Entergy

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May 11, 2006

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

SUBJECT: Entergy Nuclear Operations, Inc.
Pilgrim Nuclear Power Station
Docket No. 50-293
License No. DPR-35

Annual Radiological Environmental Operating Report
for January 1 through December 31, 2005

LETTER NUMBER: 2.06.038

Dear Sir or Madam:

In accordance with Pilgrim Technical Specification 5.6.2, Entergy Nuclear Operations, Inc. submits the attached Annual Radiological Environmental Monitoring Program Report for January 1 through December 31, 2005.

Should you have questions or require additional information, I can be contacted at (508) 830-8403.

This letter contains no commitments.

Sincerely,

Bryan Ford

WGL/dm
Attachment: Pilgrim Nuclear Power Station Radiological Environmental Monitoring Program Report, January 1 through December 31, 2005

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PILGRIM NUCLEAR POWER STATION

Facility Operating License DPR-35

Radiological Environmental Monitoring Program Report

January 1 through December 31, 2005

PILGRIM NUCLEAR POWER STATION
Facility Operating License DPR-35

RADIOLOGICAL ENVIRONMENTAL
MONITORING PROGRAM REPORT

JANUARY 01 THROUGH DECEMBER 31, 2005

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Pilgrim Nuclear Power Station
Radiological Environmental Monitoring Program Report
January-December 2005

TABLE OF CONTENTS

SECTION	SECTION TITLE	PAGE
--	EXECUTIVE SUMMARY	5
1.0	INTRODUCTION	7
1.1	Radiation and Radioactivity	7
1.2	Sources of Radiation	8
1.3	Nuclear Reactor Operations	9
1.4	Radioactive Effluent Control	15
1.5	Radiological Impact on Humans	17
2.0	RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM	21
2.1	Pre-Operational Monitoring Results	21
2.2	Environmental Monitoring Locations	22
2.3	Interpretation of Radioactivity Analyses Results	24
2.4	Ambient Radiation Measurements	25
2.5	Air Particulate Filter Radioactivity Analyses	26
2.6	Charcoal Cartridge Radioactivity Analyses	26
2.7	Milk Radioactivity Analyses	27
2.8	Forage Radioactivity Analyses	27
2.9	Vegetable/Vegetation Radioactivity Analyses	27
2.10	Cranberry Radioactivity Analyses	28
2.11	Soil Radioactivity Analyses	28
2.12	Surface Water Radioactivity Analyses	28
2.13	Sediment Radioactivity Analyses	28
2.14	Irish Moss Radioactivity Analyses	29
2.15	Shellfish Radioactivity Analyses	29
2.16	Lobster Radioactivity Analyses	29
2.17	Fish Radioactivity Analyses	29
3.0	SUMMARY OF RADIOLOGICAL IMPACT ON HUMANS	64
4.0	REFERENCES	66
APPENDIX A	Special Studies	67
APPENDIX B	Effluent Release Information	68
APPENDIX C	Land Use Census	78
APPENDIX D	Environmental Monitoring Program Discrepancies	79
APPENDIX E	J.A. Fitzpatrick Interlaboratory Comparison Program	83

LIST OF TABLES

TABLE	TABLE TITLE	PAGE
1.2-1	Radiation Sources and Corresponding Doses	8
1.3-1	PNPS Operating Capacity Factor During 2005	9
2.2-1	Routine Radiological Environmental Sampling Locations	31
2.4-1	Offsite Environmental TLD Results	33
2.4-2	Onsite Environmental TLD Results	35
2.4-3	Average TLD Exposures By Distance Zone During 2005	36
2.5-1	Air Particulate Filter Radioactivity Analyses	37
2.6-1	Charcoal Cartridge Radioactivity Analyses	38
2.7-1	Milk Radioactivity Analyses	39
2.8-1	Forage Radioactivity Analyses	40
2.9-1	Vegetable/Vegetation Radioactivity Analyses	41
2.10-1	Cranberry Radioactivity Analyses	42
2.12-1	Surface Water Radioactivity Analyses	43
2.13-1	Sediment Radioactivity Analyses	44
2.14-1	Irish Moss Radioactivity Analyses	45
2.15-1	Shellfish Radioactivity Analyses	46
2.16-1	Lobster Radioactivity Analyses	47
2.17-1	Fish Radioactivity Analyses	48
3.0-1	Radiation Doses From 2005 Pilgrim Station Operations	65
B.1	Supplemental Information	69
B.2-A	Gaseous Effluents Summation of All Releases	70
B.2-B	Gaseous Effluents - Elevated Releases	71
B.2-C	Gaseous Effluents - Ground Level Releases	73
B.3-A	Liquid Effluents Summation of All Releases	75
B.3-B	Liquid Effluents: January-June 2005	76
E.3-1	Ratio of Agreement	84
E.4-1	Interlaboratory Intercomparison Program	88

LIST OF FIGURES

FIGURE	FIGURE TITLE	PAGE
1.3-1	Radioactive Fission Product Formation	11
1.3-2	Radioactive Activation Product Formation	12
1.3-3	Barriers to Confine Radioactive Materials	13
1.5-1	Radiation Exposure Pathways	18
2.2-1	Environmental TLD Locations Within the PNPS Protected Area	49
2.2-2	TLD and Air Sampling Locations: Within 1 Kilometer	51
2.2-3	TLD and Air Sampling Locations: 1 to 5 Kilometers	53
2.2-4	TLD and Air Sampling Locations: 5 to 25 Kilometers	55
2.2-5	Terrestrial and Aquatic Sampling Locations	57
2.2-6	Environmental Sampling and Measurement Control Locations	59
2.5-1	Airborne Gross Beta Radioactivity Levels: Near Station	61
2.5-2	Airborne Gross Beta Radioactivity Levels: Property Line	62
2.5-3	Airborne Gross Beta Radioactivity Levels: Offsite	63

EXECUTIVE SUMMARY

ENTERGY NUCLEAR
PILGRIM NUCLEAR POWER STATION
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM REPORT
JANUARY 01 THROUGH DECEMBER 31, 2005

INTRODUCTION

This report summarizes the results of the Entergy Nuclear Radiological Environmental Monitoring Program (REMP) conducted in the vicinity of Pilgrim Nuclear Power Station (PNPS) during the period from January 1 to December 31, 2005. This document has been prepared in accordance with the requirements of PNPS Technical Specifications section 5.6.2.

The REMP has been established to monitor the radiation and radioactivity released to the environment as a result of Pilgrim Station's operation. This program, initiated in August 1968, includes the collection, analysis, and evaluation of radiological data in order to assess the impact of Pilgrim Station on the environment and on the general public.

SAMPLING AND ANALYSIS

The environmental sampling media collected in the vicinity of PNPS and at distant locations included air particulate filters, charcoal cartridges, seawater, shellfish, Irish moss, American lobster, fishes, sediment, milk, cranberries, vegetation, and animal forage.

During 2005, there were 1,242 samples collected from the atmospheric, aquatic, and terrestrial environments. In addition, 435 exposure measurements were obtained using environmental thermoluminescent dosimeters (TLDs).

A small number of inadvertent issues were encountered during 2005 in the collection of environmental samples in accordance with the PNPS Offsite Dose Calculation Manual (ODCM). Five out of 440 TLDs were unaccounted for during the quarterly retrieval process. However, the 435 TLDs that were collected provided the information necessary to assess ambient radiation levels in the vicinity of Pilgrim Station. Equipment failures and power outages resulted in a small number of instances in which lower than normal volumes were collected at the airborne sampling stations. In some cases, outages were of sufficient duration to yield no sample, and 572 of 583 air particulate and charcoal cartridges were collected and analyzed as required. A full description of any discrepancies encountered with the environmental monitoring program is presented in Appendix D of this report.

There were 1,298 analyses performed on the environmental media samples. Analyses were performed by the J.A. Fitzpatrick Environmental Laboratory in Fulton, New York. Samples were analyzed as required by the PNPS ODCM.

LAND USE CENSUS

The annual land use census in the vicinity of Pilgrim Station was conducted as required by the PNPS ODCM between July 15 and October 28, 2005. A total of 22 vegetable gardens having an area of more than 500 square feet were identified within five kilometers (three miles) of PNPS. No new milk or meat animals were located during the census. Of the 22 garden locations identified, samples were collected at or near four of the gardens as part of the environmental monitoring program.

RADIOLOGICAL IMPACT TO THE ENVIRONMENT

During 2005, samples (except charcoal cartridges) collected as part of the REMP at Pilgrim Station continued to contain detectable amounts of naturally-occurring and man-made radioactive materials. No samples indicated any detectable radioactivity attributable to Pilgrim Station Operations. Offsite ambient radiation measurements using environmental TLDs beyond the site boundary ranged between 46 and 78

milliRoentgens per year. The range of ambient radiation levels observed with the TLDs is consistent with natural background radiation levels for Massachusetts as determined by the Environmental Protection Agency (EPA).

RADIOLOGICAL IMPACT TO THE GENERAL PUBLIC

During 2005, radiation doses to the general public as a result of Pilgrim Station's operation continued to be well below the federal limits and much less than the dose due to other sources of man-made (e.g., X-rays, medical, fallout) and naturally-occurring (e.g., cosmic, radon) radiation.

The calculated total body dose to the maximally exposed member of the general public from radioactive effluents and ambient radiation resulting from PNPS operations for 2005 was about 5.1 mrem for the year. This conservative estimate is well below the EPA's annual dose limit to any member of the general public and is a fraction of a percent of the typical dose received from natural and man-made radiation.

CONCLUSIONS

The 2005 Radiological Environmental Monitoring Program for Pilgrim Station resulted in the collection and analysis of hundreds of environmental samples and measurements. The data obtained were used to determine the impact of Pilgrim Station's operation on the environment and on the general public.

An evaluation of direct radiation measurements, environmental sample analyses, and dose calculations showed that all applicable federal criteria were met. Furthermore, radiation levels and resulting doses were a small fraction of those that are normally present due to natural and man-made background radiation.

Based on this information, there is no significant radiological impact on the environment or on the general public due to Pilgrim Station's operation.

1.0 INTRODUCTION

The Radiological Environmental Monitoring Program for 2005 performed by Entergy Nuclear Company for Pilgrim Nuclear Power Station (PNPS) is discussed in this report. Since the operation of a nuclear power plant results in the release of small amounts of radioactivity and low levels of radiation, the Nuclear Regulatory Commission (NRC) requires a program to be established to monitor radiation and radioactivity in the environment (Reference 1). This report, which is required to be published annually by Pilgrim Station's Technical Specifications section 5.6.2, summarizes the results of measurements of radiation and radioactivity in the environment in the vicinity of the Pilgrim Station and at distant locations during the period January 1 to December 31, 2005.

The Radiological Environmental Monitoring Program consists of taking radiation measurements and collecting samples from the environment, analyzing them for radioactivity content, and interpreting the results. With emphasis on the critical radiation exposure pathways to humans, samples from the aquatic, atmospheric, and terrestrial environments are collected. These samples include, but are not limited to: air, soil, seawater, shellfish, lobster, fishes, milk, cranberries, vegetables, and forage. Thermoluminescent dosimeters (TLDs) are placed in the environment to measure gamma radiation levels. The TLDs are processed and the environmental samples are analyzed to measure the very low levels of radiation and radioactivity present in the environment as a result of PNPS operation and other natural and man-made sources. These results are reviewed by PNPS's radiological staff and have been reported semiannually or annually to the Nuclear Regulatory Commission and others since 1972.

In order to more fully understand how a nuclear power plant impacts humans and the environment, background information on radiation and radioactivity, natural and man-made sources of radiation, reactor operations, radioactive effluent controls, and radiological impact on humans is provided. It is believed that this information will assist the reader in understanding the radiological impact on the environment and humans from the operation of Pilgrim Station.

1.1 Radiation and Radioactivity

All matter is made of atoms. An atom is the smallest part into which matter can be broken down and still maintain all its chemical properties. Nuclear radiation is energy, in the form of waves or particles that is given off by unstable, radioactive atoms.

Radioactive material exists naturally and has always been a part of our environment. The earth's crust, for example, contains radioactive uranium, radium, thorium, and potassium. Some radioactivity is a result of nuclear weapons testing. Examples of radioactive fallout that is normally present in environmental samples are cesium-137 and strontium-90. Some examples of radioactive materials released from a nuclear power plant are cesium-137, iodine-131, strontium-90, and cobalt-60.

Radiation is measured in units of millirem, much like temperature is measured in degrees. A millirem is a measure of the biological effect of the energy deposited in tissue. The natural and man-made radiation dose received in one year by the average American is 300 to 400 mrem (References 2, 3, 4).

Radioactivity is measured in curies. A curie is that amount of radioactive material needed to produce 37,000,000,000 nuclear disintegrations per second. This is an extremely large amount of radioactivity in comparison to environmental radioactivity. That is why radioactivity in the environment is measured in picocuries. One picocurie is equal to one trillionth of a curie.

1.2 Sources of Radiation

As mentioned previously, naturally occurring radioactivity has always been a part of our environment. Table 1.2-1 shows the sources and doses of radiation from natural and man-made sources.

Table 1.2-1

Radiation Sources and Corresponding Doses

NATURAL		MAN-MADE	
Source	Radiation Dose (millirem/year)	Source	Radiation Dose (millirem/year)
Cosmic/cosmogenic	30	Medical/Dental X-Rays	39
Internal	40	Nuclear Medicine	14
Terrestrial	30	Consumer Products	10
Radon/Thoron	200	Weapons Fallout	1
		Nuclear Power Plants	1
Approximate Total	300	Approximate Total	60

Cosmic radiation from the sun and outer space penetrates the earth's atmosphere and continuously bombards us with rays and charged particles. Some of this cosmic radiation interacts with gases and particles in the atmosphere, making them radioactive in turn. These radioactive byproducts from cosmic ray bombardment are referred to as cosmogenic radionuclides. Isotopes such as beryllium-7 and carbon-14 are formed in this way. Exposure to cosmic and cosmogenic sources of radioactivity results in about 30 mrem of radiation dose per year.

Additionally, natural radioactivity is in our body and in the food we eat (about 40 millirem/yr), the ground we walk on (about 30 millirem/yr) and the air we breathe (about 200 millirem/yr). The majority of a person's annual dose results from exposure to radon and thoron in the air we breathe. These gases and their radioactive decay products arise from the decay of naturally occurring uranium, thorium and radium in the soil and building products such as brick, stone, and concrete. Radon and thoron levels vary greatly with location, primarily due to changes in the concentration of uranium and thorium in the soil. Residents at some locations in Colorado, New York, Pennsylvania, and New Jersey have a higher annual dose as a result of higher levels of radon/thoron gases in these areas. In total, these various sources of naturally-occurring radiation and radioactivity contribute to a total dose of about 300 mrem per year.

In addition to natural radiation, we are normally exposed to radiation from a number of man-made sources. The single largest doses from man-made sources result from therapeutic and diagnostic applications of x-rays and radiopharmaceuticals. The annual dose to an individual in the U.S. from medical and dental exposure is about 50 mrem. Consumer products, such as televisions and smoke detectors, contribute about 10 mrem/yr. Much smaller doses result from weapons fallout (less than 1 mrem/yr) and nuclear power plants (less than 1 mrem/yr). Typically, the average person in the United States receives about 60 mrem per year from man-made sources.

1.3 Nuclear Reactor Operations

Pilgrim Station generates about 700 megawatts of electricity at full power, which is enough electricity to supply the entire city of Boston, Massachusetts. Pilgrim Station is a boiling water reactor whose nuclear steam supply system was provided by General Electric Co. The nuclear station is located on a 1600-acre site about eight kilometers (five miles) east-southeast of Plymouth Center. Commercial operation began in December 1972.

Pilgrim Station was operational during most of 2005, with the exception of the refueling outage which was performed between 18-Apr-2005 and 14-May-2005. The resulting monthly capacity factors are presented in Table 1.3-1.

TABLE 1.3-1

PNPS OPERATING CAPACITY FACTOR DURING 2005
(Based on rated reactor thermal power)

Month	Percent Capacity
January	99.1%
February	98.3%
March	97.1%
April	49.6%
May	57.5%
June	99.1%
July	99.9%
August	99.2%
September	99.9%
October	97.4%
November	98.6%
December	99.9%
Annual Average	91.3%

Nuclear-generated electricity is produced at Pilgrim Station by many of the same techniques used for conventional oil and coal-generated electricity. Both systems use heat to boil water to produce steam. The steam turns a turbine, which turns a generator, producing electricity. In both cases, the steam passes through a condenser where it changes back into water and recirculates back through the system. The cooling water source for Pilgrim Station is the Cape Cod Bay.

The key difference between Pilgrim's nuclear power and conventional power is the source of heat used to boil the water. Conventional plants burn fossil fuels in a boiler, while nuclear plants make use of uranium in a nuclear reactor.

Inside the reactor, a nuclear reaction called fission takes place. Particles, called neutrons, strike the nucleus of a uranium-235 atom, causing it to split into fragments called radioactive fission products. The splitting of the atoms releases both heat and more neutrons. The newly-released neutrons then collide with and split other uranium atoms, thus making more heat and releasing even more neutrons, and on and on until the uranium fuel is depleted or spent. This process is called a chain reaction.

The operation of a nuclear reactor results in the release of small amounts of radioactivity and low levels of radiation. The radioactivity originates from two major sources, radioactive fission products and radioactive activation products.

Radioactive fission products, as illustrated in Figure 1.3-1 (Reference 5), originate from the fissioning of the nuclear fuel. These fission products get into the reactor coolant from their release by minute amounts of uranium on the outside surfaces of the fuel cladding, by diffusion through the fuel pellets and cladding and, on occasion, through defects or failures in the fuel cladding. These fission products circulate along with the reactor coolant water and will deposit on the internal surfaces of pipes and equipment. The radioactive fission products on the pipes and equipment emit radiation. Examples of some fission products are krypton-85 (Kr-85), strontium-90 (Sr-90), iodine-131 (I-131), xenon-133 (Xe-133), and cesium-137 (Cs-137).

Nuclear Fission

Fission is the splitting of the uranium-235 atom by a neutron to release heat and more neutrons, creating a chain reaction. Radiation and fission products are by-products of the process.

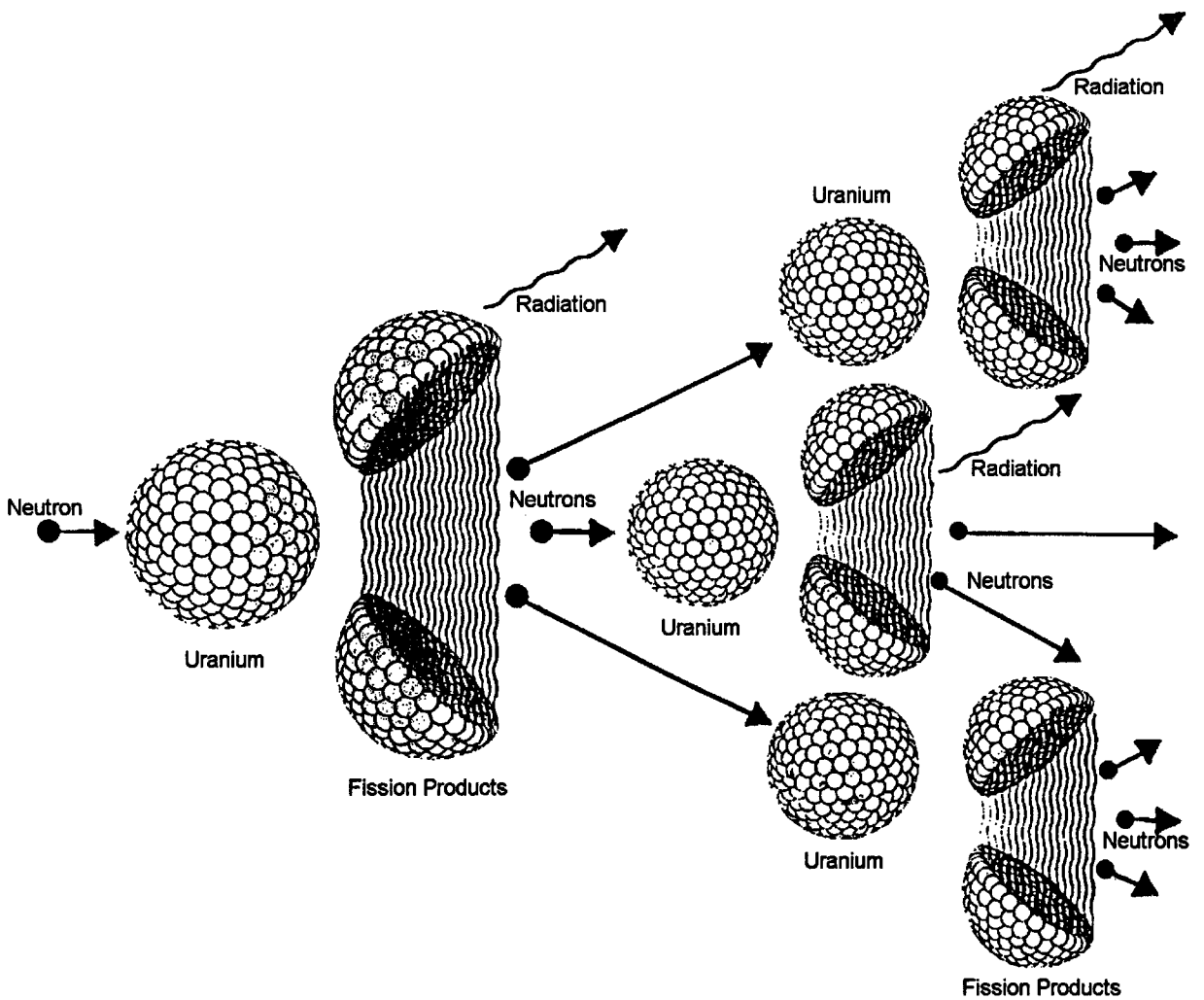


Figure 1.3-1
Radioactive Fission Product Formation

Radioactive activation products (see Figure 1.3-2), on the other hand, originate from two sources. The first is by neutron bombardment of the hydrogen, oxygen and other gas (helium, argon, nitrogen) molecules in the reactor cooling water. The second is a result of the fact that the internals of any piping system or component are subject to minute yet constant corrosion from the reactor cooling water. These minute metallic particles (for example: nickel, iron, cobalt, or magnesium) are transported through the reactor core into the fuel region, where neutrons may react with the nuclei of these particles, producing radioactive products. So, activation products are nothing more than ordinary naturally-occurring atoms that are made unstable or radioactive by neutron bombardment. These activation products circulate along with the reactor coolant water and will deposit on the internal surfaces of pipes and equipment. The radioactive activation products on the pipes and equipment emit radiation. Examples of some activation products are manganese-54 (Mn-54), iron-59 (Fe-59), cobalt-60 (Co-60), and zinc-65 (Zn-65).

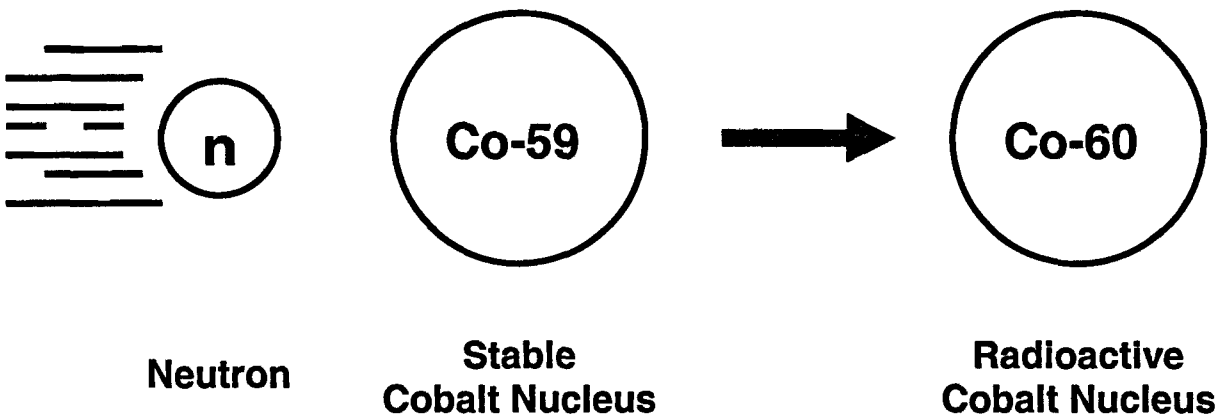


Figure 1.3-2
Radioactive Activation Product Formation

At Pilgrim Nuclear Power Station there are five independent protective barriers that confine these radioactive materials. These five barriers, which are shown in Figure 1.3-3 (Reference 5), are:

- fuel pellets;
- fuel cladding;
- reactor vessel and piping;
- primary containment (drywell and torus); and,
- secondary containment (reactor building).

SIMPLIFIED DIAGRAM OF A BOILING WATER REACTOR

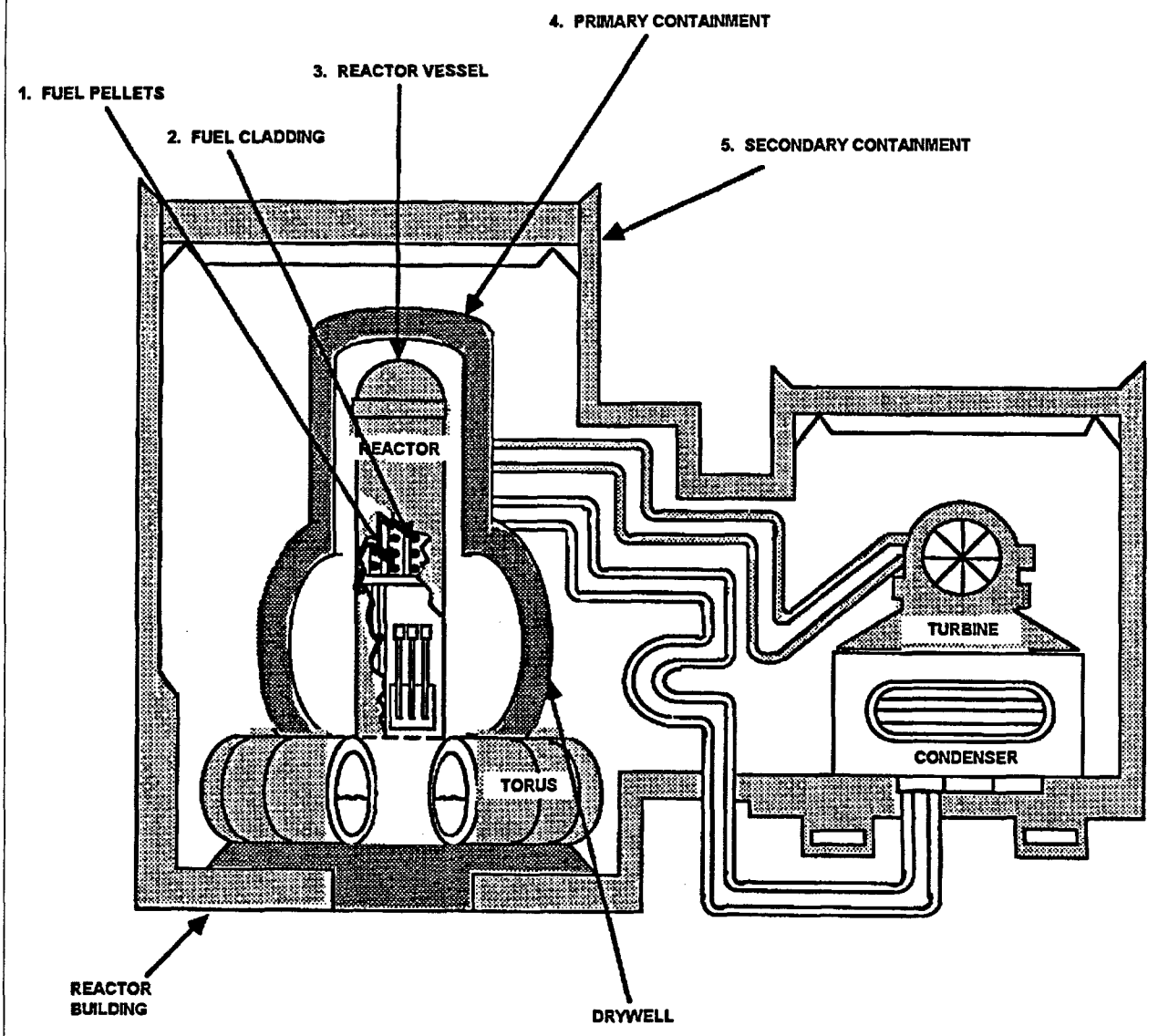


Figure 1.3-3
Barriers To Confine Radioactive Materials

The ceramic uranium fuel pellets provide the first barrier. Most of the radioactive fission products are either physically trapped or chemically bound between the uranium atoms, where they will remain. However, a few fission products that are volatile or gaseous may diffuse through the fuel pellets into small gaps between the pellets and the fuel cladding.

The second barrier, the fuel cladding, consists of zirconium alloy tubes that confine the fuel pellets. The small gaps between the fuel and the cladding contain the noble gases and volatile iodines that are types of radioactive fission products. This radioactivity can diffuse to a small extent through the fuel cladding into the reactor coolant water.

The third barrier consists of the reactor pressure vessel, steel piping and equipment that confine the reactor cooling water. The reactor pressure vessel, which holds the reactor fuel, is a 65-foot high by 19-foot diameter tank with steel walls about nine inches thick. This provides containment for radioactivity in the primary coolant and the reactor core. However, during the course of operations and maintenance, small amounts of radioactive fission and activation products can escape through valve leaks or upon breaching of the primary coolant system for maintenance.

The fourth barrier is the primary containment. This consists of the drywell and the torus. The drywell is a steel lined enclosure that is shaped like an inverted light bulb. An approximately five foot thick concrete wall encloses the drywell's steel pressure vessel. The torus is a donut-shaped pressure suppression chamber. The steel walls of the torus are nine feet in diameter with the donut itself having an outside diameter of about 130 feet. Small amounts of radioactivity may be released from primary containment during maintenance.

The fifth barrier is the secondary containment or reactor building. The reactor building is the concrete building that surrounds the primary containment. This barrier is an additional safety feature to contain radioactivity that may escape from the primary containment. This reactor building is equipped with a filtered ventilation system that is used when needed to reduce the radioactivity that escapes from the primary containment.

The five barriers confine most of the radioactive fission and activation products. However, small amounts of radioactivity do escape via mechanical failures and maintenance on valves, piping, and equipment associated with the reactor cooling water system. The small amounts of radioactive liquids and gases that do escape the various containment systems are further controlled by the liquid purification and ventilation filtration systems. Also, prior to a release to the environment, control systems exist to collect and purify the radioactive effluents in order to reduce releases to the environment to as low as is reasonably achievable. The control of radioactive effluents at Pilgrim Station will be discussed in more detail in the next section.

