Entergy

Entergy Nuclear Operations, Inc.
600 Rocky Hill Road
Plymouth, MA 02360

Pilgrim Nuclear Power Station

May 15, 2014

U.S. Nuclear Regulatory Commission
Attn: 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, 2013

LETTER NUMBER: 2.14.038

Dear Sir or Madam:

In accordance with Pilgrim Technical Specification 5.6.2, Entergy Nuclear Operations, Inc submits the attached Annual Radiological Environmental Operating Report for January 1, 2013 through December 31, 2013.

This letter contains no commitments.

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

Sincerely,

Joseph R. Lynch
Manager, Regulatory Assurance

Attachment: Pilgrim Annual Radiological Environmental Operating Report for January 1, 2013 through December 31, 2013

cc: U.S. Nuclear Regulatory Commission
Region 1
2100 Renaissance Blvd, Suite 100
King of Prussia, PA 19406-2713

USNRC Senior Resident Inspector
Pilgrim Nuclear Power Station

Ms. Nadiyah Morgan, Project Manager
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Mail Stop O-8-F2
11555 Rockville Pike
Rockville, MD 20852

IE25
NRR

Attachment 1
Letter Number 2.14.038

Pilgrim Annual Radiological Environmental Operating Report
for January 1, 2013 through December 31, 2013

PILGRIM NUCLEAR POWER STATION

Facility Operating License DPR-35

Annual Radiological Environmental Operating Report

January 1 through December 31, 2013

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PILGRIM NUCLEAR POWER STATION
Facility Operating License DPR-35

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

JANUARY 01 THROUGH DECEMBER 31, 2013

Prepared by: 05-May-2014
K.J. Sejkora
Senior HP/Chemistry Specialist

Reviewed by: 5-12-14
G.W. Blankenbiller
Chemistry Superintendent

Reviewed by: 5/7/14
S.E. Brewer
Radiation Protection Manager

Pilgrim Nuclear Power Station
Annual Radiological Environmental Operating Report
January-December 2013

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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, 2013. 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 include air particulate filters, charcoal cartridges, animal forage, vegetation, cranberries, seawater, sediment, Irish moss, shellfish, American lobster, and fishes.

During 2013, there were 1,230 samples collected from the atmospheric, aquatic, and terrestrial environments. In addition, 431 exposure measurements were obtained using environmental thermoluminescent dosimeters (TLDs).

A small number of inadvertent issues were encountered during 2013 in the collection of environmental samples in accordance with the PNPS Offsite Dose Calculation Manual (ODCM). Nine out of 440 TLDs were unaccounted for during the quarterly retrieval process. However, the 431 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 563 of 572 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 1,286 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 September 09 and September 20, 2013. A total of 30 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 30 garden locations identified, samples were collected at or near three of the gardens as part of the environmental

monitoring program. Other samples of natural vegetation were also collected in predicted high-deposition areas.

RADIOLOGICAL IMPACT TO THE ENVIRONMENT

During 2013, 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 40 and 76 milliRoentgens per year. The range of ambient radiation levels observed with the TLDs is consistent with natural background radiation levels for Massachusetts.

RADIOLOGICAL IMPACT TO THE GENERAL PUBLIC

During 2013, 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 collective 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 2013 was about 0.9 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 2013 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 2013 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, 2013.

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, animal forage, vegetation, cranberries, seawater, sediment, Irish moss, shellfish, American lobster, and fish. 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 Chemistry 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 about 620 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 [1]

NATURAL		MAN-MADE	
Source	Radiation Dose (millirem/year)	Source	Radiation Dose (millirem/year)
Internal, inhalation[2]	230	Medical[3]	300
External, space	30	Consumer[4]	12
Internal, ingestion	30	Industrial[5]	0.6
External, terrestrial	20	Occupational	0.6
		Weapons Fallout	< 1
		Nuclear Power Plants	< 1
Approximate Total	310	Approximate Total	315
Combined Annual Average Dose: Approximately 620 to 625 millirem/year			

(1) Information from NCRP Reports 160 and 94

(2) Primarily from airborne radon and its radioactive progeny

(3) Includes CT (150 millirem), nuclear medicine (74 mrem), interventional fluoroscopy (43 mrem) and conventional radiography and fluoroscopy (30 mrem)

(4) Primarily from cigarette smoking (4.6 mrem), commercial air travel (3.4 mrem), building materials (3.5 mrem), and mining and agriculture (0.8 mrem)

(5) Industrial, security, medical, educational, and research

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 30 millirem/yr), the ground we walk on (about 20 millirem/yr) and the air we breathe (about 230 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 310 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 300 mrem. Consumer activities, such as smoking, commercial air travel, and building materials contribute about 13 mrem/yr. Much smaller doses result from weapons fallout (less than 1 mrem/yr) and nuclear power plants. Typically, the average person in the United States receives about 314 mrem per year from man-made sources. The collective dose from naturally-occurring and man-made sources results in a total dose of approximately 620 mrem/yr to the average American.

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 the downtown area of Plymouth, Massachusetts. Commercial operation began in December 1972.

Pilgrim Station was operational during most of 2013, with the exception of the refueling outage that occurred between mid-April through May. The resulting monthly capacity factors are presented in Table 1.3-1.

TABLE 1.3-1

PNPS OPERATING CAPACITY FACTOR DURING 2013
(Based on rated reactor thermal power of 2028 Megawatts-Thermal)

Month	Percent Capacity
January	69.3%
February	68.8%
March	92.8%
April	38.9%
May	1.8%
June	97.0%
July	99.6%
August	76.8%
September	67.7%
October	76.7%
November	99.0%
December	86.8%
Annual Average	72.9%

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.

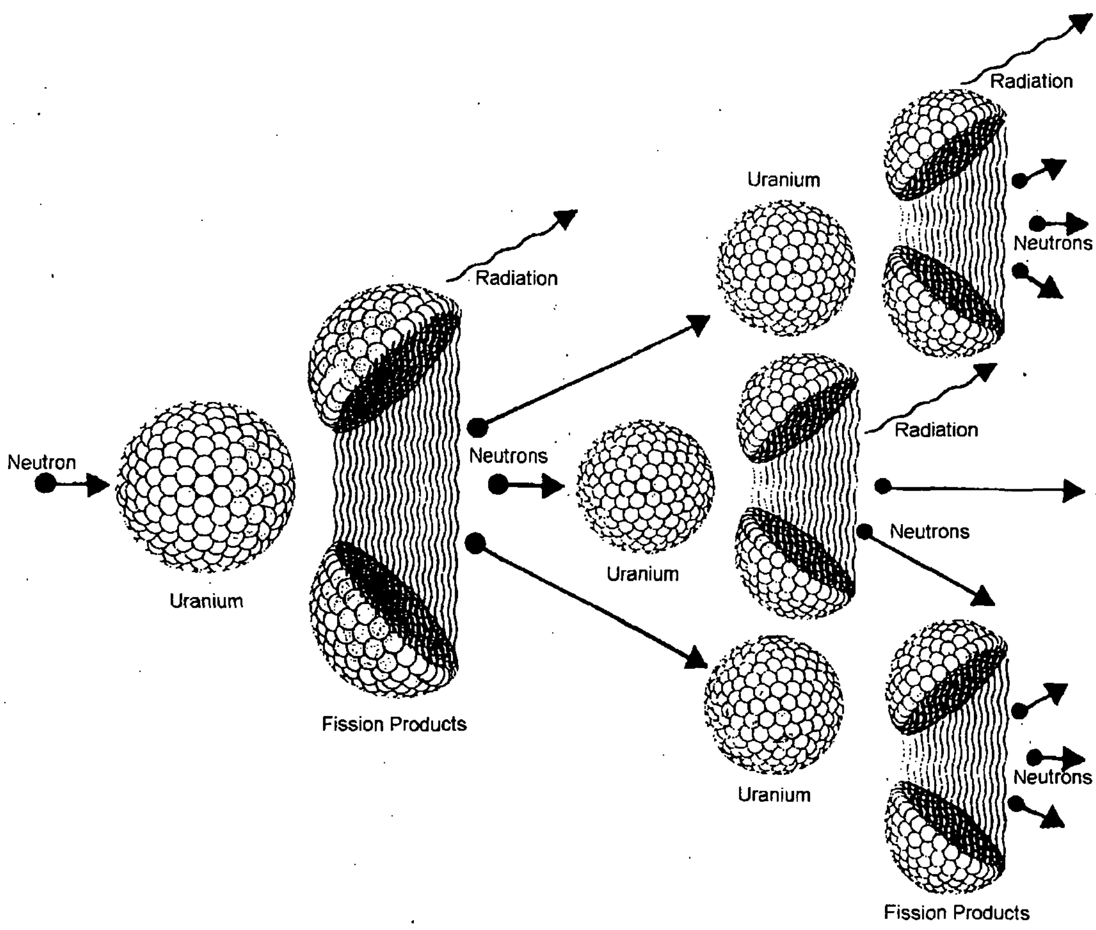


Figure 1.3-1
Radioactive Fission Product Formation

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).

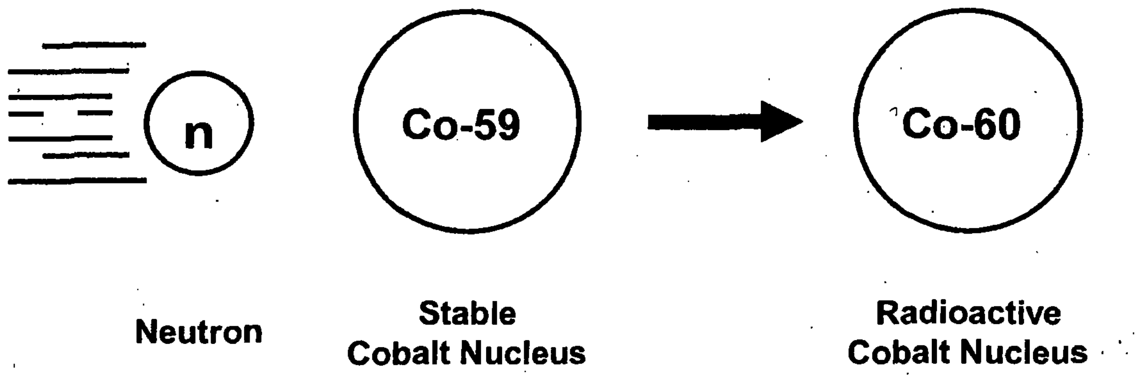


Figure 1.3-2
Radioactive Activation Product Formation

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

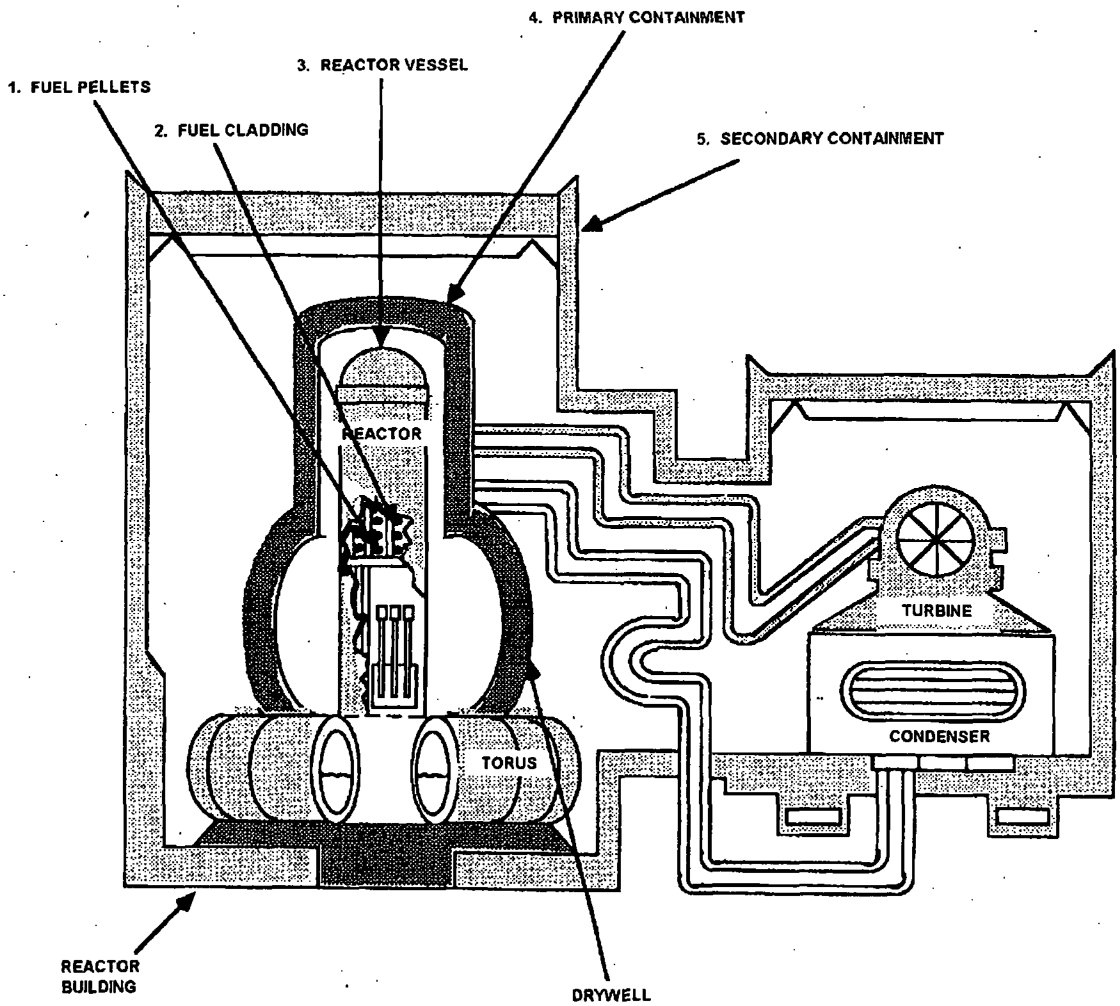


Figure 1.3-3
Barriers To Confine Radioactive Materials

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 2013 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

