wells in the area could indeed be drinking contaminated water. There has been no offsite testing of private drinking water wells for the type of radionuclides Pilgrim discharges into the groundwater.

1. Human Impacts

Radionuclides are a serious concern for public health. Exposure to radiation is known to increase the risk of damage to tissues, cells, and DNA and can cause genetic mutations, cancers, birth defects, and reproductive, immune and endocrine system disorders. There is no safe threshold to exposure to radiation.

Just because the standards and limits exist, it does not mean they are valid or safe.[24] According to a U.S. General Accounting Office Report in 2000, U.S. radiation standards for public protection, especially for low-level radiation, lack a conclusively verified scientific basis.[25] Many effects of radiation, especially from low-level doses, are largely unknown.

A study published in 1987 found five towns near Pilgrim with a 60% increase in leukemia rate, excluding leukemia not caused by radiation exposure.[26] The rate of myelogenous leukemia (the type most likely to be triggered by exposure to radiation) among males in the five towns was found to be 2.5 times greater than the statewide average.

In another study published in 1990, MassDPH investigated whether communities near Pilgrim had elevated leukemia rates associated with radioactive plant discharges. The report found a two to four-fold increase in risk of leukemia among residents of certain towns within a 20-mile radius from Pilgrim.[27] Pilgrim did not like the results and cut a political deal allowing it to appoint a second peer review panel to re-review the study and write a report. Even Pilgrim's hand-picked panel concluded that, "The original study team adhered to generally accepted epidemiological principles… [And] …the findings of the study cannot be readily dismissed on the basis of methodological errors or proven biases… [and last]…the association found link between leukemia and proximity to the Pilgrim nuclear facility was unexpectedly strong."

According to Dr. Richard Clapp, an epidemiologist and Professor Emeritus of Environmental Health at Boston University School of Public Health, "The effects of radiation exposure are cumulative. The radionuclides released from Pilgrim include substances that will remain active in the local environment for the foreseeable future and should be taken into account when actual on-going doses to the public and the environment are evaluated."[28]

> ***"…radionuclides released from Pilgrim include substances that will remain active in the local environment for the foreseeable future and should be taken into account when actual on-going doses to the public and the environment are evaluated." – Dr. Richard Clapp, MPH, DSc.***

2. Ecological Risk and Screening Levels

Radiation protection has historically focused on human health and safety. If plants and animals are tested for radionuclides, it has typically been for tracking potential threats to people as opposed to concern for the environment itself. However, more recently it has become evident that environmental health is strongly tied to economic, social, and health issues. As a result, there has been a higher priority to the protecting the environment directly (i.e., biological diversity, conservation of species, and the health of natural habitats and ecosystems).[29]

Radioecology, the study of radioactive materials in the environment (e.g., movement and accumulation within ecological systems, and effects on species, populations, communities, and ecosystems) is a growing field but many gaps still exist. The relationships between radiation dose levels and effects on animals and plants are still not well understood. Much of the existing data focus only on effects to individuals and acute exposure, and not so much on populations or communities and chronic lower dose exposures.

With humans we know that health risks increase with increased radiation exposure. However, with wildlife, some studies have found chromosomal abnormalities stay constant and there is an increase in embryonic mortality, even when radiation doses decrease over time – suggesting that chronic low doses of radiation may be more detrimental to non-human biota than previously assumed.[30] Some potential population-level effects have also been found at doses below what was previously assumed to be safe.[31]

…chronic low doses of radiation may be more detrimental to non-human biota than previously assumed.

Concerns for plants and animals include increased mortality, decreased fecundity, and a variety of other sub-lethal effects, and mammals, birds, fish, amphibians, reptiles, crustaceans, insects, and mollusks are among the most sensitive organisms.[32] In terms of reproductive impacts, fish may be the most sensitive in the marine environment.[33]

It is interesting to note that dose limits for plants and wildlife exist in some contexts; however, these limits do not apply to commercial nuclear power reactors in the U.S. At no point does the NRC, EPA, or state directly consider or limit the impacts of radionuclides on plants or wildlife.

The U.S. Department of Energy (DOE) has developed non-human biota dose limits for the protection of populations from effects of ionizing radiation at DOE facilities.[34] Below these limits, populations of wildlife and plants are unlikely to be harmed by ionizing radiation, however individual organisms within populations could still be harmed (Figure 3).

The European Union has also developed dose limits for the protection of ecological resources. However, again these limits would not apply to Pilgrim. The European Union determined that a rate of 10 µGy/hr (0.024 rd/d) to be the "no effect dose rate" for chronic radiological exposure to terrestrial, freshwater, and marine/estuarine ecosystems, meaning 95% of the species in these systems are protected from chronic exposure if the rate does not exceed this limit (Figure 3).

It has been suggested by officials at the New York State Department of Environmental Conservation that these limits are not appropriate when rare, threatened, or endangered species are present.[35] In those circumstances, site-specific values must be developed for the protection of individual organisms.

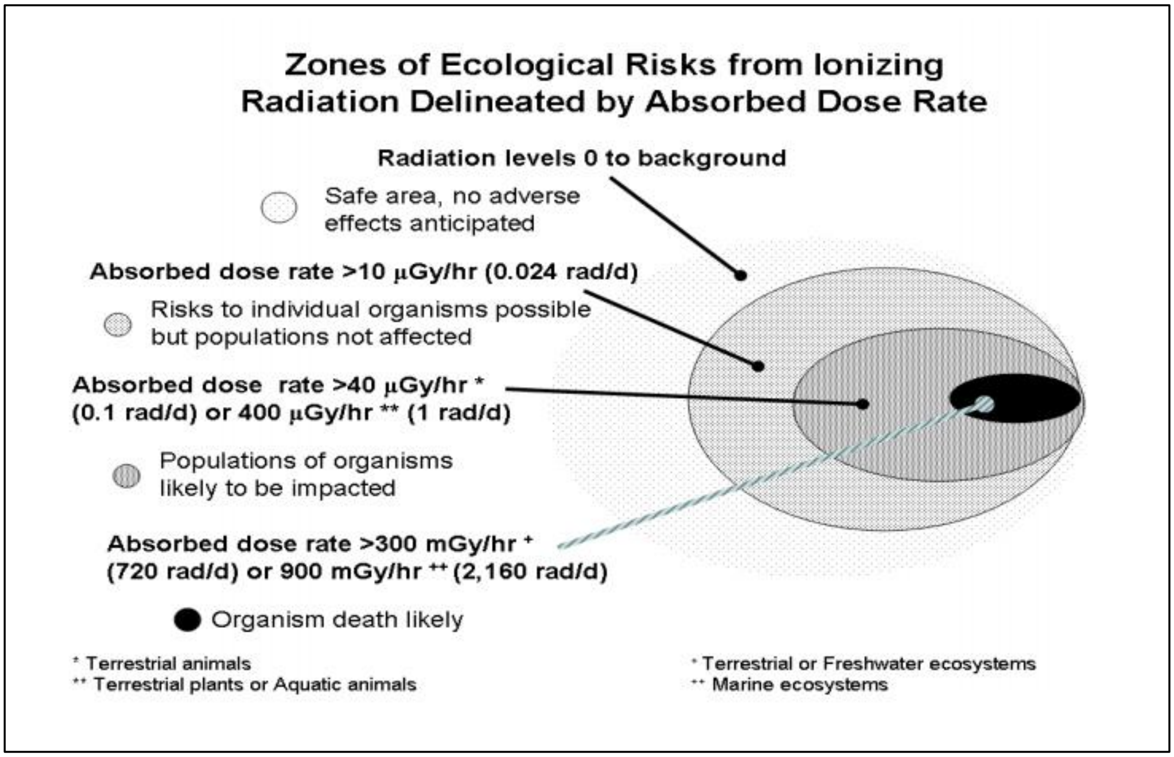

Figure 3. Levels of ecological risk for individuals and populations that can be associated with increasing levels of ionizing radiation. (Source: NY Dpt. of Environmental Conservation, 2014.)

In the case of Pilgrim, not only are there no limits to directly protect ecological resources, but Cape Cod Bay and its coastline are also home to an array of rare and protected species. There are approximately 140 species protected by the Massachusetts Endangered Species Act in Cape Cod Bay or in the coastal areas adjacent to the Bay. There are eight marine species under the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) jurisdiction that have the potential to be in the immediate vicinity of Pilgrim and are protected under the Federal Endangered Species Act. This includes the North Atlantic right whale, which is one of the rarest large whales in the world that has critical habitat just offshore from Pilgrim.

Under state law Cape Cod Bay has been a protected "Ocean Sanctuary" since 1970[36] and is ranked as a "SA" water body, meaning it is an "excellent habitat for fish, other aquatic life and wildlife." Pilgrim's operations cause impingement and entrainment of billions of marine organisms each year, including species of special concern. Furthermore, the plant's impact to flounder have required hatchery releases to attempt species restoration. This calls into question whether the "excellent habitat" standard is being upheld near Pilgrim. Under federal law, Cape Cod Bay is also designated as critical habitat for right whales – an area critical to the species' survival.[37]

Pilgrim's operations could negatively impact the primary food source for right whales, copepods, or even the whales directly by the discharge of radioactive waste. Pilgrim regularly discharges thousands of gallons of radioactive water through surface water outfalls directly into Cape Cod Bay. Entergy believes that dilution by sea water solves the problem of radioactive waste pollution; however, the potential negative impacts to right whales and important features of their critical habitat area should be considered by regulators.

There will continue to be implications for plants and wildlife after Pilgrim shuts down if uncontrolled radioactive leaks occur from nuclear waste storage areas or if the groundwater and soils are not promptly cleaned up. Human protection limits should not be assumed to automatically protect plants and wildlife in the vicinity of Pilgrim, especially threatened and endangered species. Some non-human biota may be in high-dose locations that humans are not (i.e., in the soil), or could be susceptible to low doses of radiation over an extended time frame.

3. Limits to Voluntary Groundwater Testing

Tritium is a radioactive isotope of hydrogen with a 12.5 year half-life.[38](Read more about tritium in Section V). Exposure to radioactivity over time, no matter how little, increases cancer risk, according to the World Health Organization's IARC.[39] The NRC adopted the Nuclear Entergy Institute's (NEI)[40] Voluntary Groundwater Protection Initiative in 2007 to test for tritium in groundwater. NEI proposed the monitoring initiative in 2006 after tritium was being found at high levels at several nuclear facilities throughout the U.S. This initiative is nothing more than an unenforceable set of "guidelines" established by the industry to police itself.

Entergy began with six monitoring wells at Pilgrim in 2007 as recommended by industry and as a result of a nation-wide initiative. Tritium was detected in groundwater at Pilgrim as soon as the testing began in 2007. Leaks likely occurred before this time but no monitoring was in place.

Normal background levels for tritium, while variable depending on soils, rock type, wind, and drainage, are typically 5-25 picocuries per liter (pCi/L) in surface water and about 6-13 piC/L in groundwater. MassDPH's established screening level is 3,000 pCi/L for tritium in groundwater, meaning further investigation is undertaken if tritium levels are detected in excess of this level at Pilgrim. When testing began in 2007, levels as high as 3,300 piC/L were recorded. Over the past seven years, tritium levels have consistently been much higher than background levels ranging from annual highs of 70,599 piC/L in 2013 to 1,726 piC/L in 2009 (see Section V for a full history of tritium leaks at Pilgrim).

In July 2010, 25,000 picocuries per liter (pCi/L) of tritium was found in one of Pilgrim's wells. MassDPH's Bureau of Environmental Health – charged with the broad mission of protecting public health from a variety of environmental exposures -- recommended that Entergy install additional wells and start testing surface water in Cape Cod Bay. By August 2010, Entergy installed 6 additional wells. Over time, and due to additional detections of tritium, Entergy has installed even more monitoring wells. Today, Entergy collects samples from 23 groundwater monitoring wells and two surface water locations (Figure 4).[41] The samples are split between two labs – one lab contracted by Entergy and the other is the Massachusetts Environmental Radiation Lab (MERL). MassDPH officials, as well as the Massachusetts Emergency Management Agency (MEMA) and the NRC are provided with the results.

Figure 4. Approximate locations of groundwater monitoring wells around the Pilgrim facility. (Source: MassDPH)

Tritium contamination has been found every month since testing began in 2007. Instead of requiring a cleanup, the NRC and MassDPH simply allowed Entergy to install more wells, while continuing to operate and continuing to leak and discharge radioactive contamination into the environment. MassDPH merely requires Entergy to collect more samples, rather than halt contamination that threatens the health of important environmental resources.

In addition to being unenforceable, another problem with the volunteer program is that Pilgrim's groundwater wells are sampled only for gamma-emitting nuclides and tritium. Minimal requirements exist for analyzing beta- and alpha-emitting radionuclides. Today's radiological monitoring requirements were applicable to nuclear operations in the 1970s (i.e., higher gamma-emitting radionuclides), but today new technologies exist that have created new waste streams (i.e., lower fraction of gamma-emitting radionuclides and a higher fraction of weak beta-emitters). In other words, outdated testing that is used today could be missing radionuclides significant to public and environmental health.

…outdated testing that is used today could be missing radionuclides significant to public and environmental health.

More information is also needed about the groundwater flow direction and hydrology at the Pilgrim site to understand the true extent of the contamination. Some sources estimate that groundwater on the site flows north and east toward Cape Cod Bay at an average rate of 0.4 feet (0.1 meter) per day.[42] On the other hand, MassDPH states that groundwater could flow in the southeast direction on some areas of the site. Both are possible. Pilgrim's reactor building and foundation reach forty feet below ground, cutting through many soil layers, and it is unknown how this vertical connection between layers affects groundwater flow.[43]

Six years ago, MassDPH admitted that additional data are needed since variations of flow on the site have not been well characterized and it is unknown how subsurface conditions may have changed since the plant was first constructed. Yet, no action has been taken to further characterize the groundwater flow direction despite documented tritium leaks on the site since at least 2007.

Relatively few datasets exist for groundwater elevations on the Pilgrim site. Some sources show that elevations on the site vary by location and tide cycle and are estimated to be 0-14 feet below ground.[44] It is important to note that groundwater elevations on site and locally in the PCA will change with tidal fluctuations, and will also increase over time with sea level rise. Rising groundwater levels also impact the capacity of the ground to absorb rain or flood water, potentially contributing to more site-wide flooding at Pilgrim, as suggested in Pilgrim's own reporting.[45] How this influences the distribution and flow of contamination on site is unknown, but must be understood to effect proper safeguards and ultimately decontaminate the site.

IV. Routine Releases

Pilgrim routinely releases radioactive materials to the environment as part of its operations in the form of liquids and gases.[46] These releases are allowed by the NRC, as long as they meet certain limits. Planned releases at Pilgrim include both continuous radioactive emissions and routine batch-releases to the surface water of Cape Cod Bay. The NRC requires Entergy to summarize and report Pilgrim's radioactive releases in REMP reports on an annual basis. As discussed in Section III, there are concerns associated with radiological standards and limits approved by regulatory agencies. For example, cumulative impacts nor impacts to flora and fauna are considered when agencies set these purportedly "safe" limits.

REMP reports are intended to monitor levels of radioactivity in the environment and ensure that potential impacts of radiation are detected. However, REMP reports prepared by Entergy at the end of the year summarize what it has discharged the prior year, which does nothing to prevent excessive amounts of radiation from being discharged.

In addition to the REMP reports, Entergy is required by the NRC to conduct some radiation monitoring at locations outside the Pilgrim site. As part of the state's Emergency Planning Zone radiation sampling program, MassDPH also collects samples, but funding constraints prevent a full assessment of the extent of Pilgrim's contamination. Groundwater testing performed by Entergy and the State is only carried out in monitoring wells located on the Pilgrim site; no offsite groundwater testing is done.

1. Discharges to Cape Cod Bay

The Federal Clean Water Act does not regulate radioactivity from the nuclear power industry; therefore, the EPA does not monitor Entergy's routine discharge of radioactive materials into Cape Cod Bay, even though they are a part of routine operations. Pilgrim routinely discharges thousands of gallons of radioactive effluent by eleven surface water outfalls directly into the surface waters of Cape Cod Bay.[47] From 2010 to 2012, Pilgrim discharged more than 478 billion gallons of diluted radioactive effluent (more than 465,000 gallons undiluted) into Cape Cod Bay through its surface water outfalls. Forty different discharges contained a total of over 7 curies of radioactive products, including tritium. This is an excessive level when compared to EPA's MCL for tritium in drinking water which is 4 mrem per year (an average concentration of 20,000 pCi/L is estimated to result in 4 mrem per year).

From 2010 to 2012, Pilgrim discharged more than 478 billion gallons of diluted radioactive effluent (more than 465,000 gallons undiluted) into Cape Cod Bay through its surface water outfalls.

The NRC simply requires Entergy to self-report discharges of lethal radionuclides into Cape Cod Bay via its REMP reports. The NRC never tests Pilgrim's radioactive discharges to see if Entergy's reports are accurate, nor does any other government agency.

In order to reduce the contamination levels to the NRC allowable limits, Entergy just dilutes the highly contaminated wastewater. The 478 billion gallons it discharged from 2010 to 2012 started out as more than 465,000 gallons of undiluted, highly-contaminated radioactive water. Entergy had to add about 472 billion gallons of non-contaminated water in order to achieve levels acceptable to the NRC.

Pilgrim's liquid radioactive waste system collects waste in sumps and drain tanks at various locations. The waste is then sent to a receiving tank for processing or disposal. The "liquid waste effluent discharge header" has a shielded radioactivity monitor. The radiation monitor is designed to set off an alarm before radioactivity levels exceed release limits. However, some liquid waste sources said to contain "very low levels of contamination," may be discharged directly to the discharge canal that dumps directly into Cape Cod Bay without passing through the liquid radioactive waste discharge header.

One source of the liquid waste that bypasses the radioactive waste discharge header is the neutralizing sump. Prior to discharging such liquid wastes, the tank is mixed and a representative sample is collected for analysis of radioactivity prior to discharge. One means of adjusting liquid radioactive waste concentrations to below federal limits is by simply mixing plant cooling water from the condenser with the liquid effluents in the discharge canal. This larger volume of cooling water dilutes the radioactivity levels to below the release limits. Entergy regularly practices dilution as a solution to deal with water contaminated with radioactive waste.

2. DISCHARGES TO GROUNDWATER

In 1991, Pilgrim's wastewater treatment plant was built and began treating its regular discharge of pollutants into groundwater and soils (prior to 1991, Pilgrim only used an on-site septic system for wastewater). At that time, Pilgrim's owner was required by the state Clean Waters Act to treat wastewater flows over 15,000 gallons per day (gpd) to a higher level than could be accomplished using Title 5 technology. Since Pilgrim's groundwater discharge permit was approved in 1988 for a maximum flow of 37,500 gpd, state regulations required a wastewater treatment plant be installed.[48] Wastewater from industrial operations is sent to the wastewater treatment building and then is discharged to a leaching field (Figure 5). These discharges enter the groundwater and soils, which are part of the PCA (see Section II for more about the PCA).

MassDEP's permit for Pilgrim's wastewater treatment plant, which was originally issued in 1989, is inadequate and allows Entergy to discharge pollutants at levels that would be prohibited if it were a municipal wastewater treatment plant. MassDEP has rolled back pollution limits for Entergy and completely eliminated limits for chloride and total dissolved solids in Pilgrim's newest 2007 permit – both of which are unlawful since, when renewing water pollution permits, MassDEP is supposed to apply limits "at least as stringent" as prior permits.

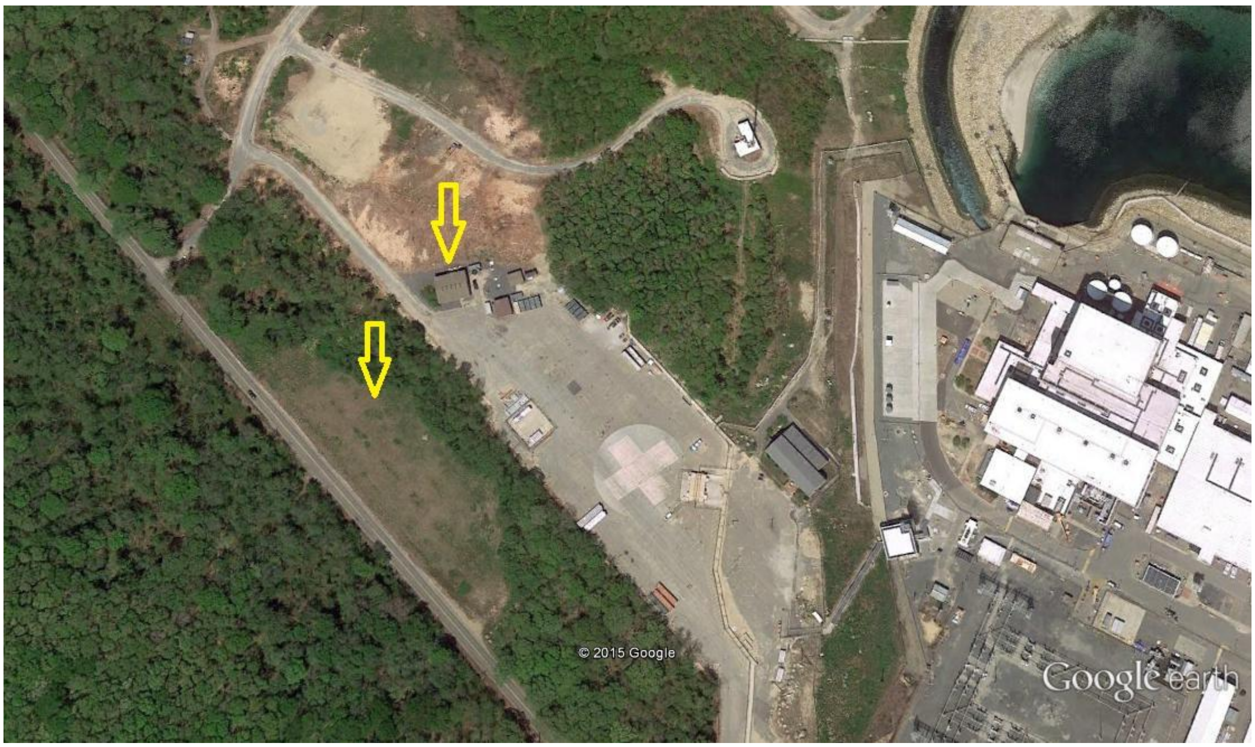

Figure 5. Northern side of the Pilgrim site. Yellow arrows point to the wastewater treatment building and the leaching field just off Rocky Hill Rd., Plymouth.

Entergy has repeatedly and chronically violated the nitrogen pollution limit set by MassDEP in Pilgrim's permit. MassDEP standards require municipal wastewater treatment facilities (including the Town of Plymouth) to discharge a maximum nitrogen limit of 10 mg/L. However, Pilgrim's nitrogen discharges to the ground regularly exceeded that limit by up to twelve times in 2012. Nevertheless, MassDEP has allowed Entergy to delay compliance with this limit from 2007.

Although not a radioactive form of pollution, Nitrogen is still a major concern for Cape Cod Bay and worth outlining in this report. Once excess nitrogen passes though soils and groundwater, it ends up in surface waters where it promotes algal growth and decay. This condition depletes the oxygen supply in the water, making it difficult for fish, sea grass, and other marine life to thrive.

Excess nutrient loading is one of the greatest threats facing water quality in Massachusetts' coastal estuaries and bays. Government and private groups dedicate extensive resources to mitigate and clean up nitrogen pollution in Cape Cod Bay; however, Entergy has been allowed to exceed pollution limits without any ramifications. State officials have failed to take any action to stop this pollution.

MassDEP has also improperly classified Pilgrim's wastewater as "domestic" instead of "industrial," and applies lower standards that accompany a domestic permit. If Pilgrim were properly classified as industrial user, which it clearly is, Entergy would be required to comply with stricter regulations.

Another concern and possible source of pollution is Entergy's "sludge press" at Pilgrim. In 2008, Entergy added an industrial sludge press in the wastewater treatment building. The press is used to extract radionuclides from the facility's process water. It is unclear where Entergy is disposing of sludge from this industrial press. There is also concern that radioactive materials passing through the sludge press or the wastewater treatment plant are being discharged to the leaching field. Based on current knowledge, there has been no regular testing of these discharges for radioactive materials.

V. Unpermitted Releases

Over the years, Pilgrim has had a number of unpermitted leaks into the groundwater and soils on the site. Due to these leaks, a number of lethal radionuclides, including tritium, manganese-54, cesium-137, and cobalt-60, have been found in the surface water, groundwater, and soils at Pilgrim at levels exceeding "background" levels - or what would be expected to be found there if there were no man-made source of contamination.

As discussed in Section II, Pilgrim is sited above the PCA, which makes these unpermitted leaks even more concerning. The PCA is the second largest aquifer in the state that provides drinking water to seven towns and supports a variety of natural resources (Figure 6).

1. Buried pipes and tanks

Beneath Pilgrim is a network of underground[49] pipes and tanks. These components are made from a variety of materials, including concrete, carbon steel, stainless steel, titanium and have external coatings and wrappings – much of which is susceptible to age-related and environmental degradation.

Underground piping at nuclear facilities is designed to support safety and non-safety related systems including fire protection, emergency diesel generator fuel oil, cooling, gas treatments, salt service water, and more.[50] Some of these pipes and tanks contain industrial process and wastewater contaminated with radionuclides, and degradation of these components can lead to leaks of toxic materials into groundwater and soils.[51]

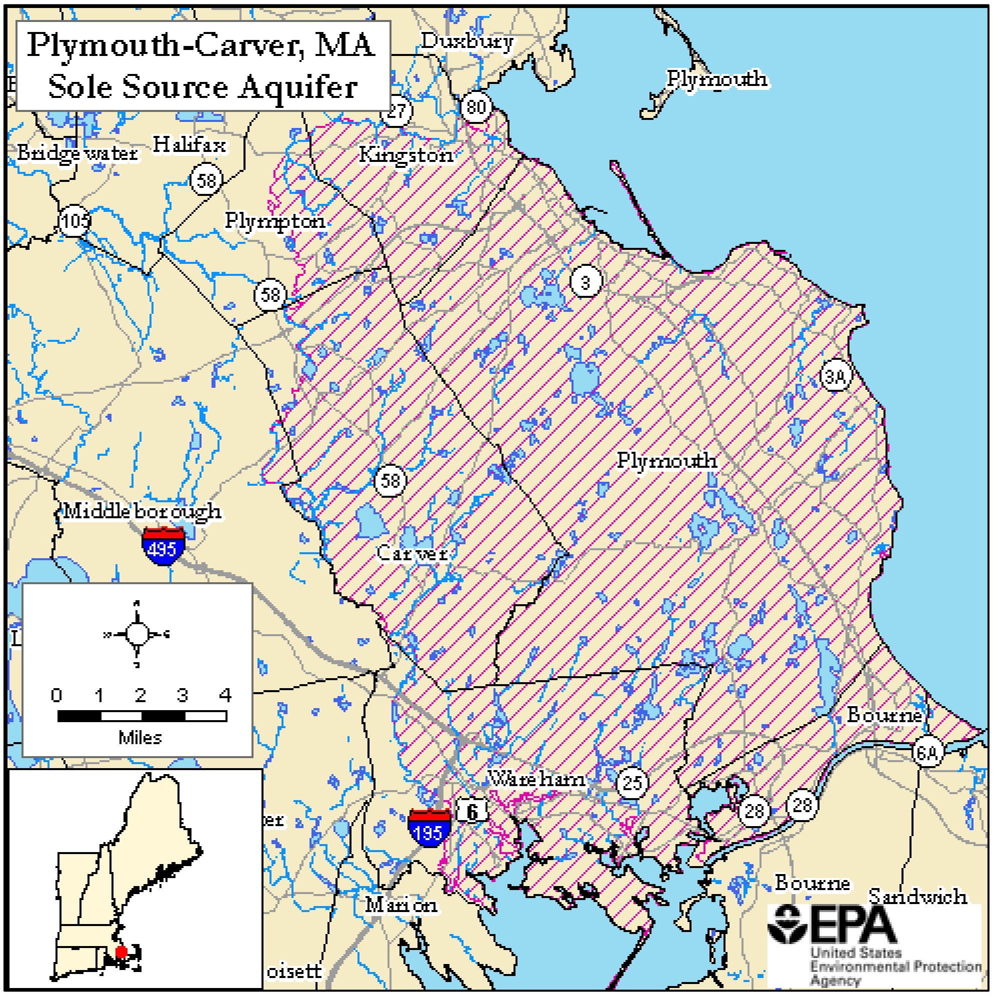

Figure 6. Plymouth-Carver Sole Source Aquifer. (Source: EPA, www3.EPA.GOV)

NRC's program for inspecting buried pipes and tanks is inadequate and allows leaks and spills to go unnoticed.[52] For decades Pilgrim's subsurface components have been (and will increasingly be) exposed to inundation with salt water, rising groundwater tables, and flooding,[53] which could provide conduits for radioactive materials to leak into the environment. According to Entergy, all of Pilgrim's underground pipes are within 10 feet of the surface,[54] which is well within reach of groundwater and salt water flooding.

A nuclear industry initiative, called the Buried Piping/Underground Piping and Tanks Integrity Initiative, began in 2009 to inspect underground pipes and tanks at nuclear power plants like Pilgrim for leaks. Like groundwater monitoring, this initiative is voluntary only. In 2010, the NRC also revised its Aging Management Program to manage the effects of aging on structures or components, including underground piping.[55]

The NRC's monitoring programs are inadequate. They are based on inaccurate assumptions about corrosion and an insufficient inspection regime (i.e., physical inspections conducted only in those rare instances when pipes are dug out for other purposes). Rather than a comprehensive approach to dealing with leaks of radioactive materials from buried pipes and tanks, the NRC allows the industry take piecemeal approach by only fixing sections of pipe.[56] These processes are incapable of ensuring the integrity of decades-old piping systems.[57]

2. TRITIUM AND OTHER RADIONUCLIDES IN GROUNDWATER

Tritium (H-3) is a radioactive isotope of hydrogen that is produced during routine nuclear facility operations, and has a half-life of 12.5 years.[58] A half-life is essentially the time it takes for a radioactive substance to lose half its radioactivity. Tritium is a carcinogen and a significant hazard when inhaled, ingested via food or water, or absorbed through the skin.[59] The most common form of tritium is in water. Tritiated water is colorless and odorless, and is commonly leaked at nuclear plants.[60]

Tritium is overwhelmingly the most common radionuclide released from nuclear facilities; however, it is not the only radionuclide. Tritium is an indicator contaminant. It is highly soluble in water and easily and rapidly flows with groundwater, whereas other radionuclides adsorb strongly to some soils. Tritium may be detected sooner than other contaminants and can be a good indication that other radionuclides are also leaking.[61]

Since 2007, Entergy's own groundwater well tests have confirmed what many had long suspected: Pilgrim is leaking radionuclides and contaminating the soil and groundwater. Entergy's tests have shown levels ranging from non-detect levels to as high as 70,000 piC/L.[62] Every year since 2007 there has been at least one well with levels well above the upper limit of normal background levels. Background levels for tritium, while variable depending on the substrate, drainage, and other factors, are typically 5-25 piC/L in surface water and about 6-13 piC/L in groundwater.

In all but 2 years, there was at least one well above MassDPH's screening level of 3,000 piC/L and 3 years with at least one well above EPA's safe drinking water standard of 20,000 piC/L (Table 2; see Section III for more about "safe" standards). By 2016, nine years after Entergy itself confirmed that Pilgrim is leaking tritium into the groundwater and soil, nothing has been done to clean it up or stop the illegal discharges that are inevitably moving toward and into Cape Cod Bay.

By 2016, nine years after Entergy itself confirmed that Pilgrim is leaking tritium into the groundwater and soil, nothing has been done to clean it up or stop these illegal discharges.

One of the more publicized tritium leaks at Pilgrim began in April 2013, when an underground line leading to the discharge canal was suspected to have separated. The leak was accidently discovered when tritiated water was found coming out of an electrical junction box inside the facility.[63] Five months later, groundwater tests results showed tritium levels trending high in one of the wells (4,882-5,307 pCi/L), and this was suspected to be related to the separated underground line.[64] Soil sampling was done soon after, and preliminary results showed the presence of radioactive contaminants: tritium, cobalt-60, and cesium-137 at levels above normal (1,150 picocuries per kilogram (pCi/kg) of cobalt-60 and 2,490 pCi/kg of cesium-137). [65]

Table 2. Range of tritium levels detected in Pilgrim's groundwater monitoring wells each year since monitoring began in 2007. (ND = non-detect levels)

YEAR	Range of Tritium Levels (piC/L)
2007	371 - 3,300
2008	ND - 2,409
2009	ND - 1,726-
2010	ND - 27,142
2011	ND - 16,013
2012	ND - 8,671
2013	ND - 70,599
2014	ND - 21,012
2015	ND - 3,572
2016	<265 - 6,481

Three new wells were eventually installed; two of which were part of a broader tritium leak investigation. By January 2014 – nine months after the leak was originally discovered – excessive levels of tritium (69,000-70,000 pCi/L; the highest in Pilgrim's recorded history) were detected near a basin that collects radiologically contaminated water and ultimately sends it to Cape Cod Bay. Despite these alarming levels of tritium at this time, Entergy and MassDPH only continued their investigation, all the while, high levels of hazardous pollutants continued to enter the groundwater and soils.[66]

More than a year later, Pilgrim's newest groundwater wells continued to show elevated levels of tritium and final soil testing results show levels of tritium, manganese-54, cesium-137, and cobalt-60 at various depths near the separated underground line above typical background levels.[67]

According to MassDPH in its August 2014,[68] November 2014, and May 2015 Groundwater Monitoring Reports, tritium levels continued to trend higher in some of Pilgrim's wells and radionuclides (e.g., Cobalt-60 and Cesium-137) were still being found in soils on the site. The November report even describes new samples showing high levels of tritium in air conditioning condensate at the facility (3,500-4,000 piC/L).

Despite all the "investigations" and explanations that Entergy and the state has provided in the nearly three years since this leak was originally discovered, at no point does age-related degradation ever come up. Extreme temperatures and storms, salt water and air, corrosive chemicals, and intense radiation most likely have caused components to thin and crack, compromising the structural integrity of the facility and underground/buried pipes. However, state and federal agencies responsible for regulating Pilgrim have not indicated that Entergy will suffer any consequences whatsoever for the groundwater and soil pollution related to the leaks discussed above.

In addition to the most recent spill described in detail above, there have been five other historic spill events that have been reported on the Pilgrim site since 1976.[69] For instance, in 1988 there was a spill of low-level radioactive waste water. The radioactively contaminated liquid waste was discovered inside a process building and had leaked outside the building. An estimated 2,300 gallons of contaminated water were spilled and 200 gallons leaked outside the building from under a door. About 2,500 square feet of asphalt and 600 cubic feet of sand and gravel were contaminated.[70]

These leaks and spills are only the ones known about and reported. As discussed in Section II.3, leaky underground piping and tanks are difficult to monitor for leaks. Even when leaks are known, it is hard to predict the movement of contaminants.

Regulators like the NRC, EPA and MassDPH often downplay the presence of tritium in groundwater at Pilgrim. In particular, MassDPH asserts that since no one is drinking water from Pilgrim's wells, everything is fine. MassDPH uses EPA's drinking water limit of 20,000 pCi/L to justify Pilgrim's unlawful, unpermitted leaks and discharges of radionuclides into the PCA as "safe." This is not an adequate defense for allowing Entergy to continue to contaminate the groundwater with radionuclides-as it has been doing on an ongoing basis since at least 2007.

No level of groundwater contamination is acceptable, regardless of whether or not anyone is directly drinking the water from Pilgrim's wells. The PCA is a resource that belongs to everyone: it is not Entergy's to contaminate. In addition, as described above, Entergy has failed to adequately assess the groundwater flow direction and indeed, residents with wells in the area may indeed be drinking contaminated water. There has been no offsite testing of private drinking water wells for radionuclides of the type Entergy discharges into the groundwater. No one knows where the groundwater is going in the future or what will be contaminated.

Soil samples obtained in 2014 as part of a larger tritium leak investigation showed high levels of manganese-54, cesium-137, and cobalt-60 at various depths near a separated underground line above typical background levels (Table 3).[71]

Table 3. Final results from soil samples near the line separation area tested by Entergy in July 2013.

Depth	Tritium (pCi/kg)	Manganese-54 (pCi/kg)	Cesium-137 (pCi/kg)	Cobalt-60 (pCi/kg)
3 ft	1,300	138	604	304
5 ft	5,760	146	997	350
5.5-6 ft	26,100	148	1,600	2,530
6-7 ft	34,300	295	1,910	832

For the non-drinking water reporting standards for cobalt-60 (5.27 years half-life), cesium-137 (30.17 years half-life), and manganese-54 (312 days half-life), see Table 4. For drinking water, EPA's MCL for these radionuclides is 4 mrem per year. For cesium-137, the level found in Pilgrim's soil was 38x more than the reporting standard. For cobalt-60, the level found in Pilgrim's soil was more than 8x the reporting standard.

Table 4. EPA's maximum contaminant level (MCL), non-drinking water reporting standards, and the average concentration assumed to yield 4 mrem per year for select radionuclides.[72]

Radionuclide	EPA's MCL for Drinking Water	Non-Drinking Water Reporting Standards (Entergy/NRC)[73]	Average Concentration assumed to yield 4 mrem/year
Tritium	4 mrem/year	30,000 piC/L	20,000 piC/L
Manganese-54	4 mrem/year	1,000 piC/L	300 piC/L
Cesium-137	4 mrem/year	50 piC/L	200 piC/L
Cobalt-60	4 mrem/year	300 piC/L	100 piC/L

3. Stormwater Drains and Electrical Vaults

Pilgrim has twenty-five electrical vaults on site that are a source of stormwater. The vaults and other sources of untreated water are pumped out to four stormwater drains and directly into Cape Cod Bay. Over the past twenty-five years, Pilgrim's storm drains were supposed to be tested twice per year for pollutants,[74] as required by EPA. Despite this, Entergy failed to conduct sampling over roughly the past 10 years, according to EPA.[75] Sampling has only occurred three times since January 2009, and only three of the four storm drains were tested.

While it is known that radioactive tritium has been leaking into the groundwater and soils on the site since at least 2007, whether this contamination has been discharged to Cape Cod Bay via these storm drains is unknown since testing for radionuclides is not required for the drains.

There is also a fifth "miscellaneous" storm drain has never been covered under any permit, and therefore has never been tested. As of 2016, EPA acknowledges the drain and authorizes its discharges, but no monitoring requirements apply since it is inaccessible, according to Entergy. Entergy reports that it is not often used and it is not expected to drain to Cape Cod Bay except during extreme storm events; however, testing should still be required. Testing will be particularly important after decommissioning begins, when structures are demolished and soils disturbed, as this outfall could become a channel for contaminates entering Cape Cod Bay. Furthermore, the consequences of climate change are being experienced along the Northeast coastline, including more intense storm events, precipitation and storm surge. If this storm drain only drains to Cape Cod Bay during extreme storm events, there is no better time than now to apply monitoring and pollution limits for this outfall location.

Even more concerning is that when storm drain sampling was done more frequently (from 1998-2007), certain parameters were exceeded on many occasions.[76] Not only has testing rarely been done, but exceedances were likely regularly occurring and went unreported to state and federal regulatory agencies. No penalties for the lack of testing, or for the known exceedances, have been imposed.

Only in 2016, and after going unmonitored for years, EPA and MassDEP established draft testing requirements for the twenty-five electrical vaults. Regulatory agencies potentially knew about these discharge locations for more than two decades but failed to make them subject to monitoring requirements until now. Furthermore, the draft testing requirements seem insufficient. While a one-time test of all twenty-five vaults is required, quarterly monitoring for only five vaults is considered sufficient by regulatory agencies.

Initial sampling by EPA from only seven vaults found total suspended solids, cyanide, phenols, phthalates, PCBs, antimony, iron, copper, zinc, lead, nickel, cadmium, hexavalent chromium. Lead, copper, and zinc exceeded marine water quality criteria.

In the new testing requirements developed by EPA, not all of these pollutants are included. Cyanide, antimony, nickel, and hexavalent chromium are apparently omitted. Shockingly, EPA is only requiring Entergy to monitor these toxic pollutants in order to assess the need for limitations. The fact that these pollutants were found in the vaults should be enough evidence to establish limitations immediately. Further, if stormwater from these 25 vaults is being discharged to stormwater drains, the drains themselves should also tested for the full list of pollutants.

Hexavalent chromium (Cr(VI)) – found in Pilgrim's electrical vaults but omitted from future testing requirements -- is particularly harmful to aquatic life. One study[77] conducted research on eels, trout, and winter flounder (species found near Pilgrim) and found that chromium is highly toxic to fish and can cause physiologic, histologic, bio-chemical, enzymatic, and genetic problems, even upon short-term exposure. Cr(VI) induced "alterations in the morphology of gills and liver in fish in a dose- and time-dependent manner." Despite the toxic effects of Cr(VI), no limits have been established by regulatory agencies to ensure this pollutant is not causing harm in Cape Cod Bay.

The fact that EPA and MassDEP have allowed these discharges to occur for an unknown length of time and are only now subjecting Pilgrim's electrical vaults to the limited monitoring requirements is an egregious failure of regulatory oversight.

As climate change impacts get worse and decommissioning commences in 2019 storm drains and stormwater testing will become even more critical, as these outlets could become further conduits for pollution into Cape Cod Bay. Increased flooding and storm intensity, sea level rise, and rising groundwater tables could increasingly flush contaminates present in groundwater and soil into Cape Cod Bay. As Pilgrim commences decommissioning in 2019 (site cleanup could be deferred for up to 60 years), understanding how coastal impacts will influence contamination of Cape Cod Bay via storm drains and stormwater runoff will become more critical. Additional sources of contamination could result from disturbed soils or demolished structures on the site; however, decommissioning does not include cleanup or management of non-radiological contaminants. It is up to our regulatory agencies to ensure that non-radiological and radiological contamination present on site does not flush into water sources over time.

Regulators have also directed Entergy to monitor standing water in storm water manholes, junction boxes, and electrical duct banks. Monitoring results show radioactive materials at generally less than the minimum detectable limit for tritium (400 piC/L), but as high as 1,500 pCi/L in some storm water manholes and up to 4,500 pCi/L in some electrical duct bank manholes.[78] Even though these levels may be low in relation to the excessive levels in the groundwater, they still exceed the background level of 5-25 piC/L for surface water and 6-13 piC/L for groundwater. Moreover, they are ongoing and cumulative.

VI. Long-Term Nuclear Waste Storage at Pilgrim

Nuclear waste will be stored at Pilgrim indefinitely. There is no long-term, geological repository in the U.S., nor is there an interim storage site in place. Plans for the Yucca Mountain nuclear waste storage site in Nevada are on hold. Even if Yucca Mountain were completed in the future, it is likely incapable of holding all nuclear waste present in the U.S. today. Right now DOE is in process of developing "consent-based siting" plans for more permanent storage solutions in collaboration with communities across the country. However, solutions are a long way away and no saying the process will even be successful.

All of the high-level nuclear waste generated at Pilgrim since it started generating power in 1972 is now stored on site. This high-level nuclear waste is also called "spent nuclear fuel." This waste is so lethal that, upon removal from the reactor it could deliver a fatal dose within minutes to someone in the immediate vicinity who is inadequately shielded.[79]

Most of Pilgrim's spent nuclear fuel is currently stored inside the reactor building in its spent fuel pool. Since Pilgrim's pool is near capacity, Entergy has started moving the waste to a dry cask nuclear waste storage facility, also known as an Independent Spent Fuel Storage Installation

(ISFSI; Figure 7). Entergy plans to expand the ISFSI so that it can eventually store all 40+ years' worth of Pilgrim's spent nuclear fuel in dry casks on site.

As seen in Figure 7, Pilgrim's ISFSI is located too close to the shoreline and is only about four feet above the Federal Emergency Management Agency's (FEMA) flood level. Pilgrim's nuclear waste will remain in Plymouth indefinitely and the ISFSI is currently sited within reach of rising sea levels, coastal storms, and saltwater degradation -- creating a potential source of contamination, long after Pilgrim shuts down in 2019.

…the ISFSI is currently sited within reach of rising sea levels, coastal storms, and saltwater degradation, creating a potential source of further contamination, long after Pilgrim shuts down.

Entergy built the ISFSI without proper zoning approval from the Town of Plymouth. In August 2016, a legal trial concluded related to Entergy's non-compliance with Plymouth's zoning by-laws and failure to obtain a special permit for Pilgrim's ISFSI. If Entergy were to be required to obtain a special permit, the Town of Plymouth would have authority to impose conditions on the ISFSI in order to ensure that it is properly sited, operated, and maintained.[80] The court's decision is due before the end of 2016.

Entergy also stores so called "low-level" radioactive waste (LLRW) at Pilgrim, some of which is located in containers along the shoreline – another potential source of contamination to Cape Cod Bay.

The "low-level" category has nothing to do with the actual radioactivity level or how long the waste will remain radioactive. Instead, radioactive waste is defined solely by the process which produced it. High-level waste is defined as spent reactor fuel, or wastes resulting from the reprocessing of spent nuclear fuel. LLRW is a catch-all, and includes all radioactive waste that is not high-level waste, and includes transuranic wastes (material contaminated with radioactive elements heavier than uranium, such as plutonium, neptunium, americium and curium that have extremely long hazardous lives) or uranium mill tailings. A typical nuclear reactor's LLRW is significantly more radioactive that some of the military's high-level waste. Pilgrim's LLRW, for example, includes the control rods, resins, sludge, filters, and will include the entire nuclear power reactor when it is eventually dismantled.[81]

Figure 7. Pilgrim's ISFSI project (circled) begins approximately 106 ft. from the shoreline. The first casks (pictured) were filled and placed on the concrete pad in early 2015.

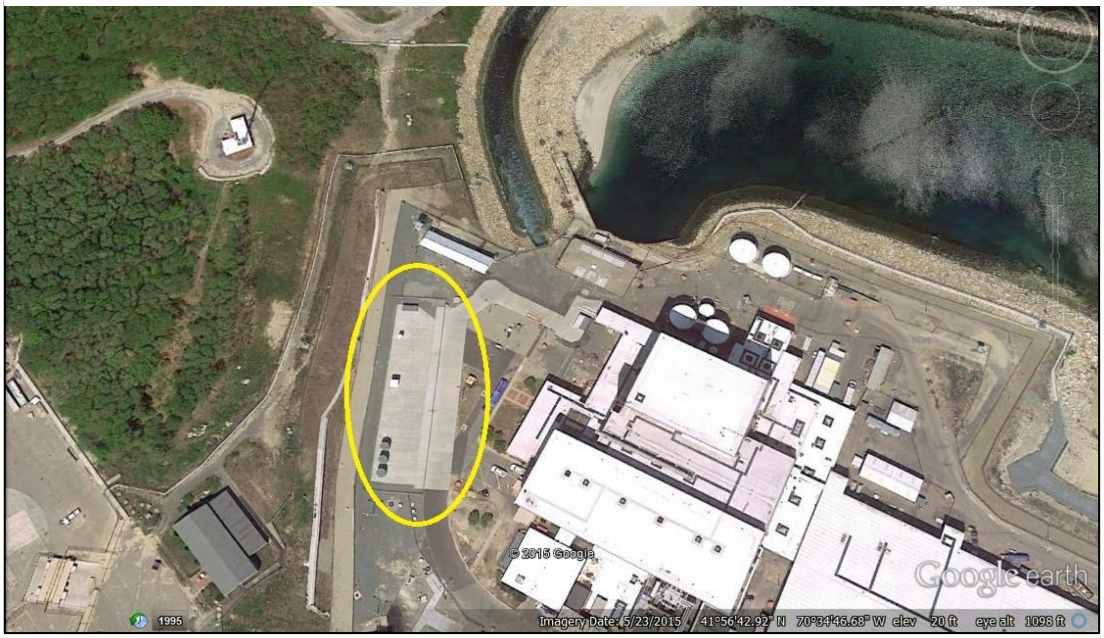

Figure 8 shows the shoreline location of Entergy's storage of LLWR. It shows that Pilgrim has about 20-30 white storage containers located approximately 30 feet away from the coastal bank. According to the NRC, only one of these containers currently contains Greater-than-Class-C waste, the most toxic type of LLRW, and that all of the others are now empty.

Figure 8. The white containers pictured here are LLRW containers, located about 30 ft. away from Cape Cod Bay. At least one of these holds radioactive waste and many more will likely be filled during decommissioning. Also shown to the right of the storage area is the LLRW building containing equipment that compresses materials to be stored for shipment.

The Greater-than-Class-C waste will remain on the Pilgrim site, like the high-level radioactive waste, until an offsite repository is developed. Huge amounts of LLRW will result during the decommissioning process, and likely more of these storage containers will be used.

All of Pilgrim's low- and high-level radioactive wastes need to be moved to higher-elevation areas, farther away from Cape Cod Bay and securely protected from natural and man-made hazards to prevent future leaks from happening.

VII. DECOMMISSIONING AND SITE CLEANUP

Entergy has announced it will stop generating electricity at Pilgrim by May 31, 2019. Once it closes, the NRC allows Entergy to choose a scenario for decommissioning and site cleanup. One scenario is long-term SAFSTOR, a process that allows Entergy set aside Pilgrim for up to 60 years before decommissioning is completed. Under NRC rules, decommissioning a nuclear power plant includes dismantling buildings and cleaning up radioactive contamination.

The 60-year time frame is chosen since it corresponds to 10 half-lives for cobalt-60, one of the more common radioactive isotopes left behind at a nuclear facility. Over the decades, the radioactivity is thought to decay. At 60 years, cobalt-60 reportedly decays to background levels. Entergy may take down some non-essential buildings, etc. before buttoning it up for the 60 years.

If the NRC allows Entergy to choose SAFSTOR, the ongoing leaks and environmental contamination do not have to be addressed for 60 years. Contamination is currently migrating toward Cape Cod Bay and it will continue to do so. Pilgrim's location directly on the Cape Cod Bay shoreline makes it vulnerable to rising sea levels and groundwater levels, intense storms, precipitation and flooding. These coastal impacts will increasingly create challenges for site cleanup and potentially cause more flushing of contaminants into Cape Cod Bay. Allowing decades to pass may decrease the radioactivity at Pilgrim, but more likely due to dilution into the environment faster than decay.

Aside from establishing some technical and financial criteria, the NRC has very little say in the decommissioning process itself. For example, Entergy will need to submit a PSDAR (Post Shutdown Decommissioning Activities Report) to the NRC, which is due within two years of shutdown. The PSDAR will provide a description and schedule for planned decommissioning activities, an estimate of expected costs, and a discussion concluding that the environmental impacts will be bounded by already issued Environmental Impact Statements. The NRC only reviews this PDSAR, but does not have to approve it. While public comments on the PSDAR will be solicited by the NRC, the agency will not be required to incorporate any concerns and comments into the final PSDAR document. The NRC also does not require Entergy to restore the

Pilgrim site to the conditions that existed before the construction of the plant, nor does it ensure that there are sufficient funds in the decommissioning trust fund to achieve this.

With Pilgrim slated to close, it is more important than ever to understand the extent of the environmental contamination at the site. There should be an independent site assessment and decontamination plan that goes beyond inadequate NRC standards. Regulators and elected officials need to step up to ensure that this contamination is addressed immediately. This report is a call for a process that provides full transparency and public participation in all phases of cleanup and improvements to Entergy's current plan for long-term storage of high-level nuclear waste on the shore of Cape Cod Bay. Pilgrim's high-level nuclear waste dry cask storage facility should be made more robust, moved to a higher elevation farther away from Cape Cod Bay and securely protected from natural hazards.

1. NRC and EPA Clean Up Rules

When Entergy remediates contaminated soil and groundwater, the "clean" standards that will be used differ from the "safe" standards discussed in Section III.

The NRC's ultimate goal for a closed nuclear reactor site is for "unrestricted use," meaning the radioactive materials left after the facility closes are not to exceed 25 mrem per year. According to the NRC, if this standard is met then the site can be reused for any purpose.[82] On the other hand, if a site cannot meet these criteria it may instead be reused for limited purposes, with a formal legal restriction recorded on the deed. The NRC does not require that the site be returned to the uncontaminated state it was in before Pilgrim was built. Even if this were possible, the NRC does not require Entergy to have sufficient funds in its decommissioning trust fund to achieve it.[83] The NRC only requires radioactive remediation, or "meaning it is safe for use by the public from a nuclear perspective," said one NRC staff member.[84] In addition to the legacy of contaminated soil and water, the lethal spent nuclear fuel at Pilgrim is likely to remain there for hundreds of years or more.

In 1997 the NRC adopted the License Termination Rule (LTR), which established cleanup standards for nuclear sites.[85] The LTR sets a total dose limit of 25 mrem per year from all radiological sources (i.e., air, groundwater, surface water, soil), as the cleanup standard to be achieved before a facility's license can be terminated. This rule applies to Pilgrim. Entergy must also demonstrate that it has reduced the residual dose at Pilgrim following decommissioning to ALARA, considering economic and other factors.[86] The NRC does not, however, set specific groundwater protections.

In 2012 the LTR regulations were amended when the NRC's "Legacy" Final Rule went into effect.[87] Now nuclear facilities are required to minimize the introduction of radioactivity into groundwater and soils during operations and to provide additional reporting concerning costs of cleanup and contamination. But the new rule still does not provide specific groundwater cleanup standards.

EPA established its own cleanup standards for decommissioned nuclear sites in 1997, in the form of non-binding Superfund law guidance. [88] This sets a maximum dose of 15 mrem per year from all sources, and MCLs for ground and surface waters used for drinking. This is the same year that the NRC finalized its own standards of 25 mrem per year.

For the next five years, the NRC and EPA were at odds about their differing policies and regulatory approaches, mainly over EPA's specific groundwater protections.[89] EPA favors more restrictive protections and views groundwater as an important national resource. The NRC, on the other hand, has no specific groundwater restrictions and views groundwater as one of many pathways included under its 25 mrem per year umbrella. One reason the NRC may favor this less restrictive approach is that it is costlier for licensees (plant operators like Entergy) to implement. For instance, according to an EPA analysis it would cost $1 billion to achieve 25 mrem per year, but $1.5 billion to achieve 15 mrem per year.[90]

To bridge the disagreement and better define regulatory roles, in 2002, NRC and EPA entered into a Memorandum of Understanding (MOU) regarding the coordination of decommissioning.[91] Essentially EPA will only get involved if it determines a site is not being properly responded to by the NRC. These federal agencies are required to consult with each other if the following circumstances occur:

1. NRC determines that residual levels in groundwater will exceed radionuclide MCLs established under the Safe Drinking Water Act,
2. residual levels in soil will exceed the soil concentrations in "MOU Table 1: Consultation Triggers for Residential and Commercial/Industrial Soil Contamination,"
3. NRC contemplates that future use of the site will be restricted by conditions contained in the license termination,[92] or
4. NRC contemplates the use of alternative criteria for license termination (i.e., a site-specific dose greater than NRC's primary dose limit of 25 mrem per year may be allowed).

If radioactive groundwater contamination is above either EPA's MCLs for drinking water or if soil contamination exceeds specific concentrations (Table 5), EPA can list a nuclear reactor site as a Superfund site and have more oversight in the cleanup. Only in these cases would EPA's more restrictive protections apply. Otherwise, EPA's cleanup standards are not applicable to commercial nuclear reactor sites.

MassDEP does set some cleanup standards on a case-by-case basis, under the Massachusetts Contingency Plan (Chapter 21E) but it are largely the federal standards that apply.

Table 5. EPA/NRC consultation triggers (concentration, piC/g) for industrial soil contamination

Radionuclide	Soil Concentration
Tritium (H-3)	423 piC/g
Manganese (Mn-54)	112 piC/g
Cobalt 60 (Co-60)	6 piC/g
Cesium 137 (Cs-137)	11 piC/g

2. HISTORIC MIDNIGHT DUMPING AT PILGRIM

Sources have reported that drums of hazardous waste were buried on the Pilgrim site in the 1980s and/or 1990s.[93] Barrels of chemical waste were reportedly shipped from New Jersey were buried along Power House Road (Pilgrim's access road) and then over-planted with evergreen trees (Figure 9).

This contamination was the subject of public comments to the NRC in 2007.[94] These comments are reported in Pilgrim's "Generic Environmental Impact Statement for License Renewal," which as follows: "The public, NRC officials and Entergy staff also are well aware of burials off the Access Road." The NRC responded to this comment by saying that the comment was noted and would be kept on file to "ensure that these types of areas will be identified during plant decommissioning. In addition, these regulations provide assurance that any contamination will be appropriately remediated during site decommissioning. Specifically, at the time of decommissioning, the licensee is required to submit a License Termination Plan which contains information on the types and quantities of radioactive materials on the site."

Figure 9. Location of suspected chemical waste dumping site on the Pilgrim property.

In October 2015, community members filed a formal "Chapter 21E"[95] report to MassDEP about these hazardous materials. The Chapter 21E report triggers regulations that requires the agency to investigate and report its findings to the public. MassDEP followed up a year saying that without more evidence, such as samples showing contamination, or pictures of stuff being buried, there is nothing more the agency could do.

VIII. Emergency Backup Cooling

In 2012, one year after the Fukushima nuclear disaster in Japan, the NRC ordered Entergy to install upgrades at Pilgrim to prevent a similar disaster at Pilgrim.

One of the fixes that the NRC ordered is a backup emergency water system. Even when it is not operating, Pilgrim needs water to cool the nuclear reactor and spent fuel pool where the nuclear waste is stored. Pilgrim also needs offsite power in order to run pumps that cool the pool and reactor. Since 1974, Pilgrim has regularly lost power during storms, requiring it to use its emergency backup generators. The NRC found that if there was a severe natural event like a nor'easter, blizzard, hurricane, earthquake or tsunami that knocked out the generator and offsite power, it could lead to Pilgrim having a meltdown or spent fuel fire. Hence, the need for a backup cooling system.

Part of Entergy's proposal to the NRC, dubbed the "Fukushima Fix" and 'Recipe for Disaster" by critics (Figure 10), was to install moorings in Cape Cod Bay so that during an event like a hurricane, it could send workers to the mean high water line where they would attach strainers to the moorings and then connect a hose that would pump cooling water from Cape Cod Bay directly into the reactor.

Entergy needed a state Waterways License to put the moorings in the public tidelands of Cape Cod Bay. Under state law, the shoreline of Massachusetts (i.e., tidelands) belongs to the public and is held in trust for the people; therefore, Entergy needed get permission and a Waterways License from the state to install the moorings in this area. When Entergy applied to MassDEP for the license, it claimed that the moorings would be in "private tidelands" and not harm public rights in the intertidal area.

In the summer of 2014, local residents and the Jones River Watershed Association (JRWA) submitted comments to MassDEP challenging Entergy's license application. MassDEP held a public hearing in Plymouth in November 2014, where many of the 80 attendees raised concerns about the backup cooling system. A few months later, MassDEP issued the Waterways License despite the objections raised by the public. Twelve local residents and JRWA filed a legal appeal in March 2015.

MassDEP's judge held a hearing in September 2016 and heard evidence from JRWA, the residents, Entergy and MassDEP staff. The judge's February 5, 2016 decision upheld the License granted to Entergy.[96] The judge's decision has two parts: first, JRWA and the residents had legal standing to challenge the Waterways License. This is a significant victory for the rights of citizens to challenge actions by the state that may harm the environment. Entergy argued that the appeal should be thrown out since JRWA did not meet the legal standing and it could not show that it would suffer "harm" from the project. The judge disagreed.

The judge wrote that if the proposed mooring system fails to work in an emergency at Pilgrim, "this may result in inadequate cooling of the radioactive [spent fuel pool] at Pilgrim and lead to a [spent fuel pool] fire, and if that occurs, dire environmental consequences would likely befall the Jones River and Cape Cod Bay." The judge went on to describe the various ways that this harm would occur: "the quality, habitat and ecosystem of that area would be harmed by radioactive contamination resulting from the spent fuel fire, and as a result, JRWA and its members would suffer harm to their conservational, recreational, and aesthetic interests in the area because their ability to use and enjoy the Jones River, its estuary, and the functioning of

Cape Cod Bay as a habitat, nursery, and migratory route for fish and marine species connected with the Jones River would be impaired."

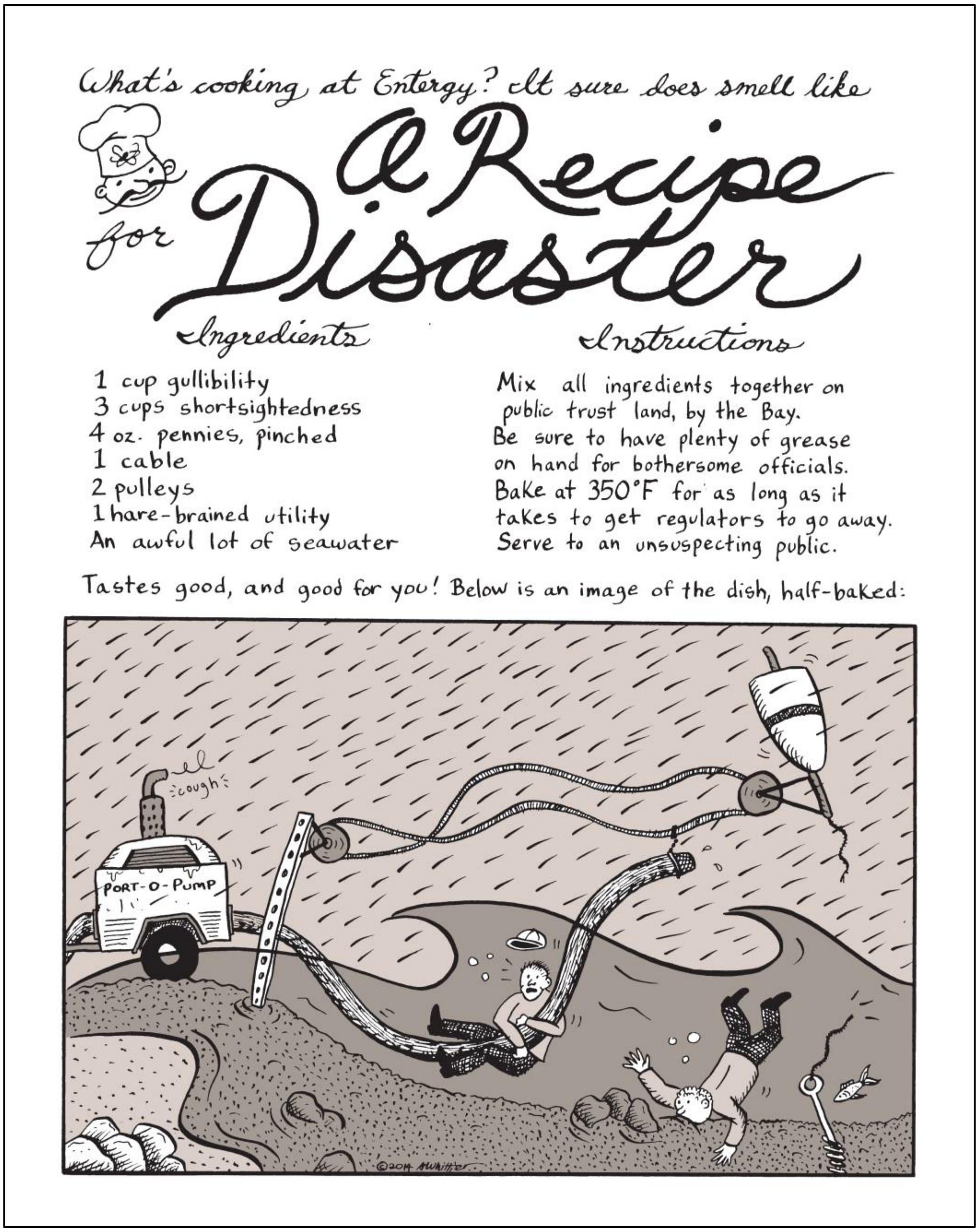

Figure 10. Critics dubbed Entergy's backup cooling plan a "Recipe for Disaster" (Source/Artwork: Adam Whittier)

The judge based this finding on testimony from JRWA and a chronology of "loss of offsite power" events that have occurred at Pilgrim since 1975. This showed that from September 1975 to February 2015 Pilgrim had 21 losses of offsite power events which forced Pilgrim into emergency shutdown situations. The judge ruled "…weather related events demonstrate that Pilgrim is vulnerable to adverse weather conditions such as a nor'easter or blizzard."

Even though JRWA and the group of citizens were found to have legal standing to bring the appeal, it was ruled that MassDEP properly applied the Chapter 91 law to grant the Tidelands License to Entergy. This law includes a complex set of legal regulations that, in part, require MassDEP to locate the proper boundaries of the high and low water lines on the shoreline.

At the crux of the legal appeal was the method MassDEP used to determine where the high and low water marks are at Pilgrim. The citizen groups said the moorings were below the low water mark, meaning a stricter standard of regulation applied. Entergy and MassDEP said they were above the low water mark, in the intertidal zone or "private tidelands" and subject to looser regulations. The judge agreed with Entergy and MassDEP, and based the decision on maps from 1866. The judge did not agree with the testimony of the citizens' expert who said the 1866 map was outdated and the mooring system was in public tidelands.

MassDEP issued the final Chapter 91 license on March 2, 2016. Even though the citizens ultimately lost the appeal, the Decision is a major victory for advocates and local residents who want to use the law to protect their rights to the environment. By granting standing to JRWA and the twelve residents, the judge set a legal precedent that can be relied on in many types of lawsuits seeking to enforce environmental laws.

It's also important to note that, as part of Entergy's emergency backup plan for Pilgrim, three deep groundwater wells were installed as an emergency source of cooling water. The wells are located south of the reactor building at depths of approximately 80 feet, reaching the underlying bedrock. The influence of these deep wells on the movement of groundwater and contaminants is unknown.

IX. Conclusion

Regulatory agencies, including the NRC, have repeatedly tolerated accidental and uncontrolled radioactive leaks at Pilgrim, and Entergy has never faced any consequences. The NRC selectively enforces regulations, and enforcement appears to have nothing to do with the quantity, duration or severity of a leak.[97] Typically, when leaks are discovered and reported, industry only monitors and investigates them but is not required to stop them. The NRC has largely replaced its regulatory oversight of radioactive leaks with voluntary initiatives. Other regulatory inadequacies over the past four decades include:

- Agencies use various "safe" standards and limits for radiation exposure, even though in reality there are no safe levels, as a way to deflect public concern about contamination.
- EPA's MCLGs are focused solely on public health and set acceptable levels of tritium and other radionuclides as zero; however, these goals are not enforceable.
- Due to regulatory conflict with the NRC, EPA's more restrictive cleanup standards are not applicable to commercial nuclear reactor sites.
- Agencies absurdly downplay the risk of tritium by stating that Pilgrim's monitoring wells are not used for drinking water, thus allowing ongoing contamination of the PCA and the bay.
- The impact of radionuclides on ecological health is not properly evaluated; even human tolerances, if fully understood, could not be assumed to automatically protect plants and wildlife, especially threatened and endangered species.
- Pilgrim's groundwater wells are only sampled only for gamma-emitting nuclides and tritium; outdated testing that is used today could be missing other radionuclides significant to public and environmental health.
- The Federal Clean Water Act does not regulate radioactive waste even though Pilgrim regularly discharges radioactive water directly into the surface waters of Cape Cod Bay.
- State agencies have failed to enforce water quality standards for radioactive materials even though Entergy routinely dumps these materials into Cape Cod Bay, a "Class A" water body under the state's Clean Waters Act.
- Pilgrim's wastewater treatment facility has polluted groundwater since it began operating; the state has allowed delayed compliance with nitrogen limits and eliminated some pollution limits altogether from Pilgrim's newest groundwater discharge permit.