1.4 Radioactive Effluent Control

The small amounts of radioactive liquids and gases that might escape the five barriers are purified in the liquid and gaseous waste treatment systems, then monitored for radioactivity, and released only if the radioactivity levels are below the federal release limits.

Radioactivity released from the liquid effluent system to the environment is limited, controlled, and monitored by a variety of systems and procedures which include:

- reactor water cleanup system;
- liquid radwaste treatment system;
- sampling and analysis of the liquid radwaste tanks; and,
- liquid waste effluent discharge header radioactivity monitor.

The purpose of the reactor water cleanup system is to continuously purify the reactor cooling water by removing radioactive atoms and non-radioactive impurities that may become activated by neutron bombardment. A portion of the reactor coolant water is diverted from the primary coolant system and is directed through ion exchange resins where radioactive elements, dissolved and suspended in the water, are removed through chemical processes. The net effect is a substantial reduction of the radioactive material that is present in the primary coolant water and consequently the amount of radioactive material that might escape from the system.

Reactor cooling water that might escape the primary cooling system and other radioactive water sources are collected in floor and equipment drains. These drains direct this radioactive liquid waste to large holdup tanks. The liquid waste collected in the tanks is purified again using the liquid radwaste treatment system, which consists of a filter and ion exchange resins.

Processing of liquid radioactive waste results in large reductions of radioactive liquids discharged into Cape Cod Bay. Of all wastes processed through liquid radwaste treatment, 90 to 95 percent of all wastes are purified and the processed liquid is re-used in plant systems.

Prior to release, the radioactivity in the liquid radwaste tank is sampled and analyzed to determine if the level of radioactivity is below the release limits and to quantify the total amount of radioactive liquid effluent that would be released. If the levels are below the federal release limits, the tank is drained to the liquid effluent discharge header.

This liquid waste effluent discharge header is provided with a shielded radioactivity monitor. This detector is connected to a radiation level meter and a strip chart recorder in the Control Room. The radiation alarm is set so that the detector will alarm before radioactivity levels exceed the release limits. The liquid effluent discharge header has an isolation valve. If an alarm is received, the liquid effluent discharge valve will automatically close, thereby terminating the release to the Cape Cod Bay and preventing any liquid radioactivity from being released that may exceed the release limits. An audible alarm notifies the Control Room operator that this has occurred.

Some liquid waste sources which have a low potential for containing radioactivity, and/or may contain very low levels of contamination, may be discharged directly to the discharge canal without passing through the liquid radwaste discharge header. One such source of liquids is the neutralizing sump. However, prior to discharging such liquid wastes, the tank is thoroughly mixed and a representative sample is collected for analysis of radioactivity content prior to being discharged.

Another means for adjusting liquid effluent concentrations to below federal limits is by mixing plant cooling water from the condenser with the liquid effluents in the discharge canal. This larger volume of cooling water further dilutes the radioactivity levels far below the release limits.

The preceding discussion illustrates that many controls exist to reduce the radioactive liquid effluents released to the Cape Cod Bay to as far below the release limits as is reasonably achievable.

Radioactive releases from the radioactive gaseous effluent system to the environment are limited, controlled, and monitored by a variety of systems and procedures which include:

- reactor building ventilation system;
- reactor building vent effluent radioactivity monitor;
- sampling and analysis of reactor building vent effluents;
- standby gas treatment system;
- main stack effluent radioactivity monitor and sampling;
- sampling and analysis of main stack effluents;
- augmented off-gas system;
- steam jet air ejector (SJAE) monitor; and,
- off-gas radiation monitor.

The purpose of the reactor building ventilation system is to collect and exhaust reactor building air. Air collected from contaminated areas is filtered prior to combining it with air collected from other parts of the building. This combined airflow is then directed to the reactor building ventilation plenum that is located on the side of the reactor building. This plenum, which vents to the atmosphere, is equipped with a radiation detector. The radiation level meter and strip chart recorder for the reactor building vent effluent radioactivity monitor is located in the Control Room. To supplement the information continuously provided by the detector, air samples are taken periodically from the reactor building vent and are analyzed to quantify the total amount of tritium and radioactive gaseous and particulate effluents released.

If air containing elevated amounts of noble gases is routed past the reactor building vent's effluent radioactivity monitor, an alarm will alert the Control Room operators that release limits are being approached. The Control Room operators, according to procedure, will isolate the reactor building ventilation system and initiate the standby gas treatment system to remove airborne particulates and gaseous halogen radioactivity from the reactor building exhaust. This filtration assembly consists of high-efficiency particulate air filters and charcoal adsorber beds. The purified air is then directed to the main stack. The main stack has dilution flow that further reduces concentration levels of gaseous releases to the environment to as far below the release limits as is reasonably achievable.

The approximately 335 foot tall main stack has a special probe inside it that withdraws a portion of the air and passes it through a radioactivity monitoring system. This main stack effluent radioactivity monitoring system continuously samples radioactive particulates, iodines, and noble gases. Grab samples for a tritium analysis are also collected at this location. The system also contains radioactivity detectors that monitor the levels of radioactive noble gases in the stack flow and display the result on radiation level meters and strip chart recorders located in the Control Room. To supplement the information continuously provided by the detectors, the particulate, iodine, tritium, and gas samples are analyzed periodically to quantify the total amount of radioactive gaseous effluent being released.

The purpose of the augmented off-gas system is to reduce the radioactivity from the gases that are removed from the condenser. This purification system consists of two 30-minute holdup lines to reduce the radioactive gases with short half-lives, several charcoal adsorbers to remove radioactive iodines and further retard the short half-life gases, and offgas filters to remove radioactive particulates. The recombiner collects free hydrogen and oxygen gas and recombines them into water. This helps reduce the gaseous releases of short-lived isotopes of oxygen that have been made radioactive by neutron activation.

The radioactive off-gas from the condenser is then directed into a ventilation pipe to which the off-gas radiation monitors are attached. The radiation level meters and strip chart recorders for this detector are also located in the Control Room. If a radiation alarm setpoint is exceeded, an audible alarm will sound to

alert the Control Room operators. In addition, the off-gas bypass and charcoal adsorber inlet valve will automatically re-direct the off-gas into the charcoal adsorbers if they are temporarily being bypassed. If the radioactivity levels are not returned to below the alarm setpoint within 13 minutes, the off-gas releases will be automatically isolated, thereby preventing any gaseous radioactivity from being released that may exceed the release limits.

Therefore, for both liquid and gaseous releases, radioactive effluent control systems exist to collect and purify the radioactive effluents in order to reduce releases to the environment to as low as is reasonably achievable. The effluents are always monitored, sampled and analyzed prior to release to make sure that radioactivity levels are below the release limits. If the release limits are being approached, isolation valves in some of the waste effluent lines will automatically shut to stop the release, or Control Room operators will implement procedures to ensure that federal regulatory limits are always met.

1.5 Radiological Impact on Humans

The final step in the effluent control process is the determination of the radiological dose impact to humans and comparison with the federal dose limits to the public. As mentioned previously, the purpose of continuous radiation monitoring and periodic sampling and analysis is to measure the quantities of radioactivity being released to determine compliance with the radioactivity release limits. This is the first stage for assessing releases to the environment.

Next, calculations of the dose impact to the general public from Pilgrim Station's radioactive effluents are performed. The purpose of these calculations is to periodically assess the doses to the general public resulting from radioactive effluents to ensure that these doses are being maintained as far below the federal dose limits as is reasonably achievable. This is the second stage for assessing releases to the environment.

The types and quantities of radioactive liquid and gaseous effluents released from Pilgrim Station during each given year are reported to the Nuclear Regulatory Commission annually. The 2005 Radioactive Effluents are provided in Appendix B and will be discussed in more detail in Section 3 of this report. These liquid and gaseous effluents were well below the federal release limits and were a small percentage of the PNPS ODCM effluent control limits.

These measurements of the physical and chemical nature of the effluents are used to determine how the radionuclides will interact with the environment and how they can result in radiation exposure to humans. The environmental interaction mechanisms depend upon factors such as the hydrological (water) and meteorological (atmospheric) characteristics in the area. Information on the water flow, wind speed, wind direction, and atmospheric mixing characteristics are used to estimate how radioactivity will distribute and disperse in the ocean and the atmosphere.

The most important type of information that is used to evaluate the radiological impact on humans is data on the use of the environment. Information on fish and shellfish consumption, boating usage, beach usage, locations of cows and goats, locations of residences, locations of gardens, drinking water supplies, and other usage information are utilized to estimate the amount of radiation and radioactivity received by the general public.

The radiation exposure pathway to humans is the path radioactivity takes from its release point at Pilgrim Station to its effect on man. The movement of radioactivity through the environment and its transport to humans is portrayed in Figure 1.5-1.

EXAMPLES OF PILGRIM STATION'S RADIATION EXPOSURE PATHWAYS

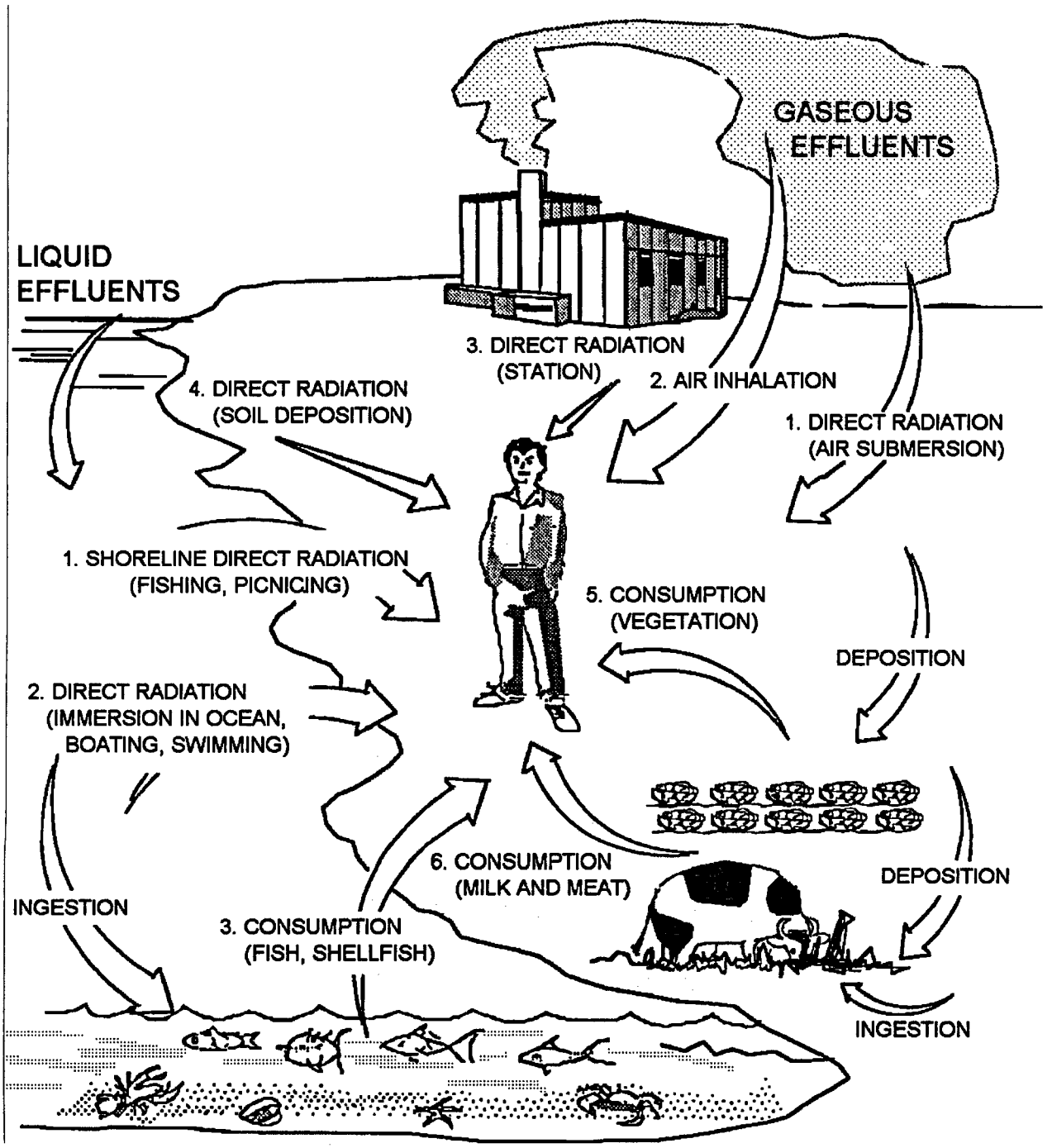


Figure 1.5-1
Radiation Exposure Pathways

There are three major ways in which liquid effluents affect humans:

- external radiation from liquid effluents that deposit and accumulate on the shoreline;
- external radiation from immersion in ocean water containing radioactive liquids; and,
- internal radiation from consumption of fish and shellfish containing radioactivity absorbed from the liquid effluents.

There are six major ways in which gaseous effluents affect humans:

- external radiation from an airborne plume of radioactivity;
- internal radiation from inhalation of airborne radioactivity;
- external radiation from deposition of radioactive effluents on soil;
- ambient (direct) radiation from contained sources at the power plant;
- internal radiation from consumption of vegetation containing radioactivity absorbed from the soil due to ground deposition of radioactive effluents; and,
- internal radiation from consumption of milk and meat containing radioactivity deposited on forage that is eaten by cattle and other livestock.

In addition, ambient (direct) radiation emitted from contained sources of radioactivity at PNPS contributes to radiation exposure in the vicinity of the plant. Radioactive nitrogen-16 contained in the steam flowing through the turbine accounts for the majority of this "sky shine" radiation exposure immediately adjacent to the plant. Smaller amounts of ambient radiation result from low-level radioactive waste stored at the site prior to shipping and disposal.

To the extent possible, the radiological dose impact on humans is based on direct measurements of radiation and radioactivity in the environment. When PNPS-related activity is detected in samples that represent a plausible exposure pathway, the resulting dose from such exposure is assessed (see Appendix A). However, the operation of Pilgrim Nuclear Power Station results in releases of only small amounts of radioactivity, and, as a result of dilution in the atmosphere and ocean, even the most sensitive radioactivity measurement and analysis techniques cannot usually detect these tiny amounts of radioactivity above that which is naturally present in the environment. Therefore, radiation doses are calculated using radioactive effluent release data and computerized dose calculations that are based on very conservative NRC-recommended models that tend to result in over-estimates of resulting dose. These computerized dose calculations are performed by or for Entergy Nuclear personnel. These computer codes use the guidelines and methodology set forth by the NRC in Regulatory Guide 1.109 (Reference 6). The dose calculations are documented and described in detail in the Pilgrim Nuclear Power Station's Offsite Dose Calculation Manual (Reference 7), which has been reviewed by the NRC.

Monthly dose calculations are performed by PNPS personnel. It should be emphasized that because of the very conservative assumptions made in the computer code calculations, the maximum hypothetical dose to an individual is considerably higher than the dose that would actually be received by a real individual.

After dose calculations are performed, the results are compared to the federal dose limits for the public. The two federal agencies that are charged with the responsibility of protecting the public from radiation and radioactivity are the Nuclear Regulatory Commission (NRC) and The Environmental Protection Agency (EPA).

The NRC, in 10CFR 20.1301 (Reference 8) limits the levels of radiation to unrestricted areas resulting from the possession or use of radioactive materials such that they limit any individual to a dose of:

- less than or equal to 100 mrem per year to the total body.

In addition to this dose limit, the NRC has established design objectives for nuclear plant licensees. Conformance to these guidelines ensures that nuclear power reactor effluents are maintained as far below the legal limits as is reasonably achievable.

The NRC, in 10CFR 50 Appendix I (Reference 9) establishes design objectives for the dose to a member of the general public from radioactive material in liquid effluents released to unrestricted areas to be limited to:

- less than or equal to 3 mrem per year to the total body; and,
- less than or equal to 10 mrem per year to any organ.

The air dose due to release of noble gases in gaseous effluents is restricted to:

- less than or equal to 10 mrad per year for gamma radiation; and,
- less than or equal to 20 mrad per year for beta radiation.

The dose to a member of the general public from iodine-131, tritium, and all particulate radionuclides with half-lives greater than 8 days in gaseous effluents is limited to:

- less than or equal to 15 mrem per year to any organ.

The EPA, in 40CFR190.10 Subpart B (Reference 10), sets forth the environmental standards for the uranium fuel cycle. During normal operation, the annual dose to any member of the public from the entire uranium fuel cycle shall be limited to:

- less than or equal to 25 mrem per year to the total body;
- less than or equal to 75 mrem per year to the thyroid; and,
- less than or equal to 25 mrem per year to any other organ.

The summary of the 2005 radiological impact for Pilgrim Station and comparison with the EPA dose limits and guidelines, as well as a comparison with natural/man-made radiation levels, is presented in Section 3 of this report.

The third stage of assessing releases to the environment is the Radiological Environmental Monitoring Program (REMP). The description and results of the REMP at Pilgrim Nuclear Power Station during 2005 is discussed in Section 2 of this report.

2.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

2.1 Pre-Operational Monitoring Results

The Radiological Environmental Monitoring Program (REMP) at Pilgrim Nuclear Power Station was first initiated in August 1968, in the form of a pre-operational monitoring program prior to bringing the station on-line. The NRC's intent (Reference 11) with performing a pre-operational environmental monitoring program is to:

- measure background levels and their variations in the environment in the area surrounding the licensee's station; and,
- evaluate procedures, equipment, and techniques for monitoring radiation and radioactivity in the environment.

The pre-operational program (Reference 12) continued for approximately three and a half years, from August 1968 to June 1972. Examples of background radiation and radioactivity levels measured during this time period are as follows:

- Airborne Radioactivity Particulate Concentration (gross beta): 0.02 - 1.11 pCi/m^3;
- Ambient Radiation (TLDs): 4.2 - 22 micro-R/hr (37 - 190 mR/yr);
- Seawater Radioactivity Concentrations (gross beta): 12 - 31 pCi/liter;
- Fish Radioactivity Concentrations (gross beta): 2,200 - 11,300 pCi/kg;
- Milk Radioactive Cesium-137 Concentrations: 9.3 - 32 pCi/liter;
- Milk Radioactive Strontium-90 Concentrations: 4.7 - 17.6 pCi/liter;
- Cranberries Radioactive Cesium-137 Concentrations: 140 - 450 pCi/kg;
- Forage Radioactive Cesium-137 Concentrations: 150 - 290 pCi/kg.

This information from the pre-operational phase is used as a basis for evaluating changes in radiation and radioactivity levels in the vicinity of the plant following plant operation. In April 1972, just prior to initial reactor startup (June 12, 1972), Boston Edison Company implemented a comprehensive operational environmental monitoring program at Pilgrim Nuclear Power Station. This program (Reference 13) provides information on radioactivity and radiation levels in the environment for the purpose of:

- demonstrating that doses to the general public and levels of radioactivity in the environment are within established limits and legal requirements;
- monitoring the transfer and long-term buildup of specific radionuclides in the environment to revise the monitoring program and environmental models in response to changing conditions;
- checking the condition of the station's operation, the adequacy of operation in relation to the adequacy of containment, and the effectiveness of effluent treatment so as to provide a mechanism of determining unusual or unforeseen conditions and, where appropriate, to trigger special environmental monitoring studies;
- assessing the dose equivalent to the general public and the behavior of radioactivity released during the unlikely event of an accidental release; and,
- determining whether or not the radiological impact on the environment and humans is significant.

The Nuclear Regulatory Commission requires that Pilgrim Station provide monitoring of the plant environs for radioactivity that will be released as a result of normal operations, including anticipated operational occurrences, and from postulated accidents. The NRC has established guidelines (Reference 14) that specify an acceptable monitoring program. The PNPS Radiological Environmental Monitoring Program was designed to meet and exceed these guidelines. Guidance contained in the NRC's Radiological Assessment Branch Technical Position on Environmental Monitoring (Reference 15) has been used to improve the program. In addition, the program has incorporated the provisions of an agreement made with the Massachusetts Wildlife Federation (Reference 16). The program was supplemented by including improved analysis of shellfish and sediment at substantially higher sensitivity levels to verify the adequacy of effluent controls at Pilgrim Station.

2.2 Environmental Monitoring Locations

Sampling locations have been established by considering meteorology, population distribution, hydrology, and land use characteristics of the Plymouth area. The sampling locations are divided into two classes, indicator and control. Indicator locations are those that are expected to show effects from PNPS operations, if any exist. These locations were primarily selected on the basis of where the highest predicted environmental concentrations would occur. While the indicator locations are typically within a few kilometers of the plant, the control stations are generally located so as to be outside the influence of Pilgrim Station. They provide a basis on which to evaluate fluctuations at indicator locations relative to natural background radiation and natural radioactivity and fallout from prior nuclear weapons tests.

The environmental sampling media collected in the vicinity of Pilgrim Station during 2005 included air particulate filters, charcoal cartridges, seawater, shellfish, Irish moss, American lobster, fishes, sediment, milk, cranberries, vegetation, and forage. The sampling medium, station description, station number, distance, and direction for indicator and control samples are listed in Table 2.2-1. These sampling locations are also displayed on the maps shown in Figures 2.2-1 through 2.2-6.

The radiation monitoring locations for the environmental TLDs are shown in Figures 2.2-1 through 2.2-4. The frequency of collection and types of radioactivity analysis are described in Pilgrim Station's ODCM, Sections 3/4.5.

The land-based (terrestrial) samples and monitoring devices are collected by Entergy personnel. The aquatic samples are collected by Marine Research, Inc. The radioactivity analysis of samples and the processing of the environmental TLDs are performed by Entergy's J.A. Fitzpatrick Environmental Laboratory.

The frequency, types, minimum number of samples, and maximum lower limits of detection (LLD) for the analytical measurements, are specified in the PNPS ODCM. During 2003, a revision was made to the PNPS ODCM to standardize it to the model program described in NUREG-1302 (Reference 14) and the Branch Technical Position of 1979 (Reference 15). In accordance with this standardization, a number of changes occurred regarding the types and frequencies of sample collections.

In regard to terrestrial REMP sampling, routine collection and analysis of soil samples was discontinued in lieu of the extensive network of environmental TLDs around PNPS, and the weekly collection of air samples at 11 locations. Such TLD monitoring and air sampling would provide an early indication of any potential deposition of radioactivity, and follow-up soil sampling could be performed on an as-needed basis. Also, with the loss of the indicator milk sample at the Plymouth County Farm, it was deemed unnecessary to continue to collect and analyze control samples of milk. Consequently, routine milk sampling was also dropped from the terrestrial sampling program.

In the area of marine sampling, a number of the specialized sampling and analysis requirements implemented as part of the Agreement with the Massachusetts Wildlife Federation (Reference 16) for licensing of a second reactor at PNPS were dropped. This agreement, made in 1977, was predicated on the construction of a second nuclear unit, and was set to expire in 1987. However, since the specialized requirements were incorporated into the PNPS Technical Specifications at the time, the requirements were continued. When the ODCM was revised in 1999 in accordance with NRC Generic Letter 89-01, the

sampling program description was relocated to the ODCM. When steps were taken in 2003 to standardize the PNPS ODCM to the NUREG-1302 model, the specialized marine sampling requirements were changed to those of the model program. These changes include the following:

- A sample of the surface layer of sediment is collected, as opposed to specialized depth-incremental sampling to 30 cm and subdividing cores into 2 cm increments.
- Standard LLD levels of about 150 to 180 pCi/kg were established for sediment, as opposed to the specialized LLDs of 50 pCi/kg.
- Specialized analysis of sediment for plutonium isotopes was removed.
- Sampling of Irish moss, shellfish, and fish was rescheduled to a semiannual period, as opposed to a specialized quarterly sampling interval.
- Analysis of only the edible portions of shellfish (mussels and clams), as opposed to specialized additional analysis of the shell portions.
- Standard LLD levels of 130 to 260 pCi/kg were established for edible portions of shellfish, as opposed to specialized LLDs of 5 pCi/kg.

Upon receipt of the analysis results from the analytical laboratories, the PNPS staff reviews the results. If the radioactivity concentrations are above the reporting levels, the NRC must be notified within 30 days. For radioactivity that is detected that is attributable to Pilgrim Station's operation, calculations are performed to determine the cumulative dose contribution for the current year. Depending upon the circumstances, a special study may also be completed (see Appendix A for 2005 special studies). Most importantly, if radioactivity levels in the environment become elevated as a result of the station's operation, an investigation is performed and corrective actions are recommended to reduce the amount of radioactivity to as far below the legal limits as is reasonably achievable.

The radiological environmental sampling locations are reviewed annually, and modified if necessary. A garden and milk animal census is performed every year to identify changes in the use of the environment in the vicinity of the station to permit modification of the monitoring and sampling locations. The results of the 2005 Garden and Milk Animal Census are reported in Appendix C.

The accuracy of the data obtained through Pilgrim Station's Radiological Environmental Monitoring Program is ensured through a comprehensive Quality Assurance (QA) programs. PNPS's QA program has been established to ensure confidence in the measurements and results of the radiological monitoring program through:

- Regular surveillances of the sampling and monitoring program;
- An annual audit of the analytical laboratory by the sponsor companies;
- Participation in cross-check programs;
- Use of blind duplicates for comparing separate analyses of the same sample; and,
- Spiked sample analyses by the analytical laboratory.

QA audits and inspections of the Radiological Environmental Monitoring Program are performed by the NRC, American Nuclear Insurers, and by the PNPS Quality Assurance Department.

The J.A. Fitzpatrick Environmental Laboratory conducts extensive quality assurance and quality control programs. The 2005 results of these programs are summarized in Appendices E and F. These results indicate that the analyses and measurements performed during 2005 exhibited acceptable precision and accuracy.

2.3 Interpretation of Radioactivity Analyses Results

The following pages summarize the analytical results of the environmental samples collected during 2005. Data for each environmental medium are included in a separate section. A table that summarizes the year's data for each type of medium follows a discussion of the sampling program and results. The unit of measurement for each medium is listed at the top of each table. The left hand column contains the radionuclides being reported, total number of analyses of that radionuclide, and the number of measurements that exceed ten times the yearly average for the control station(s). The latter are classified as "non-routine" measurements. The next column lists the Lower Limit of Detection (LLD) for those radionuclides that have detection capability requirements specified in the PNPS ODCM.

Those sampling stations within the range of influence of Pilgrim Station and which could conceivably be affected by its operation are called "indicator" stations. Distant stations, which are beyond plant influence, are called "control" stations. Ambient radiation monitoring stations are broken down into four separate zones to aid in data analysis.

For each sampling medium, each radionuclide is presented with a set of statistical parameters. This set of statistical parameters includes separate analyses for (1) the indicator stations, (2) the station having the highest annual mean concentration, and (3) the control stations. For each of these three groups of data, the following values are calculated:

- The mean value of detectable concentrations, including only those values above LLD;
- The standard deviation of the detectable measurements;
- The lowest and highest concentrations; and,
- The number of positive measurements (activity which is three times greater than the standard deviation), out of the total number of measurements.

Each single radioactivity measurement datum is based on a single measurement and is reported as a concentration plus or minus one standard deviation. The quoted uncertainty represents only the random uncertainty associated with the measurement of the radioactive decay process (counting statistics), and not the propagation of all possible uncertainties in the sampling and analysis process. A sample or measurement is considered to contain detectable radioactivity if the measured value (e.g., concentration) exceeds three times its associated standard deviation. For example, a milk sample with a strontium-90 concentration of 3.5 ± 0.8 pCi/liter would be considered "positive" (detectable Sr-90), whereas another sample with a concentration of 2.1 ± 0.9 pCi/liter would be considered "negative", indicating no detectable strontium-90. The latter sample may actually contain strontium-90, but the levels counted during its analysis were not significantly different than background levels.

As an example of how to interpret data presented in the results tables, refer to the first entry on the table for air particulate filters (page 37). Gross beta (GR-B) analyses were performed on 572 routine samples. None of the samples exceeded ten times the average concentration at the control location. The lower limit of detection (LLD) required by the ODCM is 0.01 pCi/m^3.

For samples collected from the ten indicator stations, 520 out of 520 samples indicated detectable activity at the three-sigma (standard deviation) level. The mean concentration of gross beta activity in these 520 indicator station samples was 0.011 ± 0.005 (1.1E-2 ± 5.6E-3) pCi/m^3. Individual values ranged from 0.0003 to 0.046 (3.4E-4 – 4.6E-2) pCi/m^3.

The monitoring station which yielded the highest mean concentration was station EW (East Weymouth), which yielded a mean concentration of 0.014 ± 0.007 pCi/m^3, based on 52 observations. Individual values ranged from 0.0036 to 0.034 pCi/m^3. Fifty-two of the fifty-two samples showed detectable activity at the three-sigma level.

At the control location, 52 out of 52 samples yielded detectable gross beta activity, for an average concentration of 0.014 ± 0.007 pCi/m^3. Individual samples at the control location ranged from 0.0036 to 0.034 pCi/m^3.

Referring to the last entry in the table, analyses for cesium-137 (Cs-137) were performed 44 times (quarterly composites for 11 stations * 4 quarters). No samples exceeded ten times the mean control station concentration. The required LLD value Cs-137 in the PNPS ODCM is 0.06 pCi/m^3.

At the indicator stations, all 40 of the Cs-137 measurements were below the detection level. The same was true for the four measurements made on samples collected from the control location.

2.4 Ambient Radiation Measurements

The primary technique for measuring ambient radiation exposure in the vicinity of Pilgrim Station involves posting environmental thermoluminescent dosimeters (TLDs) at given monitoring locations and retrieving the TLDs after a specified time period. The TLDs are then taken to a laboratory and processed to determine the total amount of radiation exposure received over the period. Although TLDs can be used to monitor radiation exposure for short time periods, environmental TLDs are typically posted for periods of one to three months. Such TLD monitoring yields average exposure rate measurements over a relatively long time period. The PNPS environmental TLD monitoring program is based on a quarterly (three month) posting period, and a total of 110 locations are monitored using this technique. In addition, 27 of the 110 TLDs are located onsite, within the PNPS protected/restricted area, where the general public does not have access.

Out of the 440 TLDs (110 locations * 4 quarters) posted during 2005, 435 were retrieved and processed. Those TLDs missing from their monitoring locations were lost to storm damage, vandalism, and/or replacement of the utility poles to which they were attached, and their absence is discussed in Appendix D. The results for environmental TLDs located offsite, beyond the PNPS protected/restricted area fence, are presented in Table 2.4-1. Results from onsite TLDs posted within the restricted area are presented in Table 2.4-2. In addition to TLD results for individual locations, results from offsite TLDs were grouped according to geographic zone to determine average exposure rates as a function of distance. These results are summarized in Table 2.4-3. All of the listed exposure values represent continuous occupancy (2190 hr/qtr or 8760 hr/yr).