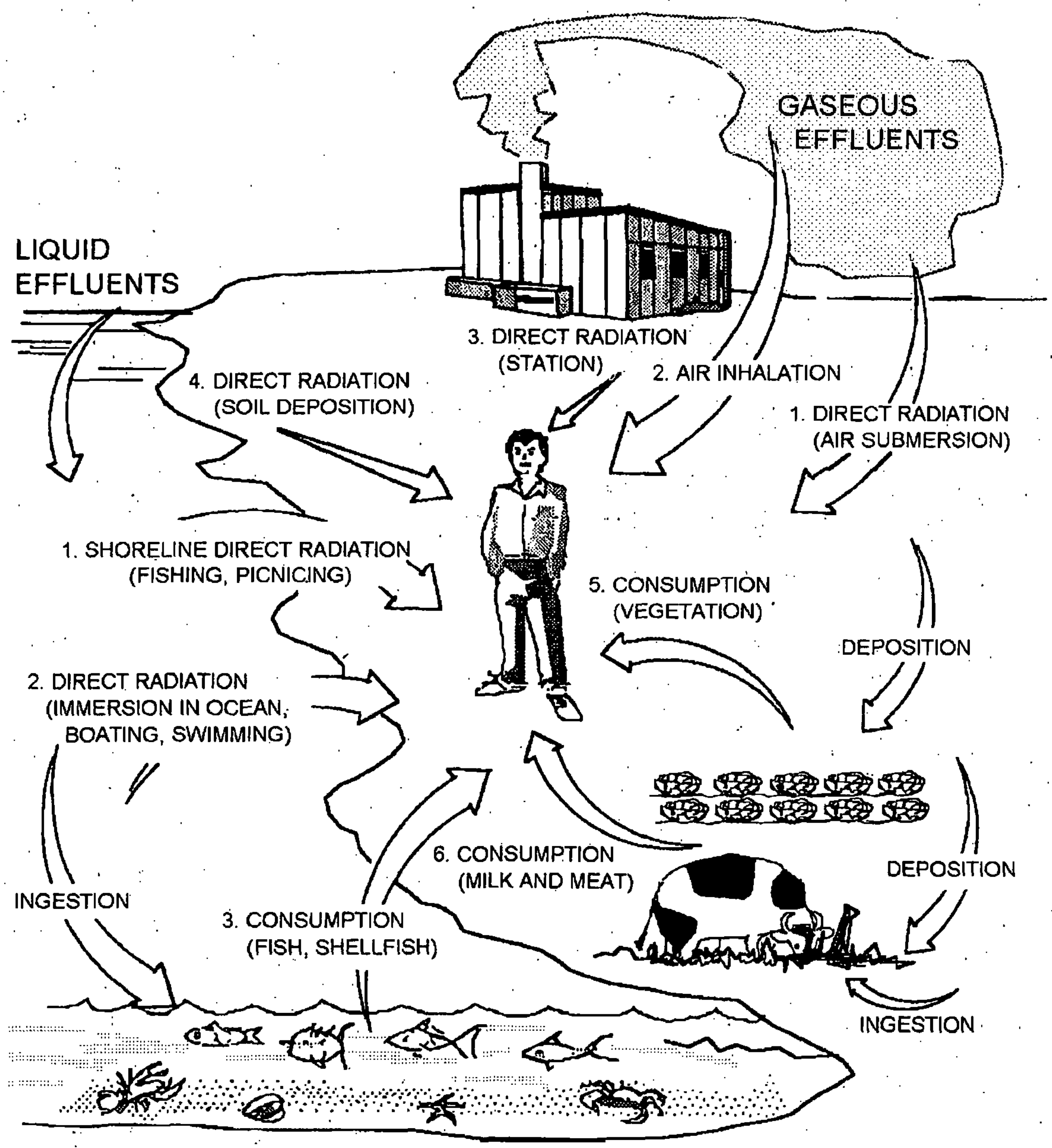


Figure 1.5-1
Radiation Exposure Pathways

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 deposited on vegetation or 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 2013 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 2013 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 2013 included air particulate filters, charcoal cartridges, animal forage, vegetation, cranberries, seawater, sediment, Irish moss, shellfish, American lobster, and fishes. 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 and the lack of a sufficient substitute location that could provide suitable volumes for analysis, 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. NRC guidance (Reference 14) contains provisions for collection of vegetation and forage samples in lieu of milk sampling. Such samples have historically been collected near Pilgrim Station as part of the routine REMP 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.

The PNPS ODCM was revised in 2009. In conjunction with this revision, two changes were made to the environmental sampling program. Due to damage from past storms to the rocky areas at Manomet Point, there is no longer a harvestable population of blue mussels at this site. Several attempts have been made over the past years to collect samples from this location, but all efforts were unsuccessful. Because of unavailability of mussels at this location as a viable human foodchain exposure pathway, this location was dropped from the sampling program. The other change involved the twice per year sampling of Group II fishes in the vicinity of the PNPS discharge outfall, represented by species such as cunner and tautog. Because these fish tend to move away from the discharge jetty during colder months, they are not available for sampling at a six-month semi-annual sampling period. The sampling program was modified to reduce the sampling for Group II fishes to once per year, when they are available during warmer summer months.

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 2013 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 2013 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 2013 results of these programs are summarized in Appendix E. These results indicate that the analyses and measurements performed during 2013 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 2013. 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 vegetation sample with a cesium-137 concentration of 85 ± 21 pCi/kilogram would be considered "positive" (detectable Cs-137), whereas another sample with a concentration of 60 ± 32 pCi/kilogram would be considered "negative", indicating no detectable cesium-137. The latter sample may actually contain cesium-137, but the levels counted during its analysis were not significantly different than the 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 41). Gross beta (GR-B) analyses were performed on 563 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, 511 out of 511 samples indicated detectable activity at the three-sigma (standard deviation) level. The mean concentration of gross beta activity in these 511 indicator station samples was 0.014 ± 0.0049 (1.4E-2 ± 4.9E-3) pCi/m^3. Individual values ranged from 0.00047 to 0.035 (4.7E-4 – 3.5E-2) pCi/m^3.

The monitoring station which yielded the highest mean concentration was the Control location EW (East Weymouth), which yielded a mean concentration of 0.014 ± 0.0053 pCi/m^3, based on 52

observations. Individual values ranged from 0.0044 to 0.030 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 ± 0.0043 pCi/m^3. Individual samples at the control location ranged from 0.0044 to 0.030 pCi/m^3.

Referring to the next-to-last entry row in the table, analyses for cesium-137 (Cs-137) were performed 43 times (quarterly composites for 11 stations * 4 quarters, minus one quarterly sample). 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 2013, 431 were retrieved and processed. Those TLDs missing from their monitoring locations were lost to storm damage, and/or building renovation, 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 locations beyond the PNPS protected area boundary ranged from 40 to 154 mR/yr. The average exposure rate at control locations greater than 15 km from Pilgrim Station (i.e., Zone 4) was 60.2 ± 10.9 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 93 mR/yr. The results for all TLDs within 15 km (excluding those Zone 1 TLDs posted within the site boundary) ranged from 40 to 81 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 average natural 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, PB, and P01) and/or transit and storage of radwaste onsite (e.g., locations BLE and BLW). Due to heightened security measures following September 11 2001, members for the general public do not have access to such locations within the owner-controlled area.

One TLD, located in the basement of the Plymouth Memorial Hall, indicated an annual exposure of 76 mR in 2013. 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 71.6 ± 21.3 mR/yr to 62.2 ± 8.9 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 adjacent to the nearest offsite residence 0.80 kilometers (0.5 miles) southeast of the PNPS Reactor Building was 62.1 ± 7.7 mR/yr, which compares quite well with the average control location exposure of 62.2 ± 8.9 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 572 filters (11 locations * 52 weeks), 563 samples were collected and analyzed during 2013. Several air sampling stations lost power during winter storm Nemo during the week of 05-Feb through 12-Feb 2014. Another problem occurred at location WR when tree trimming activities on 14-Aug-2012 resulted in damage to the electrical service and sampling station. The sampler was not repaired until 28-Feb-2013, resulting in the loss of sampling capabilities at this location for the last 21 weeks of 2012, and the first eight weeks of 2013. This event is described in Condition Report CR-PNP-2012-3545. There were also 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. All of these discrepancies are noted in Appendix D.

The results of the analyses performed on these 563 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 563 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 44 out of 44 of the quarterly composites analyzed with gamma spectroscopy. Naturally-occurring potassium-40 (K-40) was detected in 1 of 4 control samples. No airborne radioactivity attributable to Pilgrim Station was

detected in any of the samples collected during 2013, 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 572 cartridges (11 locations * 52 weeks), 563 samples were collected and analyzed during 2013. Several air sampling stations lost power during winter storm Nemo during the week of 05-Feb through 12-Feb 2014. Another problem occurred at location WR when tree trimming activities on 14-Aug-2012 resulted in damage to the electrical service and sampling station. The sampler was not repaired until 28-Feb-2013, resulting in the loss of sampling capabilities at this location for the last 21 weeks of 2012, and the first eight weeks of 2013. This event is described in Condition Report CR-PNP-2012-3545. There were also 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. All of these discrepancies are noted in Appendix D. Despite such events during 2013, required LLDs were met on 563 of the 563 cartridges collected during 2013.

The results of the analyses performed on these charcoal cartridges are summarized in Table 2.6-1. No airborne radioactive iodine attributable to Pilgrim Station 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 within 5 miles as specified in NRC guidance (Reference 14), a suitable substitute location 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 suitable milk sampling location existed in the vicinity of Pilgrim Station.

The nearest milk animals to Pilgrim Station are located at the Plimoth Plantation, approximately 2.5 miles west of PNPS, in a relatively upwind direction. Due to the limited number of milk animals available, this location is not able to provide the necessary volume of 4 gallons of milk every two weeks to facilitate the milk sampling program and meet the required detection sensitivities. Although milk sampling is not performed at Plimoth Plantation, effluent dose calculations are performed for this location assuming the presence of a milk ingestion pathway, as part of the annual Effluent and Waste Disposal Report (Reference 17).

As included in a provision in standard ODCM guidance in NUREG-1302 (Reference 13), sampling and analysis of vegetation from the offsite locations calculated to have the highest D/Q deposition factor can be performed in lieu of milk sampling. Such vegetation sampling has been routinely performed at Pilgrim Station as part of the radiological environmental monitoring program, and the results of this sampling are presented in Section 2.9.