The role for regulators and elected officials is obvious: a push for transparency in the decommissioning and cleanup process and ensure that the highest standards are applied. There needs to be a complete, thorough site assessment that looks at all areas of potential contamination. It will be critical to fully understand the extent of the contamination in order for proper clean up to be accomplished. An independent site assessment and decontamination plan that addresses radioactive and non-radiological contamination on the property is needed.

It is also important to consider sea level rise, rising groundwater tables, and other coastal hazards that could potentially influence contaminants present on the site and the success of decommissioning. Cleanup activities should not be delayed, but rather accelerated. This also holds true for Pilgrim's nuclear waste – currently in reach of coastal hazards – that will likely remain a potential source of leaks and contamination for hundreds of years or longer. Pilgrim's nuclear waste storage area needs to be moved away from Cape Cod Bay and secure from coastal and man-made hazards.

The public should be reimbursed for natural resource damages to the PCA and Cape Cod Bay. Pilgrim's leaks and releases have negatively impacted Cape Cod Bay and the regional environment. Natural resources belong to the public, and are not Entergy's to pollute at will, without consequences. Entergy has essentially created a sacrifice zone: in all likelihood the site will be off limits for generations due to the scale and scope of contamination.

The harm caused by Pilgrim's long history of regulated and accidental discharges of radioactive materials to the environment, plus the inadequacy of regulatory oversight and enforcement are major concerns and must be addressed post operations. It is imperative Pilgrim' toxic legacy is dealt with quickly and fully to best protect public health and safety and our environmental resources.

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Addendum to Entergy's Legacy of Contamination at Pilgrim Nuclear Power Station (Draft 2, February 2017)

2017 Update: Massachusetts Department of Public Health (MassDPH) May 2017 Groundwater Investigation Update for Entergy's Pilgrim Nuclear Power Station

In May 2017, the Mass. Department of Public Health (MassDPH) published its latest Groundwater Investigation Update for Entergy's Pilgrim Nuclear Power Station. The reports covers testing that occurred in the the last six months of 2016.

Even though Pilgrim is scheduled to shut down in 2019, it is important to remember that there are two more years of operations. This means there will also be two more years of tritium entering the groundwater and soils on the site. It is important to understand the contamination on the site considering decommissioning is right around the corner. If Pilgrim is allowed to postpone full cleanup of the site for decades (up to 60 years is possible!), then contamination will undoubtedly migrate and flush into Cape Cod Bay over time. This is especially true given rising sea levels and storms affecting the site.

Background:

Energy collects water samples from 23 groundwater monitoring wells and two surface water locations on the Pilgrim site. The samples are split between two labs – one lab contracted by Entergy (Teledyne) and the other is the Massachusetts Environmental Radiation Lab (MERL).

Some important numbers to keep in mind are:

- 3,000 picocuries per liter (piC/L) = screening level; based on 1/10th the NRC approved level of tritium in non-drinking water (30,000 piC/L). Anything above 3,000 piC/L is of concern.
- 20,000 piC/L = U.S. Environmental Protection Agency's (EPA) "safe" drinking water standard for tritium.
- 0 piC/L = The level of safe exposure identified by the National Academies of Science's 2005 report called "Health Risks from Exposure to Low Levels of Ionizing Radiation." There is no safe level of exposure to radiation and even low doses can cause cancer. To address this, EPA set a Maximum Contaminant Level Goal (MCLG) for all radionuclides (including tritium) as ZERO. EPA defines MCLG as the "level of a contaminant in drinking water below which there is no known or expected risk to health."
- 5-25 piC/L = Normal background levels for tritium. While this can be variable depending on soils, rock type, wind, and drainage, typically 5-25 pCi/L are found in surface water and about 6-13 piC/L in groundwater.

Overview of May 2017 Report:

According to MassDPH, seven of Pilgrim's wells had no detectable levels above background. Fourteen wells had stable levels of tritium (above background but similar to historical records). Two of the wells (#216 & 210) saw increases in tritium levels. Two wells (#216 and #218) had levels above the 3,000 piC/L threshold.

Monitoring Well 210 – Monitoring of well #210 will increase from quarterly to every 3 weeks until the tritium levels stabilize. This is due to levels increasing from 597 pCi/L in August to 1,180 pCi/L in November.

Monitoring Well 216 – Well #216 is historically a "problem" well. It is located on the northeast corner of the turbine/reactor building. Historically, there have been increases in tritium in well #216 during the months of September and November. Last year was no different, and the "peak" was higher in 2016 (5,756 piC/L) than it was the previous year (4,300 piC/L). Entergy and MassDPH have been trying to figure out why these spikes occur since 2013. The 2017 MassDPH report states that Entergy is still working with a consultant (ERM) to figure out the cause. It is suspected to be due to residual tritium in a seismic gap (seismic gaps are man-made spaces between building foundations that allow them to move during an earthquake). According to a 2015 MassDPH report, the gap was re-sealed that year. However, spikes in tritium are still occurring during the fall months.

Monitoring Well 218 – Monitoring well #218 has also been a "problem" well. It was installed as part of the Neutralization Sump Discharge Line Investigation in late 2013 (due to excessive levels of tritium (69,000-70,000 pCi/L) detected in monitoring well #219).

Tritium has fluctuated from about 960 pCi/L to 6,481 pCi/L since this well was installed 2013 — with the highest tritium levels occurring in 2016 (a peak of 6,481 piC/L in March). Despite this, MassDPH reports that the levels in #218 (as well as well #211) have "stabilized" after a leak in the Condenser Bay area. This leak reportedly contributed to elevated levels in both wells. The leak was detected and repaired in early 2016. MassDPH states, "Recent results are near previous levels and Entergy continues to monitor the Condenser Bay area for leaks." It is unclear if MassDPH is referring to results from testing done in 2017 (around the time the report was published), or results from late 2016 (July-Dec 2016 results ranged from 2,230 to 4,086 piC/L).

PILGRIM NUCLEAR POWER STATION

ENVIRONMENTAL RADIATION MONITORING PROGRAM
REPORT NO. 15

JANUARY 1 THROUGH DECEMBER 31, 1982

ISSUED: APRIL 1983

BY: NUCLEAR OPERATIONS SUPPORT DEPARTMENT
ENVIRONMENTAL AND RADIOLOGICAL
HEALTH AND SAFETY GROUP

BOSTON EDISON COMPANY

BOSTON EDISON COMPANY

PILGRIM NUCLEAR POWER STATION

Environmental Radiation Monitoring Program

REPORT NO. 15

January 1, 1982 through December 31, 1982

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Date of Submittal: April 1, 1983

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I. Introduction and Summary

This report presents a summary of the results of measurements of direct radiation and radioactivity in environmental media in the vicinity of the Pilgrim Nuclear Power Station - Unit 1 (PNPS-1) and at selected control locations for the period January 1 - December 31, 1982. The results of this Program indicate that PNPS-1 has had a negligible and most often immeasurably small impact on the environment in the vicinity of the plant. Conservatively, estimated doses resulting from the measured highest station mean concentrations are typically less than 1% of the doses resulting from naturally occurring radionuclides and residual fallout from atmospheric nuclear weapons testing.

Estimates of concentrations of radionuclides in vegetation and milk and estimates of dose to man, as quoted in this report, were made using methods similar to those described in Regulatory Guide 1.109 and 1.111.

The performance record of the PNPS-1 for the calendar year of 1982 reflects an average capacity factor of 56.0%. Monthly capacity factors are given in Table I-1.

A tabulation of radioactive effluents from the PNPS-1 is provided in Appendix B for the 1982 calendar year.

There were no Anomalous Measurement Reports made for the calendar year of 1982.

Essentially, all samples required by the PNPS-1 Technical Specifications were collected on schedule. The only exceptions were the unavailability of two milk sample locations, and two air sampling locations until the third quarter of 1982 plus occasional failures of the air samplers. In addition, a total of four TLDs were found to be missing from their field locations during 1982.

These incidents affected only about 5% of the total number of samples scheduled for collection.

Both Plimoth Plantation and Plymouth County Farm were unavailable as milk sampling locations during 1982. Plimoth Plantation informed Boston Edison in January 1981 that milk producing animals would no longer be available as they disposed of their cow. This situation had not changed for 1982. The Plymouth County Farm has not been available as a milk sampling station since 1979 as they had sold all of their cows. Recently, the Plymouth County Farm began to reparticipate in the Program in December, 1982.

The two air sampling stations which became unavailable during 1981 were the Plymouth Center and Cleft Rock sites. The Cleft Rock air sampling station was lost during the second quarter of 1981 (between 4/6/81 -4/14/81) when vandals destroyed the equipment and protective facilities. The communications tower at the site was also heavily damaged. Full operation of the Cleft Rock (actually Pine Hills) air sampling station site was reinitiated on 7/12/82.

The Plymouth Center air sampling station (Old Fire House on Main Street) was lost during the third quarter of 1981 (between 7/28/81 - 8/4/81) when a private individual bought the Old Fire House. The individual declined to participate in the Program. A search for a suitable public building in the Plymouth Center area was then initiated. Full operation of the Plymouth Center air sampling station site was reinitiated on 7/12/82 at the Plymouth Town Hall.

TABLE I-1

PNPS-1

CAPACITY FACTORS

1982

(Based on 670 MWe)

Month	Percent Capacity
January	0.0
February	0.0
March	0.0
April	44.1
May	80.1
June	87.5
July	97.2
August	75.7
September	68.3
October	39.9
November	88.9
December	87.1
Average	56.0

II. Description of the Monitoring Program

The Radiological Monitoring Program conducted in accordance with the PNPS-1 Technical Specification is included as Appendix D. The program is essentially identical to that conducted during 1981 and incorporates supplemental provisions as specified in the Settlement Agreement between the Massachusetts Wildlife Federation and Boston Edison Company, June 9, 1977[2]. The exceptions to the program are as follows:

1) There is no TLD station at Saquish Neck since the Mass Wildlife Federation has not yet provided a means for placement and retrival of the TLD as prescribed by the agreement noted above.
2) There is no longer a milk producing cow at Plimoth Plantation. The Plymouth County Farm location was unavailable since 1979 but has recently been reinstated into the Program (December 1982), and the Plimoth Plantation location has been unavailable since 1981. The nearest cow location is at the Plymouth County Farm, which is 3.5 miles from PNPS in the West sector.
3) There is no longer a Karbott Farm. Vegetable samples are now collected at the two nearest gardens near the W and ESE site boundaries.

The 1982 site Census conducted according to Technical Specification requirements determined that there are several vegetable gardens near the site boundary in the W-WNW and SE-ESE sectors (see Appendix E). In the ESE sector, the nearest garden is at the J. B. Work residence (0.6 miles ESE). A sample of pumpkin leaves were collected on 9/4/82. In the west direction, the location of the nearest observed garden of approximately 500 square feet was at the residence of M. Lloyd Evans (0.7 miles W). A sample of rhuhbarb was collected from this location on 9/27/82.

In addition to the above, a sample of lettuce was obtained from the Whipple Farm (1.5 miles SSW) on 9/14/82, and a sample of rhubarb was collected from the Hoton Residence (2.5 miles SE) on 9/27/82.

The 1982 Census indicates that 5 goats are located at the Lloyd residence on Long Pond Road, however they are miniature goats (not full size) and the milk is used for personal consumption only. Two goats were located at the Raymond residence but are no longer available at this location. During 1982 every effort was made to identify and locate milk-producing animals in the near vicinity (5 miles) of PNPS-1. The Plymouth County Farm (3.5 miles W) agreed to reparticipate in the Environmental Program and sampling was reinitiated in December of 1982. The Plimoth Plantation declined to participate in the Program. The only other available milk-producing cow within 5 miles of PNPS is located on Beaver Dam Road (2.5 miles S) and is owned by C. Mann. Mr. Mann provided one milk sample (October 1982) for the remainder of the year, and stated that milk samples will be provided in accordance with the Environmental Program starting in the spring of 1983.

In perspective, cows and goat locations within a 5 mile radius of PNPS-1 are rare and transitory at best. It is extremely unlikely that the cow-milk pathway could be responsible for even small doses to any member of the general public.

III. Results and Analyses

This section summarizes the results of the analyses of environmental media samples in compliance with the monitoring program described in Appendix D. The section is divided into sub-sections, each of which describes a particular media or potential exposure pathway.

The results of analyses conducted on environmental media are maintained in a computerized data file which constitutes a data base used for statistical analyses by a computer code entitled ERMAP[3].

ERMAP calculates a set of statistical parameters for each radionuclide whose concentration is reported in a given environmental medium. Tnis set of statistical parameters includes separate analyses for (1) the indicator stations, (2) the control stations, and (3) the station having the highest annual mean concentraion. For each of these three groups of data, ERMAP calculates:

1) the mean value of all measured concentrations;
2) the square root of the mean square deviation (this is an estimate of the sample variance);
3) the lowest and highest calculated concentrations;
4) the number of positive measurements divided by the total number of measurements;

Entries listed under the heading LLD* are the mean of all LLD values, where each LLD equals 4.67 times the standard error of the associated background measurement.

*Lower Limit of Detection

The results of ERMAP are provided in each subsection for the appropriate media. In addition, plots of measured concentration as a function of sampling time are included for certain isotopes in certain media in an effort to simplify interpretation of the results.

Sample station identification numbers used by the ERMAP program are provided in Table III-A-1.

TABLE III-A-1

Sample Station Identification Codes

Media	Station Code Number	Station Location
Air Particulate and Iodine Filters	00	Warehouse (0.03 mi-SSE)
	01	Rocky Hill Road (0.8 mi-SE)
	03	Rocky Hill Road (0.3 mi-WNW)
	06	Property Line (0.34 mi-NW)
	07	Pedestrian Bridge (0.14 mi-N)
	08	Overlook Area (0.03 mi-W)
	09	East Breakwater (0.35 mi-ESE)
	10	Cleft Rock (0.9 mi-S)
	15	Plymouth Center (4.0 mi-W-WNW)
	17	Manomet Substation (2.5 mi-SSE)
	21	East Weymouth (control-21 mi-NW)
Waterborne	11	Discharge Canal
	17	Bartlett Pond (1.7 mi-SE)
	23	Power Point (control 7.8 mi-NNW)
Shellfish	11	Discharge Canal Outfall
	12	Plymouth Harbor
	13	Duxbury Bay
	15	Manomet Point
	24	Marshfield (Control)
Algae (Irish Moss)	11	Discharge Canal Outfall
	15	Manomet Point
	22	Ellisville (Control)
Lobster (Arthropods)	11	Vicinity of Discharge Canal Offshore
	15/99	Offshore (Control)
	25	Scituate (Control)
Fish	2	Round Hill Point-Offshore-(Control)
	11	Vicinity of Discharge Canal
	21	Auto Trawl Station-Offshore-(Control)
	22	Offshore-(Control)
	28	Cataumet, Bourne-(Control)
	29	Priest Cove-Offshore-(Control)
Sediment	11	Rocky Point
	12	Plymouth Harbor
	13	Duxbury Bay
	14	Plymouth Beach
	15	Manomet Point
	24	Marshfield (Control)

TABLE III-A-1 (Continued)

Media	Station Code Number	Station Location
Milk	11	Plymouth County Farm (3.5 mi-W)
	21	Whitman Farm (Control-21 mi-NW)
	22	King Residence (Control-12 mi-W)
	28	Beaver Dam Road (2.5 mi-S)
Cranberries	13	Manomet Point Bog (2.5 mi-SE)
	14	Bartlett Road Bog (2.8 mi-SSE/S)
	23	Pine Street Bog (Control-17 mi-WNW)
Vegetation	11	Plymouth County Farm (3.5 mi-W)
	16	Work Residence (0.6 mi-ESE)
	17	Evans Garden (0.7 mi-W)
	27	Bridgewater Farm (Control-20 mi-W)
	43	Whipple Farm (1.5 mi-SSW)
	45	Hoton Residence (2.5 mi-SE)
Beef Forage	11	Plymouth County Farm (3.5 mi-W)
	15	Plimoth Plantation (2.2 mi-W)
	21	Whitman Farm (Control-21 mi-NW)
	27	Bridgewater Farm (Control-20 mi-W)

III. A. Air Particulate Filters

Sample collection systems consisting of a cellulose particulate filter and a charcoal filter cartridge are used to collect particulate matter and iodine isotopes respectively. Analyses of the particulate filters for beta radiation is performed weekly. In addition, quarterly composite particulate samples are analysed for gamma emitting isotopes. Table III-A-2 presents the results of the ERMAP for air particulate analyses. (The station identification numbers correspond to the locations identified in Table III-A-1.)

For ease of interpretation of these measurements, a plot of gross beta activity vs. time for all indicator stations is provided in Figure III-A-1 and for the control station in Figure III-A-2.

Positive measurements of specific isotopes characteristic of reactor operation (ie., Cs-137 and Co-60) were observed in the quarterly composite samples. An indication of the presence of Co-60 (Co-60 peak) was observed at the Overlook (Station 08-0.03 mi-W) during the first quarter, and Cs-137 was observed at Cleft Rock (Station 10-0.9 mi-S) during the fourth quarter and at East Weymouth (Station 21-21 mi-NW) during the first quarter. Only the positive indication of Co-60 at the Overlook was due to the effluents of PNPS-1. Both positive measurements of Cs-137 were due to atmospheric fa' out from previous weapons testing - there was a lack of Cs-134 at Cleft Rock which would have indicated that the effluents of PNPS-1 were the cause, and East Weymouth is a control station.

However, even if an individual were to breathe air with the Co-60 concentration (3.4×10^{-4} pCi/m^3), the maximum exposed individual would receive an annual dose of less than 0.00003 mrem to the total body and 0.009 mrem to the maximum exposed organ (Infant-Lung).

In consideration of the natural background dose rate of 80 to 100 mrem/year, there was clearly no significant environmental effect observed in the air particulate media as a result of the operation of PNPS-1.

TABLE III-A-2

ERMAP RESULTS

AIR PARTICULATE FILTERS

PILGRIM I   OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING   83/03/16.   PAGE 5

SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS: PCI/CU. M

MEDIUM: AIR PARTICULATE FILTERS

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN,RANGE,AND NO. DETECTED**	STA.	HIGHEST STATION MEAN,RANGE,AND NO. DETECTED**	CONTROL LOCATIONS MEAN,RANGE,AND NO. DETECTED**
GR-A (55) (0)	2.0E-03	(4.7 + .3)E -3 (-1.7 - 5.9)E -2 *(49/49)*	21	(6.5 + .9)E -3 (-1.2 - 2.5)E -2 *(16/ 55)*	(6.5 + .9)E -3 (-1.2 - 2.5)E -2 *(16/ 55)*
GR-B (55) (1)	4.0E-03	(2.0 + .1)E -2 (-1.1 - 34.1)E -2 *(463/464)*	21	(3.0 + .7)E -2 (-1.4 - 420.0)E -3 *(53/ 55)*	(3.0 + .7)E -2 (-1.4 - 420.0)E -3 *(53/ 55)*
BE-7 (58) (46)	2.0E-02	(6.5 + .3)E -2 (1.9 - 11.9)E -2 *(46/ 52)*	07	(9.6 + 1.2)E -2 (2.6 - 11.9)E -2 *(6/ 7)*	(-5.3 + 5.7)E -1 (-3.4 - .1)E 0 *(5/ 6)*
K-40 (58) (0)	4.0E-02	(6.4 + 3.4)E -3 (-8.9 - 8.6)E -2 *(8/ 52)*	21	(2.3 + 2.2)E 2 (1.0 -********)E -3 *(3/ 6)*	(2.3 + 2.2)E 2 (1.0 -********)E -3 *(3/ 6)*
CR-51 (58) (0)	2.0E-02	(1.3 + 17.8)E -4 (-6.3 - 5.9)E -2 *(0/ 52)*	21	(1.5 + 1.5)E 0 *(0/ 6)*	(1.5 + 1.5)E 0 (-9.0 - 8810.0)E -3 *(0/ 6)*
MN-54 (58) (0)	2.0E-03	(9.9 + 22.1)E -5 (-2.9 - 6.1)E -3 *(0/ 52)*	21	(1.1 + 1.1)E -1 *(0/ 6)*	(1.1 + 1.1)E -1 (-2.0 -68800.0)E -5 *(4/ 6)*
CO-57 (58) (0)	1.0E-03	(1.1 + 1.1)E -4 (-1.9 - 3.1)E -3 *(0/ 52)*	03	(5.3 + 5.1)E -4 *(0/ 5)*	(-7.4 + 7.5)E -2 (-4.5 - .0)E -1 *(0/ 6)*
CO-58 (58) (0)	2.0E-03	(-3.4 + 185.9)E -6 (-4.4 - 5.7)E -3 *(0/ 52)*	21	(4.6 + 4.7)E -2 *(0/ 6)*	(4.6 + 4.7)E -2 (-2.2 - 200.0)E -3 *(0/ 6)*
FE-59 (58) (0)	3.0E-03	(-4.6 + 5.5)E -4 (-1.9 - 1.2)E -2 *(0/ 52)*	21	(7.5 + 7.5)E -2 *(0/ 6)*	(7.5 + 7.5)E -2 (-1.9 - 452.0)E -3 *(0/ 6)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-A-2
CONTINUED

UNITS: PCI/CU. M

MEDIUM: AIR PARTICULATE FILTERS

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA.	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
CO-60 (58) (0)	2.0E-03	(-6.6 ± 3.4)E -4 (-1.4 - .2)E -2 *(0/ 52)*	09	(1.1 ± 4.4)E -4 *(0/ 6)*	(-3.6 ± 3.6)E -1 (-2.7 - .0)E 0 *(0/ 6)*
ZN-65 (58) (0)	4.0E-03	(1.2 ± 4.1)E -4 (-7.8 - 8.0)E -3 *(0/ 52)*	10	(2.4 ± 2.1)E -3 *(0/ 5)*	(-5.1 ± 5.1)E -1 (-3.1 - .0)E 0 *(0/ 6)*
ZR-95 (58) (0)	3.0E-03	(1.0 ± .4)E -3 (-5.6 - 11.4)E -3 *(0/ 52)*	15	(3.5 ± 3.3)E -3 *(0/ 5)*	(-2.7 ± 2.7)E -1 (-1.6 - .0)E 0 *(0/ 6)*
NB-95 (58) (0)	1.0E-02	(3.2 ± 1.4)E -4 (-2.1 - 4.3)E -3 *(0/ 52)*	00	(1.4 ± .8)E -3 *(0/ 6)*	(-1.8 ± 1.8)E -1 (-1.1 - .0)E 0 *(0/ 6)*
AG-110M(58) (0)	2.0E-03	(-3.3 ± 1.0)E -3 (-4.5 - 3.0)E -2 *(0/ 52)*	10	(2.5 ± 3.2)E -3 *(0/ 5)*	(-2.4 ± 2.4)E 0 (-1.[illegible] - .0)E 1 *([illegible]/ 6)*
RU-103 (58) (0)	2.0E-03	(1.6 ± 16.0)E -5 (-3.6 - 4.4)E -3 *(0/ 52)*	00	(4.3 ± 7.1)E -4 *(0/ 6)*	(-6.5 ± 6.6)E -2 (-3.9 - .0)E -1 *(0/ 6)*
RU-106 (58) (0)	2.0E-02	(-2.0 ± 2.4)E -3 (-8.7 - 3.5)E -2 *(0/ 52)*	21	(9.5 ± 9.6)E -1 *(0/ 6)*	(9.5 ± 9.6)E -1 (-4.7 - 5730.0)E -3 *(0/ 6)*
I-131 (58) (0)	3.0E-03	(3.3 ± 2.7)E -4 (-3.5 - 4.4)E -3 *(0/ 52)*	21	(2.1 ± 2.1)E -1 *(0/ 6)*	(2.1 ± 2.1)E -1 (-2.7 -12500.0)E -4 *(0/ 6)*
CS-134 (58) (0)	2.0E-03	(-2.8 ± 1.6)E -4 (-8.4 - 3.7)E -3 *(0/ 52)*	00	(3.0 ± 7.3)E -4 *(0/ 6)*	(-1.1 ± 1.1)E -1 (-6.5 - .0)E -1 *(0/ 6)*
CS-137 (58) (0)	2.0E-03	(4.9 ± 2.5)E -4 (-4.9 - 7.1)E -3 *(1/ 52)*	21	(1.1 ± 1.1)E 0 (-5.1 - 6400.0)E -3 *(2/ 6)*	(1.1 ± 1.1)E 0 (-5.1 - 6400.0)E -3 *(2/ 6)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-A-2
CONTINUED

PILGRIM I

OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING 83/03/16. PAGE 7
SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS PCI/CU. M

MEDIUM: AIR PARTICULATE FILTERS

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
BA-140 (52) (0)	5.0E-03	(-1.4 ± .7)E -3 (-8.2 - 1.5)E -2 *(0/ 52)*	21	(2.2 ± 4.1)E -2 *(0/ 6)*	(2.2 ± 2.1)E -2 (-8.7 - 1290.0)E -6 *(0/ 6)*
CE-141 (52) (0)	3.0E-03	(2.5 ± 2.5)E -4 (-5.4 - 4.4)E -3 *(0/ 52)*	21	(4.2 ± 4.2)E -1 *(0/ 6)*	(4.2 ± 4.2)E -1 (-3.5 -25200.0)E -4 *(0/ 6)*
CE-144 (52) (0)	2.0E-02	(5.0 ± 81.2)E -5 (-2.1 - 1.3)E -2 *(0/ 52)*	21	(7.2 ± 7.2)E -1 *(0/ 6)*	(7.2 ± 7.2)E -1 (-6.4 - 4310.0)E -3 *(0/ 6)*
TH-228 (52) (0)	9.0E-03	(-1.4 ± 10.3)E -4 (-2.2 - 2.2)E -2 *(0/ 52)*	10	(7.5 ± 7.4)E -3 *(0/ 6)*	(-7.9 ± 7.9)E -1 (-4.8 - .0)E 0 *(0/ 6)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

FIGURE III-A-1
GROSS BETA ACTIVITY
AIR PARTICULATES
INDICATOR STATIONS

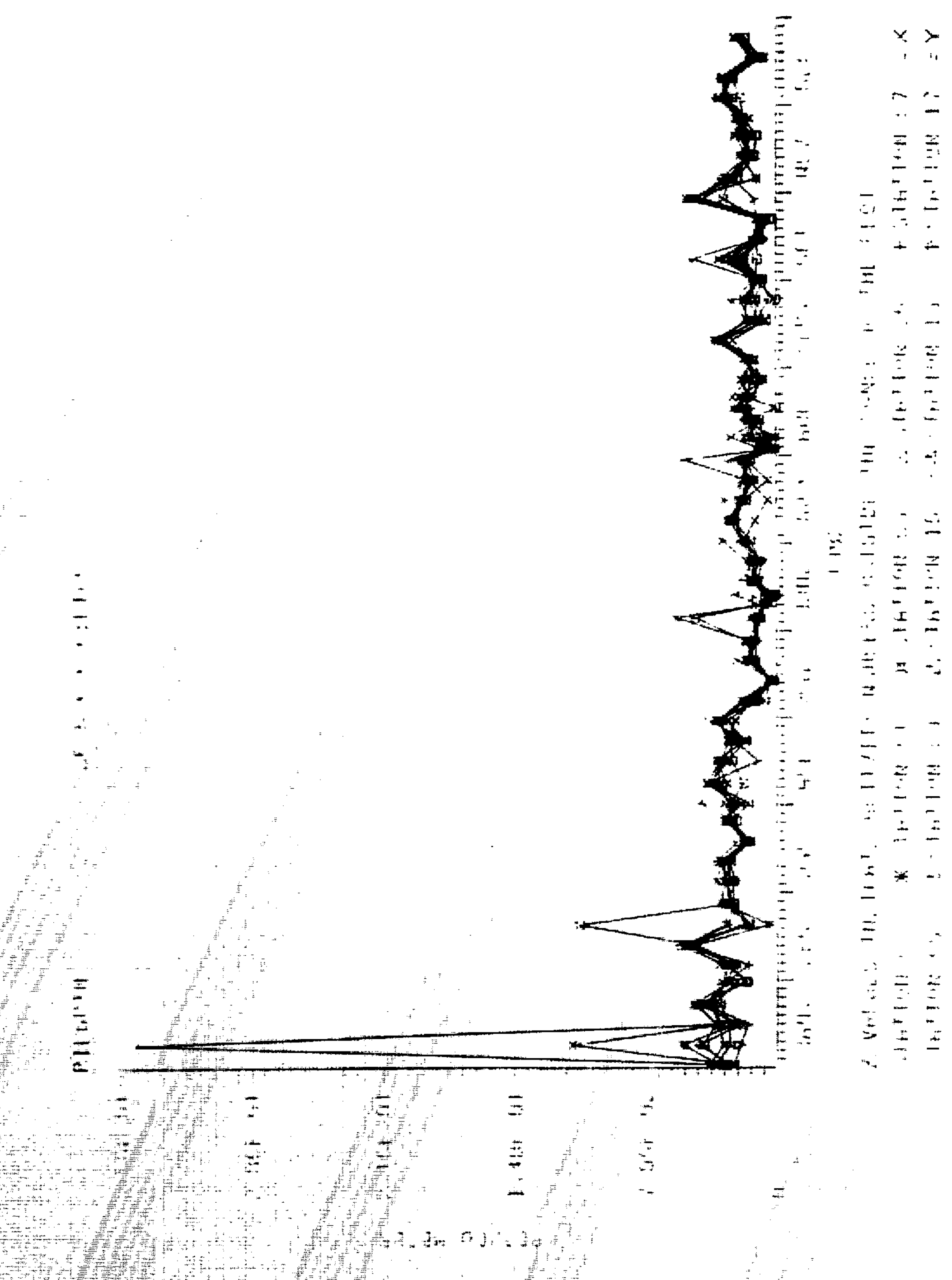


FIGURE III-A-2
GROSS BETA ACTIVITY
AIR PARTICULATES
CONTROL STATION

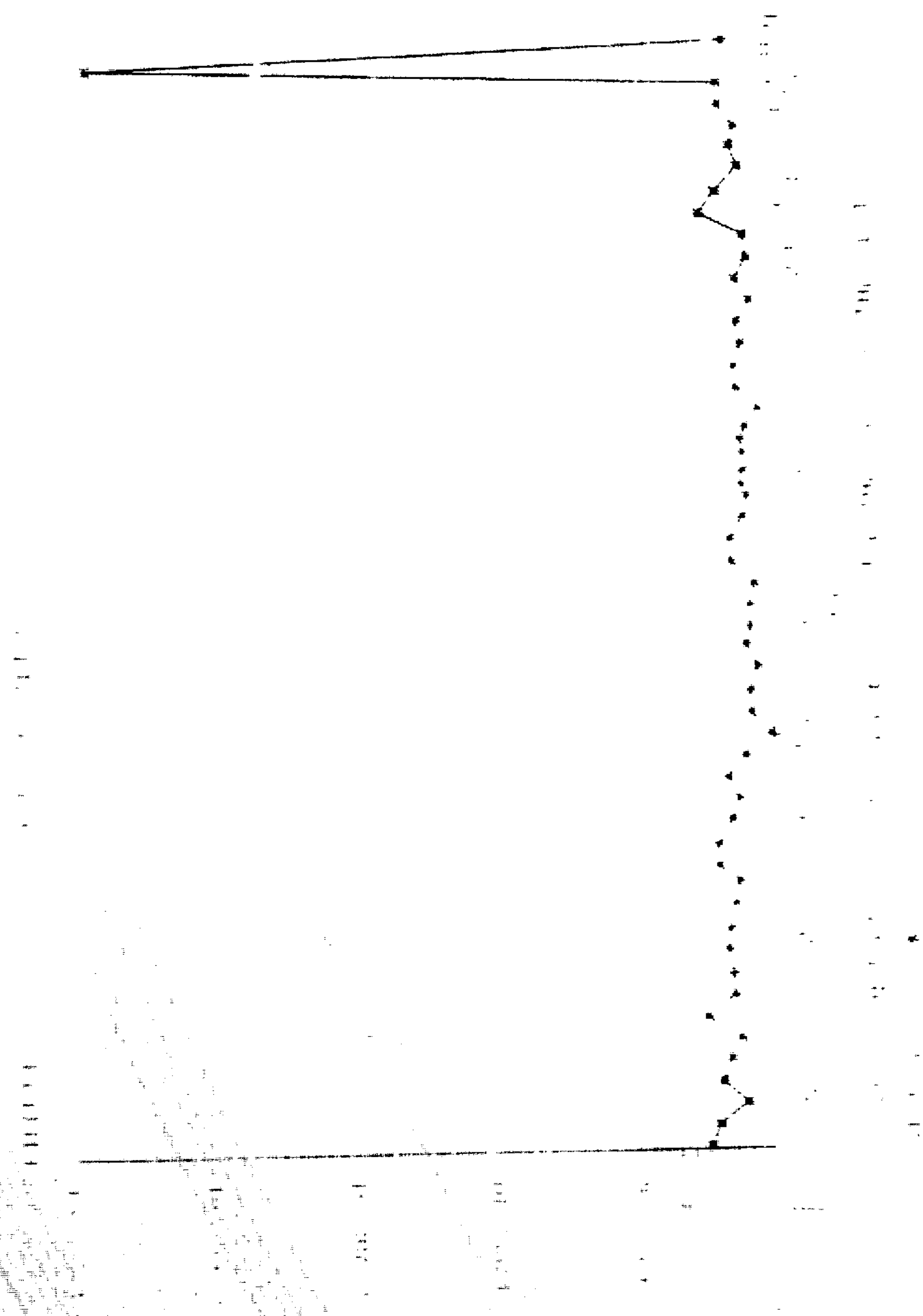


FIGURE III-A-3
CONCENTRATIONS OF Ce-144
AIR PARTICULATES
INDICATOR STATIONS

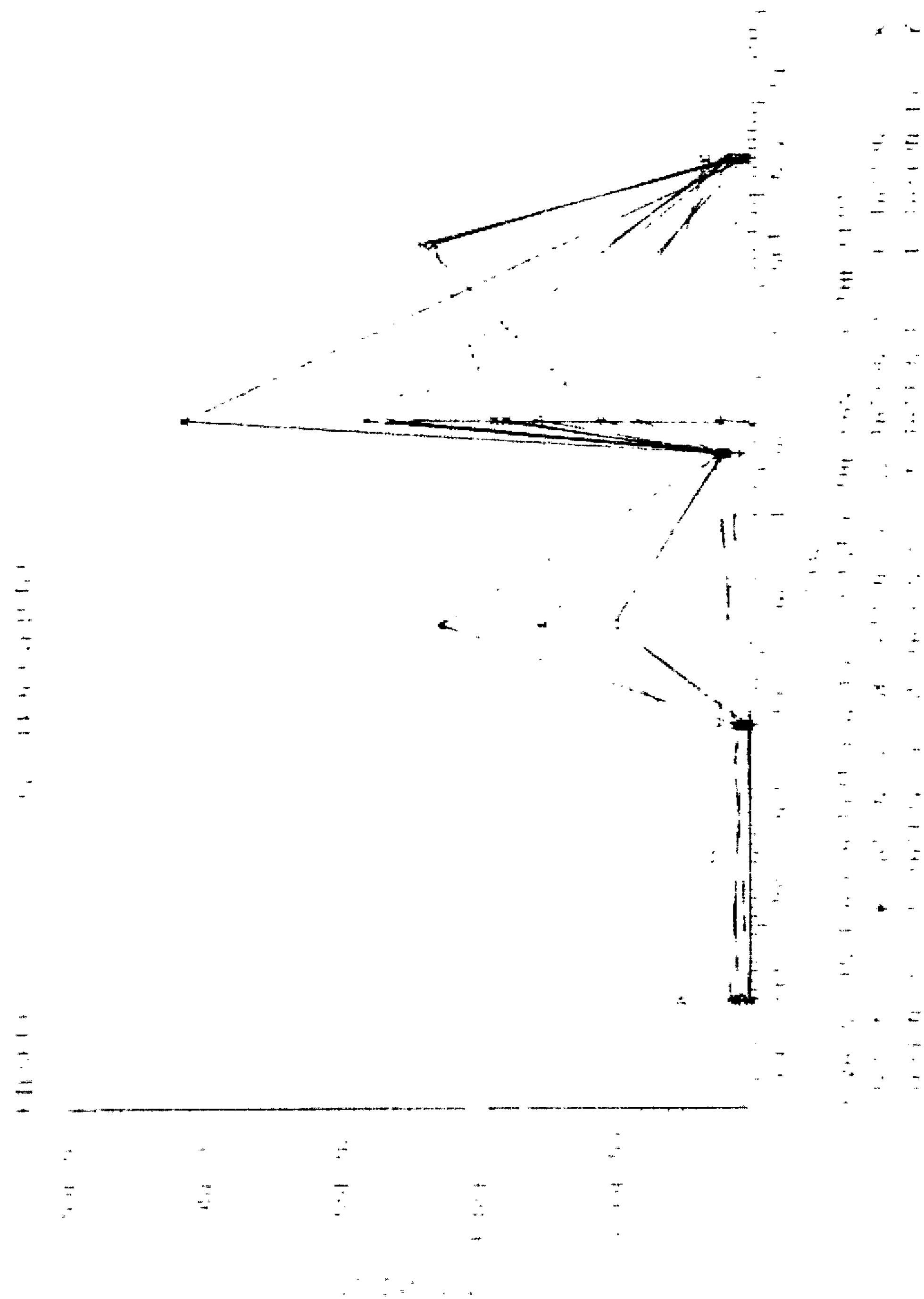


FIGURE III-A-4
CONCENTRATIONS OF Ce-144
AIR PARTICULATES
CONTROL STATION

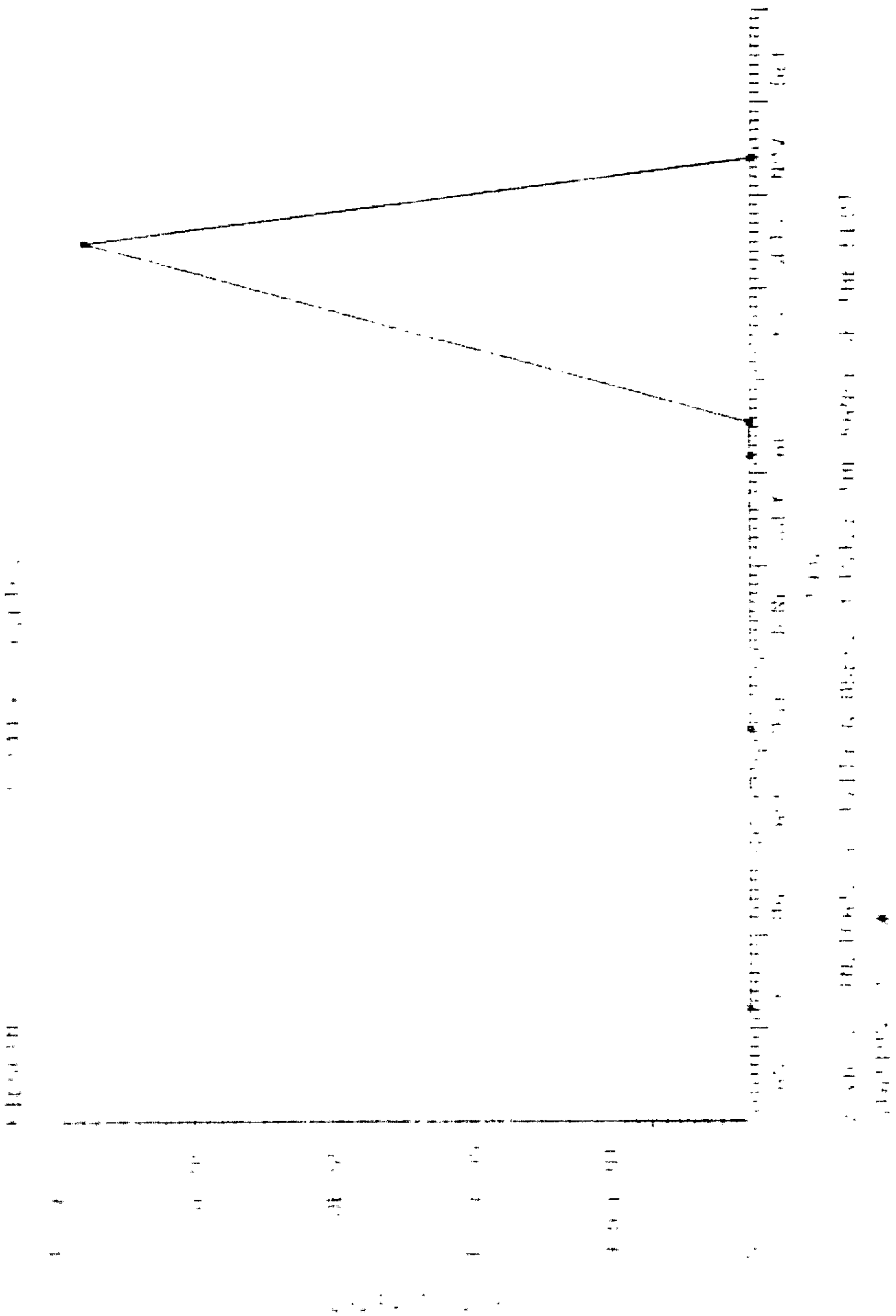


FIGURE III-A-5
CONCENTRATIONS OF Ce-141
AIR PARTICULATES
INDICATOR STATIONS

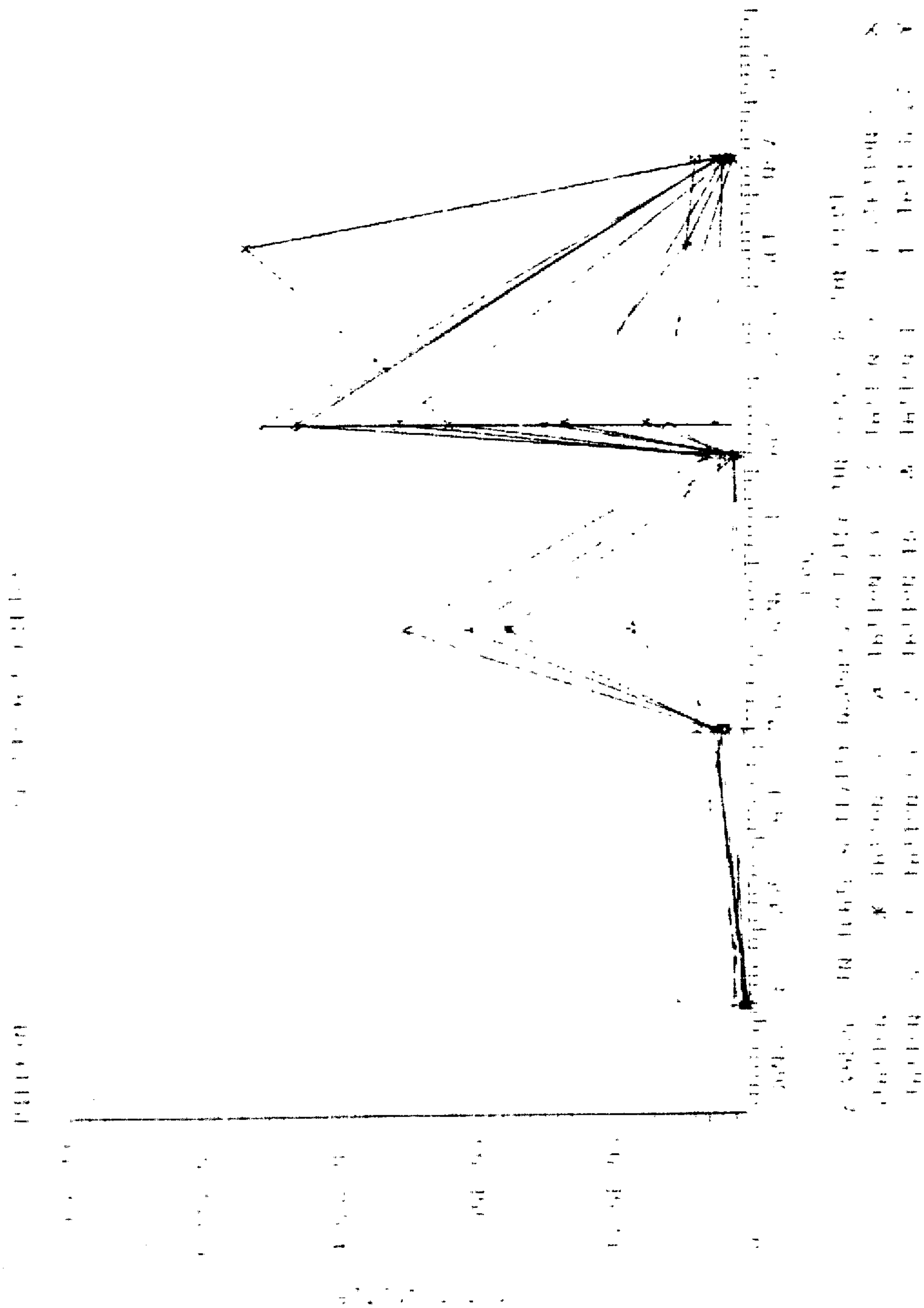


FIGURE III-A-6
CONCENTRATIONS OF Ce-141
AIR PARTICULATES
CONTROL STATION

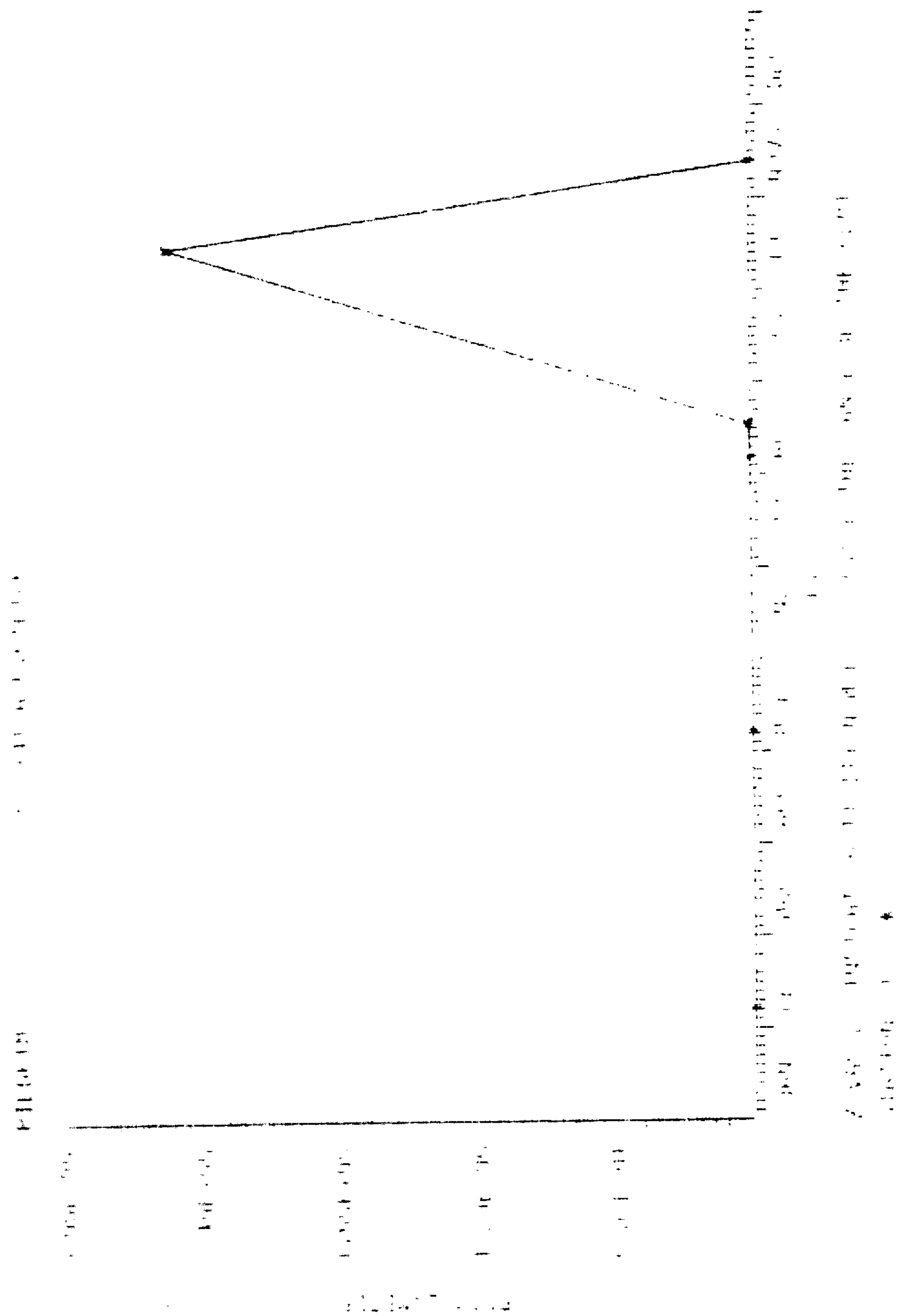


FIGURE III-A-7
CONCENTRATIONS OF Ru-103
AIR PARTICULATES
INDICATOR STATIONS

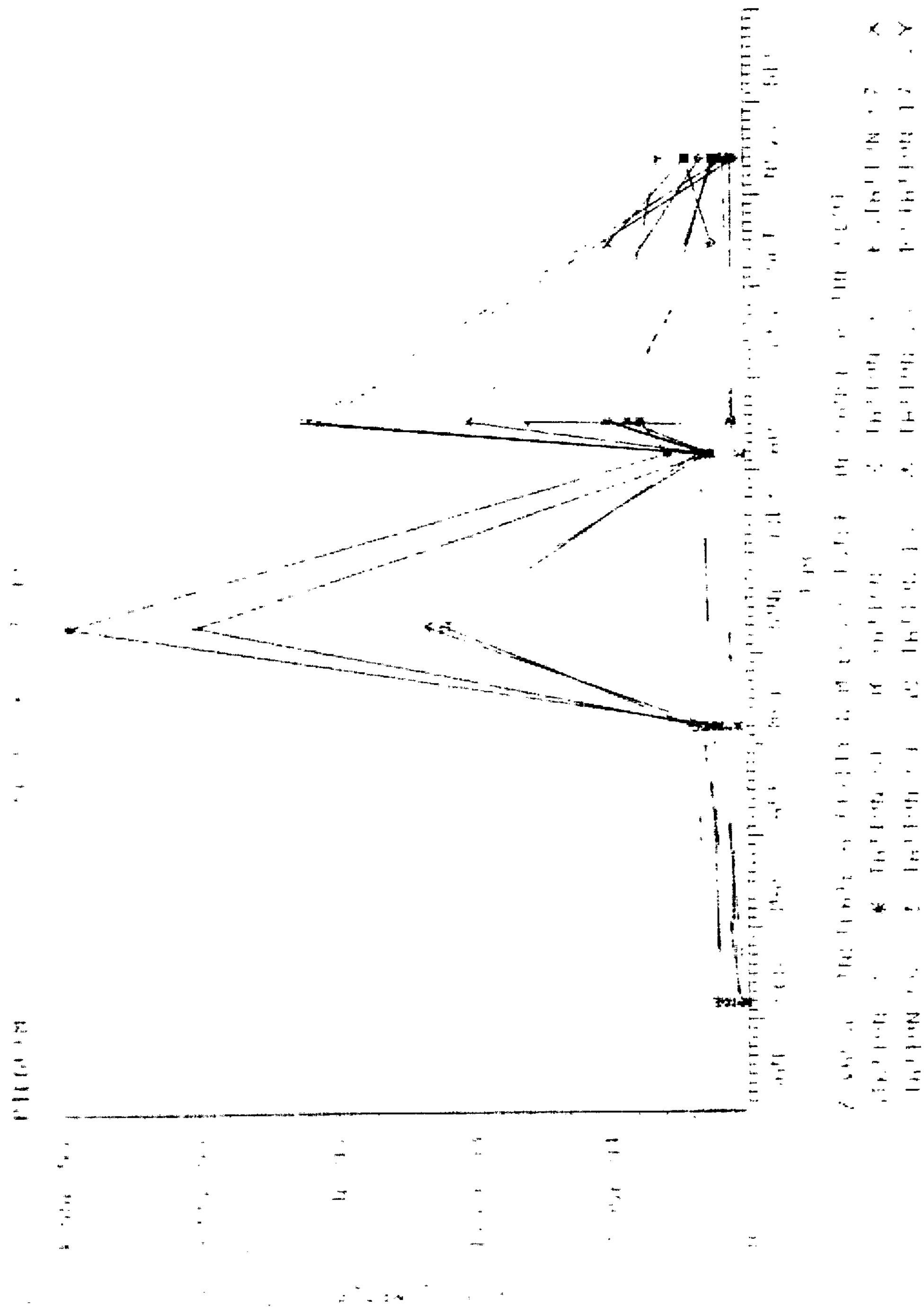


FIGURE III-A-8
CONCENTRATIONS OF Ru-103
AIR PARTICULATES
CONTROL STATION

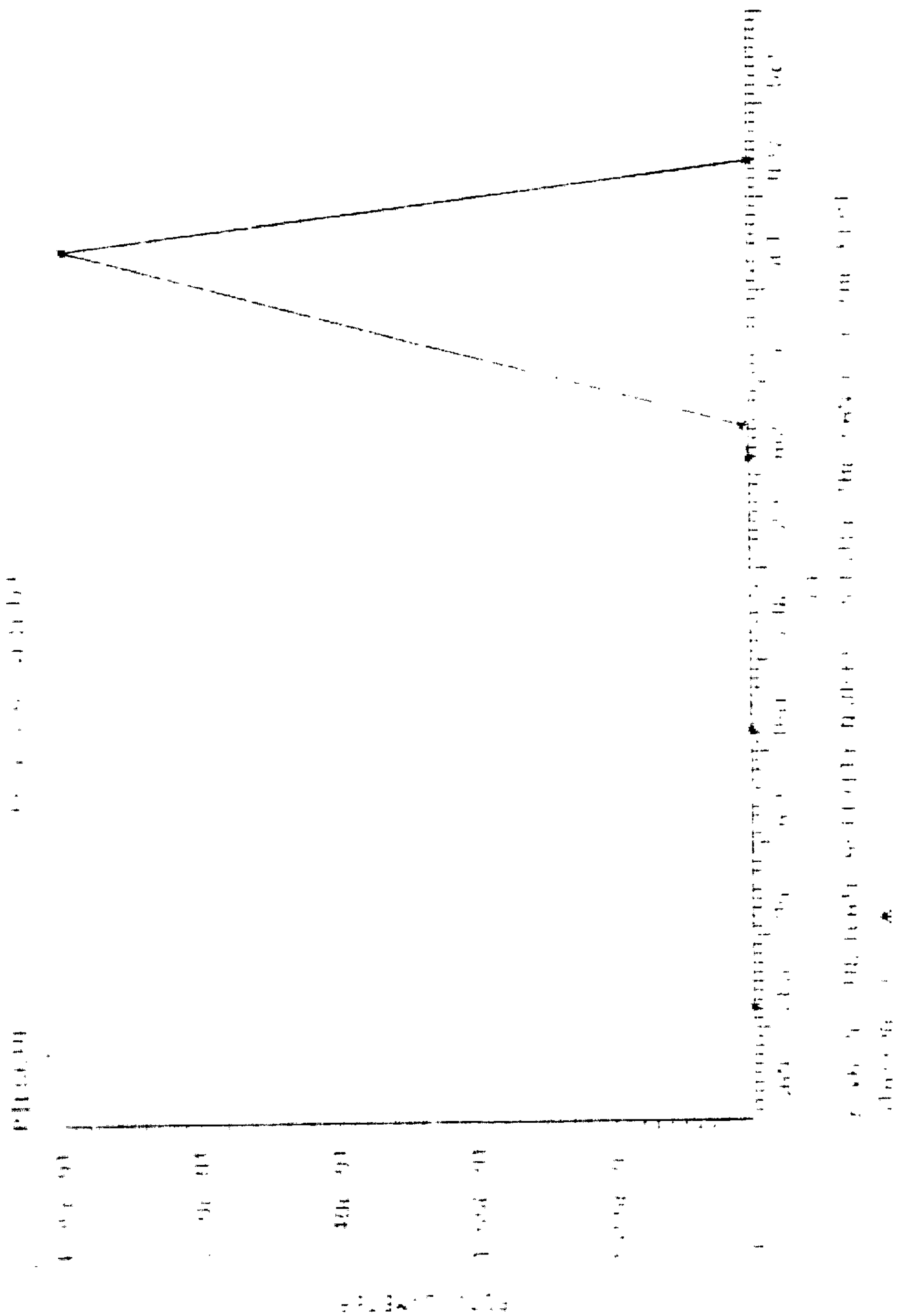


FIGURE III-A-9
CONCENTRATIONS OF Zr-95
AIR PARTICULATES
INDICATOR STATIONS

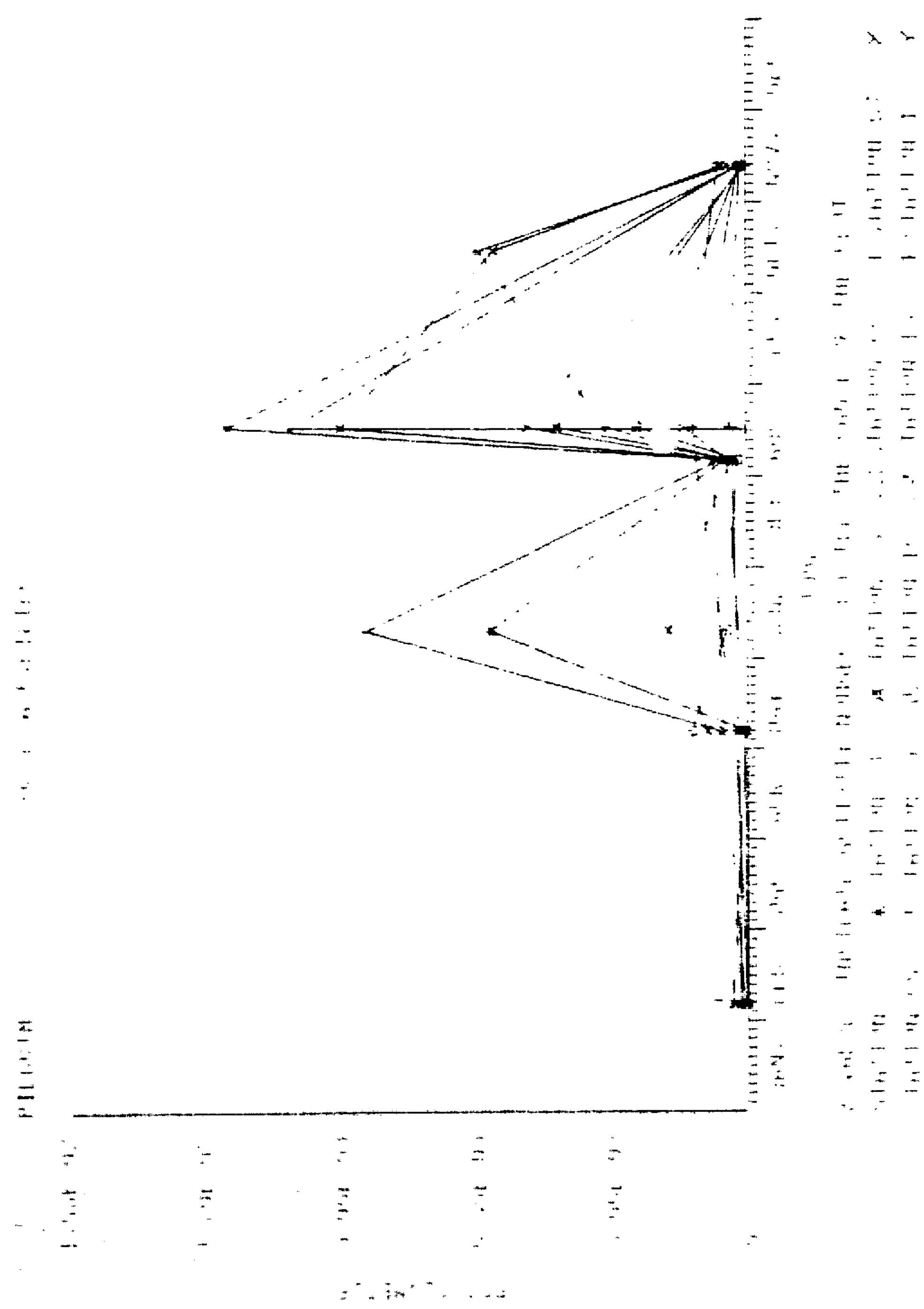


FIGURE III-A-10
CONCENTRATIONS OF Zr-95
AIR PARTICULATES
CONTROL STATION

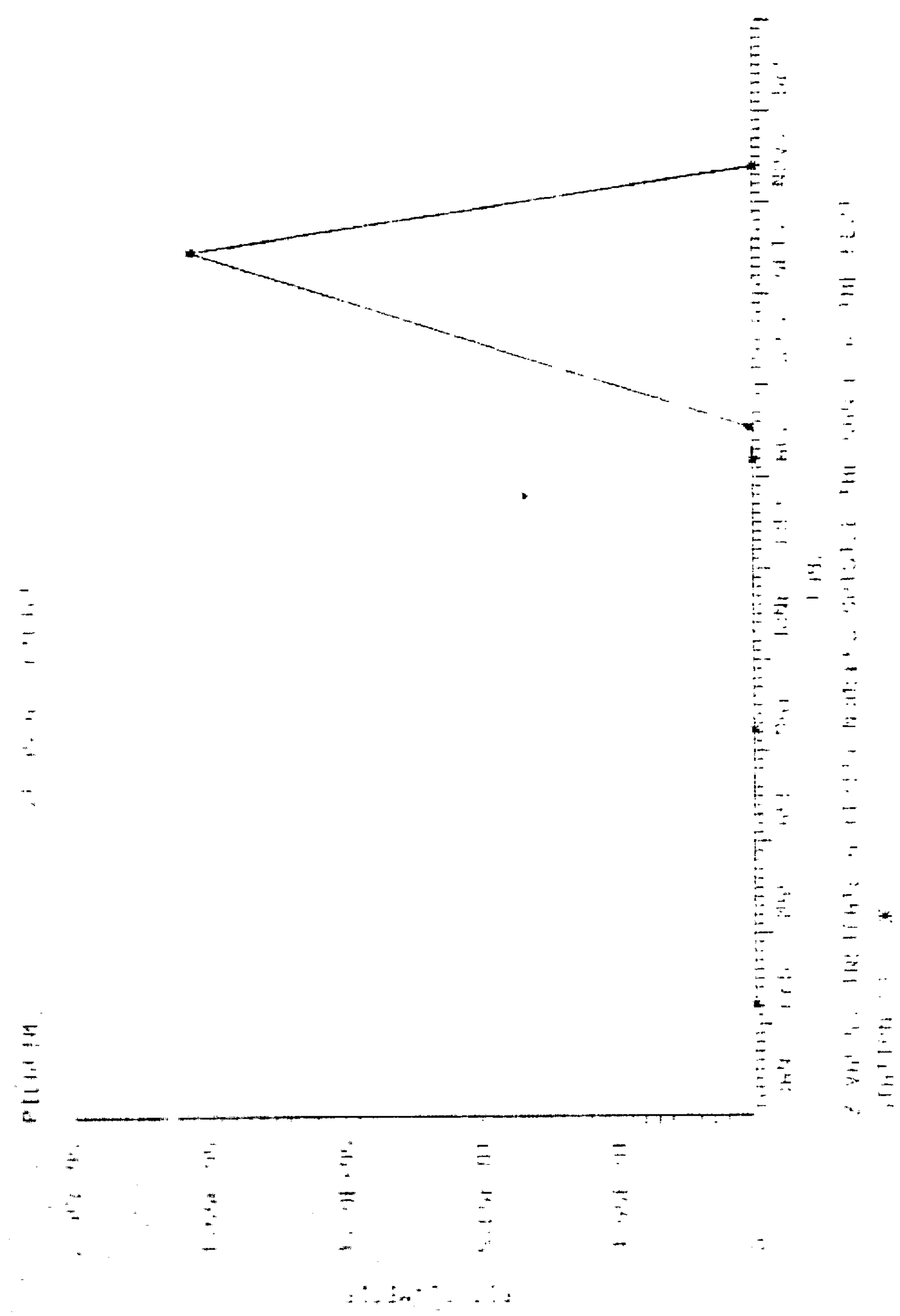


FIGURE III-A-11
CONCENTRATIONS OF Nb-95
AIR PARTICULATES
INDICATOR STATIONS

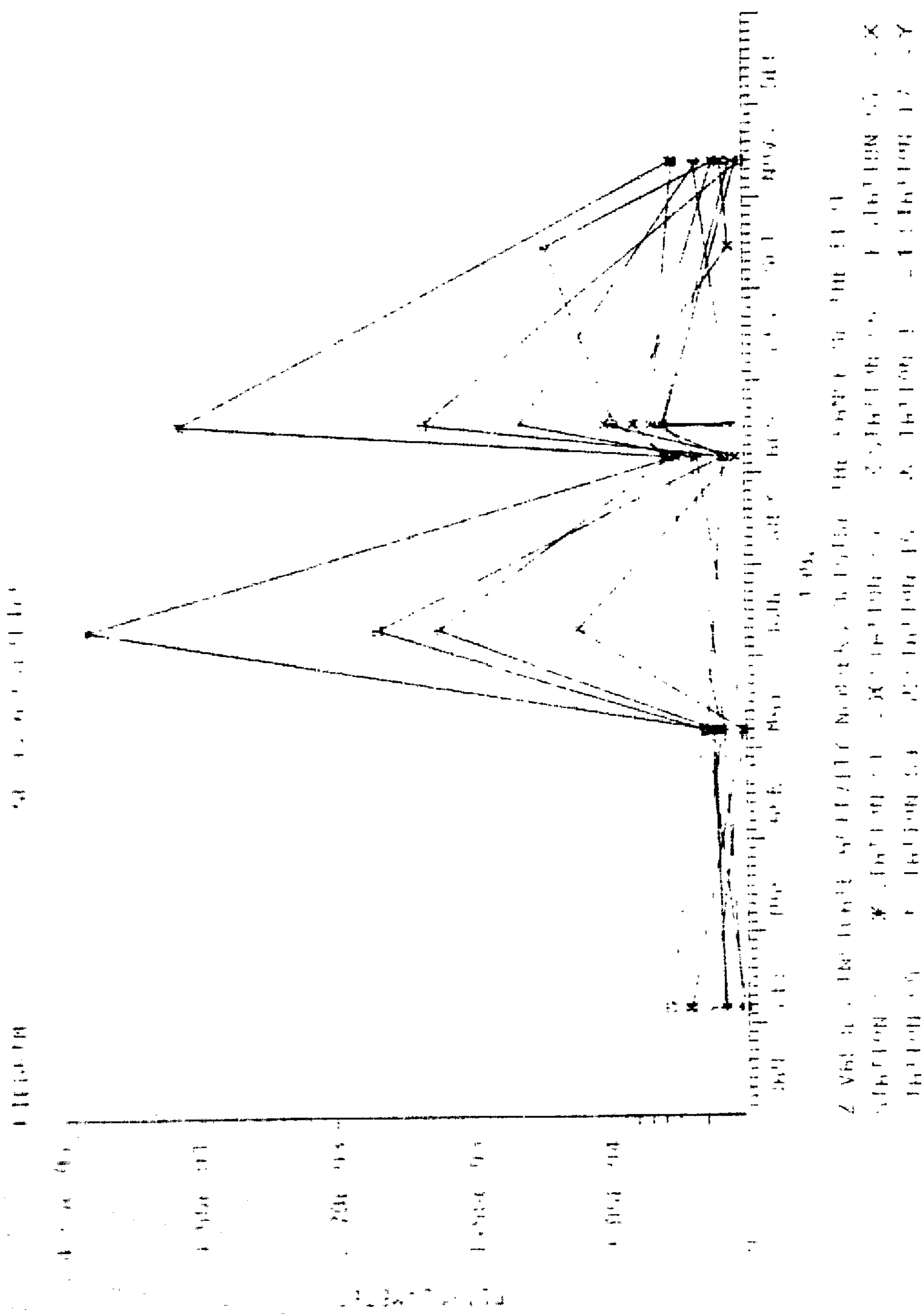
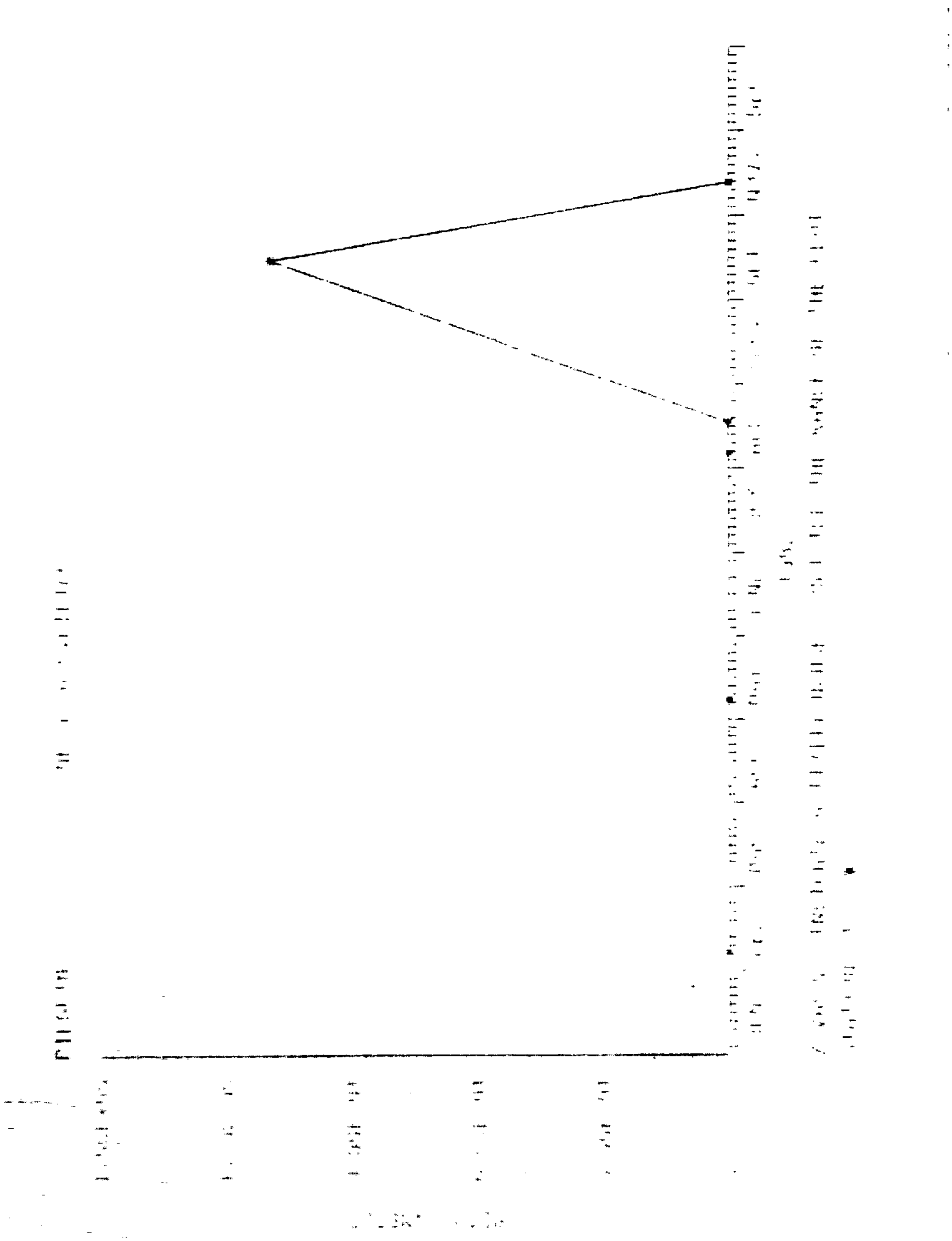


FIGURE III-A-12
CONCENTRATIONS OF Nb-95
AIR PARTICULATES
CONTROL STATION



III. B. Iodine

The same sample collection systems used to collect airborne particulates are used to collect gaseous iodine on a charcoal filter cartridge. The cartridge is removed and analyzed for I-131 weekly. The results of the ERMAP program for this media are provided in Table III-B-1. It is not apparent from this table that the mean value of the calculated concentrations for the indicator stations is greater than the mean value for the control station. The results of these analyses are presented graphically in Figure III-B-1 for the indicator stations and Figure III-B-2 for the control station.