Annual exposure rates measured at offsite locations ranged from 46 to 550 mR/yr. The average exposure rate at control locations greater than 15 km from Pilgrim Station (i.e., Zone 4) was 63.8 ± 12.3 mR/yr. When the 3-sigma confidence interval is calculated based on these control measurements, 99% of all measurements of background ambient exposure would be expected to be between 27 and 101 mR/yr. The results for all TLDs within 15 km (excluding those Zone 1 TLDs posted within the site boundary) ranged from 46 to 78 mR/yr, which compares favorably with the preoperational results of 37 - 190 mR/yr.

Inspection of onsite TLD results listed in Table 2.4-2 indicates that all of those TLDs located within the PNPS protected/restricted area yield exposure measurements higher than the expected background. Such results are expected due to the close proximity of these locations to radiation sources onsite. The radionuclide nitrogen-16 (N-16) contained in steam flowing through the turbine accounts for most of the exposure onsite. Although this radioactivity is contained within the turbine and is not released to the atmosphere, the "sky shine" which occurs from the turbine increases the ambient radiation levels in areas near the turbine building.

A small number of offsite TLD locations in close proximity to the protected/restricted area indicated ambient radiation exposure above expected background levels. All of these locations are on Pilgrim Station controlled property, and experience exposure increases due to turbine sky shine (e.g., locations OA, TC, P01, and WS) and/or transit and storage of radwaste onsite (e.g., location BLW). A hypothetical maximum exposed member of the public accessing these near-site areas on Pilgrim Station controlled property for limited periods of time would receive a maximum dose of about 2.2 mrem/yr above their average ambient background dose of 64 mrem/yr.

One TLD, located in the basement of the Plymouth Memorial Hall, indicated an annual exposure of 78 mR in 2005. The higher exposure within the building at this location is due to the close proximity of stone building material, which contains higher levels of naturally-occurring radioactivity, as well as from the buildup of radon in this area of the building.

It should be noted that several of the TLDs used to calculate the Zone 1 averages presented in Table 2.4-3 are located on Pilgrim Station property. If the Zone 1 value is corrected for the near-site TLDs (those less than 0.6 km from the Reactor Building), the Zone 1 mean falls from a value of 95.1 ± 81.4 mR/yr to 65.2 ± 11.4 mR/yr. Additionally, exposure rates measured at areas beyond Entergy's control did not indicate any increase in ambient exposure from Pilgrim Station operation. For example, the annual exposure rate calculated from the two TLDs nearest the nearest offsite residence 0.80 kilometers (0.5 miles) southeast of the PNPS Reactor Building was 66.1 ± 11.1 mR/yr, which compares quite well with the average control location exposure of 63.8 ± 12.3 mR/yr.

In conclusion, measurements of ambient radiation exposure around Pilgrim Station do not indicate any significant increase in exposure levels. Although some increases in ambient radiation exposure level were apparent on Entergy property very close to Pilgrim Station, there were no measurable increases at areas beyond Entergy's control.

2.5 Air Particulate Filter Radioactivity Analyses

Airborne particulate radioactivity is sampled by drawing a stream of air through a glass fiber filter that has a very high efficiency for collecting airborne particulates. These samplers are operated continuously, and the resulting filters are collected weekly for analysis. Weekly filter samples are analyzed for gross beta radioactivity, and the filters are then composited on a quarterly basis for each location for gamma spectroscopy analysis. PNPS uses this technique to monitor 10 locations in the Plymouth area, along with the control location in East Weymouth.

Out of 583 filters (11 locations * 53 weeks), 572 samples were collected and analyzed during 2005. There were a few instances where power was lost or pumps failed during the course of the sampling period at some of the air sampling stations, resulting in lower than normal sample volumes. In one of the cases, a tree damaged the service line providing electricity to one of the sampling stations, and the sampler could not be operated. All of these discrepancies are noted in Appendix D. These occurrences did not adversely affect the monitoring results.

The results of the analyses performed on these 572 filter samples are summarized in Table 2.5-1. Trend plots for the gross beta radioactivity levels at the near station, property line, and offsite airborne monitoring locations are shown in Figures 2.5-1, 2.5-2 and 2.5-3, respectively. Gross beta radioactivity was detected in 572 of the filter samples collected, including 52 of the 52 control location samples. This gross beta activity arises from naturally-occurring radionuclides such as radon decay daughter products. Naturally-occurring beryllium-7 was detected in 40 out of 44 of the quarterly composites analyzed with gamma spectroscopy. Naturally-occurring potassium-40 (K-40) was detected in 2 of 40 indicator samples, and in none of four control samples. No airborne radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2005, and results of any detectable naturally-occurring radioactivity were similar to those observed in the preoperational monitoring program.

2.6 Charcoal Cartridge Radioactivity Analyses

Airborne radioactive iodine is sampled by drawing a stream of air through a charcoal cartridge after it has passed through the high efficiency glass fiber filter. As is the case with the air particulate filters, these samplers are operated continuously, and the resulting cartridges are collected weekly for analysis. Weekly cartridge samples are analyzed for radioactive iodine. The same eleven locations monitored for airborne particulate radioactivity are also sampled for airborne radioiodine.

Out of 583 cartridges (11 locations * 53 weeks), 572 samples were collected and analyzed during 2005. There were a few instances where power was lost or pumps failed during the course of the sampling period at some of the air sampling stations, resulting in lower than normal sample volumes. In one of the cases, a tree damaged the service line providing electricity to one of the sampling stations, and the sampler could not be operated. All of these discrepancies are noted in Appendix D. Despite such events during 2005, required LLDs were met on 572 of the 572 filters collected during 2005.

The results of the analyses performed on these 572 charcoal cartridges are summarized in Table 2.6-1. No airborne radioactive iodine was detected in any of the charcoal cartridges collected.

2.7 Milk Radioactivity Analyses

In July 2002, the Plymouth County Farm ceased operation of its dairy facility. This was historically the only dairy facility near Pilgrim Station, and had been sampled continuously since Pilgrim Station began operation in 1972. Although attempts were made to obtain samples from an alternate indicator location, a suitable substitute could not be found. Thus, milk collection at an indicator location was discontinued in July 2002, but control samples of milk continued to be collected and analyzed in the event an indicator location could be secured. In conjunction with the standardization of the ODCM during 2003, the decision was made to remove milk sampling from the PNPS Radiological Environmental Monitoring Program since no milk ingestion pathway existed in the vicinity of Pilgrim Station.

2.8 Forage Radioactivity Analyses

Samples of animal forage (hay) are collected from the Plymouth County Farm and from a control location in Bridgewater. Samples are collected annually and analyzed by gamma spectroscopy.

All samples of forage were collected and analyzed as required during 2005. Results of the gamma analyses of forage samples are summarized in Table 2.8-1. Naturally-occurring beryllium-7, potassium-40, radium-226, and actinium/thorium-228 were detected in forage samples collected during 2005. Low levels of cesium-137 were detected in both samples of naturally-growing vegetation collected from the Bridgewater control location, with concentrations ranging from 30 to 37 pCi/kg. These Cs-137 results are within the range expected for weapons-testing fallout (75 to 145 pCi/kg), and are not indicative of any releases associated with Pilgrim Station. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2005, and results of any detectable naturally-occurring radioactivity were similar to those observed in the preoperational monitoring program.

2.9 Vegetable/Vegetation Radioactivity Analyses

Samples of vegetables had historically been collected from the Plymouth County Farm and from the control location in Bridgewater. However, some problems were encountered in collection of crop samples during 2005. Crops were not grown at the Plymouth County Farm (CF) during 2005. Due to a loss of state funding at the Bridgewater Correctional Facility, garden samples were not available from this source. An alternate sampling location (Hanson Farm) was identified in the general vicinity in Bridgewater, and was used as a source of control vegetable samples. In addition, samples of vegetables or leafy vegetation were collected at or near a number of gardens identified during the Annual Land Use Census. Results of this census are discussed in Appendix C. Samples of vegetables are collected annually and analyzed by gamma spectroscopy.

Twelve samples of vegetables/vegetation were collected and analyzed as required during 2005. Results of the gamma analyses of these samples are summarized in Table 2.9-1. Naturally-occurring beryllium-7, potassium-40, radium-226, and actinium/thorium-228 were identified in most of the samples collected. Cesium-137 was also detected in two out of 11 samples of naturally-growing vegetation collected, with concentrations ranging from 77 to 99 pCi/kg. These Cs-137 results are in the range expected for weapons-testing fallout (75 to 145 pCi/kg), and are not indicative of any releases associated with Pilgrim

Station. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2005, and results of any detectable naturally-occurring radioactivity were similar to those observed in the preoperational monitoring program.

2.10 Cranberry Radioactivity Analyses

Samples of cranberries are routinely collected from two bogs in the Plymouth area and from the control location in Kingston. Samples of cranberries are collected annually and analyzed by gamma spectroscopy. In 2002, the bog at Manomet Point ceased harvesting operations, and a sample was collected from an alternate location along Beaver Dam Road. This discrepancy is noted in Appendix D.

Three samples of cranberries were collected and analyzed during 2005. Results of the gamma analyses of cranberry samples are summarized in Table 2.10-1. Cranberry samples collected during 2005 yielded detectable levels of naturally-occurring potassium-40. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2005, and results of any detectable naturally-occurring radioactivity were similar to those observed in the preoperational monitoring program.

2.11 Soil Radioactivity Analyses

In the past, a survey of radioactivity in soil had been conducted once every three years at the 10 air sampling stations in the Plymouth area and the control location in East Weymouth. However, in conjunction with standardization of the ODCM during 2003, the soil survey effort was abandoned in favor of the extensive TLD monitoring effort at Pilgrim Station. Prior to ending the soil survey effort, there had been no apparent trends in radioactivity measurements at these locations.

2.12 Surface Water Radioactivity Analyses

Samples of surface water are routinely collected from the discharge canal, Bartlett Pond in Manomet and from the control location at Powder Point Bridge in Duxbury. Grab samples are collected weekly from the Bartlett Pond and Powder Point Bridge locations. Samples of surface water are composited every four weeks and analyzed by gamma spectroscopy and low-level iodine analysis. These monthly composites are further composited on a quarterly basis and tritium analysis is performed on this quarterly sample.

A total of 36 samples (3 locations * 12 sampling periods) of surface water were collected and analyzed as required during 2005. Results of the analyses of water samples are summarized in Table 2.12-1. Naturally-occurring potassium-40, radium-226, and actinium/thorium-228 were detected in several of the samples, especially those composed primarily of seawater. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2005, and results of any detectable naturally-occurring radioactivity were similar to those observed in the preoperational monitoring program.

2.13 Sediment Radioactivity Analyses

Samples of sediment are routinely collected from the outfall area of the discharge canal and from three other locations in the Plymouth area (Manomet Point, Plymouth Harbor and Plymouth Beach), and from control locations in Duxbury and Marshfield. Samples are collected twice per year and are analyzed by gamma spectroscopy.

Twelve samples of sediment were collected during 2005. Gamma analyses were performed on these samples. Results of the gamma analyses of sediment samples are summarized in Table 2.13-1. Naturally-occurring beryllium-7, potassium-40, radium-226, and actinium/thorium-228 were detected in a number of the samples. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2005, and results of any detectable naturally-occurring radioactivity were similar to those observed in the preoperational monitoring program.

2.14 Irish Moss Radioactivity Analyses

Samples of Irish moss are collected from the discharge canal outfall and two other locations in the Plymouth area (Manomet Point, Ellisville), and from a control location in Marshfield (Green Harbor). All samples are collected on a semiannual basis, and processed in the laboratory for gamma spectroscopy analysis.

Eight samples of Irish moss scheduled for collection during 2005 were obtained and analyzed. Results of the gamma analyses of these samples are summarized in Table 2.14-1. Naturally-occurring beryllium-7, potassium-40, radium-226, and actinium/thorium-228 were detected in a number of the samples. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2005, and results of any detectable naturally-occurring radioactivity were similar to those observed in the preoperational monitoring program.

2.15 Shellfish Radioactivity Analyses

Samples of blue mussels, soft-shell clams and quahogs are collected from the discharge canal outfall and two other locations in the Plymouth area (Manomet Point, Plymouth Harbor), and from control locations in Duxbury and Marshfield. All samples are collected on a semiannual basis, and edible portions processed in the laboratory for gamma spectroscopy analysis.

All 12 samples of shellfish meat scheduled for collection during 2005 were obtained and analyzed. Results of the gamma analyses of these samples are summarized in Table 2.15-1. Naturally-occurring potassium-40, radium-226, and actinium/thorium-228 were detected in a number of the samples. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2005, and results of any detectable naturally-occurring radioactivity were similar to those observed in the preoperational monitoring program.

2.16 Lobster Radioactivity Analyses

Samples of lobsters are routinely collected from the outfall area of the discharge canal and from the control location in Duxbury. Samples are collected monthly from the discharge canal outfall from June through September and annually from the control location. Due to inclement weather in July, the collection of the July lobster sample was delayed into the latter part of August, and the remainder of the year's lobster collection efforts was shifted by one month. This discrepancy is noted in Appendix D. All lobster samples are analyzed by gamma spectroscopy.

All five samples of lobsters were collected and analyzed as required during 2005. Results of the gamma analyses of lobster samples are summarized in Table 2.16-1. The only radionuclides detected in any of the samples were naturally-occurring potassium-40, radium-226, and actinium/thorium-228. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2005, and results of any detectable naturally-occurring radioactivity were similar to those observed in the preoperational monitoring program.

2.17 Fish Radioactivity Analyses

Samples of fish are routinely collected from the area at the outfall of the discharge canal and from the control locations in Cape Cod Bay and Buzzard's Bay. Fish species are grouped into four major categories according to their biological requirements and mode of life. These major categories and the representative species are as follows:

- Group I - Bottom Oriented: Winter Flounder, Yellowtail Flounder
- Group II - Near-Bottom Distribution: Tautog, Cunner, Pollock, Atlantic Cod, Hake

- Group III - Anadromous: Alewife, Smelt, Striped Bass
- Group IV - Coastal Migratory: Bluefish, Herring, Menhaden, Mackerel

Group I and II fishes are sampled on a semiannual basis from the outfall area of the discharge canal, and on an annual basis from a control location. Group III and IV fishes are sampled annually from the discharge canal outfall and control location. All samples of fish are analyzed by gamma spectroscopy.

Due to declining fish stock and the migration of fish to deeper water during colder seasons, samples of Groups I and II fishes could not be collected during the latter half of the year. Although repeated and concerted efforts were made to collect the fish in the vicinity of the Discharge Canal Outfall, no samples could be obtained. Additional details regarding these discrepancies can be found in Appendix D.

Eight samples of fish were collected during 2005. Results of the gamma analyses of fish samples collected are summarized in Table 2.17-1. The only radionuclides detected in any of the samples were naturally-occurring potassium-40, radium-226, and actinium/thorium-228. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2005, and results of any detectable naturally-occurring radioactivity were similar to those observed in the preoperational monitoring program.

Table 2.2-1

Routine Radiological Environmental Sampling Locations
Pilgrim Nuclear Power Station, Plymouth, MA

Description	No	Code	Distance	Direction
Air Particulate Filters, Charcoal Cartridges				
Medical Building	00	WS	0.2 km	SSE
East Rocky Hill Road	01	ER	0.9 km	SE
West Rocky Hill Road	03	WR	0.8 km	WNW
Property Line	06	PL	0.5 km	NNW
Pedestrian Bridge	07	PB	0.2 km	N
Overlook Area	08	OA	0.1 km	W
East Breakwater	09	EB	0.5 km	ESE
Cleft Rock	10	CR	1.3 km	SSW
Plymouth Center	15	PC	6.7 km	W
Manomet Substation	17	MS	3.6 km	SSE
East Weymouth Control	21	EW	40 km	NW
Milk				
Plymouth County Farm	11	CF	5.6 km	W
Whitman Farm Control	21	WF	34 km	WNW
Forage				
Plymouth County Farm	11	CF	5.6 km	W
Whitman Farm Control	12	WF	34 km	WNW
Whipple Farm	43	WH	2.9 km	SW
Vegetation				
Plymouth County Farm	11	CF	5.6 km	W
Bridgewater Farm Control	27	BF	31 km	W
Cranberries				
Manomet Point Bog	13	MR	3.9 km	SE
Bartlett Road Bog	14	BR	4.3 km	SSE
Pine Street Bog Control	23	PS	26 km	WNW

Table 2.2-1 (continued)

Routine Radiological Environmental Sampling Locations
Pilgrim Nuclear Power Station, Plymouth, MA

Description	No	Code	Distance	Direction
Surface Water				
Discharge Canal	11	DIS	0.2 km	N
Bartlett Pond	17	BP	2.7 km	SE
Powder Point Control	23	PP	13 km	NNW
Sediment				
Discharge Canal Outfall	11	DIS	0.8 km	NE
Plymouth Harbor	12	Ply-H	4.1 km	W
Duxbury Bay Control	13	Dux-Bay	14 km	NNW
Plymouth Beach	14	PLB	4.0 km	WNW
Manomet Point	15	MP	3.3 km	ESE
Green Harbor Control	24	GH	16 km	NNW
Irish Moss				
Discharge Canal Outfall	11	DIS	0.7 km	NNE
Manomet Point	15	MP	4.0 km	ESE
Ellisville	22	EL	12 km	SSE
Brant Rock Control	34	BR	18 km	NNW
Shellfish				
Discharge Canal Outfall	11	DIS	0.7 km	NNE
Plymouth Harbor	12	Ply-H	4.1 km	W
Duxbury Bay Control	13	Dux-Bay	13 km	NNW
Manomet Point	15	MP	4.0 km	ESE
Green Harbor Control	24	GH	16 km	NNW
Lobster				
Discharge Canal Outfall	11	DIS	0.5 km	N
Plymouth Harbor	15	Ply-H	6.4 km	WNW
Duxbury Bay Control	13	Dux-Bay	11 km	NNW
Fishes				
Discharge Canal Outfall	11	DIS	0.5 km	N
Priest Cove Control	29	PC	48 km	SW
Jones River Control	30	JR	13 km	WNW
Vineyard Sound Control	92	MV	64 km	SSW
Buzzard's Bay Control	90	BB	40 km	SSW
Cape Cod Bay Control	98	CC-Bay	24 km	ESE

Table 2.4-1

Offsite Environmental TLD Results

TLD Station		TLD Location*	Quarterly Exposure - mR/quarter (Value ± Std.Dev.)				2005 Annual** Exposure mR/year
ID	Description	Distance/Direction	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	
Zone 1 TLDs: 0-3 km		0-3 km	25.6 ± 22.6	21.0 ± 15.0	26.7 ± 22.5	22.0 ± 20.5	95.1 ± 81.4
BLW	BOAT LAUNCH WEST	0.11 km E	56.0 ± 3.1	51.2 ± 2.5	63.0 ± 5.3	65.3 ± 3.1	235.4 ± 27.0
OA	OVERLOOK AREA	0.15 km W	155.5 ± 8.0	100.7 ± 6.8	155.0 ± 7.0	138.3 ± 10.9	549.5 ± 104.3
TC	HEALTH CLUB	0.15 km WSW	42.0 ± 1.5	35.5 ± 1.2	51.3 ± 2.5	42.4 ± 1.8	171.2 ± 26.2
BLE	BOAT LAUNCH EAST	0.16 km ESE	69.1 ± 4.0	54.2 ± 2.2	47.4 ± 2.6	42.7 ± 2.1	213.4 ± 46.4
PB	PEDESTRIAN BRIDGE	0.21 km N	37.8 ± 2.7	31.4 ± 1.1	41.3 ± 2.1	35.8 ± 1.3	146.3 ± 17.1
P01	SHOREFRONT SECURITY	0.22 km NNW	38.2 ± 1.0	27.7 ± 2.2	39.9 ± 2.0	33.9 ± 1.9	139.7 ± 22.0
WS	MEDICAL BUILDING	0.23 km SSE	36.4 ± 2.4	28.5 ± 2.5	35.6 ± 1.7	30.6 ± 1.6	131.1 ± 16.0
CT	PARKING LOT	0.31 km SE	25.8 ± 1.1	22.8 ± 1.8	24.3 ± 1.1	21.1 ± 1.7	94.1 ± 8.5
PA	SHOREFRONT PARKING	0.35 km NNW	24.5 ± 0.8	19.7 ± 0.9	25.0 ± 1.5	20.1 ± 0.8	89.3 ± 11.5
A	STATION A	0.37 km WSW	25.6 ± 1.4	20.1 ± 0.7	Missing	18.7 ± 1.1	85.8 ± 14.8
F	STATION F	0.43 km NW	21.2 ± 0.9	18.3 ± 0.8	Missing	17.4 ± 0.9	75.8 ± 8.1
EB	EAST BREAKWATER	0.44 km ESE	18.6 ± 0.6	15.7 ± 0.9	18.6 ± 1.1	14.6 ± 0.7	67.5 ± 8.4
B	STATION B	0.44 km S	25.1 ± 0.9	22.1 ± 0.8	25.5 ± 1.4	22.2 ± 1.2	94.8 ± 7.7
PMT	PNPS MET TOWER	0.44 km WNW	23.4 ± 0.6	19.2 ± 1.1	22.8 ± 1.4	20.8 ± 1.1	86.3 ± 8.1
H	STATION H	0.47 km SW	25.1 ± 0.9	21.9 ± 1.4	26.5 ± 1.3	21.8 ± 1.1	95.3 ± 9.7
I	STATION I	0.48 km WNW	20.8 ± 1.2	16.5 ± 0.9	20.2 ± 0.9	17.2 ± 1.0	74.6 ± 8.8
L	STATION L	0.50 km ESE	22.0 ± 0.9	20.0 ± 1.2	22.0 ± 1.3	18.3 ± 0.9	82.3 ± 7.5
G	STATION G	0.53 km W	18.3 ± 0.6	14.2 ± 0.5	17.8 ± 0.8	13.6 ± 1.1	63.9 ± 9.8
D	STATION D	0.54 km NNW	19.4 ± 0.7	16.9 ± 0.9	20.7 ± 0.9	18.3 ± 1.1	75.3 ± 6.8
PL	PROPERTY LINE	0.54 km NW	17.7 ± 0.5	16.5 ± 1.1	20.4 ± 0.9	15.9 ± 1.3	70.5 ± 8.4
C	STATION C	0.57 km ESE	18.4 ± 0.6	15.6 ± 0.6	18.1 ± 0.9	14.2 ± 0.6	66.4 ± 8.2
HB	HALL'S BOG	0.63 km SE	19.5 ± 0.7	17.6 ± 0.7	20.8 ± 1.2	16.1 ± 0.8	74.0 ± 8.6
GH	GREENWOOD HOUSE	0.65 km ESE	20.7 ± 0.9	17.8 ± 0.6	21.6 ± 1.1	17.7 ± 0.8	77.7 ± 8.2
WR	W ROCKY HILL ROAD	0.83 km WNW	19.4 ± 1.2	17.1 ± 0.7	21.8 ± 1.1	19.2 ± 1.5	77.5 ± 8.1
ER	E ROCKY HILL ROAD	0.89 km SE	14.1 ± 0.7	14.3 ± 1.3	16.9 ± 0.9	12.9 ± 0.8	58.2 ± 7.0
MT	MICROWAVE TOWER	1.03 km SSW	19.0 ± 0.6	16.3 ± 0.9	18.1 ± 1.0	16.7 ± 0.7	70.1 ± 5.3
CR	CLEFT ROCK	1.27 km SSW	19.0 ± 1.3	15.9 ± 0.8	18.2 ± 0.8	14.8 ± 0.8	67.9 ± 8.1
BD	BAYSHORE/GATE RD	1.34 km WNW	18.9 ± 0.6	16.1 ± 0.7	21.4 ± 1.0	14.4 ± 1.0	70.7 ± 12.5
MR	MANOMET ROAD	1.38 km S	14.9 ± 0.8	14.2 ± 0.6	16.3 ± 1.1	17.6 ± 1.2	63.1 ± 6.4
DR	DIRT ROAD	1.48 km SW	16.7 ± 0.5	13.4 ± 0.8	14.5 ± 1.0	14.3 ± 0.9	58.9 ± 5.8
EM	EMERSON ROAD	1.53 km SSE	16.6 ± 0.9	14.8 ± 0.5	20.7 ± 1.3	12.0 ± 0.6	64.1 ± 14.7
EP	EMERSON/PRISCILLA	1.55 km SE	17.6 ± 0.7	14.9 ± 0.9	20.9 ± 1.2	13.1 ± 0.6	66.5 ± 13.8
AR	EDISON ACCESS ROAD	1.59 km SSE	19.7 ± 0.8	14.4 ± 0.6	16.0 ± 0.8	13.5 ± 0.7	63.6 ± 11.0
BS	BAYSHORE	1.76 km W	20.6 ± 1.1	17.3 ± 1.0	21.9 ± 1.2	15.3 ± 0.6	74.9 ± 12.2
E	STATION E	1.86 km S	15.6 ± 0.5	15.7 ± 0.6	17.6 ± 1.0	16.9 ± 1.0	65.8 ± 4.1
JG	JOHN GAULEY	1.99 km W	19.3 ± 0.5	15.9 ± 0.8	22.4 ± 1.1	14.3 ± 0.8	72.0 ± 14.6
J	STATION J	2.04 km SSE	14.5 ± 0.7	16.1 ± 2.0	15.8 ± 1.2	15.0 ± 0.9	61.4 ± 4.0
WH	WHITEHORSE ROAD	2.09 km SSE	16.0 ± 0.5	14.0 ± 0.5	21.1 ± 1.0	14.5 ± 2.1	65.7 ± 13.2
RC	PLYMOUTH YMCA	2.09 km WSW	15.3 ± 0.7	14.8 ± 0.7	17.0 ± 0.9	15.8 ± 1.0	62.9 ± 4.1
K	STATION K	2.17 km S	14.6 ± 0.4	14.7 ± 0.8	17.1 ± 2.8	14.5 ± 0.9	60.9 ± 5.9
TT	TAYLOR/THOMAS	2.26 km SE	16.4 ± 0.8	12.1 ± 0.5	22.5 ± 1.2	11.2 ± 0.6	62.2 ± 20.8
YV	YANKEE VILLAGE	2.28 km WSW	14.7 ± 0.5	14.9 ± 0.8	19.7 ± 1.2	12.2 ± 0.9	61.5 ± 12.6
GN	GOODWIN PROPERTY	2.38 km SW	15.3 ± 0.8	11.7 ± 0.6	13.2 ± 0.7	12.4 ± 0.6	52.6 ± 6.4
RW	RIGHT OF WAY	2.83 km S	13.5 ± 0.5	11.3 ± 0.6	16.9 ± 0.8	8.9 ± 0.5	50.5 ± 13.7
TP	TAYLOR/PEARL	2.98 km SE	17.5 ± 1.5	12.8 ± 0.6	18.6 ± 0.9	13.4 ± 0.7	62.4 ± 11.8

* Distance and direction are measured from centerline of Reactor Building to the monitoring location.