2.8 Forage Radioactivity Analyses

Samples of animal forage (hay) had been collected in the past from the Plymouth County Farm, and from control locations in Bridgewater. However, due to the absence of any grazing animals within a five-mile radius of Pilgrim Station that are used for generation of food products (milk or meat), no samples of forage were collected during 2013. A number of wild vegetation samples were collected within a five mile radius of Pilgrim Station as part of the vegetable/vegetation sampling effort, and the results of this sampling would provide an indication of any radioactivity potentially entering the forage-milk or forage-meat pathways. Results of the vegetable/vegetation sampling effort are discussed in the following section.

2.9 Vegetable/Vegetation Radioactivity Analyses

Samples of vegetables and naturally-growing vegetation have historically been collected from the Plymouth County Farm and from the control locations in Bridgewater, Sandwich, and Norton. 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. In addition to these garden samples, naturally-growing vegetation is collected from locations yielding the highest D/Q deposition factors. All of the various samples of vegetables/vegetation are collected annually and analyzed by gamma spectroscopy.

Twenty-three samples of vegetables/vegetation were collected and analyzed as required during 2013. 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 several of the samples collected. Cesium-137 was also detected in four out of 15 samples of vegetation collected from indicator locations, and one of eight control samples collected, with concentrations ranging from non-detectable (<12 pCi/kg) up to 61 pCi/kg. The highest concentration of 61 pCi/kg was detected in a sample of natural vegetation collected from the Pine Hills area of the Pine Hills south of PNPS. This Cs-137 result is within of the normal range of _average_ values expected for weapons-testing fallout (75 to 145 pCi/kg as projected from the pre-operational sampling program). It should be noted that natural vegetation samples collected in the 1990s often showed detectable Cs-137 from nuclear weapons tests up into the range of 300 to 400 pCi/kg, whereas soil samples often indicated concentrations in excess of 2000 pCi/kg. Cs-137 has a 30-year half-life, and measureable concentrations still remain in soil and vegetation as a result of atmospheric nuclear weapons testing performed during the 1950s through 1970s. Weekly particulate air filters collected from the Cleft Rock sampling station within 400 meters of where the vegetation was sampled indicated no detectable Cs-137. A review of effluent data presented in Appendix B indicates that there were no measurable airborne releases of Cs-137 from Pilgrim Station during 2013 that could have attributed to this level. The sample with the highest level of Cs-137 also contained high levels of Ra-226 and AcTh-228, indicating appreciable soil content on the vegetation. This sample of natural vegetation was analyzed "as is" without any measure to clean the samples as normally would be performed prior to consuming vegetables, and would have detected any Cs-137 in soil adhering to those leaves collected. Certain species of plants such as sassafras are also known to concentrate chemical elements like cesium, and this higher-than-expected level is likely due to a combination of external soil contamination and bioconcentration in the leaves of the plants sampled. These levels are not believed to be indicative of any releases associated with Pilgrim Station. No radioactivity attributable to Pilgrim Station was detected in any of the vegetable/vegetation samples collected during 2013, 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 normally 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 2012, the bog on Bartlett Road ceased harvesting operations, and a sample was collected from an alternate location along Beaver Dam Road. Samples were also not available from the historical control location in Halifax, and a substitute control sample was collected from a bog in Kingston. These discrepancies are noted in Appendix D.

Two samples of cranberries were collected and analyzed during 2013. One of the bogs normally sampled along Bartlett Road is no longer in production. Results of the gamma analyses of cranberry samples are summarized in Table 2.10-1. Cranberry samples collected during 2013 yielded detectable levels of naturally-occurring beryllium-7, potassium-40, and radium-226. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2013, 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 these quarterly samples.

A total of 36 samples (3 locations * 12 sampling periods) of surface water were collected and analyzed as required during 2013. 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 surface water samples collected during 2013.

In response to the Nuclear Energy Institute Groundwater Protection Initiative, Pilgrim Station installed a number of groundwater monitoring wells within the protected area in late 2007. Because all of these wells are onsite, they are not included in the offsite radiological monitoring program, and are not presented in this report. Details regarding Pilgrim Station's groundwater monitoring effort can be found in the Annual Radioactive Effluent Release Report.

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 of twelve required samples of sediment were collected during 2013. 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 2013, 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 (Brant Rock). 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 2013 were obtained and analyzed. Results of the gamma analyses of these samples are summarized in Table 2.14-1. Naturally-occurring potassium-40 and radium-226 were detected in a number of the samples. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2013, 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 one other location in the Plymouth area (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.

Ten of the 10 required samples of shellfish meat scheduled for collection during 2013 were obtained and analyzed. Results of the gamma analyses of these samples are summarized in Table 2.15-1. Naturally-occurring potassium-40 and radium-226 were detected in a number of the samples. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2013, 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 control locations in Cape Cod Bay and Vineyard Sound. Samples are collected monthly from the discharge canal outfall from June through September and once annually from the control locations. All lobster samples are normally analyzed by gamma spectroscopy.

Five samples of lobsters were collected as required during 2013. Results of the gamma analyses of these samples are summarized in Table 2.16-1. Naturally-occurring potassium-40 and radium-226 were detected in a number of the samples. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2013, 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 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 II, III, and IV fishes are sampled annually from the discharge canal outfall and control location. All samples of fish are analyzed by gamma spectroscopy.

Eight samples of fish were collected during 2013. The autumn sample of Group I Fish (flounder) was not available during the October sampling period due to seasonal unavailability as the fish moved away from the Discharge Outfall to deeper water. 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 and radium-226. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2013, 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	Code	Distance	Direction
Air Particulate Filters, Charcoal Cartridges			
Medical Building	WS	0.2 km	SSE
East Rocky Hill Road	ER	0.9 km	SE
West Rocky Hill Road	WR	0.8 km	WNW
Property Line	PL	0.5 km	NNW
Pedestrian Bridge	PB	0.2 km	N
Overlook Area	OA	0.1 km	W
East Breakwater	EB	0.5 km	ESE
Cleft Rock	CR	1.3 km	SSW
Plymouth Center	PC	6.7 km	W
Manomet Substation	MS	3.6 km	SSE
East Weymouth Control	EW	40 km	NW
Forage			
Plymouth County Farm	CF	5.6 km	W
Hansen Farm Control	HN	35 km	W
Vegetation			
Plymouth County Farm	CF	5.6 km	W
Hansen Farm Control	HN	35 km	W
Cranberries			
Bartlett Road Bog	BT	4.3 km	SSE
Beaverdam Road Bog	MR	3.4 km	S
Hollow Farm Bog Control	HF	16 km	WNW

Table 2.2-1 (continued)

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

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 Harbor	Ply-H	4.1 km	W
Duxbury Bay Control	Dux-Bay	14 km	NNW
Plymouth Beach	PLB	4.0 km	WNW
Manomet Point	MP	3.3 km	ESE
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	BR	18 km	NNW
Shellfish			
Discharge Canal Outfall	DIS	0.7 km	NNE
Plymouth Harbor	Ply-H	4.1 km	W
Duxbury Bay Control	Dux-Bay	13 km	NNW
Manomet Point	MP	4.0 km	ESE
Green Harbor Control	GH	16 km	NNW
Lobster			
Discharge Canal Outfall	DIS	0.5 km	N
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
Priest Cove Control	PC	48 km	SW
Jones River Control	JR	13 km	WNW
Vineyard Sound Control	MV	64 km	SSW
Buzzard's Bay Control	BB	40 km	SSW
Cape Cod Bay Control	CC-Bay	24 km	ESE

Table 2.4-1

Offsite Environmental TLD Results

TLD Station		TLD Location*	Quarterly Exposure - mR/quarter (Value ± Std.Dev.)				2013 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	17.1 ± 5.1	16.5 ± 4.8	18.4 ± 5.8	19.6 ± 5.2	71.6 ± 21.3
BLW	BOAT LAUNCH WEST	0.11 km E	32.6 ± 1.6	33.1 ± 1.0	35.5 ± 2.1	34.4 ± 2.9	135.6 ± 6.7
OA	OVERLOOK AREA	0.15 km W	37.9 ± 2.0	30.3 ± 1.4	42.9 ± 2.5	43.2 ± 1.7	154.3 ± 24.3
TC	HEALTH CLUB	0.15 km WSW	18.4 ± 0.8	16.5 ± 0.6	20.5 ± 0.8	20.6 ± 0.9	76.0 ± 7.9
BLE	BOAT LAUNCH EAST	0.16 km ESE	27.0 ± 1.9	31.7 ± 2.4	31.8 ± 1.2	29.1 ± 1.8	119.5 ± 9.9
PB	PEDESTRIAN BRIDGE	0.21 km N	26.2 ± 1.4	24.4 ± 0.8	26.9 ± 1.1	27.4 ± 1.5	104.9 ± 5.9
P01	SHOREFRONT SECURITY	0.22 km NNW	15.9 ± 0.8	16.5 ± 0.7	18.1 ± 1.2	18.6 ± 1.0	69.1 ± 5.5
WS	MEDICAL BUILDING	0.23 km SSE	18.6 ± 1.2	18.2 ± 0.8	20.0 ± 1.0	21.0 ± 1.0	77.8 ± 5.5
CT	PARKING LOT	0.31 km SE	19.2 ± 1.3	18.2 ± 0.6	20.9 ± 0.8	19.0 ± 0.7	77.3 ± 4.9
PA	SHOREFRONT PARKING	0.35 km NNW	16.3 ± 0.9	17.8 ± 0.7	19.7 ± 1.0	18.7 ± 0.9	72.5 ± 6.0
A	STATION A	0.37 km WSW	14.6 ± 1.5	14.4 ± 0.8	16.5 ± 0.8	18.9 ± 0.9	64.4 ± 8.6
F	STATION F	0.43 km NW	15.0 ± 0.7	14.0 ± 0.8	16.4 ± 0.7	18.8 ± 1.0	64.2 ± 8.4
EB	EAST BREAKWATER	0.44 km ESE	16.0 ± 0.9	17.5 ± 1.0	18.6 ± 0.7	19.0 ± 0.9	71.1 ± 5.7
B	STATION B	0.44 km S	22.7 ± 0.9	18.6 ± 0.7	21.5 ± 1.2	23.4 ± 1.2	86.2 ± 8.7
PMT	PNPS MET TOWER	0.44 km WNW	17.3 ± 0.9	15.7 ± 1.0	17.7 ± 0.7	20.8 ± 1.1	71.5 ± 8.7
H	STATION H	0.47 km SW	17.7 ± 1.4	16.6 ± 0.6	19.6 ± 1.0	21.9 ± 1.1	75.8 ± 9.5
I	STATION I	0.48 km WNW	15.9 ± 1.0	13.9 ± 0.7	16.9 ± 0.8	19.5 ± 0.9	66.2 ± 9.5
L	STATION L	0.50 km ESE	15.4 ± 0.7	18.6 ± 0.7	19.2 ± 0.8	18.5 ± 1.0	71.7 ± 7.0
G	STATION G	0.53 km W	15.3 ± 0.9	14.1 ± 0.8	16.1 ± 0.7	16.2 ± 0.8	61.8 ± 4.2
D	STATION D	0.54 km NNW	18.5 ± 0.9	15.5 ± 0.6	17.3 ± 1.0	20.2 ± 1.0	71.5 ± 8.1
PL	PROPERTY LINE	0.54 km NW	15.4 ± 0.8	15.9 ± 0.8	16.6 ± 1.1	16.8 ± 0.9	64.7 ± 3.2
C	STATION C	0.57 km ESE	16.0 ± 0.8	14.7 ± 0.6	18.4 ± 1.2	17.8 ± 0.9	66.8 ± 6.9
HB	HALL'S BOG	0.63 km SE	14.6 ± 0.8	17.3 ± 0.6	19.1 ± 1.0	Missing	67.9 ± 9.2
GH	GREENWOOD HOUSE	0.65 km ESE	16.4 ± 0.9	17.0 ± 0.7	Missing	17.7 ± 0.8	68.1 ± 3.4
WR	W ROCKY HILL ROAD	0.83 km WNW	19.6 ± 0.8	19.2 ± 0.9	20.9 ± 0.9	20.8 ± 1.0	80.5 ± 3.8
ER	E ROCKY HILL ROAD	0.89 km SE	14.0 ± 0.9	14.2 ± 0.7	14.4 ± 0.8	15.2 ± 0.8	57.8 ± 2.6
MT	MICROWAVE TOWER	1.03 km SSW	14.4 ± 0.6	18.0 ± 0.7	16.0 ± 0.8	16.9 ± 0.9	65.2 ± 6.4
CR	CLEFT ROCK	1.27 km SSW	18.3 ± 0.8	17.5 ± 0.9	15.9 ± 1.1	17.3 ± 1.2	68.9 ± 4.4
BD	BAYSHORE/GATE RD	1.34 km WNW	14.9 ± 0.7	14.8 ± 0.6	16.7 ± 0.8	17.8 ± 0.9	64.2 ± 6.0
MR	MANOMET ROAD	1.38 km S	16.0 ± 0.7	15.2 ± 0.6	17.4 ± 0.7	20.3 ± 1.0	68.9 ± 9.2
DR	DIRT ROAD	1.48 km SW	12.9 ± 0.6	11.7 ± 0.5	13.4 ± 0.6	16.8 ± 1.2	54.8 ± 8.9
EM	EMERSON ROAD	1.53 km SSE	15.9 ± 0.8	14.2 ± 0.6	16.1 ± 0.7	16.9 ± 1.0	63.1 ± 4.8
EP	EMERSON/PRISCILLA	1.55 km SE	Missing	14.5 ± 0.8	16.4 ± 0.9	17.4 ± 0.9	64.5 ± 6.2
AR	EDISON ACCESS ROAD	1.59 km SSE	13.1 ± 0.7	12.8 ± 0.6	14.3 ± 0.7	17.2 ± 0.8	57.5 ± 8.2
BS	BAYSHORE	1.76 km W	16.1 ± 0.8	15.4 ± 0.8	17.3 ± 0.7	20.3 ± 1.0	69.1 ± 8.9
E	STATION E	1.86 km S	15.1 ± 0.7	13.7 ± 0.5	15.6 ± 0.6	17.9 ± 1.0	62.3 ± 7.2
JG	JOHN GAULEY	1.99 km W	15.4 ± 0.7	14.6 ± 0.6	16.4 ± 0.8	18.1 ± 1.2	64.5 ± 6.2
J	STATION J	2.04 km SSE	13.5 ± 0.7	13.1 ± 0.5	15.1 ± 1.2	17.4 ± 0.8	59.2 ± 8.0
WH	WHITEHORSE ROAD	2.09 km SSE	15.6 ± 0.6	14.5 ± 0.5	16.2 ± 0.8	17.1 ± 0.8	63.4 ± 4.7
RC	PLYMOUTH YMCA	2.09 km WSW	14.0 ± 0.6	14.0 ± 0.6	15.3 ± 0.7	18.8 ± 1.0	62.1 ± 9.2
K	STATION K	2.17 km S	13.5 ± 0.6	13.1 ± 0.8	14.2 ± 0.8	17.0 ± 0.8	57.9 ± 7.1
TT	TAYLOR/THOMAS	2.26 km SE	15.2 ± 0.8	12.8 ± 0.7	15.0 ± 0.7	16.0 ± 1.0	59.0 ± 5.6
YV	YANKEE VILLAGE	2.28 km WSW	14.7 ± 0.6	14.4 ± 0.6	15.2 ± 1.3	18.6 ± 0.9	62.9 ± 8.0
GN	GOODWIN PROPERTY	2.38 km SW	11.2 ± 0.8	10.1 ± 0.6	11.5 ± 0.5	14.9 ± 1.0	47.8 ± 8.4
RW	RIGHT OF WAY	2.83 km S	12.7 ± 0.8	11.4 ± 0.9	12.9 ± 0.6	13.0 ± 0.7	50.0 ± 3.4
TP	TAYLOR/PEARL	2.98 km SE	15.0 ± 0.7	12.6 ± 0.6	15.0 ± 1.4	15.3 ± 0.9	57.8 ± 5.4