There was clearly no significantly environmental effect observed in the airborne gaseous iodine collection media as a result of operation of PNPS-1.

The Yankee Atomi Environmental Laboratory determined that Co-60, an activation product often associated with releases from nuclear facilities, and abnormally high levels of normally present Cs-137, were present on the charcoal cartridges from PNPS-1 and another sponsor company. The manufacturer of the cartridges is Nuclear Consulting Services (NUCON) and the affected lot and batch numbers to date are lot 002 and batch 02.

This fact originally came to light during mid October 1982 when the analysis of seventy percent of the charcoal cartridges submitted weekly by PNPS-1 showed positive ^{60}Co concentrations (~ 90 dpm/cartridge). PNPS-1 charcoal cannisters had been used during the week in question. Analysis of six unused cannisters from the newly instituted material confirmed the presence and quantity of ^{60}Co and ^{137}Cs.

Analyses of charcoal cannisters subsequently submitted were conducted by high resolution gamma spectromety, rather than the screening methodology, pending the outcome of negotiations between the sponsor company and NUCON. During the early part of January, 1983, this exact set of circumstances was repeated for a second sponsor company. At this time, the Laboratory contacted NUCON directly to ascertain the cause of the problem.

NUCON's representative indicated that their analysis of samples from the affected batch and from the raw materials used to prepare the batch confirmed the presence and levels of ^{60}Co. The basic material used to make the charcoal is coconut shell which has been fired, charred, ground and refired in the presence of steam to provide activated sites on the charcoal. This material is then purchased by NUCON and subjected to further testing and processing. The raw material under investigation was purchased by NUCON from the Phillipines. NUCON postulates that radioactive fallout from previous Chinese nuclear weapons testing is just entering the food web (coconuts) and is responsible for the presence of the ^{60}Co and abnormally high levels of ^{137}Cs.

Since the majority of charcoal of this type originates from the Southeast Asian region, it is most probable that all manufacturers of charcoal cannisters will eventually be faced with this contamination problem. The test data developed by NUCON for each batch of charcoal relative to the efficiencies of collection for various ^{131}I species remains valid.

TABLE III-B-1

ERMAP RESULTS

CHARCOAL CARTRIDGES

PILGRIM 1 OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING 83/03/16. PAGE 11

SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

MEDIUM: CHARCOAL FILTERS

UNITS: PCI/CU. M

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STAT	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
I-131 (551) (0)	3.0E-03	(-2.2 ± .6)E -5 (-1.1 - 1.2)E -1 *(0/496)*	09	(-6.2 ± 15.0)E -4 *(0/ 56)*	(-1.9 ± 1.7)E -3 (-3.4 - 3.9)E -2 *(0/ 55)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

FIGURE III-B-1
CONCENTRATIONS OF I-131
CHARCOAL FILTER
INDICATOR STATIONS

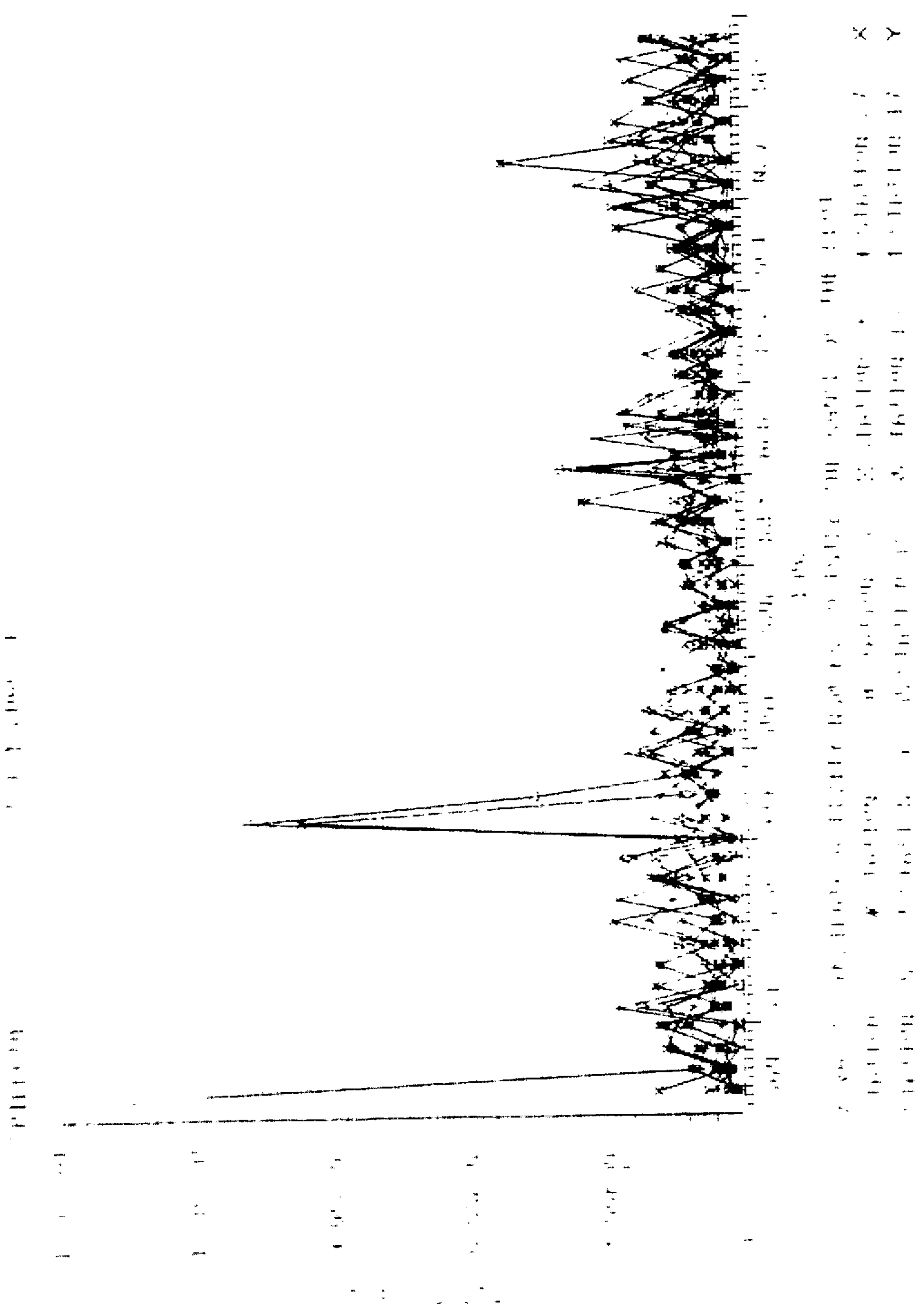
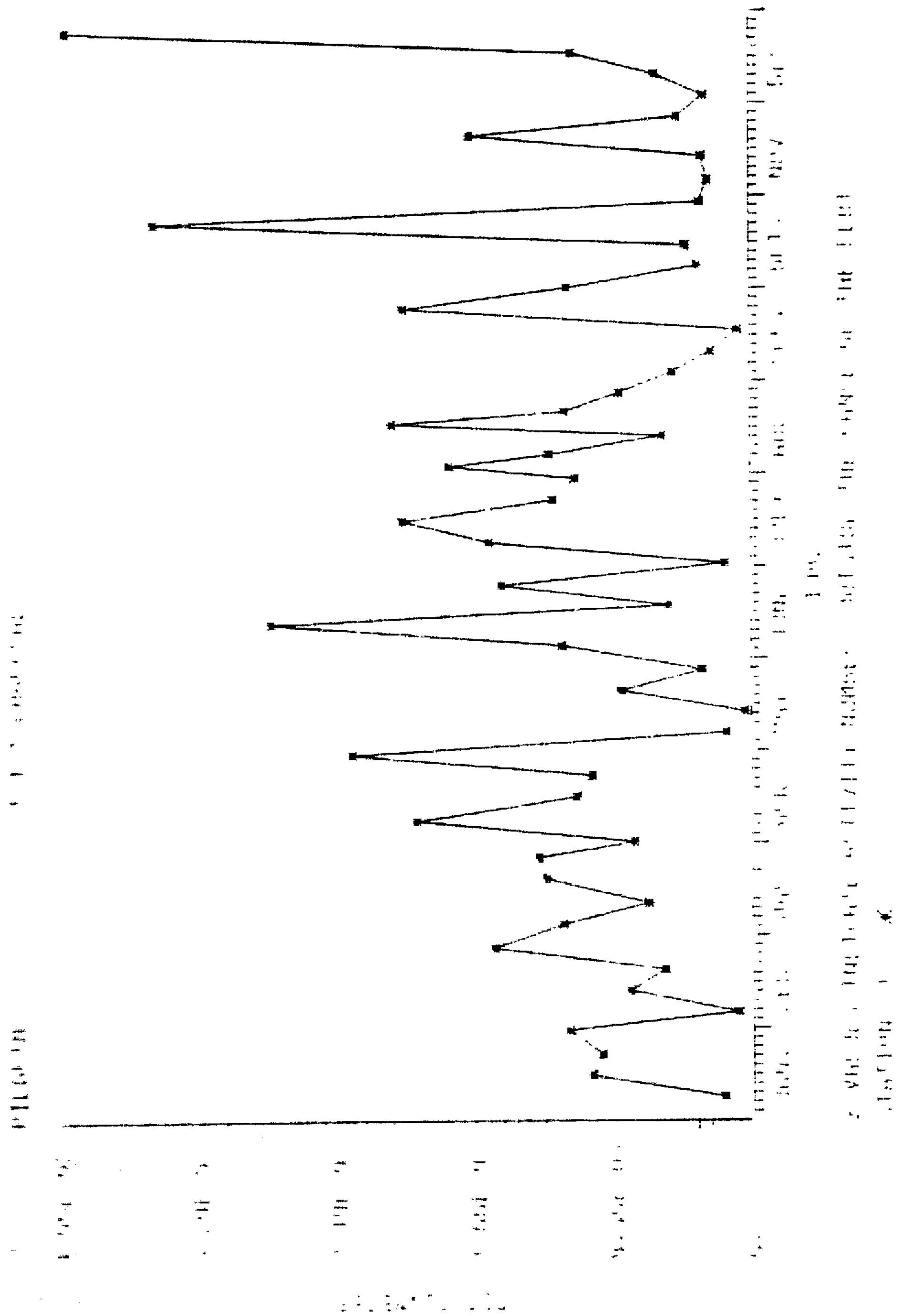


FIGURE III-B-2
CONCENTRATIONS OF I-131
CHARCOAL FILTERS
CONTROL STATION



III. C. Soil

Soil surveys at eleven locations are requireu once every three years in compliance with the revised Technical Specifications which went into effect on April 19, 1977. These in-situ surveys were conducted during May, October and December of 1982. The results of these surveys are included in Appendix C of this report.

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III. D Direct Radiation

1. Continuous Thermoluminescent Dosimetry

Thermoluminescent dosimeters (TLD) of the $CaSO_4$(Dy) type are used to record direct gamma radiation from all sources including direct and scattered radiation from Nitrogen-16 in the turbine building, and cosmic and other natural and artificial gamma radiation. TLD's are installed at the locations identified in Table III-D-1.

Tables III-D-2 through III-D-5 show quarterly average doses from direct gamma radiation in uR/hr at these stations.

In addition to average doses for each TLD for each readout period, geographic regional average doses for sectors of different nearness are computed; viz, in immediate proximity to PNPS, more distant but near the site boundary, up to several miles away - "neighborhood", and far away (background). Each set of data show consistent trends; the near plant dosimeters (QA, PB, PA, WS) stand out among all readings and have an average above the dose rates further away. The next region has a lower average dose rate, and beyond 0.7 mile (distant neighborhood and background) the dose rates are statistically consistent.

In all cases, the near plant levels are distinctly higher than those off-site and off-site dose rates are not significantly sensitive to distance variations beyond the site itself. Thus, beyond the "exclusion area" (for this purpose, the 0.25-0.7 mile region), dose rates show no significant plant effect; populated areas are therefore beyond the limits of elevated dose rates.

2. Field Survey

A gamma exposure survey of Plymouth Beach and Priscilla/White Horse Beach was conducted during June of 1982. The results of this most recent survey are in agreement with the last five beach surveys conducted for 1981, 1980, 1979, 1978 and 1977. In addition, a comprehensive soil survey of 11 locations was conducted during the spring and fall of 1982. This study included both gamma exposure rate measurements and in-situ gamma spectrometry analysis for each location. Laboratory soil analyses were also conducted for selected locations. The results of this study are presented in Appendix C. The latest gamma exposure survey was conducted using a Reuter Stokes RS-111 high pressure ion chamber (HPCI). Serial Number 4-1656. The design and calibration of this instrument were described in the above report.[4]

The present survey was designed to detect differences in the external exposure rate encountered at beaches near the plant (Plymouth and Priscilla/White Horse) and a control location (Duxbury). The detector's calibration was checked before each measurement.

The data (Table III-D-7) indicate that the exposure rates at Plymouth Beach (behind Berts Restaurant) and Priscilla/White Horse Beach are not significantly greater than the exposure rates measured at the control station in Duxbury. The small differences are likely due to the presence of granite beach stones which are essentially absent at the Duxbury location.

It has been demonstrated that proximity to beach stones results in higher exposure rates than in sandy areas (see Annual Report No. 10).

This survey indicates that the natural background exposure rate at beaches near Pilgrim Station is probably 6-9 uR/hr. These results are in complete agreement with similar measurements performed in Maine[5], where the natural background exposure rate at shoreline locations was found to vary between 6.6 and 14.5 uR/hr. These exposure rates were also found to vary directly with the size and proximity of granite outcroppings[5].

These latest measurements are also in agreement with the soil survey mentioned earlier. The results of that survey indicate that off-site dose rates have a range of 9.3 to 10.5 uR/hr with an average of 9.7 uR/hr.

TABLE III-D-1

THERMOLUMINESCENT DOSIMETER LOCATIONS

Surveillance Stations				Station Specification				
Near Plant (0-0.16 miles)	Exclusion Area (0.25-0.7)	Distant Neighborhood (0.96-6.5 miles)	Background (8-23 miles)	Station Code	See Fig.	Item No.	† Distance (miles)	Direction
Overlook Area				OA	11-2	9	0.09	W-WSW
*Warehouse				WS	11-2	23	0.10	E-SSE
*Pedestrian Bridge				PB	11-2	8	0.15	NNW
Public Parking Area				PA	11-2	7	0.16	NW-NNW
	*Property Line			A	11-2	5	0.25	W-WSW
	*Property Line			F	11-2	2	0.27	NNW-NW
	*East Breakwater			EB	11-2	18	0.31	ESE
	Property Line			B	11-2	13	0.32	SSE
	Property Line (SW)			H	11-2	6	0.33	SW
	Property Line			I	11-2	3	0.33	W-WNW
	*Property Line			PL	11-2	24	0.34	NNW-NW
	*Property Line			D	11-2	1	0.37	NW-NNW
	*Property Line			L	11-2	22	0.40	ESE-SE
	*Property Line			HB	11-2	12	0.41	SE
	*Property Line			C	11-2	11	0.44	ESE-SE
	*Property Line (West)			G	11-2	4	0.44	W
	Rocky Hill Road (West)			WR	11-2	10	0.53	WNW
	Microwave Tower			MT	11-2	14	0.55	S-SSW
	Cleft Rock Area			CR	11-1	7	0.63	S-SSW
	Rocky Hill Road (East)			ER	11-2	21	0.68	SE
	*Bay Shore Drive			BD	11-1	6	0.70	W-WNW
		*Emerson Road		EM	11-2	15	0.97	SSE
		*Property Line		J	11-2	19	1.21	S-SSE
		*Property Line (South)		K	11-2	17	1.23	S
		*White Horse Road		WH	11-2	16	1.31	SSE
		*Property Line		X	11-2	20	1.32	S-SSE
		Manomet Point		MP	11-1	8	2.25	E-ESE
		Manomet Elem. School		ME	11-1	9	2.50	SE
		Manomet Substation		MS	11-1	10	2.50	SSE
		South Plymouth		SP	11-1	5	3.00	WSW
		*Manomet Beach		MB	11-1	11	3.50	SE-SSE
		Plymouth Center		PC	11-1	4	4.50	W-WNW
		North Plymouth		NP	11-1	3	5.50	WNW
		*Standish Shores (Bus)		SS	11-1	1	6.25	NW
		*College Pond		CP	11-1	12	6.50	SW
			Sherman Airport (Ply)	SA	11-1	14	8.00	WSW
			Cedarville Sub. (Sag)	CS	11-1	13	10.00	S-SSE
			Kingston Substation	KS	11-1	2	10.00	WNW
			East Weymouth	EW	11-1	15	23.00	NW

*Not required by operating license.
† Distances measured from Unit 1 reactor building.

TABLE III-D-2
GAMMA EXPOSURE (TLD) DATE FOR QUARTER #1 1982

TLD No.	Station	Micror/ Hour	+-	2 Sigma
229	CP	4.16	+-	0.96
225	CR	7.97	+-	2.67
230	CS	5.22	+-	1.54
231	ER	4.63	+-	1.51
232	EW	4.00	+-	1.08
233	KS	4.41	+-	1.45
234	MB	3.55	+-	1.12
235	ME	6.46	+-	1.75
236	MP	5.11	+-	1.35
237	MS	4.73	+-	1.26
238	NP	4.59	+-	1.31
ND*	PC	ND	+-	ND
240	SA	2.68	+-	0.68
241	SP	5.91	+-	2.26
242	SS	3.95	+-	1.02
243	WR	4.64	+-	1.39
244	BD	5.32	+-	1.28
245	EB	4.84	+-	1.55
246	EM	2.92	+-	0.68
247	MT	4.06	+-	0.97
248	OA	6.95	+-	2.13
249	PA	5.07	+-	1.73
250	PB	8.32	+-	2.60
251	WH	3.75	+-	1.39
252	A	4.58	+-	1.29
253	B	4.02	+-	1.73
254	C	ND	+-	ND
255	D	7.73	+-	2.08
256	E	3.65	+-	0.98
257	F	5.01	+-	1.44
258	G	4.52	+-	1.05
259	H	8.11	+-	1.91
260	I	4.34	+-	1.17
261	J	4.17	+-	1.04
262	K	3.23	+-	1.10
224	L	9.42	+-	3.43
263	PL	4.38	+-	1.09
205	WS	16.38	+-	6.00
264	HB	4.94	+-	1.55
266	RL	2.04	+-	0.61
239	RL	2.75	+-	0.85

Geographic Regional Averages this period are:

Near Plant (0-.16 mi)	9.18	+-	2.36
Exclusion Area (.25-.68 mi)	5.54	+-	0.49
Distant Neighborhood (.7-6.5 mi)	4.39	+-	0.38
Background (8-21 mi)	4.08	+-	0.82

*ND - No Data due to missing TLD.

TABLE III-D-3
GAMMA EXPOSURE (TLD) DATA FOR QUARTER =2 1982

TLD No.	Station	Micror/ Hour	+-	2 Sigma
277	CP	8.16	+-	2.20
278	CR	8.89	+-	3.07
279	CS	ND*	+-	ND*
280	ER	6.14	+-	1.98
281	EW	8.30	+-	2.02
282	KS	6.45	+-	1.69
283	MB	6.17	+-	1.82
284	ME	9.33	+-	2.54
285	MP	7.19	+-	2.20
286	MS	8.28	+-	2.33
287	NP	8.47	+-	2.41
288	PC	4.60	+-	1.16
289	SA	5.89	+-	1.79
290	SP	6.80	+-	2.26
291	SS	7.42	+-	2.08
292	WR	11.22	+-	3.26
293	BD	8.53	+-	2.75
294	EB	8.18	+-	2.52
295	EM	8.70	+-	2.38
296	MT	9.55	+-	2.31
297	OA	22.51	+-	8.67
298	PA	8.73	+-	2.19
301	PB	17.49	+-	6.79
302	WH	12.49	+-	3.64
303	A	7.93	+-	2.31
304	B	8.94	+-	3.23
305	C	11.10	+-	3.84
306	D	9.10	+-	2.75
307	E	7.59	+-	1.90
308	F	7.11	+-	2.43
309	G	9.16	+-	2.44
310	H	15.97	+-	4.08
311	I	8.98	+-	2.85
312	J	8.88	+-	3.17
313	K	7.89	+-	2.38
314	L	7.66	+-	2.22
315	PL	7.29	+-	2.43
316	WS	10.83	+-	3.40
317	HB	8.37	+-	4.19
318	RL	2.12	+-	0.56
319	RL	1.88	+-	0.71

Geographic Regional Averages this period are:

Near Plant (0-.16 mi)	14.89	+-	3.91
Exclusion Area (.25-.68 mi)	9.10	+-	0.79
Distant Neighborhood (.7-6.5 mi)	8.03	+-	0.67
Background (8-21 mi)	6.87	+-	1.59

*ND - No date due to missing TLD

TABLE III-D-4
GAMMA EXPOSURE (TLD) DATA FOR QUARTER #3 1982

TLD No.	Station	Micror/ Hour	+-	2 Sigma
229	CP	3.98	+-	7.45
225	CR	15.52	+-	2.89
230	CS	6.82	+-	3.10
231	ER	6.91	+-	2.40
232	EW	11.84	+-	2.00
233	KS	8.14	+-	3.29
234	MB	13.37	+-	4.93
235	ME	16.43	+-	3.67
236	MP	10.91	+-	3.57
237	MS	20.77	+-	3.90
238	NP	14.11	+-	5.35
265	PC	7.62	+-	2.05
240	SA	15.40	+-	2.68
241	SP	12.91	+-	4.27
242	SS	10.28	+-	2.27
243	WR	17.15	+-	3.21
244	BD	10.42	+-	1.65
245	EB	10.10	+-	1.66
246	EM	13.00	+-	2.78
247	MT	13.21	+-	3.28
248	OA	30.99	+-	7.50
249	PA	11.26	+-	3.07
250	PB	22.81	+-	3.36
251	WH	10.98	+-	2.84
252	A	8.42	+-	2.81
253	B	8.28	+-	1.97
336	C	5.33	+-	1.68
255	D	11.19	+-	3.58
256	E	10.19	+-	2.21
257	F	8.58	+-	2.33
258	G	14.49	+-	4.03
259	H	11.43	+-	4.57
260	I	10.93	+-	2.31
261	J	11.22	+-	2.30
262	K	9.95	+-	1.56
224	L	16.23	+-	3.53
263	PL	11.75	+-	2.08
205	WS	26.60	+-	7.75
264	HB	9.97	+-	3.19
266	RL	1.84	+-	0.14
239	RL	1.98	+-	0.41

Geographic Regional Averages this period are:

Near Plant (0-.16 mi)	22.92	+-	3.90
Exclusion Area (.25-.68 mi)	11.22	+-	0.78
Distant Neighborhood (.7-6.5 mi)	11.74	+-	1.03
Background (8-21 mi)	10.55	+-	1.87

TABLE III-D-5
GAMMA EXPOSURE (TLD) DATA FOR QUARTER #4 1982

TLD No	Station	Micror/ Hour	+-	2 Sigma
2[illegible]	CP	7.06	+-	1.54
278	CR	8.57	+-	3.04
346	CS	6.50	+-	1.77
280	ER	10.84	+-	2.99
281	EW	8.62	+-	1.73
282	KS	8.55	+-	2.11
283	MB	9.25	+-	3.24
284	ME	ND*	+-	ND
285	MP	7.59	+-	2.76
286	MS	9.28	+-	2.36
287	NP	8.21	+-	1.76
288	PC	6.01	+-	1.55
289	SA	6.87	+-	1.90
290	SP	6.61	+-	1.78
291	SS	7.26	+-	1.77
292	WR	9.85	+-	2.10
293	BD	11.04	+-	3.62
294	EB	7.77	+-	2.65
295	EM	9.03	+-	2.58
296	MT	9.44	+-	3.56
297	OA	22.97	+-	4.97
298	PA	7.30	+-	1.43
301	PB	17.60	+-	6.02
302	WH	7.38	+-	2.96
303	A	11.49	+-	3.82
304	B	11.15	+-	3.63
305	C	ND*	+-	ND
306	D	8.08	+-	3.75
307	E	6.82	+-	1.66
308	F	10.21	+-	3.26
309	G	7.73	+-	2.36
310	H	12.89	+-	3.80
311	I	9.31	+-	3.75
312	J	8.19	+-	2.16
313	K	6.28	+-	2.21
314	L	7.01	+-	1.58
315	PL	10.31	+-	3.88
316	WS	14.03	+-	3.66
317	HB	8.81	+-	4.41
333	RL	2.33	+-	0.51
334	RL	2.18	+-	0.52

Geographic Regional Averages this period are:			
Near Plant (0-.16 mi)	15.47	+-	2.91
Exclusion Area (.25-.68 mi)	9.56	+-	0.92
Distant Neighborhood (.7-6.5 mi)	7.86	+-	0.68
Background (8-21 mi)	7.63	+-	1.26

*ND - No date due to missing TLD

TABLE III-D-6
QUARTERLY AVERAGE
EXPOSURE RATES
1982

QUARTERLY AVERAGES FOR GAMMA EXPOSURE RATES

STATION	1ST QUARTER MICROR/HR			2ND QUARTER MICROR/HR			3RD QUARTER MICROR/HR			4TH QUARTER MICROR/HR		
CP	4.16	+-	0.96	8.16	+-	2.20	3.98	+-	7.45	7.06	+	1.54
CR	7.97	+-	2.67	8.89	+-	3.07	15.52	+-	2.89	8.57	+-	3.04
CS	5.22	+-	1.54	0.00	+-	0.00	6.82	+-	3.10	6.50	+-	1.77
ER	4.63	+-	1.51	6.14	+-	1.98	6.91	+-	2.40	10.84	+-	2.99
EW	4.00	+-	1.08	8.30	+-	2.02	11.84	+-	2.00	8.62	+-	1.73
KS	4.41	+-	1.45	6.45	+-	1.69	8.14	+-	3.29	8.55	+-	2.11
MB	3.55	+-	1.12	6.17	+-	1.82	13.37	+-	4.93	9.25	+-	3.24
ME	6.46	+-	1.75	9.33	+-	2.54	16.43	+-	3.67	0.00	+-	0.00
MP	5.11	+-	1.35	7.19	+-	2.20	10.91	+-	3.57	7.57	+-	2.76
MS	4.73	+-	1.26	8.28	+-	2.33	20.77	+-	3.90	9.28	+-	2.36
NP	4.59	+-	1.31	8.47	+-	2.41	14.11	+-	5.35	8.21	+-	1.76
PC	0.00	+-	0.00	4.60	+-	1.16	7.62	+-	2.05	6.01	+-	1.55
SA	2.68	+-	0.68	5.86	+-	1.79	15.40	+-	2.60	6.87	+-	1.90
SP	5.91	+-	2.26	6.80	+-	2.26	12.91	+-	4.27	6.61	+-	1.78
SS	3.95	+-	1.02	7.42	+-	2.08	10.28	+-	2.27	7.26	+-	1.77
WR	4.64	+-	1.39	11.22	+-	3.26	17.15	+-	3.21	9.85	+-	2.10
BD	5.32	+-	1.28	8.53	+-	2.75	10.42	+-	1.65	11.04	+-	3.62
EB	4.84	+-	1.55	8.18	+-	2.52	10.10	+-	1.66	7.77	+-	2.65
EM	2.92	+-	0.68	8.70	+-	2.38	13.00	+-	2.78	9.03	+-	2.58
MT	4.06	+-	0.97	9.55	+-	2.31	13.21	+-	3.28	9.44	+-	3.56
OA	6.95	+-	2.13	22.51	+-	8.67	30.99	+-	7.50	22.97	+-	4.97
PA	5.07	+-	1.73	8.73	+-	2.19	11.26	+-	3.07	7.30	+-	1.43
PB	8.32	+-	2.60	17.49	+-	6.79	22.81	+-	3.36	17.60	+-	6.02
WH	3.75	+-	1.39	12.49	+-	3.64	10.98	+-	2.84	7.38	+-	2.96
A	4.58	+-	1.29	7.93	+-	2.31	8.42	+-	2.81	11.49	+-	3.82
B	4.02	+-	1.73	8.94	+-	3.23	8.28	+-	1.97	11.15	+-	3.63
C	0.00	+-	0.00	11.10	+-	3.84	5.33	+-	1.68	0.00	+-	0.00
D	7.73	+-	2.08	9.10	+-	2.75	11.19	+-	3.58	8.08	+-	3.75
E	3.65	+-	0.98	7.59	+-	1.90	10.19	+-	2.21	6.82	+-	1.66
F	5.01	+-	1.44	7.11	+-	2.43	8.58	+-	2.33	10.21	+-	3.26
G	4.52	+-	1.05	9.16	+-	2.44	14.49	+-	4.03	7.73	+-	2.36
H	8.11	+-	1.91	15.97	+-	4.00	11.43	+-	4.57	12.89	+-	3.80
I	4.34	+-	1.17	8.98	+-	2.85	10.93	+-	2.31	9.31	+-	3.75
J	4.17	+-	1.04	8.88	+-	3.17	11.22	+-	2.30	8.19	+-	2.16
K	3.23	+-	1.10	7.89	+-	2.38	9.95	+-	1.56	6.28	+-	2.21
L	9.42	+-	3.43	7.66	+-	2.22	16.23	+-	3.53	7.01	+-	1.58
PL	4.38	+-	1.09	7.29	+-	2.43	11.75	+-	2.08	10.31	+-	3.88
WS	16.38	+-	6.00	10.83	+-	3.40	26.60	+-	7.75	14.03	+-	3.66
HB	4.94	+-	1.55	8.37	+-	4.19	9.97	+-	3.19	8.81	+-	4.41
RL	2.04	+-	0.61	2.12	+-	0.56	1.84	+-	0.14	2.33	+-	0.51
RL	2.75	+-	0.85	1.88	+-	0.71	1.98	+-	0.41	2.18	+-	0.52

TABLE III-D-7

1982 DIRECT RADIATION SURVEY RESULTS

Location	Exposure Rate (uR/Hr)	Beach Terrain
White Horse Beach (near Hill P. Avenue)	7.3 ± 0.5	Sand with large amount of course gravel, granite boulders near beach area.
White Horse Beach (in back of Blue Sail Bar)	6.4 ± 0.5	Sandy with small amount of gravel.
Plymouth Beach (outer beach)	5.7 ± 0.4	Sandy
Plymouth Beach (inner beach)	6.1 ± 0.4	Sandy
Plymouth Beach (behind Berts Restaurant)	8.7 ± 0.4	Sandy, with large amounts of course gravel, granite boulders near beach area.
Duxbury Beach (Control) (ocean side)	6.9 ± 0.3	Sandy with course gravel.

III. E **Waterborne**

Samples of seawater are collected at three locations, the Station Discharge Canal, (Station 11), Bartlett Pond (Station 17 - 1.7 mi - SE) and Powder Point (Station 23 - 7.8 mi - NNW). The Discharge Canal sample is collected by a continuously compositing sampler which extracts a sample of about 20 ml of water from the Discharge Canal every one-half hour. Grab samples are taken weekly from each of the other two locations.

The results of the ERMAP program for seawater samples are presented in Table III-E-1.

There were no positive measurements of isotopes characteristic of reactor operation observed at any of the three sampling locations. The only positive measurements observed were due to naturally occurring isotopes (K-40 and AcTh-228).

Therefore, there was clearly no significant environmental effect observed in the seawater media as a result of the operation of PNPS-1.

TABLE III-E-1

ERMAP RESULTS

WATERBORNE

PILGRIM 1 — OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING — 83/03/16. PAGE 36

SUMMARY FOR THE PERIOD 12/29/81 - 12/31/82

UNITS: PCI/LITER

MEDIUM: WATER - SEA

RADIONUCLIDES (NO. ANALYSED) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA.	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
BE-7 (37) (0)	8.0E+01	(8.4 ± 12.2)E -1 (-9.7 - 13.9)E 0 *(0/ 25)*	11	(2.4 ± 1.8)E 0 *(0/ 13)*	(2.1 ± 1.0)E 0 (-5.4 - 6.1)E 0 *(0/ 12)*
K-40 (37) (0)	2.0E+02	(1.4 ± .3)E 2 (-1.2 - 55.3)E 1 *(13/ 25)*	13	(3.1 ± .0)E 2 (2.8 - 3.3)E 2 *(13/ 13)*	(2.7 ± .1)E 2 (1.9 - 3.2)E 2 *(12/ 12)*
CR-51 (37) (0)	1.7E+01	(-1.5 ± 1.4)E 0 (-1.5 - 1.5)E 1 *(0/ 25)*	11	(-5.3 ± 21.5)E -1 *(0/ 13)*	(-9.3 ± 16.0)E -1 (-1.0 - .7)E 1 *(0/ 12)*
MN-54 (37) (0)	8.	(5.7 ± 16.5)E -2 (-1.5 - 1.9)E 0 *(0/ 25)*	11	(1.2 ± 2.3)E -1 *(0/ 13)*	(-2.9 ± 1.6)E -1 (-1.4 - .5)E 0 *(0/ 12)*
CO-57 (37) (0)	1.5E+00	(4.9 ± 15.2)E -2 (-3.1 - 1.3)E 0 *(0/ 25)*	11	(2.2 ± 2.0)E -1 *(0/ 13)*	(-1.6 ± 22.2)E -2 (-1.9 - 1.0)E 0 *(0/ 12)*
CO-58 (37) (0)	8.	(-3.2 ± 1.5)E -1 (-1.4 - 1.2)E 0 *(0/ 25)*	17	(-4.1 ± 23.7)E -2 *(0/ 12)*	(-2.3 ± 2.4)E -1 (-1.5 - 1.5)E 0 *(0/ 12)*
FE-59 (37) (0)	1.0E+01	(4.2 ± 2.8)E -1 (-3.0 - 2.9)E 0 *(0/ 25)*	17	(6.9 ± 8.6)E -1 *(0/ 12)*	(-7.8 ± 6.1)E -1 (-3.3 - 2.7)E 0 *(0/ 12)*
CO-60 (37) (0)	8.	(-2.6 ± 1.8)E -1 (-1.6 - 1.3)E 0 *(0/ 25)*	11	(5.2 ± 21.1)E -2 *(0/ 13)*	(-4.2 ± 2.0)E -1 (-1.7 - .9)E 0 *(0/ 12)*
ZN-65 (37) (0)	8.	(3.8 ± 24.0)E -2 (-2.1 - 2.3)E 0 *(0/ 25)*	17	(1.0 ± 2.8)E -1 *(0/ 12)*	(-3.9 ± 8.8)E -1 (-3.6 - 1.8)E 0 *(0/ 12)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-E-1
CONTINUED

PILGRIM I   OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING   83/03/16.   PAGE 37
SUMMARY FOR THE PERIOD   12/21/81 - 12/31/82

MEDIUM: WATER - SEA   UNITS: PCI/LITER

RADIONUCLIDES (NO. ANALYZED) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
ZR-95 (37) (0)	3.0E+01	(-4.9 ± 29.8)E -2 (-1.9 - 2.5)E 0 *(0/ 25)*	23	(4.5 ± 2.8)E -1 *(0/ 12)*	(4.5 ± 2.0)E -1 (-1.7 - 2.0)E 0 *(0/ 12)*
NB-95 (37) (0)	2.	(5.7 ± 14.2)E -2 (-1.5 - 1.4)E 0 *(0/ 25)*	23	(7.1 ± 2.4)E -1 *(0/ 12)*	(2.1 ± 2.0)E -1 (-8.2 - 20.0)E -1 *(0/ 12)*
AG-110M(37) (0)	1.4E+01	(-8.3 ± 11.2)E -1 (-1.1 - 1.5)E 1 *(0/ 25)*	17	(2.0 ± 16.9)E -1 *(0/ 12)*	(-7.8 ± 16.0)E -1 (-1.1 - .8)E 1 *(0/ 12)*
RU-103 (37) (0)	8.	(-4.8 ± 2.0)E -1 (-2.3 - 1.5)E 0 *(0/ 25)*	23	(-4.0 ± 1.8)E -1 *(0/ 12)*	(-4.0 ± 1.8)E -1 (-1.3 - .8)E 0 *(0/ 12)*
RU-106 (37) (0)	6.0E+01	(2.9 ± 12.5)E -1 (-1.4 - 1.5)E 1 *(0/ 25)*	11	(3.8 ± 15.2)E -1 *(0/ 13)*	(-2.6 ± 1.9)E 0 (-1.2 - 1.0)E 1 *(0/ 12)*
I-131 (37) (0)	8.	(-9.3 ± 50.8)E -2 (-3.5 - 2.9)E 0 *(0/ 25)*	23	(7.9 ± 52.3)E -2 *(0/ 12)*	(7.9 ± 52.3)E -2 (-3.1 - 3.3)E 0 *(0/ 12)*
CS-134 (37) (0)	9.	(-3.2 ± 1.1)E -1 (-1.5 - .8)E 0 *(0/ 25)*	23	(-1.8 ± 1.8)E -1 *(0/ 12)*	(-1.8 ± 1.8)E -1 (-1.1 - .9)E 0 *(0/ 12)*
CS-137 (37) (0)	9.	(5.9 ± 13.5)E -2 (-1.3 - 1.2)E 0 *(0/ 25)*	11	(2.1 ± 1.7)E -1 *(0/ 13)*	(1.9 ± 22.2)E -2 (-1.5 - 1.2)E 0 *(0/ 12)*
BA-140 (37) (0)	1.5E+01	(-3.0 ± 3.0)E -1 (-3.0 - 3.1)E 0 *(0/ 25)*	11	(-2.0 ± 2.6)E -1 *(0/ 13)*	(-7.0 ± 8.0)E -1 (-2.0 - 2.5)E 0 *(0/ 12)*
CE-141 (37) (0)	2.0E+01	(5.1 ± 2.1)E -1 (-1.3 - 2.8)E 0 *(0/ 25)*	23	(1.5 ± .3)E 0 *(0/ 12)*	(1.5 ± .3)E 0 (3.7 - 300.0)E -2 *(0/ 12)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

PILGRIM 1 OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING 83/03/16. PAGE 38
SUMMARY FOR THE PERIOD 12/01/81 - 12/31/82

UNITS: PCI/LITER

MEDIUM: WATER - SEA

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA.	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
CE-144 (37) (0)	8.0E+01	(7.4 ± 12.1)E -1 (-1.3 - 1.1)E 1 *(0/ 25)*	11	(1.9 ± 1.6)E 0 *(0/ 13)*	(-4.3 ± 15.2)E -1 (-1.2 - .9)E 1 *(0/ 12)*
TH-228 (37) (0)	1.0E+01	(2.0 ± 6.7)E -1 (-4.1 - 5.9)E 0 *(0/ 25)*	17	(3.7 ± 6.7)E -1 *(0/ 12)*	(-2.2 ± 9.2)E -1 (-2.8 - 8.1)E 0 *(0/ 12)*
H-3 (12) (0)	9.0E+01	(2.1 ± 5.0)E 1 (-2.2 - 2.3)E 2 *(0/ 8)*	11	(2.9 ± 9.3)E 1 *(0/ 4)*	(3.8 ± 80.4)E 0 (-2.1 - 1.3)E 2 *(0/ 4)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-E-1
CONTINUED

III. F. Shellfish

Shellfish are normally sampled quarterly from 5 locations, the Station Discharge Canal, Duxbury Bay, Manomet Point, Plymouth Harbor and Marshfield. The results of the ERMAP program for shellfish are presented in Table III-F-1. It is clear from this table that there have been positive measurements of a few isotopes (Mn-54, Zn-65, and Co-60) in the Discharge Canal. In addition there have been positive measurements of Be-7 and Co-60 at Manomet Point; Be-7, Cs-137 and Co-60 at Plymouth Harbor; and, Be-7 at the control station in Marshfield.

The observed concentrations of Zn-65, Co-60 and Mn-54 are most probably the result of PNPS-1 liquid releases. However, the observed concentrations of Be-7 (mussel body, first quarter-Plymouth Harbor) and Cs-137 (soft-shell clam shell, second-quarter-Plymouth Harbor) are probably due to fallout from previous weapons testing.

However, even if a person were to consume the maximum annual quantity of seafood (5 kilograms/year) with the highest mean concentrations of Zn-65, Co-60 and Mn-54, they would receive a dose of less than 0.002 mrem to the total body and about 0.01 mrem to the most restrictive organ (Adult, GI-LLI).

When compared to the natural background dose rate of 80-100 mrem/year, there was clearly no significant environmental impact observed in shellfish as a result of the operations of PNPS-1.

The mussel shells for the years of 1981 and 1982, although collected appropriately for these years, were not analyzed [illegible] ing collection due to an administrative error. This error was identified in late 1982 at which time the Yankee Atomic Environmental Laboratory was notified and instructed to analyze the 1981 and 1982 mussel shell samples. In addition, a review was made of the mussel shell sample data for the years of 1977-1980. This review identified that all except one mussel shell sample had been analyzed. Although mussel shell samples are to be collected and analyzed on a semi-annual basis from the control station (Green Harbor, Marshfield), only one mussel shell sample was analyzed during 1980. However, the 1980 mussel shell samples had already been disposed of and could not be analyzed at this point in time.

The results of the analyses reports indicated positive measurements of Co-60 in all of the mussel shell samples for 1981 and 1982 which were collected at the Discharge Canal Outfall Area (indicator station). The analyses results of the shells collected from the indicator station during the first and second quarter of 1981 indicate that Co-60 concentrations of 45.7 pCi/kg and 69.4 pCi/kg existed in the shells at the time of collection. Under the Technical Specifications in effect at that time these results would have been considered anomalous (greater than 10 times the control station lower limit of detection). Under current Technical Specifications, these results are not anomalous since they are below the current reporting level for Co-60 of $1x10^4$ pCi/kg.

Although there has been an inordinate amount of time between sample collection and analyses, we believe it is appropriate to use the current Technical Specifications reporting criteria, since this represents a more meaningful assessment of environmental impact.

The presence of Co-60 in the above samples are undoubtly due to liquid effluents from PNPS-1. Since mussel shells are not a consumable food product, there is no potential impact on man from this media.

TABLE III-F-1

ERMAP RESULTS

SHELLFISH

PILGRIM 1 — OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING — 83/03/16. PAGE 24

SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS: PCI/KG WET

MEDIUM: SHELLFISH

RADIONUCLIDES (NO. ANALYSED) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN,RANGE,AND NO. DETECTED**	STA.	HIGHEST STATION MEAN,RANGE,AND NO. DETECTED**	CONTROL LOCATIONS MEAN,RANGE,AND NO. DETECTED**
BE-7 (36) (0)	.2	(8.6 ± 1.4)E 1 (-7.2 - 35.4)E 1 *(5/ 29)*	12	(6.2 ± 3.4)E 1 (-1.1 - 35.0)E 1 *(1/ 10)*	(2.2 ± .8)E 1 (-2.1 - 50.2)E 0 *(1/ 7)*
K-40 (36) (0)	.5	(1.2 ± .1)E 3 (1.4 - 21.8)E 2 *(28/ 29)*	15	(1.6 ± .2)E 3 (1.2 - 1.9)E 3 *(4/ 4)*	(8.4 ± 2.2)E 2 (1.4 - 15.0)E 2 *(7/ 7)*
CR-51 (36) (0)	3.2E+02	(-1.0 ± 1.8)E 2 (-8.4 - 1.6)E 3 *(0/ 29)*	12	(1.5 ± 1.6)E 2 *(0/ 10)*	(-2.5 ± 3.7)E 1 (-2.5 - .3)E 2 *(0/ 7)*
MN-54 (36) (1)	2.0E-02	(7 . . 8.0)E -1 (-9.8 - 12.8)E 0 *(1/ 29)*	12	(1.2 ± 2.1)E 0 *(0/ 10)*	(-2.8 ± 4.2)E -1 (-1.5 - 1.7)E 0 *(0/ 7)*
CO-57 (36) (0)	3.5E+01	(7.4 ± 3.0)E -1 (-4.1 - 6.0)E 0 *(0/ 29)*	12	(1.5 ± .8)E 0 *(0/ 10)*	(2.2 ± 1.0)E -1 (-1.7 - 4.5)E -1 *(0/ 7)*
CO-58 (36) (0)	2.0E-02	(2.1 ± 8.1)E -1 (-7.7 - 15.4)E 0 *(0/ 29)*	11	(8.0 ± 10.0)E -1 *(0/ 10)*	(2.4 ± 9.4)E -1 (-2.3 - 4.9)E 0 *(0/ 7)*
FE-59 (36) (0)	3.0E+01	(-2.8 ± 8.2)E 0 (-2.0 - .9)E 2 *(0/ 29)*	13	(6.2 ± 4.3)E 0 *(0/ 5)*	(-5.8 ± 2.8)E 0 (-2.2 - .0)E 1 *(0/ 7)*
CO-60 (36) (11)	2.0E-02	(8.2 ± 2.4)E 0 (-6.5 - 45.0)E 0 *(11/ 29)*	11	(2.1 ± .4)E 1 (2.1 - 45.0)E 0 *(9/ 10)*	(-6.6 ± 6.4)E -1 (-3.0 - 2.4)E 0 *(0/ 7)*
ZN-65 (36) (0)	6.7E+01	(-1.6 ± 1.6)E 0 (-3.2 - 1.1)E 1 *(1/ 29)*	11	(2.6 ± 1.1)E 0 (-1.5 - 6.5)E 0 *(1/ 10)*	(7.8 ± 4.6)E -1 (-7.7 - 23.2)E -1 *(0/ 7)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

PILGRIM 1 OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING 83/03/16. PAGE 25
SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS: PCI/KG WET

MEDIUM: SHELLFISH

RADIONUCLIDES (NO. ANALYZED) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN,RANGE,AND NO. DETECTED**	STA.	HIGHEST STATION MEAN,RANGE,AND NO. DETECTED**	CONTROL LOCATIONS MEAN,RANGE,AND NO. DETECTED**
ZR-95 (36) (0)	4.0E-02	(5.5 ± 2.0)E 0 (-7.6 - 37.4)E 0 *(0/ 29)*	13	(2.0 ± .7)E 1 *(0/ 5)*	(5.5 ± 7.5)E -1 (-2.4 - 3.8)E 0 *(0/ 7)*
NB-95 (36) (0)	3.9E+01	(2.6 ± 1.3)E 0 (-1.1 - 2.0)E 1 *(0/ 29)*	13	(8.9 ± 5.0)E 0 *(0/ 5)*	(2.0 ± 1.7)E 0 (-1.0 - 11.5)E 0 *(0/ 7)*
AG-110M(36) (0)	2.5E+02	(-4.7 ± 60.3)E -1 (-1.1 - .4)E 2 *(0/ 29)*	11	(5.7 ± 5.[illegible])E 0 *(0/ 10)*	(-2.3 ± 21.8)E -1 (-6.7 - 7.8)E 0 *(0/ 7)*
RU-103 (36) (0)	2.0E-02	(4.0 ± 7.6)E 0 (-8.5 - 71.7)E 0 *(0/ 29)*	12	(9.0 ± 7.1)E 0 *(0/ 10)*	(-1.6 ± 5.3)E -1 (-2.4 - 1.8)E 0 *(0/ 7)*
RU-106 (36) (0)	.2	(2.4 ± 10.9)E 0 (-1.3 - 2.0)E 2 *(0/ 29)*	12	(8.1 ± 14.7)E 0 *(0/ 10)*	(-7.4 ± 6.1)E 0 (-3.8 - .7)E 1 *(0/ 7)*
I-131 (36) (0)	0.	(2.7 ± 2.4)E 8 (-1.3 -********)E 8 *(0/ 29)*	11	(7.0 ± 1.0)E 8 *(0/ 10)*	(2.7 ± 2.7)E 5 (-4.8 -********)E 0 *(0/ 7)*
CS-134 (36) (0)	2.0E-02	(-2.1 ± .8)E 0 (-1.3 - .7)E 1 *(0/ 29)*	24	(-3.8 ± 2.7)E -1 *(0/ 7)*	(-3.8 ± 2.7)E -1 (-1.4 - .5)E 0 *(0/ 7)*
CS-137 (36) (1)	2.0E-02	(8.5 ± 9.0)E -1 (-1.3 - 1.3)E 1 *(1/ 29)*	13	(2.4 ± 4.4)E 0 *(0/ 5)*	(5.5 ± 4.4)E -1 (-6.2 - 28.0)E -1 *(0/ 7)*
BA-140 (36) (0)	8.0E-02	(-1.4 ± 1.1)E 5 (-3.1 - .4)E 6 *(0/ 29)*	15	(-3.5 ± 2.3)E 0 *(0/ 4)*	(-2.1 ± 2.1)E 3 (-1.5 - .0)E 4 *(0/ 7)*
CE-141 (36) (0)	4.0E-02	(4.7 ± 5.1)E 1 (-1.4 - 81.9)E 1 *(0/ 29)*	12	(8.6 ± 8.2)E 1 *(0/ 10)*	(5.0 ± 2.7)E 0 (-1.3 - 17.7)E 0 *(0/ 7)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-F-1
CONTINUED

PILGRIM I   OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING   83/03/16.   PAGE 26
SUMMARY FOR THE PERIOD   12/21/81 - 12/31/82

MEDIUM: SHELLFISH   UNITS: PCI/KG WET

RADIONUCLIDES (NO. ANALYSES) (NONROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA.	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
CE-144 (36) (0)	.2	(8.9 ± 39.7)E -1 (-9.8 - 5.4)E 1 *(0/ 29)*	13	(7.5 ± 21.4)E 0 *(0/ 5)*	(-3.1 ± 3.3)E 0 (-1.0 - 1.0)E 1 *(0/ 7)*
TH-228 (36) (0)	2.0E-02	(1.5 ± .5)E 1 (-1.9 - 11.7)E 1 *(5/ 29)*	13	(2.5 ± 2.4)E 1 (-1.9 - 11.7)E 1 *(1/ 5)*	(1.6 ± .5)E 1 (-4.4 - 307.0)E -1 *(4/ 7)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. 3-SIGMA) IS INDICATED WITHIN *(   )*.

TABLE III-F-1
CONTINUED

III. G. Algae (Irish Moss)

Algae, referred to as Irish Moss or Chondrus Chrispus, is sampled quarterly at three locations, the PNPS Discharge Canal, Manomet Point and Ellisville. The results of the ERMAP program for Algae are presented in Table III-G-1.

It is clear from this table that there have been positive measurements of Be-7, Co-60 and Mn-54 at the Discharge Canal. In addition, there have been positive measurements of Be-7 and Co-60 at Manomet Point (Station 15-3 miles SE); and Be-7 at the control station of Ellisville (Station 22-8 mi-SSE).

The measured concentrations of Co-60, and Mn-54 at the Discharge Canal are certainly due to liquid effluents from PNPS-1. The observed concentrations of Co-60 at Manomet Point are most probably the result of PNPS-1 liquid releases. There were no positive measurements of reactor operations related isotopes at the control station in Ellisville, approximately eight miles away.

It is important to note that due to processing and market dilution, the presence of the Co-60, and Mn-54 concentrations do not represent a significant potential source of dose to the general public. In fact, even direct human consumption of Algae (which to our knowledge, does not occur) with the highest mean concentrations would result in a dose rate of less than 0.04 mrem/yr to the total body and about 0.05 mrem/yr to the most sensitive organ (Adult-GI-LLI, using the models presented in Regulatory Guide 1.109) and assuming consumption of 5 kg/year of unprocessed material.

When compared with the natural background dose rate of 80-100 mrem/yr, there was clearly no significant environmental impact observed in Algae as a result of the operation of PNPS-1.

TABLE III-G-1
ERMAP RESULTS
ALGAE

MEDIUM: VEGETATION - AQUATIC

UNITS: PCI/KG WET

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN,RANGE,AND NO. DETECTED**	STA.	HIGHEST STATION MEAN,RANGE,AND NO. DETECTED**	CONTROL LOCATIONS MEAN,RANGE,AND NO. DETECTED**
BE-7 (12) (0)	.2	(1.6 + .5)E 2 (8.6 - 30.2)E 1 *(8/ 8)*	11	(2.0 + .9)E 2 (1.1 - 3.0)E 2 *(4/ 4)*	(1.1 + .3)E 2 (2.9 - 18.9)E 1 *(3/ 4)*
K-40 [illegible] ([illegible])	.5	(5.7 + 1.1)E 1 (3.8 - 12.8)E 1 *(8/ 8)*	11	(7.3 + 1.9)E 1 (4.1 - 12.8)E 1 *(4/ 4)*	(5.0 + .4)E 1 (4.6 - 5.6)E 1 *(4/ 4)*
CR-51 (12) (0)	-1.0-100	(-1.8 + 1.4)E 1 (-7.3 - 3.6)E 1 *(0/ 8)*	15	(-6.2 + 20.8)E 0 *(0/ 4)*	(-9.0 + 14.3)E 0 (-5.1 - 1.5)E 1 *(0/ 4)*
MN-54 (12) (1)	2.0E-02	(8.4 + 1.5)E 0 (-6.8 - 117.0)E -1 *(1/ 8)*	11	(7.8 + 1.7)E 0 (3.9 - 11.7)E 0 *(1/ 4)*	(-1.2 + 1.1)E 0 (-3.6 - 1.3)E 0 *(0/ 4)*
CO-57 (12) (0)	-1.0-100	(-9.8 + 3.5)E -1 (-2.4 - .8)E 0 *(0/ 8)*	22	(8.9 + 8.6)E -1 *(0/ 4)*	(8.9 + 8.6)E -1 (-1.0 - 2.7)E 0 *(0/ 4)*
CO-58 (12) (0)	2.0E-02	(4.9 + 7.5)E -1 (-2.7 - 3.5)E 0 *(0/ 8)*	11	(9.1 + 11.3)E -1 *(0/ 4)*	(-8.2 + 1.6)E 0 (-7.7 - 0.0)E 0 *(0/ 4)*
FE-59 (12) (0)	3.0E+01	(4.0 + 4.1)E 0 (-8.9 - 28.2)E 0 *(0/ 8)*	11	(1.1 + .7)E 1 *(0/ 4)*	(3.8 + 3.1)E 0 (-3.4 - 10.8)E 0 *(0/ 4)*
CO-60 (12) (6)	2.0E-02	(4.0 + 1.2)E 1 (2.0 - 96.6)E 0 *(6/ 8)*	11	(6.6 + 1.5)E 1 (3.6 - 9.7)E 1 *(4/ 4)*	(3.5 + 2.1)E 0 (-2.6 - 5.8)E 0 *(0/ 4)*
ZN-65 (12) (0)	-1.0-100	(-8.9 + 12.9)E -1 (-7.8 - 5.2)E 0 *(0/ 8)*	15	(1.3 + 1.4)E 0 *(0/ 4)*	(-7.4 + 11.1)E 0 (-3.9 - 1.3)E 1 *(0/ 4)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-G-1

CONTINUED

PILGRIM 1   OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING   83/03/16.   PAGE 31

SUMMARY FOR THE PERIOD   12/21/81 - 12/31/82

MEDIUM: VEGETATION - AQUATIC   UNITS: PCI/KG WET

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN,RANGE,AND NO. DETECTED**	STA.	HIGHEST STATION MEAN,RANGE,AND NO. DETECTED**	CONTROL LOCATIONS MEAN,RANGE,AND NO. DETECTED**
ZR-95 (12) (0)	4.0E-02	(5.6 ± 1.0)E 0 (9.8 - 806.0)E -2 *(0/ 8)*	11	(3.9 ± 1.4)E 0 *(0/ 4)*	(-5.5 ± 3.3)E 0 (-1.3 - .1)E 1 *(0/ 4)*
NB-95 (12) (1)	-1.0-100	(5.0 ± 1.6)E 0 (-2.7 - 23.0)E 0 *(1/ 8)*	15	(6.4 ± 5.7)E 0 (-2.6 - 23.0)E 0 *(1/ 4)*	(1.9 ± 1.8)E 0 (-2.2 - 5.6)E 0 *(0/ 4)*
AG-110M(12) (0)	-1.0-100	(-1.8 ± 6.9)E 0 (-2.7 - 2.8)E 1 *(0/ 8)*	11	(-7.6 ± 12.5)E 0 *(0/ 4)*	(-1.0 ± 1.6)E 1 (-6.5 - .9)E 1 *(0/ 4)*
RU-103 (12) (0)	2.0E-02	(-2.6 ± 1815.9)E -3 (-8.9 - 9.4)E 0 *(0/ 8)*	15	(1.4 ± 2.7)E 0 *(0/ 4)*	(8.3 ± 23.7)E -1 (-3.9 - 7.4)E 0 *(0/ 4)*
RU-106 (12) (0)	.2	(-1.8 ± 13.6)E 0 (-4.6 - 7.5)E 1 *(0/ 8)*	11	(2.5 ± 1.8)E 1 *(0/ 4)*	(-8.5 ± 23.7)E 0 (-4.7 - 5.5)E 1 *(0/ 4)*
I-131 (12) (0)	0.	(6.0 ± 2.4)E 0 (-6.2 - 12.9)E 0 *(0/ 8)*	11	(7.1 ± 2.9)E 0 *(0/ 4)*	(-3.9 ± 9.6)E 0 (-3.0 - 1.9)E 1 *(0/ 4)*
CS-134 (12) (0)	2.0E-02	(-3.7 ± 1.3)E 0 (-8.5 - 5.9)E 0 *(0/ 8)*	22	(-1.4 ± 2.0)E 0 *(0/ 4)*	(-1.4 ± 2.0)E 0 (-5.8 - 2.5)E 0 *(0/ 4)*
CS-137 (12) (0)	2.0E-02	(3.3 ± 1.0)E 0 (5.1 - 86.8)E -1 *(0/ 8)*	11	(3.5 ± 1.8)E 0 *(0/ 4)*	(2.8 ± 1.2)E 0 (6.1 - 59.7)E -1 *(0/ 4)*
BA-140 (12) (0)	8.0E-02	(-6.5 ± 29.1)E -1 (-8.2 - 18.3)E 0 *(0/ 8)*	11	(1.1 ± 5.7)E 0 *(0/ 4)*	(-2.2 ± 5.3)E 0 (-1.8 - .5)E 1 *(0/ 4)*
CE-141 (12) (0)	4.0E-02	(4.1 ± 20.8)E -1 (-7.9 - 7.2)E 0 *(0/ 8)*	22	(8.4 ± 2.6)E 0 *(0/ 4)*	(4.4 ± 2.6)E 0 (-2.4 - 9.9)E 0 *(0/ 4)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

PILGRIM 1 OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING 03/03/83 PAGE 32
SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS: PCI/KG WET

MEDIUM: VEGETATION - AQUATIC

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN,RANGE,AND NO. DETECTED**	STA	HIGHEST STATION MEAN,RANGE,AND NO. DETECTED**	CONTROL LOCATIONS MEAN,RANGE,AND NO. DETECTED**
CE-144 (10) (1)	.2	(1.1 ± .4)E 1 (-1.5 - 4.2)E 1 *(1/ 4)*	15	(1.1 ± 1.2)E 1 (-1.5 - 4.2)E 1 *(1/ 4)*	(2.4 ± 11.0)E 0 (-2.4 - 2.9)E 1 *(0/ 4)*
TH-228 (10) (8)	2.0E+02	(2.8 ± .4)E 1 (7.0 - 52.0)E 0 *(3/ 4)*	27	(4.0 ± 1.4)E 1 (1.2 - 4.5)E 1 *(1/ 4)*	(4.0 ± 1.9)E 1 (1.2 - 4.5)E 1 *(1/ 4)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-G-1
CONTINUED

III. H. Lobster (Arthropods)

Lobster samples are collected four times per season at two locations, the vicinity of the Discharge Canal Outfall area and at a distant point off-shore. The results of the ERMAP program for Lobsters are presented in Table III-H-1. These results are unremarkable in that there were no positive measurements of any isotopes other than K-40 in either the indicator or the control samples (K-40 is a naturally occurring isotope). Therefore, there is no evidence of any environmental impact on this media as a result of the operation of PNPS-1.