** Annual value is based on arithmetic mean of the observed quarterly values multiplied by four quarters/year.

Table 2.4-1 (continued)

Offsite Environmental TLD Results

TLD Station		TLD Location*	Quarterly Exposure - mR/quarter (Value ± Std.Dev.)				2005 Annual** Exposure mR/year
ID	Description	Distance/Direction	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	
Zone 2 TLDs: 3-8 km		3-8 km	15.6 ± 2.0	13.4 ± 1.8	18.8 ± 2.8	12.3 ± 2.1	59.9 ± 13.1
VR	VALLEY ROAD	3.26 km SSW	15.9 ± 0.5	11.3 ± 0.6	20.6 ± 1.1	9.4 ± 0.6	57.2 ± 20.1
ME	MANOMET ELEM	3.29 km SE	Missing	13.5 ± 0.6	20.4 ± 0.9	11.3 ± 0.6	60.3 ± 19.0
WC	WARREN/CLIFFORD	3.31 km W	14.0 ± 0.7	13.5 ± 0.8	18.5 ± 1.3	12.1 ± 0.6	58.1 ± 11.2
BB	RT.3A/BARTLETT RD	3.33 km SSE	14.9 ± 0.6	14.3 ± 0.7	15.5 ± 0.9	14.6 ± 1.0	59.2 ± 2.6
MP	MANOMET POINT	3.57 km SE	17.9 ± 0.8	12.2 ± 0.6	17.5 ± 0.8	13.7 ± 0.7	61.4 ± 11.5
MS	MANOMET SUBSTATION	3.60 km SSE	17.1 ± 0.6	17.5 ± 1.0	22.9 ± 2.5	17.5 ± 0.9	75.1 ± 11.5
BW	BEACHWOOD ROAD	3.93 km SE	16.1 ± 0.8	14.0 ± 0.7	21.0 ± 1.3	11.7 ± 0.6	62.8 ± 16.0
PT	PINES ESTATE	4.44 km SSW	14.5 ± 0.7	13.3 ± 1.7	18.9 ± 0.9	9.1 ± 0.7	55.9 ± 16.3
EA	EARL ROAD	4.60 km SSE	12.8 ± 0.6	13.8 ± 0.7	15.5 ± 1.1	13.8 ± 0.9	55.9 ± 4.7
SP	S PLYMOUTH SUBST	4.62 km W	14.5 ± 0.5	14.5 ± 0.9	21.5 ± 1.1	12.5 ± 1.1	63.0 ± 16.0
RP	ROUTE 3 OVERPASS	4.81 km SW	15.1 ± 0.8	13.0 ± 0.6	20.0 ± 1.0	11.4 ± 0.6	59.6 ± 15.0
RM	RUSSELL MILLS RD	4.85 km WSW	14.1 ± 0.6	12.8 ± 0.7	19.8 ± 1.4	10.8 ± 0.9	57.5 ± 15.6
HD	HILLDALE ROAD	5.18 km W	14.8 ± 0.7	14.2 ± 0.8	19.5 ± 1.4	12.7 ± 0.7	61.2 ± 11.9
MB	MANOMET BEACH	5.43 km SSE	17.1 ± 0.5	13.8 ± 0.6	19.8 ± 1.2	12.2 ± 0.6	62.9 ± 13.7
BR	BEAVERDAM ROAD	5.52 km S	16.2 ± 0.5	13.2 ± 0.9	Missing	12.0 ± 0.7	55.3 ± 8.8
PC	PLYMOUTH CENTER	6.69 km W	12.8 ± 0.7	9.6 ± 0.5	12.9 ± 0.9	10.9 ± 0.9	46.2 ± 6.5
LD	LONG POND/DREW RD	6.97 km WSW	17.0 ± 1.0	13.7 ± 0.7	19.9 ± 1.5	11.8 ± 0.7	62.3 ± 14.5
HR	HYANNIS ROAD	7.33 km SSE	16.1 ± 0.7	13.2 ± 0.5	18.5 ± 0.9	11.0 ± 0.7	58.9 ± 13.4
SN	SAQUISH NECK	7.58 km NNW	14.9 ± 0.8	10.9 ± 0.6	12.6 ± 0.8	10.7 ± 1.0	49.1 ± 7.9
MH	MEMORIAL HALL	7.58 km WNW	22.0 ± 0.9	17.5 ± 0.7	21.2 ± 1.2	17.3 ± 1.0	78.0 ± 10.0
CP	COLLEGE POND	7.59 km SW	15.0 ± 0.7	12.4 ± 0.6	18.6 ± 1.1	11.9 ± 1.3	57.9 ± 12.5
Zone 3 TLDs: 8-15 km		8-15 km	16.1 ± 1.4	13.4 ± 1.5	18.7 ± 2.6	11.3 ± 1.5	59.6 ± 13.3
DW	DEEP WATER POND	8.59 km W	17.2 ± 0.8	15.8 ± 0.8	23.0 ± 1.3	12.4 ± 0.6	68.4 ± 17.9
LP	LONG POND ROAD	8.88 km SSW	14.1 ± 0.7	12.2 ± 0.5	18.1 ± 1.0	9.6 ± 0.6	54.0 ± 14.4
NP	NORTH PLYMOUTH	9.38 km WNW	18.7 ± 0.6	16.4 ± 0.9	22.9 ± 1.1	14.0 ± 1.1	72.1 ± 15.3
SS	STANDISH SHORES	10.39 km NW	16.9 ± 0.6	12.8 ± 0.6	15.2 ± 0.9	12.5 ± 0.7	57.3 ± 8.6
EL	ELLISVILLE ROAD	11.52 km SSE	16.2 ± 0.6	13.3 ± 0.8	19.1 ± 1.2	10.9 ± 0.5	59.5 ± 14.4
UC	UP COLLEGE POND RD	11.78 km SW	14.5 ± 0.8	12.1 ± 1.2	17.2 ± 0.9	9.4 ± 0.8	53.2 ± 13.4
SH	SACRED HEART	12.92 km W	15.4 ± 0.7	13.0 ± 0.8	19.0 ± 1.1	10.3 ± 0.6	57.8 ± 14.8
KC	KING CAESAR ROAD	13.11 km NNW	16.7 ± 1.7	12.5 ± 0.8	16.2 ± 1.1	12.7 ± 0.9	58.1 ± 9.2
BE	BOURNE ROAD	13.37 km S	14.9 ± 0.5	12.3 ± 0.5	16.9 ± 0.9	10.1 ± 0.9	54.1 ± 12.1
SA	SHERMAN AIRPORT	13.43 km WSW	16.6 ± 0.5	13.8 ± 0.6	19.4 ± 1.5	11.4 ± 0.6	61.1 ± 14.0
Zone 4 TLDs: >15 km		>15 km	16.8 ± 1.6	14.3 ± 1.9	19.0 ± 2.6	13.4 ± 2.8	63.8 ± 12.3
CS	CEDARVILLE SUBST	15.93 km S	16.3 ± 0.7	14.6 ± 0.6	21.1 ± 0.9	12.5 ± 0.7	64.6 ± 14.7
KS	KINGSTON SUBST	16.15 km WNW	14.4 ± 1.0	13.0 ± 0.7	18.5 ± 0.9	9.9 ± 0.8	55.7 ± 14.3
LR	LANDING ROAD	16.46 km NNW	17.1 ± 0.6	14.0 ± 0.6	17.7 ± 1.2	14.0 ± 0.9	62.8 ± 8.1
CW	CHURCH/WEST	16.56 km NW	15.9 ± 0.6	11.5 ± 0.5	14.3 ± 0.8	Missing	55.6 ± 9.1
MM	MAIN/MEADOW	17.02 km WSW	16.1 ± 1.3	13.6 ± 0.6	19.8 ± 1.0	11.3 ± 0.8	60.8 ± 14.8
DMF	DIV MARINE FISH	20.97 km SSE	18.6 ± 0.7	16.8 ± 0.8	22.3 ± 1.6	15.2 ± 0.9	72.9 ± 12.5
EW	E WEYMOUTH SUBST	39.69 km NW	18.9 ± 0.7	16.4 ± 0.7	19.6 ± 0.9	17.5 ± 0.9	72.4 ± 6.0

* Distance and direction are measured from centerline of Reactor Building to the monitoring location.
** Annual value is based on arithmetic mean of the observed quarterly values multiplied by four quarters/year.

Table 2.4-2

Onsite Environmental TLD Results

TLD Station		TLD Location*	Quarterly Exposure - mR/quarter (Value ± Std.Dev.)				2005 Annual** Exposure mR/year
ID	Description	Distance/Direction	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	
Onsite TLDs							
P21	O&M/RXB. BREEZEWAY	50 m SE	24.3 ± 0.7	22.8 ± 1.0	27.2 ± 1.6	22.9 ± 1.2	97.2 ± 8.5
P24	EXEC.BUILDING	57 m W	78.1 ± 2.0	59.0 ± 2.1	80.9 ± 4.7	77.5 ± 3.4	295.5 ± 40.7
P04	FENCE-R SCREENHOUSE	66 m N	76.9 ± 3.2	75.9 ± 2.5	97.8 ± 5.3	86.2 ± 3.9	336.9 ± 41.4
P20	O&M - 2ND W WALL	67 m SE	71.4 ± 1.7	56.6 ± 3.0	76.1 ± 5.7	66.8 ± 6.6	270.9 ± 34.5
P25	EXEC.BUILDING LAWN	76 m WNW	116.0 ± 5.5	128.8 ± 5.8	121.8 ± 6.6	113.9 ± 7.4	480.5 ± 29.6
P05	FENCE-WATER TANK	81 m NNE	30.4 ± 1.7	29.5 ± 1.1	38.0 ± 2.6	32.1 ± 1.8	130.0 ± 15.7
P06	FENCE-OIL STORAGE	85 m NE	44.5 ± 2.9	51.1 ± 3.4	61.7 ± 3.6	52.7 ± 4.6	209.9 ± 29.3
P19	O&M - 2ND SW CORNER	86 m S	30.5 ± 1.0	27.6 ± 1.6	35.9 ± 2.0	28.3 ± 1.1	122.3 ± 15.3
P18	O&M - 1ST SW CORNER	90 m S	59.9 ± 4.3	49.3 ± 1.8	73.9 ± 3.4	63.2 ± 2.2	246.3 ± 40.9
P08	COMPRESSED GAS STOR	92 m E	59.8 ± 2.0	58.5 ± 6.1	68.8 ± 3.5	61.2 ± 4.0	248.2 ± 20.3
P03	FENCE-L SCREENHOUSE	100 m NW	91.1 ± 5.5	66.8 ± 3.8	90.2 ± 4.5	83.5 ± 4.0	331.5 ± 45.9
P17	FENCE-EXEC.BUILDING	107 m W	179.5 ± 15.5	131.7 ± 3.8	190.0 ± 8.9	179.6 ± 14.1	680.8 ± 107.1
P07	FENCE-INTAKE BAY	121 m ENE	44.7 ± 3.7	41.7 ± 4.0	51.7 ± 5.4	42.6 ± 1.8	180.7 ± 19.8
P23	O&M - 2ND S WALL	121 m SSE	46.1 ± 1.8	36.0 ± 2.0	53.1 ± 2.4	46.3 ± 2.4	181.5 ± 28.5
P26	FENCE-WAREHOUSE	134 m ESE	54.6 ± 5.9	46.0 ± 2.8	58.6 ± 4.8	49.2 ± 1.7	208.5 ± 23.8
P02	FENCE-SHOREFRONT	135 m NW	58.7 ± 2.2	47.2 ± 2.8	60.5 ± 2.3	57.2 ± 2.8	223.6 ± 24.3
P09	FENCE-W BOAT RAMP	136 m E	43.7 ± 2.9	40.1 ± 2.8	49.2 ± 4.6	46.0 ± 3.5	179.1 ± 16.9
P22	O&M - 2ND N WALL	137 m SE	91.5 ± 3.4	76.0 ± 4.5	106.4 ± 5.0	95.1 ± 4.6	369.0 ± 50.9
P16	FENCE-W SWITCHYARD	172 m SW	152.8 ± 11.8	110.6 ± 6.5	154.5 ± 13.6	135.2 ± 6.9	553.2 ± 84.1
P11	FENCE-TCF GATE	183 m ESE	58.2 ± 3.9	114.0 ± 6.6	61.8 ± 3.8	56.5 ± 3.0	290.4 ± 111.0
P27	FENCE-TCF/BOAT RAMP	185 m ESE	39.2 ± 1.7	34.1 ± 3.1	37.5 ± 2.7	32.9 ± 1.6	143.8 ± 12.7
P12	FENCE-ACCESS GATE	202 m SE	35.6 ± 1.9	30.0 ± 1.4	40.4 ± 3.3	36.4 ± 2.2	142.4 ± 17.7
P15	FENCE-E SWITCHYARD	220 m S	51.5 ± 1.4	39.4 ± 1.9	53.9 ± 3.0	48.5 ± 2.6	193.2 ± 25.7
P10	FENCE-TCF/INTAKE BAY	223 m E	43.7 ± 1.9	39.1 ± 2.8	39.2 ± 2.5	33.9 ± 1.6	155.7 ± 16.6
P13	FENCE-MEDICAL BLDG.	224 m SSE	35.4 ± 1.4	30.8 ± 1.4	37.0 ± 2.0	33.8 ± 1.5	137.0 ± 11.1
P14	FENCE-BUTLER BLDG	228 m S	33.6 ± 1.7	26.9 ± 2.4	35.8 ± 1.9	32.2 ± 1.4	128.6 ± 15.6
P28	FENCE-TCF/PRKNG LOT	259 m ESE	47.6 ± 2.1	46.0 ± 1.7	55.9 ± 3.4	36.8 ± 1.4	186.3 ± 31.8

* Distance and direction are measured from centerline of Reactor Building to the monitoring location.
** Annual value is based on arithmetic mean of the observed quarterly values multiplied by four quarters/year.

Table 2.4-3

Average TLD Exposures By Distance Zone During 2005

Exposure Period	Average Exposure ± Standard Deviation: mR/period			
	Zone 1* 0-3 km	Zone 2 3-8 km	Zone 3 8-15 km	Zone 4 >15 km
Jan-Mar	25.6 ± 22.6	15.6 ± 2.0	16.1 ± 1.4	16.8 ± 1.6
Apr-Jun	21.0 ± 15.0	13.4 ± 1.8	13.4 ± 1.5	14.3 ± 1.9
Jul-Sep	26.7 ± 22.5	18.8 ± 2.8	18.7 ± 2.6	19.0 ± 2.6
Oct-Dec	22.0 ± 20.5	12.3 ± 2.1	11.3 ± 1.5	13.4 ± 2.8
Jan-Dec	95.1 ± 81.4	59.9 ± 13.1	59.6 ± 13.3	63.8 ± 12.3

* Zone 1 extends from the PNPS restricted/protected area boundary outward to 3 kilometers (2 miles), and includes several TLDs located within the site boundary.

** When corrected for TLDs located within the site boundary, the Zone 1 annual average is calculated to be 65.2 ± 11.4 mR/yr.

Table 2.5-1
Air Particulate Filter Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2005)

MEDIUM: Air Particulates (AP) UNITS: pCi/cubic meter

Radionuclide	No. Analyses Non-routine*	Required LLD	Indicator Stations Mean ± Std.Dev. Range Fraction>LLD	Station with Highest Mean Station: Mean ± Std.Dev. Range Fraction>LLD	Control Stations Mean ± Std.Dev. Range Fraction>LLD
Gross Beta	572 0	0.01	1.1E-2 ± 5.6E-3 3.4E-4 - 4.6E-2 520 / 520	EW: 1.4E-2 ± 6.6E-3 3.6E-3 - 3.4E-2 52 / 52	1.4E-2 ± 6.6E-3 3.6E-3 - 3.4E-2 52 / 52
Be-7	44 0		6.9E-2 ± 1.8E-2 <LLD - 1.1E-1 37 / 40	CR: 8.1E-2 ± 1.5E-2 <LLD - 8.8E-2 3 / 4	7.5E-2 ± 1.8E-2 <LLD - 9.0E-2 3 / 4
K-40	44 0		3.7E-2 ± 1.1E-2 <LLD - 4.3E-2 2 / 40	CR: 4.3E-2 ± 1.2E-2 <LLD - 4.3E-2 1 / 4	<LLD <LLD 0 / 4
Cs-134	44 0	0.05	<LLD <LLD 0 / 40	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
Cs-137	44 0	0.06	<LLD <LLD 0 / 40	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4

* Non-Routine refers to those radionuclides that exceeded the Reporting Levels in ODCM Table 3.5-4.

Table 2.6-1
Charcoal Cartridge Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2005)

MEDIUM: Charcoal Cartridge (CF) UNITS: pCi/cubic meter

Radionuclide	No. Analyses Non-routine*	Required LLD	Indicator Stations Mean ± Std.Dev. Range Fraction>LLD	Station with Highest Mean Station: Mean ± Std.Dev. Range Fraction>LLD	Control Stations Mean ± Std.Dev. Range Fraction>LLD
I-131	572	0.07	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 520	0 / 52	0 / 52

* Non-Routine refers to those radionuclides that exceeded the Reporting Levels in ODCM Table 3.5-4.

Table 2.7-1
Milk Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2005)

No milk sampling was performed during 2005, as no indicator locations were available for sampling within 5 miles of Pilgrim Station.

Table 2.8-1
Forage Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2005)

MEDIUM: Forage (TC) UNITS: pCi/kg wet

Radionuclide	No. Analyses Non-routine*	Required LLD	Indicator Stations Mean ± Std.Dev. Range Fraction>LLD	Station with Highest Mean Station: Mean ± Std.Dev. Range Fraction>LLD	Control Stations Mean ± Std.Dev. Range Fraction>LLD
Be-7	2 0		3.1E+3 ± 2.9E+2 3.1E+3 - 3.1E+3 1 / 1	BF: 2.7E+3 ± 8.3E+2 2.2E+3 - 3.3E+3 2 / 2	2.7E+3 ± 8.3E+2 2.2E+3 - 3.3E+3 2 / 2
K-40	2 0		1.6E+4 ± 8.5E+2 1.6E+4 - 1.6E+4 1 / 1	BF: 1.3E+4 ± 3.1E+3 1.1E+4 - 1.6E+4 2 / 2	1.3E+4 ± 3.1E+3 1.1E+4 - 1.6E+4 2 / 2
I-131	2 0		<LLD <LLD 0 / 1	<LLD <LLD 0 / 1	<LLD <LLD 0 / 2
Cs-134	2 0		<LLD <LLD 0 / 1	<LLD <LLD 0 / 1	<LLD <LLD 0 / 2
Cs-137	2 0		<LLD <LLD 0 / 1	BF: 3.3E+1 ± 6.4E+0 3.0E+1 - 3.7E+1 2 / 2	3.3E+1 ± 6.4E+0 3.0E+1 - 3.7E+1 2 / 2
Ra-226	2 0		8.5E+2 ± 3.7E+2 8.5E+2 - 8.5E+2 1 / 1	BF: 7.4E+2 ± 3.3E+2 5.3E+2 - 9.6E+2 2 / 2	7.4E+2 ± 3.3E+2 5.3E+2 - 9.6E+2 2 / 2
AcTh-228	2 0		<LLD <LLD 0 / 1	BF: 1.3E+2 ± 6.5E+1 8.5E+1 - 1.7E+2 2 / 2	1.3E+2 ± 6.5E+1 8.5E+1 - 1.7E+2 2 / 2

* Non-Routine refers to those radionuclides that exceeded the Reporting Levels in ODCM Table 3.5-4.

Table 2.9-1
Vegetable/Vegetation Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2005)

MEDIUM: Vegetation (TF) UNITS: pCi/kg wet

Radionuclide	No. Analyses Non-routine*	Required LLD	Indicator Stations Mean ± Std.Dev. Range Fraction>LLD	Station with Highest Mean Station: Mean ± Std.Dev. Range Fraction>LLD	Control Stations Mean ± Std.Dev. Range Fraction>LLD
Be-7	12 0		8.2E+2 ± 4.7E+2 <LLD - 1.5E+3 8 / 11	MwvTwr: 1.5E+3 ± 1.2E+2 1.5E+3 - 1.5E+3 1 / 1	1.1E+2 ± 5.4E+1 1.1E+2 - 1.1E+2 1 / 1
K-40	12 0		4.2E+3 ± 2.0E+3 2.0E+3 - 6.9E+3 11 / 11	BF: 7.1E+3 ± 2.1E+2 7.1E+3 - 7.1E+3 1 / 1	7.1E+3 ± 2.1E+2 7.1E+3 - 7.1E+3 1 / 1
I-131	12 0	60	<LLD <LLD 0 / 11	<LLD <LLD 0 / 2	<LLD <LLD 0 / 1
Cs-134	12 0	60	<LLD <LLD 0 / 11	<LLD <LLD 0 / 2	<LLD <LLD 0 / 1
Cs-137	12 0	80	8.8E+1 ± 1.8E+1 <LLD - 9.9E+1 2 / 11	PineHill: 9.9E+1 ± 1.4E+1 9.9E+1 - 9.9E+1 1 / 1	<LLD <LLD 0 / 1
Ra-226	12 0		5.2E+2 ± 2.7E+2 <LLD - 8.4E+2 6 / 11	Whipple: 8.4E+2 ± 2.8E+2 8.4E+2 - 8.4E+2 1 / 1	3.1E+2 ± 1.1E+2 3.1E+2 - 3.1E+2 1 / 1
AcTh-228	12 0		2.0E+2 ± 4.6E+1 <LLD - 2.6E+2 6 / 11	PineHill: 2.6E+2 ± 5.3E+1 2.6E+2 - 2.6E+2 1 / 1	<LLD <LLD 0 / 1

* Non-Routine refers to those radionuclides that exceeded the Reporting Levels in ODCM Table 3.5-4.

Table 2.10-1
Cranberry Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2005)

MEDIUM: Cranberries (CB) UNITS: pCi/kg wet

Radionuclide	No. Analyses Non-routine*	Required LLD	Indicator Stations Mean ± Std.Dev. Range Fraction>LLD	Station with Highest Mean Station: Mean ± Std.Dev. Range Fraction>LLD	Control Stations Mean ± Std.Dev. Range Fraction>LLD
Be-7	3		<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 2	0 / 1	0 / 1
K-40	3		1.6E+3 ± 4.2E+2	1.9E+3 ± 2.3E+2	0.0E+0 ± 0.0E+0
	0		1.3E+3 - 1.9E+3	1.9E+3 - 1.9E+3	8.6E+2 - 8.6E+2
			2 / 2	1 / 1	1 / 1
I-131	3	60	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 2	0 / 1	0 / 1
Cs-134	3	60	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 2	0 / 1	0 / 1
Cs-137	3	80	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 2	0 / 1	0 / 1
Ra-226	3		<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 2	0 / 1	0 / 1
AcTh-228	3		<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 2	0 / 1	0 / 1

* Non-Routine refers to those radionuclides that exceeded the Reporting Levels in ODCM Table 3.5-4.

Table 2.12-1
Surface Water Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2005)

MEDIUM: Surface Water (WS) UNITS: pCi/kg

Radionuclide	No. Analyses Non-routine*	Required LLD	Indicator Stations Mean ± Std.Dev. Range Fraction>LLD	Station with Highest Mean Station: Mean ± Std.Dev. Range Fraction>LLD	Control Stations Mean ± Std.Dev. Range Fraction>LLD
H-3	12 0	3000	<LLD <LLD 0 / 8	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
Be-7	36 0		<LLD <LLD 0 / 24	<LLD <LLD 0 / 12	<LLD <LLD 0 / 12
K-40	36 0		3.2E+2 ± 1.7E+2 7.9E+1 - 6.6E+2 24 / 24	PP: 5.0E+2 ± 1.1E+2 3.7E+2 - 6.7E+2 12 / 12	5.0E+2 ± 1.1E+2 3.7E+2 - 6.7E+2 12 / 12
Mn-54	36 0	15	<LLD <LLD 0 / 24	<LLD <LLD 0 / 12	<LLD <LLD 0 / 12
Fe-59	36 0	30	<LLD <LLD 0 / 24	<LLD <LLD 0 / 12	<LLD <LLD 0 / 12
Co-58	36 0	15	<LLD <LLD 0 / 24	<LLD <LLD 0 / 12	<LLD <LLD 0 / 12
Co-60	36 0	15	<LLD <LLD 0 / 24	<LLD <LLD 0 / 12	<LLD <LLD 0 / 12
Zn-65	36 0	30	<LLD <LLD 0 / 24	<LLD <LLD 0 / 12	<LLD <LLD 0 / 12
Zr-95	36 0	30	<LLD <LLD 0 / 24	<LLD <LLD 0 / 12	<LLD <LLD 0 / 12
Nb-95	36 0	15	<LLD <LLD 0 / 24	<LLD <LLD 0 / 12	<LLD <LLD 0 / 12
I-131	36 0	15	<LLD <LLD 0 / 24	<LLD <LLD 0 / 12	<LLD <LLD 0 / 12
Cs-134	36 0	15	<LLD <LLD 0 / 24	<LLD <LLD 0 / 12	<LLD <LLD 0 / 12
Cs-137	36 0	18	<LLD <LLD 0 / 24	<LLD <LLD 0 / 12	<LLD <LLD 0 / 12
Ba-140	36 0	60	<LLD <LLD 0 / 24	<LLD <LLD 0 / 12	<LLD <LLD 0 / 12
La-140	36 0	15	<LLD <LLD 0 / 24	<LLD <LLD 0 / 12	<LLD <LLD 0 / 12
Ra-226	36 0		8.2E+1 ± 2.8E+1 3.9E+1 - 1.5E+2 24 / 24	PP: 1.0E+2 ± 3.0E+1 <LLD - 1.5E+2 11 / 12	1.0E+2 ± 3.0E+1 <LLD - 1.5E+2 11 / 12
AcTh-228	36 0		8.5E+0 ± 4.6E+0 <LLD - 1.5E+1 4 / 24	PP: 3.3E+1 ± 5.3E+1 <LLD - 1.3E+2 5 / 12	3.3E+1 ± 5.3E+1 <LLD - 1.3E+2 5 / 12

* Non-Routine refers to those radionuclides that exceeded the Reporting Levels in ODCM Table 3.5-4.

Table 2.13-1
Sediment Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2005)

MEDIUM: Sediment (SE) UNITS: pCi/kg dry

Radionuclide	No. Analyses Non-routine*	Required LLD	Indicator Stations Mean ± Std.Dev. Range Fraction>LLD	Station with Highest Mean Station: Mean ± Std.Dev. Range Fraction>LLD	Control Stations Mean ± Std.Dev. Range Fraction>LLD
Be-7	12 0		8.5E+2 ± 1.9E+2 <LLD - 8.5E+2 1 / 8	Ply-H: 8.5E+2 ± 1.9E+2 <LLD - 8.5E+2 1 / 2	4.1E+2 ± 1.5E+2 <LLD - 4.1E+2 1 / 4
K-40	12 0		1.3E+4 ± 2.9E+3 9.4E+3 - 1.8E+4 8 / 8	DIS: 1.4E+4 ± 5.5E+3 1.0E+4 - 1.8E+4 2 / 2	1.3E+4 ± 1.2E+3 1.1E+4 - 1.4E+4 4 / 4
Cs-134	12 0	50	<LLD <LLD 0 / 8	<LLD <LLD 0 / 2	<LLD <LLD 0 / 4
Cs-137	12 0	50	<LLD <LLD 0 / 8	<LLD <LLD 0 / 2	<LLD <LLD 0 / 4
Ra-226	12 0		1.1E+3 ± 3.6E+2 5.4E+2 - 1.7E+3 8 / 8	Ply-H: 1.5E+3 ± 3.7E+2 1.4E+3 - 1.7E+3 2 / 2	1.0E+3 ± 3.4E+2 <LLD - 1.3E+3 3 / 4
AcTh-228	12 0		3.9E+2 ± 8.0E+1 <LLD - 5.3E+2 7 / 8	Ply-H: 4.9E+2 ± 8.6E+1 4.5E+2 - 5.3E+2 2 / 2	4.5E+2 ± 7.5E+1 3.9E+2 - 5.2E+2 4 / 4

* Non-Routine refers to those radionuclides that exceeded the Reporting Levels in ODCM Table 3.5-4.

Table 2.14-1
Irish Moss Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2005)

MEDIUM: Irish Moss (AL) UNITS: pCi/kg wet

Radionuclide	No. Analyses Non-routine*	Required LLD	Indicator Stations Mean ± Std.Dev. Range Fraction>LLD	Station with Highest Mean Station: Mean ± Std.Dev. Range Fraction>LLD	Control Stations Mean ± Std.Dev. Range Fraction>LLD
Be-7	8 0		1.8E+2 ± 6.0E+1 <LLD - 2.2E+2 3 / 6	EL: 2.1E+2 ± 5.4E+1 2.0E+2 - 2.2E+2 2 / 2	<LLD <LLD 0 / 2
K-40	8 0		6.6E+3 ± 2.3E+3 3.7E+3 - 9.9E+3 6 / 6	Dis: 9.3E+3 ± 9.1E+2 8.7E+3 - 9.9E+3 2 / 2	8.3E+3 ± 4.6E+2 8.0E+3 - 8.6E+3 2 / 2
Mn-54	8 0	130	<LLD <LLD 0 / 6	<LLD <LLD 0 / 2	<LLD <LLD 0 / 2
Fe-59	8 0	260	<LLD <LLD 0 / 6	<LLD <LLD 0 / 2	<LLD <LLD 0 / 2
Co-58	8 0	130	<LLD <LLD 0 / 6	<LLD <LLD 0 / 2	<LLD <LLD 0 / 2
Co-60	8 0	130	<LLD <LLD 0 / 6	<LLD <LLD 0 / 2	<LLD <LLD 0 / 2
Zn-65	8 0	260	<LLD <LLD 0 / 6	<LLD <LLD 0 / 2	<LLD <LLD 0 / 2
I-131	8 0		<LLD <LLD 0 / 6	<LLD <LLD 0 / 2	<LLD <LLD 0 / 2
Cs-134	8 0	130	<LLD <LLD 0 / 6	<LLD <LLD 0 / 2	<LLD <LLD 0 / 3
Cs-137	8 0	150	<LLD <LLD 0 / 6	<LLD <LLD 0 / 2	<LLD <LLD 0 / 2
Ra-226	8 0		3.6E+2 ± 1.6E+2 <LLD - 5.4E+2 4 / 6	MP: 4.4E+2 ± 1.6E+2 3.4E+2 - 5.4E+2 2 / 2	3.7E+2 ± 8.3E+1 <LLD - 3.7E+2 1 / 2
AcTh-228	8 0		9.9E+1 ± 2.2E+1 <LLD - 1.1E+2 2 / 6	EL: 9.9E+1 ± 2.2E+1 9.2E+1 - 1.1E+2 2 / 2	<LLD <LLD 0 / 2

* Non-Routine refers to those radionuclides that exceeded the Reporting Levels in ODCM Table 3.5-4.

Table 2.15-1
Shellfish Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2005)

MEDIUM: Shellfish (SF) UNITS: pCi/kg wet

Radionuclide	No. Analyses Non-routine*	Required LLD	Indicator Stations Mean ± Std.Dev. Range Fraction>LLD	Station with Highest Mean Station: Mean ± Std.Dev. Range Fraction>LLD	Control Stations Mean ± Std.Dev. Range Fraction>LLD
Be-7	12 0		<LLD <LLD 0 / 8	<LLD <LLD 0 / 2	<LLD <LLD 0 / 4
K-40	12 0		2.5E+3 ± 9.6E+2 8.2E+2 - 3.8E+3 8 / 8	Ply-H: 2.9E+3 ± 9.2E+2 2.1E+3 - 3.8E+3 4 / 4	2.6E+3 ± 7.7E+2 2.2E+3 - 3.7E+3 4 / 4
Mn-54	12 0	130	<LLD <LLD 0 / 8	<LLD <LLD 0 / 2	<LLD <LLD 0 / 4
Fe-59	12 0	260	<LLD <LLD 0 / 8	<LLD <LLD 0 / 2	<LLD <LLD 0 / 4
Co-58	12 0	130	<LLD <LLD 0 / 8	<LLD <LLD 0 / 2	<LLD <LLD 0 / 4
Co-60	12 0	130	<LLD <LLD 0 / 8	<LLD <LLD 0 / 2	<LLD <LLD 0 / 4
Zn-65	12 0	260	<LLD <LLD 0 / 8	<LLD <LLD 0 / 2	<LLD <LLD 0 / 4
Cs-134	12 0	130	<LLD <LLD 0 / 24	<LLD <LLD 0 / 2	<LLD <LLD 0 / 4
Cs-137	12 0	150	<LLD <LLD 0 / 8	<LLD <LLD 0 / 2	<LLD <LLD 0 / 4
Ra-226	12 0		4.7E+2 ± 2.4E+2 <LLD - 7.1E+2 5 / 8	GH: 2.2E+3 ± 2.1E+2 2.2E+3 - 2.2E+3 2 / 2	1.6E+3 ± 1.0E+3 <LLD - 2.2E+3 3 / 4
AcTh-228	12 0		4.5E+1 ± 5.0E+1 <LLD - 7.6E+1 2 / 8	Dux: 1.0E+2 ± 4.8E+1 <LLD - 1.0E+2 1 / 2	1.0E+2 ± 4.8E+1 <LLD - 1.0E+2 1 / 4

* Non-Routine refers to those radionuclides that exceeded the Reporting Levels in ODCM Table 3.5-4.