* 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.)				2013 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	14.2 ± 2.3	13.0 ± 1.9	14.8 ± 2.0	15.9 ± 2.0	57.8 ± 9.0
VR	VALLEY ROAD	3.26 km SSW	14.2 ± 0.8	11.7 ± 0.6	14.3 ± 0.9	Missing	53.6 ± 6.2
ME	MANOMET ELEM	3.29 km SE	14.8 ± 0.7	13.1 ± 0.8	15.4 ± 0.7	Missing	57.8 ± 5.0
WC	WARREN/CLIFFORD	3.31 km W	12.7 ± 0.6	12.3 ± 0.7	Missing	16.9 ± 0.9	55.9 ± 10.5
BB	RT.3A/BARTLETT RD	3.33 km SSE	14.9 ± 0.8	13.5 ± 0.5	14.9 ± 0.6	18.1 ± 1.1	61.4 ± 7.9
MP	MANOMET POINT	3.57 km SE	15.0 ± 0.7	13.0 ± 1.0	15.1 ± 0.7	14.9 ± 0.8	57.9 ± 4.3
MS	MANOMET SUBSTATION	3.60 km SSE	16.9 ± 0.6	17.1 ± 0.9	17.5 ± 0.8	17.8 ± 0.9	69.2 ± 2.3
BW	BEACHWOOD ROAD	3.93 km SE	15.6 ± 0.7	12.6 ± 0.7	15.6 ± 0.8	16.4 ± 1.1	60.3 ± 6.9
PT	PINES ESTATE	4.44 km SSW	13.2 ± 0.7	11.6 ± 0.6	14.1 ± 0.7	14.2 ± 0.8	53.2 ± 4.9
EA	EARL ROAD	4.60 km SSE	11.9 ± 0.6	12.1 ± 0.6	12.8 ± 1.0	16.4 ± 1.1	53.2 ± 8.7
SP	S PLYMOUTH SUBST	4.62 km W	15.8 ± 1.1	13.4 ± 0.5	15.8 ± 1.2	15.6 ± 0.8	60.6 ± 5.1
RP	ROUTE 3 OVERPASS	4.81 km SW	15.8 ± 1.2	13.6 ± 0.6	16.0 ± 0.7	15.8 ± 0.7	61.2 ± 5.0
RM	RUSSELL MILLS RD	4.85 km WSW	14.3 ± 1.2	12.4 ± 0.6	14.9 ± 0.7	15.1 ± 0.8	56.7 ± 5.3
HD	HILLDALE ROAD	5.18 km W	13.8 ± 1.0	13.6 ± 0.9	15.2 ± 0.9	17.7 ± 0.9	60.2 ± 7.7
MB	MANOMET BEACH	5.43 km SSE	15.7 ± 0.8	13.4 ± 0.6	15.7 ± 1.0	16.3 ± 0.9	61.2 ± 5.4
BR	BEAVERDAM ROAD	5.52 km S	15.0 ± 1.3	13.4 ± 0.6	15.7 ± 1.5	16.0 ± 0.8	60.1 ± 5.0
PC	PLYMOUTH CENTER	6.69 km W	9.7 ± 0.7	9.9 ± 0.6	9.9 ± 0.8	11.0 ± 0.6	40.5 ± 2.7
LD	LONG POND/DREW RD	6.97 km WSW	10.9 ± 0.5	14.0 ± 0.6	13.7 ± 0.6	16.5 ± 0.9	55.2 ± 9.2
HR	HYANNIS ROAD	7.33 km SSE	Missing	Missing	14.0 ± 0.7	15.0 ± 0.7	57.9 ± 3.4
SN	SAQUISH NECK	7.58 km NNW	10.6 ± 1.1	9.2 ± 0.4	11.8 ± 0.9	12.8 ± 0.9	44.6 ± 6.5
MH	MEMORIAL HALL	7.58 km WNW	19.1 ± 0.7	17.6 ± 0.7	19.4 ± 0.8	19.9 ± 0.9	76.0 ± 4.2
CP	COLLEGE POND	7.59 km SW	13.3 ± 0.7	13.3 ± 0.6	14.3 ± 0.8	Missing	54.4 ± 3.0
Zone 3 TLDs: 8-15 km		8-15 km	13.8 ± 1.1	13.0 ± 1.7	14.1 ± 1.7	15.9 ± 1.9	56.7 ± 7.6
DW	DEEP WATER POND	8.59 km W	15.3 ± 0.9	14.4 ± 0.5	16.9 ± 1.1	18.8 ± 1.4	65.3 ± 8.0
LP	LONG POND ROAD	8.88 km SSW	13.2 ± 0.7	12.2 ± 0.6	13.1 ± 0.6	14.8 ± 0.7	53.3 ± 4.5
NP	NORTH PLYMOUTH	9.38 km WNW	15.3 ± 0.7	17.4 ± 1.0	17.3 ± 1.0	19.5 ± 1.5	69.4 ± 7.3
SS	STANDISH SHORES	10.39 km NW	13.3 ± 0.6	11.9 ± 0.6	13.5 ± 0.7	15.1 ± 1.0	53.9 ± 5.4
EL	ELLISVILLE ROAD	11.52 km SSE	14.6 ± 0.9	12.7 ± 0.6	14.0 ± 0.9	15.3 ± 0.8	56.7 ± 4.6
UC	UP COLLEGE POND RD	11.78 km SW	11.7 ± 1.5	11.6 ± 0.4	12.2 ± 0.8	13.7 ± 0.8	49.2 ± 4.3
SH	SACRED HEART	12.92 km W	14.3 ± 0.8	12.6 ± 0.8	13.8 ± 0.6	15.7 ± 0.8	56.5 ± 5.4
KC	KING CAESAR ROAD	13.11 km NNW	13.6 ± 0.8	12.1 ± 0.5	13.4 ± 0.6	15.8 ± 0.8	54.8 ± 6.3
BE	BOURNE ROAD	13.37 km S	13.4 ± 0.7	12.1 ± 0.5	12.9 ± 0.5	14.4 ± 1.1	52.8 ± 4.0
SA	SHERMAN AIRPORT	13.43 km WSW	13.1 ± 0.6	12.5 ± 0.7	13.5 ± 0.7	15.8 ± 1.0	54.9 ± 5.9
Zone 4 TLDs: >15 km		>15 km	14.7 ± 2.9	13.9 ± 3.0	15.2 ± 2.6	16.4 ± 2.5	60.2 ± 10.9
CS	CEDARVILLE SUBST	15.93 km S	15.8 ± 0.7	13.9 ± 0.6	16.3 ± 0.8	17.3 ± 1.4	63.3 ± 6.1
KS	KINGSTON SUBST	16.15 km WNW	15.3 ± 0.8	14.3 ± 0.5	15.2 ± 0.7	16.6 ± 0.9	61.4 ± 4.1
LR	LANDING ROAD	16.46 km NNW	13.4 ± 0.9	12.8 ± 0.5	14.6 ± 0.7	15.2 ± 0.9	56.0 ± 4.6
CW	CHURCH/WEST	16.56 km NW	9.1 ± 0.5	8.5 ± 0.5	10.4 ± 0.9	11.7 ± 0.7	39.7 ± 5.9
MM	MAIN/MEADOW	17.02 km WSW	14.4 ± 0.7	13.4 ± 0.8	14.5 ± 1.0	16.7 ± 1.3	59.0 ± 5.8
DMF	DIV MARINE FISH	20.97 km SSE	17.5 ± 0.9	17.8 ± 1.3	17.6 ± 0.7	19.4 ± 0.9	72.4 ± 4.0
EW	E WEYMOUTH SUBST	39.69 km NW	17.6 ± 1.0	16.4 ± 0.9	17.9 ± 0.7	18.0 ± 1.2	69.9 ± 3.5