TABLE III-H-1

ERMAP RESULTS

LOBSTER

PILGRIM I — OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING — 83/03/16. PAGE 8

SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS: PCI/KG WET

MEDIUM: ARTHROPODS

RADIONUCLIDES (NO. ANALYSED) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA#	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
BE-7 (3) (0)	.2	(5.7 ± 8.3)E 1 (-1.2 - 1.6)E 2 *(0/ 3)*	11	(5.7 ± 8.3)E 1 *(0/ 3)*	(-1.1 ± .7)E 2 (-1.1 - 0.0)E 2 *(0/ 1)*
K-40 (3) (0)	.5	(2.3 ± .7)E 3 (2.1 - 2.6)E 3 *(3/ 3)*	11	(2.3 ± .2)E 3 (2.1 - 2.6)E 3 *(3/ 3)*	(2.0 ± .2)E 3 *(1/ 1)*
CR-51 (3) (0)	3.2E+02	(8.1 ± 5.5)E 1 (-1.2 - 18.0)E 1 *(0/ 3)*	11	(8.1 ± 5.5)E 1 *(0/ 3)*	(6.1 ± 7.2)E 1 *(0/ 1)*
MN-54 (3) (0)	2.0E+02	(2.2 ± 8.2)E 0 (-7.3 - 18.5)E 0 *(0/ 3)*	11	(2.2 ± 6.2)E 0 *(0/ 3)*	(-1.6 ± .9)E 1 (-1.6 - 0.0)E 1 *(0/ 1)*
CO-57 (3) (0)	8.5E+01	(5.0 ± 5.0)E 0 (5.5 - 106.0)E -1 *(0/ 3)*	12	(1.2 ± .7)E 1 *(0/ 1)*	(1.2 ± .7)E 1 *(0/ 1)*
CO-58 (3) (0)	2.0E+02	(-5.3 ± 5.6)E 0 (-1.2 - .6)E 1 *(0/ 3)*	11	(-5.3 ± 5.6)E 0 *(0/ 3)*	(-1.1 ± .9)E 1 (-1.1 - 0.0)E 1 *(0/ 1)*
FE-59 (3) (0)	3.0E+01	(-7.5 ± 12.2)E 0 (-3.1 - 1.0)E 1 *(0/ 3)*	12	(3.9 ± 16.7)E 0 *(0/ 1)*	(3.9 ± 16.7)E 0 *(0/ 1)*
CO-60 (3) (0)	2.0E+02	(-9.8 ± 5.5)E 0 (-1.8 - .1)E 1 *(0/ 3)*	12	(-3.0 ± 13.1)E 0 *(0/ 1)*	(-3.0 ± 13.1)E 0 (-3.0 - 0.0)E 0 *(0/ 1)*
ZN-65 (3) (0)	6.7E+01	(1.1 ± 1.2)E 1 (-2.1 - 35.6)E 0 *(0/ 3)*	11	(1.1 ± 1.2)E 1 *(0/ 3)*	(1.3 ± 16.2)E 0 *(0/ 1)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-H-1
CONTINUED

PILGRIM 1 OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING 83/03/16. PAGE 9
SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS: PCI/KG WET

MEDIUM: ARTHROPODS

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA#	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
ZR-95 (3) (0)	4.0E-02	(8.9 ± 12.1)E 0 (-8.7 - 32.0)E 0 *(0/ 3)*	11	(8.9 ± 12.1)E 0 *(0/ 3)*	(-3.3 ± 1.7)E 1 (-3.3 - 0.0)E 1 *(0/ 1)*
NB-95 (3) (0)	3.9E+01	(3.9 ± 5.9)E 0 (-8.0 - 12.3)E 0 *(0/ 3)*	12	(8.1 ± 8.8)E 0 *(0/ 1)*	(8.1 ± 8.8)E 0 *(0/ 1)*
AG-110M(3) (0)	2.5E+02	(-6.6 ± 92.3)E 0 (-1.9 - .9)E 2 *(0/ 3)*	11	(-6.6 ± 92.3)E 0 *(0/ 3)*	(-7.1 ± 7.1)E 1 (-7.1 - 0.0)E 1 *(0/ 1)*
RU-103 (3) (0)	2.0E-02	(-6.1 ± 6.4)E 0 (-1.9 - .2)E 1 *(0/ 3)*	12	(-2.6 ± 7.6)E 0 *(0/ 1)*	(-2.6 ± 7.6)E 0 (-2.6 - 0.0)E 0 *(0/ 1)*
RU-106 (3) (0)	.2	(-2.8 ± 2.4)E 1 (-6.0 - 1.9)E 1 *(0/ 3)*	12	(4.9 ± 7.6)E 1 *(0/ 1)*	(4.9 ± 7.6)E 1 *(0/ 1)*
I-131 (3) (0)	0.	(3.8 ± 3.5)E 1 (-3.1 - 7.8)E 1 *(0/ 3)*	11	(3.8 ± 3.5)E 1 *(0/ 3)*	(-5.6 ± 16.7)E 0 (-5.6 - 0.0)E 0 *(0/ 1)*
CS-134 (3) (0)	2.0E-02	(4.5 ± 90.1)E -1 (-1.5 - 1.6)E 1 *(0/ 3)*	11	(4.5 ± 90.1)E -1 *(0/ 3)*	(-6.3 ± 7.0)E 0 (-6.3 - 0.0)E 0 *(0/ 1)*
CS-137 (3) (0)	2.0E-02	(-8.8 ± 39.4)E -1 (-8.4 - 4.8)E 0 *(0/ 3)*	12	(1.5 ± .9)E 1 *(0/ 1)*	(1.5 ± .9)E 1 *(0/ 1)*
BA-140 (3) (0)	8.0E-02	(1.5 ± 2.1)E 1 (-9.9 - 56.1)E 0 *(0/ 3)*	11	(1.5 ± 2.1)E 1 *(0/ 3)*	(-1.3 ± 13.5)E 0 (-1.3 - 0.0)E 0 *(0/ 1)*
CE-141 (3) (0)	4.0E-02	(9.7 ± 9.2)E 0 (-1.8 - 27.9)E 0 *(0/ 3)*	11	(9.7 ± 9.2)E 0 *(0/ 3)*	(-7.6 ± 13.3)E 0 (-7.6 - 0.0)E 0 *(0/ 1)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT
** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

PILGRIM I   OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING   83/03/16.   PAGE 10
SUMMARY FOR THE PERIOD   12/21/81 - 12/31/82

UNITS: PCI/KG WET

MEDIUM: ANTHROPODS

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA.	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
CE-144 (4) (0)	.2	(-1.1 + 5.9)E 1 (-1.3 - .0)E 2 *(0/ 3)*	12	(2.5 + 4.9)E 1 *(0/ 1)*	(2.5 + 4.9)E 1 *(0/ 1)*
TH-228 (4) (0)	2.0E-02	(-3.2 + 27.1)E 0 (-3.4 - 5.1)E 1 *(0/ 3)*	12	(3.6 + 3.9)E 1 *(0/ 1)*	(3.6 + 3.9)E 1 *(0/ 1)*

TABLE III-H-1
CONTINUED

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. 3-SIGMA) IS INDICATED WITHIN *( )*.

III. I. Fish

Fish samples of Bottom Oriented (Group 1) and Near Bottom (Group II) species are collected quarterly in the vicinity of the Discharge Canal Outfall. In addition, samples of Anadromous (Group III) and Coastal Migratory (Group IV) species are collected when in season, in this same area. Lastly, a sample from each group is collected once per year at a distant location offshore.

The result of the ERMAP program of fish are presented in Table III-I-1. There was a positive measurement of Cs-137 at the indicator station (Discharge Canal - Station 11) and one at a control station (Truro - Station -98).

A salmon sample collected on 1/7/82 at the Discharge Canal Outfall Area, and a striped bass sample collected on 10/21/82 at a control station (Truro) both indicated a positive measurement of Cs-137. Both salmon and striped bass are in the Group III category (Anadromous). The control station sample (striped bass) measurement was about three times higher than the indicator station (salmon) measurement, which indicates that the Cs-137 is most likely from a source other than PNPS-I. Even if an individual were to consume the maximum annual quantity of fish (21 kilograms/year) with the highest mean concentration of Cs-137, they would receive a dose of less than 0.07 mrem to the total body and about 0.01 mrem to the most restrictive organ (Adult-Liver).

Therefore, there is little evidence of any environmental impact on this media as a result of the operation of PNPS-1.

TABLE III-I-1

ERMAP RESULTS

FISH

PILGRIM I   OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING   83/03/16.   PAGE 18

SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS: PCI/KG WET

MEDIUM: FISH

RADIONUCLIDES (NO. ANALYZED) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN,RANGE,AND NO. DETECTED**	STA#	HIGHEST STATION MEAN,RANGE,AND NO. DETECTED**	CONTROL LOCATIONS MEAN,RANGE,AND NO. DETECTED**
BE-7 (39) (0)	.2	(1.6 + 1.0)E 1 (-6.6 - 11.9)E 1 *(0/ 27)*	98	(9.1 + 6.4)E 1 *(0/ 1)*	(6.4 + 19.1)E 0 (-7.5 - 9.1)E 1 *(0/ 8)*
K-40 (39) (0)	.5	(3.2 + .1)E 3 (2.5 - 4.0)E 3 *(27/ 27)*	98	(3.9 + .2)E 3 *(1/ 1)*	(3.0 + .4)E 3 (2.1 - 3.9)E 3 *(8/ 8)*
CR-51 (39) (0)	5.2E+02	(-1.1 + 1.4)E 1 (-1.9 - 1.6)E 2 *(0/ 27)*	98	(1.4 + .7)E 2 *(0/ 1)*	(4.2 + 2.4)E 1 (-6.8 - 14.2)E 1 *(0/ 8)*
MN-54 (39) (0)	2.0E-02	(1.4 + 1.6)E 0 (-1.7 - 1.4)E 1 *(0/ 27)*	98	(8.4 + 7.7)E 0 *(0/ 1)*	(1.4 + 3.7)E 0 (-1.6 - 1.7)E 1 *(0/ 8)*
CO-57 (39) (0)	2.5E+01	(-5.8 + 12.0)E -1 (-1.5 - 1.1)E 1 *(0/ 27)*	99	(5.2 + 8.2)E 0 *(0/ 2)*	(-1.4 + 2.5)E 0 (-1.0 - 1.3)E 1 *(0/ 8)*
CO-58 (39) (0)	2.0E-02	(-7.7 + 18.2)E -1 -1.9 - 1.3)E 1 *(0/ 27)*	12	(1.7 + 3.3)E 0 *(0/ 2)*	(-1.4 + 1.0)E 0 (-1.0 - .6)E 1 *(0/ 8)*
FE-59 (39) (0)	3.0E+01	(-1.7 + 4.9)E 0 (-4.9 - 5.3)E 1 *(0/ 27)*	98	(1.3 + 1.8)E 1 *(0/ 1)*	(3.2 + 5.1)E 0 (-2.5 - 1.7)E 1 *(0/ 8)*
CO-60 (39) (0)	2.0E-02	(-4.3 + 19.8)E -1 (-1.8 - 1.4)E 1 *(0/ 27)*	11	(2.7 + 210.5)E -2 *(0/ 25)*	(-7.4 + 2.4)E 0 (-1.6 - .4)E 1 *(0/ 8)*
ZN-65 (39) (0)	6.7E+01	(-8.6 + 340.3)E -2 (-2.5 - 9.3)E 1 *(0/ 27)*	98	(1.6 + 1.7)E 1 *(0/ 1)*	(4.5 + 5.7)E 0 (-3.1 - 2.1)E 1 *(0/ 8)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-I-1
CONTINUED

PILGRIM 1 OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING 83/03/16. PAGE 19
SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS: PCI/KG WET

MEDIUM: FISH

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN,RANGE,AND NO. DETECTED**	STA.	HIGHEST STATION MEAN,RANGE,AND NO. DETECTED**	CONTROL LOCATIONS MEAN,RANGE,AND NO. DETECTED**
ZR-95 (35) (0)	4.0E-02	(3.0 ± 240.2)E -2 (-2.8 - 2.4)E 1 *(0/ 27)*	11	(4.3 ± 28.0)E -1 *(0/ 25)*	(-8.8 ± 5.2)E 0 (-2.9 - 1.4)E 1 *(0/ 8)*
NB-95 (35) (0)	3.4E+01	(-1.3 ± 17.6)E -1 (-1.5 - 2.6)E 1 *(0/ 27)*	22	(6.7 ± 6.4)E 0 *(0/ 2)*	(-9.4 ± 33.7)E -1 (-1.2 - 1.3)E 1 *(0/ 8)*
AG-110M(35) (0)	2.5E+02	(1.7 ± 1.6)E 1 (-1.1 - 2.5)E 2 *(0/ 27)*	22	(5.0 ± .0)E 1 *(0/ 2)*	(2.7 ± 35.5)E 0 (-2.0 - .9)E 2 *(0/ 8)*
RU-103 (35) (0)	2.0E-02	(-1.3 ± 1.4)E 0 (-1.6 - .9)E 1 *(0/ 27)*	49	(9.5 ± 1.3)E 0 *(0/ 2)*	(2.6 ± 3.1)E 0 (-3.6 - 1.1)E 1 *(0/ 8)*
RU-106 (35) (0)	.2	(2.9 ± 1.6)E 1 (-1.0 - 1.9)E 2 *(0/ 27)*	12	(6.7 ± 5.6)E 1 *(0/ 2)*	(2.2 ± 15.5)E 0 (-7.6 - 5.1)E 1 *(0/ 8)*
I-131 (35) (0)	0.	(-1.6 ± 1.9)E 1 (-4.7 - .8)E 2 *(0/ 27)*	49	(3.4 ± 2.2)E 1 *(0/ 2)*	(-1.2 ± 13.2)E 0 (-5.8 - 5.0)E 1 *(0/ 8)*
CS-134 (35) (0)	2.0E-02	(-3.1 ± 14.2)E -1 (-1.4 - 1.0)E 1 *(0/ 27)*	49	(5.7 ± 1.0)E 0 *(0/ 2)*	(9.7 ± 26.2)E -1 (-1.3 - .6)E 1 *(0/ 8)*
CS-137 (35) (0)	2.0E-02	(8.2 ± 1.6)E 0 (-1.5 - 1.9)E 1 *(1/ 27)*	48	(4.5 ± .9)E 1 *(1/ 1)*	(1.4 ± .5)E 1 (-3.0 - 45.1)E 0 *(1/ 8)*
BA-140 (35) (0)	8.0E-02	(-1.9 ± 3.1)E 0 (-2.5 - 5.5)E 1 *(0/ 27)*	48	(5.4 ± 12.4)E 0 *(0/ 1)*	(-6.6 ± 8.6)E 0 (-5.4 - 2.4)E 1 *(0/ 8)*
CE-141 (35) (0)	4.0E-02	(5.8 ± 4.1)E 0 (-3.2 - 7.1)E 1 *(0/ 27)*	22	(1.1 ± .9)E 1 *(0/ 2)*	(5.5 ± 6.0)E 0 (-1.8 - 3.4)E 1 *(0/ 8)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-I-1
CONTINUED

PILGRIM I — OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING — 83/03/16. — PAGE 20

SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS: PCI/KG WET

MEDIUM: FISH

RADIONUCLIDES (NO. ANALYZED) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA.	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
CE-144 (36) (0)	.2	(3.6 ± 7.5)E 0 (-9.7 - 7.9)E 1 *(0/ 27)*	12	(1.2 ± .5)E 1 *(0/ 2)*	(-2.1 ± 1.4)E 1 (-6.9 - 4.3)E 1 *(0/ 8)*
TH-228 (35) (6)	2.0E-02	(-0.8 ± 9.1)E 0 (-6.1 - 4.5)E 1 *(0/ 27)*	98	(5.0 ± 3.1)E 1 *(0/ 1)*	(6.4 ± 10.7)E 0 (-5.8 - 5.0)E 1 *(0/ 8)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSED YIELDING DETECTABLE MEASUREMENTS (I.E. 3SIGMA) IS INDICATED WITHIN *( )*.

III. J. Sediments

Sediment samples are taken semi-annually at five indicator stations including Rocky Point, Plymouth Harbor, Duxbury Bay, Plymouth Beach and Manomet Point and a control sample is taken from Marshfield. There is a detailed subdivision of individual sample cores in which samples are sectioned into 2 cm increments during the first half of the year (this applies to all locations except Plymouth Beach and Marshfield), and samples are sectioned into 5 cm increments during the second half of the year.

The surface and alternate sections are analyzed for gamma emitting isotopes. In addition, the surface section from each core and a mid-depth section from Rocky Point and Plymouth Harbor are analyzed for Pu-238 and Pu-239, 240.

The results of the ERMAP program for sediments are presented in Table III-J-1. It is clear from this table that Cs-137 was observed in a sediment sample (5-10 cm) taken from Rocky Point (Station 11) which is near the Discharge Canal Outfall. This sample was collected on 10/29/82. Previous samples collected from the same location on 5/26/82 showed no evidence of any isotopes characteristic of reactor operation. The observation of Cs-137 at the 5-10 cm level was most likely due to liquid releases from PNPS-1. The only other noteworthy values are the measured concentrations of Cs-137 at Plymouth Harbor for both sediment samples and an observation of a Co-60 peak (4-6 cm) in the sample collected on 5/10/82;

Cs-137 at Marshfield for both sediment samples; and Ce-144, Ce-141, Be-7, Cs-137 and an observation of a Co-60 peak in Duxbury Bay samples collected on 5/25/82 and Cs-137 in the samples collected on 10/22/82. The concentrations of Cs-137 may be explained by the fact that the sediment samples taken at Duxbury have a silty character not common to the other samples. The Plymouth Harbor sediment is very similar to Duxbury Bay. It may be that the nature of the Duxbury sediment is such that certain materials are retained more strongly than others. This theory is supported by the fact that the Duxbury indicator station also had the highest mean concentration of K-40, an isotope which is chemically similar to Cs-137. In addition, a Co-60 peak was detected during the first half of 1982 in the 4-6 cm level at Plymouth Harbor and in the 0-2 cm and 4-6 cm level at Duxbury Bay. Since Co-60 was not detected during the second half of the year, the observation is most probably a transient effect. The measured concentrations of Ce-144, Ce-141, and Be-7 at Duxbury Bay, and to some extent Cs-137 at Duxbury Bay, Plymouth Harbor and Marshfield, are attributed to the fission products related to fallout from previous weapons testing.

Analyses for plutonium isotopes in sediment samples were performed by the EAL Corporation (formally LFE Environmental Analyses Laboratories) in Richmond, California. The results of these analyses are presented in Table III-J-2. There is no apparent trend in these data to indicate that the PNPS-1 is contributing measurably to levels of Pu-238 or 239, 240 in the environment since levels of plutonium at Rocky Point are among the lowest measured at any location.

TABLE III-J-1
ERMAP RESULTS
SEDIMENT

PILGRIM 1 — OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING 83/05/16. PAGE 27
SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS: PCI/KG DRY

MEDIUM: SEDIMENT/SILT

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA.	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
BE-7 (78) (3)	.2	(6.7 ± 3.5)E 1 (-1.3 - 22.2)E 2 *(3/ 67)*	13	(2.3 ± 2.0)E 2 (-1.3 - 22.2)E 2 *(2/ 11)*	(-1.7 ± 2.3)E 1 (-1.1 - 1.0)E 2 *(0/ 11)*
K-40 (78) (0)	.5	(1.0 ± .0)E 4 (5.7 - 17.9)E 3 *(67/ 67)*	13	(1.5 ± .0)E 4 (1.0 - 1.8)E 4 *(11/ 11)*	(8.6 ± .2)E 3 (7.5 - 9.5)E 3 *(11/ 11)*
CR-51 (78) (0)	3.7E+02	(-1.7 ± 1.7)E 1 (-3.9 - 3.3)E 2 *(0/ 67)*	11	(1.5 ± 3.0)E 1 *(0/ 13)*	(-1.1 ± .3)E 2 (-3.3 - .3)E 2 *(0/ 11)*
MN-54 (78) (0)	2.0E-02	(2.2 ± 1.3)E 0 (-6.0 - 2.7)E 1 *(0/ 67)*	11	(5.5 ± 1.9)E 0 *(0/ 13)*	(-2.2 ± 19.9)E -1 (-9.7 - 7.9)E 0 *(0/ 11)*
CO-57 (78) (0)	1.8E+01	(-2.4 ± 68.8)E -2 (-1.8 - 1.2)E 1 *(0/ 67)*	28	(3.3 ± 1.2)E 0 *(0/ 11)*	(3.3 ± 1.2)E 0 (-5.5 - 9.5)E 0 *(0/ 11)*
CO-58 (78) (0)	2.0E-02	(-2.1 ± 1.4)E 0 (-3.8 - 2.4)E 1 *(0/ 67)*	15	(1.4 ± 2.9)E 0 *(0/ 11)*	(9.2 ± 35.4)E -1 (-1.4 - 1.0)E 1 *(0/ 11)*
FE-59 (78) (0)	5.0E+01	(-4.6 ± 3.3)E 0 (-7.7 - 7.3)E 1 *(0/ 67)*	12	(3.2 ± 4.6)E 0 *(0/ 11)*	(-7.0 ± 3.2)E 0 (-2.1 - 1.0)E 1 *(0/ 11)*
CO-60 (78) (1)	2.0E-02	(3.7 ± 2.1)E 0 (-2.6 - 10.0)E 1 *(1/ 67)*	14	(7.3 ± 5.6)E 0 (-2.3 - 10.0)E 1 *(1/ 21)*	(-1.4 ± 391.7)E -2 (-2.5 - 1.6)E 1 *(0/ 11)*
ZN-65 (78) (0)	6.8E+01	(2.0 ± 3.1)E 0 (-5.5 - 6.2)E 1 *(0/ 67)*	14	(9.1 ± 7.2)E 0 *(0/ 21)*	(-2.8 ± 4.5)E 0 (-2.3 - 2.0)E 1 *(0/ 11)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

PILGRIM I — OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING — 83/03/16. PAGE 28
SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

MEDIUM: SEDIMENT/SILT — UNITS: PCI/KG DRY

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA.	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
ZR-95 (78) (0)	4.0E-02	(3.4 + 1.0)E 0 (-5.8 - 6.5)E 1 *(0/ 67)*	15	(1.1 + .7)E 1 *(0/ 11)*	(1.6 + 5.3)E 0 (-2.1 - 4.4)E 1 *(0/ 11)*
NB-95 (78) (0)	3.1E+01	(1.6 + 1.5)E 0 (-4.2 - 4.8)E 1 *(2/ 67)*	13	(1.5 + .5)E 1 (-1.2 - 4.8)E 1 *(2/ 11)*	(2.8 + 3.2)E 0 (-1.3 - 2.2)E 1 *(0/ 11)*
AG-110M(78) (0)	1.9E+02	(-1.1 + 1.0)E 1 (-2.7 - 2.6)E 2 *(0/ 67)*	12	(2.2 + 1.4)E 1 *(0/ 11)*	(-1.4 + 1.8)E 1 (-1.2 - .7)E 2 *(0/ 11)*
RU-103 (78) (0)	2.0E-02	(5.4 + 15.2)E -1 (-3.3 - 5.0)E 1 *(0/ 67)*	12	(4.1 + 1.9)E 0 *(0/ 11)*	(-1.3 + 3.3)E 0 (-1.7 - 2.0)E 1 *(0/ 11)*
RU-106 (78) (0)	.2	(-5.0 + 9.4)E 0 (-2.2 - 1.9)E 2 *(0/ 67)*	13	(1.7 + 2.0)E 1 *(0/ 11)*	(-3.1 + 1.5)E 1 (-1.4 - .8)E 2 *(0/ 11)*
I-131 (78) (0)	0.	(-2.4 + 1.6)E 1 (-7.3 - 4.2)E 2 *(0/ 67)*	24	(9.1 + 9.5)E 1 *(0/ 11)*	(9.1 + 6.3)E 1 (-3.4 - 59.0)E 1 *(0/ 11)*
CS-134 (78) (0)	2.0E-02	(-5.1 + 1.1)E 0 (-3.2 - 1.0)E 1 *(0/ 67)*	12	(-1.7 + 1.8)E 0 *(0/ 11)*	(-2.1 + 3.5)E 0 (-1.8 - 2.2)E 1 *(0/ 11)*
CS-137 (78) (0)	2.0E-02	(2.5 + .5)E 1 (-1.6 - 18.0)E 1 *(19/ 67)*	13	(9.6 + .8)E 1 (5.6 - 14.0)E 1 *(11/ 11)*	(1.7 + .4)E 1 (-4.8 - 47.4)E 0 *(3/ 11)*
BA-140 (78) (0)	4.0E-02	(-4.3 + .8)E 1 (-2.1 - 1.0)E 2 *(0/ 67)*	19	(-3.4 + 1.2)E 1 *(0/ 21)*	(-9.1 + 3.7)E 1 (-3.6 - .1)E 2 *(0/ 11)*
CE-141 (78) (1)	4.0E-02	(1.6 + .3)E 1 (-4.5 - 7.8)E 1 *(1/ 67)*	12	(2.0 + .8)E 1 *(0/ 11)*	(1.0 + .4)E 1 (-1.9 - 3.4)E 1 *(0/ 11)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-J-1
CONTINUED

PILGRIM I OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING 83/03/16. PAGE 29
SUMMARY FOR THE PERIOD 12/29/81 - 12/31/82

MEDIUM: SEDIMENT/SILT UNITS: PCI/KG DRY

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN,RANGE,AND NO. DETECTED**	STA.	HIGHEST STATION MEAN,RANGE,AND NO. DETECTED**	CONTROL LOCATIONS MEAN,RANGE,AND NO. DETECTED**
CE-144 (78) (0)	.2	(-1.4 ± .8)E 1 (-2.1 - 2.7)E 2 *(1/ 67)*	13	(4.5 ± 29.2)E 0 (-1.1 - 2.7)E 2 *(1/ 11)*	(-2.6 ± 1.4)E 1 (-6.4 - 5.0)E 1 *(0/ 11)*
TH-228 (78) (0)	2.0E-02	(3.2 ± .2)E 2 (5.0 - 82.4)E 1 *(57/ 67)*	13	(6.6 ± .3)E 2 (4.1 - 9.3)E 2 *(11/ 11)*	(2.0 ± .2)E 2 (1.4 - 3.0)E 2 *(11/ 11)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-J-2
RESULTS OF SEDIMENT ANALYSES FOR PLUTONIUM

Location	Depth cm	Results pCi/Kg (dry) ± % Error (1σ) (a)	
		^{238}Pu	$^{239,240}Pu$
Duxbury	0-2	1.73 ± 16%	40.7 ± 5%
Duxbury	16-18	2.80 ± 19%	54.4 ± 6%
Plymouth Harbor	0-2	0.48 ± 28%	11.4 ± 6%
Rocky Point	0-2	0.24 ± 39%	3.44 ± 9%
Rocky Point	16-18	0.44 ± 27%	3.48 ± 11%
Manomet Point	0-2	0.21 ± 50%	2.54 ± 10%
Marshfield-Control	0-5	0.17 ± 38%	2.55 ± 9%

(a) If the result is zero, the error is in pCi/Kg

(b) Sample analyses for mid-depth sample at Plymouth Harbor not available as of this date.

III. K. Milk

Milk samples were collected at essentially two locations during 1982, the King Residence (Station 22-12 mi-W) and the Whitman Farm (Station 21-21 mi-NW). As stated in Section II, one sample was collected from Beaver Dam Road (Station 28-2.5 mi-S) in October and one sample was collected from Plymouth County Farm (Station 11-3.5 mi W) in December. The milk samples from the Plymouth County Farm have been collected without interruption into 1983. The milk samples from Beaver Dam Road will be collected on a scheduled basis starting in the spring of 1983. Thus, although there was no dependable indicator station (within 5 miles) for milk near PNPS-1 during 1982, it is expected that there will be two dependable indicator stations for 1983. This was confirmed in the 1982 Census (see Appendix E). Milk sampling from the King Residence was interrupted during the later half of 1982. The King Residence provides milk from two sources, a cow and a goat. The cow gave birth to a calf between 7/11/82 and 8/5/82. A milk sample from the cow was unavailable during the week of July 18, 1982 and samples were not available on a scheduled basis until the week of October 10, 1982.

When available, samples were collected semi-monthly when animals are on pasture and monthly at other times.

The results of the ERMAP program for the milk media are presented in Table III-K-1. The results of analyses for Cs-137 and Sr-90 are presented graphically in Figures III-K-1 and III-K-2 respectively.

The highest mean concentration of Sr-90 occurred at Beaver Dam Road and the highest mean concentration of Sr-89 occurred at the Whitman Farm. However, there were no positive measurements made of either Sr-89 or Sr-90, there were only indications of the presence of Sr-90 (activity greater than three times the standard deviation). Station releases for this period exhibited a Sr-89/Sr-90 ratio of about 1/200 and therefore it is unlikely that PNPS-1 is the major source of the indicator station activity since the measured Sr-89/Sr-90 was at most 1/10.

In the case of Cs-137, the highest mean value of concentration occurred at the King Residence (12 mi - W). As can be seen in Figure III-K-1, the Cs-137 concentration for the King Residence - cow peaks in late June. This increase in Cs-137 parallels the pregnancy of the cow very well. It is not uncommon to find marked increase of Cs-137 associated with a cows pregnancy, and this was most likely the cause.

In addition, the measured average concentration of Cs-137, Sr-90 and Sr-89 were all greater than 1,000,000 times in excess of the concentrations expected to be present based on measured releases from PNPS-1 and the conservative dose estimation methodology described in Regulatory Guide 1.109 and 1.111. In other words, PNPS-1 probably contributed much less than 0.01% of the measured concentration of Sr-90, Sr-89 and Cs-137 in milk at the indicator stations. Since the King Residence is greater than 10 miles from PNPS-1, it is highly unlikely that PNPS-1 contributed to the measured concentration of Cs-137 at this location. The remainder of the measured cesium and strontium radioactivity is unquestionably due to atmospheric fallout resulting from atmospheric weapons testing.

When compared with the natural background dose rate of 80 to 100 mrem/year, there was clearly no significant environmental impact on the milk media as a result of operation of PNPS-1.

TABLE III-K-1
ERMAP RESULTS
MILK

PILGRIM 1 — OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING — 83/03/16. PAGE 21
SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS: PCI/LITER

MEDIUM: MILK

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA.	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
SR-89 (41) (0)	4.	(-1.4 + 8.0)E -1 (-9.4 - 2.1)E -1 *(0/ 2)*	21	(4.7 + 1.1)E -1 *(0/ 18)*	(3.6 + 1.1)E -1 (-2.4 - 1.9)E 0 *(0/ 39)*
SR-90 (41) (0)	.4	(10.0 + 7.2)E 0 (2.8 - 17.2)E 0 *(2/ 2)*	28	(1.7 + .1)E 1 *(1/ 1)*	(3.4 + .3)E 0 (1.0 - 10.1)E 0 *(30/ 39)*
BE-7 (41) (0)	6.0E+01	(-2.2 + 5.2)E 0 (-7.3 - 5.0)E 0 *(0/ 2)*	11	(3.0 + 5.3)E 0 *(0/ 1)*	(-1.5 + 1.0)E 0 (-2.0 - 1.3)E 1 *(0/ 39)*
K-40 (41) (0)	2.0E+02	(1.4 + .1)E 3 (1.3 - 1.4)E 3 *(2/ 2)*	11	(1.4 + .0)E 3 *(1/ 1)*	(1.4 + .0)E 3 (1.1 - 1.7)E 3 *(39/ 39)*
CR-51 (41) (0)	-1.0-100	(-5.6 + 2.5)E 0 (-8.1 - 0.0)E 0 *(0/ 2)*	22	(5.9 + 14.8)E -1 *(0/ 21)*	(-4.0 + 13.4)E -1 (-2.5 - 1.5)E 1 *(0/ 39)*
MN-54 (41) (0)	8.	(4.9 + 4.7)E -1 (-1.9 - 92.9)E -2 *(0/ 2)*	11	(9.3 + 6.8)E -1 *(0/ 1)*	(-2.2 + 1.3)E -1 (-3.2 - 1.2)E 0 *(0/ 39)*
CO-57 (41) (0)	-1.0-100	(-1.1 + 1.0)E -1 (-2.0 - 0.0)E -1 *(0/ 2)*	22	(2.8 + 11.7)E -2 *(0/ 21)*	(4.3 + 106.8)E -3 (-2.6 - 1.0)E 0 *(0/ 39)*
CO-58 (41) (0)	8.	(5.1 + 4.8)E -1 (2.8 - 99.3)E -2 *(0/ 2)*	28	(9.9 + 8.0)E -1 *(0/ 1)*	(-2.4 + 1.7)E -1 (-2.6 - 2.1)E 0 *(0/ 39)*
FE-59 (41) (0)	1.0E+01	(1.5 + 4.9)E -1 (-3.3 - 6.4)E -1 *(0/ 2)*	11	(6.4 + 17.0)E -1 *(0/ 1)*	(1.1 + 3.1)E -1 (-2.8 - 4.1)E 0 *(0/ 39)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-K-1
CONTINUED

UNITS: PCI/LITER

MEDIUM: MILK

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN,RANGE,AND NO. DETECTED**	STAT	HIGHEST STATION MEAN,RANGE,AND NO. DETECTED**	CONTROL LOCATIONS MEAN,RANGE,AND NO. DETECTED**
CO-60 (41) (0)	8.	(-9.3 + 19.3)E -1 (-2.3 - .4)E 0 *(0/ 2)*	11	(6.1 + 4.8)E -1 *(0/ 1)*	(-3.3 + 1.5)E -1 (-2.4 - 1.7)E 0 *(0/ 39)*
ZN-65 (41) (0)	-1.0-100	(1.1 + 8.5)E 0 (-1.4 - 3.6)E 0 *(0/ 2)*	11	(3.6 + 2.0)E 0 *(0/ 1)*	(-3.9 + 4.0)E -1 (-5.8 - 4.7)E 0 *(0/ 39)*
ZR-95 (41) (0)	1.0E+01	(-1.9 + 19.2)E -2 (-1.7 - 1.3)E -1 *(0/ 2)*	21	(3.3 + 4.5)E -1 *(0/ 18)*	(1.0 + 2.8)E -1 (-5.4 - 3.5)E 0 *(0/ 39)*
NB-95 (41) (0)	-1.0-100	(-2.3 + 3.6)E -1 (-5.9 - 1.2)E -1 *(0/ 2)*	22	(5.3 + 1.5)E -1 *(0/ 21)*	(3.0 + 1.1)E -1 (-1.5 - 1.0)E 0 *(0/ 39)*
AG-110M(41) (0)	-1.0-100	(3.4 + 5.3)E 0 (-1.7 - 4.0)E 0 *(0/ 2)*	28	(9.0 + 6.8)E 0 *(0/ 1)*	(8.6 + 13.0)E -1 (-1.9 - 2.3)E 1 *(0/ 39)*
RU-103 (41) (0)	8.	(-1.1 + .6)E 0 (-1.6 - 6.0)E 0 *(0/ 2)*	28	(-6.9 + 7.9)E -1 *(0/ 1)*	(-1.1 + .1)E 0 (-2.6 - .9)E 0 *(0/ 39)*
RU-106 (41) (0)	8.0E+01	(-5.0 + 4.7)E 0 (-9.7 - 0.0)E 0 *(0/ 2)*	21	(-1.1 + 180.0)E -2 *(0/ 18)*	(-1.0 + 1.2)E 0 (-3.0 - 1.3)E 1 *(0/ 39)*
I-131 (41) (0)	.5	(1.8 + 2.8)E -2 (-1.4 - 6.2)E -2 *(0/ 2)*	28	(4.2 + 5.7)E -2 *(0/ 1)*	(8.3 + 8.1)E -3 (-1.3 - 1.0)E -1 *(0/ 39)*
CS-134 (41) (0)	9.	(9.1 + 4.8)E -1 (6.6 - 95.2)E -2 *(0/ 2)*	11	(9.5 + 7.0)E -1 *(0/ 1)*	(-5.5 + 1.4)E -1 (-3.3 - .6)E 0 *(0/ 39)*
CS-137 (41) (0)	9.	(1.6 + 1.2)E 1 (4.2 - 27.9)E 0 *(2/ 2)*	28	(2.8 + .1)E 1 *(1/ 1)*	(1.8 + .3)E 1 (8.8 - 1170.0)E -1 *(34/ 39)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-K-1
CONTINUED

PILGRIM I   OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING   83/03/16.   PAGE 23
SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS: PCI/LITER

MEDIUM: MILK

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA.	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
BA-140 (41) (0)	1.5E+01	(-9.4 ± 10.3)E -1 (-2.0 - .0)E 0 *(0/ 2)*	28	(4.7 ± 108.0)E -2 *(0/ 1)*	(-5.6 ± 2.1)E -1 (-3.7 - 4.3)E 0 *(0/ 39)*
CE-141 (41) (0)	2.0E+01	(1.2 ± .7)E 0 (4.9 - 19.3)E -1 *(0/ 2)*	28	(1.9 ± 1.3)E 0 *(0/ 1)*	(2.3 ± 2.0)E -1 (-2.5 - 2.0)E 0 *(0/ 39)*
CE-144 (41) (0)	6.0E+01	(-1.2 ± 3.5)E 0 (-4.7 - 2.3)E 0 *(0/ 2)*	28	(2.3 ± 4.9)E 0 *(0/ 1)*	(-2.6 ± 65.4)E -2 (-8.6 - 11.0)E 0 *(0/ 39)*
TH-228 (41) (0)	1.0E+01	(3.7 ± 1.1)E 0 (2.7 - 4.8)E 0 *(0/ 2)*	28	(4.8 ± 3.4)E 0 *(0/ 1)*	(3.9 ± 6.6)E -1 (-7.0 - 14.2)E 0 *(0/ 39)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

FIGURE III-K-1
CONCENTRATIONS OF Cs-137 in MILK
ALL STATIONS

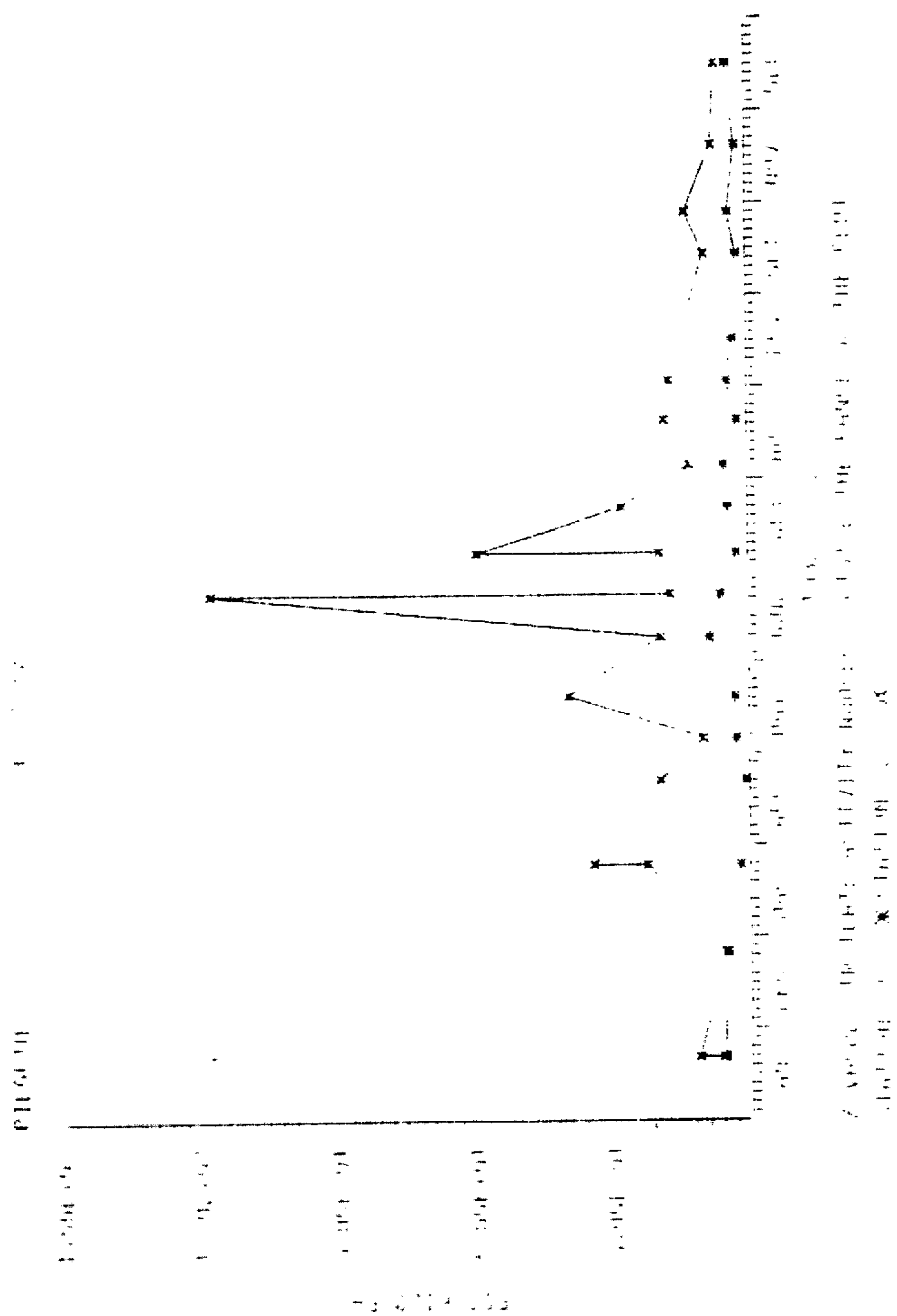
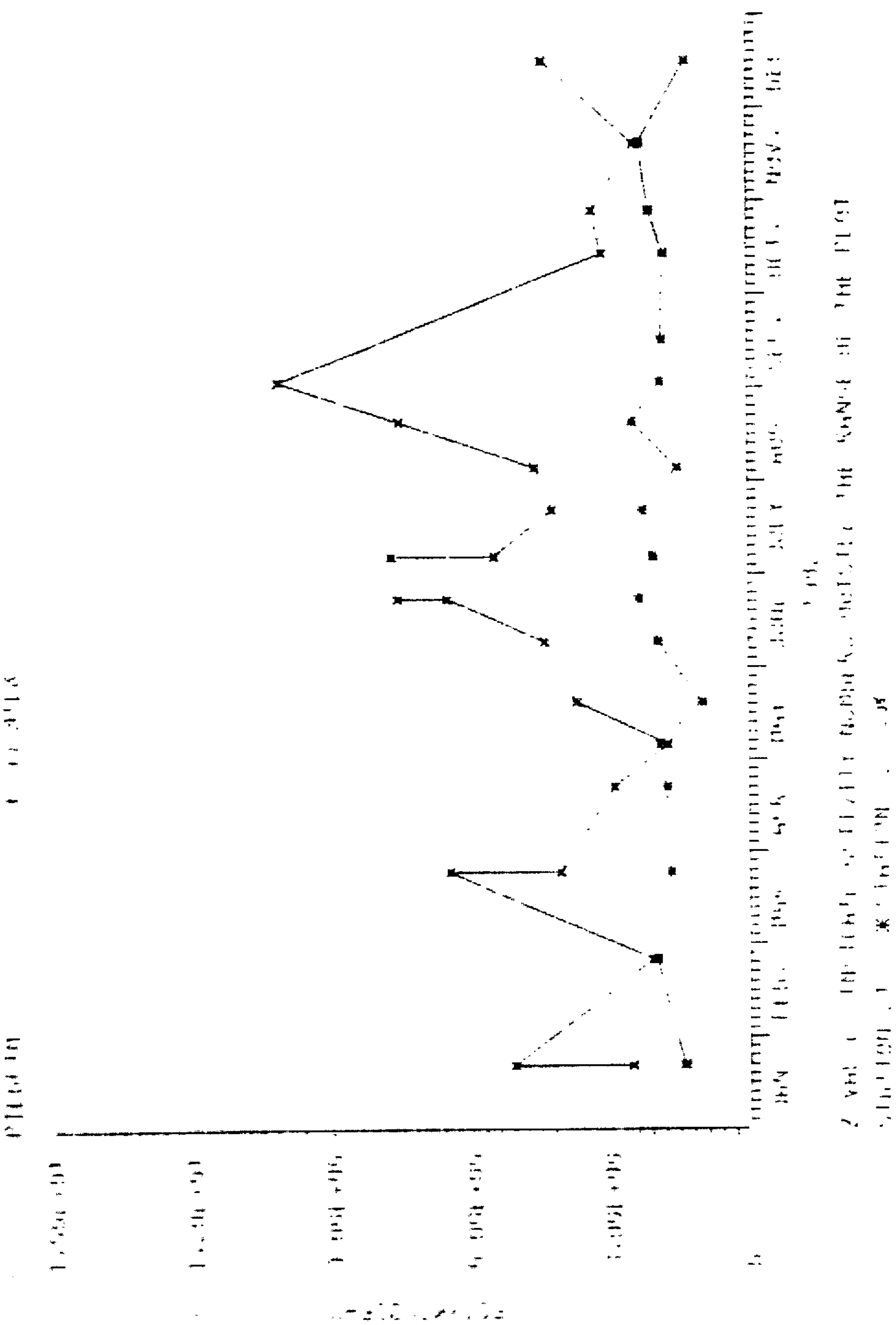


FIGURE III-K-2
CONCENTRATIONS OF Sr-90 in MILK
ALL STATIONS



III. L. Cranberries

Cranberries are collected from three locations, the Manomet Point Bog (2.5 mi-SE-Station 13), the Bartlett Road Bog (2.8 mi-SSE/S Station 14) and the Pine Street Bog (17 mi - WNW - Station 23) at the time of harvest. The results of the ERMAP program for this media are presented in Table III-L-1. The only man-made radionuclide detected was Cs-137 which appeared in all of the sample locations. A comprehensive study of cesium uptake in cranberries was performed during 1978. The results of this study are published in the 1978 Environmental Radiation Monitoring Program Report No. 11. This report identified fallout from previous nuclear weapons testing as the primary source of cesium in cranberries. In addition, this report indicated that cesium uptake in cranberries can be increased when conditions of low soil potassium occur, as cesium is a chemical congener of potassium. The results of this study and the fact that no other reactor related isotopes were measured above LLD in cranberry samples makes it extremely unlikely that there was any environmental impact on cranberries due to operation of PNPS-1, but rather that the measured concentration was due to fallout from previous weapons testing and a lack of adequate potassium in the soil.

TABLE III-L-1
ERMAP RESULTS
CRANBERRIES

PILGRIM I   OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING   83/03/16.   PAGE 12
SUMMARY FOR THE PERIOD   12/21/81 - 12/31/82

UNITS: PCI/KG WET

MEDIUM: FOOD CRANBERRIES

RADIONUCLIDES (NO. ANALYZED) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN,RANGE,AND NO. DETECTED**	STA.	HIGHEST STATION MEAN,RANGE,AND NO. DETECTED**	CONTROL LOCATIONS MEAN,RANGE,AND NO. DETECTED**
BE-7 (3) (0)	.2	(3.9 ± 3.7)E 1 (2.2 - 76.8)E 0 *(0/ 2)*	13	(7.7 ± 6.2)E 1 *(0/ 1)*	(1.9 ± 3.9)E 1 *(0/ 1)*
K-40 (3) (0)	.5	(5.4 ± .3)E 2 (5.1 - 5.8)E 2 *(2/ 2)*	23	(5.9 ± .9)E 2 *(1/ 1)*	(5.9 ± .9)E 2 *(1/ 1)*
CR-51 (3) (0)	3.2E+02	(-2.3 ± 1.0)E 1 (-3.3 - 0.0)E 1 *(0/ 2)*	13	(-1.2 ± 6.0)E 1 *(0/ 1)*	(-1.3 ± 3.8)E 1 (-1.3 - 0.0)E 1 *(0/ 1)*
MN-54 (3) (0)	3.0E+02	(-2.7 ± 1.0)E 0 (-5.6 - .3)E 0 *(0/ 2)*	23	(2.7 ± 4.4)E 0 *(0/ 1)*	(2.7 ± 4.4)E 0 *(0/ 1)*
CO-57 (3) (0)	2.5E+01	(5.6 ± 4.8)E 0 (10.0 - 102.0)E -1 *(0/ 2)*	13	(1.0 ± .9)E 1 *(0/ 1)*	(4.2 ± 3.3)E 0 *(0/ 1)*
CO-58 (3) (0)	3.0E+02	(1.6 ± 2.0)E 0 (-4.2 - 36.1)E -1 *(0/ 2)*	14	(3.6 ± 4.5)E 0 *(0/ 1)*	(-1.7 ± 4.5)E 0 (-1.7 - 0.0)E 0 *(0/ 1)*
FE-59 (3) (0)	3.0E+01	(-2.1 ± 5.1)E 0 (-5.1 - 1.0)E 0 *(0/ 2)*	14	(1.0 ± 6.1)E 0 *(0/ 1)*	(-2.8 ± 9.4)E 0 (-2.8 - 0.0)E 0 *(0/ 1)*
CO-60 (3) (0)	2.0E+02	(-2.4 ± 45.3)E -1 (-9.8 - 4.2)E 0 *(0/ 2)*	13	(4.2 ± 11.1)E 0 *(0/ 1)*	(-6.1 ± 8.4)E 0 (-6.1 - 0.0)E 0 *(0/ 1)*
ZN-65 (3) (0)	6.7E+01	(2.7 ± 8.7)E 0 (-6.0 - 11.4)E 0 *(0/ 2)*	13	(1.1 ± 1.4)E 1 *(0/ 1)*	(4.1 ± 10.0)E 0 *(0/ 1)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *(   )*.

TABLE III-L-1
CONTINUED

PILGRIM 1 OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING 83/03/16. PAGE 13
SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS: PCI/KG WET

MEDIUM: FOOD CRANBERRIES

RADIONUCLIDES (NO. ANALYSES) (NONROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA.	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
ZR-95 (5) (0)	4.0E-02	(-7.3 ± 4.2)E 0 (-1.6 - .2)E 1 *(0/ 2)*	23	(6.1 ± 7.7)E 0 *(0/ 1)*	(6.1 ± 7.7)E 0 *(0/ 1)*
NB-95 (5) (0)	3.0E+01	(4.5 ± 3.2)E 0 (1.8 - 7.7)E 0 *(0/ 2)*	14	(1.7 ± 5.0)E 0 *(0/ 1)*	(1.1 ± 4.2)E 0 *(0/ 1)*
AG-110M(5) (0)	2.5E+02	(-8.6 ± 5.4)E 1 (-8.5 - 0.0)E 1 *(0/ 2)*	14	(-6.7 ± 40.3)E 0 *(0/ 1)*	(-5.9 ± 3.0)E 1 (-5.9 - 0.0)E 1 *(0/ 1)*
RU-103 (5) (0)	2.0E-02	(-6.7 ± 8.5)E 0 (-1.1 - 0.0)E 1 *(0/ 2)*	23	(9.5 ± 5.0)E 0 *(0/ 1)*	(1.5 ± 5.0)E 0 *(0/ 1)*
RU-106 (5) (0)	.2	(-1.1 ± 11.1)E 1 (-1.2 - 1.0)E 2 *(0/ 2)*	14	(1.0 ± .4)E 2 *(0/ 1)*	(-6.9 ± 4.3)E 1 (-6.9 - 0.0)E 1 *(0/ 1)*
I-131 (5) (0)	0.	(-1.9 ± 12.9)E 0 (-1.5 - 1.1)E 1 *(0/ 2)*	13	(1.1 ± 1.2)E 1 *(0/ 1)*	(3.1 ± 60.3)E -1 *(0/ 1)*
CS-134 (5) (0)	2.0E-02	(-1.2 ± .8)E 1 (-2.0 - 0.0)E 1 *(0/ 2)*	23	(4.3 ± 4.5)E 0 *(0/ 1)*	(4.3 ± 4.5)E 0 *(0/ 1)*
CS-137 (5) (1)	2.0E-02	(1.2 ± 1.0)E 2 (2.2 - 22.1)E 1 *(2/ 2)*	13	(2.2 ± .2)E 2 *(1/ 1)*	(2.1 ± .7)E 1 *(1/ 1)*
BA-140 (5) (0)	6.0E-02	(3.0 ± .9)E 0 (2.0 - 3.9)E 0 *(0/ 2)*	14	(3.9 ± 7.6)E 0 *(0/ 1)*	(-6.1 ± 7.9)E 0 (-6.1 - 0.0)E 0 *(0/ 1)*
CE-141 (5) (0)	4.0E-02	(1.1 ± .3)E 1 (8.5 - 14.0)E 0 *(0/ 2)*	13	(1.4 ± 1.0)E 1 *(0/ 1)*	(3.1 ± 6.3)E 0 *(0/ 1)*

* NONROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-L-1 CONTINUED

PILGRIM 1 — OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING — 83/03/16. PAGE 14

SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

MEDIUM: FOOD CRANBERRIES — UNITS: PCI/KG WET

RADIONUCLIDES (NO. ANALYZED) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA.	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
CE-144 (3) (0)	.8	(-2.2 + 1.7)E 1 (-5.8 - 1.0)E 1 *(0/ 2)*	14	(10.0 + 25.9)E 0 *(0/ 1)*	(-2.8 + 2.5)E 1 (-2.8 - 0.0)E 1 *(0/ 1)*
TH-228 (3) (0)	2.0E-02	(7.9 + 28.4)E 0 (-2.0 - 3.4)E 1 *(0/ 2)*	14	(3.6 + 1.9)E 1 *(0/ 1)*	(2.6 + 2.3)E 1 *(0/ 1)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *(   )*.

III. M. Vegetation

Samples of tuberous and green leafy vegetables were collected at the time of harvest at six locations, Plymouth County Farm (3.5 mi-W), Bridgewater Farm (20 mi-W), the Evans Residence (0.7 mi - W), the Work Residence (0.6 mi - ESE), the Whipple Farm (1.5 mi - SSW), and the Hoton Residence (2.5 mi - SE). The results of the ERMAP program for this media are presented in Table III-M-1.

The only isotopes observed (other than naturally occuring AcTh-228 (peak) and K-40)was Be-7 and Cs-137. Positive measurements of Cs-137 were detected in vegetation samples from the Evans residence (rhubarb, (18.4 pCi/kg))and the Whipple Farm (lettuce, (31.9 pCi/kg)). The absence of Cs-134 at both of these locations and the fact that measured Cs-137 concentrations are greater than 1,000,000 times what would be expected at these locations based on releases from PNPS-1, strongly indicates that fallout, not PNPS-1, is the primary source of this Cs-137. Therefore, it is extremely unlikely that there was any environmental impact on vegetation due to the operation of PNPS-1.

TABLE III-M-1
ERMAP RESULTS
VEGETATION

PILGRIM 1 — OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING — 83/03/16. PAGE 15
SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS: PCI/KG WET

MEDIUM: FOOD/GARDEN CROPS

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA#	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
BE-7 (10) (3)	.2	(8.4 + 8.6)E 1 (-3.5 - 25.8)E 1 *(3/ 7)*	16	(2.8 + .3)E 2 *(1/ 1)*	(-2.5 + 4.7)E 1 (-1.2 - .4)E 2 *(0/ 3)*
K-40 (10) (0)	.5	(2.7 + .4)E 3 (1.3 - 5.0)E 3 *(7/ 7)*	11	(5.0 + 1.1)E 3 (1.3 - 5.0)E 3 *(3/ 3)*	(1.4 + .4)E 3 (6.6 - 21.4)E 2 *(3/ 3)*
CR-51 (10) (0)	3.2E+02	(1.2 + 1.8)E 1 (-3.3 - 7.3)E 1 *(0/ 7)*	43	(7.3 + 4.3)E 1 *(0/ 1)*	(9.3 + 35.7)E 0 (-4.8 - 7.7)E 1 *(0/ 3)*
MN-54 (10) (0)	2.0E+02	(-1.0 + 16.5)E -1 (-8.6 - 5.6)E 0 *(0/ 7)*	16	(5.6 + 3.6)E 0 *(0/ 1)*	(6.0 + 16.7)E -1 (-2.7 - 2.8)E 0 *(0/ 3)*
CO-57 (10) (0)	2.5E+01	(1.3 + 1.3)E 0 (-3.8 - 5.5)E 0 *(0/ 7)*	43	(5.5 + 3.6)E 0 *(0/ 1)*	(-2.2 + 1.9)E 0 (-5.0 - .9)E 0 *(0/ 3)*
CO-58 (10) (0)	2.0E+02	(-1.6 + 2.1)E 0 (-1.1 - .5)E 1 *(0/ 7)*	27	(6.5 + 3.8)E 0 *(0/ 1)*	(6.5 + 3.8)E 0 (-1.1 - 11.1)E 0 *(0/ 3)*
FE-59 (10) (0)	3.0E+01	(-5.7 + 2.2)E 0 (-1.6 - .2)E 1 *(0/ 7)*	27	(-3.9 + 64.9)E -1 *(0/ 3)*	(-3.9 + 64.9)E -1 (-1.1 - 1.1)E 1 *(0/ 3)*
CO-60 (10) (0)	2.0E+02	(2.4 + 11.2)E -1 (-5.5 - 2.9)E 0 *(0/ 7)*	45	(2.3 + 6.6)E 0 *(0/ 1)*	(-3.1 + 5.5)E 0 (-1.2 - .7)E 1 *(0/ 3)*
ZN-65 (10) (0)	6.7E+01	(5.0 + 46.1)E -1 (-1.6 - 1.9)E 1 *(0/ 7)*	43	(1.9 + 1.3)E 1 *(0/ 1)*	(-5.6 + 5.7)E 0 (-1.5 - .4)E 1 *(0/ 3)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-M-1
CONTINUED

PILGRIM I OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING 83/05/16. PAGE 16
SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS: PCI/KG WET

MEDIUM: FOOD/GARDEN CROPS

RADIONUCLIDES (NO. ANALYZED) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA.	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
ZR-95 (10) (0)	8.0E-02	(2.8 + 3.8)E 0 (-7.9 - 21.2)E 0 *(0/ 7)*	17	(2.1 + .7)E 1 *(0/ 1)*	(8.5 + 3.8)E 0 (7.9 - 127.0)E -1 *(0/ 3)*
NB-95 (10) (0)	3.9E+0.	(1.1 + 1.2)E 0 (-3.1 - 5.9)E 0 *(0/ 7)*	16	(5.9 + 4.2)E 0 *(0/ 1)*	(2.1 + 3.5)E 0 (-1.8 - 9.0)E 0 *(0/ 3)*
AG-110M(10) (0)	2.5E+02	(-2.9 + 8.8)E 0 (-8.0 - 2.6)E 1 *(0/ 7)*	45	(2.6 + 3.6)E 1 *(0/ 1)*	(-1.0 + 2.7)E 1 (-4.3 - 4.4)E 1 *(0/ 3)*
RU-103 (10) (0)	2.0E-02	(7.7 + 16.0)E -1 (-7.6 - 5.4)E 0 *(0/ 7)*	43	(3.0 + 4.8)E 0 *(0/ 1)*	(2.9 + 6.3)E 0 (-6.8 - 14.7)E 0 *(0/ 3)*
RU-106 (10) (0)	.2	(-2.7 + 2.0)E 1 (-1.2 - .5)E 2 *(0/ 7)*	17	(2.2 + 3.2)E 1 *(0/ 1)*	(1.1 + 1.4)E 1 (-6.8 - 38.9)E 0 *(0/ 3)*
I-131 (10) (0)	0.	(-1.7 + 2.2)E 0 (-9.5 - 7.2)E 0 *(0/ 7)*	43	(7.2 + 7.6)E 0 *(0/ 1)*	(-1.6 + 54.0)E -1 (-9.1 - 9.6)E 0 *(0/ 3)*
CS-134 (10) (0)	2.0E-02	(-4.6 + 1.1)E 0 (-9.6 - .4)E 0 *(0/ 7)*	27	(1.8 + 7.1)E 0 *(0/ 3)*	(1.6 + 7.1)E 0 (-9.3 - 15.0)E 0 *(0/ 3)*
CS-137 (10) (2)	2.0E-02	(8.0 + 5.2)E 0 (-6.1 - 31.9)E 0 *(2/ 7)*	43	(3.2 + .7)E 1 *(1/ 1)*	(9.5 + 6.1)E 0 (-1.2 - 20.0)E 0 *(0/ 3)*
BA-140 (10) (0)	8.0E-02	(1.2 + 4.4)E 0 (-2.4 - 1.0)E 1 *(0/ 7)*	45	(6.6 + 6.0)E 0 *(0/ 1)*	(7.0 + 45.3)E -1 (-7.3 - 8.4)E 0 *(0/ 3)*
CE-141 (10) (0)	4.0E-02	(6.8 + 2.5)E 0 (-5.3 - 14.0)E 0 *(0/ 7)*	17	(1.4 + .6)E 1 *(0/ 1)*	(1.3 + .7)E 1 (3.3 - 25.6)E 0 *(0/ 3)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

PILGRIM 1 OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING 83/03/16. PAGE 17
SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

MEDIUM: FOOD/GARDEN CROPS

UNITS: PCI/KG WET

RADIONUCLIDES (NO. ANALYSED) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN,RANGE,AND NO. DETECTED**	STA.	HIGHEST STATION MEAN,RANGE,AND NO. DETECTED**	CENTRAL LOCATIONS MEAN,RANGE,AND NO. DETECTED**
CE-144 (10) (0)	.2	(-7.3 + 9.9)E 0 (-3.5 - 4.3)E 1 *(0/ 7)*	16	(4.3 + 2.1)E 1 *(0/ 1)*	(1.2 + 2.9)E 1 (-4.4 - 5.6)E 1 *(0/ 3)*
TH-228 (10) (0)	2.0E-02	(2.2 + .9)E 1 (-9.1 - 1.4)E 0 *(0/ 7)*	16	(4.3 + 2.0)E 1 *(0/ 1)*	(1.4 + 1.7)E 1 (-1.6 - 4.4)E 1 *(0/ 3)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-M-1
CONTINUED

III. N. Forage

Beef Forage is collected from three locations annually, the Plymouth County Farm (3.5 mi - W - Station Number 11), Whitman Farm (21 mi-NW - Station Number 21) and Bridgewater Farm (20 mi-W-Station Number 27). The results of the ERMAP program for the media are presented in Table III-N-1. The following positive measurements were made: Be-7 at the Plymouth County Farm; Be-7 at the Bridgewater Farm; and, Be-7 and Cs-137 at the Whitman Farm. All of the above nuclides are attributable to fission products related to fallout from previous atmospheric weapons testing.

The only positive measurement of Cs-137 occurred at the Whitman Farm. The Whitman Farm is a control station and is located 21 miles-NW from PNPS-1, thus the source of this Cs-137 is due to fallout from previous atmospheric weapons testing. Therefore, it is extremely unlikely that there was any environmental impact on forage due to operation of PNPS-1.

TABLE III-N-1
ERMAP RESULTS
FORAGE

PILGRIM 1 — OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING — 83/03/16. PAGE 33
SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

MEDIUM: VEGETATION - TERRESTRIAL — UNITS: PCI/KG WET

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA.	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
BE-7 (5) (0)	.2	(3.5 + .3)E 3 *(1/ 1)*	11	(3.5 + .3)E 3 *(1/ 1)*	(1.9 + .3)E 3 (1.6 - 2.2)E 3 *(2/ 2)*
K-40 (5) (0)	.5	(1.1 + .1)E 4 (1.0 - 1.1)E 4 *(1/ 1)*	11	(1.1 + .1)E 4 (1.0 - 1.1)E 4 *(1/ 1)*	(7.1 + 1.6)E 3 (5.5 - 8.7)E 3 *(2/ 2)*
CR-51 (5) (0)	-1.0-100	(1.3 + 15.0)E 1 *(0/ 1)*	11	(1.3 + 15.0)E 1 *(0/ 1)*	(-1.0 + .7)E 2 (-1.7 - 0.0)E 2 *(0/ 2)*
MN-54 (5) (0)	2.0E-02	(2.1 + 1.5)E 1 *(0/ 1)*	11	(2.1 + 1.5)E 1 *(0/ 1)*	(9.2 + 8.7)E 0 (5.0 - 179.0)E -1 *(0/ 2)*
CO-57 (5) (0)	-1.0-100	(1.0 + 1.0)E 1 *(0/ 1)*	11	(1.0 + 1.0)E 1 *(0/ 1)*	(8.7 + 1.2)E 0 (5.5 - 8.0)E 0 *(0/ 2)*
CO-58 (5) (0)	2.0E-02	(6.4 + 16.1)E 0 *(0/ 1)*	11	(6.4 + 16.1)E 0 *(0/ 1)*	(-1.7 + 1.6)E 1 (-3.0 - .1)E 1 *(0/ 2)*
FE-59 (5) (0)	3.0E+01	(1.6 + 3.8)E 1 *(0/ 1)*	21	(4.3 + 2.7)E 1 *(0/ 1)*	(8.4 + 34.2)E 0 (-2.6 - 4.3)E 1 *(0/ 2)*
CO-60 (5) (0)	2.0E-02	(1.3 + 23.2)E 0 *(0/ 1)*	27	(4.6 + 20.7)E 0 *(0/ 1)*	(2.6 + 2.1)E 0 (4.8 - 46.2)E -1 *(0/ 2)*
ZN-65 (5) (0)	-1.0-100	(-1.7 + 3.4)E 1 (-1.7 - 0.0)E 1 *(0/ 1)*	27	(3.5 + 3.0)E 1 *(0/ 1)*	(1.4 + 2.1)E 1 (-7.5 - 35.3)E 0 *(0/ 2)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

TABLE III-N-1
CONTINUED

UNITS: PCI/KG WET

MEDIUM: VEGETATION - TERRESTIAL

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINES)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA.	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
ZR-95 (3) (0)	4.0E-02	(-2.8 + 5.2)E 1 (-2.8 - 0.0)E 1 *(0/ 1)*	21	(3.3 + 27.1)E 0 *(0/ 1)*	(2.4 + 1.0)E 0 (1.4 - 3.4)E 0 *(0/ 2)*
NB-95 (3) (0)	-1.0-100	(-2.7 + 1.8)E 1 (-2.7 - 0.0)E 1 *(0/ 1)*	21	(2.6 + 13.4)E 0 *(0/ 1)*	(-8.4 + 11.0)E 0 (-1.9 - .3)E 1 *(0/ 2)*
AG-110M(3) (0)	-1.0-100	(-1.9 + 1.0)E 2 (-1.9 - 0.0)E 2 *(0/ 1)*	27	(1.6 + 1.1)E 2 *(0/ 1)*	(2.5 + 13.9)E 1 (-1.1 - 1.6)E 2 *(0/ 2)*
RU-103 (3) (0)	2.0E-02	(1.9 + 1.6)E 1 *(0/ 1)*	11	(1.9 + 1.6)E 1 *(0/ 1)*	(-6.2 + 1.0)E 0 (-7.2 - 0.0)E 0 *(0/ 2)*
RU-106 (3) (0)	.2	(-1.3 + 1.8)E 2 (-1.3 - 0.0)E 2 *(0/ 1)*	21	(5.7 + 12.9)E 1 *(0/ 1)*	(4.5 + 1.2)E 1 (3.3 - 5.7)E 1 *(0/ 2)*
I-131 (3) (0)	0.	(1.4 + 6.5)E 1 *(0/ 1)*	11	(1.4 + 6.5)E 1 *(0/ 1)*	(-7.2 + 15.8)E 0 (-2.3 - .8)E 1 *(0/ 2)*
CS-134 (3) (0)	2.0E-02	(-2.5 + 1.5)E 1 (-2.5 - 0.0)E 1 *(0/ 1)*	21	(1.5 + 13.2)E 0 *(0/ 1)*	(-7.3 + 10.7)E 0 (-1.8 - .3)E 1 *(0/ 2)*
CS-137 (3) (0)	2.0E-02	(3.5 + 1.6)E 1 *(0/ 1)*	21	(4.8 + 1.4)E 1 *(1/ 1)*	(4.3 + 2.5)E 1 (1.7 - 6.8)E 1 *(1/ 2)*
BA-140 (3) (0)	8.0E-02	(-8.5 + 41.7)E 0 (-8.5 - 0.0)E 0 *(0/ 1)*	27	(4.6 + 2.5)E 1 *(0/ 1)*	(2.7 + 2.2)E 1 (5.1 - 48.4)E 0 *(0/ 2)*
CE-141 (3) (0)	4.0E-02	(5.6 + 2.5)E 1 *(0/ 1)*	11	(5.6 + 2.5)E 1 *(0/ 1)*	(-2.0 + 1.4)E 1 (-3.4 - 0.0)E 1 *(0/ 2)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN *( )*.