Table 2.16-1
Lobster Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2005)

MEDIUM: American Lobster (HA) UNITS: pCi/kg wet

Radionuclide	No. Analyses Non-routine*	Required LLD	Indicator Stations Mean ± Std.Dev. Range Fraction>LLD	Station with Highest Mean Station: Mean ± Std.Dev. Range Fraction>LLD	Control Stations Mean ± Std.Dev. Range Fraction>LLD
Be-7	5 0		<LLD <LLD 0 / 4	<LLD <LLD 0 / 4	<LLD <LLD 0 / 1
K-40	5 0		3.4E+3 ± 5.5E+2 2.8E+3 - 4.0E+3 4 / 4	Dis: 3.4E+3 ± 5.5E+2 2.8E+3 - 4.0E+3 4 / 4	3.5E+3 ± 1.7E+2 3.5E+3 - 3.5E+3 1 / 1
Mn-54	5 0	130	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4	<LLD <LLD 0 / 1
Fe-59	5 0	260	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4	<LLD <LLD 0 / 1
Co-58	5 0	130	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4	<LLD <LLD 0 / 1
Co-60	5 0	130	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4	<LLD <LLD 0 / 1
Zn-65	5 0	260	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4	<LLD <LLD 0 / 1
Cs-134	5 0	130	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4	<LLD <LLD 0 / 1
Cs-137	5 0	150	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4	<LLD <LLD 0 / 1
Ra-226	5 0		4.3E+2 ± 2.4E+2 <LLD - 6.8E+2 3 / 4	Dis: 4.3E+2 ± 2.4E+2 <LLD - 6.8E+2 3 / 4	4.1E+2 ± 1.3E+2 4.1E+2 - 4.1E+2 1 / 1
AcTh-228	5 0		5.4E+1 ± 2.0E+1 <LLD - 5.4E+1 1 / 4	5.4E+1 ± 2.0E+1 <LLD - 5.4E+1 1 / 4	<LLD <LLD 0 / 1

* Non-Routine refers to those radionuclides that exceeded the Reporting Levels in ODCM Table 3.5-4.

Table 2.17-1
Fish Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2005)

MEDIUM: Fish (FH) UNITS: pCi/kg wet

Radionuclide	No. Analyses Non-routine*	Required LLD	Indicator Stations Mean ± Std.Dev. Range Fraction>LLD	Station with Highest Mean Station: Mean ± Std.Dev. Range Fraction>LLD	Control Stations Mean ± Std.Dev. Range Fraction>LLD
Be-7	8 0		<LLD <LLD 0 / 4	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
K-40	8 0		5.9E+3 ± 9.1E+2 5.0E+3 - 7.1E+3 4 / 4	Dis: 5.9E+3 ± 9.1E+2 5.0E+3 - 7.1E+3 4 / 4	5.4E+3 ± 1.5E+3 4.2E+3 - 7.5E+3 4 / 4
Mn-54	8 0	130	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
Fe-59	8 0	260	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
Co-58	8 0	130	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
Co-60	8 0	130	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
Zn-65	8 0	260	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
Cs-134	8 0	130	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
Cs-137	8 0	150	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
Ra-226	8 0		3.3E+3 ± 3.3E+3 5.0E+2 - 7.1E+3 4 / 4	Dis: 3.3E+3 ± 3.3E+3 5.0E+2 - 7.1E+3 4 / 4	7.0E+2 ± 3.4E+2 <LLD - 1.0E+3 3 / 4
AcTh-228	8 0		6.7E+1 ± 3.6E+1 <LLD - 6.7E+1 1 / 4	BuzzBay: 1.0E+2 ± 3.7E+1 1.0E+2 - 1.0E+2 1 / 1	8.1E+1 ± 3.5E+1 <LLD - 1.0E+2 2 / 4

* Non-Routine refers to those radionuclides that exceeded the Reporting Levels in ODCM Table 3.5-4.

Figure 2.2-1

Environmental TLD Locations Within the PNPS Protected Area

TLD Station		Location*
Description	Code	Distance/Direction
TLDs Within Protected Area		
O&M/RXB. BREEZEWAY	P21	50 m SE
EXEC.BUILDING	P24	57 m W
FENCE-R SCREENHOUSE	P04	66 m N
O&M - 2ND W WALL	P20	67 m SE
EXEC.BUILDING LAWN	P25	76 m WNW
FENCE-WATER TANK	P05	81 m NNE
FENCE-OIL STORAGE	P06	85 m NE
O&M - 2ND SW CORNER	P19	86 m S
O&M - 1ST SW CORNER	P18	90 m S
COMPRESSED GAS STOR	P08	92 m E
FENCE-L SCREENHOUSE	P03	100 m NW
FENCE-EXEC.BUILDING	P17	107 m W
O&M - 2ND S WALL	P23	121 m ENE
FENCE-INTAKE BAY	P07	121 m SSE
FENCE-WAREHOUSE	P26	134 m ESE
FENCE-SHOREFRONT	P02	135 m NW
FENCE-W BOAT RAMP	P09	136 m E
O&M - 2ND N WALL	P22	137 m SE
FENCE-W SWITCHYARD	P16	172 m SW
FENCE-TCF GATE	P11	183 m ESE
FENCE-TCF/BOAT RAMP	P27	185 m ESE
FENCE-ACCESS GATE	P12	202 m SE
FENCE-E SWITCHYARD	P15	220 m S
FENCE-TCF/INTAKE BAY	P10	223 m E
FENCE-MEDICAL BLDG.	P13	224 m SSE
FENCE-BUTLER BLDG	P14	228 m S
FENCE-TCF/PRKNG LOT	P28	259 m ESE

* Distance and direction are measured from centerline of Reactor Building to the monitoring location.

Figure 2.2-1 (continued)
Environmental TLD Locations Within the PNPS Protected Area

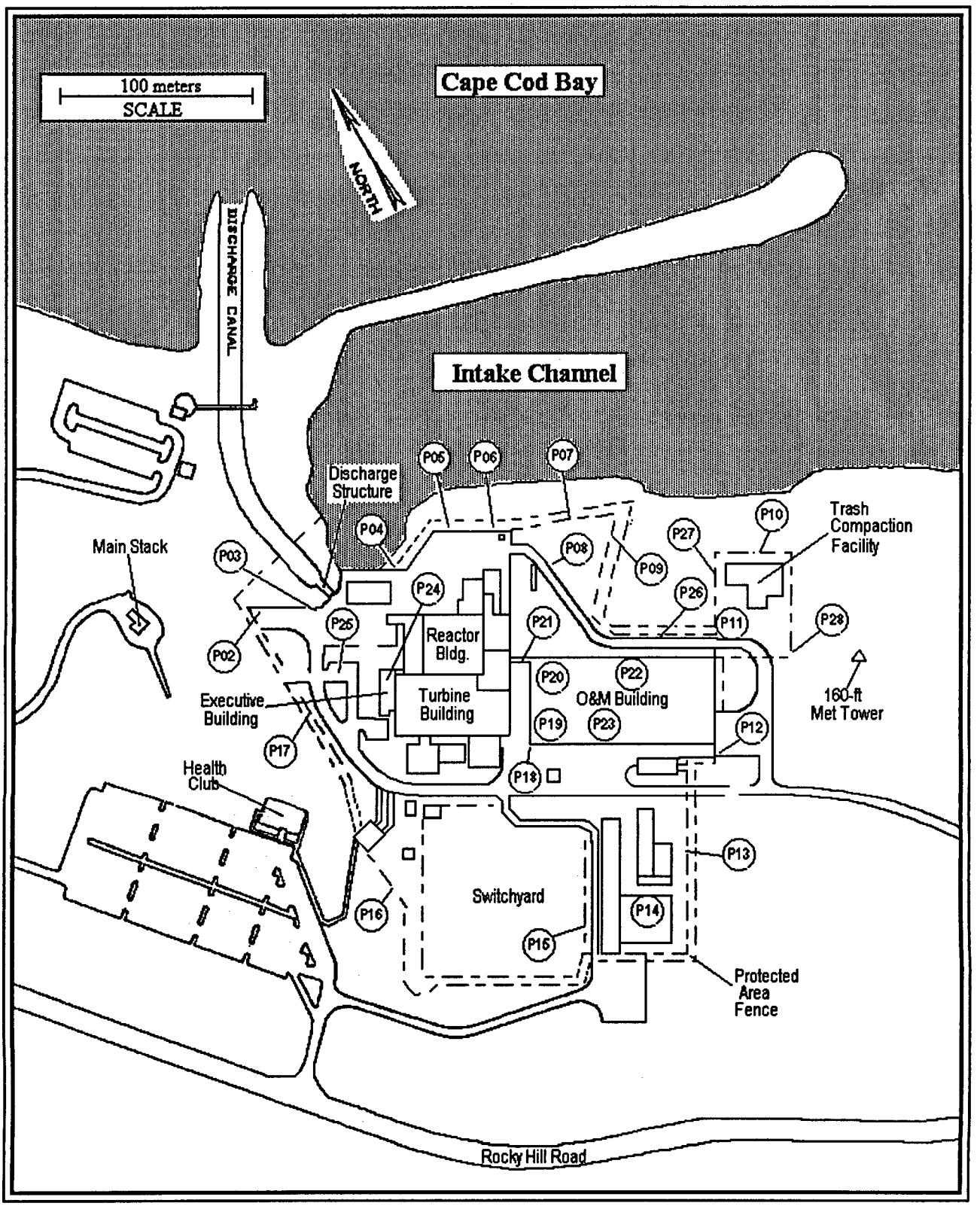


Figure 2.2-2

TLD and Air Sampling Locations: Within 1 Kilometer

TLD Station		Location*	Air Sampling Station		Location*
Description	Code	Distance/Direction	Description	Code	Distance/Direction
Zone 1 TLDs: 0-3 km					
BOAT LAUNCH WEST	BLW	0.11 km E	OVERLOOK AREA	OA	0.15 km W
OVERLOOK AREA	OA	0.15 km W	PEDESTRIAN BRIDGE	PB	0.21 km N
HEALTH CLUB	TC	0.15 km WSW	MEDICAL BUILDING	WS	0.23 km SSE
BOAT LAUNCH EAST	BLE	0.16 km ESE	EAST BREAKWATER	EB	0.44 km ESE
PEDESTRIAN BRIDGE	PB	0.21 km N	PROPERTY LINE	PL	0.54 km NNW
SHOREFRONT SECURITY	P01	0.22 km NNW	W ROCKY HILL ROAD	WR	0.83 km WNW
MEDICAL BUILDING	WS	0.23 km SSE	E ROCKY HILL ROAD	ER	0.89 km SE
PARKING LOT	CT	0.31 km SE			
SHOREFRONT PARKING	PA	0.35 km NNW			
STATION A	A	0.37 km WSW			
STATION F	F	0.43 km NW			
STATION B	B	0.44 km S			
EAST BREAKWATER	EB	0.44 km ESE			
PNPS MET TOWER	PMT	0.44 km WNW			
STATION H	H	0.47 km SW			
STATION I	I	0.48 km WNW			
STATION L	L	0.50 km ESE			
STATION G	G	0.53 km W			
STATION D	D	0.54 km NW			
PROPERTY LINE	PL	0.54 km NNW			
STATION C	C	0.57 km ESE			
HALL'S BOG	HB	0.63 km SE			
GREENWOOD HOUSE	GH	0.65 km ESE			
W ROCKY HILL ROAD	WR	0.83 km WNW			
E ROCKY HILL ROAD	ER	0.89 km SE			

Figure 2.2-2 (continued)

TLD and Air Sampling Locations: Within 1 Kilometer

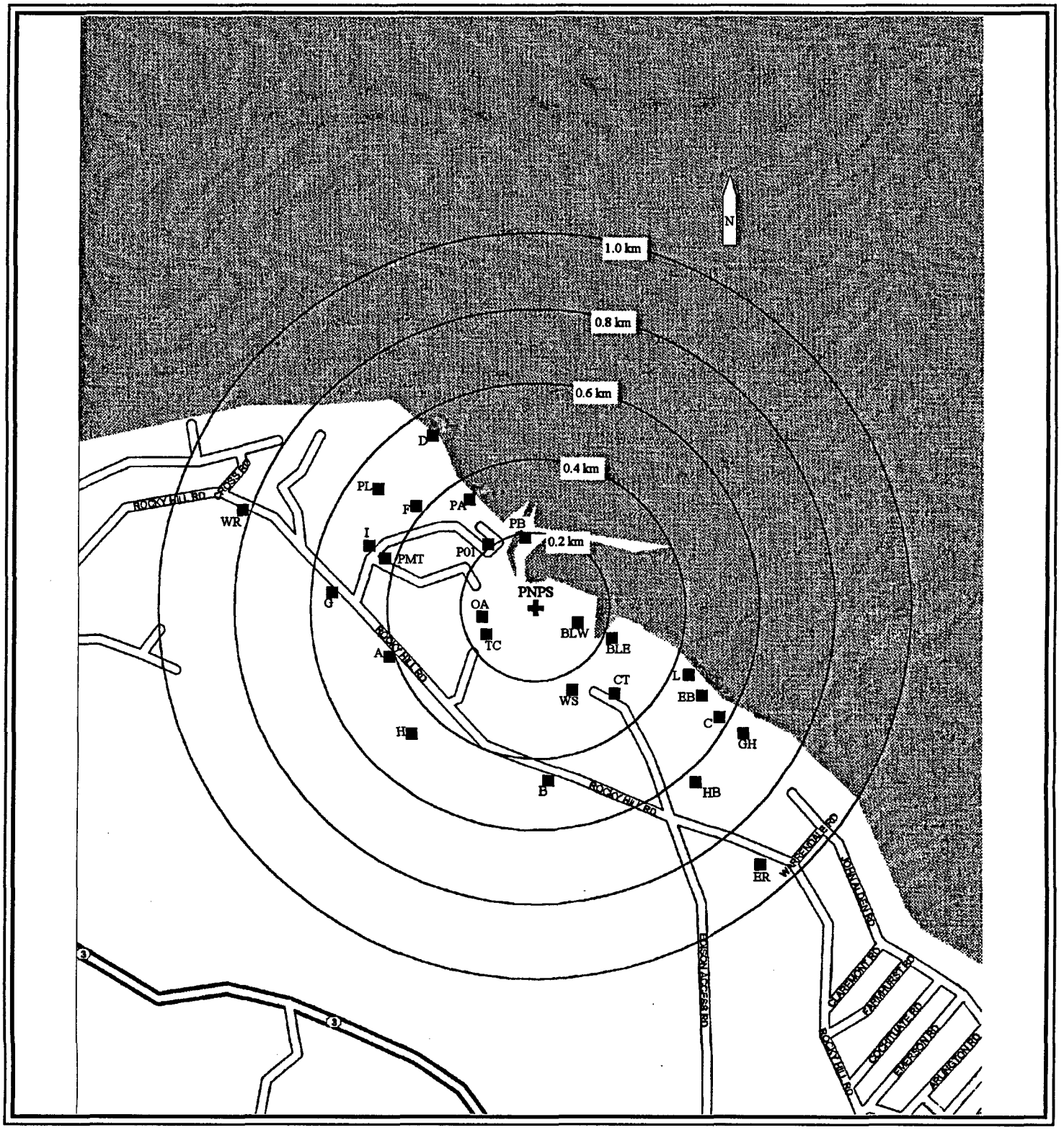


Figure 2.2-3

TLD and Air Sampling Locations: 1 to 5 Kilometers

TLD Station		Location*	Air Sampling Station		Location*
Description	Code	Distance/Direction	Description	Code	Distance/Direction
Zone 1 TLDs: 0-3 km					
MICROWAVE TOWER	MT	1.03 km SSW	CLEFT ROCK	CR	1.27 km SSW
CLEFT ROCK	CR	1.27 km SSW	MANOMET SUBSTATION	MS	3.60 km SSE
BAYSHORE/GATE RD	BD	1.34 km WNW			
MANOMET ROAD	MR	1.38 km S			
DIRT ROAD	DR	1.48 km SW			
EMERSON ROAD	EM	1.53 km SSE			
EMERSON/PRISCILLA	EP	1.55 km SE			
EDISON ACCESS ROAD	AR	1.59 km SSE			
BAYSHORE	BS	1.76 km W			
STATION E	E	1.86 km S			
JOHN GAULEY	JG	1.99 km W			
STATION J	J	2.04 km SSE			
WHITEHORSE ROAD	WH	2.09 km SSE			
PLYMOUTH YMCA	RC	2.09 km WSW			
STATION K	K	2.17 km S			
TAYLOR/THOMAS	TT	2.26 km SE			
YANKEE VILLAGE	YV	2.28 km WSW			
GOODWIN PROPERTY	GN	2.38 km SW			
RIGHT OF WAY	RW	2.83 km S			
TAYLOR/PEARL	TP	2.98 km SE			
Zone 2 TLDs: 3-8 km					
VALLEY ROAD	VR	3.26 km SSW			
MANOMET ELEM	ME	3.29 km SE			
WARREN/CLIFFORD	WC	3.31 km W			
RT.3A/BARTLETT RD	BB	3.33 km SSE			
MANOMET POINT	MP	3.57 km SE			
MANOMET SUBSTATION	MS	3.60 km SSE			
BEACHWOOD ROAD	BW	3.93 km SE			
PINES ESTATE	PT	4.44 km SSW			
EARL ROAD	EA	4.60 km SSE			
S PLYMOUTH SUBST	SP	4.62 km W			
ROUTE 3 OVERPASS	RP	4.81 km SW			
RUSSELL MILLS RD	RM	4.85 km WSW			

* Distance and direction are measured from centerline of Reactor Building to the monitoring location.

Figure 2.2-3 (continued)

TLD and Air Sampling Locations: 1 to 5 Kilometers

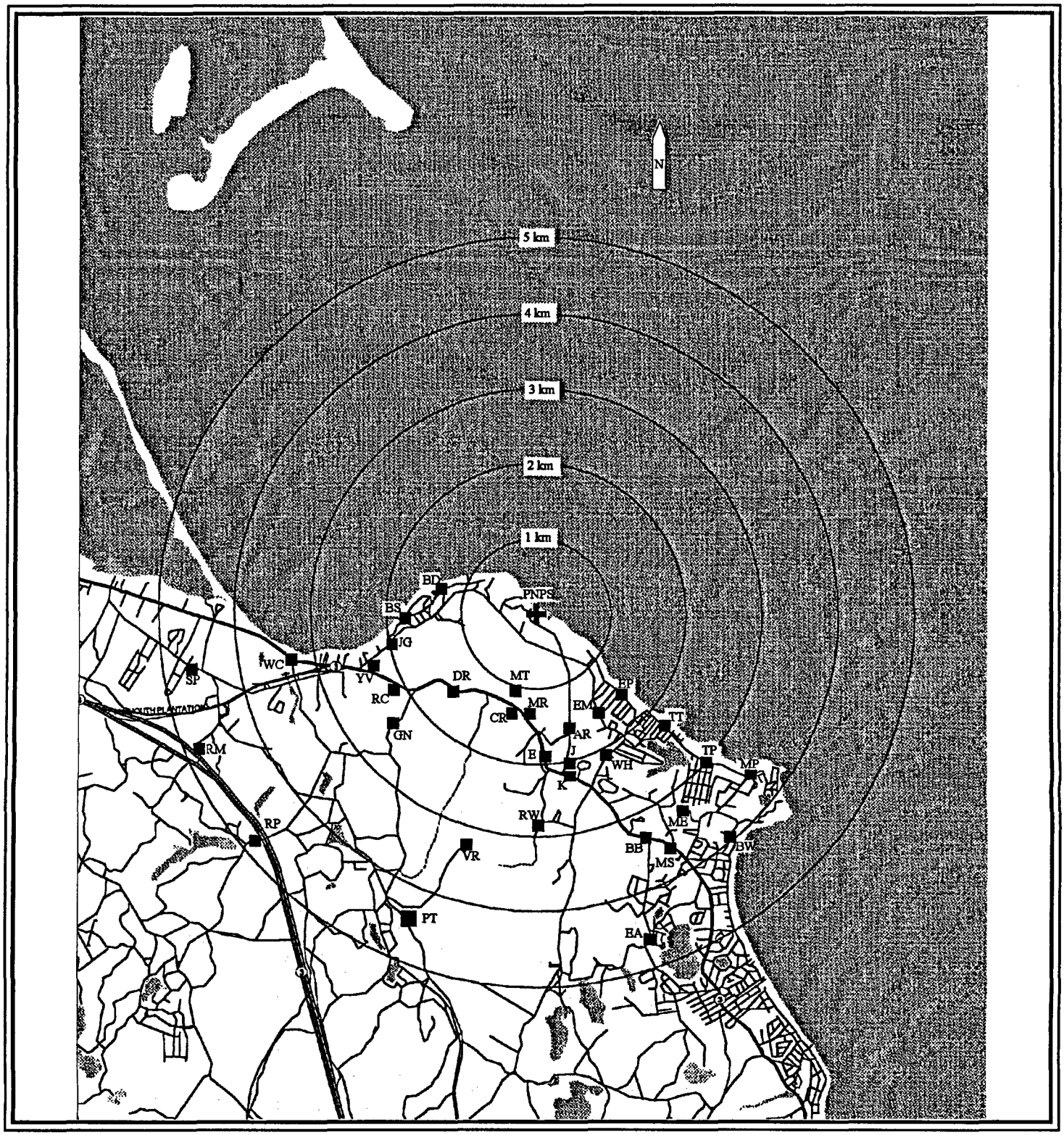


Figure 2.2-4

TLD and Air Sampling Locations: 5 to 25 Kilometers

TLD Station		Location*	Air Sampling Station		Location*
Description	Code	Distance/Direction	Description	Code	Distance/Direction
Zone 2 TLDs: 3-8 km					
HILLDALE ROAD	HD	5.18 km W	PLYMOUTH CENTER	PC	6.69 km W
MANOMET BEACH	MB	5.43 km SSE			
BEAVER DAM ROAD	BR	5.52 km S			
PLYMOUTH CENTER	PC	6.69 km W			
LONG POND/DREW RD	LD	6.97 km WSW			
HYANNIS ROAD	HR	7.33 km SSE			
MEMORIAL HALL	MH	7.58 km WNW			
SAQUISH NECK	SN	7.58 km NNW			
COLLEGE POND	CP	7.59 km SW			
Zone 3 TLDs: 8-15 km					
DEEP WATER POND	DW	8.59 km W			
LONG POND ROAD	LP	8.88 km SSW			
NORTH PLYMOUTH	NP	9.38 km WNW			
STANDISH SHORES	SS	10.39 km NW			
ELLISVILLE ROAD	EL	11.52 km SSE			
UP COLLEGE POND RD	UC	11.78 km SW			
SACRED HEART	SH	12.92 km W			
KING CAESAR ROAD	KC	13.11 km NNW			
BOURNE ROAD	BE	13.37 km S			
SHERMAN AIRPORT	SA	13.43 km WSW			
Zone 4 TLDs: >15 km					
CEDARVILLE SUBST	CS	15.93 km S			
KINGSTON SUBST	KS	16.15 km WNW			
LANDING ROAD	LR	16.46 km NNW			
CHURCH/WEST	CW	16.56 km NW			
MAIN/MEADOW	MM	17.02 km WSW			
DIV MARINE FISH	DMF	20.97 km SSE			

* Distance and direction are measured from centerline of Reactor Building to the monitoring location.

Figure 2.2-4 (continued)

TLD and Air Sampling Locations: 5 to 25 Kilometers

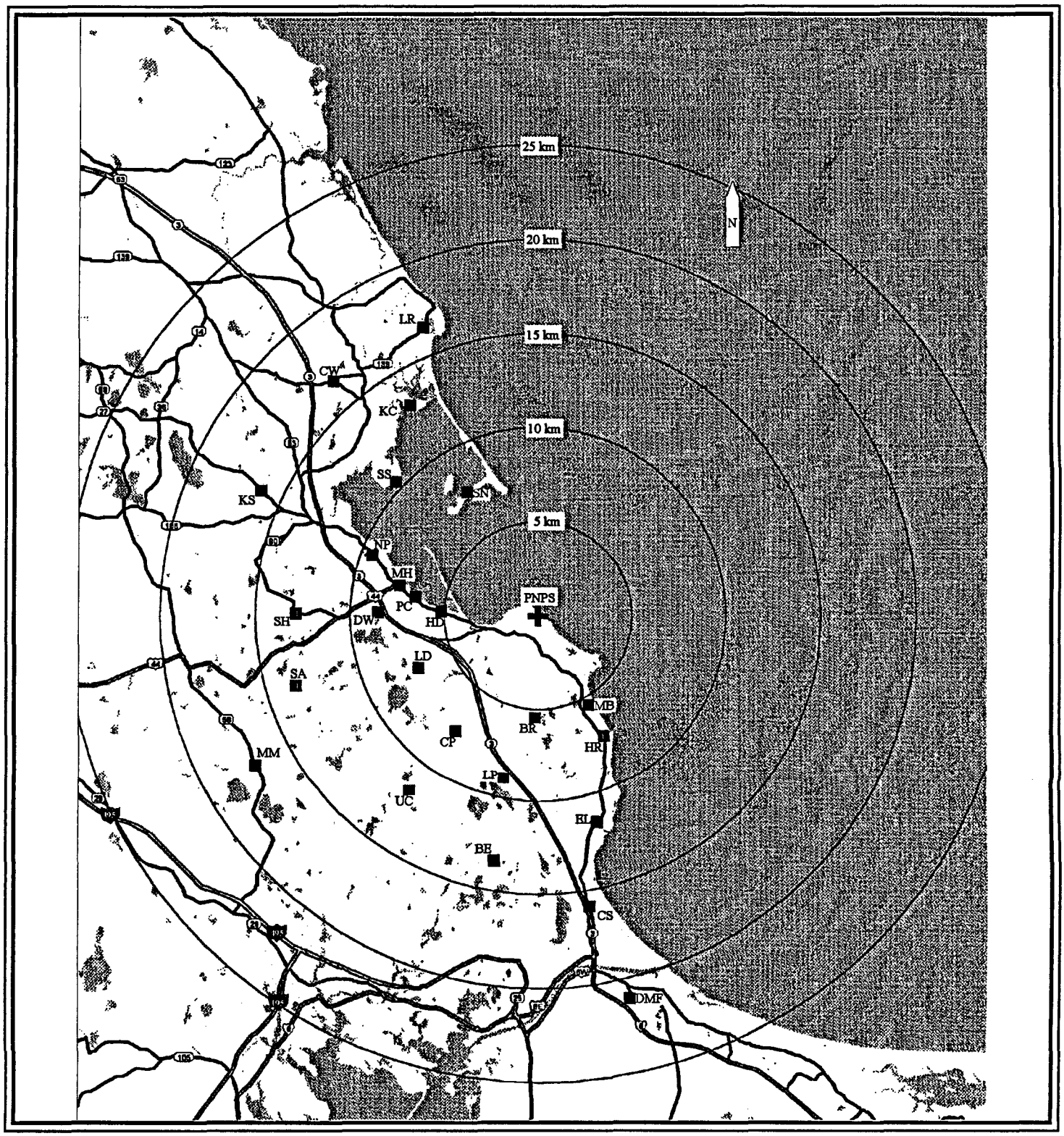


Figure 2.2-5

Terrestrial and Aquatic Sampling Locations

Description	Code	Distance/Direction*
MILK		
Plymouth County Farm	CF	5.6 km W
Whitman Farm Control	WF	34 km WNW
FORAGE		
Whipple Farm	WH	2.9 km SW
Plymouth County Farm	CF	5.6 km W
Whitman Farm Control	WF	34 km WNW
VEGETABLES/VEGETATION		
Site Boundary C	BC	0.5 km SW
Site Boundary B	BB	0.5 km ESE
Rocky Hill Road	RH	0.9 km SE
Site Boundary D	Bd	1.1 km SSW
Site Boundary A	BA	1.5 km SSW
Clay Hill Road	CH	1.6 km W
Brook Road	BK	2.9 km SSE
Beaver Dam Road	BD	3.4 km S
Plymouth County Farm	CF	5.6 km W
Div. Marine Fisheries	DMF	21 km SSE
Bridgewater Control	BF	31 km W
CRANBERRIES		
Manomet Point Bog	MR	3.9 km SE
Bartlett Road Bog	BT	4.3 km SSE
Pine Street Bog Control	PS	26 km WNW

Description	Code	Distance/Direction*
SURFACE WATER		
Discharge Canal	DIS	0.2 km N
Bartlett Pond	BP	2.7 km SE
Powder Point Control	PP	13 km NNW
SEDIMENT		
Discharge Canal Outfall	DIS	0.8 km NE
Plymouth Beach	PLB	4.0 km W
Manomet Point	MP	3.3 km ESE
Plymouth Harbor	PLY-H	4.1 km W
Duxbury Bay Control	DUX-BAY	14 km NNW
Green Harbor Control	GH	16 km NNW
IRISH MOSS		
Discharge Canal Outfall	DIS	0.7 km NNE
Manomet Point	MP	4.0 km ESE
Ellisville	EL	12 km SSE
Brant Rock Control	BK	18 km NNW
SHELLFISH		
Discharge Canal Outfall	DIS	0.7 km NNE
Plymouth Harbor	PLY-H	4.1 km W
Manomet Point	MP	4.0 km ESE
Duxbury Bay Control	DUX-BAY	13 km NNW
Powder Point Control	PP	13 km NNW
Green Harbor Control	GH	16 km NNW
LOBSTER		
Discharge Canal Outfall	DIS	0.5 km N
Plymouth Beach	PLB	4.0 km W
Plymouth Harbor	PLY-H	6.4 km WNW
Duxbury Bay Control	DUX-BAY	11 km NNW
FISHES		
Discharge Canal Outfall	DIS	0.5 km N
Plymouth Beach	PLB	4.0 km W
Jones River Control	JR	13 km WNW
Cape Cod Bay Control	CC-BAY	24 km ESE
N River-Hanover Control	NR	24 km NNW
Cataumet Control	CA	32 km SSW
Provincetown Control	PT	32 km NE
Buzzards Bay Control	BB	40 km SSW
Priest Cove Control	PC	48 km SW
Nantucket Sound Control	NS	48 km SSE
Atlantic Ocean Control	AO	48 km E
Vineyard Sound Control	MV	64 km SSW

* Distance and direction are measured from the centerline of the reactor to the sampling/monitoring location.