* 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.)				2013 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	28.2 ± 1.2	29.0 ± 1.2	26.5 ± 1.2	24.5 ± 1.1	108.2 ± 8.4
P24	EXEC.BUILDING	57 m W	42.7 ± 1.5	41.1 ± 1.5	47.7 ± 2.4	50.8 ± 2.8	182.4 ± 18.5
P04	FENCE-R SCREENHOUSE	66 m N	36.5 ± 1.3	41.2 ± 2.0	43.4 ± 1.8	44.0 ± 1.8	165.2 ± 14.1
P20	O&M - 2ND W WALL	67 m SE	27.3 ± 1.7	24.1 ± 0.8	28.0 ± 2.2	28.3 ± 1.9	107.7 ± 8.4
P25	EXEC.BUILDING LAWN	76 m WNW	33.9 ± 1.7	43.0 ± 2.1	43.1 ± 2.5	47.4 ± 3.2	167.4 ± 23.2
P05	FENCE-WATER TANK	81 m NNE	21.1 ± 0.9	21.7 ± 1.0	22.5 ± 0.9	24.2 ± 0.9	89.4 ± 5.6
P06	FENCE-OIL STORAGE	85 m NE	29.4 ± 1.2	29.4 ± 1.4	30.3 ± 1.8	31.5 ± 2.4	120.6 ± 5.4
P19	O&M - 2ND SW CORNER	86 m S	20.2 ± 1.0	19.8 ± 0.8	20.8 ± 1.2	22.4 ± 1.1	83.2 ± 4.9
P18	O&M - 1ST SW CORNER	90 m S	24.3 ± 1.4	23.5 ± 0.8	29.8 ± 1.1	31.3 ± 2.0	108.9 ± 15.8
P08	COMPRESSED GAS STOR	92 m E	31.9 ± 2.4	31.5 ± 2.5	32.4 ± 1.3	34.2 ± 1.6	130.0 ± 6.2
P03	FENCE-L SCREENHOUSE	100 m NW	33.7 ± 1.2	29.0 ± 0.9	32.8 ± 1.2	35.0 ± 2.4	130.5 ± 10.7
P17	FENCE-EXEC.BUILDING	107 m W	51.0 ± 2.9	42.9 ± 3.3	52.5 ± 2.1	52.9 ± 1.9	199.3 ± 19.4
P07	FENCE-INTAKE BAY	121 m ENE	25.4 ± 1.3	25.5 ± 1.3	28.7 ± 1.2	28.2 ± 1.1	107.8 ± 7.5
P23	O&M - 2ND S WALL	121 m SSE	26.0 ± 1.3	23.4 ± 0.9	27.1 ± 1.4	29.2 ± 1.4	105.8 ± 10.0
P26	FENCE-WAREHOUSE	134 m ESE	28.3 ± 1.2	31.1 ± 1.2	29.6 ± 1.7	30.4 ± 1.7	119.4 ± 5.7
P02	FENCE-SHOREFRONT	135 m NW	25.4 ± 1.2	23.5 ± 0.8	28.7 ± 1.7	29.7 ± 1.2	107.4 ± 11.8
P09	FENCE-W BOAT RAMP	136 m E	26.1 ± 1.2	25.9 ± 1.5	27.5 ± 1.6	26.5 ± 1.5	106.0 ± 4.1
P22	O&M - 2ND N WALL	137 m SE	20.6 ± 1.1	20.7 ± 0.8	21.8 ± 0.9	22.2 ± 1.2	85.3 ± 3.7
P16	FENCE-W SWITCHYARD	172 m SW	69.1 ± 2.7	56.4 ± 3.3	76.1 ± 4.0	75.4 ± 5.0	276.9 ± 37.3
P11	FENCE-TCF GATE	183 m ESE	40.1 ± 1.7	53.0 ± 1.6	51.5 ± 3.0	38.4 ± 1.8	183.0 ± 30.5
P27	FENCE-TCF/BOAT RAMP	185 m ESE	21.8 ± 1.0	23.6 ± 1.1	25.0 ± 1.9	23.5 ± 1.3	93.9 ± 5.8
P12	FENCE-ACCESS GATE	202 m SE	23.9 ± 1.0	21.8 ± 0.7	23.5 ± 1.3	25.3 ± 1.3	94.6 ± 6.2
P15	FENCE-E SWITCHYARD	220 m S	22.0 ± 1.1	21.7 ± 1.0	24.5 ± 0.9	25.1 ± 1.7	93.2 ± 7.4
P10	FENCE-TCF/INTAKE BAY	223 m E	24.9 ± 1.7	28.6 ± 1.2	29.6 ± 1.6	24.8 ± 1.1	107.9 ± 10.2
P13	FENCE-MEDICAL BLDG.	224 m SSE	21.5 ± 1.2	20.3 ± 1.5	22.9 ± 1.4	24.7 ± 1.4	89.4 ± 8.1
P14	FENCE-BUTLER BLDG	228 m S	20.8 ± 0.9	18.9 ± 1.1	21.1 ± 0.9	22.9 ± 1.3	83.7 ± 6.7
P28	FENCE-TCF/PRKNG LOT	259 m ESE	68.2 ± 2.3	53.1 ± 2.8	80.0 ± 4.7	55.7 ± 2.1	257.1 ± 50.0

* 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 2.4-3

Average TLD Exposures By Distance Zone During 2013

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	17.1 ± 5.1	14.2 ± 2.3	13.8 ± 1.1	14.7 ± 2.9
Apr-Jun	16.5 ± 4.8	13.0 ± 1.9	13.0 ± 1.7	13.9 ± 3.0
Jul-Sep	18.4 ± 5.8	14.8 ± 2.0	14.1 ± 1.7	15.2 ± 2.6
Oct-Dec	19.6 ± 5.2	15.9 ± 2.0	15.9 ± 1.9	16.4 ± 2.5
Jan-Dec	71.6 ± 21.3**	57.8 ± 9.0	56.7 ± 7.6	60.2 ± 10.9

* 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 62.2 ± 8.9 mR/yr.

Table 2.5-1
Air Particulate Filter Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2013)

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	563 0	0.01	1.3E-2 ± 4.9E-3 4.7E-4 - 3.5E-2 511 / 511	EW: 1.4E-2 ± 5.3E-3 4.4E-3 - 3.0E-2 52 / 52	1.4E-2 ± 5.3E-3 4.4E-3 - 3.0E-2 52 / 52
Be-7	43 0		1.0E-1 ± 1.9E-2 6.3E-2 - 1.4E-1 40 / 40	EW: 1.2E-1 ± 1.9E-2 1.0E-1 - 1.4E-1 4 / 4	1.2E-1 ± 1.9E-2 1.0E-1 - 1.4E-1 4 / 4
K-40	43 0		<LLD <LLD 0 / 40	5.9E-2 ± 1.3E-2 <LLD - 5.9E-2 1 / 4	5.9E-2 ± 1.3E-2 <LLD - 5.9E-2 1 / 4
Cs-134	43 0	0.05	<LLD <LLD 0 / 40	<LLD <LLD 0 / 40	<LLD <LLD 0 / 4
Cs-137	43 0	0.06	<LLD <LLD 0 / 40	<LLD <LLD 0 / 40	<LLD <LLD 0 / 4
Ra-226	43 0		<LLD <LLD 0 / 40	<LLD <LLD 0 / 40	<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 2013)

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	563 0	0.07	<LLD <LLD 0 / 511	<LLD <LLD 0 / 52	<LLD <LLD 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 2013)

No milk sampling was performed during 2013, as no suitable indicator locations for milk production 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 2013)

No forage sampling was performed during 2013, as no grazing animals used for food products were available at any indicator locations within 5 miles of Pilgrim Station.

Table 2.9-1
Vegetable/Vegetation Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2013)

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	23 0		1.5E+3 ± 8.9E+2 <LLD - 2.8E+3 10 / 15	DMF: 3.5E+3 ± 1.3E+2 3.5E+3 - 3.5E+3 1 / 1	2.0E+3 ± 1.5E+3 <LLD - 3.5E+3 3 / 8
K-40	23 0		3.2E+3 ± 8.7E+2 2.1E+3 - 5.3E+3 15 / 15	Norton: 7.7E+3 ± 2.5E+2 7.7E+3 - 7.7E+3 1 / 1	3.7E+3 ± 2.2E+3 1.0E+3 - 7.7E+3 8 / 8
I-131	23 0	60	<LLD <LLD 0 / 15	<LLD <LLD 0 / 15	<LLD <LLD 0 / 8
Cs-134	23 0	60	<LLD <LLD 0 / 15	<LLD <LLD 0 / 15	<LLD <LLD 0 / 8
Cs-137	23 0	80	3.7E+1 ± 1.9E+1 <LLD - 6.1E+1 4 / 15	Pine Hills: 6.1E+1 ± 7.1E+0 6.1E+1 - 6.1E+1 1 / 1	9.2E+0 ± 4.1E+0 <LLD - 9.2E+0 1 / 8
Ra-226	23 0		4.8E+2 ± 3.6E+2 <LLD - 7.4E+2 2 / 15	Ply Cnty: 7.4E+2 ± 1.3E+2 <LLD - 7.4E+2 1 / 4	4.0E+2 ± 2.0E+2 <LLD - 5.7E+2 4 / 8
AcTh-228	23 0		2.5E+2 ± 2.6E+2 <LLD - 6.4E+2 4 / 15	Greenwood: 6.4E+2 ± 3.0E+1 6.4E+2 - 6.4E+2 1 / 1	1.1E+2 ± 6.4E+1 <LLD - 1.7E+2 3 / 8

* 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 2013)

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	2 0		2.7E+2 ± 4.8E+1 2.7E+2 - 2.7E+2 1 / 1	BvdamRd: 2.7E+2 ± 4.8E+1 2.7E+2 - 2.7E+2 1 / 1	<LLD <LLD 0 / 1
K-40	2 0		8.4E+2 ± 9.2E+1 8.4E+2 - 8.4E+2 1 / 1	HollowBog: 9.7E+2 ± 8.5E+1 9.7E+2 - 9.7E+2 1 / 1	9.7E+2 ± 8.5E+1 9.7E+2 - 9.7E+2 1 / 1
I-131	2 0	60	<LLD <LLD 0 / 1	<LLD <LLD 0 / 1	<LLD <LLD 0 / 1
Cs-134	2 0	60	<LLD <LLD 0 / 1	<LLD <LLD 0 / 1	<LLD <LLD 0 / 1
Cs-137	2 0	80	<LLD <LLD 0 / 1	<LLD <LLD 0 / 1	<LLD <LLD 0 / 1
Ra-226	2 0		2.3E+2 ± 1.0E+2 2.3E+2 - 2.3E+2 1 / 1	HollowBog: 3.5E+2 ± 1.2E+2 3.5E+2 - 3.5E+2 1 / 1	3.5E+2 ± 1.2E+2 3.5E+2 - 3.5E+2 1 / 1
AcTh-228	2 0		<LLD <LLD 0 / 1	<LLD <LLD 0 / 1	<LLD <LLD 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 2013)

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

Radionuclide	No. Analyses	Required	Indicator Stations	Station with Highest Mean	Control Stations
H-3	12	3000	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 24	#N/A	0 / 4
Be-7	36		<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 24	0 / 12	0 / 12
K-40	36		2.8E+2 ± 1.5E+2	PP: 3.9E+2 ± 8.3E+1	3.9E+2 ± 8.3E+1
	0		<LLD - 5.8E+2	3.0E+2 - 5.2E+2	3.0E+2 - 5.2E+2
			20 / 24	12 / 12	12 / 12
Mn-54	36	15	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 24	0 / 12	0 / 12
Fe-59	36	30	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 24	0 / 12	0 / 12
Co-58	36	15	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 24	0 / 12	0 / 12
Co-60	36	15	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 24	0 / 12	0 / 12
Zn-65	36	30	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 24	0 / 12	0 / 12
Zr-95	36	30	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 24	0 / 12	0 / 12
Nb-95	36	15	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 24	0 / 12	0 / 12
I-131	36	15	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 24	0 / 12	0 / 12
Cs-134	36	15	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 24	0 / 12	0 / 12
Cs-137	36	18	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 24	0 / 12	0 / 12
Ba-140	36	60	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 24	0 / 12	0 / 12
La-140	36	15	<LLD	<LLD	<LLD
	0		<LLD	<LLD	<LLD
			0 / 24	0 / 12	0 / 12
Ra-226	36		9.2E+1 ± 2.7E+1	PP: 9.8E+1 ± 2.9E+1	9.8E+1 ± 2.9E+1
	0		<LLD - 1.5E+2	<LLD - 1.5E+2	<LLD - 1.5E+2
			18 / 24	9 / 12	9 / 12
AcTh-228	36		8.2E+0 ± 2.2E+0	DIS: 8.7E+0 ± 2.6E+0	8.4E+0 ± 3.1E+0
	0		<LLD - 1.2E+1	<LLD - 1.2E+1	<LLD - 1.4E+1
			8 / 24	5 / 12	9 / 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 2013)