PILGRIM I OFFSITE ENVIRONMENTAL RADIOLOGICAL MONITORING 83/03/10. PAGE 35
SUMMARY FOR THE PERIOD 12/21/81 - 12/31/82

UNITS: PCI/KG WET

MEDIUM: VEGETATION - TERRESTIAL

RADIONUCLIDES (NO. ANALYSES) (NON-ROUTINE)*	NOMINAL LLD	INDICATOR STATIONS MEAN, RANGE, AND NO. DETECTED**	STA.	HIGHEST STATION MEAN, RANGE, AND NO. DETECTED**	CONTROL LOCATIONS MEAN, RANGE, AND NO. DETECTED**
CE-144 (3) (0)	.2	(-8.6 ± 7.3)E 1 (-8.6 - 0.0)E 1 0(0/ 1)*	21	(3.3 ± 5.6)E 1 0(0/ 1)*	(2.3 ± 1.0)E 1 (1.3 - 3.3)E 1 0(0/ 2)*
TH-228 (3) (0)	8.0E-02	(-8.2 ± 7.2)E 1 (-8.2 - 0.0)E 1 0(0/ 1)*	21	(1.5 ± .6)E 2 0(0/ 1)*	(1.0 ± .5)E 2 (5.3 - 15.1)E 1 0(0/ 2)*

* NON-ROUTINE REFERS TO THE NUMBER OF SEPARATE MEASUREMENTS WHICH WERE GREATER THAN TEN (10) TIMES THE AVERAGE BACKGROUND FOR THE PERIOD OF THE REPORT

** THE FRACTION OF SAMPLE ANALYSES YIELDING DETECTABLE MEASUREMENTS (I.E. >3SIGMA) IS INDICATED WITHIN A( )*.

TABLE III-N-1
CONTINUED

IV. References

1. Regulatory Guide 1.109 - CALCULATION OF ANNUAL DOSES TO MAN FROM ROUTINE RELEASES OF REACTOR EFFLUENTS FOR THE PURPOSE OF EVALUATING COMPLIANCE WITH 10 CFR PART 50, APPENDIX I - Revision 1, October 1977

2. SETTLEMENT AGREEMENT BETWEEN MASSACHUSETTS WILDLIFE FEDERATION AND BOSTON EDISON COMPANY RELATING TO OFFSITE RADIOLOGICAL MONITORING - June 9, 1977

3. Yankee Atomic Electric Company - Program "ERMAP", Version 3.1 - January 9, 1979, Author - J. E. Vossahlik

4. Memorandum, Yankee Atomic Electric Company, 1982 Annual Direct Radiation Survey, REG 124/82, August 1982, C. A. Pierno.

5. Memorandum, Yankee Atomic Electric Company, Reg. 211/76, A. E. Desrosiers

6. Report on Accumulation of Cesium - 137 in Cranberries, March 1979 Yankee Atomic Electric Company, M. Strum

APPENDIX A - ANOMALOUS MEASUREMENT REPORTS

There were no Anomalous Measurement Reports

for the year of 1982.

APPENDIX B - Radioactive Effluents

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT

Supplemental Information
January - June 1982

Facility Pilgrim Nuclear Power Station Licensee DPR-35

1. **Regulatory Limits**
   a. Fission and activation gases. $\frac{Qs}{0.25/\bar{E}} + \frac{Qv}{0.10/\bar{E}} \leq 1$
   b. Iodines 2Ci/Quarter
   c. Particulates, half-lives >8 days 13(1.8E4Qs+1.8E5Qv)≤1
   d. Liquid effluents: 10Ci/Quarter

2. **Maximum Permissible Concentration**

   Provide the MPCs used in determining allowable release rates or concentrations.
   a. Fission and activation gases: } 10 CFR 20
   b. Iodines: } Appendix B
   c. Particulates, half-lives >8 days: } Table II
   d. Liquid effluents $H-3 = 1 \times 10^{-5}$ μCi/ml; all rest, 10 CFR 20, Appendix B, Table II

3. **Average Energy**

   Provide the average energy ($\bar{E}$) of the radionuclide mixture in releases of fission and activation gases, if applicable
   MS=0.324:RBV=0.503

4. **Measurements and Approximations of Total Radioactivity**

   Provide the methods used to measure or approximate the total radioactivity in effluents and the methods used to determine radionuclide composition.
   a. Fission and activation gases } GeLi
   b. Iodines. } Istopic
   c. Particulates: } Analysis
   d. Liquid effluents:

5. **Batch Releases**

   Provide the following information relating to batch releases of radioactive materials in liquid and gaseous effluents

   a. **Liquid**

      1. Number of batch releases 121
      2. Total time period for batch releases 192.92hrs
      3. Maximum time period for a batch release - 7.75hrs
      4. Average time period for batch releases 1.59hrs
      5. Minimum time period for a batch release - 0.25hrs
      6. Average stream flow during periods of release of effluent into a flowing stream 1.90E+5GPM

   b. **Gaseous** **(Not Applicable)**

6. **Abnormal Releases**

   a.
   b. None

TABLE 1A

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT

GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

January - June 1982

	Unit	Quarter 1	Quarter 2	Est. Total Error, %
A. Fission and activation gases				
1. Total release	Ci	-	3.55E+3	2.50E+1
2. Average release rate for period	μCi/sec	-	4.52E+2	
3. Percent of Technical Specification limit	%	-	6.92E-2	
B. Iodines				
1. Total iodine-131	Ci	-	3.97E-3	2.54E+1
2. Average release rate for period	μCi/sec	-	5.05E-4	
3. Percent of Technical Specification limit	%	-	1.99E-1	
C. Particulates				
1. Particulates with half-lives > 8 days	Ci	< 3.68E-4	4.26E-3	3.05E+1
2. Average release rate for period	μCi/sec	< 4.73E-5	5.42E-4	
3. Percent of Technical Specification limit	%	< 8.39E-3	6.98E-2	
4. Gross alpha radioactivity	Ci	< 4.52E-7	< 5.61E-7	
D. Tritium				
1. Total release	Ci	2.34E0	5.92E0	3.20E+1
2. Average release rate for period	μCi/sec	3.01E-1	7.52E-1	
3. Percent of Technical Specification limit	%	-	-	

TABLE 1B

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1982)

GASEOUS EFFLUENTS – ELEVATED RELEASE

January - June 1982

		CONTINUOUS MODE		BATCH MODE	
Nuclides Released	**Unit**	**Quarter**	**Quarter**	**Quarter**	**Quarter**
1. Fission gases					
krypton-85	Ci	-	1.37E-2		
krypton-85m	Ci	-	2.93E+2		
krypton-87	Ci	-	6.55E+1		
krypton-88	Ci	-	3.62E+2		
xenon-133	Ci	-	2.28E+3		
xenon-135	Ci	-	2.61E+2		
xenon-135m	Ci	-	< 6.06E+0		
xenon-138	Ci	-	< 2.38E+1		
xenon-131m	Ci	-	-		
xenon-137	Ci	-	-		
xenon-133m	Ci	-	4.28E+1		
Total for period	Ci	-	3.33E+3		
2. Iodines					
iodine-131	Ci	-	2.53E-3		
iodine-133	Ci	-	7.90E-3		
iodine-135	Ci	-	< 6.55E-3		
Total for period	Ci	-	< 1.70E-2		
3. Particulates					
strontium-89	Ci	< 6.32E-7	5.16E-4		
strontium-90	Ci	< 6.26E-8	5.50E-6		
cesium-134	Ci				
cesium-137	Ci	< 1.04E-5	1.14E-5		
barium-lanthanum-140	Ci		1.57E-3		
chromium-51	Ci				
manganese-54	Ci	8.90E-6	2.90E-6		
cobalt-58	Ci				
iron-59	Ci				
cobalt-60	Ci	< 7.86E-5	3.00E-5		
zinc-65	Ci				
zirconium-niobium-95	Ci				
cerium-141	Ci				
cerium-144	Ci				
ruthenium-103	Ci				
ruthenium-106	Ci				

TABLE 1C

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1982)

GASEOUS EFFLUENTS - GROUND LEVEL RELEASE

January - June 1982

Nuclides Released	Unit	CONTINUOUS MODE Quarter	CONTINUOUS MODE Quarter	BATCH MODE Quarter	BATCH MODE Quarter
1. Fission gases					
krypton-85	Ci	-	1.01E-5		
krypton-85m	Ci	-	2.47E+1		
krypton-87	Ci	-	2.51E+0		
krypton-88	Ci	-	4.55E+1		
xenon-133	Ci	-	4.19E+1		
xenon-135	Ci	-	1.07E+2		
xenon-135m	Ci	-	-		
xenon-138	Ci	-	-		
Total for period	Ci	-	2.22E+2		
2. Iodines					
iodine-131	Ci	-	1.44E-3		
iodine-133	Ci	-	6.50E-3		
iodine-135	Ci	-	<1.02E-2		
Total for period	Ci	-	<1.81E-2		
3. Particulates					
strontium-89	Ci	1.64E-5	1.46E-3		
strontium-90	Ci	4.76E-7	1.44E-6		
cesium-134	Ci	1.17E-6			
cesium-137	Ci	2.42E-5	3.67E-5		
barium-lanthanum-140	Ci		3.95E-4		
manganese-54	Ci	1.08E-5	5.88E-6		
cobalt-58	Ci				
iron-59	Ci				
cobalt-60	Ci	2.16E-4	2.27E-4		
zinc-65	Ci				
zirconium-niobium-95	Ci				
cerium-141	Ci				
ruthenium-103	Ci				
ruthenium-106	Ci				

TABLE 2A

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1982)

LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

January - June 1982

	Unit	Quarter 1	Quarter 2	Est. Total Error, %
A. Fission and activation products				
1. Total release (not including tritium, noble gases, or alpha)	Ci	5.72E-1	1.44E-1	3.00E+1
2. Average diluted concentration during period	μCi/ml	8.91E-8	7.58E-8	
3. Percent of applicable limit	%	5.72E0	1.44E0	
B. Tritium				
1. Total release	Ci	5.26E0	1.99E-1	3.00E+1
2. Average diluted concentration during period	μCi/ml	8.19E-7	1.05E-7	
3. Percent of applicable limit	%	8.19E0	1.05E0	
C. Dissolved and entrained gases				
1. Total release	Ci	-	-	-
2. Average diluted concentration during period	μCi/ml	-	-	
3. Percent of applicable limit	%	-	-	
D. Gross alpha radioactivity				
1. Total release	Ci	< 1.44E-4	< 1.73E-5	4.00E+1
E. Volume of waste released (prior to dilution)	liters	1.61E6	1.10E5	2.00E+1
F. Volume of dilution water used during period	liters	6.42E9	1.90E9	2.00E+1

TABLE 2B
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1982)

LIQUID EFFLUENTS
January - June 1982

		CONTINUOUS MODE		BATCH MODE	
Nuclides Released	**Unit**	**Quarter**	**Quarter**	**Quarter**	**Quarter**
strontium-89	Ci			6.70E-4	1.89E-3
strontium-90	Ci			4.17E-4	1.65E-4
cesium-134	Ci			1.46E-2	7.42E-4
cesium-137	Ci			1.08E-1	6.60E-3
iodine-131	Ci			-	2.25E-6
cobalt-58	Ci			2.54E-3	8.23E-4
cobalt-60	Ci			2.44E-1	7.00E-2
iron-59	Ci			4.27E-5	3.06E-6
zinc-65	Ci			4.28E-3	1.20E-3
manganese-54	Ci			2.61E-2	1.01E-2
chromium-51	Ci			-	1.20E-5
zirconimum-niobium-95	Ci			5.16E-4	6.74E-4
molybdenum 99-technetium 99m	Ci			-	-
barium-lanthanum-140	Ci			-	4.96E-5
cerium-141	Ci			1.65E-5	-
iodine-133	Ci			-	2.70E-6
cerium-144	Ci			-	1.75E-5
silver-110m	Ci			-	-
iron-55	Ci			1.47E-1	2.43E-2
unidentified	Ci			2.40E-2	2.72E-2
Total for period (above)	Ci			5.72E-1	1.44E-1
xenon-133	Ci			-	-
xenon-135	Ci			-	-

TABLE 3

EFFLUENT AND WASTE DISPOSAL SEMI-ANNUAL REPORT (1982)
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
JANUARY - JUNE 1982

A. SOLID WASTE SHIPPED OFF SITE FOR BURIAL OR DISPOSAL. (Not irradiated fuel.)

1. TYPE OF WASTE	UNIT	6 MONTH PERIOD	EST. TOTAL ERROR %
a. Spent resins, filter sludges, evaporator bottoms, etc.	m^3 Ci	97.299 123.60353	N/A N/A
b. Dry compressible waste, contaminated equipment, etc.	m^3 Ci	1539.11 10.67373	N/A N/A
c. Irradiated components, control rods, etc.	m^3 Ci	NONE	N/A
d. Other (Describe) Miscellaneous low-level waste	m^3 Ci	NONE	N/A

2. ESTIMATE OF MAJOR NUCLIDE COMPOSITION. (By Type of Waste)

		%	E(Curies)
a. Spent Resins, Filter	Sr90	.522	.64564
Sludges, Evap. Bottoms,	Sr89	19.972	24.68618
Diatomateous Earth, Etc.	Fe55	12.697	15.69454
	Cs134	4.156	5.13671
	Cs137	26.327	32.54062
	Co58	1.220	1.50773
	Mn54	2.712	3.35228
	Zn65	.450	.55669
	Co60	31.633	39.09916
	La-140	.019	.02323
	Ba-140	.005	.00623
	I-131	.004	.00494
	Cr-51	.283	.34958
	TOTALS	100.000	123.60353

		%	E(Curies)
b. Dry Compressible Waste	Co60	50.24	5.36260
Contaminated Equipment	Co58	7.63	.81467
	Cs137	22.48	2.39956
	Cs134	6.75	.72011
	Fe55	1.75	.18635
	Fe59	1.14	.12171
	Sr89	.12	.01328
	Sr90	.01	.00027
	Zn65	.23	.02488
	Mn54	9.65	1.03030
	TOTALS	100.00	10.67373

c. N/A

d. N/A

3. SOLID WASTE DISPOSITION

Number of Shipments	Mode of Transportation	Destination
20	Tractor Trailer	Richland, Wash.
32	Tractor Trailer	Barnwell, S.C.

B. IRRADIATED FUEL SHIPMENTS (Disposition)

Number of Shipments	Mode of Transportation	Destination
NONE	N/A	N/A

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT

Supplemental Information

July-December 1982

Facility Pilgrim Nuclear Power Station Licensee DPR-35

1. Regulatory Limits

a. Fission and activation gases $\frac{Qs}{0.25/\bar{E}} + \frac{Qv}{0.10/\bar{E}} = \leq 1$

b. Iodines 2Ci per quarter

c. Particulates, half-lives >8 days 13(1.8E4Qs + 1.8E5Qv) ≤ 1

d. Liquid effluents 10Ci per quarter

2. Maximum Permissible Concentration

Provide the MPC's used in determining allowable release rates or concentrations

a. Fission and activation gases
b. Iodines
c. Particulates, half-lives >8 days

} 10 CFR 20 Appendix B Table II

d. Liquid effluents H - 3 = 1 X 10^{-5} µCi/ml; all rest, 10 CFR 20, Appendix B, Table II

3. Average Energy

Provide the average energy ($\bar{E}$) of the radionuclide mixture in releases of fission and activation gases, if applicable $\bar{E}$ = 1 Mev

MS = 0.304&0.287: RBV = 0.391&0.494 (3rd & 4th quarter)

4 Measurements and Approximations of Total Radioactivity

Provide the methods used to measure or approximate the total radioactivity in effluents and the methods used to determine radionuclide composition

a. Fission and activation gases
b. Iodines
c. Particulates
d. Liquid effluents

} GeLi Istopic Analysis

5. Batch Releases

Provide the following information relating to batch releases of radioactive materials in liquid and gaseous effluents

a **Liquid**

1 Number of batch releases 77
2 Total time period for batch releases 87.48hrs
3 Maximum time period for a batch release – 4.08hrs
4 Average time period for batch releases 1.14hrs
5 Minimum time period for a batch release – 0.33hrs
6 Average stream flow during periods of release of effluent into a flowing stream 3.05E+5 GPM

b **Gaseous** (Not Applicable)

6. Abnormal Releases

a.
b. None

TABLE 1A

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT

GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

July-December 1982

	Unit	Quarter (3)	Quarter (4)	Est. Total Error, %
A. Fission and activation gases				
1. Total release	Ci	< 1.07E+4	< 5.19E+3	2.49E+1
2. Average release rate for period	µCi/sec	< 1.35E+3	< 6.53E+2	
3. Percent of Technical Specification limit	%	< 1.77E-1	< 8.25E-2	
B. Iodines				
1. Total iodine-131	Ci	1.03E-2	9.32E-3	2.51E+1
2. Average release rate for period	µCi/sec	1.30E-3	1.17E-3	
3. Percent of Technical Specification limit	%	5.15E-1	4.66E-1	
C. Particulates				
1. Particulates with half-lives > 8 days	Ci	8.20E-3	8.01E-3	3.03E+1
2. Average release rate for period	µCi/sec	1.03E-3	1.01E-3	
3. Percent of Technical Specification limit	%	9.67E-2	8.72E-2	
4. Gross alpha radioactivity	Ci	< 5.14E-7	< 4.50E-7	
D. Tritium				
1. Total release	Ci	4.90E0	5.93E0	3.30E+1
2. Average release rate for period	µCi/sec	6.16E-1	7.46E-1	
3. Percent of Technical Specification limit	%	-	-	

TABLE 1B

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1982)

GASEOUS EFFLUENTS – ELEVATED RELEASE

July-December 1982

Nuclides Released	Unit	CONTINUOUS MODE Quarter (3)	CONTINUOUS MODE Quarter (4)	BATCH MODE Quarter	BATCH MODE Quarter
1. Fission gases					
krypton-85	Ci	1.62E-2	1.60E-2		
krypton-85m	Ci	7.69E+2	5.47E+2		
krypton-87	Ci	< 1.87E+2	< 4.58E+1		
krypton-88	Ci	8.99E+2	4.99E+2		
xenon-133	Ci	4.51E+3	3.07E+3		
xenon-135	Ci	3.73E+3	7.36E+2		
xenon-135m	Ci	< 1.54E+1	< 9.26E0		
xenon-138	Ci	< 3.75E+1	< 3.90E+1		
xenon-131m	Ci	-	-		
xenon-137	Ci	-	-		
xenon-133m	Ci	1.30E+2	8.49E+1		
Total for period	Ci	< 1.03E+4	5.03E+3		
2. Iodines					
iodine-131	Ci	4.66E-3	6.53E-3		
iodine-133	Ci	1.68E-2	2.24E-2		
iodine-135	Ci	< 1.22E-2	< 1.48E-2		
Total for period	Ci	< 3.37E-2	< 4.37E-2		
3. Particulates					
strontium-89	Ci	1.62E-3	2.78E-3		
strontium-90	Ci	1.73E-5	1.83E-5		
cesium-134	Ci	8.15E-6	2.61E-6		
cesium-137	Ci	7.38E-5	5.76E-5		
barium-lanthanum-140	Ci	3.55E-3	2.68E-3		
chromium-51	Ci	-	-		
manganese-54	Ci	1.28E-5	3.65E-6		
cobalt-58	Ci	-	2.09E-6		
iron-59	Ci	-	-		
cobalt-60	Ci	1.55E-4	3.97E-5		
zinc-65	Ci	-	-		
zirconium-niobium-95	Ci	-	-		
cerium-141	Ci	-	-		
cerium-144	Ci	-	1.53E-5		
ruthenium-103	Ci	-	-		
ruthenium-106	Ci	2.70E-5	-		

TABLE 1C

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1982)

GASEOUS EFFLUENTS - GROUND LEVEL RELEASE

July-December 1982

Nuclides Released	Unit	CONTINUOUS MODE Quarter (3)	CONTINUOUS MODE Quarter (4)	BATCH MODE Quarter	BATCH MODE Quarter
1. Fission gases					
krypton-85	Ci	< 1.49E-5	5.03E-6		
krypton-85m	Ci	< 3.46E+1	1.21E+1		
krypton-87	Ci	< 9.16E0	< 4.07E0		
krypton-88	Ci	< 1.55E+1	2.43E+1		
xenon-133	Ci	1.41E+2	5.99E+1		
xenon-135	Ci	1.86E+2	5.86E+1		
xenon-135m	Ci	-	-		
xenon-138	Ci	-	-		
Total for period	Ci	< 3.86E+2	< 1.59E+2		
2. Iodines					
iodine-131	Ci	5.66E-3	2.79E-3		
iodine-133	Ci	2.63E-2	1.18E-2		
iodine-135	Ci	4.26E-2	2.10E-2		
Total for period	Ci	7.46E-2	3.56E-2		
3. Particulates					
strontium-89	Ci	1.29E-3	1.53E-3		
strontium-90	Ci	2.55E-6	2.53E-6		
cesium-134	Ci	1.89E-6	4.46E-6		
cesium-137	Ci	6.64E-5	2.14E-5		
barium-lanthanum-140	Ci	1.24E-3	7.85E-4		
manganese-54	Ci	1.25E-5	1.31E-6		
cobalt-58	Ci	-	3.74E-6		
iron-59	Ci	-	-		
cobalt-60	Ci	1.29E-4	5.90E-5		
zinc-65	Ci	-	-		
zirconium-niobium-95	Ci	-	-		
cerium-141	Ci	-	-		
ruthenium-103	Ci	-	-		
ruthenium-106	Ci	-	2.60E-5		

TABLE 2A
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1982)
LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

JULY-December 1982

	Unit	3rd Quarter	4th Quarter	Est. Total Error, %
A. Fission and activation products				
1. Total release (not including tritium, noble gases, or alpha)	Ci	3.09E-2	1.25E-1	2.98E+1
2. Average diluted concentration during period	μCi/ml	7.39E-9	6.65E-8	
3. Percent of applicable limit	%	3.09E-1	1.25E0	
B. Tritium				
1. Total release	Ci	8.29E-4	4.55E-1	3.00E+1
2. Average diluted concentration during period	μCi/ml	1.98E-10	2.42E-7	
3. Percent of applicable limit	%	1.98E-3	2.42E0	
C. Dissolved and entrained gases				
1. Total release	Ci	-	5.39E-3	3.98E+1
2. Average diluted concentration during period	μCi/ml	-	2.87E-9	
3. Percent of applicable limit	%	-	-	
D. Gross alpha radioactivity				
1. Total release	Ci	< 6.60E-6	< 1.65E-5	4.01E+1
E. Volume of waste released (prior to dilution)	liters	8.47E+4	2.01E+5	2.00E+1
F. Volume of dilution water used during period	liters	4.18E+9	1.88E+9	2.00E+1

TABLE 2B
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1982)

LIQUID EFFLUENTS

July-December 1982

Nuclides Released	Unit	CONTINUOUS MODE 3rd Quarter	CONTINUOUS MODE 4th Quarter	BATCH MODE Quarter	BATCH MODE Quarter
strontium-89	Ci	1.64E-5	2.10E-5		
strontium-90	Ci	4.70E-5	7.78E-5		
cesium-134	Ci	3.30E-4	7.05E-4		
cesium-137	Ci	3.73E-3	9.65E-3		
iodine-131	Ci	5.87E-6	4.12E-5		
cobalt-58	Ci	4.42E-5	1.96E-3		
cobalt-60	Ci	8.67E-3	3.66E-2		
iron-59	Ci	3.49E-6	5.30E-4		
zinc-65	Ci	5.09E-5	5.37E-5		
manganese-54	Ci	6.49E-4	3.74E-3		
chromium-51	Ci	4.02E-5	6.57E-3		
zirconimum-niobium-95	Ci	-	1.21E-6		
molybdenum 99-technetium 99m	Ci	-	5.71E-5		
barium-lanthanum-140	Ci	1.03E-6	4.38E-5		
cerium-141	Ci	2.14E-6	1.10E-4		
iodine-133	Ci	-	3.04E-6		
cerium-144	Ci	-	-		
silver-110m	Ci	-	8.01E-4		
iron-55	Ci	1.28E-2	2.41E-2		
unidentified	Ci	4.49E-3	3.95E-2		
Total for period (above)	Ci	3.09E-2	1.25E-1		
xenon-133	Ci	-	2.18E-3		
xenon-135	Ci	-	3.21E-3		

TABLE 3

EFFLUENT AND WASTE DISPOSAL SEMI-ANNUAL REPORT (1982)
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS
JULY - DECEMBER 1982

A. SOLID WASTE SHIPPED OFF SITE FOR BURIAL OR DISPOSAL. (not irradiated fuel)

1. TYPE OF WASTE	UNIT	6 MONTH PERIOD	EST. TOTAL ERROR %
a. Spent resins, filter sludges, evaporator bottoms, etc.	m^3 Ci	99.007 819.10	N/A N/A
b. Dry compressible waste, contaminated equipment, etc.	m^3 Ci	547.666 5.14564	N/A N/A
c. Irradiated components, control rods, etc.	m^3 Ci	none none	N/A N/A
d. Other (describe) Miscellaneous low-level waste	m^3 Ci	none none	N/A N/A

2. ESTIMATE OF MAJOR NUCLIDE COMPOSITION. (by type of waste)

		%	E(Curies)
a. Spent Resins, Filter	Co-60	41.324	338.48620
Sludges, Evaporator	Co-58	3.864	31.65107
Bottoms, etc.	Cs-137	13.426	109.97068
	Cs-134	1.489	12.19371
	Fe-55	11.164	99.44832
	Fe-59	.597	4.89055
	I-131	.464	3.79925
	I-133	.070	.57668
	La-140	.220	1.80569
	Ba-140	.019	.15592
	Sr-89	15.478	126.78505
	Sr-90	.345	2.82477
	Sr-91	.003	.02146
	Tc-99m	.040	.32557
	Zn-65	.723	5.92615
	Mn-54	4.614	37.79740

2. ESTIMATE OF MAJOR NUCLIDE COMPOSITION. (by type of waste)

CONTINUED

		%	E(Curies)
a. Spent Resins, Filter Sludges,	Nb-95	.002	.01495
Evap. Bottoms, Diatomateous	Cr-51	6.090	49.88606
Earth, etc.	Ag-110m	< .001	.00641
continued	Ce-141	.030	.24916
	Ru-103	.014	.11290
	Sr-92	.001	.00691
	Sb-124	.010	.08267
	Xe-133	< .001	.00034
	Xe-135	.004	.03266
	Mo-99	.007	.05629
	TOTAL:	100.000	819.10682

		%	E(Curies)
b. Dry Compressible Waste,	Co-60	17.46	.89843
Contaminated Equipment	Co-58	6.32	.32546
	Cs-137	6.04	.31058
	Cs-134	1.65	.08565
	Fe-59	1.17	.06038
	I-131	2.74	.14116
	Ba-140	3.76	.19341
	Zn-65	.86	.04430
	Mn-54	3.39	.17448
	Cr-51	56.60	2.91179
	TOTAL:	100.000	5.14564

c. N/A

d. N/A

3. SOLID WASTE DISPOSITION

Number of Shipments	Mode of Transportation	Destination
37	Tractor Trailer	Barnwell, S.C.
2	Tractor Trailer	Richland, Wash.

4. IRRADIATED FUEL SHIPMENTS (Disposition)

Number of Shipments	Mode of Transportation	Destination
none	N/A	N/A

TABLE 4A-1

Distribution of Wind Directions and Speeds for the 33 Ft. Level of the 160 Ft. Tower

160 FT TOWER - 33 FT EL

33.0 FT WIND DATA 7/1/82 - 9/31/82

STABILITY CLASS A-- DELTA T LESS THAN -1.9 DEG C PER 100 METERS CLASS FREQUENCY (PERCENT) = 44.89

WIND DISTRIBUTION SUMMARY

SPEED(MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
-CALM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALM- 3.5	0	9	0	6	3	0	0	3	0	3	0	0	0	0	0	0	24
(1)	0.0	1.2	0.0	0.8	0.4	0.0	0.0	0.4	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	3.3
(2)	0.0	0.5	0.0	0.4	0.2	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.5
3.6- 7.5	12	6	9	6	15	45	54	21	15	30	12	6	18	27	18	33	327
(1)	1.6	0.8	1.2	0.8	2.0	6.1	7.3	2.8	2.0	4.1	1.6	0.8	2.4	3.7	2.4	4.5	44.3
(2)	0.7	0.4	0.5	0.4	0.9	2.7	3.3	1.3	0.9	1.8	0.7	0.4	1.1	1.6	1.1	2.0	19.9
7.6-12.5	6	3	0	0	0	0	6	12	9	75	87	48	45	24	3	3	321
(1)	0.8	0.4	0.0	0.0	0.0	0.0	0.8	1.6	1.2	10.2	11.8	6.5	6.1	3.3	0.4	0.4	43.5
(2)	0.4	0.2	0.0	0.0	0.0	0.0	0.4	0.7	0.5	4.6	5.3	2.9	2.7	1.5	0.2	0.2	19.5
12.6-18.5	9	6	0	0	0	0	0	0	0	33	15	3	0	0	0	0	66
(1)	1.2	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	2.0	0.4	0.0	0.0	0.0	0.0	8.9
(2)	0.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.9	0.2	0.0	0.0	0.0	0.0	4.0
18.6-24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVER-24.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ALL SPEEDS	27	24	9	12	18	45	60	36	24	141	114	57	63	51	21	36	738
(1)	3.7	3.3	1.2	1.6	2.4	6.1	8.1	4.9	3.3	19.1	15.4	7.7	8.5	6.9	2.8	4.9	100.0
(2)	1.6	1.5	0.5	0.7	1.1	2.7	3.6	2.2	1.5	8.6	6.9	3.5	3.8	3.1	1.3	2.2	44.9

(1)-PERCENT OF ALL GOOD OBSERVATIONS FORTHIS PAGE
(2)-PERCENT OF ALL GOOD OBSERVATIONS FOR THE PERIOD

NUMBER OF GOOD OBSERVATIONS ON THIS PAGE= 738

CALM=WIND SPEED LESS THAN 1.00MPH

APPENDIX C - 1982 Soil Survey

Results of Boston Edison *In Situ* Gamma

Spectrometry Soil Analysis for 1982

Introduction

In compliance with Boston Edison's Technical Specifications for radiological monitoring of the environment, *in situ* gamma spectrometry analyses were performed at eleven sites during May, October and December of 1982. In addition to the gamma spectrometry, which employs a Ge(Li) "downlooker" detector in accordance with Reference 1, measurements were taken with a pressurized ion chamber (PIC) to assess the total exposure rates, and soil core samples were taken at five of the stations to confirm the *in situ* results.

At all eleven stations, by far the major contributors to the exposure rate due to soil were naturally occurring radionuclides and Cs-137, which is a result of fallout from weapons testing. A small amount of Co-60 was present in the soil at one site. These results are summarized in Tables 1-12, and the original data is on permanent file at the Environmental Laboratory.

Methodology

In situ gamma spectrometry was performed at each of the eleven locations, along with PIC measurements for comparison. When possible, a soil sample was also taken for laboratory gamma analysis.

In situ gamma spectrometry is a convenient and efficient technique used to evaluate the radioactive constituents of the soil. Using assumptions concerning the soil composition and distribution of the radionuclide of interest, the exposure rate and activity concentration of that radionuclide can be calculated. This is done using the spectrum obtained with an unshielded Ge(Li) detector placed above the ground, together with detector specific parameters such as efficiency. The radionuclides of interest are fallout and plant related fission and activation products, as well as those which occur naturally. In evaluating the activity concentration and exposure rate for a given radionuclide, a parameter describing depth distribution, α/ρ, must be evaluated. For naturally occurring radionuclides a value of zero is assumed, implying no increase or decrease in the concentration with soil depth. For radionuclides present only on the surface, such as those from fresh fallout, a value of infinity is used. (This value is also used for calculations of apparent activity concentrations and exposure rates for those radionuclides not found during the peak search.) For man-made radionuclides found in the soil and not believed to be recently deposited, an expotential distribution is assumed with $\alpha/\rho = .206$. This value is a good compromise between deep distribution and surface deposition; and laboratory analysis usually confirms that these radionuclides are present througout the first six inches of soil implying a period of migration. This procedure of *in situ* gamma spectrometry is explained in detail in Reference 2.

The PIC measurement, which includes all components of the exposure rate, not just terrestrial, is used to evaluate how much of the total exposure rate can be explained by the in situ results together with the cosmic contribution. At control stations, away from the plant's influence, the PIC measurement is used to check the in situ results, as one would expect the terrestrial exposure rate, calculated using the in-situ methodology, together with the cosmic contribution to closely approximate the PIC results.

When possible soil core samples are also taken and analyzed at the laboratory to confirm the presence or absence of radionuclides in the soil which have been identified in the in situ analysis. In this way, the source term is identified as soil or unknown. In the latter case, the in situ calculations are not valid and results are not reported. In addition, analysis of the different core sections aids in defining the depth distribution of the radionuclide.

Results

Tables 1-11 contain the results from the in situ gamma analysis for the eleven sites. (It should be noted that in August the Ge(Li) detector was repaired to remedy increasingly poor resolution. The poor resolution was not a problem in the measurements conducted during May; and prior to analysis of the remaining three sites, the operating characteristics of the detector were carefully checked with the result that recalibration following the repair was deemed unnecessary for in situ analysis (Reference 3).) Each table lists the apparent exposure rate and activity concentration for each of thirteen fission and activation products, as well as for three naturally occurring radionuclides. LLD values were not calculated for nuclides with more than one peak, as in these cases all of the peaks found were used to calculate the total exposure rate and activity concentration for that nuclide (or series). Table 12 contains all positive in situ results as well as PIC measurements for comparison.

With two exceptions, all exposure rates due to activity within the soil are more than 95 percent resulting from natural radiation. The remainder is almost entirely due to Cs-137 which is considered to be a result of weapons testing and is found throughout the environment. The first exception is high Cs-137 concentration at site 10, resulting in 17 percent of the total exposure rate due to soil. The activity concentration for Cs-137 at this site is greater than five times the average value for the other stations. The most probable explanation for this is that the detector may have been placed over a local accumulation point of debris, and therefore the fallout related Cs-137 was present in a higher than average concentration. It should be noted that sites considerably closer to the plant showed only typical environmental levels of Cs-137, and the high concentration is therefore not likely to be plant related. The second case in which the exposure rate due to soil was more than 5 percent related to fission or activation products, was at station 7 where Co-60 was identified during in situ analysis, and confirmed by Laboratory soil analysis. The activity concentration was calculated to be 305±7 pCi/kg, assuming a value for α/ρ equal to .206, while Laboratory analysis resulted in a value of 224±13 pCi/kg. The value for α/ρ is likely to be greater than .206, i.e. the distribution of Co-60 was more planar, as it was not found in the 2"-4" core section. This increase in α/ρ would result in a lower value for activity concentration more in line with the Laboratory results. In any case, the exposure rate due to Co-60 was calculated to be less than 1 μR/hr.

Cobolt-60 was identified at three additional sites, but could not be confirmed by Laboratory soil analysis (there was no core sample submitted for site 00). As the source term was therefore unknown for these sites, the exposure rates which were calculated assuming soil to be the source term, are not valid and were not listed in Table 12. It should also be noted that Zr-95 was detected at two sites at levels at or below LLD, but these results could not be confirmed by soil analysis at the Laboratory.

The PIC measurements agreed well with the in situ results, when a cosmic component of 3.6 μR/hr (Reference 4) was added, with a few notable exceptions. Sites 00, 07 and 08 showed relatively high PIC measurements which could not be explained with the Ge(Li) results. These sites are all within 0.15 miles of the plant so that the higher than background exposure rates were most likely a result of some source term other than soil.

References

(1) YAEL Procedure Number 510, Rev. 1, "Identification and Quantitative Determination of Radionuclides in Soil by Gamma-Ray In-Situ Spectrometry."

(2) HASL-258, "In-Situ Ge(Li) and NaI(Tl) Gamma-Ray Spectrometry," September 1972.

(3) YAEL Memo ELG 265/82 "Intrinsic Efficiency Check on Ge(Li) Detector No. 1."

(4) "Cosmic-Ray Ionization in the Lower Atmosphere," Wayne M. Londer and Harold Beck, Journal of Geophysical Research, Vol. 17, No. 19, October 1, 1966.

TABLE 1

LOCATION: WAREHOUSE

LOCATION#: 00

COUNT TIME: 6000sec

COUNT DATE: 05/27/82

InSitu COUNTING RESULTS

NUCLIDE ID	EXPOSURE RATE microR/hr		CONCENTRATION picoCi/Kgram	
NAME	EXPOSURE+-1-SIGMA RATE	LLD	CONC +- 1-SIGMA	LLD
Ce-144	(-22+- 15) E-4	53E-4	(-100+- 68) E 0	240E 0
Ce-141	(3+- 13) E-4	47E-4	(3+- 14) E 0	50E 0
I-131	(9+- 34) E-4	120E-4	(12+- 46) E-1	160E-1
Sb-125	(1+- 11) E-3	42E-3	(1+- 13) E 0	47E 0
Ru-103	(47+- 40) E-4	140E-4	(45+- 38) E-1	140E-1
Ba-140	(29+- 57) E-4	200E-4	(7+- 13) E 0	48E 0
Ru-106	(-2+- 13) E-3	47E-3	(-5+- 29) E 0	100E 0
*+ Cs-137	(1565+- 94) E-4	310E-4	(285+- 17) E 0	56E 0
Zr-95	(74+- 85) E-4	300E-4	(40+- 46) E-1	160E-1
Nb-95	(-22+- 50) E-4	180E-4	(11+- 26) E 1	74E-1
Mn-54	(118+- 53) E-4	190E-4	(54+- 24) E-1	85E-1
*+ Co-60	(707+- 21) E-3	99E-3	(2102+- 64) E-1	300E-1
La-140	(21+- 11) E-3	39E-3	(27+- 14) E-1	49E-1
*+ K-40	(2714+- 38) E-3	61E-3	(1516+- 21) E 1	34E 1
*+ Th-232	(2138+- 63) E-3	-------	(750+- 22) E 0	-------
*+ U-238	(1305+- 48) E-3	-------	(761+- 28) E 0	-------

Notes:

* Activity greater than 3*standard deviation

\+ Peak is found

------- LLD is not calculated

TABLE 2

LOCATION: ROCKY HILL RD.

LOCATION#: 01

COUNT TIME: 6000sec

COUNT DATE: 05/27/82

InSitu COUNTING RESULTS

NUCLIDE ID	EXPOSURE RATE microR/hr		CONCENTRATION picoCi/Kgram	
NAME	EXPOSURE RATE +-1-SIGMA	LLD	CONC +- 1-SIGMA	LLD
Ce-144	(-29+- 96) E-5	330E-5	(-13+- 43) E 0	150E 0
Ce-141	(-32+- 86) E-5	300E-5	(-35+- 92) E-1	320E-1
I-131	(-13+- 25) E-4	88E-4	(-17+- 34) E-1	120E-1
Sb-125	(164+- 89) E-4	320E-4	(19+- 10) E 0	36E 0
Ru-103	(15+- 31) E-4	110E-4	(14+- 27) E-1	110E-1
Ba-140	(31+- 46) E-4	170E-4	(7+- 11) E 0	39E 0
Ru-106	(6+- 10) E-3	39E-3	(12+- 23) E 0	92E 0
x: Cs-137	(1630+- 76) E-4	230E-4	(296+- 14) E 0	41E 0
Zr-95	(121+- 71) E-4	250E-4	(65+- 39) E-1	130E-1
Nb-95	(-31+- 42) E-4	150E-4	(-16+- 22) E-1	72E-1
Mn-54	(78+- 43) E-4	150E-4	(36+- 19) E-1	68E-1
Co-60	(30+- 11) E-3	40E-3	(39+- 15) E-1	52E-1
La-140	(5+- 10) E-3	39E-3	(7+- 13) E-1	48E-1
x: K-40	(2212+- 34) E-3	47E-3	(1236+- 19) E 1	27E 1
x: Th-232	(2252+- 50) E-3	------	(779+- 21) E 0	------
x: U-238	(1346+- 41) E-3	------	(740+- 23) E 0	------

Notes:

x Activity greater than 3xstandard deviation

: Peak is found

------ LLD is not calculated

TABLE 3

LOCATION: ROCKY HILL RD. (W)

LOCATION#: 03

COUNT TIME: 6000sec

COUNT DATE: 12/15/82

InSitu COUNTING RESULTS

NUCLIDE ID	EXPOSURE RATE microR/hr		CONCENTRATION picoCi/Kgram	
NAME	EXPOSURE+-1-SIGMA RATE	LLD	CONC +- 1-SIGMA	LLD
Ce-144	(-10+- 12) E-4	43E-4	(-43+- 53) E 0	190E 0
Ce-141	(3+- 11) E-4	38E-4	(8+- 11) E 0	41E 0
I-131	(-24+- 31) E-4	110E-4	(-33+- 42) E-1	150E-1
Sb-125	(27+- 94) E-4	340E-4	(3+- 11) E 0	37E 0
Ru-103	(-55+- 33) E-4	120E-4	(-52+- 32) E-1	120E-1
Ba-140	(-47+- 47) E-4	180E-4	(-11+- 11) E 0	41E 0
Ru-106	(-2+- 11) E-3	40E-3	(-4+- 24) E 0	89E 0
*+ Cs-137	(618+- 55) E-4	160E-4	(1123+- 100) E-1	270E-1
Zr-95	(42+- 73) E-4	260E-4	(23+- 40) E-1	140E-1
Nb-95	(-9+- 42) E-4	120E-4	(12+- 53) E-1	150E-1
Mn-54	(100+- 45) E-4	160E-4	(45+- 20) E-1	71E-1
Co-60	(24+- 12) E-3	44E-3	(31+- 16) E-1	56E-1
La-140	(19+- 11) E-3	38E-3	(25+- 14) E-1	49E-1
*+ K-40	(2494+- 35) E-3	44E-3	(1393+- 20) E 1	24E 1
*+ Th-232	(2470+- 57) E-3	-------	(876+- 20) E 0	-------
*+ U-238	(1170+- 35) E-3	-------	(643+- 17) E 0	-------

Notes:

* Activity greater than 3*standard deviation

\+ Peak is found

------- LLD is not calculated

TABLE 4

LOCATION: PLY. CENTER

LOCATION#: 04

COUNT TIME: 6000sec

COUNT DATE: 10/07/82

InSitu COUNTING RESULTS

NUCLIDE ID	EXPOSURE RATE microR/hr		CONCENTRATION picoCi/Kgram	
NAME	EXPOSURE+-1-SIGMA RATE	LLD	CONC +- 1-SIGMA	LLD
Ce-144	(-5+- 12) E-4	43E-4	(-22+- 33) E 0	170E 0
Ce-141	(17+- 10) E-4	37E-4	(18+- 11) E 0	40E 0
I-131	(-56+- 31) E-4	110E-4	(-76+- 43) E-1	160E-1
Sb-125	(5+- 96) E-4	350E-4	(1+- 11) E 0	37E 0
Ru-103	(-22+- 34) E-4	120E-4	(-21+- 32) E-1	120E-1
Ba-140	(-19+- 49) E-4	180E-4	(-4+- 11) E 0	41E 0
Ru-106	(-6+- 11) E-3	40E-3	(-14+- 24) E 0	89E 0
*+ Cs-137	(2763+- 24) E-4	160E-4	(302+- 14) E 0	30E 0
Zr-95	(10+- 75) E-4	270E-4	(5+- 40) E-1	150E-1
Nb-95	(-164+- 46) E-4	170E-4	(-84+- 23) E-1	80E-1
Mn-54	(-45+- 60) E-4	210E-4	(-50+- 67) E-1	240E-1
Co-60	(-3+- 12) E-3	45E-3	(-4+- 15) E-1	58E-1
La-140	(-13+- 14) E-3	52E-3	(-41+- 43) E-1	160E-1
*+ K-40	(2382+- 34) E-3	43E-3	(1331+- 19) E 1	24E 1
*+ Th-232	(2414+- 55) E-3	------	(856+- 19) E 0	------
*+ U-238	(1571+- 37) E-3	------	(863+- 21) E 0	------

Notes:
- * Activity greater than 3*standard deviation
- \+ Peak is found
- ------ LLD is not calculated

TABLE 5

LOCATION: PROPERTY LINE

LOCATION#: 06

COUNT TIME: 6000sec

COUNT DATE: 05/26/82

InSitu COUNTING RESULTS

NUCLIDE ID	EXPOSURE RATE microR/hr		CONCENTRATION picoCi/Kgram	
NAME	EXPOSURE+-1-SIGMA RATE	LLD	CONC +- 1-SIGMA	LLD
Ce-144	(4+- 12) E-4	43E-4	(16+- 54) E 0	190E 0
Ce-141	(-8+- 11) E-4	37E-4	(-8+- 11) E 0	42E 0
I-131	(25+- 31) E-4	110E-4	(34+- 42) E-1	150E-1
Sb-125	(218+- 95) E-4	340E-4	(25+- 11) E 0	38E 0
Ru-103	(38+- 32) E-4	120E-4	(36+- 31) E-1	110E-1
Ba-140	(-34+- 47) E-4	170E-4	(-8+- 11) E 0	40E 0
Ru-106	(15+- 11) E-3	39E-3	(33+- 24) E 0	85E 0
*+ Cs-137	(1072+- 82) E-4	250E-4	(344+- 15) E 0	46E 0
Zr-95	(140+- 72) E-4	250E-4	(76+- 39) E-1	140E-1
Nb-95	(33+- 41) E-4	150E-4	(17+- 21) E-1	76E-1
Mn-54	(116+- 60) E-4	210E-4	(129+- 67) E-1	230E-1
* Co-60	(39+- 12) E-3	44E-3	(50+- 16) E-1	56E-1
La-140	(3+- 11) E-3	41E-3	(3+- 14) E-1	52E-1
*+ K-40	(2108+- 34) E-3	54E-3	(1178+- 17) E 1	30E 1
*+ Th-232	(2320+- 60) E-3	------	(823+- 21) E 0	-----
*+ U-238	(1295+- 42) E-3	------	(712+- 23) E 0	------

Notes:

* Activity greater than 3*standard deviation

\+ Peak is found

------ LLD is not calculated

TABLE 6

LOCATION: PEDESTRIAN BRIDGE

LOCATION#: 07

COUNT TIME: 6000sec

COUNT DATE: 05/26/82

InSitu COUNTING RESULTS

NUCLIDE ID	EXPOSURE RATE microR/hr		CONCENTRATION picoCi/Kgram	
NAME	EXPOSURE+-1-SIGMA RATE	LLD	CONC +- 1-SIGMA	LLD
Ce-144	(5+- 15) E-4	52E-4	(23+- 67) E 0	230E 0
Ce-141	(-10+- 13) E-4	46E-4	(-11+- 14) E 0	50E 0
I-131	(48+- 35) E-4	120E-4	(65+- 47) E-1	160E-1
Sb-125	(28+- 12) E-3	42E-3	(32+- 13) E 0	48E 0
Ru-103	(37+- 40) E-4	140E-4	(35+- 38) E-1	140E-1
Ba-140	(40+- 57) E-4	210E-4	(9+- 14) E 0	50E 0
Ru-106	(14+- 13) E-3	47E-3	(31+- 29) E 0	100E 0
*+ Cs-137	(1133+- 80) E-4	250E-4	(206+- 14) E 0	46E 0
* Zr-95	(280+- 88) E-4	310E-4	(151+- 48) E-1	170E-1
Nb-95	(78+- 52) E-4	180E-4	(40+- 27) E-1	95E-1
Mn-54	(61+- 55) E-4	200E-4	(28+- 25) E-1	90E-1
*+ Co-60	(987+- 23) E-3	97E-3	(3051+- 70) E-1	300E-1
La-140	(-17+- 11) E-3	41E-3	(-21+- 14) E-1	52E-1
*+ K-40	(2143+- 34) E-3	55E-3	(1197+- 19) E 1	31E 1
*+ Th-232	(2211+- 61) E-3	-----	(784+- 22) E 0	-----
*+ U-238	(1267+- 46) E-3	-----	(696+- 25) E 0	-----

Notes:

* Activity greater than 3*standard deviation

\+ Peak is found

----- LLD is not calculated

TABLE 7

LOCATION: OVERLOOK

LOCATION#: 08

COUNT TIME: 6000sec

COUNT DATE: 05/26/82

InSitu COUNTING RESULTS

NUCLIDE ID	EXPOSURE RATE microR/hr		CONCENTRATION picoCi/Kgram	
NAME	EXPOSURE+-1-SIGMA RATE	LLD	CONC +- 1-SIGMA	LLD
Ce-144	(-25+- 21) E-4	78L-4	(-111+- 96) E 0	350E 0
Ce-141	(-18+- 19) E-4	69E-4	(-20+- 20) E 0	74E 0
I-131	(-46+- 51) E-4	180E-4	(-64+- 70) E-1	250E-1
Sb-125	(11+- 15) E-3	54E-3	(12+- 17) E 0	61E 0
Ru-103	(-56+- 54) E-4	190E-4	(-53+- 51) E-1	190E-1
Ba-140	(-6+- 75) E-4	270E-4	(-1+- 17) E 0	63E 0
Ru-106	(-25+- 17) E-3	63E-3	(-55+- 38) E 0	140E 0
*+ Cs-137	(1081+- 89) E-4	280E-4	(197+- 16) E 0	51E 0
Zr-95	(8+- 11) E-3	41E-3	(43+- 61) E-1	220E-1
Nb-95	(-65+- 67) E-4	240E-4	(-34+- 35) E-1	130E-1
Mn-54	(80+- 99) E-4	350E-4	(9+- 11) E 0	39E 0
*+ Co-60	(959+- 27) E-3	110E-3	(2759+- 82) E-1	350E-1
La-140	(-29+- 18) E-3	69E-3	(-37+- 23) E-1	88E-1
*+ K-40	(2609+- 41) E-3	91E-3	(1458+- 23) E 1	51E 1
*+ Th-232	(2052+- 73) E-3	------	(728+- 26) E 0	------
*+ U-238	(1210+- 55) E-3	------	(665+- 30) E 0	------

Notes:
- * Activity greater than 3*standard deviation
- \+ Peak is found
- ------ LLD is not calculated

TABLE 8

LOCATION: EAST BREAKWATER

LOCATION#: 09

COUNT TIME: 6000sec

COUNT DATE: 05/27/82

InSitu COUNTING RESULTS

NUCLIDE ID	EXPOSURE RATE microR/hr		CONCENTRATION picoCi/Kgram	
NAME	EXPOSURE+-1-SIGMA RATE	LLD	CONC +- 1-SIGMA	LLD
Ce-144	(6+- 12) E-4	43E-4	(27+- 54) E 0	190E 0
Ce-141	(12+- 11) E-4	38E-4	(13+- 11) E 0	41E 0
I-131	(-17+- 31) E-4	110E-4	(-23+- 42) E-1	150E-1
Sb-125	(-31+- 95) E-4	350E-4	(-3+- 11) E 0	39E 0
Ru-103	(39+- 34) E-4	120E-4	(37+- 32) E-1	110E-1
Ba-140	(50+- 49) E-4	180E-4	(12+- 11) E 0	41E 0
Ru-106	(1+- 11) E-3	41E-3	(3+- 25) E 0	89E 0
*+ Cs-137	(1000+- 69) E-4	210E-4	(182+- 13) E 0	39E 0
* Zr-95	(269+- 72) E-4	250E-4	(145+- 39) E-1	130E-1
Nb-95	(7+- 44) E-4	160E-4	(4+- 23) E-1	82E-1
Mn-54	(-14+- 46) E-4	170E-4	(-7+- 21) E-1	76E-1
Co-60	(33+- 13) E-3	47E-3	(43+- 17) E-1	61E-1
La-140	(0+- 11) E-3	40E-3	(-1+- 14) E-1	51E-1
*+ K-40	(2766+- 38) E-3	57E-3	(1545+- 21) E 1	32E 1
*+ Th-232	(2467+- 63) E-3	-----	(875+- 22) E 0	-----
*+ U-238	(1357+- 44) E-3	-----	(746+- 24) E 0	-----

Notes:
* Activity greater than 3*standard deviation
\+ Peak is found
----- LLD is not calculated

<u>**TABLE 9**</u>

LOCATION: CLEFT ROCK

LOCATION#: 10

COUNT TIME: 6000sec

COUNT DATE: 05/28/82

InSitu COUNTING RESULTS

NUCLIDE ID	EXPOSURE RATE microR/hr		CONCENTRATION picoCi/Kgram	
NAME	EXPOSURE+-1-SIGMA RATE	LLD	CONC +- 1-SIGMA	LLD
Ce-144	(95+- 99) E-5	340E-5	(43+- 44) E 0	150E 0
Ce-141	(86+- 88) E-5	310E-5	(72+- 75) E-1	330E-1
I-131	(23+- 27) E-4	92E-4	(31+- 36) E-1	130E-1
Sb-125	(108+- 96) E-4	350E-4	(12+- 11) E 0	37E 0
Ru-103	(26+- 33) E-4	120E-4	(25+- 31) E-1	110E-1
Ba-140	(-5+- 47) E-4	170E-4	(-1+- 11) E 0	40E 0
Ru-106	(28+- 11) E-3	37E-3	(61+- 23) E 0	82E 0
*+ Cs-137	(742+- 12) E-3	25E-3	(1713+- 22) E 0	45E 0
Zr-95	(110+- 65) E-4	230E-4	(59+- 35) E-1	120E-1
Nb-95	(25+- 38) E-4	140E-4	(13+- 20) E-1	70E-1
Mn-54	(-27+- 41) E-4	150E-4	(-12+- 19) E-1	69E-1
Co-60	(19+- 11) E-3	41E-3	(24+- 15) E-1	53E-1
La-140	(-56+- 96) E-4	360E-4	(-7+- 12) E-1	46E-1
*+ K-40	(1677+- 30) E-3	48E-3	(937+- 17) E 1	27E 1
*+ Th-232	(1952+- 55) E-3	-----	(692+- 20) E 0	-----
*+ U-238	(919+- 37) E-3	-----	(505+- 21) E 0	-----

Notes:
* Activity greater than 3*standard deviation
\+ Peak is found
------ LLD is not calculated

TABLE 10

LOCATION: EAST WEYMOUTH

LOCATION#: 15

COUNT TIME: 6000sec

COUNT DATE: 10/07/82

InSitu COUNTING RESULTS

NUCLIDE ID	EXPOSURE RATE microR/hr		CONCENTRATION picoCi/Kgram	
NAME	EXPOSURE+-1-SIGMA RATE	LLD	CONC +- 1-SIGMA	LLD
Ce-144	(-9+- 12) E-4	43E-4	(-39+- 54) E 0	190E 0
Ce-141	(0+- 11) E-4	38E-4	(0+- 11) E 0	41E 0
I-131	(-52+- 32) E-4	120E-4	(-71+- 43) E-1	160E-1
Sb-125	(274+- 76) E-4	340E-4	(31+- 11) E 0	37E 0
Ru-103	(-4+- 34) E-4	120E-4	(-4+- 33) E-1	120E-1
Ba-140	(-18+- 49) E-4	180E-4	(4+- 12) E 0	42E 0
Ru-106	(0+- 12) E-3	42E-3	(1+- 25) E 0	92E 0
*+ Cs-137	(2726+- 82) E-4	220E-4	(496+- 15) E 0	37E 0
Zr-95	(170+- 74) E-4	260E-4	(92+- 40) E-1	140E-1
Nb-95	(-38+- 47) E-4	170E-4	(-19+- 24) E-1	87E-1
Mn-54	(129+- 46) E-4	160E-4	(59+- 21) E-1	73E-1
Co-60	(-8+- 13) E-3	47E-3	(-10+- 17) E-1	63E-1
La-140	(25+- 10) E-3	36E-3	(32+- 13) E-1	46E-1
*+ K-40	(3007+- 39) E-3	48E-3	(1680+- 22) E 1	27E 1
*+ Th-232	(2570+- 60) E-3	-----	(911+- 21) E 0	-----
*+ U-238	(1435+- 38) E-3	-----	(708+- 21) E 0	-----

Notes:
* Activity greater than 3xstandard deviation
+ Peak is found
----- LLD is not calculated

TABLE 11

LOCATION: MANOMET SUB STA.

LOCATION#: 17

COUNT TIME: 6000sec

COUNT DATE: 05/28/82

InSitu COUNTING RESULTS

NUCLIDE ID	EXPOSURE RATE microR/hr		CONCENTRATION picoCi/Kgram	
NAME	EXPOSURE +-1-SIGMA RATE	LLD	CONC +- 1-SIGMA	LLD
Ce-144	(62+- 93) E-5	320E-5	(28+- 42) E 0	150E 0
Ce-141	(136+- 84) E-5	290E-5	(146+- 90) E-1	310E-1
I-131	(14+- 24) E-4	85E-4	(19+- 33) E-1	120E-1
Sb-125	(-102+- 89) E-4	320E-4	(-12+- 10) E 0	37E 0
Ru-103	(10+- 31) E-4	110E-4	(10+- 29) E-1	110E-1
Ba-140	(-51+- 45) E-4	170E-4	(-12+- 11) E 0	39E 0
Ru-106	(21+- 10) E-3	36E-3	(45+- 22) E 0	79E 0
*+ Cs-137	(2128+- 64) E-4	43E-4	(387+- 12) E 0	7.8E 0
Zr-95	(111+- 67) E-4	240E-4	(60+- 36) E-1	130E-1
Nb-95	(-38+- 40) E-4	140E-4	(-20+- 20) E-1	74E-1
Mn-54	(11+- 41) E-4	150E-4	(5+- 19) E-1	67E-1
Co-60	(8+- 11) E-3	39E-3	(10+- 14) E-1	51E-1
La-140	(70+- 97) E-4	360E-4	(9+- 12) E-1	45E-1
*+ K-40	(2033+- 32) E-3	47E-3	(1136+- 18) E 1	26E 1
*+ Th-232	(2210+- 58) E-3	-----	(784+- 20) E 0	-----
*+ U-238	(1280+- 39) E-3	-----	(703+- 21) E 0	-----

Notes:
- * Activity greater than 3*standard deviation
- \+ Peak is found
- ----- LLD is not calculated

TABLE 12

1982 In Situ Results
Comparison of Ge(Li) In Situ and Ion Chamber Results

Location Site No.	(Distance in Miles from Plant)	Positive Ge(Li) In Situ Results (μR/Hr) U-238	Th-232	K-40	Cs-137	Other	Total*	Ion Chamber (μR/Hr)
00	Warehouse (0.03 SSE)	1.38	2.14	2.71	0.156	(a)	10.7	13.8
01	Rockyhill Rd. (E) (0.8 SE)	1.35	2.25	2.21	0.163	-	9.6	9.4
03	Rockyhill Rd. (W) (0.3 WNW)	1.17	2.47	2.49	0.062	-	9.8	9.8
04	Plymoth Center (4.5 WNW)	1.57	2.41	2.38	0.276	-	10.2	9.9
06	Property Line (0.34 NW)	1.30	2.32	2.11	0.189	(a)	9.5	10.5
07	Pedestrial Bridge (0.14 N)	1.27	2.21	2.14	0.113	.989 (bc)	10.3	13.8
08	Overlook (0.03 W)	1.21	2.05	2.61	0.108	(a)	9.6	37.8
09	East Breakwater (0.35 ESE)	1.36	2.47	2.77	0.100	(c)	10.3	10.4
10	Cleft Rock (0.9 S)	0.92	1.95	1.68	0.942	-	9.1	9.4
15	East Weymoth (23 NW)	1.44	2.57	3.01	0.273	-	10.9	10.5
17	Manomet Substation (2.5 SE)	1.28	2.21	2.03	0.213	-	9.3	9.3

* Total includes 3.6 μR/Hr cosmic contribution.
(a) Co-60 found in in situ but not confirmed by lab soil analysis and therefore not included in total.
(b) Co-60 found in in situ and confirmed by lab soil analysis.
(c) Zr-95 found in in situ but not confirmed by lab soil analysis and therefore not included in total.

APPENDIX D - Radiological Environmental Monitoring Program

APPENDIX D

4.8.D Environmental Monitoring Program

An environmental monitoring program shall be conducted as follows:

1. Environmental samples shall be selected and analyzed according to Table 4.8.1 at the locations described in Tables 4.8.2 and 4.8.3 and shown in Figures 4.8.1, 4.8.2 and 4.8.3.

2. Analytical techniques used shall be such that the detection capabilities in Table 4.8.4 are achieved.

3. A census of gardens producing fresh leafy vegetables for human consumption (e.g., lettuce, spinach, etc.) shall be conducted near the end of the growing season to determine or verify the location of the garden (available for sampling) yielding the highest calculated thyroid dose. This census is limited to gardens having an area of 500 square feet or more and shall be conducted under the following conditions as necessary to meet the above requirement:

   a. Within a 1-mile radius of the plant site, enumeration by a door-to-door, or equivalent counting technique.

   b. If no milk-producing animals are located in the vicinity of the site, as determined by item 4 below, the census described in item 3a above shall be extended to a distance of 5 miles from the site.

   If the census indicates the existence of a garden at a location yielding a calculated thyroid dose greater than that from the previously sampled garden, the new location shall replace the garden previously having the maximum calculated iodine concentration. Also, any location from which fresh leafy vegetables can no longer be obtained may be dropped from the surveillance program as long as the NRC is notified in writing, as soon as possible that such vegetables are no longer grown or no longer available at that location.

4. A census of animals producing milk for human consumption shall be conducted at or near the middle of the grazing season to determine or verify the location yielding the highest calculated annual average thyroid dose. The census shall be conducted under the following conditions as necessary to meet the above requirement:

   a. Within a 1-mile radius from the plant site or within the 15 mrem/yr isodose line, whichever is larger, enumeration by a door-to-door or equivalent, counting technique.

   b. Within a 5-mile radius for cows and for goats, enumeration derived from referenced information from county agricultural agents or other reliable sources.

   If it is learned from this census that animals are present at a location which yields a calculated thyroid dose greater than from previously sampled animals, the new location shall be added to the surveillance program as soon as practicable. The sampling location having the lowest calculated dose may then be dropped from the surveillance program at the end of the grazing season during which the census was conducted. Also, any location from which milk can no longer be obtained may be dropped from the surveillance program as long as the NRC is notified in writing, as soon as practicable, that milk-producing animals are no longer present, or milk samples are no longer available at that location.

5. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability or to malfunction of automatic sampling equipment. In the event of equipment malfunction, every reasonable effort shall be made to complete corrective action prior to the end of the next sampling period. Any significant deviations from the sampling schedule shall be explained in the annual report.

6. Detailed written procedures, including applicable check lists and instructions, shall be prepared and followed for all activities involved in carrying out the environmental monitoring program. Procedures shall include sampling, data recording and storage, instrument calibration, measurements and analyses, and actions to be taken when anomalous measurements are discovered.

   Procedures shall be prepared for insuring the quality of program results, including analytical measurements. These procedures will identify the responsible organizations, include purchased services (e.g., contractual lab), include independent audits, and include systems (such as participation in IAEA and/or NBS intercalibration exercises and submission of "blind" quality control samples for analyses by the contractors) to identify and correct deficiencies, investigate anomalous or suspect results, and review and evaluate program results and reports. **

ES 3.8.D and 4.8.D <u>Environmental Monitoring Program</u>

An Environmental radiological monitoring program is conducted to verify the adequacy of in-plant controls on the release of radioactive materials. The program is designed to detect radioactivity concentrations which could result in radiation doses to individuals not exceeding the levels set forth in 10CFR50 Appendix I.

An example of this is the detection of I-131 in milk. Calculational Models (Regulatory Guide 1.109 March 1976) have shown that a constant concentration of 3.5 pCi I-131 per liter milk would result in a dose of 15 millirem to the thyroid of an infant consuming that milk for a year. Allowing for an open grazing season of six months, and a maximum of two half-lives between event and sampling, the lower limit of detection at time of sampling must be 2 pCi/l (3.5 x 12/6 x 1/4 = 1.8).

A supplemental monitoring program for sediments and mussels has been incorporated into the basic program (see notes f and g to Table 4.8.1) as a result of an agreement with the Massachusetts Wildlife Federation. This supplemental program is designed to provide information on radioactivity levels at substantially higher sensitivity levels in selected samples to verify the adequacy (or, alternatively, to provide a basis for later modifications) of the long-term marine sampling schedules. As part of the supplemental program, analysis of mussels for isotopes of plutonium will be performed if radiocesium activity should exceed 200 pCi/Kgm in the edible portions. **

**supplemental provision

The 200 pCi/Kgm radiocesium "action level" is based on calculations which showed that if radiocesium from plant releases reached this level, plutonium could possibly appear at levels of potential interest.* The calculations also showed that the dose delivered from these levels of plutonium would not be a significant portion of the total dose attributable to liquid effluents.

The program was also designed to be consistent, wherever applicable with Regulatory Guide 4.8 (Issued for comment December 1975). The following exceptions to the generic recommendations stated in Regulatory Guide 4.8 are justified due to site specific considerations:

1. The required detection capability for I-131 in milk is about twice the value suggested in Regulatory Guide 4.8. The justification for the higher value is presented in the second paragraph of this section. This is a conservative estimate of the capability of the milk surveillance program to detect concentrations at the appropriate annual dose level since the <u>annual</u> dose is proportional to the <u>annual average</u> concentration in milk. The detection limit for a group of samples is less than that for a single sample and is inversely proportional to the square root of the number of samples. The conservatism in this case is approximately $\sqrt{12}$, or about a factor of 3.

2. Air particulates are not analyzed for radiostrontium. The program instead calls for this analysis in milk samples. This is justified because the air-cow-milk exposure pathway can be better monitored at Pilgrim after the very low level releases of radiostrontium are reconcentrated in cow's milk (Ref. 1).

3. Soils and sediments are not routinely analyzed for Sr-90, but rather the analysis is done on a contingency basis. The rationale behind this is that Sr-90 will not contribute to long-term radionuclide buildup until the more abundant gamma emmitting nuclides appear in relatively large concentrations. Both Items 2 and 3 reflect the fact that in 3½ years of operation, Pilgrim Station liquid releases of Sr-90 have amounted to only 1/1000 of the Sr-90 inventory in Cape Cod Bay water (from weapons testing fallout) and about 4/1000,000 of the direct deposition on the Bay. Also, gaseous releases of Sr-90 have been only 1/100,000 of the terrestrial Sr-90 inventory within five miles of the station (Ref. 1).