Figure 2.2-5 (continued)

Terrestrial and Aquatic Sampling Locations

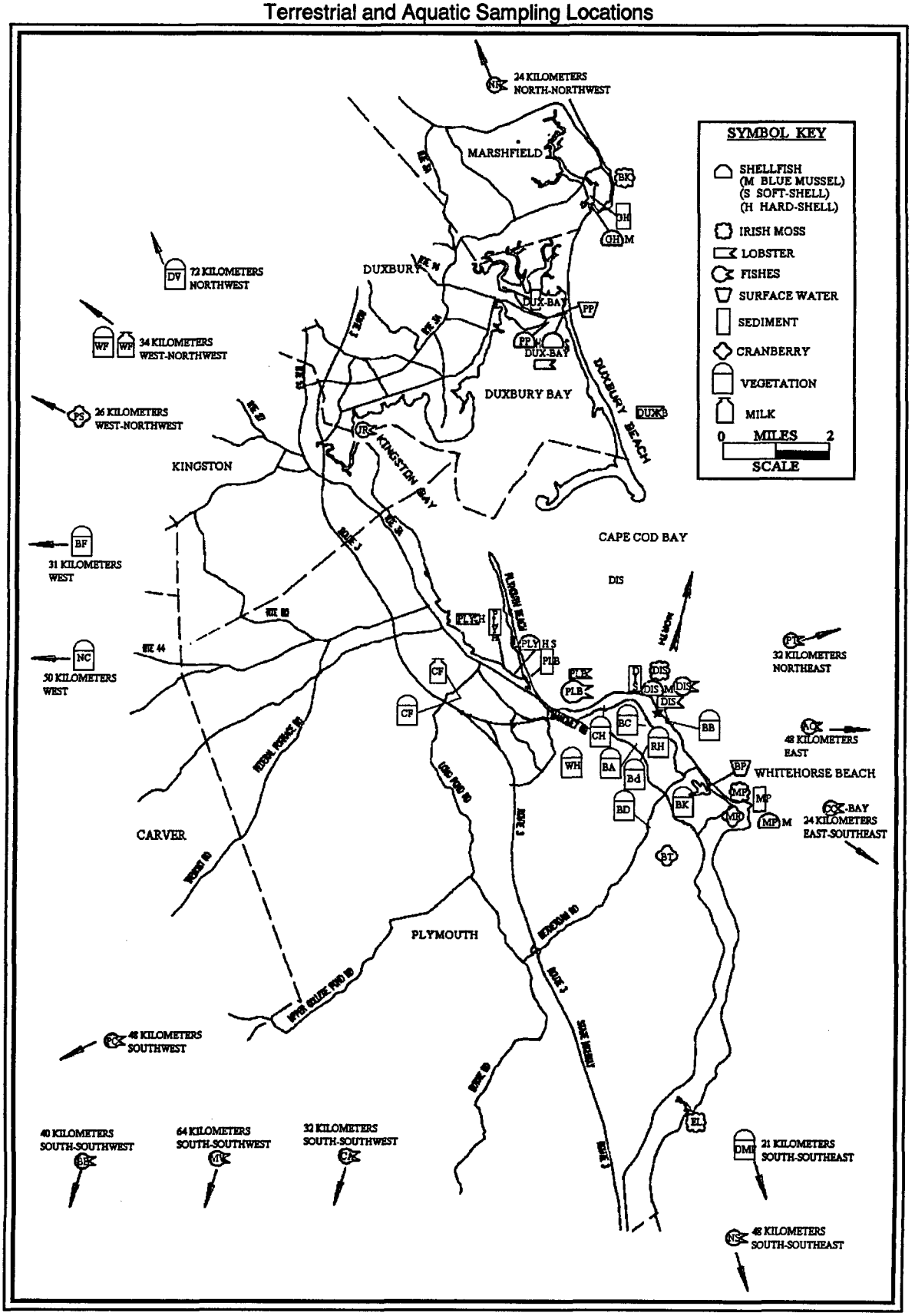


Figure 2.2-6

Environmental Sampling And Measurement Control Locations

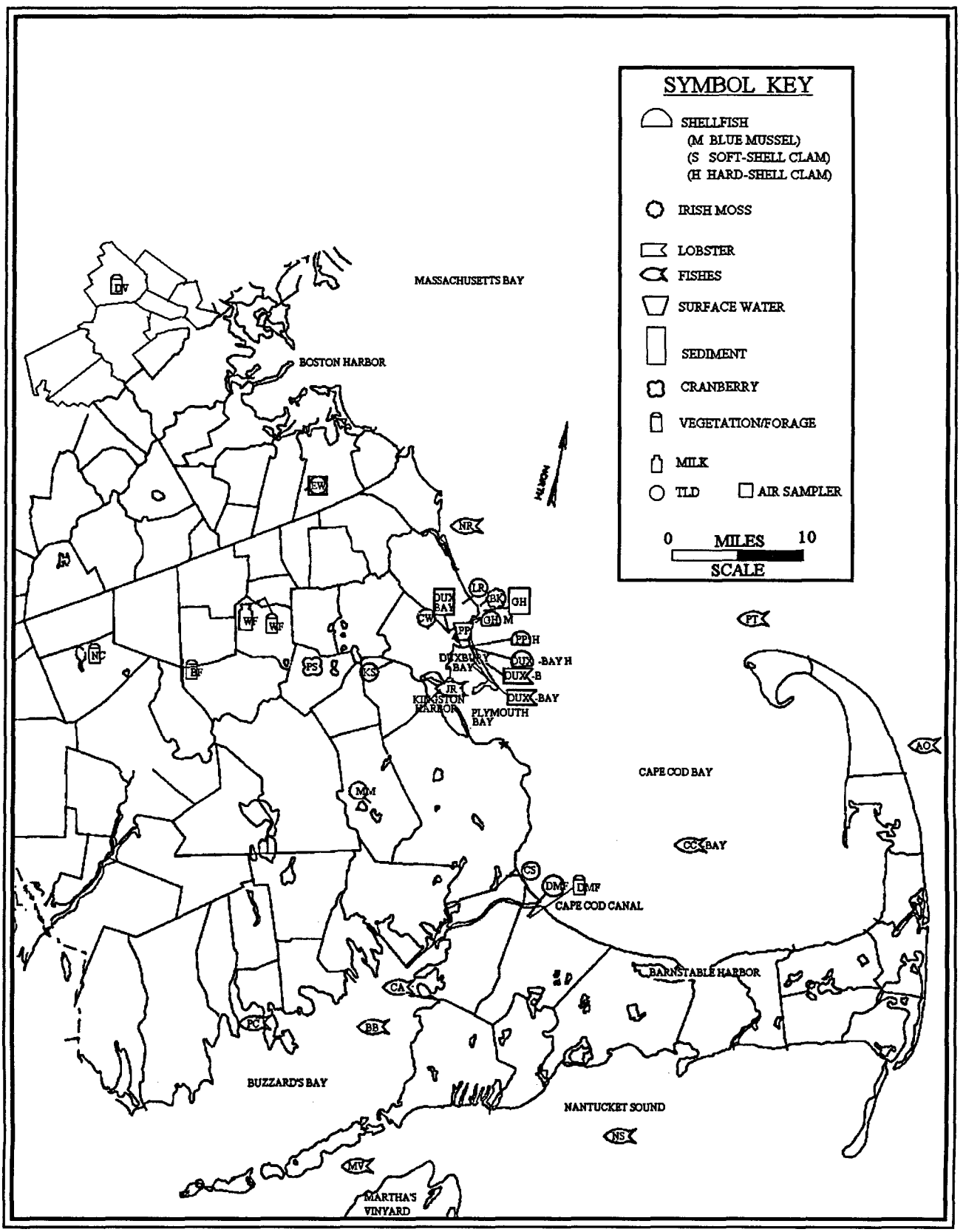
Description	Code	Distance/Direction*
TLD		
Cedarville Substation	CS	16 km S
Kingston Substation	KS	16 km WNW
Landing Road	LR	16 km NNW
Church & West Street	CW	17 km NW
Main & Meadow Street	MM	17 km WSW
Div. Marine Fisheries	DMF	21 km SSE
East Weymouth Substation	EW	40 km NW
AIR SAMPLER		
East Weymouth Substation	EW	40 km NW
MILK		
Whitman Farm Control	WF	34 km WNW
FORAGE		
Whitman Farm Control	WF	34 km WNW
VEGETABLES/VEGETATION		
Div. Marine Fish. Control	DMF	21 km SSE
Bridgewater Farm Control	BF	31 km W
CRANBERRIES		
Pine Street Bog Control	PS	26 km WNW

Description	Code	Distance/Direction*
SURFACE WATER		
Powder Point Control	PP	13 km NNW
SEDIMENT		
Duxbury Bay Control	DUX-BAY	14 km NNW
Green Harbor Control	GH	16 km NNW
IRISH MOSS		
Brant Rock Control	BK	18 km NNW
SHELLFISH		
Duxbury Bay Control	DUX-BAY	13 km NNW
Powder Point Control	PP	13 km NNW
Green Harbor Control	GH	16 km NNW
LOBSTER		
Duxbury Bay Control	DUX-BAY	11 km NNW
FISHES		
Jones River Control	JR	13 km WNW
Cape Cod Bay Control	CC-BAY	24 km ESE
N River-Hanover Control	NR	24 km NNW
Cataumet Control	CA	32 km SSW
Provincetown Control	PT	32 km NE
Buzzards Bay Control	BB	40 km SSW
Priest Cove Control	PC	48 km SW
Nantucket Sound Control	NS	48 km SSE
Atlantic Ocean Control	AO	48 km E
Vineyard Sound Control	MV	64 km SSW

* Distance and direction are measured from the centerline of the reactor to the sampling/monitoring location.

Figure 2.2-6 (continued)

Environmental Sampling And Measurement Control Locations



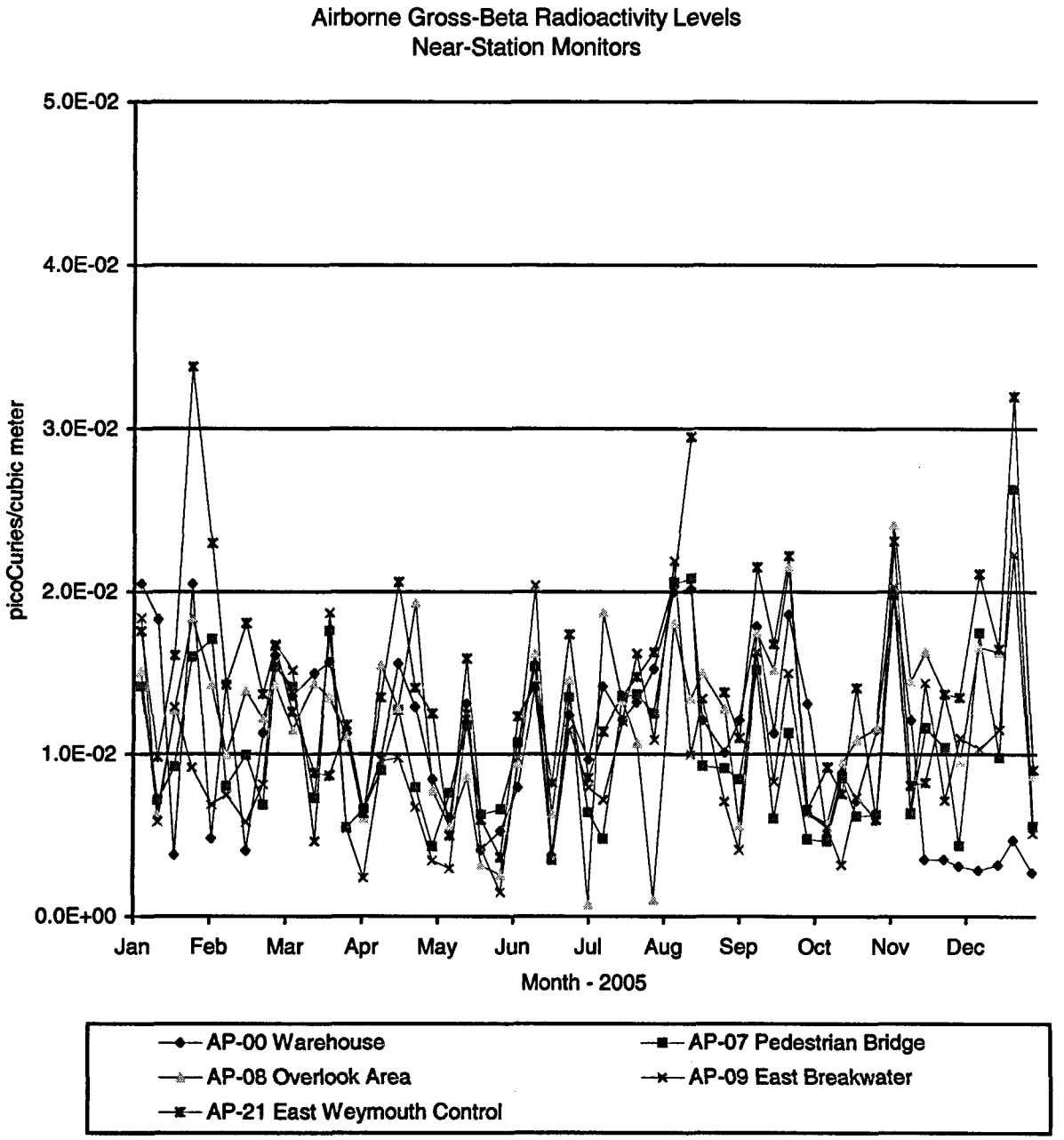


Figure 2.5-1
Airborne Gross-Beta Radioactivity Levels: Near Station Monitors

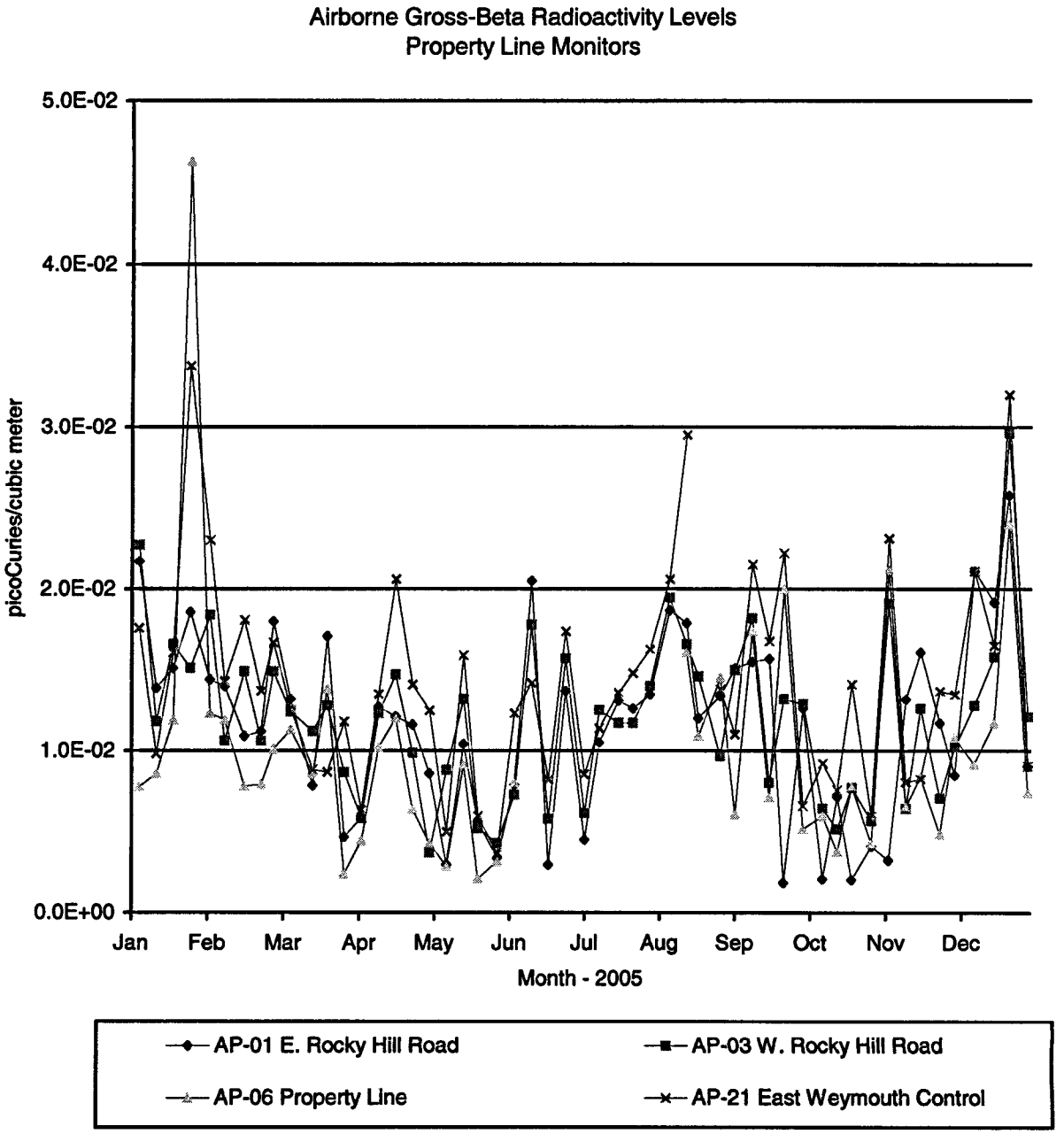


Figure 2.5-2
Airborne Gross-Beta Radioactivity Levels: Property Line Monitors

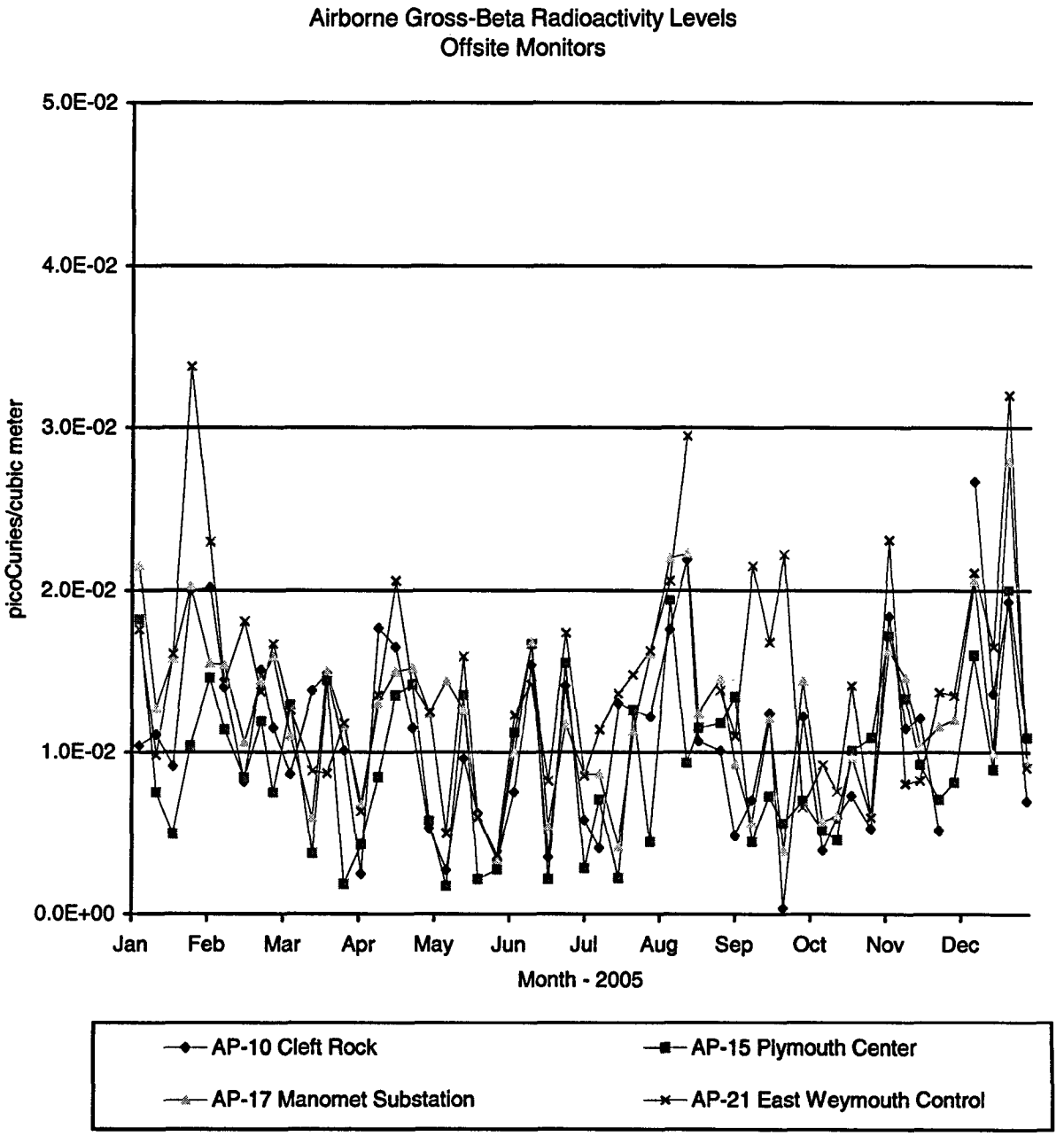


Figure 2.5-3
Airborne Gross-Beta Radioactivity Levels: Offsite Monitors

3.0 SUMMARY OF RADIOLOGICAL IMPACT ON HUMANS

The radiological impact to humans from the Pilgrim Station's radioactive liquid and gaseous releases has been estimated using two methods:

- calculations based on measurements of plant effluents; and
- calculations based on measurements of environmental samples.

The first method utilizes data from the radioactive effluents (measured at the point of release) together with conservative models that calculate the dispersion and transport of radioactivity through the environment to humans (Reference 7). The second method is based on actual measurements of radioactivity in the environmental samples and on dose conversion factors recommended by the Nuclear Regulatory Commission. The measured types and quantities of radioactive liquid and gaseous effluents released from Pilgrim Station during 2005 were reported to the Nuclear Regulatory Commission, copies of which are provided in Appendix B. The measured levels of radioactivity in the environmental samples that required dose calculations are listed in Appendix A.

The maximum individual dose from liquid effluents was calculated using the following radiation exposure pathways:

- shoreline external radiation during fishing and recreation at the Pilgrim Station Shorefront;
- external radiation from the ocean during boating and swimming; and
- ingestion of fish and shellfish.

For gaseous effluents, the maximum individual dose was calculated using the following radiation exposure pathways:

- external radiation from cloud shine and submersion in gaseous effluents;
- inhalation of airborne radioactivity;
- external radiation from soil deposition;
- consumption of vegetables; and
- consumption of milk and meat.

The results from the dose calculations based on PNPS operations are presented in Table 3.0-1. The dose assessment data presented were taken from the "Radioactive Effluent and Waste Disposal Report" for the period of January 1 through December 31, 2005.

Table 3.0-1

Radiation Doses from 2005 Pilgrim Station Operations

Receptor	Maximum Individual Dose From Exposure Pathway - mrem/yr			
	Gaseous Effluents*	Liquid Effluents	Ambient Radiation**	Total
Total Body	2.9	Zero	2.2	5.1
Thyroid	3.2	Zero	2.2	5.4
Max. Organ	3.2	Zero	2.2	5.4

* Gaseous effluent exposure pathway includes combined dose from particulates, iodines and tritium in addition to noble gases, calculated at the nearest residence.

** Ambient radiation dose for the hypothetical maximum-exposed individual at a location on PNPS property yielding highest ambient radiation exposure value as measured with TLDs.

Two federal agencies establish dose limits to protect the public from radiation and radioactivity. The Nuclear Regulatory Commission (NRC) specifies a whole body dose limit of 100 mrem/yr to be received by the maximum exposed member of the general public. This limit is set forth in Section 1301, Part 20, Title 10, of the U.S. Code of Federal Regulations (10CFR20). By comparison, the Environmental Protection Agency (EPA) limits the annual whole body dose to 25 mrem/yr, which is specified in Section 10, Part 190, Title 40, of the Code of Federal Regulations (40CFR190).

Another useful "gauge" of radiation exposure is provided by the amount of dose a typical individual receives each year from natural and man-made (e.g., diagnostic X-rays) sources of radiation. The typical American receives 300 to 400 mrem/yr from such sources.

As can be seen from the doses resulting from Pilgrim Station Operations during 2005, all values are well within the federal limits specified by the NRC and EPA. In addition, the calculated doses from PNPS operation represent only a fraction of a percent of doses from natural and man-made radiation.

In conclusion, the radiological impact of Pilgrim Station operations, whether based on actual environmental measurements or calculations made from effluent releases, would yield doses well within any federal dose limits set by the NRC or EPA. Such doses represent only a small percentage of the typical annual dose received from natural and man-made sources of radiation.

4.0 REFERENCES

1) United States of America, Code of Federal Regulations, Title 10, Part 50, Appendix A Criteria 64.

2) Donald T. Oakley, "Natural Radiation Exposure in the United States." U. S. Environmental Protection Agency, ORP/SID 72-1, June 1972.

3) National Council on Radiation Protection and Measurements, Report No. 93, "Ionizing Radiation Exposures of the Population of the United States," September 1987.

4) United States Nuclear Regulatory Commission, Regulatory Guide 8.29, "Instructions Concerning Risks from Occupational Radiation Exposure," Revision 0, July 1981.

5) Boston Edison Company, "Pilgrim Station" Public Information Brochure 100M, WNTHP, September 1989.

6) United States Nuclear Regulatory Commission, 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.

7) Pilgrim Nuclear Power Station Offsite Dose Calculation Manual, Revision 8, August 1998.

8) United States of America, Code of Federal Regulations, Title 10, Part 20.1301.

9) United States of America, Code of Federal Regulations, Title 10, Part 50, Appendix I.

10) United States of America, Code of Federal Regulations, Title 40, Part 190.

11) United States Nuclear Regulatory Commission, Regulatory Guide 4.1, "Program for Monitoring Radioactivity in the Environs of Nuclear Power Plants," Revision 1, April 1975.

12) ICN/Tracerlab, "Pilgrim Nuclear Power Station Pre-operational Environmental Radiation Survey Program, Quarterly Reports," August 1968 to June 1972.

13) International Commission of Radiological Protection, Publication No. 43, "Principles of Monitoring for the Radiation Protection of the Population," May 1984.

14) United States Nuclear Regulatory Commission, NUREG-1302, "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors," April 1991.

15) United States Nuclear Regulatory Commission, Branch Technical Position, "An Acceptable Radiological Environmental Monitoring Program," Revision 1, November 1979.

16) Settlement Agreement Between Massachusetts Wildlife Federation and Boston Edison Company Relating to Offsite Radiological Monitoring - June 9, 1977.

APPENDIX A

SPECIAL STUDIES

None of the samples collected as part of the radiological environmental monitoring program during 2005 indicated any detectable radioactivity attributable to Pilgrim Station operations. Therefore, no special dose analyses were performed.

APPENDIX B

Effluent Release Information

TABLE	TITLE	PAGE
B.1	Supplemental Information	72
B.2-A	Gaseous Effluents Summation of All Releases	73
B.2-B	Gaseous Effluents - Elevated Releases	74
B.2-C	Gaseous Effluents - Ground Level Releases	76
B.3-A	Liquid Effluents Summation of All Releases	78
B.3-B	Liquid Effluents	79

Table B.1
Pilgrim Nuclear Power Station
Effluent and Waste Disposal Report
Supplemental Information
January-December 2005

FACILITY: PILGRIM NUCLEAR POWER STATION **LICENSE: DPR-35**

1. REGULATORY LIMITS					
a. Fission and activation gases:	500 mrem/yr total body and 3000 mrem/yr for skin at site boundary				
b,c. Iodines, particulates with half-life: >8 days, tritium	1500 mrem/yr to any organ at site boundary				
d. Liquid effluents:	0.06 mrem/month for whole body and 0.2 mrem/month for any organ (without radwaste treatment)				
2. EFFLUENT CONCENTRATION LIMITS					
a. Fission and activation gases:	10CFR20 Appendix B Table II				
b. Iodines:	10CFR20 Appendix B Table II				
c. Particulates with half-life > 8 days:	10CFR20 Appendix B Table II				
d. Liquid effluents:	2E-04 µCi/mL for entrained noble gases; 10CFR20 Appendix B Table II values for all other radionuclides				
3. AVERAGE ENERGY	Not Applicable				
4. MEASUREMENTS AND APPROXIMATIONS OF TOTAL RADIOACTIVITY					
a. Fission and activation gases: b. Iodines: c. Particulates: d. Liquid effluents:	High purity germanium gamma spectroscopy for all gamma emitters; radiochemistry analysis for H-3, Fe-55 (liquid effluents), Sr-89, and Sr-90				
5. BATCH RELEASES	Jan-Mar 2005	Apr-Jun 2005	Jul-Sep 2005	Oct-Dec 2005	Jan-Dec 2005
a. Liquid Effluents					
1. Total number of releases:	0	0	0	0	0
2. Total time period (minutes):	0	0	0	0	0
3. Maximum time period (minutes):	0	0	0	0	0
4. Average time period (minutes):	0	0	0	0	0
5. Minimum time period (minutes):	0	0	0	0	0
6. Average stream flow during periods of release of effluents into a flowing stream (Liters/min):	0	0	0	0	0
b. Gaseous Effluents	None	None	None	None	None
6. ABNORMAL RELEASES					
a. Liquid Effluents	None	None	None	None	None
b. Gaseous Effluents	None	None	None	None	None

Table B.2-A
Pilgrim Nuclear Power Station
Effluent and Waste Disposal Report
Gaseous Effluents - Summation of All Releases
January-December 2005

RELEASE PERIOD	Jan-Mar 2005	Apr-Jun 2005	Jul-Sep 2005	Oct-Dec 2005	Jan-Dec 2005	Est. Total Error
A. FISSION AND ACTIVATION GASES						
Total Release: Ci	1.62E+01	4.11E+01	1.66E+01	5.90E+01	1.33E+02	±22%
Average Release Rate: µCi/sec	2.06E+00	5.21E+00	2.11E+00	7.48E+00	4.21E+00	
Percent of Effluent Control Limit*	*	*	*	*	*	
B. IODINE-131						
Total Iodine-131 Release: Ci	3.49E-04	4.10E-04	2.75E-04	2.85E-04	1.32E-03	±20%
Average Release Rate: µCi/sec	4.43E-05	5.21E-05	3.48E-05	3.62E-05	4.18E-05	
Percent of Effluent Control Limit*	*	*	*	*	*	
C. PARTICULATES WITH HALF-LIVES > 8 DAYS						
Total Release: Ci	1.48E-04	4.63E-04	1.63E-04	2.36E-05	7.97E-04	±21%
Average Release Rate: µCi/sec	1.87E-05	5.87E-05	2.07E-05	2.99E-06	2.53E-05	
Percent of Effluent Control Limit*	*	*	*	*	*	
Gross Alpha Radioactivity: Ci	NDA	NDA	NDA	NDA	NDA	
D. TRITIUM						
Total Release: Ci	1.06E+02	4.06E+01	3.62E+01	2.62E+02	4.45E+02	±20%
Average Release Rate: µCi/sec	1.34E+01	5.16E+00	4.59E+00	3.33E+01	1.41E+01	
Percent of Effluent Control Limit*	*	*	*	*	*	

Notes for Table 2.2-A:

* Percent of Effluent Control Limit values based on dose assessments are provided in Section 7 of this report.