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		4.4E+2 ± 1.1E+2 <LLD - 4.4E+2 1 / 8	Manmt Pt: 4.4E+2 ± 1.1E+2 <LLD - 4.4E+2 1 / 2	<LLD <LLD 0 / 4
K-40	12 0		9.4E+3 ± 1.5E+3 6.8E+3 - 1.2E+4 8 / 8	Grn Hrbr: 1.1E+4 ± 5.0E+3 7.5E+3 - 1.5E+4 2 / 2	1.1E+4 ± 3.0E+3 7.5E+3 - 1.5E+4 4 / 4
Cs-134	12 0	150	<LLD <LLD 0 / 6	<LLD <LLD 0 / 2	<LLD <LLD 0 / 2
Cs-137	12 0	180	<LLD <LLD 0 / 6	<LLD <LLD 0 / 2	<LLD <LLD 0 / 2
Ra-226	12 0		5.5E+2 ± 3.6E+2 <LLD - 9.8E+2 6 / 8	Manmt Pt: 8.7E+2 ± 2.6E+2 <LLD - 8.7E+2 1 / 2	5.1E+2 ± 4.1E+2 <LLD - 9.6E+2 3 / 4
AcTh-228	12 0		4.1E+2 ± 1.2E+2 <LLD - 5.9E+2 5 / 8	Ply Hbr: 5.2E+2 ± 1.1E+2 4.5E+2 - 5.9E+2 2 / 2	3.9E+2 ± 1.3E+2 2.5E+2 - 5.4E+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 2013)

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		<LLD <LLD 0 / 6	<LLD <LLD 0 / 2	<LLD <LLD 0 / 2
K-40	8 0		6.0E+3 ± 1.5E+3 4.2E+3 - 8.7E+3 6 / 6	Ellisville: 7.4E+3 ± 1.8E+3 6.2E+3 - 8.7E+3 2 / 2	5.4E+3 ± 1.9E+3 4.1E+3 - 6.8E+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 / 2
Cs-137	8 0	150	<LLD <LLD 0 / 6	<LLD <LLD 0 / 2	<LLD <LLD 0 / 2
Ra-226	8 0		4.2E+2 ± 1.4E+2 <LLD - 4.5E+2 2 / 6	Ellisville: 4.5E+2 ± 1.6E+2 <LLD - 4.5E+2 1 / 2	3.3E+2 ± 1.4E+2 <LLD - 3.3E+2 1 / 2
AcTh-228	8 0		<LLD <LLD 0 / 6	<LLD <LLD 0 / 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 2013)

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	10 0		<LLD <LLD 0 / 6	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
K-40	10 0		2.3E+3 ± 9.9E+2 1.2E+3 - 3.8E+3 6 / 6	Ply Hrbr: 2.5E+3 ± 1.1E+3 1.5E+3 - 3.8E+3 4 / 4	1.6E+3 ± 1.7E+3 1.3E+2 - 3.2E+3 4 / 4
Mn-54	10 0	130	<LLD <LLD 0 / 6	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
Fe-59	10 0	260	<LLD <LLD 0 / 6	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
Co-58	10 0	130	<LLD <LLD 0 / 6	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
Co-60	10 0	130	<LLD <LLD 0 / 6	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
Zn-65	10 0	260	<LLD <LLD 0 / 6	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
Cs-134	10 0	130	<LLD <LLD 0 / 6	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
Cs-137	10 0	150	<LLD <LLD 0 / 6	<LLD <LLD 0 / 4	<LLD <LLD 0 / 4
Ra-226	10 0		5.9E+2 ± 2.8E+2 <LLD - 5.9E+2 1 / 6	Grn Hrbr: 7.3E+2 ± 3.0E+2 <LLD - 7.3E+2 1 / 2	7.3E+2 ± 3.0E+2 <LLD - 7.3E+2 1 / 4
AcTh-228	10 0		<LLD <LLD 0 / 6	<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 2.16-1
Lobster Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2013)

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		2.8E+3 ± 5.4E+2 2.1E+3 - 3.4E+3 4 / 4	DIS: 2.8E+3 ± 5.4E+2 2.1E+3 - 3.4E+3 4 / 4	1.7E+3 ± 2.4E+2 1.7E+3 - 1.7E+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		6.7E+2 ± 2.3E+2 <LLD - 7.0E+2 2 / 4	DIS: 6.7E+2 ± 2.3E+2 <LLD - 7.0E+2 2 / 4	5.4E+2 ± 3.0E+2 5.4E+2 - 5.4E+2 1 / 1
AcTh-228	5 0		<LLD <LLD 0 / 4	<LLD <LLD 0 / 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 2013)

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 / 5	<LLD <LLD 0 / 5	<LLD <LLD 0 / 4
K-40	8 0		4.8E+3 ± 8.1E+2 3.9E+3 - 5.7E+3 4 / 4	DIS: 4.8E+3 ± 8.1E+2 3.9E+3 - 5.7E+3 4 / 4	4.5E+3 ± 5.2E+2 3.9E+3 - 4.9E+3 4 / 4
Mn-54	8 0	130	<LLD <LLD 0 / 5	<LLD <LLD 0 / 5	<LLD <LLD 0 / 4
Fe-59	8 0	260	<LLD <LLD 0 / 5	<LLD <LLD 0 / 5	<LLD <LLD 0 / 4
Co-58	8 0	130	<LLD <LLD 0 / 5	<LLD <LLD 0 / 5	<LLD <LLD 0 / 4
Co-60	8 0	130	<LLD <LLD 0 / 5	<LLD <LLD 0 / 5	<LLD <LLD 0 / 4
Zn-65	8 0	260	<LLD <LLD 0 / 5	<LLD <LLD 0 / 5	<LLD <LLD 0 / 4
Cs-134	8 0	130	<LLD <LLD 0 / 5	<LLD <LLD 0 / 5	<LLD <LLD 0 / 4
Cs-137	8 0	150	<LLD <LLD 0 / 5	<LLD <LLD 0 / 5	<LLD <LLD 0 / 4
Ra-226	8 0		1.3E+3 ± 5.7E+2 <LLD - 1.7E+3 2 / 4	DIS: 1.3E+3 ± 5.7E+2 <LLD - 1.7E+3 2 / 4	8.1E+2 ± 1.8E+2 <LLD - 8.8E+2 3 / 4
AcTh-228	8 0		<LLD <LLD 0 / 5	<LLD <LLD 0 / 5	<LLD <LLD 0 / 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