4. Surveys are conducted annually, if necessary, to determine appropriate locations for sampling of leafy vegetables and milk. The objective of these surveys is to ensure that the environmental samples are representative of realistic food chain pathways, considering local conditions. Results of the monitoring program will be used as "benchmarks" to verify calculational models used to predict the consequences of effluent releases from the station. The models can then be employed to predict doses attributable to radiation deposition at any other location of interest. The combination of monitoring results and calculations al model predictions is a practical method of demonstrating compliance with 10CFR50 Appendix I. This approach does not require (nor is it always practical) that environmental media always be sampled from the "worst case" locations: although sensitivity of the monitoring results might be improved by sampling from locations which are reasonably close to "worst case" conditions.

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* in measurable quantities having a potential dose (human food chain) significance comparable to other nuclides if present at their detection limits.

Verification of the appropriate milk sampling locations on an annual basis is satisfactory as there are very few locations suitable for the grazing of dairy herds in the vicinity of the plant (Ref. 2). This situation makes it unlikely the location of the nearest dairy herd (3.5 miles-W) will change.

5. Annual sampling of beef forage (in place of beef) is adequate because beef cattle are not raised commercially in the vicinity of the site. However, dairy cows from the Plymouth County Farm are periodically sold for beef. Feed (hay) from this location will be sampled to monitor this potential pathway for ingestion of radioactivity. If beef cattle feeding on local forage are found at locations closer to the site, forage samples from the closer location will replace the sample from the County Farm.

6. Goundwater flow at the plant site is into Cape Cod Bay; therefore, terrestrial monitoring of groundwater is not included in this program.

7. Poultry sampling is not performed because poultry in Plymouth County feed almost exclusively on imported grain and are usually raised under shelter.

8. Field gamma isotopic surveys are conducted to monitor radioactivity in soil in lieu of laboratory analysis of soil samples. The technique has several advantages over laboratory analysis. First, analysis can be performed on the same plot of land from survey to survey, and radioactivity build-up at the location can be accurately determined. Secondly, gamma exposure rate is determined directly from this technique: hence compliance with 10CFR50 Appendix I levels can be investigated directly rather than indirectly through soil sampling.

References:

1. Wrenn, M.E., "Review of Sr-90 Releases from Pilgrim 1 Nuclear Plant and a Comparison with Extant Environmental Levels", 1976.

2. Pilgrim Station Unit #2 PSAR, Appendix 11F, pp. 11FC-11 and 11A, amended June 15, 1976.

TABLE 4.8.1

OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway or Sample Type	Locations (Direction-Distance) from Reactor	Sampling and Collection Frequency	Type and Frequency of Analysis
AIRBORNE			
Particulates	11 (see Table 4.8.2)	Continuous sampling over one week	Gross beta radioactivity at least 24 hours after filter change. (a) Quarterly composite (by location) for gamma isotopic. (b)
Radioiodine	11 (see Table 4.8.2)	Continuous sampling with canister collection weekly	Analyze weekly for I-131
Soil	11 (see Table 4.8.2)	Once per three years	Field gamma isotopic. (c)
DIRECT	20 (see Table 4.8.3)	Quarterly	Gamma exposure quarterly.
	Plymouth Beach and Priscilla/White Horse Beach	Annually (Spring)	Gamma exposure survey.*
WATERBORNE	Discharge Canal Bartlett Pond (SE-1.7 mi.) Powder Point (NNW-7.8 mi.)(d)	Continuous Composit Sample Weekly grab sample Weekly grab sample	Gamma isotopic (b) monthly; and composite for H-3 analysis quarterly, (c).
AQUATIC			
Shellfish	Discharge outfall Duxbury Bay Manomet Pt. Plymouth or Kingston Harbor Marshfield (d)	Quarterly (at approximate 3-month intervals)	Gamma isotopic (b); also see note (f). *

* Note (f) and beach surveys are supplemental provision.

TABLE 4.8.1
(Cont'd)

Exposure Pathway or Sample Type	Locations (Direction-Distance) from Reactor	Sampling and Collection Frequency	Type and Frequency of Analysis
Irish Moss	Discharge outfall Manomet Pt. Ellisville (d)	Semi-annually	Gamma isotopic (b)
Lobster	Vicinity of discharge point Offshore(d)	Four times per season Once per season	Gamma isotopic (b) on edible portions.
Fish	Vicinity of discharge point Offshore(d)	Quarterly, Groups I and II (e) in season, Groups III and IV (e) Annually, each group	Gamma isotopic (b) on edible portions(e)
Sediments	Rocky Point Plymouth Harbor Duxbury Bay Plymouth Beach Manomet Pt. Marshfield (d)	Semi-annually	Gamma isotopic (b) (c), see also note (g) *
INGESTION (Terrestrial)			
Milk	Plymouth County Farm (W-3.5 mi.)(h): Whitman Farm (NW-21 mi.) (d)	Semi-monthly during periods when animals are on pasture, otherwise monthly	Gamma isotopic (b) Sr-89, 90 monthly; radioiodine analysis all samples.
Cranberries	Manomet Pt. Bog (SE-2.6 mi.) Bartlett Rd. Bog (SSE/S-2.8 mi.) Pine St. Bog (WNW-17 mi.) (d)	At time of harvest	Gamma isotopic (b) on edible portions.

*Note (g) is supplemental provision

TABLE 4.8.1
(Cont'd)

Exposure Pathway or Sample Type	Locations (Direction-Distance) from Reactor	Sampling and Collection Frequency	Type and Frequency of Analysis
Tuberous and green leafy vegetables	Karbott Farm (SSE-2.0 mi.)(h) Bridgewater Farm (W-20 mi.) (d)	At time of harvest	Gamma isotopic (b) on edible portions.
Beef Forage	Plymouth County Farm (W-3.5 mi.) (h)	Annually	Gamma isotopic (b)

Notes

(a) If gross beta radioactivity is greater than 10 times the control value, gamma isotopic will be performed on the sample.

(b) Gamma isotopic means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

(c) If integrated gamma activity (less K-40) is greater than 10 times the control value (less K-40), strontium-90 analysis will be performed on the sample.

(d) Indicates control location.

(e) Fish analyses will be performed on a minimum of 2 sub-samples, consisting of approximately 400 grams each from each of the following groups:

I. Bottom Oriented	II. NearBottom Distribution	III. Anadromous	IV. Coastal Migratory
Winter flounder Yellowtail flounder	Tautog Cunner Atlantic cod Pollock Hakes	Alewife Rainbow smelt Striped bass	Bluefish Atlantic herring Atlantic menhaden Atlantic mackerel

(f)* Mussel samples from four locations (immediate vicinity of discharge outfall, Manomet Pt., Plymouth or Kingston Harbor, and Green Harbor in Marshfield) will be analyzed quarterly as follows:

One kilogram wet weight of mussel bodies, including fluid within shells will be collected. Bodies will be reduced in volume by drying at about 100°C. Sample will be compacted and analyzed by GE(Li) gamma spectrometry or alternate technique, if necessary, to achieve a sensitivity** of 5 pCi/kg for Cs-134, Cs-137, Co-60, Zn-65 and Zr-95 and 15 pCi/kg for Ce-144.

The mussel shell sample from one location (the location nearest the discharge canal unless otherwise specified pursuant to licensee's agreement with Mass, Wildlife Federation) will be analyzed each quarter. One additional mussel shell sample (from the Green Harbor location, unless otherwise specified pursuant to Licensee's agreement with Mass Wildlife Federation) will be analyzed semi-annually. Unscrubbed shells to be analyzed will be dried, processed, and analyzed similarly to the mussel bodies.

Because of the small volume reduction in pre-processing of shells, sensitivities attained will be less than that for mussel bodies. The equipment and counting times to be employed for analyses of shells will be the same or comparable to that employed for mussel bodies so that the reduction in sensitivities (relative to those for mussel bodies) will be strictly limited to the effects of poorer geometry related to lower sample volume reduction. Shell samples not scheduled for analysis will be reserved (unscrubbed) for possible later analysis, depending upon recommendations of the review committee.

* Supplemental provision.

**All sensitivity values to be determined in accordance with footnote (a) to Table 4.8.4., viz., LLD at 95% confidence level on K_α ; 50% confidence level on K_β (See HASL-300 for definitions).

Notes (Cont'd)

If radiocesium (Cs-134 and Cs-137) activity exceeds 200 pCi/kg (wet) in mussel bodies, these samples will be analyzed by radiochemical spearation, electrodeposition, and alpha spectrometry for radioisotopes of plutonium, with a sensitivity of 0.4 pCi/kg.

(g)* Sediment samples from four locations (Manomet Pt., Rocky Pt., Plymouth Harbor, and head of Duxbury Bay) will be analyzed once per year (preferably early summer) as follows:

Cores will be taken to depths of 30-cm, minimum depth wherever sediment conditions permit by a hand-coring sampling device. If sediment conditions do not permit 30-cm deep cores, the deepest cores achievable with a hand-coring device will be taken. In any case, core depths will not be less than 14-cm. Core samples will be sectioned into 2-cm increments, and surface and alternate increments analyzed, others reserved. Sediment sample volumes (determined by core diameter and/or number of individual cores taken from any single location) and counting technique will be sufficient to achieve sensitivities of 50 pCi/kg dry sediment for Cs-134, Cs-137, Co-60, Zn-65, and Zr-95 and 150 pCi/kg for Ce-144. In any case individual core diameters will not be less than 2 inches.

The top 2-cm section from each core will be analyzed for Pu isotopes (Pu-238, Pu-239, 240) using radiochemical separations, electrodeposition, and alpha spectrometry with target sensitivity of 25 pCi/kg dry sediment. Two additional core slices per year (mid-depth slice from core samples taken at Rocky Point and Plymouth Harbor, unless otherwise specified pursuant to licensee's agreement with Mass Wildlife Federation) will be similarly analyzed.

(h) These locations may be altered in accordance with results of surveys discussed in paragraphs 4.8.D-3 and 4.8.D-4.

* Supplemental provision

TABLE 4.8.2

AIR PARTICULATES, GASEOUS RADIOIODINE AND SOIL SURVEILLANCE STATIONS

Sampling Location (Sample Designation)	Distance and Direction from Reactor
Offsite Stations	
East Weymouth (EW) *	23 miles NW *
Plymouth Center (PC)	4.5 miles W-WNW
Manomet Substation (MS)	2.5 miles SE
Cleft Rock Area (CR)	0.9 miles S
Onsite Stations	
Rocky Hill Road (ER)	0.8 miles SE
Rocky Hill Road (WR)	0.3 miles W-WNW
Overlook Area (OA)	0.03 miles W
Property Line (PL)	0.34 miles NW
Pedestrian Bridge (PB)	0.14 miles N
East Breakwater (EB)	0.35 miles ESE
Warehouse (WS)	0.03 miles SSE

* Control Station

TABLE 4.8.3

EXTERNAL GAMMA EXPOSURE SURVEILLANCE STATIONS (TLD)

Dosimeter Location (Designation)	Distance and Direction from Station
Offsite Stations	
East Weymouth (EW)*	23 miles NW *
Kingston (KS)	10 miles WNW
Sagamore (CS)	10 miles SSE-S
Plymouth Airport (SA)	8 miles WSW
North Plymouth (NP)	5.5 miles WNW
Plymouth Center (PC)	4.5 miles W-WNW
South Plymouth (SP)	3 miles WSW
Manomet (MS)	2.5 miles SSE
Manomet (MB)	2.5 miles SE
Manomet (MP)	2.25 miles ESE-S
Cleft Rock Area (CR)	0.9 miles S
Saquish Neck (SN)**	4.6 miles NNW ***
Onsite Stations	
Rocky Hill Road (ER)	0.8 miles SE
Microwave Tower (MT)	0.38 miles S
Rocky Hill Road (WR)	0.3 miles W-WNW
Rocky Hill Road (B)	0.26 miles SSE
Property Line (H)	0.21 miles SSW
Property Line (I)	0.14 miles W
Public Parking Area (PA)	0.07 miles N-NNE
Overlook Area (OA)	0.03 miles W

* Control Station

** Data from this surveillance station is subject to detector maintenance and retrieval by a private party not subject to control by the licensee. Therefore, the requirement to maintain this station is contingent on station availability and maintenance by the outside party.

*** Supplemental provision

TABLE 4.8.4

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS (d)

Lower Limit of Detection (a)

Analysis	Water pCi/l	Airborne particulate or gas - pCi/M^3	Wet solids pCi/Kg	Dry solids pCi/Kg	Milk pCi/l
Gross beta	2	1×10^{-2}			
H-3	330				
Mn-54	15		130	60	
Fe-59	30		260	120	
CO-58,60	15	2×10^{-2}	130	60	
Zn-65	30		260	120	
Sr-89	10		40		10
Sr-90	2		8	150	2
Zr/Nb-95	10				
I-131		7×10^{-2}	80(b)		2 (c)
Cs-134,137	15	1×10^{-2}	80	150	15
Ba/La-140	15				15

(a) The nominal lower limits of detection at the 95% confidence level (defined in the ERDA Health and Safety Laboratory procedures manual, HASL-300).

(b) Applies only to analysis of green leafy vegetables.

(c) Sensitivity with 25% error at the 95% confidence level.

(d) This table applies to all analyses other than those for which higher sensitivities appl in accordance with Notes (f) and (g) to Table 4.8.1.

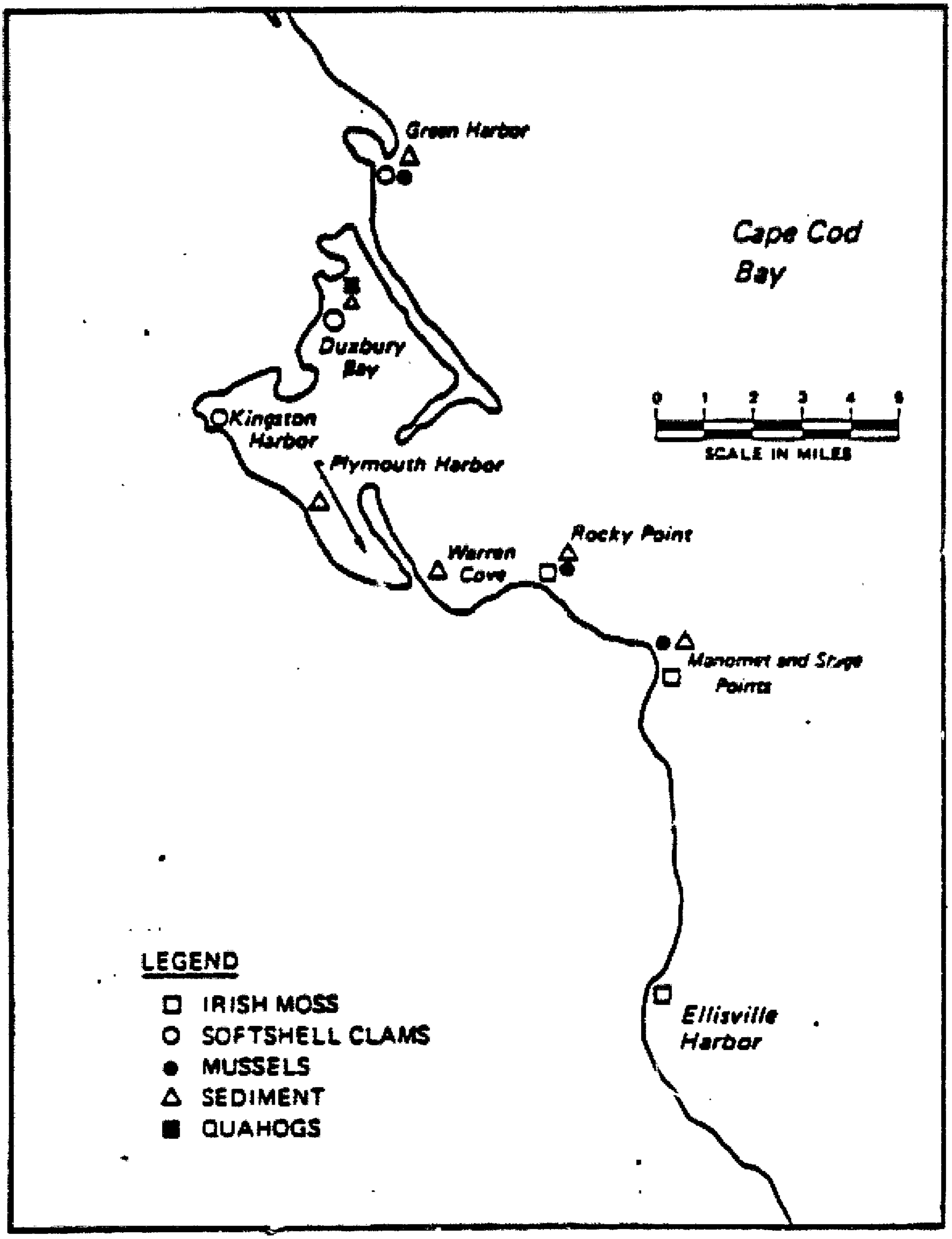


Figure ×.8-1 Typical Mollusc, Algae and Sediment Sampling Stations

6.9.C Unique Reporting Requirements

***

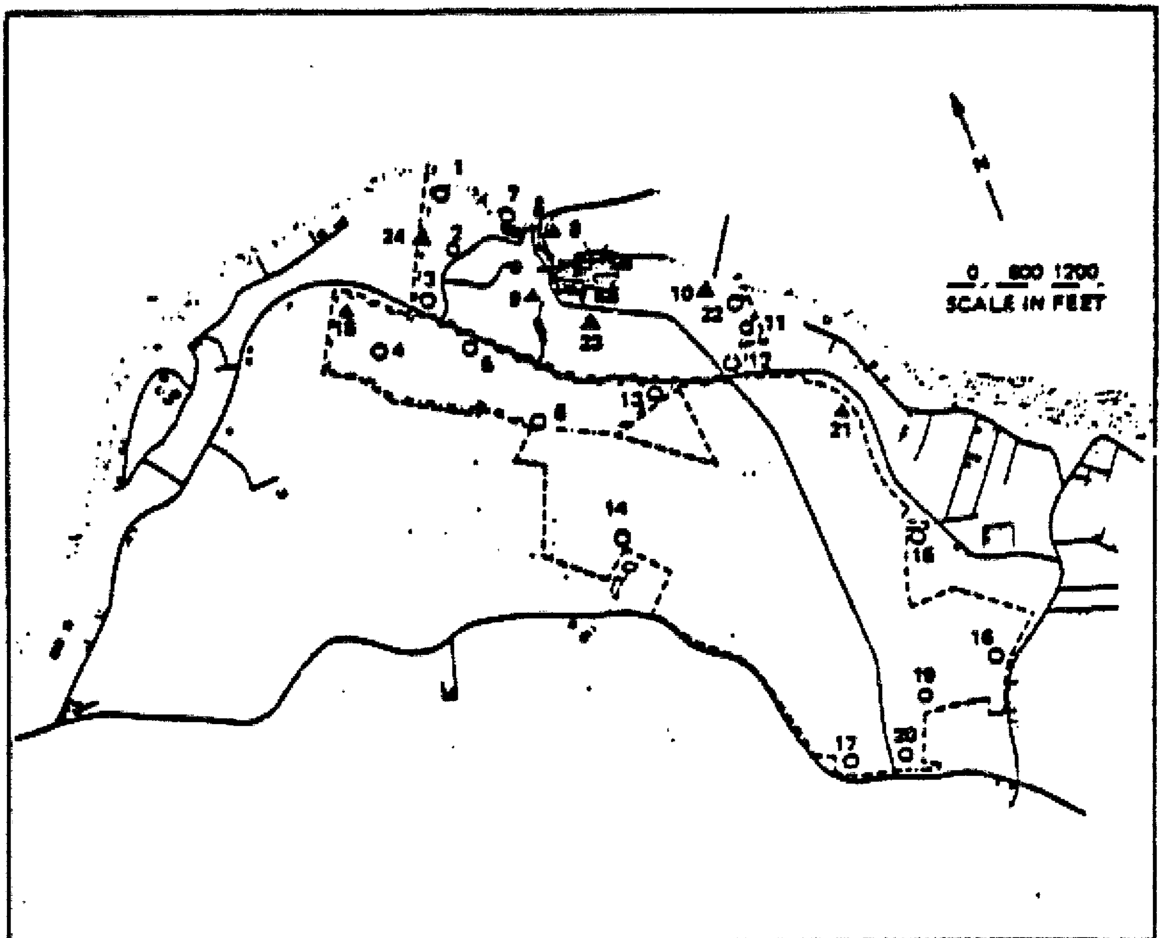
2. Environmental Program Data

a. Annual Report. A report on the radiological environmental surveillance program for the previous 12 months of operation shall be submitted to the Director of the NRC Regional Office (with a copy to the Director, Office of Nuclear Reactor Regulation) as a separate document within 90 days after January 1 of each year. The reports shall include summaries, interpretations, and statistical evaluation of the results of the radiological environmental surveillance activities for the report period, including a comparison with preoperational studies, operational controls (as appropriate), and previous environmental surveillance reports, and an assessment of the observed impacts of the plant operation on the environment. The reports shall also include the results of any land use surveys which affect the choice of sample locations. If harmful effects or evidence of irreversible damage are detected by the monitoring, the licensee shall provide an analysis of the problem and a proposed course of action to alleviate the problem.

Results of all radiological environmental samples shall be summarized and tabulated on an annual basis. In the event that some results are not available within the 90-day period, the report shall be submitted, noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

b. Anomalous measurement report. If radioactivity in an indicator medium from an off-site location is found and confirmed at a level exceeding ten times the control station value, a written report shall be submitted to the Director of the NRC Regional Office (with a copy to the Director, Office of Nuclear Reactor Regulation) within 10 days after confirmation.** This report shall include an evaluation of any release conditions, environmental factors, or other aspects necessary to explain the anomalous result.

** A confirmatory reanalysis of the original, a duplicate, or a new sample may be desirable, as appropriate. The results of the confirmatory analysis shall be completed at the earliest time consistent with the analysis, but in any case within 30 days of receipt of the anomalous result.



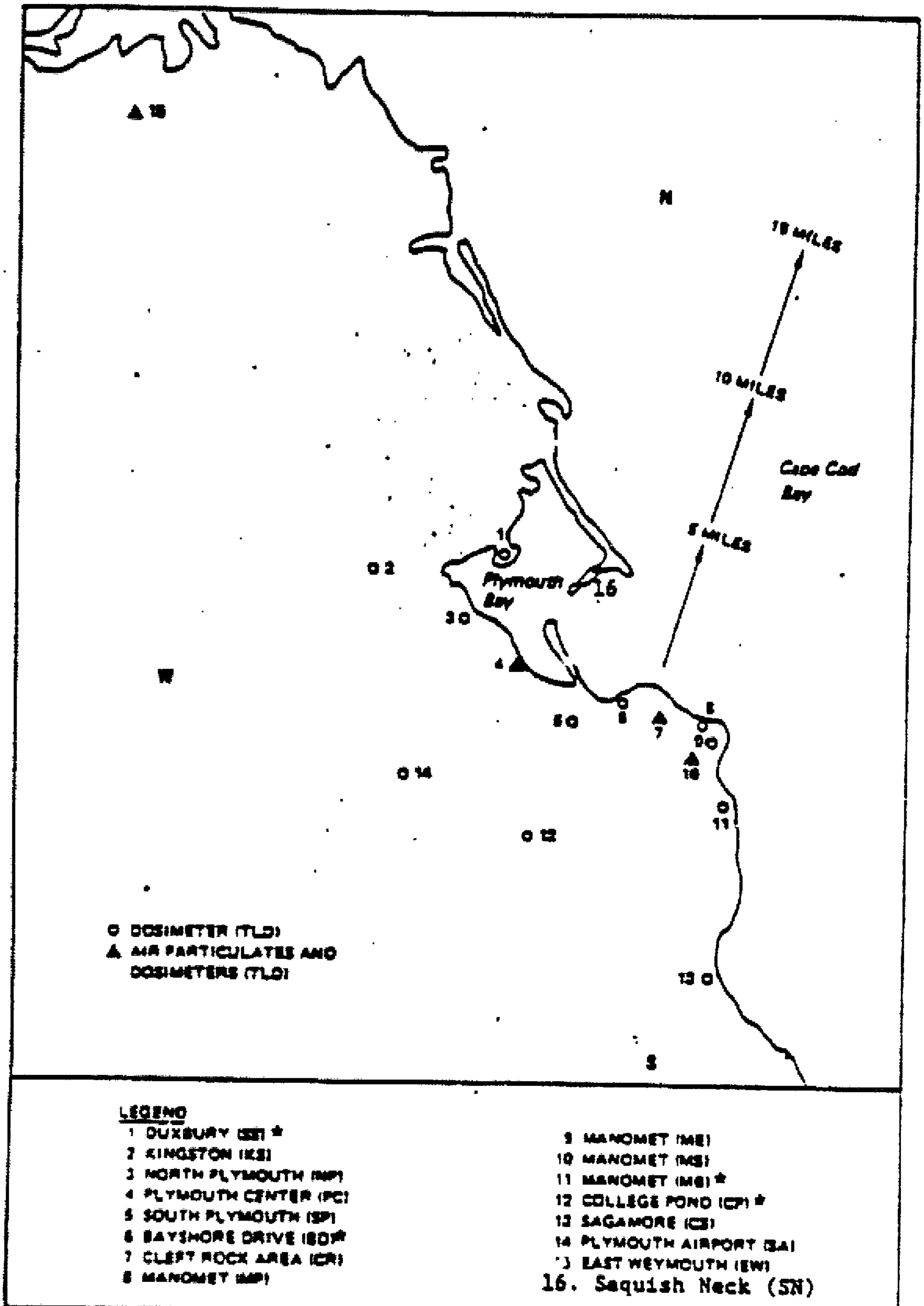
LEGEND

1 PROPERTY LINE (D) *
2 PROPERTY LINE (F) *
3 PROPERTY LINE (I)
4 PROPERTY LINE (G) *
5 ROCKY HILL ROAD (A) *
6 PROPERTY LINE (H)
7 PUBLIC PARKING AREA (PA)
8 PEDESTRIAN BRIDGE (PB)
9 OVERLOOK AREA (OA)
10 EAST BREAKWATER (EB)
11 PROPERTY LINE (C) *
12 PROPERTY LINE (HB) *
13 ROCKY HILL ROAD (B)
14 MICROWAVE TOWER (MT)
15 EMERSON ROAD (EM) *
16 WHITE HORSE ROAD (WH)*
17 PROPERTY LINE (E)*
18 ROCKY HILL ROAD (WR)
19 PROPERTY LINE (J)*
20 PROPERTY LINE (K)*
21 ROCKY HILL ROAD (ER)
22 PROPERTY LINE (L)*
23 WAREHOUSE (WS)
24 PROPERTY LINE (PL)

○ DOSIMETER (TLD)
▲ AIR PARTICULATES AND DOSIMETERS (TLD)

*additional station not required by Specification 4.8.D.1

Figure 4.8.2 Location of Onsite Monitoring Stations



*additional stations not required by Specification 4.8.D.1

Figure 4.8.3 Location of Offsite Monitoring Stations

TABLE 6.9.C-1

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Reporting Levels

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/M^3)	Fish, Mussels (pCi/Kg, wet)	Milk (pCi/l)	Vegetables (pCi/kg, wet)
H-3	2×10^4				
Mn-54	1×10^3		3×10^4		
Fe-59	4×10^2		1×10^4		
Co-58	1×10^3		3×10^4		
Co-60	3×10^2		1×10^4		
Zn-65	3×10^2		2×10^4		
Zr-95	4×10^2				
I-131	2	0.9		3	1×10^2
Cs-134	30	10	1×10^3	60	1×10^3
Cs-137	50	20	2×10^3	70	2×10^3
Ba-140	2×10^2			3×10^2	

APPENDIX E - 1982 Garden & Milk-Producing Animal Survey

Edison

OFFICE MEMORANDUM

3+1

To T. L. Sowdon   Prepared by C. E. Bowman C.E.Bowman

Date Oct. 22, 1982   Reviewed by ____

Approved by ____

Nuclear Records Control
ERMS #82-136

RECORD CATEGORY
UNIT APPLICABILITY
PNPS FILE NUMBER

2

CONTROL COPY
RECORD TYPE: A4.08
QA ☒ NON QA ☐
KEYWORDS: 1982 Annual Census
CONTROLLED DISTRIBUTION?
YES ☐ NO ☒
COMPONENT #: ——
Q-LIST #: ——
RMS CONTROL #: 2201869

Title 1982 GARDEN & MILK-PRODUCING ANIMAL CENSUS

As required by the PNPS Environmental Technical Specification, the 1982 Garden & Milk-Producing Animal Census was conducted on 9/14/82 in a street by street search of the area within 1 mile of PNPS.

The existence of gardens near the site boundaries of 0.7 miles West and 0.6 miles ESE was confirmed. These gardens are the closest and largest in the near vicinity (1 mile) of PNPS, and are less than 500 ft.² They do represent conservative garden locations for sampling analyses and dose calculation. With the assistance of Mr. Robert Tis, vegetation samples were collected from four locations. Only two of these locations are within one mile of PNPS. A sample of pumpkin leaves was collected from the J. Work Residence (0.6 miles ESE) of John Alden Road on 9/14/82, and lettuce was obtained from the Whipple Farm (1.5 miles SSW) off of Doten Road also on 9/14/82. Rhubbarb samples were collected from both the Lloyd-Evans Residence (0.7 miles West) on Gate Road and the Hoton Residence (2.5 miles SE) near the Manomet Bird Observatory on 9/27/82. A vegetation sample was collected from the Hoton Residence at their request.

In addition, no cows or goats or structures which would indicate the presence of such animals within 1 mile of PNPS were found. The Plymouth Animal Inspector was contacted and sent a listing of animals in Plymouth. The location of cows and goats are as follows:

Owner	Animals	Location	Status
Charlie Mann	1 Heifer	State Road	Agreed to particiipate in Environmental Program.
Nancy Lloyd	5 Goats	Long Pond Road	Goats are miniature in size and don't provide a large enough sample.
Warren Raymond	2 Goats	Off White Horse Road	Goats no longer at this location.
Fred Wood	1 Cow	Federal Furnace Road	Location is greater than 5 miles from PNPS.
John Davis	1 Heifer * 2 Beef Cows	Beaver Dam Road	See Charlie Mann
Pilgrim Plantation	2 Cows	Warren Avenue	Declined to participate in Environmental Program.

* Mr. Mann's heifer is located on Mr. Davis' property.

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Boston Edison Company

OFFICE MEMORANDUM

To	Prepared by
Date Oct. 22, 1982	Reviewed by
cc: Nuclear Records Center ERHS #82-136	Approved by

RECORD CATEGORY
UNIT APPLICABILITY
PNPS FILE NUMBER

Title:

In addition to the above individuals being contacted by Mr. Robert Tis at my request, the Plymouth County Farm was also contacted. They have agreed to reparticipate in the Environmental Program.

In conclusion, the 1982 Census identified two indicator stations available for milk sampling: the Plymouth County Farm (3.5 miles W), and Mr. Mann's heifer located on Beaver Dam Road (2.5 miles S). The first milk sample from Mr. Mann's heifer is scheduled to be collected in late October, and the first milk sample from the Plymouth County Farm is expected to be obtained in November.

Form 3866

GARDEN CENSUS FORM

No. Streets Surveyed 30 **Date** 9/14/82

Street Name	House Number	Garden $500\ ft^2$	Leafy Vegetables	Distance and and Azimuth	Initials
[illegible] ROAD ([illegible] Residence)	N/A	$< 500\ ft^2$	Lettuce	0.7 miles W	CEB
JOHN ALDEN ROAD (J. Work Residence)	393	$< 500\ ft^2$	Pumpkin Leaves	0.6 miles ESE	CEB
INTERSECTION OF CLIFFORD ROAD AND DOTEN ROAD (Whipple Farm)	N/A	$> 500\ ft^2$	Lettuce	1.5 miles SSW	CEB

MILK ANIMAL CENSUS FORM

No. Streets Surveyed 30 Date 9/14/82

Street Nam	House Number	No. of Animals	Type of Animals	Owner	Distance and Azimuth	Initials

None of the streets surveyed had cows or goats or structures which would indicate the presence of such animals

CEB

Paul Whipple Dotan Road	15 Beefalo 1 Sheep
Sandra Sharp 311 Carver Road	3 Pigs
Charlie Mann State Road	1 Heifer
Kenny Craig Beach Street	1 Sow
John Almeida White Oak Drive	5 Pigs
Gerald Sheehan Hedge Road	16 Black Angus
Nancy Lloyd Long Pond Road	5 Goats
Oscar Bettencourt 12 Savery Lane	3 Black Angus
Warren Raymond Off White Horse Road	2 Goats
Frank Shaw R.F.D. #8 Old Sandwich Rd.	5 Sows
George Almeida 221 South Pond Road	12 Swine
Fred Wood Federal Furnace Road	1 Cow
Milton Wood Braley Lane	2 Sows 2 steers
John Davis Beaver Dam Road	1 Heifer 1 Swine 2 Beef Cows
Pilgrim Plantation Warren Avenue	2 Cows

CHRONOLOGY OF EVENTS[1]

PILGRIM NUCLEAR POWER STATION

PLYMOUTH, MA

1960s

1967: In July 1967, the Town of Plymouth's Zoning Board of Appeals (ZBA) issues a **Special Permit** to Boston Edison for construction and operation of a nuclear plant, under the Town Zoning Bylaw. Plymouth is selected as the reactor site after a location closer to population centers near Boston was rejected. The ZBA issues the permit on finding that Pilgrim "will not be detrimental to the established or future character of the neighborhood and the town in view of the conditions and safeguards which will be imposed by the U.S. Atomic Energy Commission upon the operation of such nuclear-powered plant, and the comparative isolation of the site of the plant itself."[2] According to the Atomic Energy Commission's Provisional Construction Permit issued to Boston Edison, in 1965 the total residential and seasonal population within 1 mile of the site was 1,046; within 3 miles, 5,659; and within 10 miles, 44,629.

Original building plans for Pilgrim show storage of spent nuclear fuel (high-level radioactive waste) inside the reactor building, and discuss shipping waste offsite. U.S. Nuclear Regulatory Commission (NRC) records also indicate **spent nuclear fuel is intended to spend a relatively short time in the wet pool before being sent offsite to a reprocessing facility**.

Construction begins in 1967. The site is extensively altered by excavation and fill. Used construction equipment, including cranes, is buried on site.[3]

1970s

1970s: Massachusetts seeks to require that Boston Edison install a "closed-cycle" cooling water system for the approximate 500 million gallons of water required to run Pilgrim daily. Boston Edison files a legal challenge to avoid the cost of a "closed-cycle" system, eventually prevailing. **Pilgrim is built with a "once-through" cooling water system**. It was well-known at the time that a once-through system causes destruction of marine life. The Sierra Club and other public interest groups oppose Pilgrim's construction and use of once-through cooling.

[1] This chronology attempts to capture the major milestones related to Pilgrim Nuclear Power Station beginning with the Town of Plymouth's granting of a special permit to Boston Edison to construct a nuclear power facility.
[2] Plymouth Board of Appeals on the Zoning Bylaw: Notice of Special Permit August 22, 1967.
[3] Source available on request.

<u>1970s-1980s</u>: Pilgrim has **several spills and accidents** resulting in the release of radioactive materials into the environment. There are multiple radioactive resin spills into the building and through the storm drain into Cape Cod Bay.[4]

<u>1972</u>: The predecessor to the NRC, the Atomic Energy Commission, issues Boston Edison an **operating license**. **Pilgrim begins nuclear power production in July, 1972 using "once-through" cooling water system that impinges and entrains marine life and discharges thermal plume to Cape Cod Bay.** Federal Clean Water Act becomes law. Pilgrim begins **discharging radiological materials to the air and water during routine operations.**

<u>1973</u>: "Large impingement event" occurs, which is defined as those events involving greater than 20 fish per hour and an overall event total of 1,000 fish or more.[5] From August to September 1973, **1,600 clupeids are impinged** on Pilgrim's intake screens.

In April 1973, a **large kill of Atlantic menhaden occurs** when a school enters Pilgrim's discharge canal and thermal plume; approximately 90% of the fish exhibit signs of gas bubble disease. The resulting kill was estimated at 43,000 fish.

The only assessments of **Pilgrim's impact on phytoplankton and zooplankton** were done from 1973 to 1975.[6]

<u>1974</u>: Boston Edison **installs an off gas treatment system**, a technology which attempts to reduce the radioactivity of gases that are removed from the radioactive steam that turns the turbine in the condenser.[7]

<u>1974-1975</u>: Boston Edison **proposes to add 2 additional nuclear reactors** to the Pilgrim site (Units 2 and 3). Proposal generates significant opposition.

<u>1974-1980</u>: Opposition to Boston Edison's plans to add two new reactors at Pilgrim (Units 2 and 3) builds on a local and state-wide level, especially after the Three Mile Island nuclear accident in 1979. Following numerous legal appeals by Plymouth County Nuclear Information Committee and others, Boston Edison withdraws its proposals by 1980. Attorney Bill Abbott and others represents local residents seeking to block Units 2 and 3.

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[4] Boston Edison memo PNPS File No. TCH 82-73.

[5] Normandeau Associates. Apr. 2013. *Impingement of organisms on the intake screens at Pilgrim Nuclear Power Station, Jan. – Dec. 2012*. In: Entergy Nuclear – Pilgrim Station. 2013. Marine Ecology Studies Jan. 2012 – Dec. 2012, Report No. 81, Section 2.3.

[6] Toner R.C. *Zooplankton of western Cape Cod Bay*; Toner R.C. *Phytoplankton of western Cape Cod Bay*. Both in: *Observations on the ecology and biology of western Cape Cod Bay, Massachusetts*. 1984. Eds, Davis, J.D. and D. Merriman. Springer-Verlag.

[7] Cargill E.B. *Survey of Documents Concerning the Operation of Pilgrim Nuclear Power Station* [Preliminary Draft]. <http://www.pilgrimwatch.org/cargill.pdf>

<u>1975</u>: Massachusetts Department of Environmental Protection (MassDEP) and U.S. Environmental Protection Agency (EPA) issue **water pollution permit** under state and federal laws to Boston Edison for Pilgrim's discharge of heated water and other pollutants into Cape Cod Bay.[8] Use of once-through cooling water system continues unchanged; Pilgrim continues to discharge radiological waste to Cape Cod Bay.

On the issue of **spent fuel storage** (high level radioactive waste), legal notice in the U.S. Federal Register of September 16, 1975 says,

> "[E]lectric utilities planning to construct and operate light water nuclear power reactors contemplated that the used or spent fuel discharged from the reactors would be chemically reprocessed…. It was contemplated by the nuclear industry that spent fuel would be discharged periodically from operating reactors, stored in onsite fuel storage pools for a period of time to permit decay of the radioactive materials contained within the fuel and to cool, and periodically shipped offsite for processing.

<u>1976</u>: Scientists concerned about the **impact of Pilgrim's cooling water system on marine life in Cape Cod** Bay advocate for monitoring and oversight. Study of ichthyoplankton populations completed.

On August 5, 1976 a **"large impingement event" occurs,** and **1,900 alewife** (a species of protected river herring) are impinged on Pilgrim's intake screens.

<u>1978</u>: On February 6, 1978 Pilgrim has an **emergency scram** when heavy snowfall caused by the Blizzard of 1978 causes electrical breakers in the 345 kilovolt switchyard to flashover and trip.[9]

Pilgrim has **another emergency scram on August 6, 1978**: the reactor automatically scrams from 100% power when **lightning strikes transmission lines causing a LOOP (loss of offsite power)**. The emergency diesel generators automatically started and connected to their electrical buses. The operators manually started the reactor core isolation cooling and high pressure coolant injection systems to maintain reactor water level. The operators opened a safety relief valve to control reactor pressure. Offsite power is restored about 30 minutes later.[10]

From November 23-28, 1978 another **"large impingement event" occurs,** and **10,200 Atlantic menhaden** are impinged on Pilgrim's intake screens. Again from December 11-29, 1978 a "large impingement event" takes place, where **6,200 rainbow smelt** are killed on Pilgrim's screens.

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[8] *Entergy v. MassDEP*, 459 Mass. 319 (2011), Decision by Mass. Supreme Judicial Court

[9] Attachment 3 to March 3, 2015 Letter to Governor Baker. Summary and Excerpts from: NRC Supplemental Inspection Report 05000293/2014008 and Assignment of Two Parallel White Performance Indicator Findings, 1/26/15. <https://files.ctctcdn.com/3f5c2ed6201/d4fc04ec-bcef-481b-a9e8-9cfb8ef3aea1.pdf>

[10] Exhibit 3 to Affidavit of William Maurer, submitted with Petitioners' Pre-Filed Testimony in Waterways Appeal, June 29, 2015 MassDEP's Office of Appeals and Dispute Resolution, Docket 2015-009. <http://www.capecodbaywatch.org/wp-content/uploads/2015/09/Maurer-Exhibit-3.pdf>

<u>1979</u>: In March 1979, there is a meltdown at **Three Mile Island** nuclear reactor in Pennsylvania.

In March and April 1979, a **"large impingement event" occurs,** where **1,100 Atlantic silversides** are impinged.

On July 27, 1979, Pilgrim has **another emergency scram**. The reactor automatically scrams when a lightning strike causes a LOOP.[11] About a month later, on August 28, 1979, Pilgrim has **another emergency scram**. Again, the reactor automatically scrams when a lightning strike causes a LOOP.[12]

1980s

<u>1981</u>: Over a 2-day period (September 23-24, 1981) **6,000 Atlantic silversides** are killed in a **"large impingement event."**

<u>1982</u>: In January 1982, **NRC issues a $550,000 penalty** to Boston Edison for mismanagement and mechanical failures at Pilgrim, one of the largest NRC fines in U.S. history.[13]

U.S. Congress passes the **National Waste Policy Act** in 1982, in an effort to deal with high level nuclear waste disposal (spent fuel). Pilgrim's spent fuel remains stranded in the wet pool inside the reactor, and is never sent off site for reprocessing or disposal as planned in 1967 when Pilgrim was built. The law requires the U.S. Energy Department to identify and built two sites for long term deep geological storage of the nation's nuclear waste.

In June 1982, a **radioactive material, Cesium-137 is released into the air** when Pilgrim's filters burst.[14] Highly radioactive resin beads and particulate matter were found to have been accidentally injected into the ventilation system and outside the building. Material was discovered on roofs of several buildings and on grounds of the site. Pilgrim's Environmental Radiation 1982 Report outlines test results for milk and vegetation samples from farms 0.7 to 12 miles away from Pilgrim. Due to contamination by radioactive materials, cows at the Plymouth County Farm on Obery Street in Plymouth are killed and buried on site.[15]

On October 12, 1982, high winds cause salt accumulation on electrical equipment that led to an electrical fault and a **LOOP** lasting about 1 minute.[16,17]

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[11] *Ibid*. 10
[12] *Ibid*. 10
[13] Ackerman J. Jan. 20, 1982. $550,000 fine asked for Pilgrim N-plant. Boston Globe.
[14] Pilgrim Watch. "Emissions" <http://www.pilgrimwatch.org/emissions.html>
[15] Source: available on request.
[16] [Pilgrim] Licensee Event Report LER 1982051. See Maurer W. Aug. 5, 2015 email to NRC. <http://pbadupws.nrc.gov/docs/ML1521/ML15218A227.pdf>
[17] *Ibid*. 10

1983: Pilgrim loses off site power due to a February 1983 Nor'easter/blizzard. High winds cause salt accumulation on electrical equipment that leads to an electrical fault and **LOOP** lasting about 1 minute.[18]

Pilgrim **shuts down** in December 1983 to replace cracked circulation system piping.[19]

In July 1983, EPA and MassDEP issue joint **water pollution permit** (National Pollutant Discharge Elimination System, or NPDES, permit) under the Federal Clean Water Act for Pilgrim's once-through cooling water system.

1986-1989: From April 1986 to January 1989, Pilgrim **shuts down** due to a series of mechanical failures.[20]

1986: In April 1986, there is a **nuclear meltdown at Chernobyl** nuclear power plant in the Ukraine.

In May 1986, the NRC identifies Pilgrim as **one of the most unsafe nuclear facilities in the U.S.**[21]

In July 1986, MASSPIRG, 50 state legislators, and more than a dozen citizen groups **file a petition with the NRC** requesting a formal hearing on suspension or revocation of Pilgrim's license to operate. The NRC failed to consider the petition fully and fairly.[22]

On November 19, 1986, while the plant is in cold-shutdown, ice buildup on electrical equipment causes a fault and a **LOOP** lasting about 1 minute.[23] Also in November 1986, voters in Plymouth and Kingston approve local referenda to shut down Pilgrim.

1987: On March 31, 1987, while the plant is in cold-shutdown, **heavy winds cause an electrical fault and a LOOP** lasting about 1 minute.[24]

Court testimony of Dr. Richard Clapp, epidemiologist, Boston University in 2014 states that, in 1987, **Pilgrim exposed more of its workers to radiation than any other commercial nuclear plant in the U.S.**[25]

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[18] *Ibid*. 9

[19] Sovacool BK. Jan. 2011. Questioning the safety and reliability of nuclear power: An assessment of nuclear incidents and accidents. Gaia, 20/2: 95-103. <http://www.capecodbaywatch.org/wp-content/uploads/2012/06/Sovacool-Gaia-Nuclear-Accidents.pdf>

[20] Lochbaum D. May 2004. U.S. nuclear plants in the 21st century: The risk of a lifetime. Report by the Union of Concerned Scientists. <http://www.capecodbaywatch.org/wp-content/uploads/2012/06/nuclear04fnl.pdf>

[21] Pertman A. May 23, 1986. Boston Globe article. Pilgrim on list of worst-run nuclear units; NRC cites potential hazards.

[22] Congressional Hearing. Jan. 7, 1988. Plymouth. Transcript available at <https://archive.org/stream/restartofpilgrim00unit/restartofpilgrim00unit_djvu.txt> and U.S. Government Printing Office 83-478.

[23] *Ibid*. 10

[24] *Ibid*. 10; LER 1987005

A study is published in 1987 shows **5 towns around Pilgrim with a 60% increase in leukemia rate**, excluding leukemia not caused by radiation exposure. The rate of myelogenous leukemia (the type most likely to be triggered by exposure to radiation) among males in the 5 towns found to be 2.5x greater than statewide average.[26]

In 1987, protesters affiliated with Citizens Urging Responsible Energy and others opposed to Pilgrim coming back online after the 1986-1989 shutdown are **arrested for blocking the entrance to Pilgrim**. Issues include lack of adequate emergency planning.

In October 1987, critics including **Governor Dukakis ask the NRC to revoke Pilgrim's operating license** due to inadequate emergency plans and public safety hazards.[27]

On November 12, 1987, while the plant is in cold-shutdown, high winds caused **salt accumulation on electrical equipment that led to an electrical fault and a LOOP** lasting 21 hours and 3 minutes.[28]

1988: Before Pilgrim comes back online in 1989, a **congressional hearing is held in Plymouth on January 7, 1988 before the Senate Committee on Labor and Human Resources** (under Ted Kennedy) examining the proposed restart of Pilgrim and the potential implications for public safety and health.[29]

On January 21, 1988, a 5,000 cubic yard pile of dirt containing **radioactive cesium-134, cesium-137, and cobalt-60** is found in a parking lot near the reactor.[30]

In October 1988, at a public meeting about Pilgrim, the **NRC has an aide to Governor Dukakis removed** for saying that Boston Edison lacked an adequate emergency plan for Pilgrim. The NRC subsequently apologized.

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[25] Affidavit of Dr. Richard Clapp, MPH, in support of Plaintiffs' opposition to defendant Entergy's motion to dismiss plaintiffs' first amended complaint for lack of standing. June 2014. 19 pp.

[26] Cobb S. et al. Leukemia in Five Massachusetts Coastal Towns. Abstract for the American Epidemiologic Society. March 18, 1987.; and Clapp RW, Cobb S, Chan, Walker B. 1987. Leukemia near Massachusetts nuclear power plant. Lancet. 2:1324-5. PMID 2890916. <http://www.ncbi.nlm.nih.gov/pubmed/2890916>

[27] New York Times. Jan. 1, 1989. Pilgrim Reactor Restarted After 3-Year Shutdown. <http://www.capecodbaywatch.org/wp-content/uploads/2012/06/1989.01.01_NewYorkTimes_RestartsAfter3Years.pdf>

[28] *Ibid*. 10

[29] *Ibid*. 22

[30] Tye L. Boston Globe. Jan. 21, 1988. Radioactivity detected in dirt pile near Pilgrim. <http://www.capecodbaywatch.org/wp-content/uploads/2012/06/1988.01.21._BG_RadioactiveDirtPile.pdf>

<u>1989</u>: In January 1989, **Pilgrim goes back online** after a two year and three month shut down following mechanical failures including radiological emissions resulting from blown air filters. National media covers the story, including New York Times.[31]

1990s

<u>1990</u>: In October 1990, the Massachusetts Department of Public Health (MassDPH), Division of Environmental Health Assessment publishes a report titled "The southeastern Massachusetts health study, 1978-1986," to investigate if communities near Pilgrim have elevated leukemia mortality rates associated with radioactive plant discharges. The report found a **two to four fold increase in the risk of leukemia among residents of certain towns within a 20 mile radius from the plant**.[32]

<u>1991</u>: From July 22-25, 1991 a **"large impingement event" occurs,** and **4,200 rainbow smelt** are impinged on Pilgrim's intake screens.

On October 30, 1991, a nor'easter that evolved into a hurricane, nicknamed the **"1991 Perfect Storm,"** forces shut down of Pilgrim when it **blows seaweed into the intake structure,** clogging the circulating water pumps, and causing a loss of condenser vacuum.[33]

EPA and MassDEP, in 1991, **renews Pilgrim's Clean Water Act NPDES permit** for continued use of once-through cooling water system and discharges of heated water and other pollutants to Cape Cod Bay. Pilgrim's cooling system remains unchanged, no technology improvements required. Impingement and entrainment of marine life continues. Permit set to expire in 1996 (pursuant to the five year term set by law). Boston Edison continues "monitoring" impact to marine life and discharges to Cape Cod Bay.

<u>1992</u>: On December 13, 1992 a **nor'easter/blizzard causes an emergency shut down.** Forced automatic scram occurs due to a generator load rejection caused by flashovers in the switchyard, which are caused by salt deposits during the severe storm.[34]

<u>1993</u>: On March 13, 1993 a superstorm nicknamed the **"Storm of the Century" causes Pilgrim's reactor to automatically shut down** due to a generator load rejection caused by flashovers in the switchyard which are caused by wind-packed snow during blizzard conditions.[35]

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[31] *Ibid*. 26
[32] Morris, M., and Knorr, R.: The southeastern Massachusetts health study, 1978-1986. Report of Massachusetts Department of Public Health, Boston, October 1990.
[33] *Ibid*. 10; LER 1991024 Loss of Preferred and Secondary Offsite Power Due to Severe Coastal Storm While Shutdown.
[34] *Ibid*.10; LER 1992016 Automatic Scram Resulting From Load Rejection at 48 Percent Reactor Power.
[35] *Ibid*. 10; LER 1993004

On September 10, 1993 **Pilgrim's reactor automatically shuts down after lightning strikes** cause switchyard breakers to open.[36]

From December 15-28, 1993 a **"large impingement event" occurs,** and **5,100 Atlantic silversides** are impinged on Pilgrim's intake screens.

<u>1994</u>: U.S. EPA and MassDEP **amend Pilgrim's 1991 Clean Water Act NPDES permit** to allow discharges of additional pollutants.

From November 26-28, 1994 a **"large impingement event" occurs,** and **5,800 Atlantic silversides** are impinged on Pilgrim's intake screens. Another "large impingement event" occurs from December 26-28, where **11,400 Atlantic silversides and rainbow smelt are killed.**

<u>1995</u>: In a two day period (September 8-9, 1995), **13,100 alewife** are killed in a **"large impingement event."**

<u>1996</u>: Pilgrim's Clean Water Act **NPDES permit expires**, but is "administratively extended" by U.S. EPA and MassDEP.

<u>1997</u>: Massachusetts **deregulates** the energy industry.[37]

In the late 1990s, Pilgrim's consultants estimated that "entrainment of [winter flounder] larvae through the Pilgrim facility in 1997 resulted in a **loss to the adult Plymouth/Duxbury Bay population of 9-41%** (range based on projections from different models)."[38]

<u>1998</u>: In 1998, **one of the highest records of larval winter flounder entrainment occurred** (77,000 equivalent adults), which was nearly 30% loss of the adult population that year.[39]

<u>1999</u>: Entergy Nuclear Generation Company purchases Pilgrim, including 1,600 acres of land, from Boston Edison for $80 million; $13 million was for the facility and the 1,600-acres, and the remaining $67 million was for the nuclear fuel. Pilgrim's Clean Water Act NPDES permit transferred to Entergy.

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[36] *Ibid*. 10; LER 1993022

[37] Commonwealth of Mass. Legislature. 1997. Chapter 164. An Act Relative to Restructuring the Electric Utility Industry in the Commonwealth, Regulating the Provision of electricity and other services, and promoting enhanced consumer protections therein.

[38] Letter to EPA from Szal G.M. (PATC), Dec. 8, 1998. Re: Pilgrim Nuclear Power Plant.

[39] Letter to EPA from MassCZM, Jun. 27, 2000. Re: MCZM review of the Entergy-Pilgrim Station §316 Demonstration Report.

In August 1999, EPA and MassDEP designate the Plymouth-Carver Aquifer as a Sole Source Aquifer under the Safe Drinking Water Act. The designation states, "if contamination were to occur, it would pose a significant health hazard and a serious financial burden to the area's residents."[40] **Pilgrim sits on top of the aquifer, and has been leaking radionuclides into the ground since at least 2007**.[41]

In a 2-day period (September 17-18, 1999), a **"large impingement event"** occurs where **4,910 Atlantic menhaden** are impinged on Pilgrim's intake screens.

2000 to 2005

2000: From November 17-20, 2000 a **"large impingement event" occurs,** and **19,900 Atlantic menhaden** are impinged on Pilgrim's intake screens.

2001: The **September 11th terrorist attacks** on the U.S. raise new issues about the vulnerability of Pilgrim as a terrorist target. One of the planes flown by the terrorists took off from Boston and flew directly over Entergy's Indian Point reactors outside New York City.

2002: In January 2002, the **U.S. Coast Guard unilaterally imposes a "safety security zone" along the shoreline in front of Pilgrim**.[42] The public is excluded from the area, which includes 1 mile of Massachusetts' tidelands. The tidelands are public lands, held in trust for public benefit, and activities undertaken by private entities such as Entergy in the tidelands are governed by the Massachusetts Waterways Law, Chapter 91 and associated regulations. Entergy never obtained Chapter 91 approval for the safety and security zone in front of Pilgrim. This zone will exclude the public as long as Pilgrim operates and/or spent nuclear fuel is stored at the site. State regulators have failed to act to protect public interest in the tidelands in front of Pilgrim.

On February 5, 2002, Stratus Consulting publishes a report for EPA entitled "Habitat-based replacement costs: An ecological valuation of the benefits of minimizing impingement and entrainment at the cooling water intake structure of the Pilgrim Power Generating Station in Plymouth, Massachusetts." The report estimates that, on average, **14.5 million fish and 160 billion blue mussels are killed each year at Pilgrim through impingement and entrainment combined.**[43]

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[40] 55 Fed. Reg. 32137.

[41] MassDPH. *Summary of Tritium Detected in Groundwater Monitoring Wells, Pilgrim Nuclear Power Station, Plymouth, MA*, *2007.* <http://www.mass.gov/eohhs/gov/departments/dph/programs/environmental-health/exposure-topics/radiation/environmental-monitoring.html>

[42] 67 Fed. Reg. 4218

[43] Stratus Consulting. 2002. Habitat-based replacement costs: An ecological valuation of the benefits of minimizing impingement and entrainment at the cooling water intake structure of the Pilgrim Power Generating Station in Plymouth, Massachusetts. Report for the U.S. EPA, Region 1. <http://www.capecodbaywatch.org/library/stratusreport>

In August and September, 2002, a **"large impingement event" occurs,** and **33,300 Atlantic menhaden** are impinged on Pilgrim's intake screens.

2003: On May 19, 2003 Pilgrim's reactor **scrams** due to spurious operation of the turbine bypass valves.

On November 1, 2003 a **"large impingement event" occurs,** and **2,500 Atlantic menhaden** are impinged on Pilgrim's intake screens. In the same month, **three more "large impingement events"** happen: From November 12-17, **63,900 Atlantic menhaden** are impinged, from November 19-21, **17,900 sand lance and Atlantic menhaden** are impinged, and on November 29, **3,900 Atlantic silversides** are impinged.

2005: 97% of the more than 300,000 fish Entergy impinged in 2005 were Atlantic menhaden. There were also 19 impingement events where more than twenty fish were collected off the intake screens per hour, which consisted primarily of Atlantic menhaden and Atlantic silversides. There was one large impingement event in 2005 (August 16-18) which involved exclusively young Atlantic menhaden. This event in 2005 was **the largest single impingement event in Pilgrim's history** with a total of 107,000 fish impinged.

The National Academies of Science develops a report in 2005 called "Health Risks from Exposure to Low Levels of Ionizing Radiation," which finds that there is **no safe level of exposure to radiation**; even low doses can cause cancer. To address this, EPA sets a Maximum Contaminant Level Goal (MCLG) for all radionuclides (including tritium) as ZERO. EPA defines MCLG as the "level of a contaminant in drinking water below which there is no known or expected risk to health."

2006 to 2010

2006: Entergy files application seeking to renew its operating license with the NRC for a **20-year extension**, until 2032. The NRC process for relicensing Pilgrim begins. By the time Pilgrim is relicensed in May 2012, Pilgrim's 6-year hotly contested relicensing application will make the proceeding the longest in NRC history.

In 2006, the Nuclear Entergy Institute proposes that nuclear facilities in the U.S. begin **voluntary tritium monitoring in groundwater**. This recommendation came after tritium, a radioactive isotope of hydrogen, was being found at high levels at several nuclear facilities throughout the U.S.

In 2006, Pilgrim impinges an estimated total of **29,711 fish** consisting of 34 species, as well as **9,619 invertebrates** representing 13 taxa.[44]

[44] Normandeau Associates. Mar. 2007. Impingement monitoring, Section 3.3. In: Entergy Nuclear – Pilgrim Station. 2007. Marine Ecology Studies Jan. 2006 – Dec. 2006, Report No. 69.

2007: In January 2007, **Entergy sues MassDEP to prevent implementation of new state Clean Waters Act regulations at Pilgrim.** The new regulations seek to prevent the "unique set of environmental harms" caused by Pilgrim's once-through cooling system.[45] Entergy lost the case and the regulations take effect, but MassDEP fails to enforce the regulations. Entergy is allowed to continue to operate with an expired NPDES permit and outdated once-through cooling system.[46]

On March 17, 2007 operators **scram Pilgrim's reactor due to an increasing trend in unidentified drywell leakage.**

On November 29, 2007 Entergy begins "voluntary" groundwater monitoring with its first 6 monitoring wells on the Pilgrim site (by 2015, 24 wells exist). **Radioactive tritium has found in groundwater at Pilgrim every year since testing began.** Other radionuclides also present.[47]

In 2007, due to marine monitoring efforts required by its Clean Water Act NPDES permit, Entergy reports an impinged annual extrapolated total of 162,991 fish consisting of 36 species. Atlantic menhaden accounted for 95% of the total (154,832 fish). Atlantic silversides (3,362 fish), rainbow smelt (1,191 fish; federally listed species of concern), and winter flounder (715 fish) were also dominants. The **2007 impingement total was nearly 4x the 27-year mean** due in part to the **"large impingement event"** of juvenile menhaden that occurred on September 14-15 (6,500 fish).[48]

In 2007, Pilgrim impinges an estimated annual total of **8,884 invertebrates** representing 12 taxa.

2008: On December 19, 2008 a **nor'easter/blizzard causes Pilgrim's reactor to automatically scram** when icing occurs in the main switchyard.[49]

In 2008, Entergy impinges an estimated annual total of **11,821 fish, consisting of 37 species, as well as 8,309 invertebrates.**

2010: In January 2010, Vermont Yankee Nuclear Power Station (also owned by Entergy) notifies the Vermont Department of Health that samples taken in November 2009 from a groundwater monitoring well contains dangerously high tritium levels (a radioactive form of hydrogen). The Vermont leak prompts Plymouth-area citizens groups to demand more test wells at Pilgrim.

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[45] Entergy v. Mass. Department of Environmental Protection, 459 Mass. 319 (2011).
[46] Pilgrim's 1991 NPDES permit is still not renewed or updated as of August 2015.
[47] MassDPH reports available at <http://www.mass.gov/eohhs/gov/departments/dph/programs/environmental-health/exposure-topics/radiation/environmental-monitoring.html>
[48] Normandeau Associates. Oct. 2008. Impingement monitoring, Section 3.3. In: Entergy Nuclear – Pilgrim Station. 2008. Marine Ecology Studies Jan. 2007 – Dec. 2007, Report No. 71.
[49] *Ibid*. 10; LER 2008006; LER 2008007.

Due to **rising levels of tritium** in Pilgrim's groundwater testing well #205 in July 2010 (more than 25,000 picocuries per liter (pCi/L) is found), DPH recommended that Entergy install even more wells and start testing surface water as well. By August 2010, 6 additional wells were installed.

On July 29, 2010 a **"large impingement event" occurs,** and **1,061 alewife** are impinged on Pilgrim's intake screens.

Overall in 2010, Pilgrim impinges an estimated total of **32,962 fish consisting of 33 species, as well as 12,454 invertebrates** representing 13 taxa.

2011 to 2012

2011: On March 11, 2011 a massive earthquake off the northeastern coast of Japan and the devastating tsunami that followed set off a chain of problems at the **Fukushima Daiichi Nuclear Power Station** that eventually led to the worst nuclear accident since Chernobyl. Tsunami floods backup generators, causing failures and cutting power to pumps – overheating and meltdowns ultimately occur. Pilgrim's reactor is the same General Electric Mark I design as those at Fukushima. Unconfirmed reports say that the reactor parts built by General Electric for the cancelled Units 2 and 3 at Pilgrim were sent to Japan for use at Fukushima.

On May 10, 2011, Pilgrim's reactor automatically **scrams** on high-high flux on the intermediate range monitors during startup.

2012: On March 12, 2012 the NRC sends a letter to all U.S. nuclear reactors **requesting information to support the NRC's Near-Term Task Force (NTTF) review of the Fukushima Dai-ichi nuclear accident**.[50] The NRC establishes the NTTF after the Fukushima accident to review what happened and improve response and readiness of the U.S. nuclear fleet to beyond design basis events. The NTTF developed a report and recommendations. The NRC requires the nuclear industry, including Pilgrim, to implement **Diverse and Flexible Coping Strategies ("FLEX Strategy")** to address certain mitigation strategies for "Beyond-Design-Basis External Events" such as flooding and earthquakes that can disable Pilgrim's cooling systems. Part of the NRC's March 12, 2012 request addressed NTTF's Recommendation 2.1, and directed licensees to **reevaluate flood hazards** at reactor sites.

On March 30, 2012 the **Cape Cod National Seashore Advisory Commission sends letter to NRC asking that Pilgrim not be relicensed**.

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[50] NRC, Mar. 12, 2012. <http://pbadupws.nrc.gov/docs/ML1205/ML12053A340.pdf>

On May 3, 2012 State **Senator Dan Wolf calls for the closing of Pilgrim** in a letter to the NRC.[51]

On May 11, 2012 the NRC provides nuclear licensees with a prioritization plan and the resultant list of due dates for all for individual plants to complete flood reevaluations (based on their March 12th Request for Information).[52] **Entergy's Hazard Reevaluation Report for flooding at Pilgrim is due March 12, 2015.**

Later in May (12th), **Plymouth voters approve a referendum 59% to 41%** asking the NRC to not relicense Pilgrim until their recommendations learned from Fukushima could be implemented.[53] At this point Duxbury, Provincetown, Kingston, Scituate, Marshfield, Truro, Mashpee and Brewster all approve referendums saying the same thing.

A **labor dispute** at Pilgrim begins in May 2012. On May 16, 2012[54] Pilgrim Watch and Jones River Watershed Association (JRWA) file a legal petition asking the NRC to close Pilgrim since the plant can't be operated safely with replacement workers that have not received site specific training; do not have years of experience at the site; do not have a history specific to Pilgrim. Pilgrim Watch, on May 18th, files a supplemental petition.[55]

On May 22, 2012 operators **shut down, or scram,** Pilgrim's reactor from 35% power due to increasing condenser pressure.

On May 25, 2012 **NRC votes 3-1 to extend Pilgrim's operating license for another 20 years, until 2032**. NRC Chairman Jazcko opposes relicensing and in lengthy comments cites to the unprecedented situation of the NRC commissioners voting to relicense Pilgrim despite pending citizen challenges that have been referred to the NRC's administrative appeal board.

On June 4, 2012 Pilgrim's **labor dispute boils over, with Entergy management locking out 250 unionized workers for more than a month** and both sides accusing the other of compromising public safety. Entergy demands "major concessions on health care, salary and staffing." Pilgrim implements an emergency staffing plan. Pilgrim Watch files five supplemental requests in June 2012 based on new facts and events they say show Entergy is violating its NRC operating license.[56]

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[51] http://www.pilgrimcoalition.org/wp-content/uploads/2012/05/050312-Wolf-to-NRC.pdf

[52] <http://www.capecodbaywatch.org/wp-content/uploads/2012/06/May-11-2012-NRC-Response-Dates.pdf>

[53] Pilgrim Coalition press release: Plymouth Votes to ask NRC to Suspend Relicensing of Pilgrim Reactor.

[54] <http://www.capecodbaywatch.org/wp-content/uploads/2012/06/05.-16.12-STRIKE-2.206.pdf>

[55] <http://www.capecodbaywatch.org/wp-content/uploads/2012/06/05.-16.12-STRIKE-2.206.pdf>

[56] <http://www.capecodbaywatch.org/2012/06/supplement-to-2-206-enforcement-petition-regarding-labor-dispute-at-pilgrim/>

On June 8, 2012 **Entergy responds by letter to the NRC's Request for Information regarding the flooding aspects** of Recommendations 2.1 and 2.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident.

On October 3, 2012 the **Mass. Emergency Management Agency (MEMA) publicly admits the Bourne and Sagamore Bridges will be closed if there is an accident at Pilgrim**. MEMA says Cape Cod residents and visitors must "shelter in place" and then will "relocated" after everyone north has been evacuated.[57]

On October 5, 2012 local residents send EPA, MassDEP, and Entergy an "**intent to sue" notice letter under state and federal water pollution laws for Entergy's violations of the Clean Water Act.**[58] Entergy threatens to sue citizens in return. Due to the intent to sue, EPA and MassDEP promise to renew expired Clean Water Act NPDES permit by December 2012 - promise broken.

On October 29, 2012 Hurricane Sandy hits New York. Oyster Creek Nuclear Station in New Jersey declares a rare "emergency alert" due to power outages and equipment dangerously close to being submerged. **America's nuclear safety, including at Pilgrim, comes under scrutiny after Oyster Creek's Sandy alert.**

In 2012, Pilgrim **impinges an estimated extrapolated total of 9,287 fish representing 34 species, as well as a total of 11,931 invertebrates**.