1. NDA stands for No Detectable Activity.
2. LLD for airborne gross alpha activity listed as NDA is 1E-11 µCi/cc.

Table B.2-B
Pilgrim Nuclear Power Station
Effluent and Waste Disposal Report
Gaseous Effluents – Elevated Release
January-December 2005

CONTINUOUS MODE RELEASES FROM ELEVATED RELEASE POINT					
Nuclide Released	Jan-Mar 2005	Apr-Jun 2005	Jul-Sep 2005	Oct-Dec 2005	Jan-Dec 2005
1. FISSION AND ACTIVATION GASES: Ci					
Ar-41	2.95E-01	7.84E-01	9.53E-01	1.28E-01	2.16E+00
Kr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-85m	2.71E+00	3.76E+00	3.83E+00	7.26E+00	1.75E+01
Kr-87	0.00E+00	3.01E-01	0.00E+00	1.21E-01	4.23E-01
Kr-88	0.00E+00	1.03E+00	9.25E-01	2.34E+00	4.30E+00
Xe-131m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-133	6.11E+00	1.27E+01	4.07E+00	3.61E+01	5.90E+01
Xe-133m	0.00E+00	1.30E-01	0.00E+00	0.00E+00	1.30E-01
Xe-135	3.76E-01	1.28E+00	1.24E-01	6.58E-01	2.44E+00
Xe-135m	0.00E+00	2.73E-01	3.10E-01	3.30E-01	9.13E-01
Xe-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-138	0.00E+00	1.78E-01	0.00E+00	6.41E-01	8.19E-01
Total for Period	9.49E+00	2.04E+01	1.02E+01	4.76E+01	8.77E+01
2. IODINES: Ci					
I-131	8.94E-05	1.68E-04	6.51E-05	4.67E-05	3.69E-04
I-133	5.78E-04	7.28E-04	4.35E-04	3.11E-04	2.05E-03
Total for Period	6.67E-04	8.96E-04	5.00E-04	3.58E-04	2.42E-03
3. PARTICULATES WITH HALF-LIVES > 8 DAYS: Ci					
Cr-51	0.00E+00	1.50E-05	0.00E+00	0.00E+00	1.50E-05
Mn-54	0.00E+00	1.16E-05	0.00E+00	0.00E+00	1.16E-05
Fe-59	0.00E+00	5.70E-06	0.00E+00	0.00E+00	5.70E-06
Co-58	0.00E+00	2.04E-06	0.00E+00	0.00E+00	2.04E-06
Co-60	0.00E+00	5.31E-06	0.00E+00	0.00E+00	5.31E-06
Zn-65	0.00E+00	2.14E-06	0.00E+00	0.00E+00	2.14E-06
Sr-89	0.00E+00	1.49E-05	0.00E+00	0.00E+00	1.49E-05
Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba/La-140	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	0.00E+00	5.67E-05	0.00E+00	0.00E+00	5.67E-05
4. TRITIUM: Ci					
H-3	8.85E-01	6.56E-01	6.51E-01	7.98E-02	2.27E+00

Notes for Table 2.2-B:

1. N/A stands for not applicable.
2. NDA stands for No Detectable Activity.
3. LLDs for airborne radionuclides listed as NDA are as follows:
   Fission Gases: 1E-04 µCi/cc
   Iodines: 1E-12 µCi/cc
   Particulates: 1E-11 µCi/cc

Table B.2-B (continued)
Pilgrim Nuclear Power Station
Effluent and Waste Disposal Report
Gaseous Effluents – Elevated Release
January-December 2005

BATCH MODE RELEASES FROM ELEVATED RELEASE POINT					
Nuclide Released	Jan-Mar 2005	Apr-Jun 2005	Jul-Sep 2005	Oct-Dec 2005	Jan-Dec 2005
1. FISSION AND ACTIVATION GASES: Ci					
Ar-41	N/A	N/A	N/A	N/A	N/A
Kr-85	N/A	N/A	N/A	N/A	N/A
Kr-85m	N/A	N/A	N/A	N/A	N/A
Kr-87	N/A	N/A	N/A	N/A	N/A
Kr-88	N/A	N/A	N/A	N/A	N/A
Xe-131m	N/A	N/A	N/A	N/A	N/A
Xe-133	N/A	N/A	N/A	N/A	N/A
Xe-133m	N/A	N/A	N/A	N/A	N/A
Xe-135	N/A	N/A	N/A	N/A	N/A
Xe-135m	N/A	N/A	N/A	N/A	N/A
Xe-137	N/A	N/A	N/A	N/A	N/A
Xe-138	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A
2. IODINES: Ci					
I-131	N/A	N/A	N/A	N/A	N/A
I-133	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A
3. PARTICULATES WITH HALF-LIVES > 8 DAYS: Ci					
Cr-51	N/A	N/A	N/A	N/A	N/A
Mn-54	N/A	N/A	N/A	N/A	N/A
Fe-59	N/A	N/A	N/A	N/A	N/A
Co-58	N/A	N/A	N/A	N/A	N/A
Co-60	N/A	N/A	N/A	N/A	N/A
Zn-65	N/A	N/A	N/A	N/A	N/A
Sr-89	N/A	N/A	N/A	N/A	N/A
Sr-90	N/A	N/A	N/A	N/A	N/A
Cs-137	N/A	N/A	N/A	N/A	N/A
Ba/La-140	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A
4. TRITIUM: Ci					
H-3	N/A	N/A	N/A	N/A	N/A

Notes for Table 2.2-B:

1. N/A stands for not applicable.
2. NDA stands for No Detectable Activity.
3. LLDs for airborne radionuclides listed as NDA are as follows:
   Fission Gases: 1E-04 μCi/cc
   Iodines: 1E-12 μCi/cc
   Particulates: 1E-11 μCi/cc

Table B.2-C
Pilgrim Nuclear Power Station
Effluent and Waste Disposal Report
Gaseous Effluents – Ground-Level Release
January-December 2005

CONTINUOUS MODE RELEASES FROM GROUND-LEVEL RELEASE POINT					
Nuclide Released	Jan-Mar 2005	Apr-Jun 2005	Jul-Sep 2005	Oct-Dec 2005	Jan-Dec 2005
1. FISSION AND ACTIVATION GASES: Ci					
Ar-41	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-85m	0.00E+00	0.00E+00	0.00E+00	5.29E-01	5.29E-01
Kr-87	0.00E+00	8.65E-01	0.00E+00	8.68E-01	1.73E+00
Kr-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-131m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-133	5.09E-01	3.39E+00	4.85E-01	8.42E-01	5.22E+00
Xe-133m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-135	6.20E+00	2.24E+00	5.94E+00	9.10E+00	2.35E+01
Xe-135m	0.00E+00	8.97E-01	0.00E+00	0.00E+00	8.97E-01
Xe-137	0.00E+00	6.26E+00	0.00E+00	0.00E+00	6.26E+00
Xe-138	0.00E+00	7.04E+00	0.00E+00	0.00E+00	7.04E+00
Total for period	6.71E+00	2.07E+01	6.42E+00	1.13E+01	4.52E+01
2. IODINES: Ci					
I-131	2.60E-04	2.43E-04	2.10E-04	2.38E-04	9.51E-04
I-133	1.92E-03	1.15E-03	1.47E-03	2.05E-03	6.58E-03
Total for period	2.18E-03	1.39E-03	1.68E-03	2.28E-03	7.53E-03
3. PARTICULATES WITH HALF-LIVES > 8 DAYS: Ci					
Cr-51	0.00E+00	8.81E-06	0.00E+00	0.00E+00	8.81E-06
Mn-54	0.00E+00	2.83E-05	0.00E+00	0.00E+00	2.83E-05
Fe-59	0.00E+00	5.23E-06	0.00E+00	0.00E+00	5.23E-06
Co-58	0.00E+00	3.16E-06	0.00E+00	0.00E+00	3.16E-06
Co-60	0.00E+00	3.49E-05	0.00E+00	0.00E+00	3.49E-05
Zn-65	0.00E+00	7.62E-05	0.00E+00	0.00E+00	7.62E-05
Sr-89	1.48E-04	2.25E-04	1.38E-04	0.00E+00	5.11E-04
Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-137	0.00E+00	1.55E-06	0.00E+00	0.00E+00	1.55E-06
Ba/La-140	0.00E+00	2.28E-05	2.49E-05	2.36E-05	7.13E-05
Total for period	1.48E-04	4.06E-04	1.63E-04	2.36E-05	7.41E-04
4. TRITIUM: Ci					
H-3	1.05E+02	4.00E+01	3.55E+01	2.62E+02	4.43E+02

Notes for Table 2.2-C:

1. N/A stands for not applicable.
2. NDA stands for No Detectable Activity.
3. LLDs for airborne radionuclides listed as NDA are as follows:
   Fission Gases: 1E-04 µCi/cc
   Iodines: 1E-12 µCi/cc
   Particulates: 1E-11 µCi/cc

Table B.2-C (continued)
Pilgrim Nuclear Power Station
Effluent and Waste Disposal Report
Gaseous Effluents – Ground-Level Release
January-December 2005

BATCH MODE RELEASES FROM GROUND-LEVEL RELEASE POINT					
Nuclide Released	Jan-Mar 2005	Apr-Jun 2005	Jul-Sep 2005	Oct-Dec 2005	Jan-Dec 2005
1. FISSION AND ACTIVATION GASES: Ci					
Ar-41	N/A	N/A	N/A	N/A	N/A
Kr-85	N/A	N/A	N/A	N/A	N/A
Kr-85m	N/A	N/A	N/A	N/A	N/A
Kr-87	N/A	N/A	N/A	N/A	N/A
Kr-88	N/A	N/A	N/A	N/A	N/A
Xe-131m	N/A	N/A	N/A	N/A	N/A
Xe-133	N/A	N/A	N/A	N/A	N/A
Xe-133m	N/A	N/A	N/A	N/A	N/A
Xe-135	N/A	N/A	N/A	N/A	N/A
Xe-135m	N/A	N/A	N/A	N/A	N/A
Xe-137	N/A	N/A	N/A	N/A	N/A
Xe-138	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A
2. IODINES: Ci					
I-131	N/A	N/A	N/A	N/A	N/A
I-133	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A
3. PARTICULATES WITH HALF-LIVES > 8 DAYS: Ci					
Cr-51	N/A	N/A	N/A	N/A	N/A
Mn-54	N/A	N/A	N/A	N/A	N/A
Fe-59	N/A	N/A	N/A	N/A	N/A
Co-58	N/A	N/A	N/A	N/A	N/A
Co-60	N/A	N/A	N/A	N/A	N/A
Zn-65	N/A	N/A	N/A	N/A	N/A
Sr-89	N/A	N/A	N/A	N/A	N/A
Sr-90	N/A	N/A	N/A	N/A	N/A
Cs-137	N/A	N/A	N/A	N/A	N/A
Ba/La-140	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A
4. TRITIUM: Ci					
H-3	N/A	N/A	N/A	N/A	N/A

Notes for Table 2.2-C:

1. N/A stands for not applicable.
2. NDA stands for No Detectable Activity.
3. LLDs for airborne radionuclides listed as NDA are as follows:
   Fission Gases: 1E-04 µCi/cc
   Iodines: 1E-12 µCi/cc
   Particulates: 1E-11 µCi/cc

Table B.3-A
Pilgrim Nuclear Power Station
Effluent and Waste Disposal Report
Liquid Effluents - Summation of All Releases
January-December 2005

RELEASE PERIOD	Jan-Mar 2005	Apr-Jun 2005	Jul-Sep 2005	Oct-Dec 2005	Jan-Dec 2005	Est. Total Error
A. FISSION AND ACTIVATION PRODUCTS						
Total Release (not including tritium, gases, alpha): Ci	N/A	N/A	N/A	N/A	N/A	N/A
Average Diluted Concentration During Period: µCi/mL	N/A	N/A	N/A	N/A	N/A	
Percent of Effluent Concentration Limit*	N/A	N/A	N/A	N/A	N/A	
B. TRITIUM						
Total Release: Ci	N/A	N/A	N/A	N/A	N/A	N/A
Average Diluted Concentration During Period: µCi/mL	N/A	N/A	N/A	N/A	N/A	
Percent of Effluent Concentration Limit*	N/A	N/A	N/A	N/A	N/A	
C. DISSOLVED AND ENTRAINED GASES						
Total Release: Ci	N/A	N/A	N/A	N/A	N/A	N/A
Average Diluted Concentration During Period: µCi/mL	N/A	N/A	N/A	N/A	N/A	
Percent of Effluent Concentration Limit*	N/A	N/A	N/A	N/A	N/A	
D. GROSS ALPHA RADIOACTIVITY						
Total Release: Ci	N/A	N/A	N/A	N/A	N/A	N/A
E. VOLUME OF WASTE RELEASED PRIOR TO DILUTION						
Waste Volume: Liters	N/A	N/A	N/A	N/A	N/A	N/A
F. VOLUME OF DILUTION WATER USED DURING PERIOD						
Dilution Volume: Liters	N/A	N/A	N/A	N/A	N/A	N/A

Notes for Table 2.3-A:

* Additional percent of Effluent Control Limit values based on dose assessments are provided in Section 7 of this report.

1. N/A stands for not applicable.
2. NDA stands for No Detectable Activity.
3. LLD for dissolved and entrained gases listed as NDA is 1E-05 µCi/mL.
4. LLD for liquid gross alpha activity listed as NDA is 1E-07 µCi/mL.

Table B.3-B
Pilgrim Nuclear Power Station
Effluent and Waste Disposal Report
Liquid Effluents
January-December 2005

CONTINUOUS MODE RELEASES					
Nuclide Released	Jan-Mar 2005	Apr-Jun 2005	Jul-Sep 2005	Oct-Dec 2005	Jan-Dec 2005
1. FISSION AND ACTIVATION PRODUCTS: CI					
Cr-51	N/A	N/A	N/A	N/A	N/A
Mn-54	N/A	N/A	N/A	N/A	N/A
Fe-55	N/A	N/A	N/A	N/A	N/A
Fe-59	N/A	N/A	N/A	N/A	N/A
Co-58	N/A	N/A	N/A	N/A	N/A
Co-60	N/A	N/A	N/A	N/A	N/A
Zn-65	N/A	N/A	N/A	N/A	N/A
Zn-69m	N/A	N/A	N/A	N/A	N/A
Sr-89	N/A	N/A	N/A	N/A	N/A
Sr-90	N/A	N/A	N/A	N/A	N/A
Zr/Nb-95	N/A	N/A	N/A	N/A	N/A
Mo/Tc-99	N/A	N/A	N/A	N/A	N/A
Ag-110m	N/A	N/A	N/A	N/A	N/A
Sb-124	N/A	N/A	N/A	N/A	N/A
I-131	N/A	N/A	N/A	N/A	N/A
I-133	N/A	N/A	N/A	N/A	N/A
Cs-134	N/A	N/A	N/A	N/A	N/A
Cs-137	N/A	N/A	N/A	N/A	N/A
Ba/La-140	N/A	N/A	N/A	N/A	N/A
Ce-141	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A
2. DISSOLVED AND ENTRAINED GASES: CI					
Xe-133	N/A	N/A	N/A	N/A	N/A
Xe-135	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A

Notes for Table 2.3-B:

1. N/A stands for not applicable.
2. NDA stands for No Detectable Activity.
3. LLDs for liquid radionuclides listed as NDA are as follows:
   - Strontium: 5E-08 µCi/mL
   - Iodines: 1E-06 µCi/mL
   - Noble Gases: 1E-05 µCi/mL
   - All Others: 5E-07 µCi/mL

Table B.3-B (continued)
Pilgrim Nuclear Power Station
Effluent and Waste Disposal Report
Liquid Effluents
January-December 2005

BATCH MODE RELEASES					
Nuclide Released	Jan-Mar 2005	Apr-Jun 2005	Jul-Sep 2005	Oct-Dec 2005	Jan-Dec 2005
1. FISSION AND ACTIVATION PRODUCTS: Ci					
Cr-51	N/A	N/A	N/A	N/A	N/A
Mn-54	N/A	N/A	N/A	N/A	N/A
Fe-55	N/A	N/A	N/A	N/A	N/A
Fe-59	N/A	N/A	N/A	N/A	N/A
Co-58	N/A	N/A	N/A	N/A	N/A
Co-60	N/A	N/A	N/A	N/A	N/A
Zn-65	N/A	N/A	N/A	N/A	N/A
Zn-69m	N/A	N/A	N/A	N/A	N/A
Sr-89	N/A	N/A	N/A	N/A	N/A
Sr-90	N/A	N/A	N/A	N/A	N/A
Zr/Nb-95	N/A	N/A	N/A	N/A	N/A
Mo/Tc-99	N/A	N/A	N/A	N/A	N/A
Ag-110m	N/A	N/A	N/A	N/A	N/A
Sb-124	N/A	N/A	N/A	N/A	N/A
I-131	N/A	N/A	N/A	N/A	N/A
I-133	N/A	N/A	N/A	N/A	N/A
Cs-134	N/A	N/A	N/A	N/A	N/A
Cs-137	N/A	N/A	N/A	N/A	N/A
Ba/La-140	N/A	N/A	N/A	N/A	N/A
Ce-141	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A
2. DISSOLVED AND ENTRAINED GASES: Ci					
Xe-133	N/A	N/A	N/A	N/A	N/A
Xe-135	N/A	N/A	N/A	N/A	N/A
Total for period	N/A	N/A	N/A	N/A	N/A

Notes for Table 2.3-B:

1. N/A stands for not applicable.
2. NDA stands for No Detectable Activity.
3. LLDs for liquid radionuclides listed as NDA are as follows:
   - Strontium: 5E-08 µCi/mL
   - Iodines: 1E-06 µCi/mL
   - Noble Gases: 1E-05 µCi/mL
   - All Others: 5E-07 µCi/mL

APPENDIX C

LAND USE CENSUS RESULTS

The annual land use census for gardens and milk and meat animals in the vicinity of Pilgrim Station was performed between July 20 and October 28, 2005. The census was conducted by driving along each improved road/street in the Plymouth area within 5 kilometers (3 miles) of Pilgrim Station to survey for visible gardens with an area of greater than 500 square feet. In compass sectors where no gardens were identified within 5 km (SSW, WNW, NW, and NNW sectors), the survey was extended to 8 km (5 mi). A total of 22 gardens were identified in the vicinity of Pilgrim Station. In addition, the Town of Plymouth Animal Inspector was contacted for information regarding milk and meat animals.

Atmospheric deposition (D/Q) values at the locations of the identified gardens were compared to those for the existing sampling program locations. These comparisons enabled PNPS personnel to ascertain the best locations for monitoring for releases of airborne radionuclides. Gardens yielding higher D/Q values than those currently in the sampling program were also sampled as part of the radiological environmental monitoring program.

Based on assessment of the gardens identified during the 2005 land use census, samples of garden-grown vegetables or naturally-growing vegetation (e.g. grass, leaves from bushes or trees, etc.) were collected at or near the closest gardens in each of the following landward compass sectors. These locations, and their distance and direction relative to the PNPS Reactor Building, are as follows:

Rocky Hill Road	0.9 km SE (garden not grown in 2005; however, historic location)
Brook Road	2.9 km SSE
Beaver Dam Road	3.4 km S
Bay Colony Drive	3.1 km WSW
Clay Hill Road	1.6 km W

In addition to these special sampling locations identified and sampled in conjunction with the 2005 land use census, samples were also collected at or near the Plymouth County Farm (5.6 km W), and from a control location in Bridgewater (31 km W).

Samples of naturally-growing vegetation were also collected in the vicinity of the site boundary locations yielding the highest deposition (D/Q) factors for each of the two release points. These locations, and their distance and direction relative to the PNPS Reactor Building, are as follows:

Highest Main Stack D/Q:	1.5 km SSW
Highest Reactor Building Vent D/Q:	0.5 km ESE
2nd highest D/Q, both release points:	1.1 km S

No new milk or meat animals were identified during the land use census. In addition, the Town of Plymouth Animal Inspector stated that their office is not aware of any animals at locations other than the Plimoth Plantation and the Plymouth County Farm. Samples of milk and forage have historically been collected from the Plymouth County Farm, and forage samples were part of the 2005 sampling program.

APPENDIX D

ENVIRONMENTAL MONITORING PROGRAM DISCREPANCIES

There were a number of instances during 2005 in which inadvertent issues were encountered in the collection of environmental samples. All of these issues were minor in nature and did not have an adverse effect on the results or integrity of the monitoring program. Details of these various problems are given below.

During 2005, five thermoluminescent dosimeters (TLDs) were not recovered from their assigned locations during the quarterly retrieval process. During the first quarter retrieval, the TLD at Manomet Elementary (ME) could not be located, and was presumed lost to storm damage or vandalism. A search of the area in the immediate vicinity of the TLD posting location failed to find the TLD. All TLDs were recovered during the second quarter retrieval. Vandalism or storm damage was assumed to be the cause of losses of the TLDs at Station A, Station F, and Beaverdam Road (BR) during the third quarter. Landscaping work and brush clearing likely resulted in the loss of the TLD at Church and West Streets (CW) during the fourth quarter. Despite these losses, the 435 TLDs that were collected (99%) allowed for adequate assessment of the ambient radiation levels in the vicinity of Pilgrim Station.

Within the air sampling program, there were a few instances in which continuous sampling was interrupted at the eleven airborne sampling locations during 2005. Most of these interruptions were due to short-term power losses and were sporadic and of limited duration (less than 24 hours out of the weekly sampling period). Such events did not have any significant impact on the scope and purpose of the sampling program, and all lower limits of detection (LLDs) were met for both particulates and iodine-131 on the filters.

There were three instances where weather-related events affected air sampling. During the week of 17-23 May 2005, heavy rains and wind resulted in severe wetting of the filter housing. The excess water resulted in partial degradation and tearing of the particulate filter at the Property Line (PL) air sampler. However, this tearing did not appear to adversely affect the results, as the observed gross beat concentrations were similar to other samples collected that week. Similar rain-related particulate filter tearing was experienced at the East Rocky Hill Road (ER), Plymouth Center (PC), and Manomet Substation (MS) air samplers during the week of 20-26 Sep. Although LLDs were met on all three of these samples, the observed gross beta concentration was lower than other samples collected during that week, and it appears the filter degradation resulted in loss of particle collection efficiency. Methods of preventing such rain-related filter degradation are being evaluated.

The other weather-related event occurred at the control location in East Weymouth (EW) during the week of 09-16 Aug. A large rain event resulted in damage to an auxiliary power loop at the electrical substation where the sampler is located. The damage was not by the substation owner repaired until 24-Aug, which resulted in no sample being collected during the week of 16-22 Aug. Therefore, there were no particulate filter or charcoal cartridge samples available for analysis during this period.

There were a number of other air sampling problems related to power interruptions during 2005. As part of power load testing in conjunction with the refueling outage, power was interrupted to the air samplers at the Overlook Area (OA) and Pedestrian Bridge (PB) during the week of 19-26 Apr 2005. These losses did not appear to adversely affect the sampling results, and required LLDs were achieved on both sets of filters collected. Power was restored on 26-Apr. Another power interruption was experienced at the Pedestrian Bridge during the week of 23-31 May, and the pump ran 154.3 hours out of the nominal 192-hour period. All LLDs were met on these samples.

During the week of 22-29 Mar, a blown fuse was found at the Manomet Station (run time = 112.2 hours). The fuse were replaced and the sampler restarted. The filters were collected and analyzed. The required LLDs were achieved on the samples. A blown fuse was also found at Manomet Substation during the week of 19-26 Jul (run-time = 60.5 hours). The fuse blew as a result of the pump seizing due to a failed bearing, and the pump was replaced. Despite the lower-than-normal volume, required LLDs were met.

On 06-Jun, a tree fell and damaged the service line providing power to the Property Line (PL) air sampler. An electrical short developed in the service line, and the electrical provider NSTAR disconnected the service until the short could be repaired. Due to the extensive nature of work required to repair the line and clear overhanging branches, power was not restored to this location until 10-Aug 2005. Therefore, no samples were collected from this location for the entire period beginning 07-Jun and continuing through 09-Aug. Therefore, nine weekly samples were missed at this location, and were not available for analysis.

A problem developed with ground fault circuit interrupt (GFCI) at the Cleft Rock (CR) sampling location during the week of 22-29 Nov. This circuit was not repaired until 07-Dec, and resulted in no weekly sample being collected from the period of 29-Nov to 05-Dec. Sampling was resumed on 07-Dec, and the sample collected on 13-Dec was sufficient to meet required LLDs.

The current configuration of air samplers has been in use at Pilgrim Station since the early 1980s, and many of the sampling racks are beginning so show age-related wear. On several occasions during the year, abnormally low volumes were recorded on the dry gas meters used to determine the total air volume pulled through the filters. In these cases, the total sample volume was estimated form the logged pump run times (hours) multiplied by the flow rate (cubic feet per minute) indicated by an in-line air flow meter (rotameter). The following stations and sampling periods were affected by this type of sampling anomaly:

Property Line: 05-12 Apr;
Overlook Area: 21-28 Jun; 28-Jun to 06-Jul; 10-17 Aug
East Breakwater: 13-20 Sep; 20-26 Sep
Cleft Rock: 28 Dec 2004 to 04 Jan 2005; 04-11 Jan 2005; 28 Feb to 07-Mar; 05-12 Apr

Efforts are underway to reconfigure the existing sampling racks and upgrade both the pumps and dry gas meters to ensure more reliable operation.

Despite the lower-than-normal sampling volumes in the various instances involving power interruptions and equipment failures, required LLDs were met on 572 of the 572 particulate filters, and 572 of the 572 of the iodine cartridges collected during 2005. None of the sample analyses associated with limited pump run times indicated any questionable or anomalous results. When viewed collectively during the entire year of 2005, the following sampling recoveries were achieved in the airborne sampling program:

Location	Recovery	Location	Recovery	Location	Recovery
WS	100.0%	PB	97.8%	PC	100.0%
ER	100.0%	OA	99.4%	MS	98.4%
WR	99.9%	EB	99.8%	EW	97.4%
PL	82.4%	CR	97.7%		

An alternate location had to be found for sampling control vegetable samples in the Bridgewater area. In past years, samples had been collected at the Bridgewater County Farm, associated with the Bridgewater Correctional Facility. Due to loss of state funding for garden projects during 2005, no garden was grown. An alternate location was found at the Hanson Farm in Bridgewater, located in the same compass sector, and at approximately the same distance as the Bridgewater County Farm. As expected for control samples, vegetables collected at this location only contained naturally-occurring radioactivity (K-40).

Some problems were encountered in collection of crop samples during 2005. Crops which had normally been sampled in the past (lettuce, tomatoes, potatoes, and onions) were not grown at the Plymouth County Farm (CF) during 2005. Pumpkins and squash were substituted for the edible 'hard' vegetables, whereas samples of naturally-growing leafy vegetation (grass, leaves from trees and bushes, etc.) were substituted for the lettuce. No radionuclides attributed to PNPS operations were detected in any of the samples.

The procedure that outlines requirements for crop sampling requires that samples be shipped to the analytical laboratory within five days of collection. The shipment of samples collected during the week of 12-16 Sep 2005 had to be delayed until 19-Sep, as the analytical laboratory was closed on 16-Sep and not available to receive the samples. The decision was made to delay the shipment rather than risk loss of samples during shipment. This slight delay had no adverse effects on the analytical results, and all required LLDs were achieved on these samples.

Naturally-growing leafy vegetation (grass, leaves from trees and bushes, etc.) was collected near some gardens identified during the annual land use census. Due to the unavailability of crops grown in several of these gardens, these substitute samples were collected as near as practicable to the gardens of interest. No radionuclides attributed to PNPS operations were detected in any of the samples. Additional details regarding the land use census can be found in Appendix C of this report.

The cranberry bog at Manomet Point (MP) was not in production during 2005, so a sample could not be obtained from this location. Samples were collected as required from the other indicator bog located along Bartlett Road (BT), and an additional sample was collected from a bog located along Beaver Dam Road. Again, the extensive sampling of leafy vegetation would provide a better indication of deposition radionuclides, so the loss of the Manomet Point sample does not adversely affect overall monitoring efforts. A similar situation occurred in the case of the control location for cranberries. In the past, the control sample of cranberries had been collected from the Pine Street Bog in Halifax. Since this bog was not in production during 2005, a substitute sample was collected from a bog in Kingston, beyond the influence of Pilgrim Station.

Several problems were encountered with the continuous composite collection of water samples at the PNPS discharge canal during 2005. Although Pilgrim Station did not discharge any liquid wastes containing radioactivity during calendar year 2005, sampling capability was maintained during the year. During the period of 02-08 Feb 2005, the composite sampler was found in a halted state, and it was not clear whether the sampler was not returned to service from the previous week, or if a power interruption had resulted in the sampler entering a halted state. As part of power load testing in conjunction with the refueling outage, power was interrupted to the entire shorefront area, including the water analysis lab, during the week of 19-26 Apr 2005. A partial composite sample was collected for the period, and power was restored later in the week of 26-Apr. During the week of 23-31 May 2005, a mid-week check of the facility identified that the ground-fault circuit interrupt had tripped, and power to the sampler was not working. The GFCI was reset, and sampling was resumed. A partial composite sample was also collected for this period.

There were three occasions when problems were experienced with the composite sampler itself. During the weeks of 26-Jul to 02-Aug, 16-Aug to 23-Aug, and 24-Oct to 01-Nov, the peristaltic tubing which draws the sample suction failed, and the sampler did not collect sufficient volume. In each of these three cases, grab samples were substituted for the weekly composite samples. In the two earlier failures, the tubing was replaced and sampling was restored. When the third failure occurred in October, debris was found in the pump housing which led to the premature failure of the peristaltic tubing. The debris was removed, and the housing leaned out, and normal functionality has been restored.

As part of the standardization of the ODCM that occurred in 2003, sampling of Group I (bottom-distribution) and Group II (near-bottom distribution) fishes was changed from a quarterly interval to a semiannual interval, to be performed during the sampling windows of April-May, and again in October-November. Due to adverse weather conditions, rough seas, and poor water clarity in the April-May timeframe, the marine contractor was unable to collect all required samples by the target due data of 16-May-2006. This failure to collect by the required due date is documented in Pilgrim Station Condition Report CR-PNP-2005-2617. All required samples (sediment, Irish moss, shellfish, and fish) were all eventually collected in late May and early June, with the last sediment samples being collected on 07-Jun-2006. Samples of Group I and Group II fishes were not available for sampling in the vicinity of the discharge outfall during the latter sampling period of 2005. Such fish species move to deeper water during colder months, and were not available. Repeated and concerted efforts were made during the months of October through December, but failed to produce fish samples during the period. The failure to collect Group I and II fish during the latter part of the year is document in condition report CR-PNP-2005-4954.