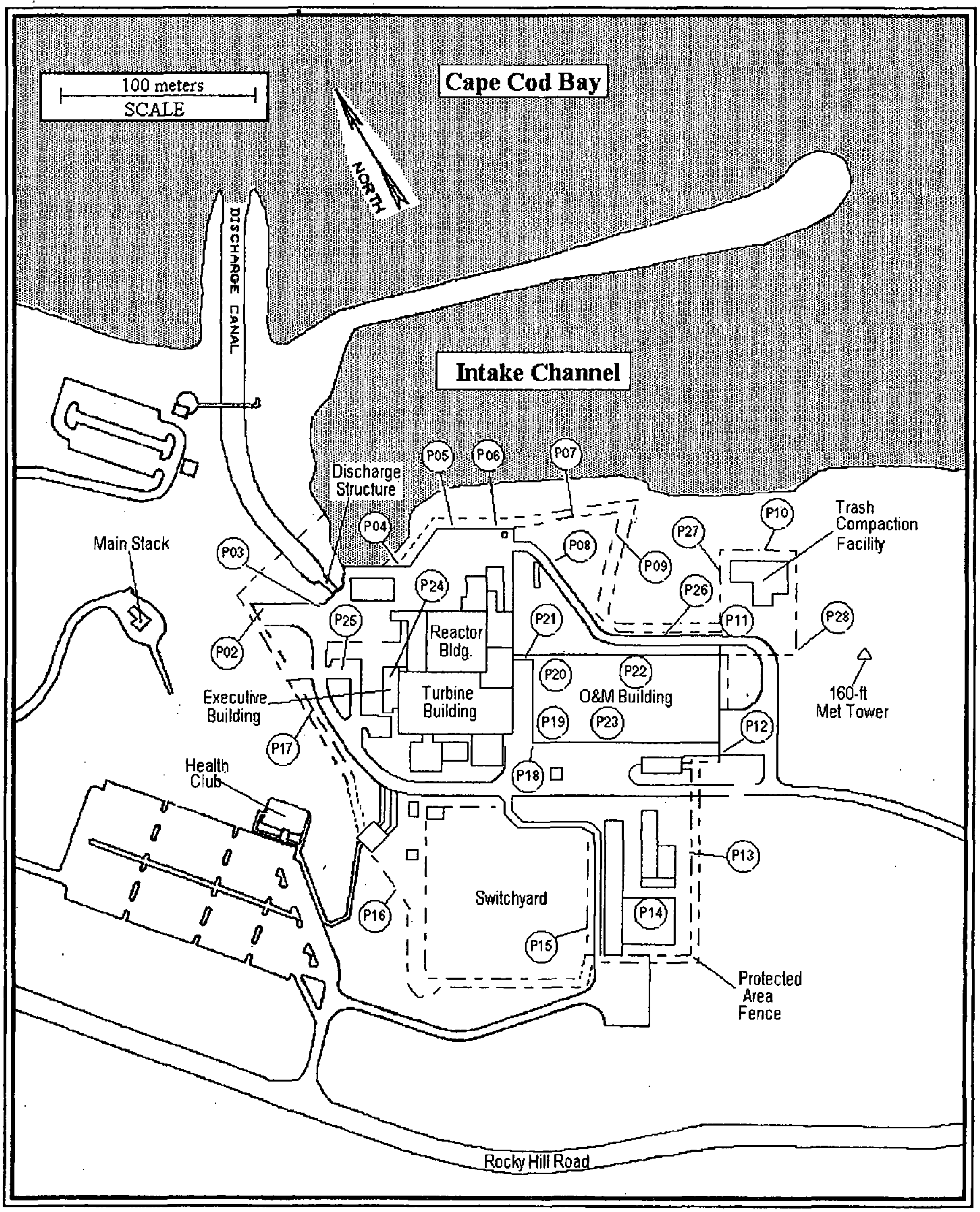


Figure 2.2-2

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

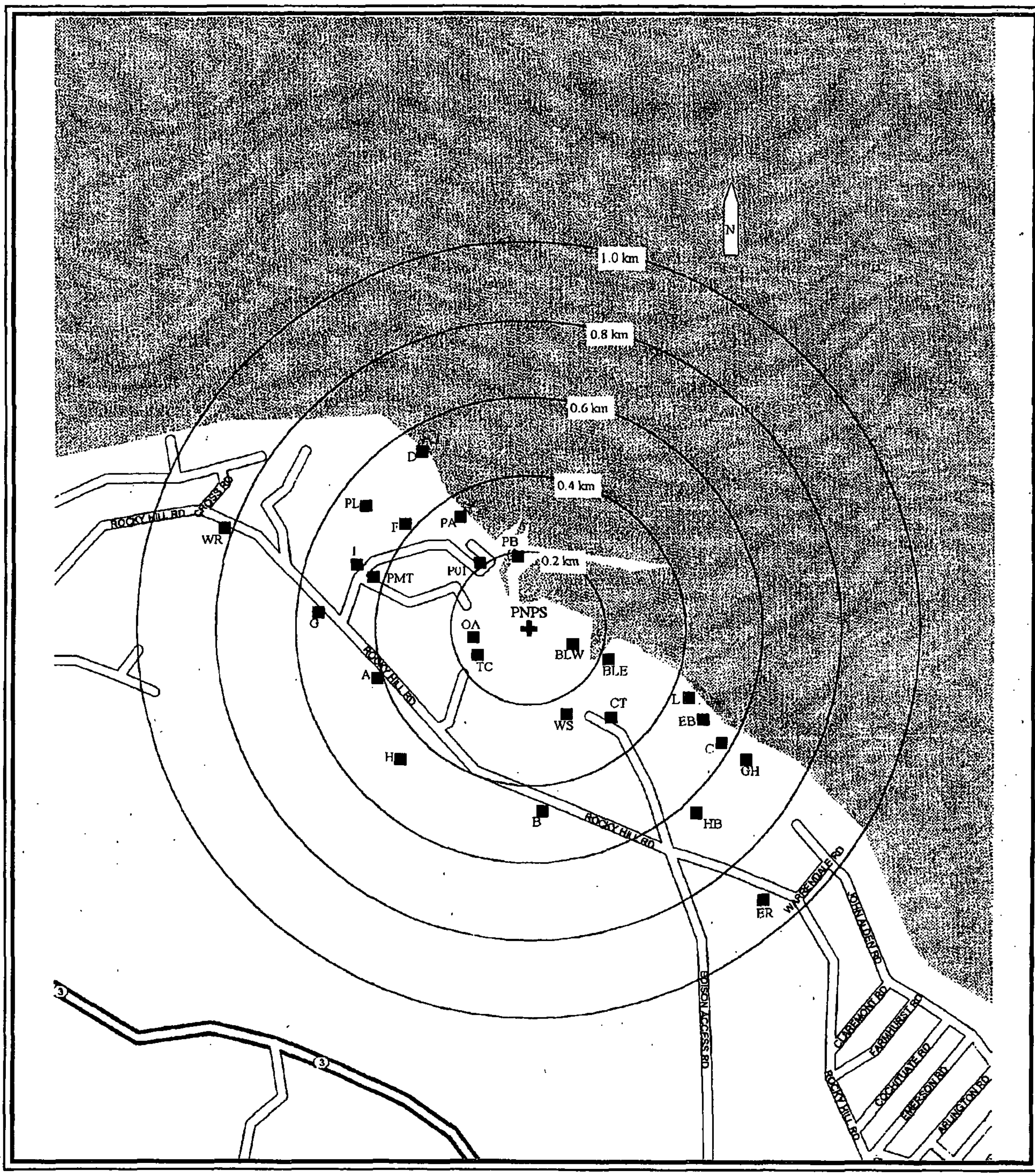


Figure 2.2-3

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

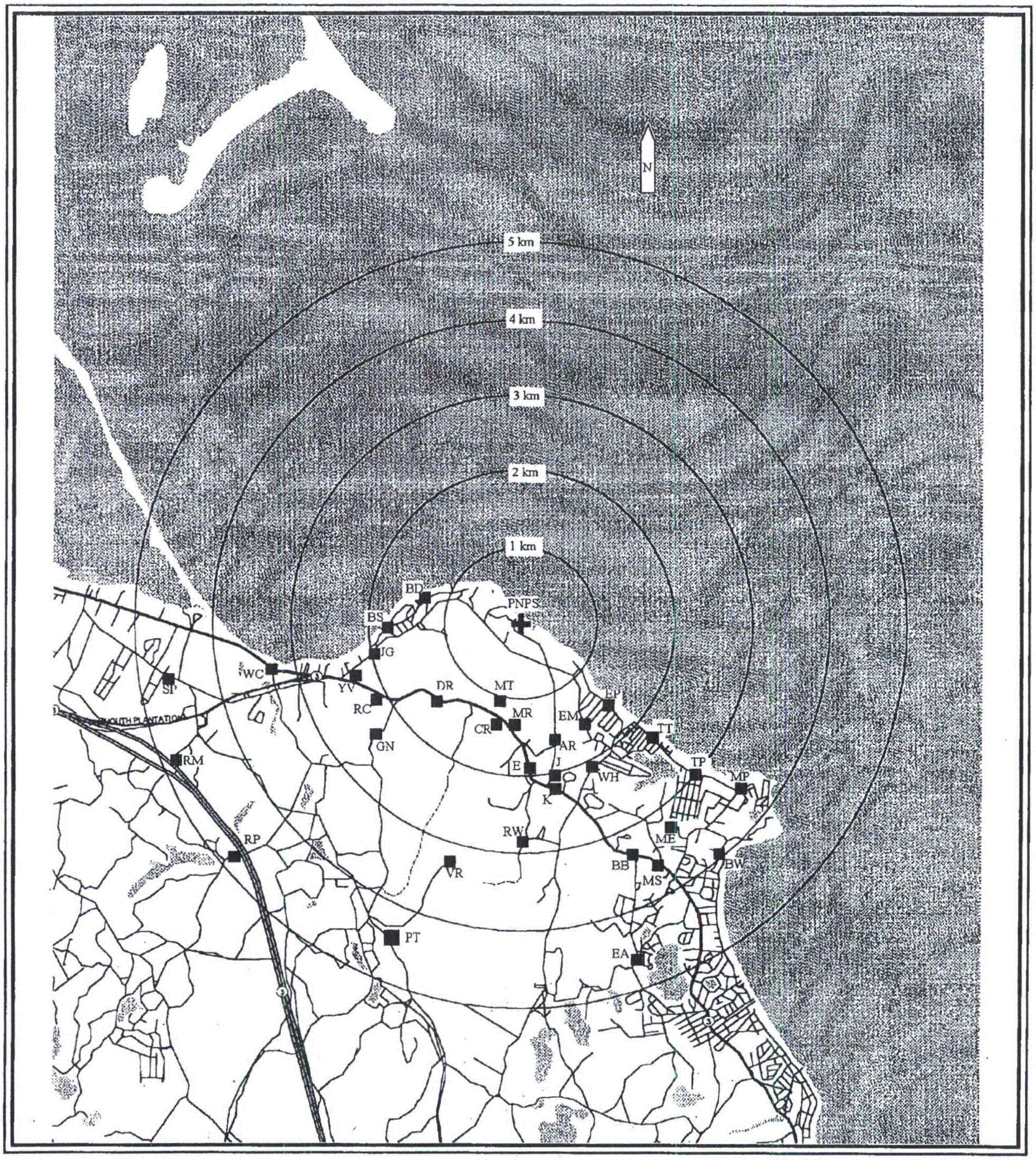


Figure 2.2-4

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

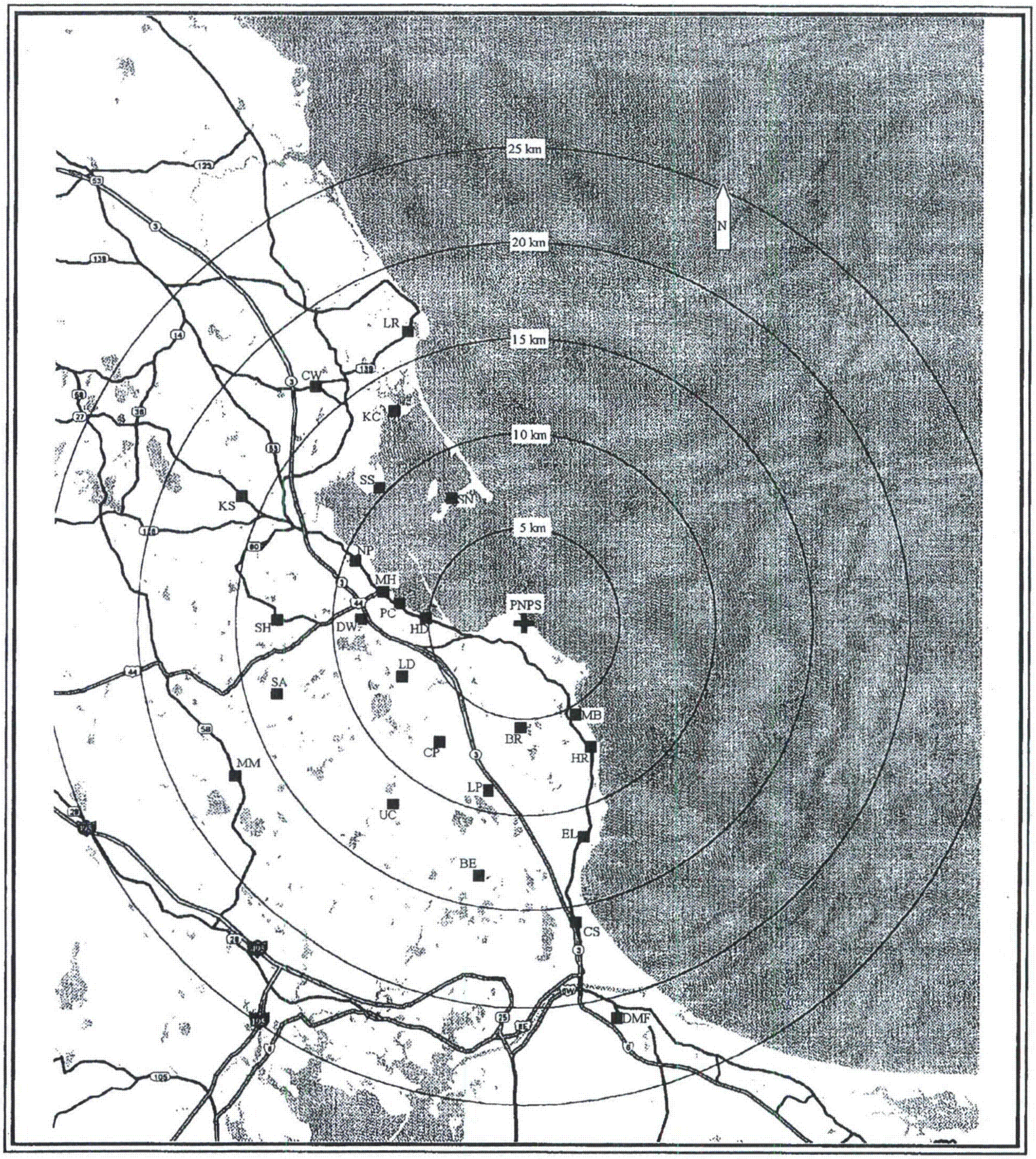


Figure 2.2-5

Terrestrial and Aquatic Sampling Locations

Description	Code	Distance/Direction*	Description	Code	Distance/Direction*
<u>FORAGE</u>			<u>SURFACE WATER</u>		
Plymouth County Farm	CF	5.6 km W	Discharge Canal	DIS	0.2 km N
Bridgewater Control	BF	31 km W	Bartlett Pond	BP	2.7 km SE
Hanson Farm Control	HN	34 km W	Powder Point Control	PP	13 km NNW
			<u>SEDIMENT</u>		
			Discharge Canal Outfall	DIS	0.8 km NE
			Plymouth Beach	PLB	4.0 km W
			Manomet Point	MP	3.3 km ESE
<u>VEGETABLES/VEGETATION</u>			Plymouth Harbor	PLY-H	4.1 km W
Site Boundary C	BC	0.5 km SW	Duxbury Bay Control	DUX-BAY	14 km NNW
Site Boundary B	BB	0.5 km ESE	Green Harbor Control	GH	16 km NNW
Rocky Hill Road	RH	0.9 km SE			
Site Boundary D	Bd	1.1 km S	<u>IRISH MOSS</u>		
Site Boundary A	BA	1.5 km SSW	Discharge Canal Outfall	DIS	0.7 km NNE
Clay Hill Road	CH	1.6 km W	Manomet Point	MP	4.0 km ESE
Brook Road	BK	2.9 km SSE	Ellisville	EL	12 km SSE
Beaver Dam Road	BD	3.4 km S	Brant Rock Control	BK	18 km NNW
Plymouth County Farm	CF	5.6 km W			
Hanson Farm Control	HN	34 km W	<u>SHELLFISH</u>		
Norton Control	NC	50 km W	Discharge Canal Outfall	DIS	0.7 km NNE
			Plymouth Harbor	PLY-H	4.1 km W
<u>CRANBERRIES</u>			Manomet Point	MP	4.0 km ESE
Bartlett Road Bog	BT	4.3 km SSE	Duxbury Bay Control	DUX-BAY	13 km NNW
Beaverdam Road Bog	MR	3.4 km S	Powder Point Control	PP	13 km NNW
Hollow Farm Bog Control	HF	16 km WNW	Green Harbor Control	GH	16 km NNW
			<u>LOBSTER</u>		
			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
			<u>FISHES</u>		
			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