2013

2013: On January 10, 2013 operators **shut down** Pilgrim's reactor (scram) after both recirculation pumps tripped.

On Jan 12, 2013 a **critically endangered North Atlantic right whale mother named Wart and her newborn calf are seen swimming close to Pilgrim**. This is the first mother-calf right whale sighting in Cape Cod Bay in January in 27 years, and the only mother-calf pair ever documented occurring near Pilgrim. Local groups ask the National Marine Fisheries Service and the NRC to reinitiate consultation under Section 7 of the Endangered Species Act (ESA).

[57] Remarks by MEMA director Kurt Schwartz at the Barnstable County Regional Emergency Planning Committee Oct. 3, 2012 Harwich Community Center <http://capedownwinders.org/wp-content/uploads/pdf/MEMA_Dir_Schwartz_BCREPC_121003_highlighted.pdf>

[58] http://www.capecodbaywatch.org/wp-content/uploads/2012/10/10.05.12-noi-w-exhibits.pdf

On February 8, 2013 Pilgrim's reactor automatically shuts down when a blizzard nicknamed "**Nemo**" causes a **LOOP**.[59]

In April 2013, an underground line leading to the discharge canal ("neutralization sump discharge line") is suspected to have separated and begun **leaking tritium**. The tritium leak is accidentally discovered when water was discovered coming out of an electrical junction box at the facility.[60]

On April 14, 2013 operators manually **shut down** Pilgrim's reactor (scram) due to reactor pressure lowering beyond established control bands.

On June 10, 2013 the **Cape Cod National Seashore Advisory Commission** sends a letter to Governor Patrick asking him to support 14 Massachusetts towns on Cape Cod that have passed warrant articles or ballot questions calling on NRC to shut Pilgrim.[61]

During the July 2013 heatwave, **Cape Cod Bay's water temperature rose above 75^{o}F**, requiring Pilgrim to shut down in order to comply with its NRC license.

In July 2013, the U.S. Department of Energy published a **report outlining vulnerabilities to climate trends at energy facilities, including nuclear power stations**. The report specifically cites climate change patterns such as increasing air and water temperatures, increasing intensity of storm events, sea level rise, and storm surges as having potential negative implications for thermoelectric forms of power generation (including nuclear facilities).[62]

In August 2013, a report commissioned by the Pentagon and published in August 2013 highlights the vulnerability of nuclear power plants nationwide to terrorist attacks. The report specifically **cites Pilgrim as one of eight plants most vulnerable to a water-borne attack**.[63]

In August 2013, local residents file **legal appeal over Entergy's failure to comply with Town of Plymouth's zoning laws** for Pilgrim's dry cask storage facility for long term storage of high-level nuclear waste. (Legal appeal pending in Massachusetts Land Court as of September 2015.)

On August 22, 2013 operators **shut down** Pilgrim's reactor (scram) due to lowering reactor water level. The cause of the lowering water level was due to the trip of all three feedwater pumps.

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[59] NRC. Event Report 48736. <http://www.nrc.gov/reading-rm/doc-collections/event-status/event/2013/20130211en.html>

[60] Old Colony Memorial. Apr. 20, 2013. PILGRIM STATION: Tritium source accidently discovered. <http://www.capecodbaywatch.org/wp-content/uploads/2012/10/Print.pdf>

[61] Cape Cod National Seashore Advisory Commission Letter to Governor Patrick, Jun. 10, 2013. <http://www.nps.gov/caco/learn/management/upload/Adv-Com-letter-to-Gov-Patrick-re-Pilgrrim-nuclear-plant-6-10-13.pdf>

[62] U.S. Dpt. of Energy. 2013. U.S. Energy Sector Vulnerabilities to Climate Change and Extreme Weather. 84 pp.

[63] Kirkham L., and A.J. Kuperman. Aug. 2013. Protecting U.S. nuclear facilities from terrorist attack: re-assessing the current "design basis threat" approach. Nuclear Proliferation Prevention Project, LBJ School of Public Affairs, University of Texas at Austin. Working paper #1. 33 pp.

In September 2013, MassDPH reported that **tritium levels from one of Pilgrim's groundwater sampling wells was trending higher** than other wells on the site (4,882-5,307 pCi/L of tritium detected in well #216 in August). MassDPH reported that the leak could be related to the separated "neutralization sump discharge line" and more investigation would be needed.[64]

On Oct 14, 2013, a **LOOP** occurs due to the loss of the second 345kV line 355 (power line out of service).

In October 2013, tritium levels in Pilgrim's groundwater monitoring well #216 continue to trend higher than the other wells (3,330-5,720 pCi/L). **Tritium** levels in wells #209 and #211 are also trending higher (797-1,350 pCi/L). The separated "neutralization sump discharge line" is again cited as a possible source by MassDPH. Tritium, cobalt-60, and cesium-137 is also found in soil at levels above normal.[65]

In 2013, led by Cape Downwinders, **all 15 towns on Cape Cod vote to support a nonbinding ballot question or a town meeting warrant article** that gives citizens the opportunity to vote yes on a statement asking Governor Patrick to call upon the Nuclear Regulatory Commission (NRC) to shut down Pilgrim based on safety concerns.

2014

2014: By January 2014, nine months since Pilgrim's neutralizing sump pump discharge line was originally suspected to have separated and begun leaking tritium, the leak(s) continue. **Excessive levels of tritium (69,000-70,000 pCi/L) were detected in monitoring well #219**.[66]

On January 2-3, 2014 **Winter Storm "Hercules"** and simultaneous high tides affect the Massachusetts coast. The storm drops 8-13 inches of snow in Plymouth County – along with high winds, frigid temperatures, and coastal flooding. What is different about this storm is that at least 2 astronomical high tides occur at the same time as the storm – a relatively rare event. JRWA sends a letter to the NRC suggesting that the storm/tidal events could be a valuable opportunity for the NRC to assess the flooding potential at Pilgrim more accurately.

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[64] MassDPH. PNPS groundwater monitoring update as of Sept. 3, 2013. <http://www.capecodbaywatch.org/wp-content/uploads/2013/09/PNPSUpdate-9-3-20131.pdf>

[65] MassDPH. PNPS groundwater monitoring update as of Oct. 18, 2013. <http://www.capecodbaywatch.org/wp-content/uploads/2013/11/PNPSUpdate-10-18-2013.pdf>

[66] Cape Cod Bay Watch. Jan. 28, 2014. Pollution of the Plymouth-Carver Sole Source Aquifer Continues. <http://www.capecodbaywatch.org/2014/01/pollution-of-the-plymouth-carver-sole-source-aquifer-continues/>

On January 28, 2014 Cape Cod Bay Watch (CCBW) **asks EPA to retire Pilgrim's Clean Water Act NPDES permit** - 18 years expired at this time. In a letter to EPA Administrator Gina McCarthy, CCBW points out EPA's broken promise to renew Pilgrim's permit by December 2013, and that the 18-year delay is unacceptable.[67]

In February, 2014 NRC identifies Pilgrim as **one of the nine worst performing nuclear reactors in the U.S.** because it had the most emergency shutdowns or reactor "scrams" in 2013.

On March 10, 2014 about **65 Cape Codders gathered at Mass. Statehouse** to provide testimony to Governor Patrick, urging him to comply with non-binding referenda passed in every Cape town and ask the NRC to close Pilgrim. About 50 people "occupy" the Governor's office, and a meeting occurs. A week later (March 17), Governor sends letter to NRC Chairman expressing concern about Pilgrim. In his letter he states, "***I urge you to require that the plant be decommissioned should Pilgrim not comply with all health, safety and environmental regulations***."

On March 18, 2014 a criminal trial is held involving **11 activists charged with criminal trespass** at Pilgrim. The activists asserted the "necessity defense," claiming that their actions were necessary to prevent the unacceptable danger caused by Pilgrim's operations. Dr. Richard Clapp, epidemiologist from Boston University, testifies that Pilgrim's continued operation is "a risk and an unacceptable risk in my view." The activists were found guilty and sentenced to one day in jail.[68]

In March 2014, The Association to Preserve Cape Cod issues a position statement regarding threats to Cape Cod's environment from Pilgrim, and **calls on public officials and regulatory agencies to revoke Pilgrim's permits and require that Pilgrim be decommissioned**.[69]

On May 10, 2014 **Plymouth residents overwhelmingly voted to approve Question 1, with 83% of voters voting yes**. Question 1 encourages town leaders to ensure that spent nuclear fuel assemblies (nuclear waste) stored at the Pilgrim Nuclear Power Station are transferred from wet pool to dry cask storage quickly and in the safest way possible.

May 14, 2014 Entergy **applies to MassDEP for a 30-year Chapter 91 permit under the Public Waterfront Act** (Mass. General Laws chapter 91) to use the public lands along the Cape Cod Bay shoreline in front of Pilgrim to install equipment for an emergency cooling water system. Entergy needs to install the equipment to comply with the NRC's "Fukushima Fixes" order and as part of its FLEX strategy.[70]

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[67] CCBW. Letter to EPA, Jan. 28, 2014. <http://www.capecodbaywatch.org/wp-content/uploads/2014/01/NPDESLetter_Final_2014Jan28.pdf>

[68] Gellerman B. Mar. 21, 2014. 12 Protesters Found Guilty of Trespassing at Pilgrim Nuclear. WBUR.

[69] APCC. Pilgrim Position Statement, March 17, 2014. <http://www.apcc.org/positionstatements/statements/2014/Pilgrim-3-17-14.pdf>

[70] <http://www.capecodbaywatch.org/wp-content/uploads/2014/10/Entergy-Chapter-91-Application.pdf>

In May 2014, the NRC orders Entergy to reevaluate Pilgrim's vulnerability to earthquakes, based on new data from the U.S. Geological Survey that says that **Pilgrim is more at risk than previously thought**.[71]

On July 10, 2014 as required by the Clean Water Act, **EPA consults with the NRC on Entergy's claims that it cannot improve the cooling water intake operations** at Pilgrim to prevent environmental destruction because of "nuclear safety" concerns.

On July 21 and July 31, local groups, including JRWA, submit comments to MassDEP concerning Energy's **Chapter 91 application** to install equipment for an emergency cooling water system in Cape Cod Bay.[72]

MassDPH issues its August 2014 report on groundwater testing at Pilgrim. **Tritium levels in wells #216, #218, and #219 are still trending higher**.[73]

In September 2014, Pilgrim Watch and Cape Downwinders **file a petition with the NRC** to "modify, suspend, or take any other action to the operating license of Pilgrim Station until the NRC can assure sufficient land-based security at Pilgrim Station is in place to provide reasonable assurance to satisfy its obligation to protect public health and safety." (Petition still pending).

In November 2014, a **public hearing takes place** on Entergy's MassDEP application for a Chapter 91 Waterways License under state law Chapter 91. Approximately 100 people attend the public hearing in Plymouth held by MassDEP. Entergy needs the Waterways License to implement part of its **"Fukushima Fix"** FLEX plan to provide emergency cooling water from Cape Cod Bay.

On November 4, 2014 **74% of voters in the Cape & Islands Senatorial District vote in favor** of the question: "Shall the state senator from this district be instructed to vote in favor of legislation to expand the radiological Plume Exposure Emergency Planning Zone around the Pilgrim Nuclear Power Station in Plymouth, an approximately 10 mile-radius area, to include all of Barnstable, Dukes and Nantucket counties?"

In 2014, according to Pilgrim's October and December Discharge Monitoring Reports (DMRs),[74] there were **3 significant impingement events**. On October 25, 2014, an impingement rate of 114 fish/hour was recorded during a screenwash (most were juvenile Atlantic menhaden). On December 3, 2014, an impingement rate of 33 fish/hour was recorded during a routine screenwash.

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[71] Legere C. May 1, 2014. Seismic activity exceeds Pilgrim nuke plant's design. Cape Cod Times. <http://www.capecodbaywatch.org/wp-content/uploads/2012/06/2014.05.01_CCT_Seismic.pdf>

[72] <http://www.capecodbaywatch.org/2014/07/Opportunity-for-public-comments-on-Entergy's-Use-of-Public-Land>

[73] MassDPH. PNPS groundwater monitoring update as of Aug. 5, 2014. <http://www.capecodbaywatch.org/wp-content/uploads/2014/08/DPH_Tritium_Aug-2014.pdf>

[74] Entergy. Nov. 2014. Discharge Monitoring Report – October 2014.; and Entergy. Jan. 20, 2015. Discharge Monitoring Report – December 2014.

On December 10, 2014, an impingement rate of 223 fish/hour was recorded during a routine screenwash (most were Atlantic silversides). All 3 events, according to Entergy, were not caused by Pilgrim's operations but were due to "natural circumstances." **Entergy blames the fish for getting trapped in the Pilgrim's cooling system**.

2015

2015: On January 26, 2015 the **NRC issues a Supplemental Inspection Report**[75] based on an inspection carried out from November 3, 2013 to December 12, 2014. This was a response to the NRC's third quarter 2013 finding that Pilgrim had crossed the threshold for allowable unplanned scrams in 2013. The NRC found that after inspection, **Entergy had not adequately addressed problems that had caused the scrams**. The inspection report found "deficiencies in the implementation of corrective action plans, as well as in understanding of the issues' causes. In its report, the team cites several examples where fixes were not completed as intended or were closed prematurely."[76] In the report the NRC also announces it will continue to place Pilgrim in the "**degraded cornerstone**."

In January-February 2015, Entergy **fills the first 3 dry casks with nuclear waste** on the Pilgrim site.

On January 27, 2015 the nor'easter "**Juno**" causes an unplanned shutdown at Pilgrim due to a **LOOP and a variety of other problems**.[77] It remains offline until February 8. This event triggers the NRC to send a **Special Inspection Team** (SIT) on Feb. 2, 2015 to evaluate Pilgrim's equipment problems following the shutdown. The SIT's final report identifies **8 violations of federal safety requirements**. Pilgrim earns 1 "white" finding, 6 green findings, and 1 Severity Level IV non-cited violation. By early June, Entergy appeals the "white finding."

On February 14, 2015 winter storm "**Neptune**" causes **planned shutdown**.

In February 2015, **MassDEP approves Energy's Chapter 91 Waterways application** to install emergency cooling equipment in Cape Cod Bay by issuing a determination letter.

In February 2015, JRWA asks the NRC and Entergy to provide an updated site assessment for the Pilgrim site (for **vulnerability to flooding, storm and wave impacts**). In a letter to the NRC dated February 12, 2015, JRWA states that "Thus far, the information and maps that Entergy has provided to your agency is misleading and inaccurate."[78]

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75 NRC 9002 Supplemental Inspection Report 05000293/2014008

76 NRC Blog, www.nrc.gov, 1/28/15.

77 *Ibid*. 10

78 <http://www.capecodbaywatch.org/2015/02/press-release-pilgrim-site-maps-cut-and-paste-local-group-wants-updates/>

One month later, on March 12, 2015 Entergy submits Pilgrim's "**flooding reevaluation report**" to NRC, which has many deficiencies.

In March 2015, local residents and JRWA **file a legal appeal challenging MassDEP's decision to issue a Waterways (Chapter 91) License for Entergy's "FLEX" Fukushima plan**, which will to put an emergency cooling water system on the Cape Cod Bay shoreline. [Appeal pending]

Also in March 2015, the **NRC holds its annual public meeting** to review Pilgrim's performance. Unlike past years, hundreds of people attend the meeting in Plymouth. Entergy organizes employees, grantees, and others to speak in favor of Pilgrim. Opponents seek answers from NRC on continuing groundwater pollution, inadequate emergency planning, pollution, etc.

In May 2015, Entergy's **Clean Water Act NPDES permit become 19 years expire**d (1996).

On May 26, 2015 **loss of condenser vacuum causes an unplanned shutdown**.

On June 8, 2015, Cape Cod Bay Watch issues a report documenting Entergy's 43-year history of polluting Cape Cod Bay and destroying marine resources. The report, entitled "**Entergy, Our Bay is Not Your Dump," calls on EPA and MassDEP to terminate Clean Water Act NPDES permit**. Twenty-four state and regional groups endorse the report.[79]

On June 11, 2015 Pilgrim Watch, Cape Downwinders, and the Town of Duxbury Nuclear Advisory Committee **file a 2.206 petition to the NRC** to "modify, suspend, or take any other action to the operating license of Pilgrim until the NRC can provide reasonable assurance that adequate protective measures based on accurate information can and will be taken to satisfy the NRC's obligation to protect public health and safety."

From June 13-16, 2015 the "**March for Our Children**," organized by the Mass. Downwinders, takes place. The march is a 4-day, 54-mile event to raise public awareness and to let elected officials know that Pilgrim is a danger to health, economy, and environment. The event ends with a rally (June 16) at Mass. Statehouse. Speakers include former Gov. Mike Dukakis, State Sen. Dan Wolf, and Paul Gunter, founder of Clamshell Alliance and Subrata Ghoshroy, research affiliate at the Program in Science, Technology, and Society at MIT speaking on his recent trip to Fukushima.

On July 28, 2015 the State's **Joint Committee on Public Health and Safety** hears testimony on several bills relating to emergency planning and radiological monitoring at Pilgrim.

On August 9, 2015 Pilgrim is **forced to reduce power due to the water in Cape Cod Bay being too warm. Later in the month**, on August 22, Pilgrim experiences an **unplanned shutdown**, or scram, due to a valve problem.

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[79] CCBW. June 8, 2015. Entergy, our bay is not your dump. <http://www.capecodbaywatch.org/2015-water-pollution-report/#toc>

On September 1, 2015 in response to Entergy's appeal of the SIT's investigation report identifying a "white finding" based on failure to anticipate and/or prevent a safety valve problem during Winter Storm "Juno," the **NRC announces it maintains its "white finding."** One day later (September 2) Pilgrim is **degraded to category IV** by the NRC – the bottom of the performance list of the nation's 99 reactors. This downgrade is based on numerous forced shutdowns and equipment failures, and is **just one step away from mandatory shutdown by federal regulators**. Only 2 other reactors in the country are currently in that category: Arkansas Nuclear One and Arkansas Nuclear Two. These two, like Pilgrim, are Entergy-owned.

On September 17, 2015 Entergy officials announce that **closure of Pilgrim is on the table**.[80] If Entergy cannot afford the multi-million dollar safety improvements and other updates required by federal regulators, then the plant will go offline.

On September 24, 2015 **a hearing takes place at the MassDEP offices** in Lakeville, Mass. The hearing is held before an administrative law judge, and concerns a residents/JRWA appeal that challenges MassDEP's decision to issue a Waterways (Chapter 91) License to Entergy for its "FLEX" Fukushima plans at Pilgrim. The appeal is still pending.

On October 2, 2015 an NRC inspection Of Pilgrim revealed **malfunctioning meteorological towers** at the facility. About a week later, on October 7, media reports reveal that Pilgrim has **posted workers on fire watch** after realizing the plant never addressed a 1992 federal advisory regarding remote reactor shutdown.

On October 13, 2015 Entergy announces that **Pilgrim will close no later than June 2019**.

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[80] Abel, D. Sept. 17, 2015. Pilgrim nuclear plant says it may shut down. Boston Globe. <http://www.capecodbaywatch.org/wp-content/uploads/2015/09/2015.09.17_BosGlobe_PilgMayShutDown.pdf>

Additional Resources:

Beyond Nuclear www.beyondnuclear.org

Cape Cod Bay Watch www.capecodbaywatch.org

Cape Downwinders www.capedownwinders.info

Cape Downwinders Cooperative www.capedownwinders.org

Concerned Neighbors of Pilgrim www.concernedneighborsofpilgrim.org

Massachusetts Downwinders www.madownwinders.org

Pilgrim Coalition www.pilgrimcoalition.org

Pilgrim Watch www.pilgrimwatch.org

Nuclear Information Resource Service www.nirs.org

Union of Concerned Scientists www.ucsusa.org/nuclear-power

U. S. Nuclear Regulatory Commission www.nrc.gov

Acronyms:

EPA	U.S. Environmental Protection Agency
FLEX	Diverse and Flexible Coping Strategies
JRWA	Jones River Watershed Association
LOOP	loss of offsite power
MassDEP	Massachusetts Department of Environmental Protection
MassDPH	Massachusetts Department of Public Health
MEMA	Mass. Emergency Management Agency
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NTTF	NRC's Near-Term Task Force
pCi/L	picocuries per liter
SIT	Special Investigation Team
ZBA	Town of Plymouth’s Zoning Board of Appeals

COASTAL RISK CONSULTING

Analysis of AREVA Flood Hazard Re-Evaluation Report Pilgrim Nuclear Power Station Plymouth, MA

Contents

Acronyms

CLB	Current Licensing Basis
CRC	Coastal Risk Consulting
FEMA	Federal Emergency Management Agency
HMR	Hydrometeorological Report
IPEEE	Individual Plant Examination of External Events
JRWA	Jones River Watershed Association
LIP	Local Intense Precipitation
NHC	National Hurricane Center
NOAA	National Oceanic and Atmospheric Administration
NRC	Nuclear Regulatory Commission
NTTF	Near Term Task Force
NWS	National Weather Service
PCA	Plymouth-Carver Aquifer
PMH	Probable Maximum Hurricane
PMP	Probable Maximum Precipitation
PMSS	Probable Maximum Storm Surge
PMWS	Probable Maximum Wind Storm
PNPS	Pilgrim Nuclear Power Station
SLAMM	Sea Level Affecting Marshes Model
USACE	United States Army Core of Engineers
USGS	United States Geological Survey
WIS	Wave Information Studies

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Executive Summary

The Pilgrim Nuclear Power Station (PNPS), owned and operated by Entergy Nuclear Generation Company, is located in Plymouth, Massachusetts directly on the Cape Cod Bay shoreline. PNPS began operating in 1972, and in 2012 it was granted a new, 20-year operating license by the Nuclear Regularly Commission (NRC, 2015a).

In 2012, the Nuclear Regulatory Commission (NRC) requested information from all U.S. nuclear reactors, including PNPS, to support its review of the Fukushima Daiichi nuclear accident (NRC, 2012). Part of this request addressed flood and seismic hazards at reactor sites. In March 2015, Entergy provided the NRC with a Flood Hazard Re-Evaluation Report prepared by AREVA, Inc. (AREVA, 2015). In September 2015, Jones River Watershed Association (JRWA) commissioned Coastal Risk Consulting, LLC (CRC) to provide an expert analysis of the methodologies and conclusions presented in the AREVA Flood Hazard Re-Evaluation Report.

Since JRWA first requested CRC to analyze the AREVA Report, Entergy announced that PNPS will close no later than June 2019, and possibly as much as two years sooner. Even post shutdown, having a detailed and robust flood assessment for PNPS is important. It will provide the basis for good planning and management for the site leading up to and throughout decommissioning, which will help curb flooding risks and ultimately protect public safety, environmental health, and the economic well-being of the area.

The following key points are presented and explained in this report:

- Local Intense Precipitation is shown in the AREVA Report to be a primary hazard of concern that could inundate the site by as much as 2.5 feet of rainwater (AREVA p. 29). However, the AREVA analysis underestimates this risk by using **outdated precipitation data and not considering future climatic conditions,** which are projected to increase precipitation amounts during heavy rainfall events.

- While the storm surge analysis was robust, **sea level rise over the next 50 years was understated** by relying primarily on historic rates of sea level rise. This approach produces only 0.46 feet of sea level rise by 2065. However, the National Oceanographic and Atmospheric Association (NOAA) estimates sea level rise of 3.05 feet by 2065.

- **Groundwater, subsidence, and erosion are not considered** in the analysis, further underestimating the risks to PNPS, particularly when analyzing the combined effects of extreme storm events.

- In addition to storm surge, other factors and mechanisms such as high tide and wave setup dramatically compound flooding. The main flaw in the Combined Flooding section of the AREVA Report relates to the limitations of the term "combined." **Of the five combined event scenarios provided in the NRC guidance document, NUREG/CR-7046, Appendix H, only one is deemed appropriate for PNPS.** This conclusion disregards a wide range of possibilities for analysis with the available tools.

In general, Entergy's AREVA Report focuses solely on past risk conditions and does not include scenarios that address updated projections for future risk, specifically with regard to climate change.

This report is organized as follows:

Introduction

Background information, history, situation analysis, and brief literature review for Pilgrim Nuclear Power Station.

Tasks 1 & 2

A review of the AREVA Flood Hazard Re-Evaluation Report methodology and results, and an analysis of the methodology for the following sections: local intense precipitation, storm surge, combined flooding, erosion, groundwater and subsidence.

Conclusion

A summary of the most important findings of the AREVA Flood Hazard Re-Evaluation Report and a closing argument concerning the evaluation.

Appendices

- A: Task 3, Modeling assessment of future flooding potential includes Coastal Risk Consulting's FIRST Score™, nuisance flood maps, and storm surge analysis from a category 4 hurricane at high tide for PNPS over 70 years of sea level rise. The full Coastal Risk Rapid Assessment™ (CRRA) is preceded by descriptions of each component.
- B: WIS Wave Gage Locations from AREVA, 2015; Figure 3-36, p. 111.

******For simplicity we have converted all values in Mean Seal Level to NAVD88 using the conversion factor of 0.3 obtained from the Boston Tide Gauge from NOAA Tides and Currents. All elevations referenced in Mean Seal Level in the AREVA Report have been converted similarly. A major challenge of the AREVA report is a lack of standardized elevations. This leads to significant confusion and conflict in the flooding evaluations they conducted.*

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Acknowledgements

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Introduction

The coastal zone of Massachusetts has a distinctive geological and geographic setting within the framework of the northeastern region of the United States (Ramsey, 2005). Due to the unique characteristics of the area, such as gradual sloping, low-lying coastlines, and a high concentration of people and property on the coast, many municipalities face an array of coastal hazards, specifically those associated with sea level rise, storm surge and nor’easters (Ramsey, 2005). The northeastern seaboard experiences the combined impacts of sea level rise, nor’easters and hurricanes compounded with storm surge, ultimately leading to flood events occurring more frequently (Climate Central, 2014).

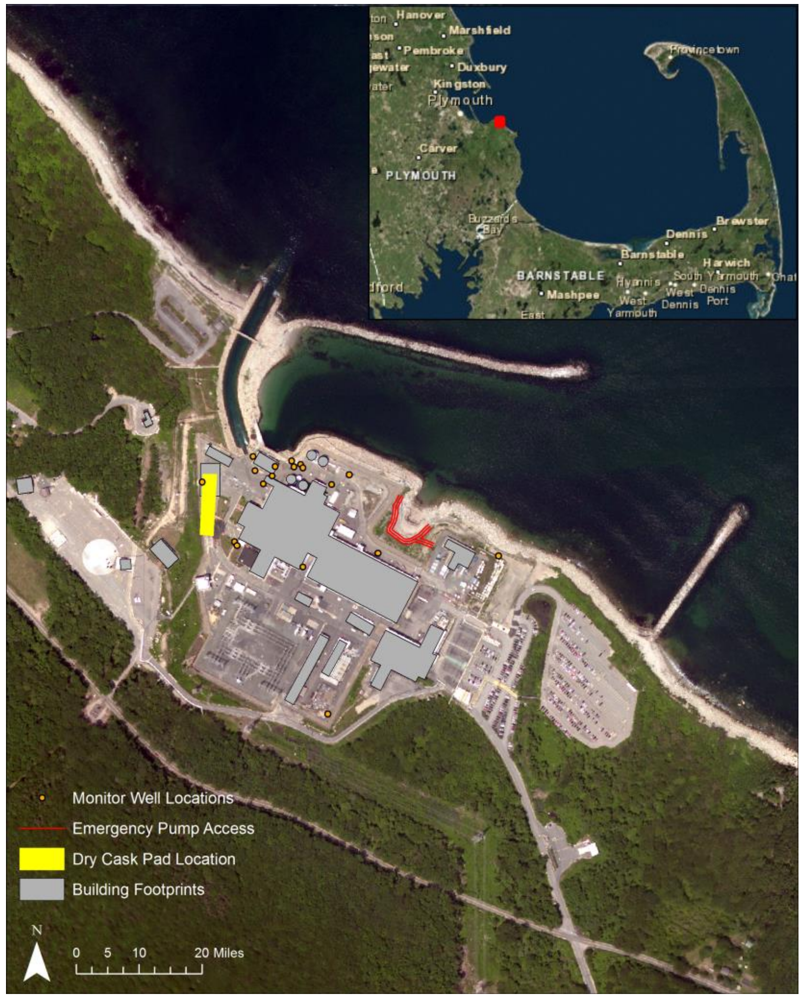

Figure 1. Overview of PNPS

Plymouth, Massachusetts is a coastal town, home to Pilgrim Nuclear Power Station (PNPS; Figure 1), and is situated at an average elevation of 23 feet relative to NAVD88 (USGS, 2014). In addition to the pressures of protecting their coastal community, Plymouth has the added responsibility of hosting a nuclear facility and a growing stockpile of nuclear waste at the Pilgrim site.

On March 12, 2012 the Nuclear Regulatory Commission (NRC) requested information from all U.S. nuclear reactors, including PNPS, to support the its Near-Term Task Force (NTTF) review of the 2011 accident at the Fukushima Daiichi nuclear facility in Japan (NRC, 2012). The NTTF was established by the NRC after the Fukushima disaster, to evaluate the current design basis for licensed nuclear facilities in the U.S. and require preparedness to avoid accidents that could challenge the U.S. nuclear fleet. The NTTF developed a report and a set of recommendations.

Part of the NRC's March 12, 2012 request for information addressed NTTF's Recommendation 2.1, which directed licensees to reevaluate flood and seismic hazards at reactor sites.

In March 2015, Entergy provided information for PNPS to the NRC in the form of a Flood Hazard Re-Evaluation Report ("AREVA Report") prepared by AREVA, Inc. (AREVA, 2015). In September 2015, Jones River Watershed Association (JWRA) commissioned Coastal Risk Consulting, LLC (CRC) to provide an expert analysis of the methodologies and conclusions presented in the AREVA Report.

Local residents and organizations, including JRWA, have raised concerns that the AREVA Report excludes or inaccurately assesses certain flood-causing mechanisms that could result in devastating outcomes – including radioactive leaks and releases – for Massachusetts' South Shore communities, especially in the context of a changing climate.

On October 13, 2015 Entergy announced PNPS will shut down no later than June 2019. It is important to understand how coastal hazards will impact PNPS's site now and in the years after shutdown. If Entergy is allowed to opt for long-term "SAFSTOR," full decommissioning and decontamination of the site could be delayed for up to 60 years. If remediation is delayed, flooding and other coastal hazards could lead to increasing and ongoing pollution of Cape Cod Bay. Flooding, sea level rise, and rising groundwater tables could increasingly flush contaminates present in the groundwater and soil into the sea. As for storage of nuclear waste, current NRC rules allow for hundreds of years of storage on-site. PNPS is now storing nuclear waste within reach of rising tides, coastal storms, and salt water degradation – creating another potential source of radioactive leaks and contamination of the environment.

Having a detailed and robust flood assessment is an important foundation for good planning and management. This will help curb flooding risks and ultimately protect public safety, environmental health, and the economic well-being of the surrounding area. This is especially true for areas such as PNPS containing hazardous materials.

Plymouth's historical data provides an indication of the potential threats climate change may pose in the future. Since 1938, at least three storms resulted in 11+ foot storm surges, which resulted in 25+ foot floods above mean sea level. For instance, during the Blizzard of 1978, Plymouth experienced flood elevations that ranged from 12.7 to 21.9 feet, causing severe damage along the coast (Figure 2). A surge of 4 feet, with waves of 12 feet on top of that, meant tides along the southern New England coast were more than 16 feet above normal levels, bringing devastating high tides for four successive tide cycles (two days) with continual onshore flow. Years later in 1991, the "Perfect Storm" caused waves over 30 feet high to develop along the Massachusetts coastline (NOAA, 2015a). More recently in 2012, the


The Boston Globe

Worst storm of century

17 die . . . record high tides . . . up to 4 feet of snow . . . winds gust up to 125 mph . . . highway traffic banned

Figure 2. Morning of Second Day, Blizzard of 1978

Northeast was hit by Hurricane Sandy. The storm caused seas to rise 20 to 25 feet off the East Coast, resulting in surges of 12.65 feet at the south end of Manhattan and 6.25 feet in Providence, Rhode Island (Blake et al., 2013).

As the climate continues to change and sea levels rise, exposure to these types of events are likely to increase, therefore increasing the severity of coastal hazard risks to communities and infrastructure along the Northeast coast.

A recent analysis was conducted for Massachusetts coastal communities that are at severe risk of increased flooding associated with sea level rise. For areas less than one to ten feet above the local high tide line, it is estimated that 121,000 members of the state's population are at risk, in addition to 67,000 homes and 48,000 acres of land area (Climate Central, 2014). Plymouth County is considered one of the largest total exposed populations, following the counties of Suffolk and Middlesex.

There are currently 61 commercially operating nuclear power facilities with 99 nuclear reactors in the U.S. (EIA, 2015). PNPS's performance rating was downgraded by the NRC on September 2, 2015 to Column IV, making it one of the bottom three worst performing reactors in the nation (NRC, 2015b).

Among 99 reactors in the United States, Pilgrim is rated as one of the three worst performers.

As new climate change projections and data emerge, it is essential that thorough and up-to-date flood risk evaluations for PNPS are prepared. This is especially important given that public attention is turning to safe closure and decommissioning, and that coastal hazards and flooding could influence the time frame and success of decommissioning and cleanup. Not understanding all possible causes of flooding will ultimately put coastal populations, ecosystems, and economics of the South Shore – and beyond – at risk.

Tasks 1 & 2: Review and Analyze AREVA Flood Hazard Re-Evaluation Report

This commentary focuses on four specific sections of the AREVA Flood Hazard Re-Evaluation Report: Local Intense Precipitation (Section 3.1), Storm Surge (Section 3.4), Channel Migration or Diversion (Section 3.8), and Combined Effect Flood (Section 3.9).

Local Intense Precipitation (AREVA Report, Section 3.1)

Local Intense Precipitation (LIP) refers to a short and heavy rainfall event centered upon the PNPS site itself. LIP is determined by modeling the Probable Maximum Precipitation (PMP) for a specific basin, or the maximum precipitation possible based on meteorological conditions. This is done by taking the largest historical storm for a basin and forcing specific atmospheric conditions in order to "maximize" the storm. PMP is estimated using historical records of extreme precipitation and maximized by the ratio of actual precipitable water in the atmosphere and maximum precipitable water derived from daily maximum dew point records (Rackecha and Singh, 2009). This catalog of extreme rain events from about 1900-1990 was compiled by the National Oceanographic and Atmospheric Association (NOAA) and used to create the Hydrometeorological Reports (HMR; Rackecha and Singh, 2009).

Previous Probable Maximum Precipitation (PMP) evaluation

PMP was evaluated as part of the Individual Plant Examination of External Events (IPEEE), although it is not part of the Current Licensing Basis (CLB). However, it was determined that a PMP event exceeds the CLB extreme storm tide level and is predicted to cause flooding at important safety locations on the plant site. This PMP evaluation was based on 1-hour precipitation rates with a probability of occurrence of $1x10^6$ per year from the National Weather Service (NWS) HYDRO-35 report (NWS, 1977).

The current flood protection measures in place for a PMP event include exterior doors on power block buildings, roof drains, and internal seals for conduits originating in manholes. Furthermore, the plant's procedure for operation during severe weather includes ensuring exterior doors are closed, installing sandbags at door bottoms and drain scuppers. During a hypothetical PMP event they concluded door sills on the south side of the plant would be submerged 1.5 feet below the maximum PMP flood depth, however an evaluation determined that these doors could withstand the force. It was also determined some roof ponding would occur, but that the PMP event would not exceed roof design if the roof drains were fully functioning.

Re-evaluation of Probable Maximum Precipitation (PMP)

LIP flood risk was modeled using FLO-2D, a physical flood routing model that simulates unconfined flow over topography and in channels. This model considers topography, building structures, coastal protection structures, and apparent land cover as static inputs. Parameters for LIP were defined using HMR-51 (NWS, 1978) and HMR-52 (NWS, 1982). They considered two storm scenarios:

1. Total rainfall depth for a 1-hour, 1-mi^2 PMP at 17.1 inches
2. Total rainfall depth for a 6-hour PMP at 25.5 inches

Only the LIP section of the AREVA Report forecasted flooding effects at important safety locations on the plant site. LIP flood elevations near the important locations ranged from 22.5 feet NAVD88 and 24.4 feet NAVD88. Maximum flood depths ranged from 0.6 feet to 2.6 feet. Hydrographs showed that peak flood levels occurred after the peak rainfall intensity due to a lag caused by off-site drainage. Therefore the maximum flood depths occur within the first two hours of the simulation and, in some areas, could take up to 10 hours to recede.

In the AREVA Report, LIP was determined to be one of the only flood hazards that exceeds the minimum entrance level for areas housing systems, structures, and components important to safety (22.7 feet NAVD88). However, as pointed out in the AREVA Report and by the Union of Concerned Scientists (Lochbaum, 2015), the LIP flood hazard is not part of the CLB for PNPS, therefore PNPS has no legal obligation to maintain or create new flood protections regarding the LIP hazard. This fact is a major safety concern for PNPS because, as proven in the AREVA Report, LIP is a primary flood hazard of concern. Furthermore, it shows that they previously underestimated LIP flooding in the IPEEE.

CRC Analysis of Local Intense Precipitation (LIP) Impact

While the issue of LIP flooding has already been brought to the attention of the NRC, CRC suggests that the AREVA Report is still underestimating the risk of LIP for the following reasons:

1. The PMP values do not consider future climatic conditions,
2. this analysis only considered one extreme storm and ignored the potential for multiple storms hitting the area,
3. it assumes static land cover for the area, and
4. it assumes that the roof drains will always be fully functioning.

Probable Maximum Precipitation (PMP) values do not consider future climatic conditions

PMP values were obtained from the NWS HYDRO-35 Report and were based on hourly rainfall measurements from 1948 - 1972 (NWS, 1977). LIP parameters for FLO-2D were derived from HMR-51 and HMR-52 that were published by NOAA's NWS in 1978 and 1982, respectively (NWS, 1978; NWS, 1982). The most discernible issue is that the data are outdated; however, it is the best available verified estimate for PMP because no updates have been made presumably due to the lack of funding for the PMP program (NWS, 2015). Despite this fact, these PMP values are strictly based on historical data and therefore do not take into account global climate change over the 30-plus years since their development or project into the future. The NRC even recognized that it is unclear how climate change will affect probable maximum events and stated that a site-specific analysis may be needed (NRC, 2011).

There have been several studies citing that PMP values are expected to increase in the future due to climate change and have been projected to increase by 20-30 percent by 2070 to 2100 (Stratz and Hossain, 2014; Kunkel et al., 2013). Furthermore, it has been demonstrated that heavy rainfall events are increasing in the northeastern United States and are projected to increase further in the coming years due to climate change (Melillo et al., 2014). The Northeast has seen the most significant increase in heavy rainfall events as compared to the rest of the country (Figure 3; Melillo et al., 2014).

RECOMMENDATION:

CRC recommends that actions be taken to update the PMP values to include more up-to-date rainfall data and future climatic scenarios be included in the LIP flood hazard analysis to achieve a true estimate of the current and future LIP flood risk. This inclusion is especially important because it has already been shown that LIP flooding based on historic conditions can already impact important safety features of PNPS. This could also have implications for decommissioning and site cleanup activities and schedules.

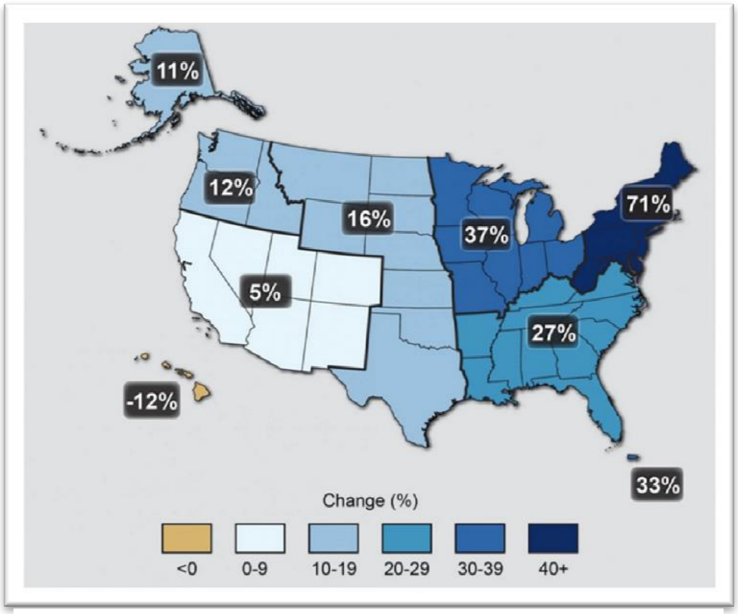

Figure 3. Percent increase in the amount of precipitation in very heavy events (the heaviest 1% of daily events) from 1958-2012. (Source: Melillo et al., 2014)

Re-Evaluation only considered one extreme storm and ignored the potential for multiple storms hitting the area

In the AREVA Flood Hazard Re-Evaluation Report, LIP was modeled using a 1-hour PMP of 17.1 inches and a 6-hour PMP of 25.5 inches. It is unclear why only these two time steps were chosen to model, especially when it is known that nor'easters may produce rain events that can last several days (Zingarelli et al., 2013). Additionally, there is no mention of modeling the combined effects of repeated storms passing over the area.

Long-lasting or repeated storms can saturate the soil and passive drainage systems with water causing significantly greater flooding. While the FLO-2D model did assume "wet conditions" for the land cover and calculations of infiltration, 18 percent of the total precipitation was still infiltrated before the flood routing started. This statement suggests that some passive drainage systems were still assumed functional during the PMP but with multiple storms or a persistent nor'easter with high sea levels backwatering the drains, this might not be the case.

RECOMMENDATION: CRC recommends that scenarios involving long-lasting and repeated storms be included in the LIP flood hazard analysis. Furthermore, in order to evaluate the "worst-case-scenario" model outputs should assume all passive drainage mechanisms are saturated and therefore not functioning. Even today, extreme events are challenging our estimations of PMP. For example, the October 2015 storm events associated with Hurricane Joaquin in Charleston, South Carolina resulted in an astounding 24.23 inches of rain near Mount Pleasant. This quickly surpassed NOAA's estimate for 17.1 inches for a 3-day 1,000-year rainfall event (Halverson, 2015). In the wake of this massive storm, it is important to realize that historical data do not predict the magnitude of storms in the future and even today.

Assuming static land cover for the area

Model infiltration was determined using land cover and soil types based on the United States Department of Agriculture's Natural Resources Conservation Service National Engineering Handbook (Part 630, Hydrology; USDA, 2004). In the model, this layer is assumed static and reflects only current conditions at the plant site. Again, depending on how long PNPS continues to operate, as well as pending decommissioning and site cleanup time frames, land cover is subject to change. For example, sea level rise is projected to cause marsh migration which would have an impact on soil type and therefore infiltration of precipitation during extreme events.

RECOMMENDATION: CRC recommends that land cover change scenarios be investigated to assess the future vulnerability of PNPS to LIP flooding. One such model that can be used to assess changing land cover is the Sea Level Affecting Marshes Model (SLAMM) developed by NOAA. However, a decommissioning program within the next decade could eliminate the need for further consideration of this issue.

Storm Surge (AREVA Report, Section 3.4)

AREVA conducted analyses of the Probable Maximum Hurricane (PMH), Probable Maximum Wind Storm (PMWS; extratropical cyclone/nor'easter), and Probable Maximum Storm Surge (PMSS) at PNPS. The PMH for PNPS was created by using NOAA Technical Report NWS 23 parameters (NOAA, 1979), analysis of past hurricane data for the area with the National Hurricane Center's (NHC) HURDAT2 program alongside synthetic hurricanes for the area created by the renowned meteorologist, Kerry Emanuel. With the analysis of historical hurricanes and synthetic hurricanes, AREVA was able to conduct a statistical study on forward speed, intensity, storm bearing and return periods affecting PNPS. The statistical study was also conducted for nor'easters using historic nor'easter data to create the PMWS.

Storm surge was analyzed for both hurricanes and nor'easters. The PMSS (hurricane related) value included the following data and analysis to be able to obtain the maximum storm surge value on PNPS: the addition of sea level rise onto monthly maximum tide gauge data (antecedent water level), a SLOSH model analysis that evaluated storm parameters that would lead to the worst case surge value, and further and finer model analysis of the conclusions made in SLOSH in ADCIRC. Maximum storm surge for nor'easters was conducted using ADCIRC alone with the data collected from the statistical study and the antecedent water level.

The PMSS for PNPS from the evaluation in this report was 14.9 feet NAVD88 without wave setup and 15.0 feet NAVD88 with wave setup (AREVA Report, Section 3.4) from a storm making landfall on the eastern shore of Cape Cod and heading in a north-northeast direction. Storm surge (still water elevations) from hurricanes for PNPS was found to have directionally dependent sensitivities to forward speed, landfall location and increased surge with an increase in the radius of maximum wind speeds. The maximum storm surge produced by a nor'easter from the evaluation in this report was 14.0 feet NAVD88 without wave setup and 14.5 feet NAVD88 with wave setup (AREVA, Section 3.4, p. 56) from a storm just to the south of Cape Cod heading in an east-northeast direction.

CRC Analysis of Storm Surge Impact

Extratropical storms are storms that have their origin from areas not in the tropics like that of a hurricane (Prociv, 2013). Therefore, a nor'easter is a type of extratropical storm. According to NOAA, "A nor'easter is a cyclonic storm that moves along the east coast of North America. It's called "nor'easter" because the winds over coastal areas blow from a northeasterly direction" (NOAA, 2013). Nor'easters affect New England more frequently than hurricanes do.

New England should expect to see 1 to 2 severe nor'easters during late fall and winter every year (Storm Solutions, 2010). According to the NHC, the return period for a hurricane (winds greater than 74 mph) is 13 to 16 years and the return period for a major hurricane (category 3 or higher) is even longer at 58 to 62 years (NHC, 2015a). In the last 80 years, New England has seen five major hurricanes along the coast.

Although surge from nor'easters is somewhat less than that for hurricanes, the surge lasts longer and can damage shoreline structures and cause major erosion. The average storm surge from a nor'easter is about 2 feet and occurs over 12 hours to 3 days, whereas a hurricane storm surge only lasts about 6 to 12 hours (Zingarelli et al., 2013). The longer duration of the nor'easter surge allows the storm to be present during multiple tidal cycles (Storm Solutions, 2010). The highest recorded flood elevations from a nor'easter in New England was from the Blizzard of 1978 where water levels reached 20.76 feet NAVD88 at the Boston Harbor with waves offshore at about 30 feet (Zingarelli et al., 2013). Near the PNPS site, there were water levels of 20.3 feet NAVD88 at Pilgrim Sands on Long Beach and 13.4 feet NAVD88 at White Horse Beach in Manomet due to wave action (Figure 4; FEMA, 2012 Flood Insurance Study).

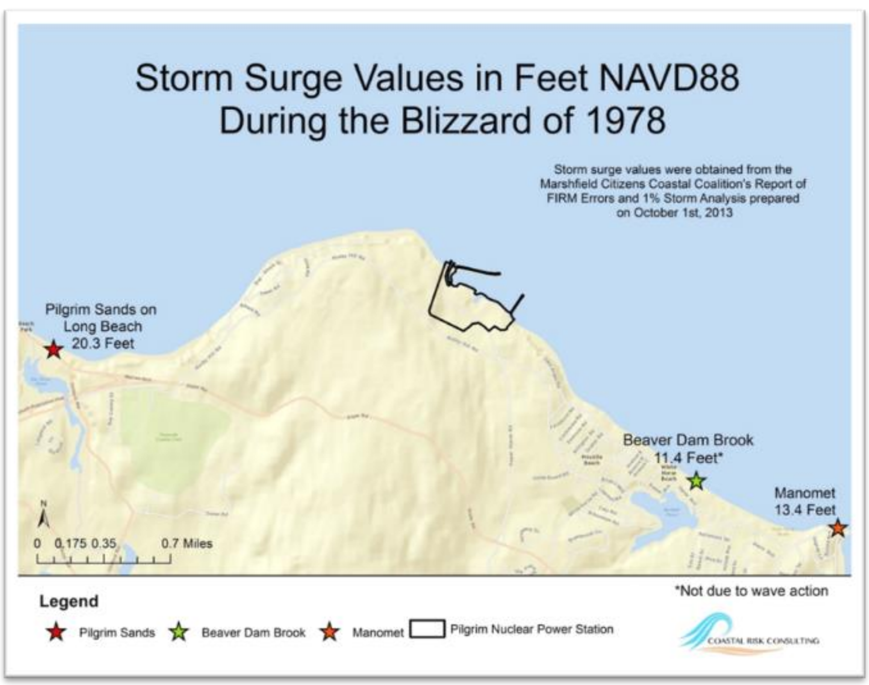

Figure 4. Areas near PNPS and their respective storm surge values from the Blizzard of 1978.

Although most nor'easters have sustained wind speeds below hurricane strength, it has been found that some nor'easters possess hurricane force wind speeds. These speeds typically do not last very long (less than 24 hours) during the lifetime of the storm. The hurricane force winds are found in a small area of the relatively large storm and are common during the rapid strengthening phase found in some nor'easters (OWS, 2015). For this reason, nor'easters provide significant threat to coastal installations such as PNPS and can compound ocean effects including producing significant surge and pounding surf from wave action.

Nor'easters have affected the PNPS area much more frequently than hurricanes, and as in the past, it is likely that at least one nor'easter will affect PNPS this winter (2015-2016).

Use of the NOAA Technical Report NWS 23 Parameters to create the Probable Maximum Hurricane (PMH) and Probable Maximum Wind Storm (PMWS) datasets

The creation and modeling of the hurricane and extratropical storm datasets seem to have sound methodology (AREVA Report, Section 3.4.2). Of concern is the use of the NOAA Technical Report NWS 23 due to its publication date (NOAA, 1979). Using meteorological parameters that follow this report raises red flags, as our climate has changed since 1979. In its report, AREVA does state limitations of the NWS 23 parameters indicating that the values would cause "overly conservative intensity recommendations for west-of-north tracking storms." Due to these limitations, AREVA conducted an in-depth, site-specific meteorology study to determine the hurricane parameters for analysis of storm surge.

It is not clear whether AREVA continues to only use parameters from the NOAA Technical Report NWS 23 report in their analysis of the PMH and the PMWS. This report would have benefited by including more of the PMWS details on data creation and model analysis of the surge produced by a PMWS instead of a PMH.

RECOMMENDATION: The analysis should include more recent methodologies on both nor'easters and tropical cyclones. The site-specific meteorology study for the creation of the PMH should use information and methodology produced in Villarini et al. 2012. In this paper, the HURDAT database is also used, but the authors corrected for storms prior to 1944 as well as modeled the frequencies of storms alongside different climate indexes. It is unclear if AREVA used the data in the HURDAT database prior to 1944. If it was used, it is also unclear if AREVA included any type of correction to the data from before 1944, or if it was just used alongside the synthetic hurricane dataset. A more recent scientific study on nor'easter climatology was conducted by the Northeast Regional Climate Center at Cornell University, which defines a nor'easter by specific meteorological requirements and parameters (Hirsch et al., 2000). This paper and its parameters for nor'easters would provide a much more robust analysis for the site-specific meteorological study of the PMWS that was then used by AREVA in the modeling of surge.

Sea level rise was not accounted for properly in the storm surge analysis

To create the PMSS for PNPS, AREVA followed a three-step methodology. An antecedent water level was calculated to consider sea level rise, the SLOSH sensitivity analysis was performed, and lastly the results from the sensitivity analysis was put through finer testing in ADCIRC and ADCIRC+SWAN for both the PMH and PMWS storm surge.

The antecedent water level was created using monthly maximum tide gauge data over a 21-year period from the Boston, Massachusetts NOAA tidal gauge station, to obtain a 10 percent exceedance high tide. The sea level rise value for a 50-year period was then added to the antecedent water level. The value was determined by the observed rates at the Boston tidal gauge station. Table 1 summarizes the results of the storm surge from a PMWS and PMH with the sea level rise value added to the tide in feet NAVD88.

Table 1. Summary of storm surge results for both PMH and PMWS in feet NAVD88. (Source: AREVA Report, Section 3.4.3)

Tide Value	Sea Level Rise	Antecedent Water Level	Max Still Water Elevation (PMH)	Max Still Water Elevation (PMWS)
7.34 Ft	0.46 Ft	7.80 Ft	14.9 Ft	14.0 Ft

The methodology AREVA used to determine sea level rise at PNPS raises red flags in terms of current sea level rise projections. According to Table 1 the level used is 0.46 feet NAVD88 over 50 years. This is a significant underestimation of current projections for sea level rise at the PNPS area over the next 50 years. Table 2 depicts the sea level rise projections from the United States Army Corps of Engineers (USACE) and from NOAA out to 2100. It is evident that 0.46 feet is extremely low considering USACE has a value of 2.31 feet and NOAA has a value of 3.05 feet in 2065. This discrepancy in the sea level rise value must be addressed for modeling surge impacts at PNPS.

Table 2. Sea level rise projections from USACE and NOAA in feet NAVD88. High indicates worst case projections and the red outline points out the projections for 50 years. (Source: USACE, 2014)		
Year	USACE High	NOAA High
2015	0.10	0.17
2025	0.39	0.54
2035	0.76	1.02
2045	1.20	1.59
2055	1.72	2.27
2065	2.31	3.05
2075	2.97	3.94
2085	3.71	4.92
2095	4.52	6.01
2100	4.96	6.59

RECOMMENDATION: Sea level rise values should be based on nationally accepted and established estimates (i.e., NOAA, USACE).

Storm surge analysis for the Probable Maximum Hurricane (PMH)

Storm surge is a very complex phenomenon caused by the buildup of water on the coast due to winds from low pressure systems. There are many factors that affect storm surge in coastal areas. Those factors are storm intensity, forward speed of the storm, radius of maximum winds, angle to which the storm hits land, coastal characteristics and the bathymetry--depth of ocean--of the coast (NHC, 2015b). The slope of the continental shelf--how rapid the transition between the deep and shallow waters--off of the coast of Massachusetts is very shallow (Figure 5). This allows for a higher surge than if the shelf dropped off quickly (NOAA, 2015b).

The AREVA Report analyzes storm intensity, forward speed, radius of maximum winds and the angle to which the storm hits land in a SLOSH PMH parameter sensitivity assessment. It was found that the surge increased in height as the radius of maximum wind in the hurricane increased (see AREVA Report, Figure 3-24, p. 76). The NHC tested this by using the SLOSH model and Hurricane Charley. Hurricane Charley was a very small (small radius of maximum winds), but strong storm. When the NHC modeled Charley with an increase in the radius of maximum winds, the surge increased (Masters, 2015a).

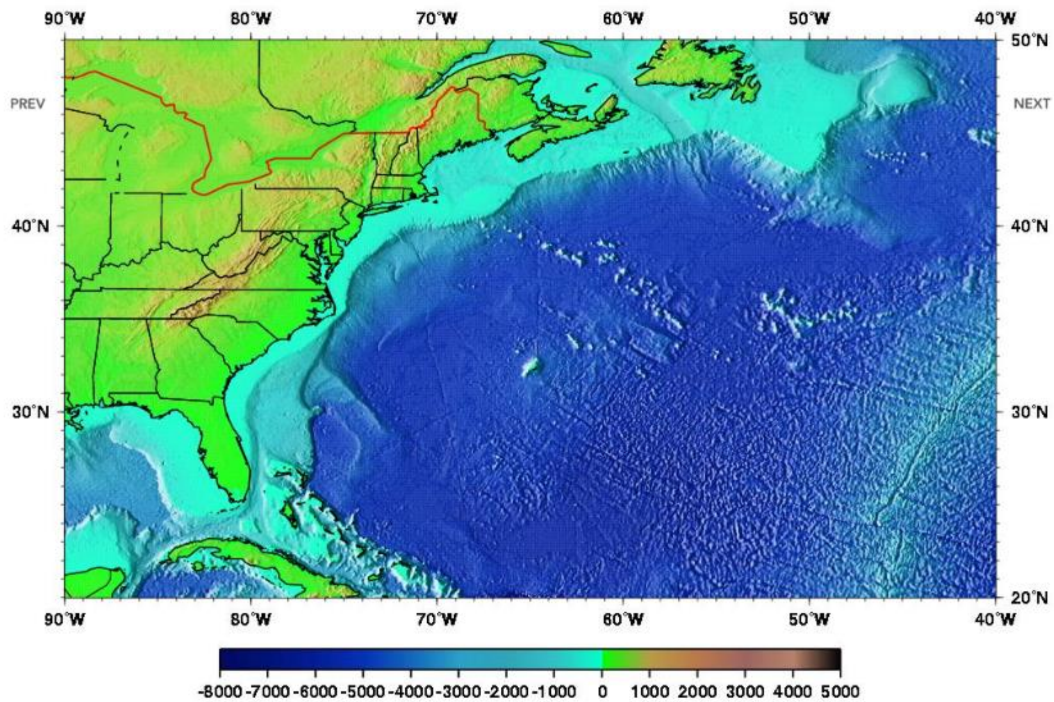

Figure 5. Bathymetry of the Gulf Stream. Lighter blue colors indicate deeper waters. (Source: Mariano and Ryan, 2015)

Another finding from the SLOSH analysis was that the faster a hurricane traveled (forward speed) the lower the surge at PNPS for most storm bearings (see AREVA Report, Figure 3-26, p. 78). In general a fast moving storm will create a greater surge for an open coast and little surge in bays, whereas a slow moving storm will cause greater surge in bays (Masters, 2015b).

An important finding from the SLOSH sensitivity analysis is that surge is affected by the angle to which the storm hits land. A storm may hit the coast from a certain direction and cause flooding in one area, but a small change in direction can cause little to no flooding in the same area and flooding in another (Masters, 2015b). A storm that makes landfall perpendicular to the coast will have a higher storm surge than a storm that makes landfall at an angle or travels parallel to the coast (NHC, 2015b). This makes it possible that, due to atmospheric flow influencing the storm bearing, coastal characteristics and all of the information presented above affecting storm surge, a storm will produce surge that will not breach the PNPS site but produce significant surge heights in other areas of Cape Cod and/or Plymouth. However, it is also possible that a storm could produce significant surge heights at PNPS and little to no flooding in other areas.

RECOMMENDATION: CRC recommends that a more site specific modeling is necessary to evaluate local storm surge heights at PNPS.

Erosion; Channel Migration or Diversion (AREVA Report, Section 3.8)

The AREVA Report addressed erosion briefly in Section 3.8, Channel Migration or Diversion. Based on a Federal Emergency Management Agency (FEMA) study, as well as a comparison of U.S. Geological Survey (USGS) topographic maps from 1977 and 2012, erosion rates were determined to be minimal in the vicinity of the PNPS site (O'Connell, 1999; USGS, 1977 and 2012). Still, an additional site assessment was conducted because Cape Cod Bay is prone to erosion.

This site assessment concluded that the shoreline protection system at the plant consisting of breakwaters, jetties and revetments provide limited potential for erosion of Cape Cod Bay shoreline at the PNPS site. Recognizing the importance of the functioning of the breakwaters to back up this claim, PNPS has committed to the NRC to monitor the breakwaters on an annual basis and after major storms to ensure their integrity (BEC, 1993; PNPS, 2013).

CRC Analysis of Erosion Impact

Erosion of the shoreline at PNPS was largely left out of the flood hazard modeling in the AREVA Report due to the conclusion that historical erosion at the site is minimal and the current shoreline protection system limits the potential for increased erosion. However, this conclusion is based on an outdated study and does not consider future conditions. Updated shoreline change rates and analyses were published after the release of the 1999 report cited by AREVA in Section 3.8. These updated data should have been used in place of the 1999 data (Thieler et al., 2013).

While the exact effect of sea level rise on local erosion rates is still unknown, it is expected that erosion rates will increase. When sea level rise is combined with a major storm, erosion rates for that event have the potential to increase significantly. In particular, it has been shown that severe nor'easters have tremendous erosion potential that is more dependent on storm tide than wave energy and duration (Zhang, 2001; USGS, 2015). Erosion at the rocky shorelines surrounding PNPS may not be the same as nearby open-coast sandy beaches. However, this is no reason to ignore erosional risk, especially considering extreme storm conditions are exacerbated by sea level rise.

Erosional forces are weakened by the coastal protection structures present at PNPS, such as the riprap and jetties. However, gaps in the protected shoreline are vulnerable to erosion such as the shoreline south of the barge ramp/boat landing. This unprotected section of shoreline is known to contain important features that are vital to the safety of PNPS, such as access for an emergency cooling pump and an adjacent storage site for low-level radioactive waste. Additionally, gaps in the protected shoreline can undermine the integrity of the entire coastal protection system in the case of an extreme storm event (JRWA, 2015).

In a standard vulnerability assessment, it is practice to first assess the natural vulnerability of an area without accounting for any man-made coastal protection structures. The reasoning behind such an analysis is that it is somewhat unreasonable to make the assumption that those structures will continue to exist and function to their full capacity through their entire lifetime. Furthermore, it is unrealistic to assume that these protection structures will not fail during an extreme storm event, as they have previously (1978, 1979); therefore, knowledge of the erosion potential if these protection structures are not functioning to their full capacity is essential.

RECOMMENDATION: CRC suggests that erosion hazards be evaluated without the presence of the coastal protection structures and that erosion potential is included in the coastal flood hazard impacts, such as storm surge and wave impacts.

Combined Effect Flood (AREVA Report, Section 3.9)

Section 3.9 evaluates flooding caused by combined events at PNPS. The AREVA Report addresses the impacts of PMSS and wave effects associated with the PMH and PMWS. THE NRC NUREG/CR-7046 document (NRC, 2011) provides five combined event scenarios. From these five scenarios, the AREVA Report only considers the H.3 scenario and determines that the other four scenarios are not applicable to PNPS. The H.3 scenario addresses floods along shores of open and semi-enclosed bodies of water and considers the combination of: probable maximum surge and seiche with wind and wave activity and an antecedent 10 percent exceedance high tide.

The methodologies used to evaluate the H.3 scenario include the following:

1. The review of USACE Wave Information Studies (WIS) stations 63057, 63060, 63061 (see Appendix B, Figure B1) for comparison to simulated offshore, deep water wave heights and periods,

2. use of ADvanced CIRCulation (ADCIRC) model coupled with Delft University's Simulation Waves Nearshore (SWAN) model 41.01 to develop the deep water waves during Probable Maximum Storm Surge,
3. use of the SWAN model and development of a local SWAN grid to develop nearshore and shallow-water waves near PNPS, and
4. use of SWAN model output reflecting wave effects for PMH and PMSS and the use of FEMA and ASCE-7 methodology to address wind-wave effects that include run-up.

The outcome for potential shore-side location on semi-enclosed water-body combined event resulted in historical storms producing wave heights that range from 23.7 to 29.1 feet for peak periods of 12.6 to 17.1 seconds, based on the top 10 wave events reported at the three stations of USACE's WIS project. The report determines that these stations are good indicators of deep-water wave conditions because they are in deeper water compared to the SWAN output points.

Offshore wave results from the coupling of the ADCIRC and SWAN model produced a deep water wave height from 18.4 to 29.7 feet with a height range from 9.9 to 15.7 seconds for peak PMH. For peak PMWS, the significant deepwater wave height varies from 16.8 to 34.5 feet with a wave height range from 11.5 to 16.4 seconds across seventeen boundary output locations. When compared to historical wave height, it produced an output that was 21.9 feet higher than the maximum WIS historical data.

Near-shore wave results simulated by the SWAN model produced a PMH and PMWS for 9 locations that are representative of important locations and structures at PNPS. For PMH, wave heights ranged from 0.9 to 7.3 feet with periods ranging from 1.8 to 9.6 seconds. For PMWS, wave height ranged from 0.6 to 7.1 feet and up to 12.7 seconds.

These results are based on the following wave effects: peak significant wave height, peak wave period and wave crest elevations of peak significant waves for the nine important locations along the PNPS coastal area.

When analyzing standing wave height at vertical structures, wave effects were calculated using the Sainflou formula for fully head-on non-breaking waves at the PNPS Intake Structure headwall. The maximum wave height calculated at the intake headwall compared to the maximum wave crest elevation may result in "infrequent run-up wedge" overtopping the intake head wall. They also considered wave run-up onto a plateau above a low bluff—that is, the site proper, or "yard area."

The AREVA Report found that the combined events water elevation for PNPS is determined to be 21.8 feet NAVD88. This water level would result in flooding the shoreline area of the site by almost two feet due to the overtopping flow from wave action. The maximum combined flood events at the Intake structure is 19.5 feet NAVD88. AREVA concluded that PNPS will be subject to hydrostatic, hydrodynamic and wave loads.

CRC Analysis of Combined Effect Flood

The main drawback for the Combined Effect Flood section relates to the limitations of the term "combined." Of the five combined event scenarios provided in NUREG/CR-7046, Appendix H (NRC, 2011), only one is deemed appropriate for PNPS. This cuts off a wide range of possibilities for analysis with the available tools.

In addition to storm surge, high tide, and wave setup, there are many other factors and mechanisms which dramatically compound flooding. In particular, intense frequency, duration, and intensity of rain events will significantly exacerbate the combined flooding scenarios. The various combinations of simultaneously occurring events will likely lead to severe impacts including compromised drainage, erosion, and structural damage from wave energy. In these cases, it is essential to consider the range of threats that can synergize to a disastrous worst case scenario. This is not the case with the AREVA Report, in which the impacts are either downplayed or not mentioned at all. The Combined Effect Flood section lacks explanations on why less extreme estimates were used in most cases, for example with the maximum waves, breaking waves, and structure loading. In the Structure Loading and Associated Effects section (3.9.2.1.8), there are slight references to erosion and groundwater, but these are not considered in any way. There is a mention of limited tidal influence on the groundwater table, but current data show otherwise, as discussed in the groundwater section.

Section 3.9.2.1.3 of the AREVA Report states, "Large deep-water waves break along the breakwaters before reaching the site. Shoreward structures are well beyond the breakwater structure and are therefore protected from the larger offshore waves." The text does not provide evidence to support this claim, and in contrast, the LiDAR elevations of the breakwater structure elevations show that they are at a maximum height of 10.9 feet NAVD88 and the partial revetment is 19.9 feet NAVD88. While this height will likely dampen wave energy, it is not rational to assume that this will offer full protection from the force of significant wave action with waves that overtop these structures.

Section 3.9.2.1.4 states, "Because simulated wave conditions generated by the PMWS are equal or less than those generated by the PMH, and because the maximum water surface elevation of [15 feet NAVD88 resulting from the PMWS is approximately 0.6 feet lower than the maximum water surface elevation of 15.6 feet NAVD88][1] resulting from the PMH, the PMH was

[1] Note: CRC has provided conversion from MSL to NAVD88.

determined to be the controlling storm event for combined effects flooding. Therefore, wave effects were calculated based on the PMSS resulting from the PMH and wind-wave effect generated by the PMH. It is noted that while the wave effects generated by the PMWS are not greater than those generated by the PMH, the duration of high intensity wave action ranges from 50 to 60 hours for the PMWS compared to the 10 to 15 hours from the PMH."