In summary, the various problems encountered in collecting and analyzing environmental samples during 2005 were relatively minor when viewed in the context of the entire monitoring program. None of the discrepancies resulted in an adverse impact on the overall monitoring program.

APPENDIX E

J.A. FITZPATRICK INTERLABORATORY COMPARISON PROGRAM

E.1 Program Description

An important factor in assuring the quality of radiological environmental monitoring results is the analytical laboratory's participation in an Interlaboratory Comparison Program. The Interlaboratory Comparison Program shall include sample media for which samples are routinely collected and for which comparison samples are commercially available. Participation in an Interlaboratory Comparison Program ensures that independent checks on the precision and accuracy of the measurement of radioactive material in the environmental samples are performed as part of the Quality Assurance Program for environmental monitoring. To fulfill the requirement for an Interlaboratory Comparison Program, the JAF Environmental Laboratory has engaged the services of two independent laboratories to provide quality assurance comparison samples. The two laboratories are Analytics, Incorporated in Atlanta, Georgia and the U.S. Department of Commerce's National Institute of Standards and Technology (NIST) in Gaithersburg, Maryland.

Analytics supplies sample media as blind sample spikes, which contain certified levels of radioactivity unknown to the analysis laboratory. These samples are prepared and analyzed using standard laboratory procedures. The results are submitted to Analytics, which issues a statistical summary report. The JAFNPP Environmental Laboratory uses predetermined acceptance criteria methodology for evaluating the laboratory's performance for Analytic's sample results.

In addition to the Analytics Program, the JAF Environmental Laboratory participates in the NEI/NIST Measurement Assurance Program. In 1987, the nuclear industry established a Measurement Assurance Program at the National Bureau of Standards (now the National Institute of Standards and Technology) to provide sponsoring nuclear utilities an independent verification, traceable to NIST, of their capability to make accurate measurements of radioactivity, as described in NRC Regulatory Guide 4.15. The program includes distribution to sponsoring utilities, approximately six times a year. The samples are prepared by NIST to present specific challenges to participating laboratories. For 2005, the two mixed gamma samples analyzed tested the ability of the JAF Environmental Laboratory to accurately account for coincidence summing from Cs-134. NIST supplies sample media as blind sample spikes. These samples are prepared and analyzed by the JAF Environmental Laboratory and the results are submitted to the Entergy Nuclear Northeast representative, who uses predetermined acceptance criteria methodology for evaluating the laboratory's performance. The performance results along with the NIST Report of Test (Certifies what activities are present in the sample) are forwarded to the laboratory.

E.2 Program Schedule

SAMPLE MEDIA	LABORATORY ANALYSIS	SAMPLE PROVIDER ANALYTICS
Water	Gross Beta	1
Water	Tritium	1
Water	I-131	2
Water	Mixed Gamma	3
Air	Gross Beta	2
Air	I-131	2
Air	Mixed Gamma	3
Milk	I-131	2
Milk	Mixed Gamma	2
Soil	Mixed Gamma	1
Vegetation	Mixed Gamma	1
TOTAL SAMPLE INVENTORY		**20**

E.3 Acceptance Criteria

Each sample result is evaluated to determine the accuracy and precision of the laboratory's analysis result. The sample evaluation method is discussed below.

E.3.1 Sample Results Evaluation

Samples provided by Analytics and NIST are evaluated using what is specified as the NRC method. This method is based on the calculation of the ratio of results reported by the participating laboratory (QC result) to the Vendor Laboratory Known value (reference result).

An Environmental Laboratory analytical result is evaluated using the following calculation:

The value for the error resolution is calculated.

$$\text{The error resolution} = \frac{\text{Reference Result}}{\text{Reference Results Error}}$$

Using the appropriate row under the Error Resolution column in Table E.3.1 below, a corresponding Ratio of Agreement interval is given.

The value for the ratio is then calculated.

$$\text{Ratio of Agreement} = \frac{\text{QC Result}}{\text{Reference Result}}$$

If the value falls within the agreement interval, the result is acceptable.

TABLE E.3-1

ERROR RESOLUTION	RATIO OF AGREEMENT
≤ 3	0.4-2.5
3.1 to 7.5	0.5-2.0
7.6 to 15.5	0.6-1.66
15.6 to 50.5	0.75-1.33
50.6 to 200	0.8-1.25
>200	0.85-1.18

This acceptance test is generally referred to as the "NRC" method. The acceptance criteria are contained in Procedure DVP-04.01 and was taken from the Criteria of Comparing Analytical Results (USNRC) and Bevington, P.R., Data Reduction and Error Analysis for the Physical Sciences, McGraw-Hill, New York, (1969). The NRC method generally results in an acceptance range of approximately ± 25% of the Known value when applied to sample results from the Analytics and NIST. Interlaboratory Comparison Program. This method is used as the procedurally required assessment method and requires the generation of a nonconformity report when results are unacceptable.

E.4 Program Results Summary

The Interlaboratory Comparison Program numerical results are provided on Table E.4-1.

E.4.1 Analytics QA Samples Results

Eighteen QA blind spike samples were analyzed as part of Analytics 2005 Interlaboratory Comparison Program. The following sample media were evaluated as part of the comparison program.

- Air Charcoal Cartridge: I-131
- Air Particulate Filter: Mixed Gamma Emitters, Gross Beta
- Water: I-131, Mixed Gamma Emitters, Tritium, Gross Beta
- Soil: Mixed Gamma Emitters
- Milk: I-131, Mixed Gamma Emitters
- Vegetation: Mixed Gamma Emitters

The JAF Environmental Laboratory performed 79 individual analyses on the eighteen QA samples. Of the 79 analyses performed, 79 were in agreement using the NRC acceptance criteria for a 100% agreement ratio.

There were no non-conformities in the 2005 program.

E.4.2 NIST QA Samples Results

In 2005, JAF Environmental Laboratory participated in the NEI/NIST Measurement Assurance Program. Two QA blind spike samples were analyzed. The following sample media were evaluated as part of the comparison program.

- Air Particulate Filter: Mixed Gamma Emitters
- Water: Mixed Gamma Emitters

The JAF Environmental Laboratory performed 10 individual analyses on the two QA samples. Of the 10 analyses performed, 10 were in agreement using the NRC acceptance criteria for a 100% agreement ratio.

There were no non-conformities in the 2005 program.

E.4.3 Numerical Results Tables

The tables on the following pages summarize the results of the various intercomparison analyses performed during 2005.

TABLE E.4.3-1
INTERLABORATORY INTERCOMPARISON PROGRAM
Gross Beta Analysis of Air Particulate Filters (pCi/filter)

DATE	JAF ENV ID NO.	MEDIUM	ANALYSIS	JAF RESULT (1)	REFERENCE LAB* (2)	RATIO (3)
6/9/05	E-4583-05	AIR pCi/filter	GROSS BETA	142.4 ± 1.8 146.6 ± 1.8 145.2 ± 1.8 Mean = 144.7 ± 1.0	138.0 ± 2.3	1.05 A
12/8/05	E-4824-05	AIR pCi/filter	GROSS BETA	202.8 ± 3.0 204.7 ± 3.0 206.5 ± 3.0 Mean = 204.7 ± 1.7	186.0 ± 3.1	1.10 A

(1) Results reported as activity ±1 sigma.
(2) Results reported as activity ±1 sigma.
(3) Ratio = Reported/Analytics (See Section 8.3).
(*) Sample provided by Analytics, Inc.
(A) Evaluation Results, Acceptable.

TABLE E.4.3-1 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Tritium Analysis Water (pCi/liter)

DATE	JAF ENV ID NO.	MEDIUM	ANALYSIS	JAF RESULT (1)	REFERENCE LAB* (2)	RATIO (3)
3/17/05	E-4487-05	WATER pCi/liter	H-3	6073 ± 176 5887 ± 175 5925 ± 175 Mean = 5962 ± 101	6040 ± 200	0.99 A

(1) Results reported as activity ±1 sigma. Sample analyzed by JAF Environmental Laboratory
(2) Results reported as activity ±1 sigma.
(3) Ratio = Reported/Analytics (See Section 8.3).
(*) Sample provided by Analytics, Inc.
(A) Evaluation Results, Acceptable.

TABLE E.4.3-1 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Iodine Analysis of Water, Air and Milk

DATE	JAF ENV ID NO.	MEDIUM	ANALYSIS	JAF RESULT (1)	REFERENCE LAB* (2)	RATIO (3)
3/17/05	E-4488-05	WATER pCi/liter	I-131**	59.4 ± 1.8 63.3 ± 2.4 64.6 ± 1.8 Mean = 62.4 ± 1.1	65.9 ± 1.1	0.95 A
6/9/05	E-4586-05	AIR pCi/cc	I-131	102.0 ± 5.6 98.7 ± 4.8 88.1 ± 4.4 Mean = 96.3 ± 2.9	92.5 ± 1.5	1.04 A
6/9/05	E-4584-05	MILK pCi/liter	I-131**	80.4 ± 2.2 81.9 ± 2.4 81.3 ± 2.7 Mean = 81.2 ± 1.4	86.9 ± 1.5	0.93 A
9/15/05	E-4716-05	AIR pCi/cc	I-131	65.2 ± 4.0 58.6 ± 4.7 66.7 ± 3.6 Mean = 63.5 ± 2.4	63.4 ± 1.1	1.00 A
9/15/05	E-4713-05	WATER pCi/liter	I-131**	77.0 ± 1.6 78.0 ± 2.0 75.6 ± 2.1 Mean = 76.9 ± 1.1	78.2 ± 1.3	0.98 A
9/15/05	E-4715-05	MILK pCi/liter	I-131**	86.4 ± 1.7 90.6 ± 1.9 84.6 ± 1.8 Mean = 87.2 ± 1.0	94.3 ± 1.6	0.92 A

(1) Results reported as activity ±1 sigma.
(2) Results reported as activity ±1 sigma.
(3) Ratio = Reported/Analytics (See Section 8.3).
(*) Sample provided by Analytics, Inc.
(**) Result determined by Resin Extraction/Gamma Spectral Analysis.
(A) Evaluation Results, Acceptable.

TABLE E.4.3-1 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis Water (pCi/liter)

DATE	JAF ENV ID NO.	MEDIUM	ANALYSIS	JAF RESULT (1)	REFERENCE LAB* (2)	RATIO (3)
3/17/05	E-4488-05	WATER pCi/liter	Ce-141	222.0 ± 11.4 248.0 ± 11.8 236.0 ± 9.4 Mean = 235.3 ± 6.3	221 ± 3.7	1.06 A
			Cr-51	278.0 ± 53.9 295.0 ± 48.7 262.0 ± 38.5 Mean = 278.3 ± 27.4	322 ± 5.4	0.86 A
			Cs-134	128.0 ± 9.6 113.0 ± 14.6 138.0 ± 6.8 Mean = 126.3 ± 6.2	134 ± 2.2	0.94 A
			Cs-137	112.0 ± 8.0 121.0 ± 7.9 130.0 ± 6.3 Mean = 121.0 ± 4.3	125 ± 2.1	0.97 A
			Mn-54	157.0 ± 9.2 162.0 ± 9.0 164.0 ± 7.0 Mean = 161.0 ± 4.9	154 ± 2.6	1.05 A
			Fe-59	106.0 ± 10.0 114.0 ± 9.6 122.0 ± 7.1 Mean = 114.0 ± 5.2	107 ± 1.8	1.07 A
			Zn-65	184.0 ± 16.4 203.0 ± 16.4 179.0 ± 11.5 Mean = 188.7 ± 8.6	191 ± 3.2	0.99 A
			Co-60	136.0 ± 6.6 131.0 ± 6.3 144.0 ± 4.9 Mean = 137.0 ± 3.5	139 ± 2.3	0.99 A
			Co-58	117.0 ± 8.2 120.0 ± 8.0 112.0 ± 5.8 Mean = 116.3 ± 4.3	111 ± 1.9	1.05 A

(1) Results reported as activity ±1 sigma.
(2) Results reported as activity ±1sigma.
(3) Ratio = Reported/Analytics (See Section 8.3).
(*) Sample provided by Analytics, Inc.
(A) Evaluation Results, Acceptable.

TABLE E.4.3-1 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis Water (pCi/liter)

DATE	JAF ENV ID NO.	MEDIUM	ANALYSIS	JAF RESULT (1)	REFERENCE LAB* (2)	RATIO (3)
9/15/05	E-4713	WATER pCi/liter	Ce-141	292.0 ± 4.4 284.0 ± 9.0 296.0 ± 4.1 Mean = 290.7 ± 3.6	282 ± 4.7	1.03 A
			Cr-51	395.0 ± 18.2 411.0 ± 38.1 397.0 ± 16.2 Mean = 401.0 ± 15.1	408 ± 6.8	0.98 A
			Cs-134	152.0 ± 3.3 152.0 ± 6.3 153.0 ± 2.9 Mean = 152.3 ± 2.6	148 ± 2.5	1.03 A
			Cs-137	234.0 ± 3.7 235.0 ± 7.2 231.0 ± 3.5 Mean = 233.3 ± 2.9	235 ± 3.9	0.99 A
			Mn-54	119.0 ± 2.8 118.0 ± 5.5 118.0 ± 2.7 Mean = 118.3 ± 2.3	111 ± 1.9	1.07 A
			Fe-59	74.7 ± 3.1 77.0 ± 6.2 81.6 ± 3.0 Mean = 77.8 ± 2.5	74 ± 1.2	1.05 A
			Zn-65	158.0 ± 5.3 160.0 ± 11.0 163.0 ± 5.2 Mean = 160.3 ± 4.4	149 ± 2.5	1.08 A
			Co-60	201.0 ± 2.7 202.0 ± 5.5 198.0 ± 2.6 Mean = 200.3 ± 2.2	202 ± 3.4	0.99 A
			Co-58	71.6 ± 2.5 81.0 ± 4.6 79.2 ± 2.5 Mean = 77.3 ± 1.9	77 ± 1.3	1.00 A

(1) Results reported as activity ±1 sigma.
(2) Results reported as activity ±1 sigma.
(3) Ratio = Reported/Analytics (See Section 8.3).
(*) Sample provided by Analytics, Inc.
(A) Evaluation Results, Acceptable.

TABLE E.4.3-1 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis of Air Particulate Filters (pCi/filter)

DATE	JAF ENV ID NO.	MEDIUM	ANALYSIS	JAF RESULT (1)	REFERENCE LAB* (2)	RATIO (3)
3/17/05	E-4489-05	FILTER pCi/filter	Ce-141	160.0 ± 6.0 151.0 ± 5.4 160.0 ± 4.8 Mean = 157.0 ± 3.1	155 ± 2.6	1.01 A
			Cr-51	268.0 ± 30.8 259.0 ± 29.6 302.0 ± 23.5 Mean = 276.3 ± 16.3	226 ± 3.8	1.22 A
			Cs-134	107.0 ± 7.0 94.5 ± 7.1 102.0 ± 5.4 Mean = 101.2 ± 3.8	93.9 ± 1.6	1.08 A
			Cs-137	91.1 ± 5.6 88.2 ± 5.9 96.5 ± 4.5 Mean = 91.9 ± 3.1	87.6 ± 1.5	1.05 A
			Mn-54	115.0 ± 6.6 116.0 ± 7.1 126.0 ± 5.5 Mean = 119.0 ± 3.7	108 ± 1.8	1.10 A
			Fe-59	79.8 ± 7.9 89.0 ± 9.1 94.2 ± 6.8 Mean = 87.7 ± 4.6	75.0 ± 1.3	1.17 A
			Zn-65	150.0 ± 12.5 162.0 ± 14.1 151.0 ± 10.0 Mean = 154.3 ± 7.1	134 ± 2.2	1.15 A
			Co-60	95.2 ± 5.0 106.0 ± 5.6 96.6 ± 4.0 Mean = 99.3 ± 2.8	97.1 ± 1.6	1.02 A
			Co-58	73.2 ± 5.8 82.6 ± 6.6 80.1 ± 4.9 Mean = 78.6 ± 3.4	77.8 ± 1.3	1.01 A

(1) Results reported as activity ±1 sigma.
(2) Results reported as activity ±1 sigma.
(3) Ratio = Reported/Analytics (See Section 8.3).
(*) Sample provided by Analytics, Inc.
(A) Evaluation Results, Acceptable.

TABLE E.4.3-1 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis of Air Particulate Filters (pCi/liter)

DATE	JAF ENV ID NO.	MEDIUM	ANALYSIS	JAF RESULT (1)	REFERENCE LAB* (2)	RATIO (3)
9/15/05	E-4714-05	FILTER pCi/liter	Ce-141	174.0 ± 4.8 173.0 ± 4.8 187.0 ± 5.8 170.0 ± 4.4 Mean = 176.0 ± 2.5	165 ± 2.8	1.07 A
			Cr-51	239.0 ± 22.1 246.0 ± 22.3 230.0 ± 24.5 232.0 ± 20.7 Mean = 236.8 ± 11.2	239 ± 4.0	0.99 A
			Cs-134	90.4 ± 5.2 93.2 ± 5.2 110.0 ± 6.6 84.7 ± 4.9 Mean = 94.6 ± 2.8	86.3 ± 1.4	1.10 A
			Cs-137	143.0 ± 5.7 144.0 ± 5.5 139.0 ± 6.6 150.0 ± 5.3 Mean = 144.0 ± 2.9	138 ± 2.3	1.04 A
			Mn-54	75.0 ± 4.4 65.4 ± 4.4 82.9 ± 5.6 84.9 ± 4.5 Mean = 77.1 ± 2.4	65.0 ± 1.1	1.19 A
			Fe-59	50.6 ± 5.2 45.2 ± 4.9 53.4 ± 5.8 51.2 ± 4.9 Mean = 50.1 ± 2.6	43.0 ± 0.7	1.17 A
			Zn-65	93.6 ± 9.3 110.0 ± 9.0 118.0 ± 10.8 93.3 ± 8.5 Mean = 103.7 ± 4.7	87.2 ± 1.5	1.19 A
			Co-60	119.0 ± 4.5 113.0 ± 4.5 133.0 ± 5.8 114.0 ± 4.3 Mean = 119.8 ± 2.4	118 ± 2.0	1.01 A

TABLE E.4.3-1 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis of Air Particulate Filters (pCi/liter)

DATE	JAF ENV ID NO.	MEDIUM	ANALYSIS	JAF RESULT (1)	REFERENCE LAB* (2)	RATIO (3)
9/15/05	E-4714-05	FILTER pCi/liter	Co-58	47.8 ± 3.9 44.3 ± 3.9 39.1 ± 4.5 47.3 ± 3.8 Mean = 44.6 ± 2.0	44.7 ± 0.8	1.00 A

(1) Results reported as activity ±1 sigma.
(2) Results reported as activity ±1 sigma.
(3) Ratio = Reported/Analytics (See Section 8.3).
(*) Sample provided by Analytics, Inc.
(A) Evaluation Results, Acceptable.

TABLE E.4.3-1 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis Milk (pCi/liter)

DATE	JAF ENV ID NO.	MEDIUM	ANALYSIS	JAF RESULT (1)	REFERENCE LAB* (2)	RATIO (3)
6/9/05	E-4584-05	MILK pCi/liter	Ce-141	85.9 ± 8.64 112.0 ± 10.6 105.0 ± 7.9 Mean = 101.0 ± 5.3	92.4 ± 1.5	1.09 A
			Cr-51	224.0 ± 48.4 298.0 ± 61.1 350.0 ± 45.5 Mean = 290.7 ± 30.1	303 ± 5.1	0.96 A
			Cs-134	83.0 ± 6.9 91.5 ± 9.8 97.5 ± 7.3 Mean = 90.7 ± 4.7	95 ± 1.6	0.95 A
			Cs-137	174.0 ± 9.8 178.0 ± 10.9 175.0 ± 8.5 Mean = 175.7 ± 5.7	189 ± 3.2	0.93 A
			Mn-54	128.0 ± 8.5 101.0 ± 9.8 124.0 ± 7.8 Mean = 117.7 ± 5.0	125 ± 2.1	0.94 A
			Fe-59	49.5 ± 10.1 71.3 ± 11.9 63.5 ± 8.3 Mean = 61.4 ± 5.9	63.9 ± 1.1	0.96 A
			Zn-65	121.0 ± 16.6 170.0 ± 20.7 179.0 ± 15.6 Mean = 156.7 ± 10.3	155 ± 2.6	1.01 A
			Co-60	142.0 ± 7.0 128.0 ± 8.3 130.0 ± 6.4 Mean = 133.3 ± 4.2	145 ± 2.4	0.92 A

(1) Results reported as activity ±1 sigma.
(2) Results reported as activity ±1 sigma.
(3) Ratio = Reported/Analytics (See Section 8.3).
(*) Sample provided by Analytics, Inc
(A) Evaluation Results, Acceptable

TABLE E.4.3-1 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis Milk (pCi/liter)

DATE	JAF ENV ID NO.	MEDIUM	ANALYSIS	JAF RESULT (1)	REFERENCE LAB* (2)	RATIO (3)
9/15/05	E-4715-05	MILK pCi/liter	Ce-141	232.0 ± 4.9 241.0 ± 8.1 237.0 ± 7.6 Mean = 236.7 ± 4.1	233 ± 3.9	1.02 A
			Cr-51	326.0 ± 21.0 344.0 ± 35.9 314.0 ± 31.4 Mean = 328.0 ± 17.4	338 ± 5.7	0.97 A
			Cs-134	130.0 ± 3.7 126.0 ± 5.7 120.0 ± 5.6 Mean = 125.3 ± 2.9	122 ± 2.0	1.03 A
			Cs-137	187.0 ± 4.0 198.0 ± 7.0 194.0 ± 6.3 Mean = 193.0 ± 3.4	195 ± 3.2	0.99 A
			Mn-54	97.2 ± 3.3 102.0 ± 5.6 102.0 ± 5.1 Mean = 100.4 ± 2.8	92.0 ± 1.5	1.09 A
			Fe-59	65.0 ± 3.7 49.9 ± 6.3 68.4 ± 6.0 Mean = 61.1 ± 3.1	61.0 ± 1.0	1.00 A
			Zn-65	124.0 ± 6.3 147.0 ± 12.3 121.0 ± 9.6 Mean = 130.7 ± 5.6	123 ± 2.1	1.07 A
			Co-60	159.0 ± 3.2 163.0 ± 5.3 169.0 ± 5.0 Mean = 163.7 ± 2.6	167 ± 2.8	0.98 A
			Co-58	55.2 ± 2.8 62.6 ± 5.0 61.8 ± 4.5 Mean = 59.9 ± 2.4	63.4 ± 1.1	0.94 A

(1) Results reported as activity ±1 sigma.
(2) Results reported as activity ±1 sigma.
(3) Ratio = Reported/Analytics (See Section 8.3).
(*) Sample provided by Analytics, Inc.
(A) Evaluation Results, Acceptable.

TABLE E.4.3-1 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis Soil (pCi/gram)

DATE	JAF ENV ID NO.	MEDIUM	ANALYSIS	JAF RESULT (1)	REFERENCE LAB* (2)	RATIO (3)
6/9/05	E-4585-05	SOIL pCi/gram	Ce-141	0.203 ± 0.022 0.157 ± 0.022 0.190 ± 0.024 0.171 ± 0.037 Mean = 0.173 ± 0.017	0.182 ± 0.003	0.95 A
			Cr-51	0.356 ± 0.101 0.593 ± 0.122 0.697 ± 0.135 0.640 ± 0.198 Mean = 0.643 ± 0.090	0.596 ± 0.010	1.08 A
			Cs-134	0.160 ± 0.015 0.204 ± 0.016 0.193 ± 0.018 0.182 ± 0.008 Mean = 0.193 ± 0.009	0.187 ± 0.003	1.03 A
			Cs-137	0.449 ± 0.021 0.480 ± 0.023 0.479 ± 0.027 0.473 ± 0.010 Mean = 0.477 ± 0.012	0.474 ± 0.008	1.01 A
			Mn-54	0.256 ± 0.018 0.255 ± 0.018 0.223 ± 0.021 0.244 ± 0.009 Mean = 0.241 ± 0.010	0.246 ± 0.004	0.98 A
			Fe-59	0.109 ± 0.025 0.104 ± 0.029 0.132 ± 0.032 0.131 ± 0.031 0.157 ± 0.033 Mean = 0.127 ± 0.013	0.126 ± 0.002	1.01 A
			Zn-65	0.320 ± 0.034 0.360 ± 0.033 0.374 ± 0.040 0.320 ± 0.017 Mean = 0.351 ± 0.018	0.305 ± 0.005	1.15 A
			Co-60	0.277 ± 0.014 0.266 ± 0.0150 0.279 ± 0.017 0.274 ± 0.007 Mean = 0.273 ± 0.008	0.285 ± 0.005	0.96 A

(1) Results reported as activity ±1 sigma.
(2) Results reported as activity ±1 sigma.
(3) Ratio = Reported/Analytics (See Section 8.3).
(*) Sample provided by Analytics, Inc.
(A) Evaluation Results, Acceptable.

TABLE E.4.3-1 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis Vegetation (pCi/gram)

DATE	JAF ENV ID NO.	MEDIUM	ANALYSIS	JAF RESULT (1)	REFERENCE LAB* (2)	RATIO (3)
6/9/05	E-4587-05	VEGETATION pCi/gram	Ce-141	0.179 ± 0.012 0.160 ± 0.012 0.193 ± 0.012 0.180 ± 0.015 Mean = 0.178 ± 0.009	0.174 ± 0.003	1.02 A
			Cr-51	0.600 ± 0.087 0.464 ± 0.075 0.470 ± 0.059 0.638 ± 0.118 Mean = 0.543 ± 0.058	0.569 ± 0.010	0.95 A
			Cs-134	0.232 ± 0.013 0.213 ± 0.013 0.197 ± 0.010 0.195 ± 0.006 Mean = 0.209 ± 0.007	0.179 ± 0.003	1.17 A
			Cs-137	0.370 ± 0.015 0.340 ± 0.015 0.341 ± 0.012 0.326 ± 0.007 Mean = 0.344 ± 0.008	0.355 ± 0.006	0.97 A
			Mn-54	0.243 ± 0.014 0.227 ± 0.014 0.238 ± 0.011 0.235 ± 0.006 Mean = 0.236 ± 0.008	0.235 ± 0.004	1.00 A
			Fe-59	0.123 ± 0.015 0.112 ± 0.016 0.139 ± 0.012 0.123 ± 0.014 Mean = 0.124 ± 0.009	0.120 ± 0.002	1.04 A
			Zn-65	0.275 ± 0.023 0.280 ± 0.029 0.301 ± 0.019 0.317 ± 0.013 Mean = 0.293 ± 0.014	0.292 ± 0.005	1.00 A

TABLE E.4.3-1 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis Vegetation (pCi/gram)

DATE	JAF ENV ID NO.	MEDIUM	ANALYSIS	JAF RESULT (1)	REFERENCE LAB* (2)	RATIO (3)
				0.273 ± 0.011		
				0.252 ± 0.011		
			Co-60	0.267 ± 0.009	0.272 ± 0.005	0.98 A
				0.271 ± 0.005		
				Mean = 0.266 ± 0.006		

(1) Results reported as activity ±1 sigma.
(2) Results reported as activity ±1 sigma.
(3) Ratio = Reported/Analytics (See Section 8.3).
(*) Sample provided by Analytics, Inc.
(A) Evaluation Results, Acceptable.

TABLE E.4.3-1 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gross Beta Analysis of Water (pCi/mL)

DATE	JAF ENV ID NO.	MEDIUM	ANALYSIS	JAF RESULT (1)	REFERENCE LAB* (2)	RATIO (3)
11/11/05	A19773-05	WATER pCi/ml	GROSS BETA	1908 ± 2 1687 ± 2 1908 ± 2 1706 ± 2 Mean = 1802 ± 2	1830 ± 46	0.98 A

(1) Results reported as activity ±1 sigma.
(2) Results reported as activity ±1 sigma.
(3) Ratio = Reported/known
(*) Sample provided by Analytics, Inc.
(A) Evaluation Results, Acceptable.

TABLE E.4.3-1 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis of NIST Filter and Water Samples

DATE	JAF ENV ID NO.	MEDIUM	ANALYSIS	JAF RESULT (1)	REFERENCE LAB* (2)	RATIO (3)
8/20005	1801-20	FILTER pCi/filter	Ce-141	1.86E5 ± 791 1.85E5 ± 887 1.96E5 ± 785 Mean = 1.89E5 ± 475	1.96E5 ± 2176	0.96 A
			Ba-133	5.25E4 ± 277 5.36E4 ± 300 5.21E4 ± 262 Mean = 5.27E4 ± 162	5.95E4 ± 619	0.89 A
			Cs-134	2.90E4 ± 230 2.30E4 ± 226 2.95E4 ± 224 Mean = 2.72E4 ± 131	2.79E4 ± 254	0.97 A
			Fe-59	1.99E5 ± 1140 1.94E5 ± 1460 2.03E5 ± 1110 Mean = 1.99E5 ± 720	1.87E5 ± 1982	1.06 A
			Zn-65	9.59E4 ± 686 9.30E4 ± 878 9.76E4 ± 664 Mean = 9.55E4 ± 432	9.02E4 ± 1344	1.06 A
8/2005	1800-10	WATER pCi/g	Ce-141	1.48E5 ± 752 1.46E5 ± 686 1.47E5 ± 845 Mean = 1.47E5 ± 441	1.48E5 ± 1125	0.99 A
			Ba-133	4.17E4 ± 193 4.22E4 ± 188 4.27E4 ± 237 Mean = 4.22E4 ± 120	4.41E4 ± 291	0.96 A
			Cs-134	2.69E4 ± 170 2.69E4 ± 166 2.74E4 ± 208 Mean = 2.71E4 ± 105	2.62E4 ± 115	1.03 A
			Fe-59	1.21E5 ± 685 1.22E5 ± 687 1.22E5 ± 871 Mean = 1.22E5 ± 435	1.18E5 ± 814	1.03 A
			Zn-65	6.16E4 ± 426 6.12E4 ± 423 6.13E4 ± 535 Mean = 6.14E4 ± 268	5.91E4 ± 745	1.04 A

(1) Results reported as activity ±1 sigma.
(1) Results reported as activity ±2 sigma (total propagated uncertainty).
(3) Ratio = Reported/NIST (see Section 8.3).
(*) Sample provided by NIST.
(A) Evaluation Results, Acceptable.

E.5 REFERENCES

E.5.1 Radioactivity and Radiochemistry, The Counting Room: Special Edition, 1994 Caretaker Publications, Atlanta, Georgia.

E.5.2 Data Reduction and Error Analysis for the Physical Sciences, Bevington P.R., McGraw Hill, New York (1969).3