These incident wave characteristics do not consider the dynamics by which the steady buildup of surge over several days can combine with intense rain, ice, and or snow, to compromise the safety of the structures, particularly those that are located at lower elevations.

In Section 3.9.2.1.6, the AREVA Report explains, "Wave runup in the yard area at PNPS was determined using empirical equations for runup on a rock armored slope (USACE, 2006)….Wave heights ranging from approximately 0.9 feet to 7.3 feet will occur for a duration of approximately ten to fifteen hours during the PMH controlling event." This statement has misconceptions related to focusing the impacts to wave runup onto a plateau above a low bluff. There is an implicit assumption that the entire slope is armored by solid rock, when in fact there is a large section of the shoreline south of the boat ramp that is not armored and has limited forms of protection. In addition, there are concerns that the revetment is not sturdy and may not withstand the hydrostatic loading levels that are realistic given the projected intensity of past, present, and future events. These kinds of assumptions are particularly dangerous when considering areas in which nuclear waste is being stored. The current coastal armoring is not adequate protection that provides certainty that accidents involving spent fuel or other hazardous substances will be fully avoided. Given the wave heights and the land elevation, it is conceivable that operational systems and structures will be compromised during extreme events.

Chen and Liu (2014) used an integrated storm surge and flood inundation modeling system to simulate compound flooding of storm surge events and high freshwater discharges from upriver. Results showed that storm surge events had dramatically increased damage when combined with freshwater discharges. Wahl et al. (2015) took this methodology in compound flooding analysis a step further by assessing the combination of storm surge events with intense precipitation. The joint occurrence leads to a complex interplay in which flood impacts are exacerbated for both inland and coastal areas. Figure 6 illustrates the results for Boston in which non-stationarity is correlated in the dependence between storm surge and precipitation for 50-year running windows (Wahl et al., 2015). The filled circles denote significant correlation (90% confidence) and grey shaded areas represent the range of natural variability (10% and 90% levels). Correlations have increased since 1970, indicating that historic observations are not sufficient for projecting future events. These results also emphasize the importance of assessing compound flooding in a manner that considers linkages to weather and climate.

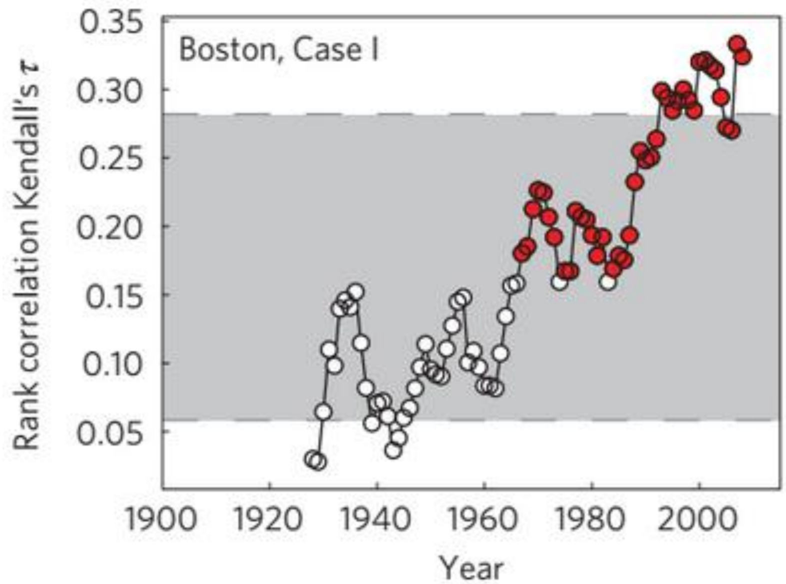

Figure 6. Results for Boston in which non-stationarity is correlated in the dependence between storm surge and precipitation for 50-year running windows. (Source: Wahl et al., 2015)

Section 3.9.2.1.7, Combined Events Water Elevations at PNPS, states, "The maximum combined events water surface elevation at PNPS was determined to be [21.8 feet NAVD88][2] due to runup from a fully head-on wave on the revetment slightly east of the reactor building portion of the plant. This results in shallow flooding of the shoreline area of the site due to overtopping flow from wave action at the revetment."

This is yet another example of how the report downplays the dire potential impacts that result from the breaching of revetment. In addition, if the revetment is damaged in one storm, there is a likelihood of a time-lag that prevents repair of the revetment before the next significant event. The AREVA Report does not look at these kinds of considerations because it is following the guidelines of the NRC. However, these guidelines are generalized and do not allow for realistic timeframes for updates and reaction times to address damage and to repair coastal armoring.

RECOMMENDATION: CRC strongly recommends that a subsequent analysis use methods similar to those used in the references cited above.

[2] Note: CRC has provided conversion from MSL to NAVD88.

Groundwater

The AREVA Report did not include an analysis of groundwater elevations as part of the flood risk assessment at PNPS. Section 3.9.2.1.8 comes to the conclusion that "the effects of storm surge on groundwater elevations are expected to be limited to those areas currently observing tidal influence on groundwater elevations."

CRC Analysis of Groundwater Impact

Omission of an analysis of local groundwater levels at PNPS precludes the ability to accurately assess flood risk at PNPS. Groundwater plays an important role in the magnitude and frequency of flood events because changing groundwater levels (along with land cover and soil type) control how much water the ground can hold during both storm events and chronic flooding due to sea-level rise. As PNPS moves to decommissioning and site cleanup, understanding the impacts from rising groundwater will become more critical.

Pilgrim is sited above the Plymouth-Carver Aquifer (PCA; EPA, 2014). The PCA is the second largest aquifer in Massachusetts and comprised of course-grained soil, sand and gravel glacial outwash deposits (EEEA, 2007). The PCA is bordered by marine waters from the northeast to the southeast (EPA, 1990). The groundwater table in an unconfined aquifer located in a coastal zone, like the PCA, oscillates with the ocean surface because of tidal fluctuations. As sea levels rise, groundwater levels will also rise, which will reduce storage capacity in some areas (Figure 7; Rotzoll and Fletcher, 2013). This positive feedback between the groundwater table elevation and mean sea level occurs because rising sea levels increase the pressure head near the coastline. This mechanism results in the groundwater table lifting by a similar magnitude as the increase in sea level (Romah, 2012). This one-to-one ratio of the groundwater table rising analogously with sea-level rise will lead to a dramatically shallower depth to groundwater below the land in some areas. The reduced soil storage capacity will lead to increased saturated land not only during storm events, but also during high tide (i.e., nuisance flooding).

Availability for accessing groundwater conditions at or near PNPS includes multiple publicly available datasets. USGS manages a network of groundwater wells and provides historical and current records of groundwater levels. However, the closest USGS wells are 6.5 miles away (Myles Standish State Forest) and 8 miles away (Plymouth Airport; USGS 2015). The U.S. Department of Agriculture's Soil Survey Geographic Database (SSURGO) also provides data on minimum water table depth based on soil storage capacity; however data are only available for locations surrounding Pilgrim (USDA, 2015). There are no data from this source for PNPS itself because SSURGO cannot gather data for impervious surfaces.

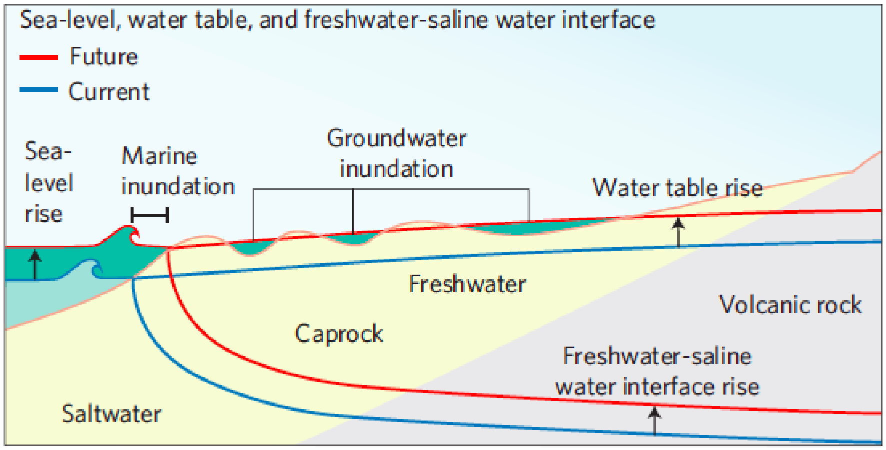

Figure 7. Conceptual diagram of groundwater inundation under sea level rise in a coastal aquifer. (Source: Rotzoll and Fletcher, 2013)

Another source of groundwater elevation data is from Environmental Resources Management's (ERM) Interim Tritium Investigation 2014 Report ("Logic Report"), which investigates tritium detections in groundwater at PNPS (ERM, 2014). The 2014 Logic Report documents results from 22 groundwater monitoring wells at PNPS (today there are 23 wells) as part of a groundwater monitoring program that started in 2007. The Logic Report includes a groundwater elevation analysis for a portion of PNPS's monitoring wells. Monitoring changes in groundwater elevations at PNPS is ongoing and will be documented in future updates to the Logic Report.

Depth to the water table at PNPS varies depending on the specific onsite location as well as throughout time due to the local tidal regime and precipitation or drought events that can recharge or deplete the aquifer, respectively (ERM, 2014). The groundwater elevations obtained in September 2012 are presented in Figure 8 and range in depth from approximately 2 to 14 feet below ground surface. Higher groundwater elevations are found west and south of the Power Block, whereas lower groundwater elevations exist along the station boundary with the Cape Cod Bay (ERM, 2014). Figure 9 depicts ERM's conceptual site model for groundwater elevations and contours on the PNPS site.

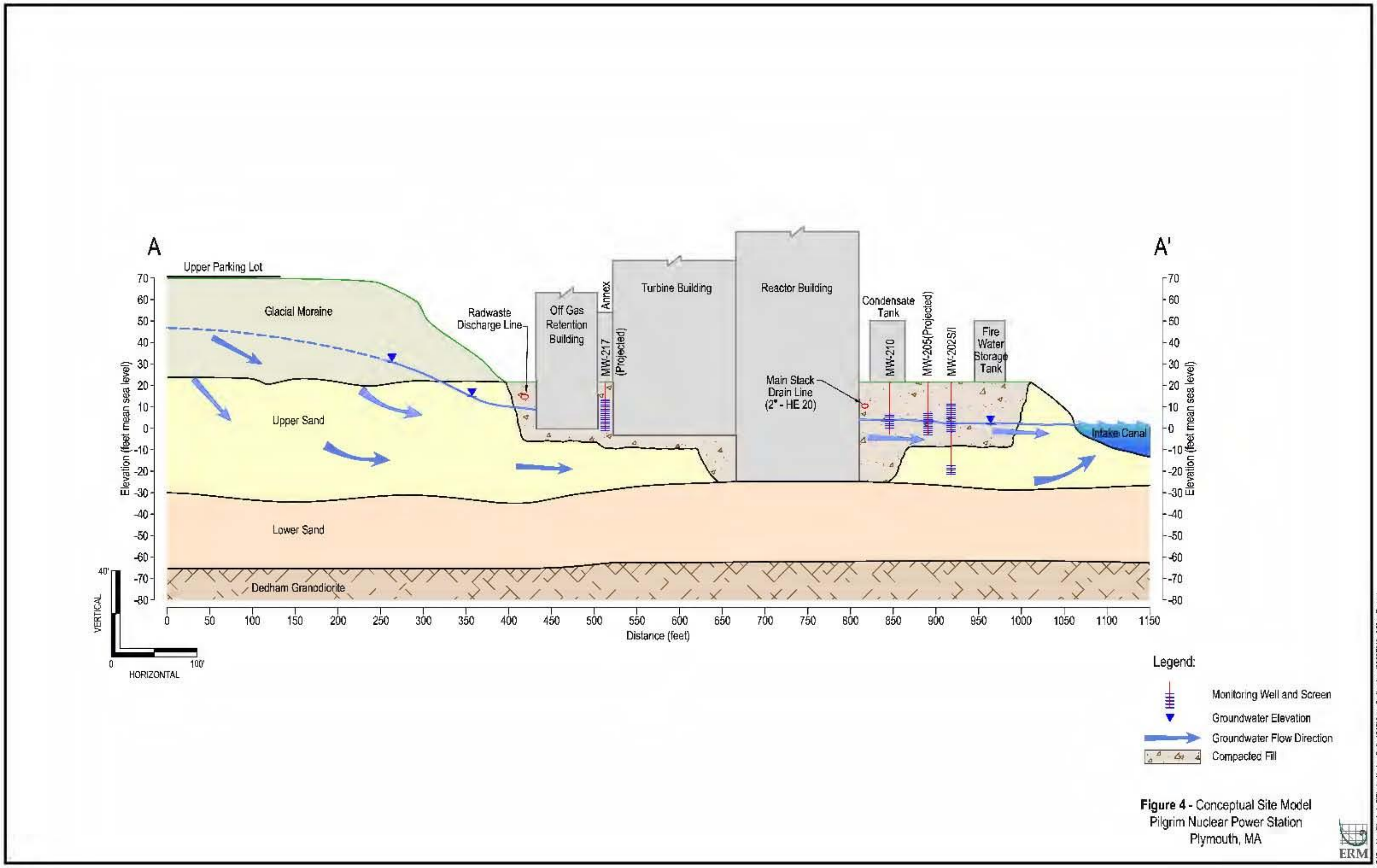

Figure 8. Conceptual PNPS site model of groundwater elevations and flow. (Source: ERM Logic Report, 2014)

Figure 9. Conceptual PNPS site model showing groundwater elevations and contours. (Source: ERM Logic Report, 2014)

Since groundwater elevations impact the capacity of the ground to absorb rain or flood water, changing levels may impact site-wide flooding. Understanding that flood proofing was a part of site construction more than 40 years ago is not proof that time, salt, and elements have not compromised that protection. While existing flood proofing may be able to withstand freshwater, assuming that protection is still in good condition, buried and underground piping and tanks might be vulnerable to saltwater corrosion as saltwater intrusion increases the salinity of the groundwater.

RECOMMENDATION: The AREVA Report should include an analysis of the potential for future groundwater changes in the evaluation of flood risk at PNPS. This type of analysis is important because, depending on the characteristics of the coastal aquifer and local topography, low-lying elevations might be expected to flood as a result of elevated groundwater levels in addition to sea level rise. Groundwater levels at the PNPS site will likely increase with an increase in tide level, with storm surge, and with the increase in precipitation expected with climate change in the northeastern Unites States.

In order to determine if the effects of storms and sea level rise would be limited only to those areas currently observing tidal influence on groundwater elevations, as indicated in the AREVA Report, it is necessary to analyze groundwater conditions at PNPS using the best available data. Current groundwater depths below PNPS are relatively shallow (ERM, 2014; Masterson and Walter, 2009; USDA, 2015) and could become increasingly shallower under future climate scenarios. CRC recommends that a thorough analysis of groundwater, as related to flood risk due to storms and sea level rise be included in the LIP flood hazard analysis, to achieve a better estimate of current and future flood risk.

Subsidence

Subsidence is not mentioned in the AREVA Report but is implicitly included in the 50-year sea level rise of 0.46 feet since that value is derived from historic Boston tide gauge trends.

CRC Analysis of Subsidence Impact

A major limitation in the study conducted by AREVA was the assumption that elevation will remain constant throughout the lifetime of PNPS. Subsidence is an example of an already observed phenomenon that would affect elevation at the PNPS and could increase flood risk in the future and is exacerbated by human activities such as groundwater pumping. Subsidence has been observed in coastal Massachusetts. For example, local vertical land motion at the Boston tide gauge is -0.85 mm/year, -0.97 mm/year at Woods Hole, and -1.16 at Nantucket

Island (Zervas et al., 2013). Coarse estimates for subsidence are included in many sea level rise projections, including those produced by USACE. However, it is clear that no analysis on localized subsidence at PNPS has been included in the AREVA Report.

RECOMMENDATION: CRC suggests that regional land motion be taken into account when examining flood risks at PNPS. There are several techniques that can be used to evaluate land movement at the site, such as extracting vertical land motion from a local tide gauge (i.e., Plymouth). However, lack of long-term, publicly-available tidal data at this site is an issue. Another more intensive option is the use of satellite measurements or GPS to obtain a higher resolution view of land movement on the site, such as using Synthetic Aperture Radar measurements of land displacement like those used to measure natural and anthropogenic subsidence in Venice, Italy (Tosi et al., 2013).

Conclusion

The goal of this report was to thoroughly critique the flood risk assessment done in the AREVA Flood Hazard Re-Evaluation Report for PNPS. Although the combined effects of high tide, storm surge and wave action can flood the landscape of PNPS under AREVA's modeling, as discussed in the above sections, many aspects of flood risk were understated or not considered in the AREVA Report. As a result, the current and future flood risk at PNPS is severely underestimated.

This analysis of the AREVA Report was prepared using the best available data, but performing a site survey or obtaining Entergy's 2014 survey would reveal further details.

It should be noted that while this report was prepared specifically for PNPS, many of these considerations apply more broadly to the NRC Flood Estimation Guidance Document (NUREG/CR-7046). When evaluating the flood risk of coastal power plants, it is essential that the all impacts of changing climate are taken into account. Modeling based solely on historical data no longer accurately represents reality.

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APPENDIX A

Task 3: Modeling assessment of future flooding potential for Pilgrim Nuclear Power Station

COASTAL RISK RAPID ASSESSMENT™

Future Potential Flooding and Storm Surge Analysis

Pilgrim Nuclear Power Station

Plymouth, MA

What is the Coastal Risk Rapid Assessment™?

Coastal Risk Consulting's Coastal Risk Rapid Assessment™ (CRRA) is a flood risk vulnerability assessment performed at the parcel level. This CRRA also includes the Initial Risk Categories, Flood Inundation Risk Score and Table™ (FIRST Score™), Parcel-Specific SLOSH model, and Airborne LiDAR High Resolution Elevation Map. This model has been adjusted for the purposes of evaluating future flood risk at Pilgrim Nuclear Power Station (PNPS) through the year 2085. The sections below outline the methods and purpose of each component of this section.

Initial Risk Categories

The Initial Risk Categories are a compilation of the climate-related, government-designated risk zones that the site currently lies within. The risk zones include: FEMA flood zones, wind zones, evacuation zones, Community Rating Score, Special Flood Hazard Areas, and the Coastal Construction Control Line where applicable.

FIRST Score™

The FIRST Score™ provides the total number of non-storm flood days the site is projected to experience over the next 30 years. A flood day is defined as days when the measured water level, enhanced by sea level rise, is greater than a threshold elevation of the site. For the assessment of PNPS the FIRST Score™ has been modeled out to 70 years (from 2015 to 2085) and is displayed using a table divided into 10-year increments to show the progression of risk over time. For PNPS, we have chosen a threshold elevation of 10 feet (NAVD88) to represent the average top elevation of the breakwaters, which ranges from approximately 9 to 11 feet (NAVD88), according to the LiDAR elevation data used in this analysis (USGS, 2013-2014).

Coastal Risk Rapid Assessment™

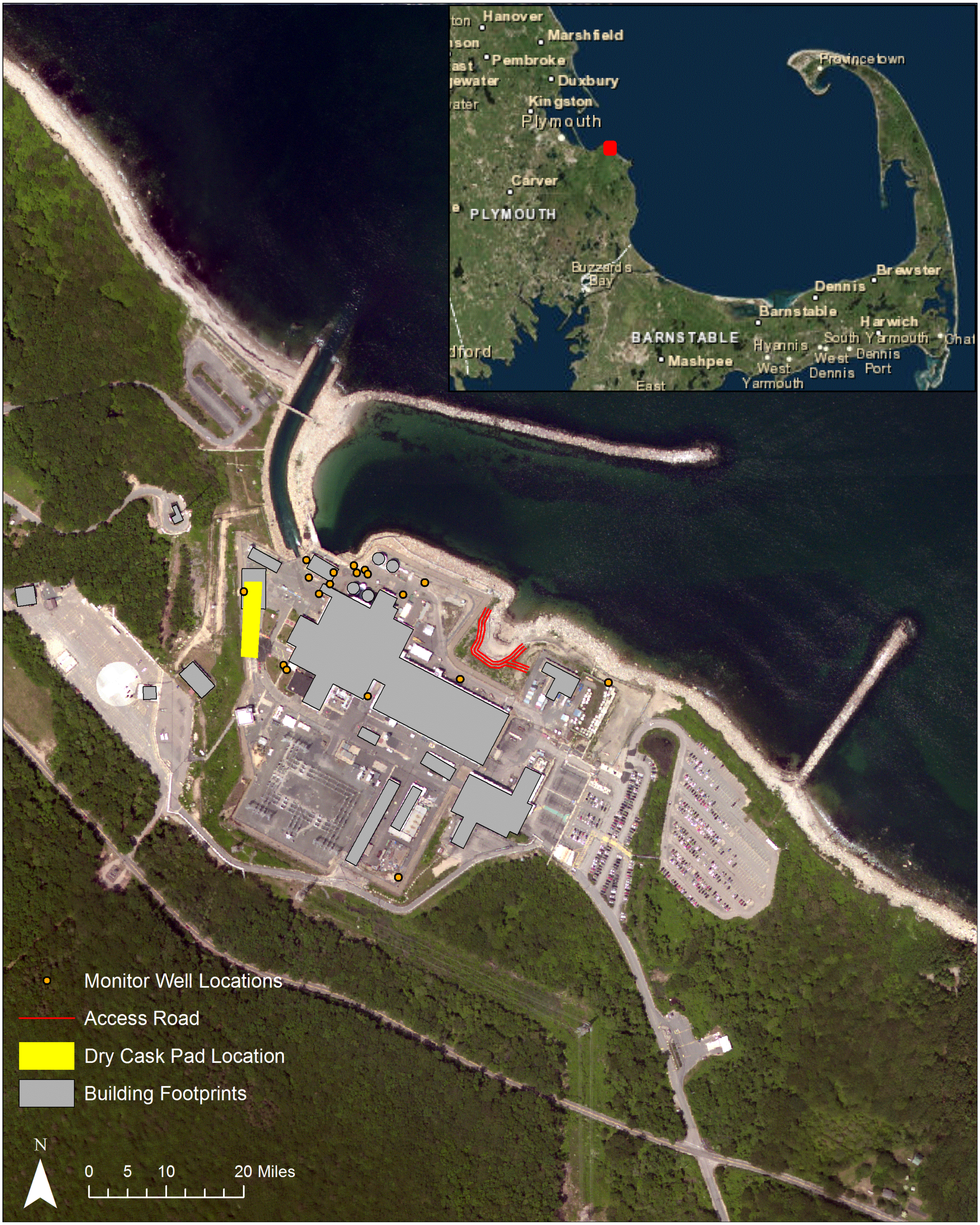
The CRRA focuses on the spatial extent of non-storm or nuisance flooding which is related to factors such as sea level rise, tidal forcing, groundwater depth, and local subsidence. The assessment consists of multiple maps which identify where flooding is projected to occur on the site. This CRRA prepared for PNPS includes 8 maps showing nuisance flooding out to 2085.

Parcel-Specific SLOSH Model

The CRRA maps showing nuisance flooding also have the option of including storm surge risk for the site as done by CRC's Parcel-Specific SLOSH Model. This model is an application of the Seas Lakes and Overland Surges from Hurricanes (SLOSH) model developed by NOAA. For the purposes of JRWA, this report models the maximum storm surge from a category 4 hurricane enhanced by sea level rise. A category 4 hurricane at high tide is modeled starting at 14.7 feet and with the addition of the NOAA high sea level rise projections, reach as high as 19.45 feet (NAVD88). A category 4 hurricane is used because no category 5 hurricanes have ever occurred in the New England region. Furthermore, this storm surge value is considered the maximum because no single storm will be able to cause this level of flooding since it is the Maximum of the Maximum Envelope of Waters (MOM) storm surge category (Masters, Storm Surge Inundation Maps for the U.S. Coast).

Airborne LiDAR High Resolution Elevation Map

The Airborne LiDAR High Resolution Elevation Map provides detailed elevation information for the extent of the site. This map provides the client with a visualization of the location of low-lying areas and helps give context to the results of the CRRA, FIRST and SLOSH models, assisting with evaluation, prioritization, and decision-making. The LiDAR data used in this report was flown in 2013-2014 by USGS to evaluate coastlines in Massachusetts, New Hampshire, and Rhode Island following Tropical Storm Sandy in 2012 (USGS, 2013-2014). This digital elevation model was acquired from NOAA digital coast and has a horizontal resolution of 2 feet and a vertical RMSE of 2 inches. All elevations are relative to NAVD88.



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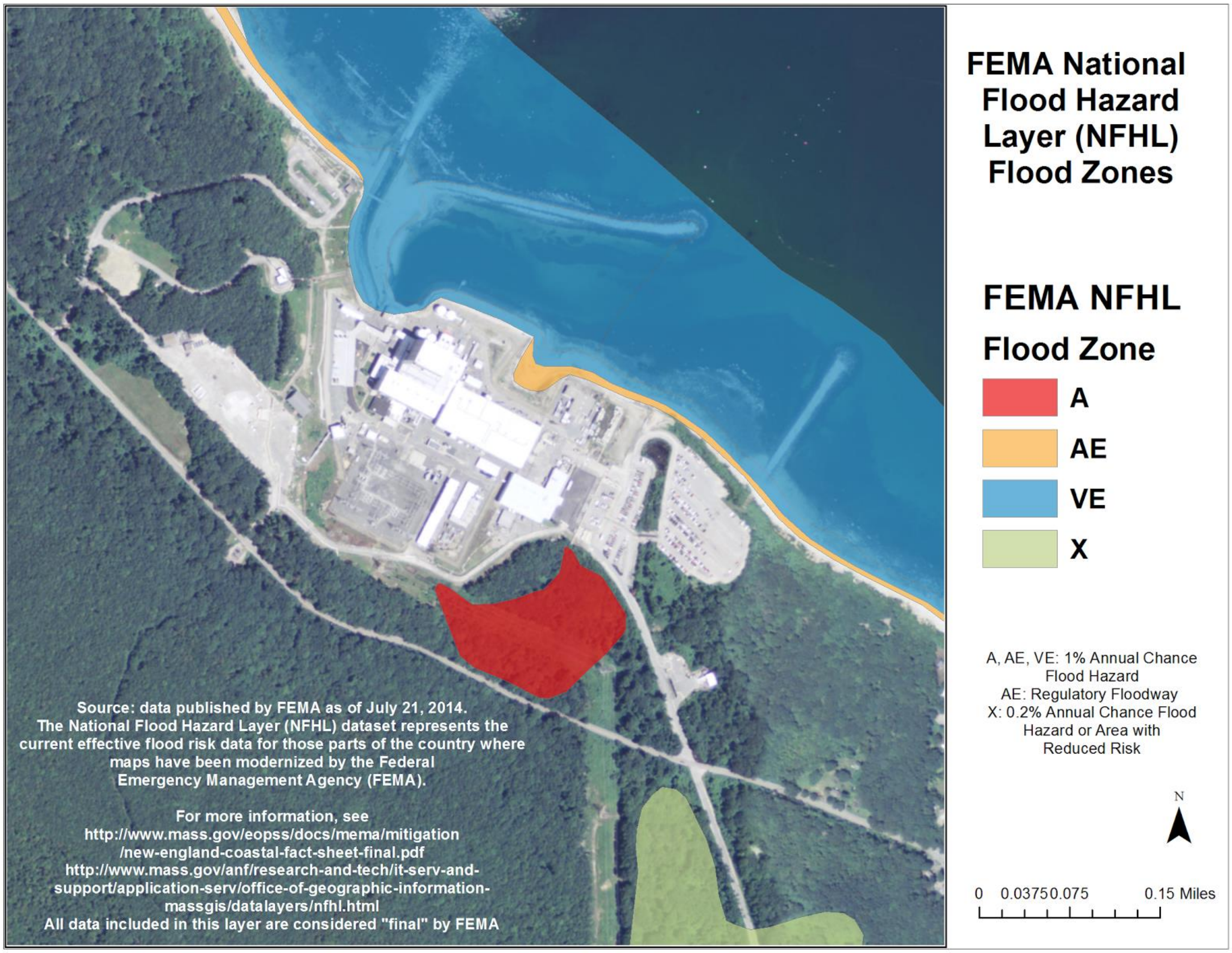
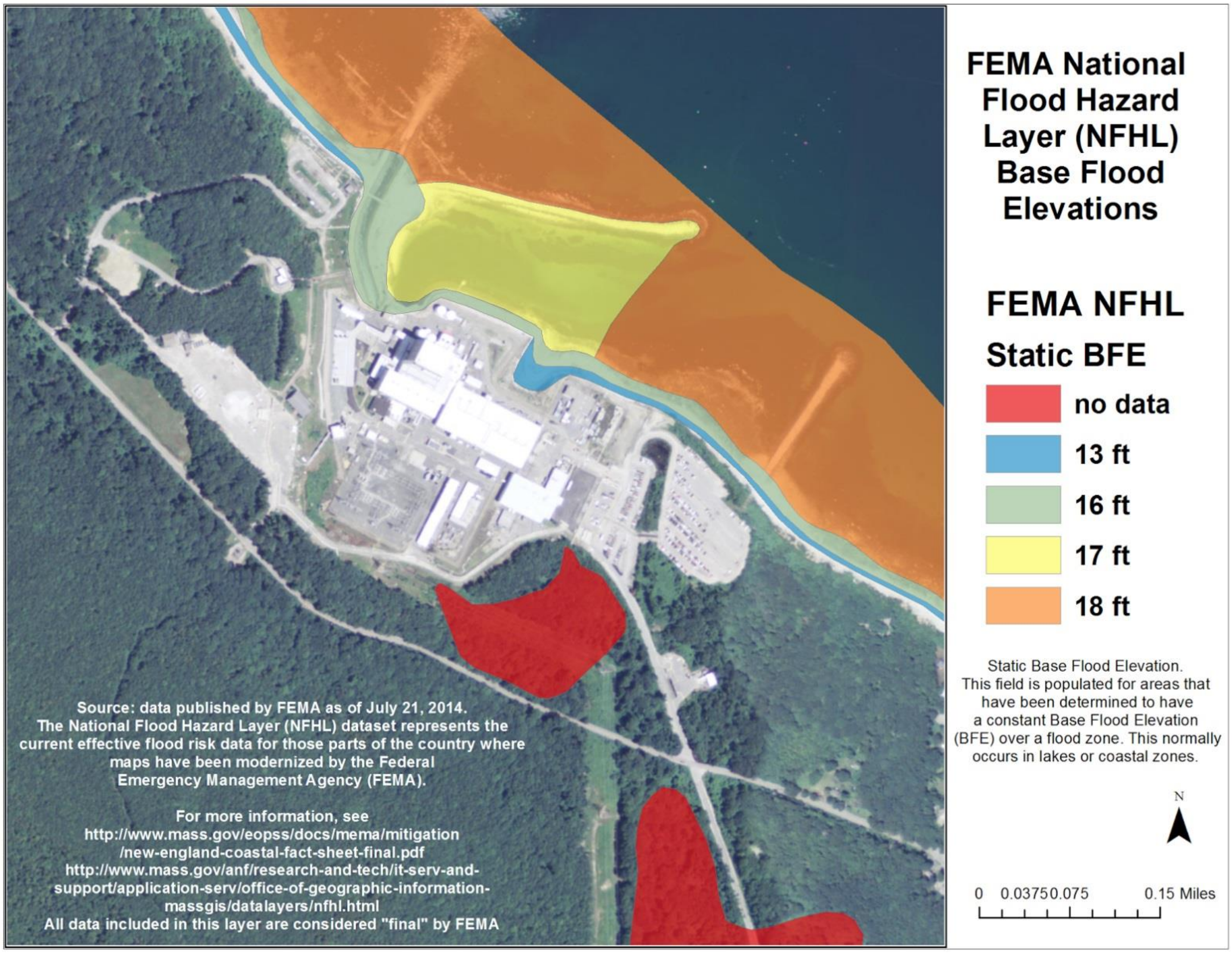
Initial Risk Categories

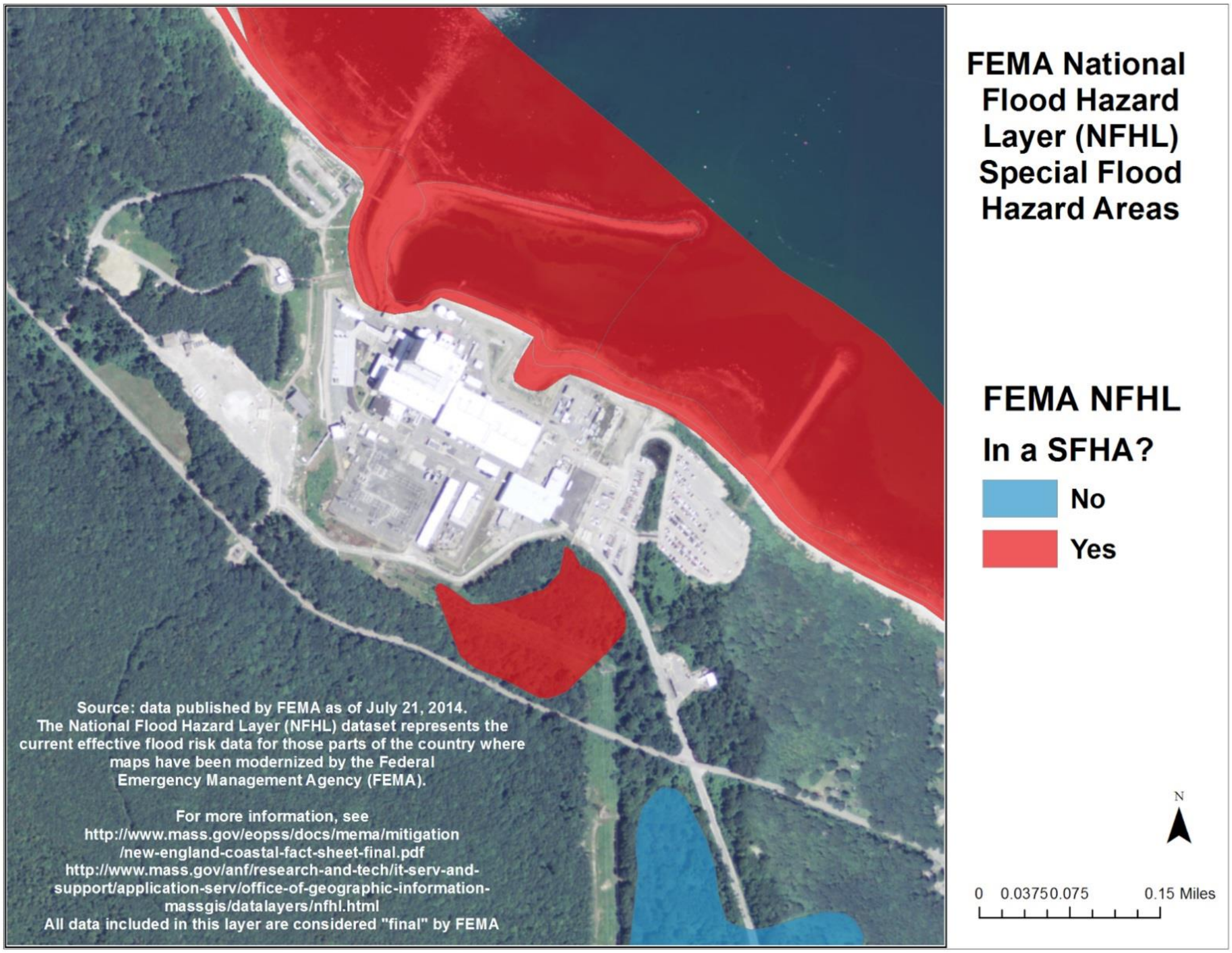
- **Flood Zones:** PNPS overlaps with flood zones A, AE, and VE. Zones AE and VE contain known base flood elevations calculated by FEMA and are shown in the maps below.




FEMA National Flood Hazard Layer (NFHL) Base Flood Elevations
FEMA NFHL
Static BFE
no data
13 ft
16 ft
17 ft
18 ft
Static Base Flood Elevation. This field is populated for areas that have been determined to have a constant Base Flood Elevation (BFE) over a flood zone. This normally occurs in lakes or coastal zones.
N
0 0.0375 0.075 0.15 Miles
Source: data published by FEMA as of July 21, 2014.
The National Flood Hazard Layer (NFHL) dataset represents the current effective flood risk data for those parts of the country where maps have been modernized by the Federal Emergency Management Agency (FEMA).
For more information, see
http://www.mass.gov/eopss/docs/mema/mitigation/new-england-coastal-fact-sheet-final.pdf
http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/nfhl.html
All data included in this layer are considered "final" by FEMA

- **Wind Zone:** Zone II & Hurricane-Susceptible Region
    - Zone II buildings have to be able to withstand up to 160 mph winds.

- **Special Flood Hazard Area (SFHA):** Yes certain areas within PNPS are located within a SFHA as shown in the map below.



Flood Inundation Risk Score and Table (FIRST SCORE™)

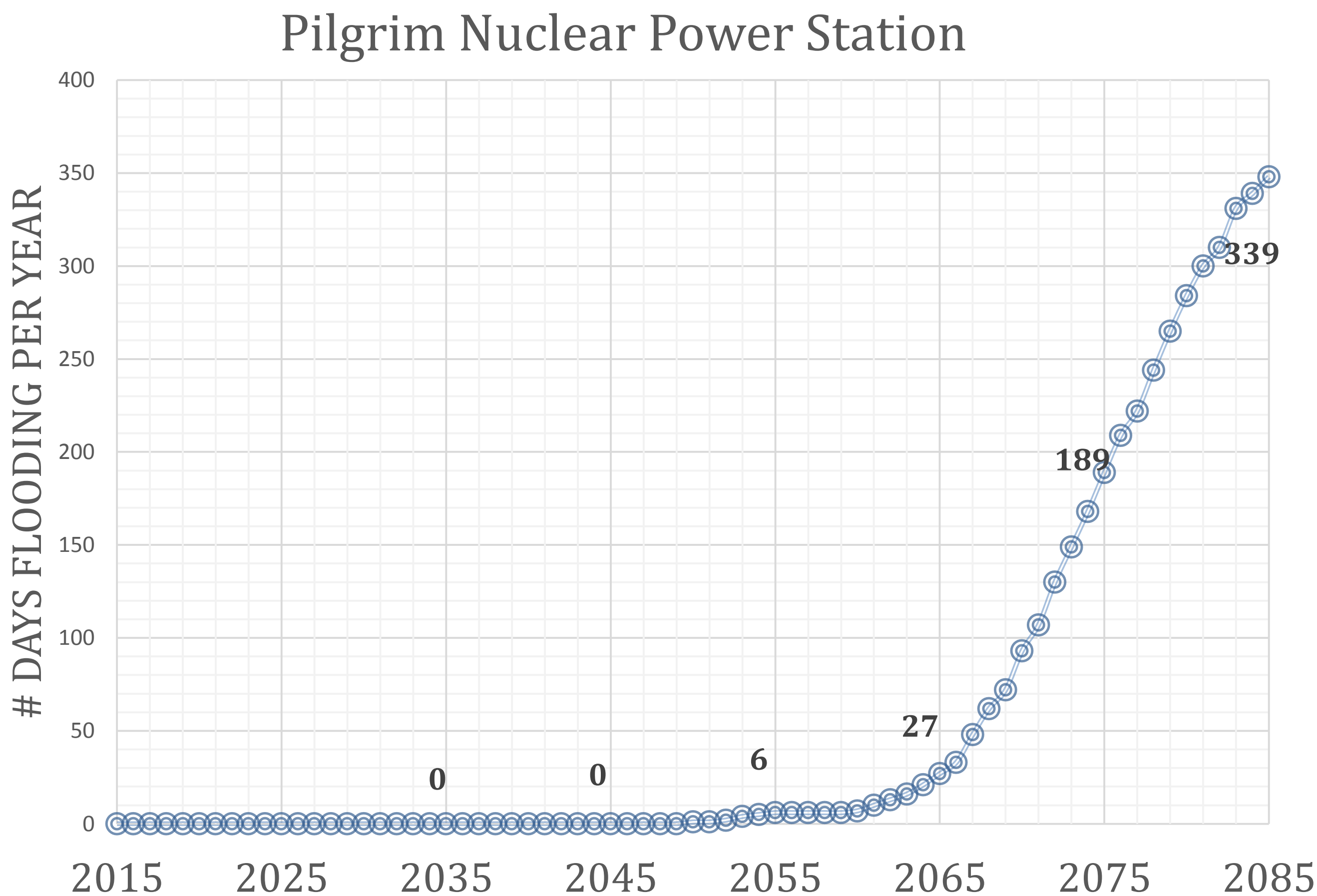
The FIRST Score™ is the total number of non-storm flood days the property will experience over the next 70-years. A flood day is defined as a day when the measured water level -- enhanced by sea level rise, is greater than a threshold ground elevation of the site. The following table shows the Cumulative FIRST Score™ divided into 10-year increments to show progression of risk over time.

Pilgrim Nuclear Power Station

Date Range	2015-2025	2026-2035	2036-2045	2046-2055	2056-2065	2066-2075	2076-2085
# Total Flood Days	0	0	0	19	118	1051	2852
Risk Meter							

Cumulative FIRST Score™ = 4040

Each year, the number of days with nuisance flooding increases, as shown in the graph below.



The FIRST Score™ is also correlated with the Coastal Risk Rapid Assessment™ (CRRA), which is shown as a series of maps on the next seven pages. These maps display non-storm flooding extent and maximum water depth every 10 years from 2015 to 2085. These maps also display the storm flooding extent and water depth of a category 4 hurricane. Each year the surge heights are enhanced with sea level rise, as projected by NOAA.

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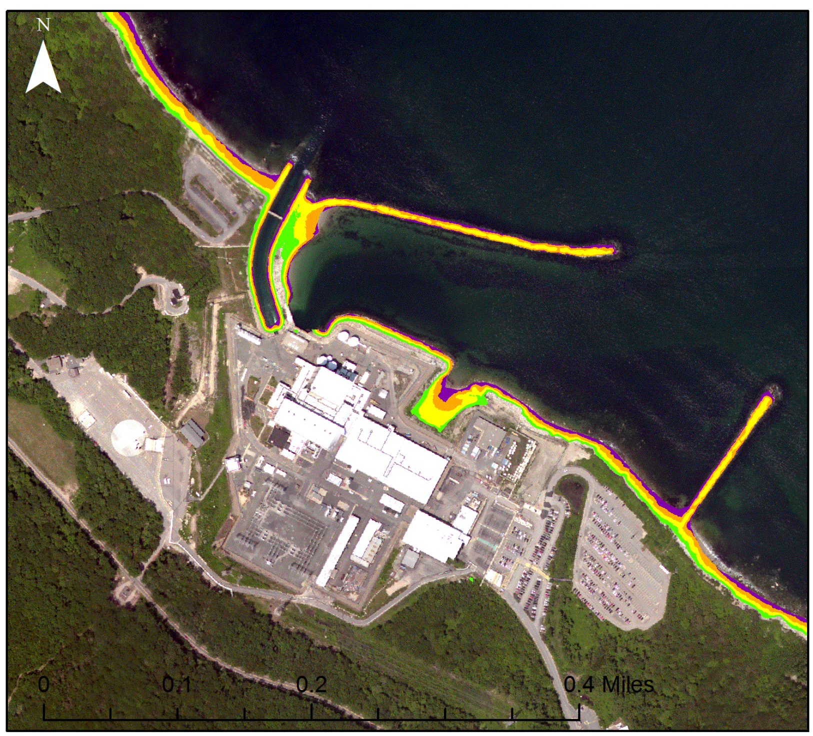
Pilgrim Nuclear Power Station

Nuisance Flooding 2015

The property is at risk of limited to no days of non-storm flooding in 2015. The map on the right is a close-up look at the area surrounding the property. The upper left map is zoomed out to show extent, but not flood risk. The black outline shown on this map depicts the extent of the close-up map as a reference.



Category 4 hurricane storm surge: 2015

- 0.1 - 3 ft
- 3 - 6 ft
- 6 - 9 ft
- 9 - 15 ft

The map shows land vulnerable to flooding and from a category 4 hurricane surge at high tide. The different colors portray the depth of flooding in terms of water above land, as shown in the legend. Green shows up to 3ft of water, yellow is 3 to 6ft, orange is 6 to 9ft, and purple is up to 15 ft. No color is no impact from storm surge.

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Nuisance Flooding 2025

The property is at risk of limited to no days of non-storm flooding in 2025. The map on the right is a close-up look at the area surrounding the property. The upper left map is zoomed out to show extent, but not flood risk. The black outline shown on this map depicts the extent of the close-up map as a reference.

Category 4 hurricane storm surge: 2025

- 0.1 - 3 ft
- 3 - 6 ft
- 6 - 9 ft
- 9 - 15 ft

The map shows land vulnerable to flooding and from a category 4 hurricane surge at high tide. The different colors portray the depth of flooding in terms of water above land, as shown in the legend. Green shows up to 3ft of water, yellow is 3 to 6ft, orange is 6 to 9ft, and purple is up to 15 ft. No color is no impact from storm surge.

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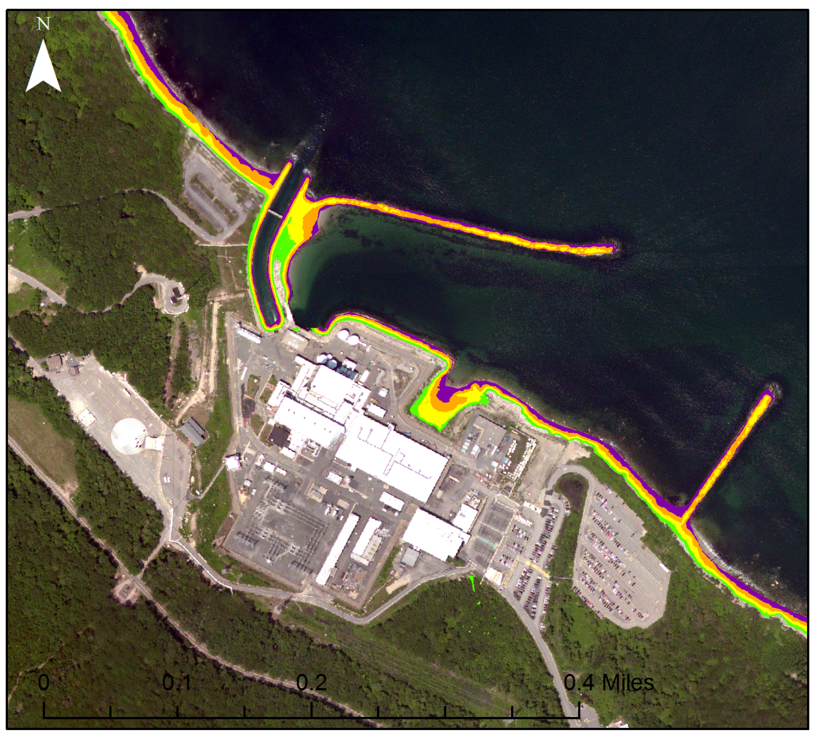
Nuisance Flooding 2035

The property is at risk of limited to no days of non-storm flooding in 2035. The map on the right is a close-up look at the area surrounding the property. The upper left map is zoomed out to show extent, but not flood risk. The black outline shown on this map depicts the extent of the close-up map as a reference.



Category 4 hurricane storm surge: 2035

- 0.1 - 3 ft
- 3 - 6 ft
- 6 - 9 ft
- 9 - 15 ft

The map shows land vulnerable to flooding and from a category 4 hurricane surge at high tide. The different colors portray the depth of flooding in terms of water above land, as shown in the legend. Green shows up to 3ft of water, yellow is 3 to 6ft, orange is 6 to 9ft, and purple is up to 15 ft. No color is no impact from storm surge.

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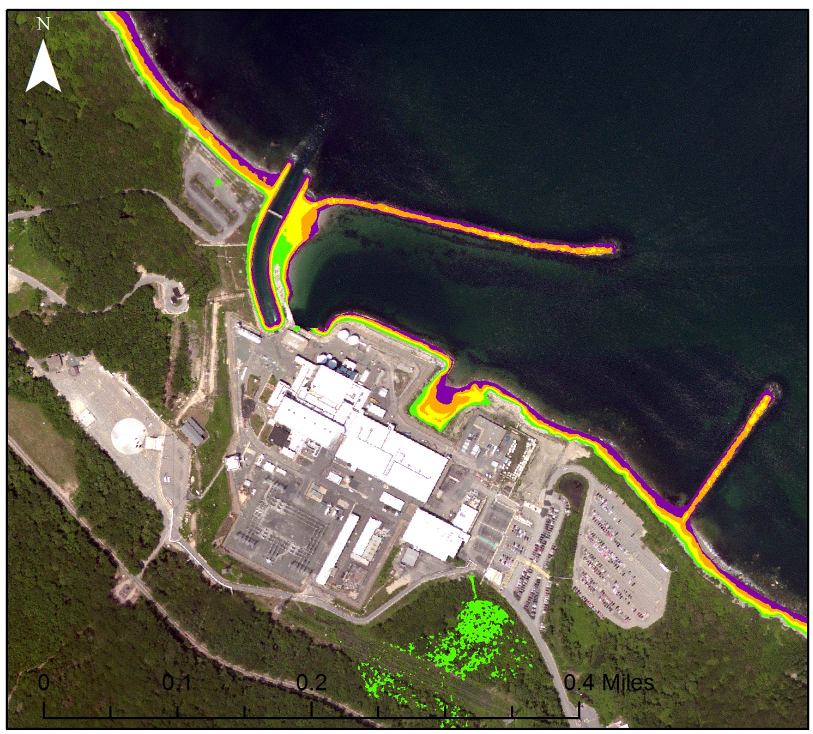
Nuisance Flooding 2045

The property is at risk of limited to no days of non-storm flooding in 2045. The map on the right is a close-up look at the area surrounding the property. The upper left map is zoomed out to show extent, but not flood risk. The black outline shown on this map depicts the extent of the close-up map as a reference.



Category 4 hurricane storm surge: 2045

- 0.1 - 3 ft
- 3 - 6 ft
- 6 - 9 ft
- 9 - 15 ft

The map shows land vulnerable to flooding and from a category 4 hurricane surge at high tide. The different colors portray the depth of flooding in terms of water above land, as shown in the legend. Green shows up to 3ft of water, yellow is 3 to 6ft, orange is 6 to 9ft, and purple is up to 15 ft. No color is no impact from storm surge.

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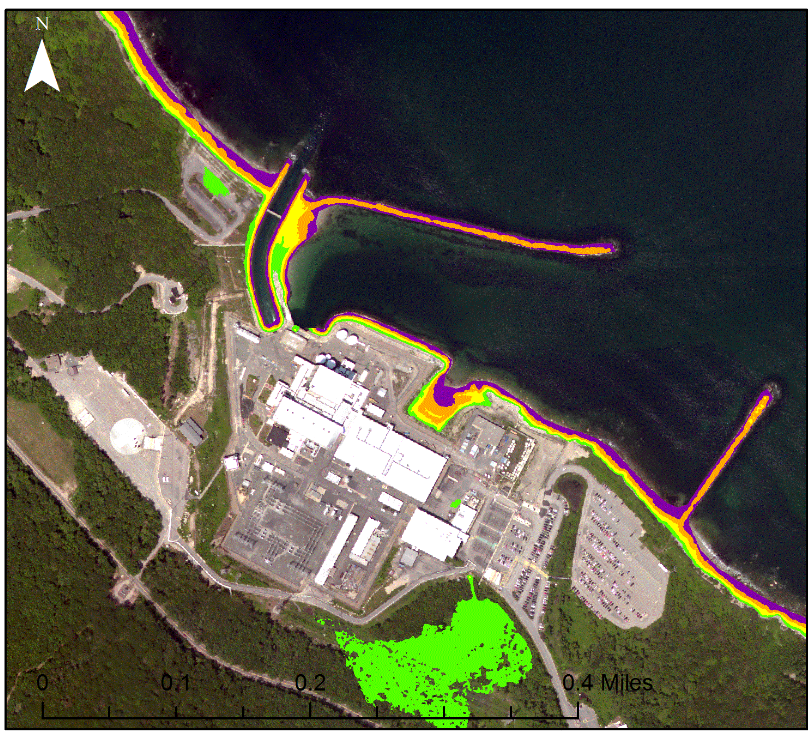
Pilgrim Nuclear Power Station

Nuisance Flooding 2055

The property is at risk of up to 6 days of non-storm flooding in 2055. The map on the right is a close-up look at the area surrounding the property. The upper left map is zoomed out to show extent, but not flood risk. The black outline shown on this map depicts the extent of the close-up map as a reference.



Category 4 hurricane storm surge: 2055

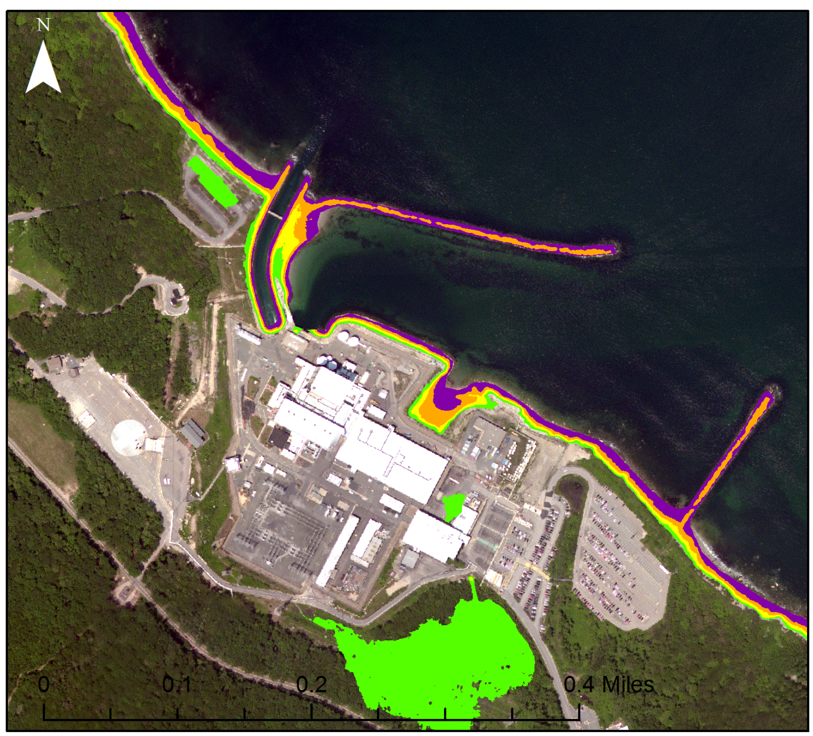
- 0.1 - 3 ft
- 3 - 6 ft
- 6 - 9 ft
- 9 - 15 ft

The map shows land vulnerable to flooding and from a category 4 hurricane surge at high tide. The different colors portray the depth of flooding in terms of water above land, as shown in the legend. Green shows up to 3ft of water, yellow is 3 to 6ft, orange is 6 to 9ft, and purple is up to 15 ft. No color is no impact from storm surge.

Coastal Risk Rapid Assessment™
Pilgrim Nuclear Power Station

Nuisance Flooding 2065

The property is at risk of up to 27 days of non-storm flooding in 2065. The map on the right is a close-up look at the area surrounding the property. The upper left map is zoomed out to show extent, but not flood risk. The black outline shown on this map depicts the extent of the close-up map as a reference.



Category 4 hurricane storm surge: 2065

- 0.1 - 3 ft
- 3 - 6 ft
- 6 - 9 ft
- 9 - 15 ft

The map shows land vulnerable to flooding and from a category 4 hurricane surge at high tide. The different colors portray the depth of flooding in terms of water above land, as shown in the legend. Green shows up to 3ft of water, yellow is 3 to 6ft, orange is 6 to 9ft, and purple is up to 15 ft. No color is no impact from storm surge.

Coastal Risk Rapid Assessment™
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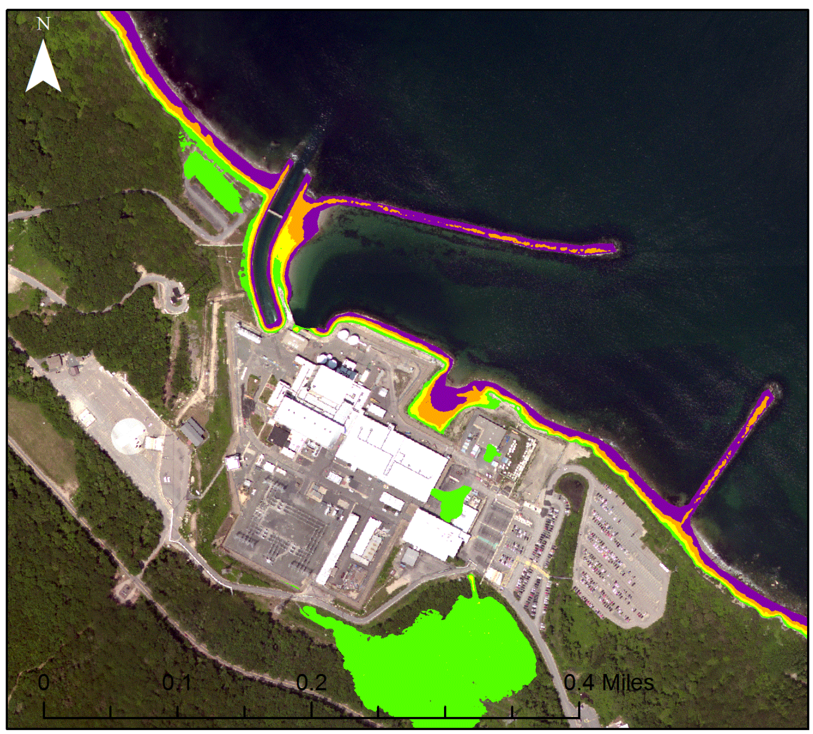
Nuisance Flooding 2075

The property is at risk of up to 189 days of non-storm flooding in 2075. The map on the right is a close-up look at the area surrounding the property. The upper left map is zoomed out to show extent, but not flood risk. The black outline shown on this map depicts the extent of the close-up map as a reference.



Category 4 hurricane storm surge: 2075

- 0.1 - 3 ft
- 3 - 6 ft
- 6 - 9 ft
- 9 - 15 ft

The map shows land vulnerable to flooding and from a category 4 hurricane surge at high tide. The different colors portray the depth of flooding in terms of water above land, as shown in the legend. Green shows up to 3ft of water, yellow is 3 to 6ft, orange is 6 to 9ft, and purple is up to 15 ft. No color is no impact from storm surge.

Coastal Risk Rapid Assessment™
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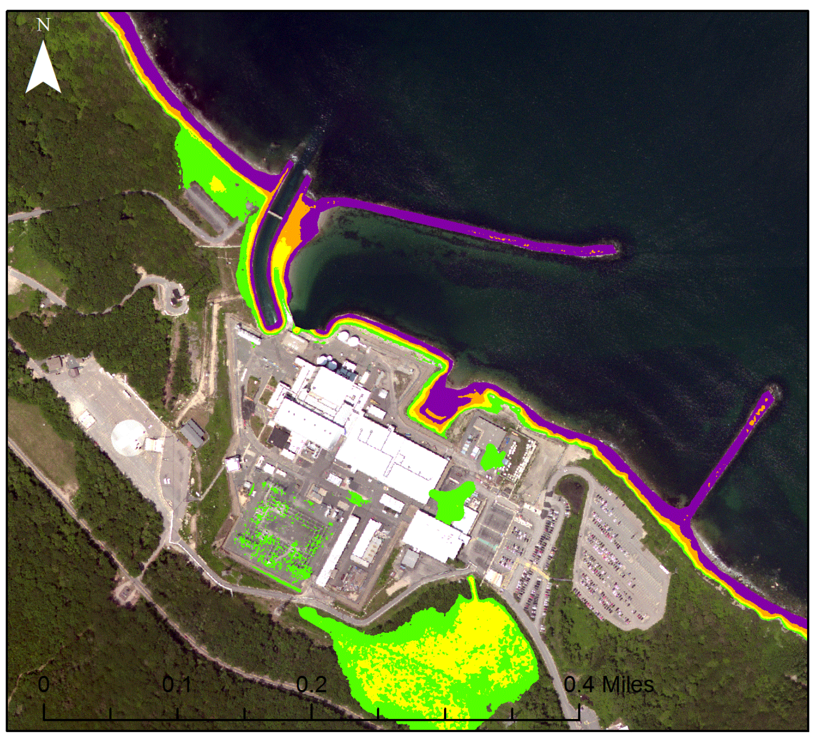
Nuisance Flooding 2085

The property is at risk of up to 348 days of non-storm flooding in 2085. The map on the right is a close-up look at the area surrounding the property. The upper left map is zoomed out to show extent, but not flood risk. The black outline shown on this map depicts the extent of the close-up map as a reference.



Category 4 hurricane storm surge: 2085

- 0.1 - 3 ft
- 3 - 6 ft
- 6 - 9 ft
- 9 - 15 ft

The map shows land vulnerable to flooding and from a category 4 hurricane surge at high tide. The different colors portray the depth of flooding in terms of water above land, as shown in the legend. Green shows up to 3ft of water, yellow is 3 to 6ft, orange is 6 to 9ft, and purple is up to 15 ft. No color is no impact from storm surge.

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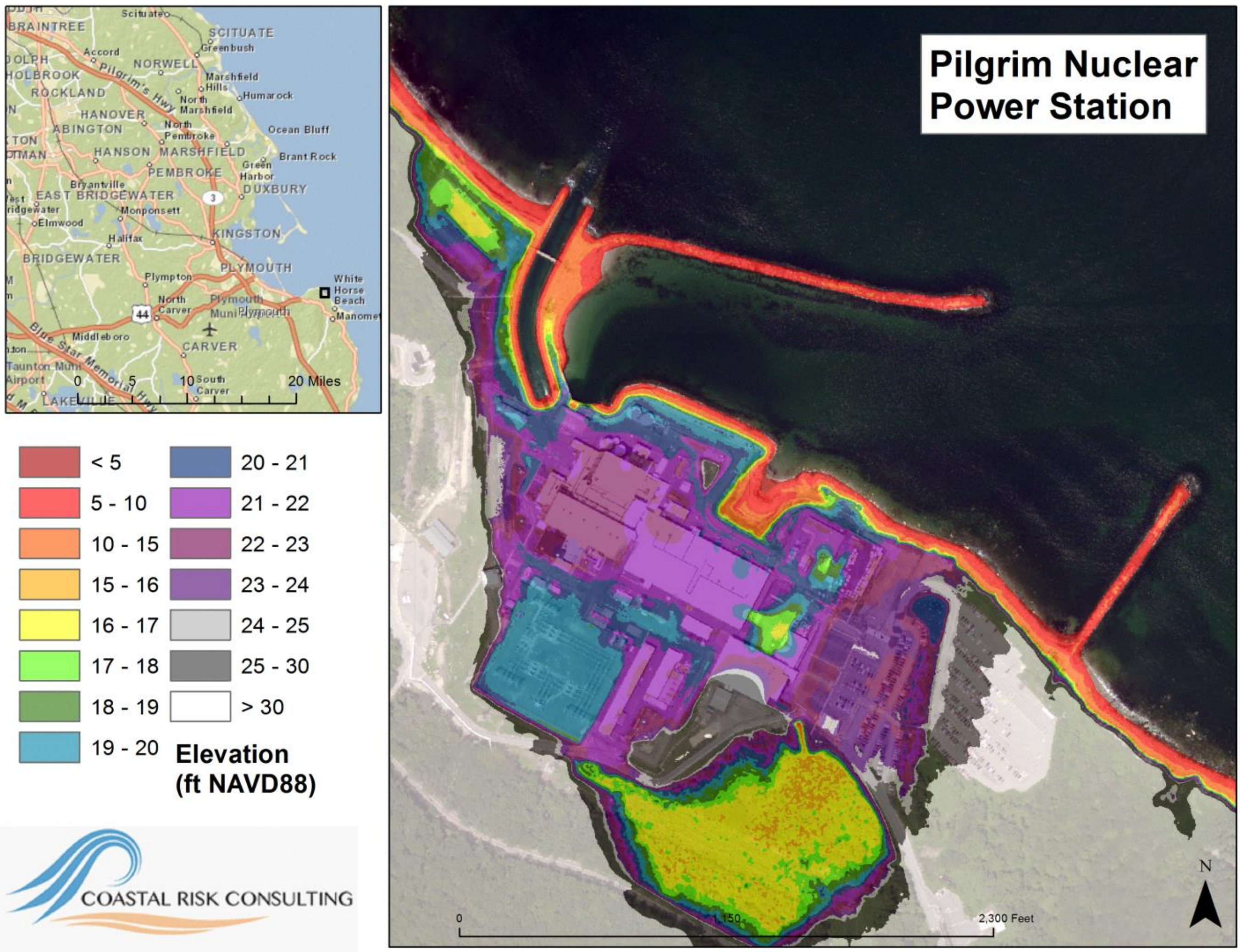
Elevation Map



The average ground elevation of the PNPS site is 22.7 feet NAVD88 and the elevation ranges from 0.73 feet to 71.15 feet NAVD88.

CRRA Conclusions

PNPS is located within 3 government-designated coastal, high-risk zones. However, these are not indicative of current resilince measures that may have been taken.

The **FIRST Score™** for PNPS is 4040 flood days for the next 70 years. The green indicates a very low score and therefore limited nuisance flooding initially; the yellow shows an increase in nuisnace flooding events from 2046-2055, the orange shows a further increase to a medium score, and by 2066 a threshold is reached where high risk of nuisance flooding has been reached. By 2085, the CRRA model projections show that PNPS will experience up to 348 flood days a year. By 2066, PNPS will surpass the known nuisance flooding threshold of 30 non-storm flood days a year.

Pilgrim Nuclear Power Station

Date Range	2015-2025	2026-2035	2036-2045	2046-2055	2056-2065	2066-2075	2076-2085
# Total Flood Days	0	0	0	19	118	1051	2852
Risk Meter							

Cumulative FIRST Score™ = 4040

As shown in the maps, nuisance flooding remains along the coastal perimeter of PNPS through 2085. However, by 2055 the breakwaters will be inundated up to 6 days a year, thereby greatly compromising their ability to protect PNPS from wave action, erosion, or the effect of a major storm. Furthermore, by 2055 PNPS also becomes vulnerable to storm surge on the site itself. The major storm surge risk, again, occurs mostly along the perimeter of PNPS in the beginning but by 2055 areas within the site, although not hydrologically connected, become vulnerable to flooding by a major storm. While the results show that nuisance flooding will not reach buildings or infrastructure on the site, the compound effects of extreme tides combined with a major storm surge, precipitation, and groundwater risk are likely to impact important locations on PNPS, especially if the revetments are overtopped

APPENDIX B

Figure 3-36: WIS Wave Gage Locations

Any illegible text or features in this figure are not pertinent to the technical purposes of this document.

Figure B1. WIS Wave Gage Locations (stations 63057, 63060, 63061). (Source: AREVA, 2015; Figure 3-36, p. 111)