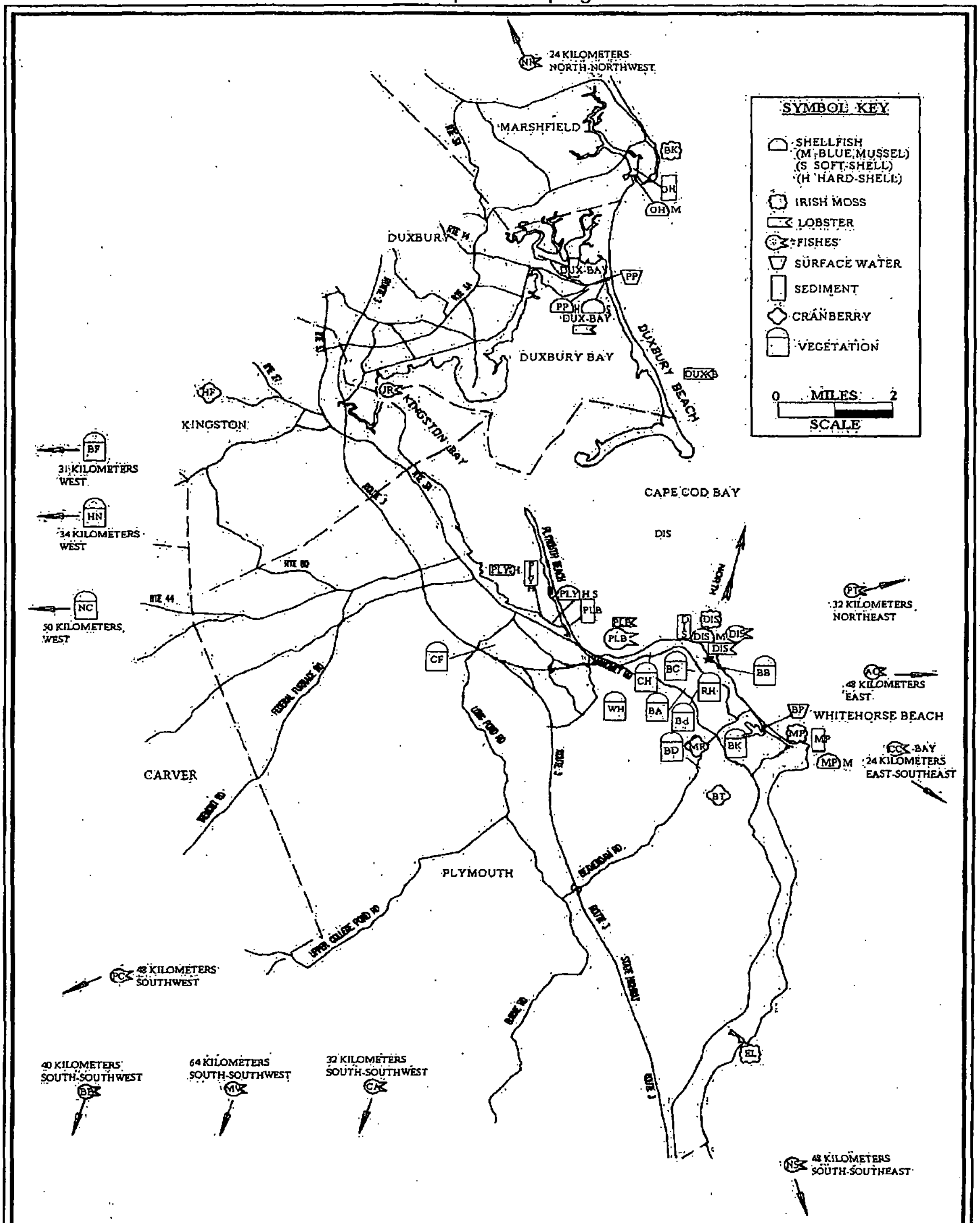


Figure 2.2-6

Environmental Sampling And Measurement Control Locations

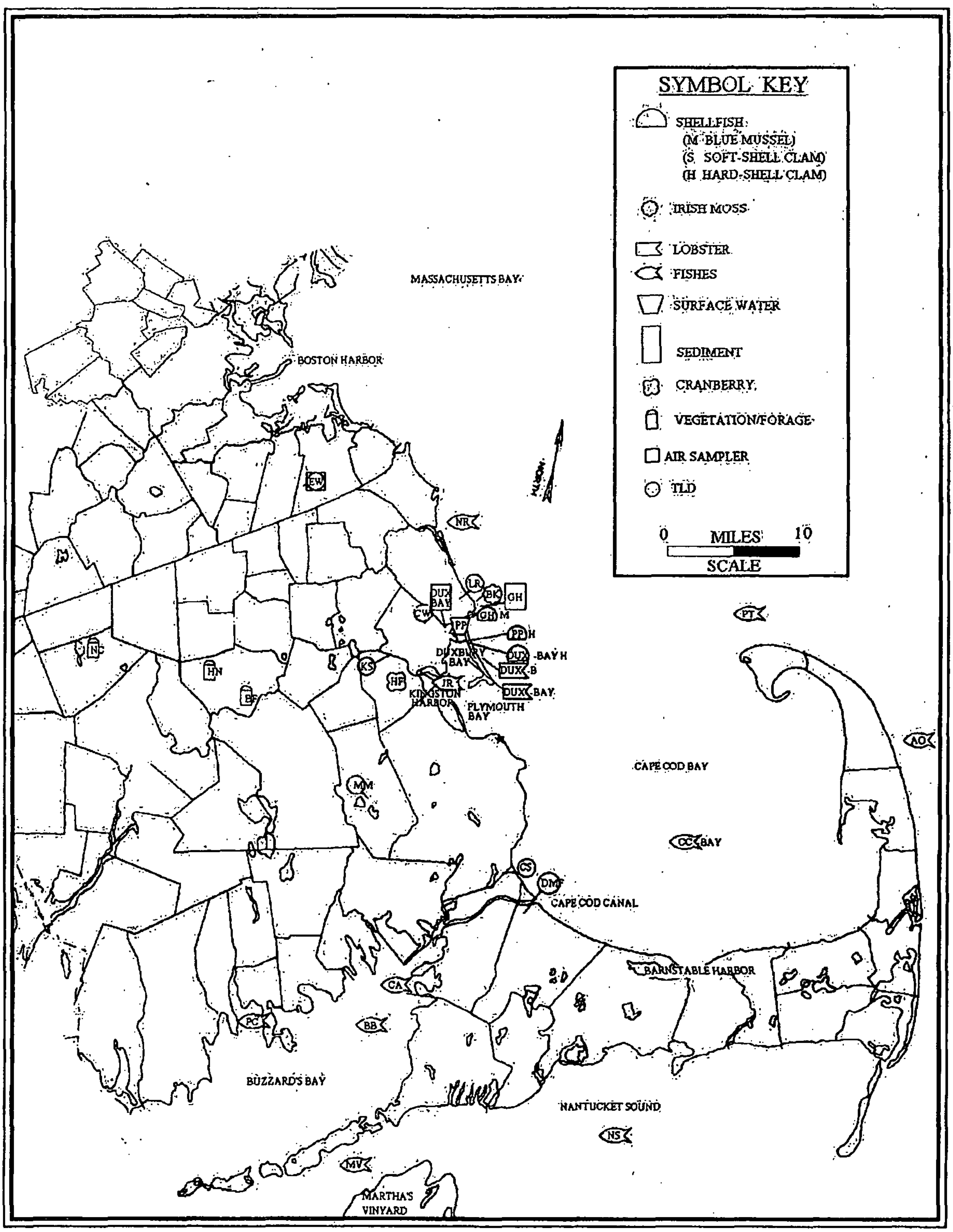
Description	Code	Distance/Direction*
<u>TLD</u>		
Cedarville Substation	CS	16 km S
Kingston Substation	KS	16 km WNW
Landing Road	LR	16 km NNW
Church & West Street	CW	17 km NW
Main & Meadow Street	MM	17 km WSW
Div. Marine Fisheries	DMF	21 km SSE
East Weymouth Substation	EW	40 km NW
<u>AIR SAMPLER</u>		
East Weymouth Substation	EW	40 km NW
<u>FORAGE</u>		
Bridgewater Control	BF	31 km W
Hanson Farm Control	HN	34 km W
<u>VEGETABLES/VEGETATION</u>		
Hanson Farm Control	HN	34 km W
Norton Control	NC	50 km W
<u>CRANBERRIES</u>		
Hollow Farm Bog Control	HF	16 km WNW

Description	Code	Distance/Direction*
<u>SURFACE WATER</u>		
Powder Point Control	PP	13 km NNW
<u>SEDIMENT</u>		
Duxbury Bay Control	DUX-BAY	14 km NNW
Green Harbor Control	GH	16 km NNW
<u>IRISH MOSS</u>		
Brant Rock Control	BK	18 km NNW
<u>SHELLFISH</u>		
Duxbury Bay Control	DUX-BAY	13 km NNW
Powder Point Control	PP	13 km NNW
Green Harbor Control	GH	16 km NNW
<u>LOBSTER</u>		
Duxbury Bay Control	DUX-BAY	11 km NNW
<u>FISHES</u>		
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



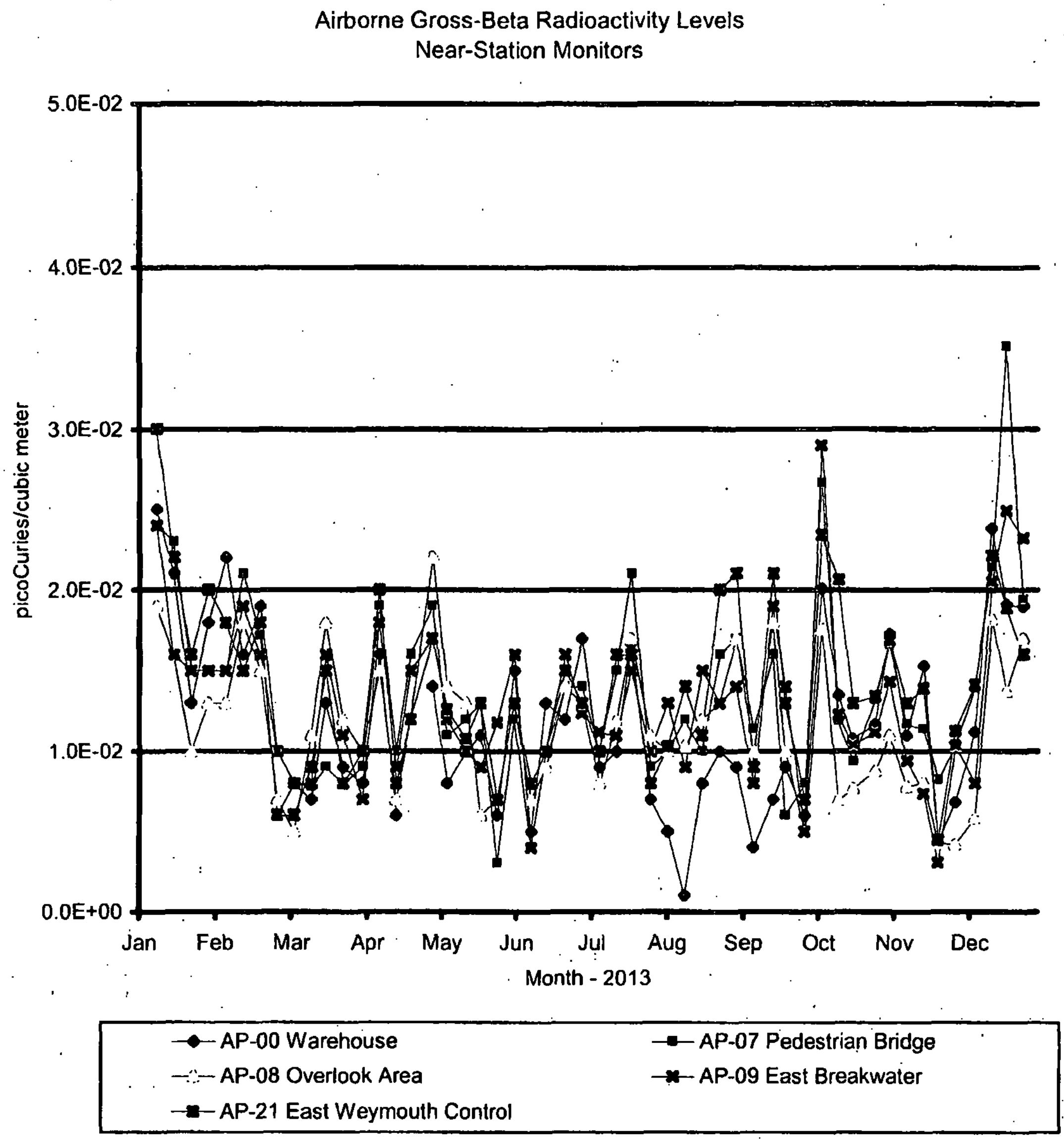


Figure 2.5-1
Airborne Gross-Beta Radioactivity Levels: Near Station Monitors

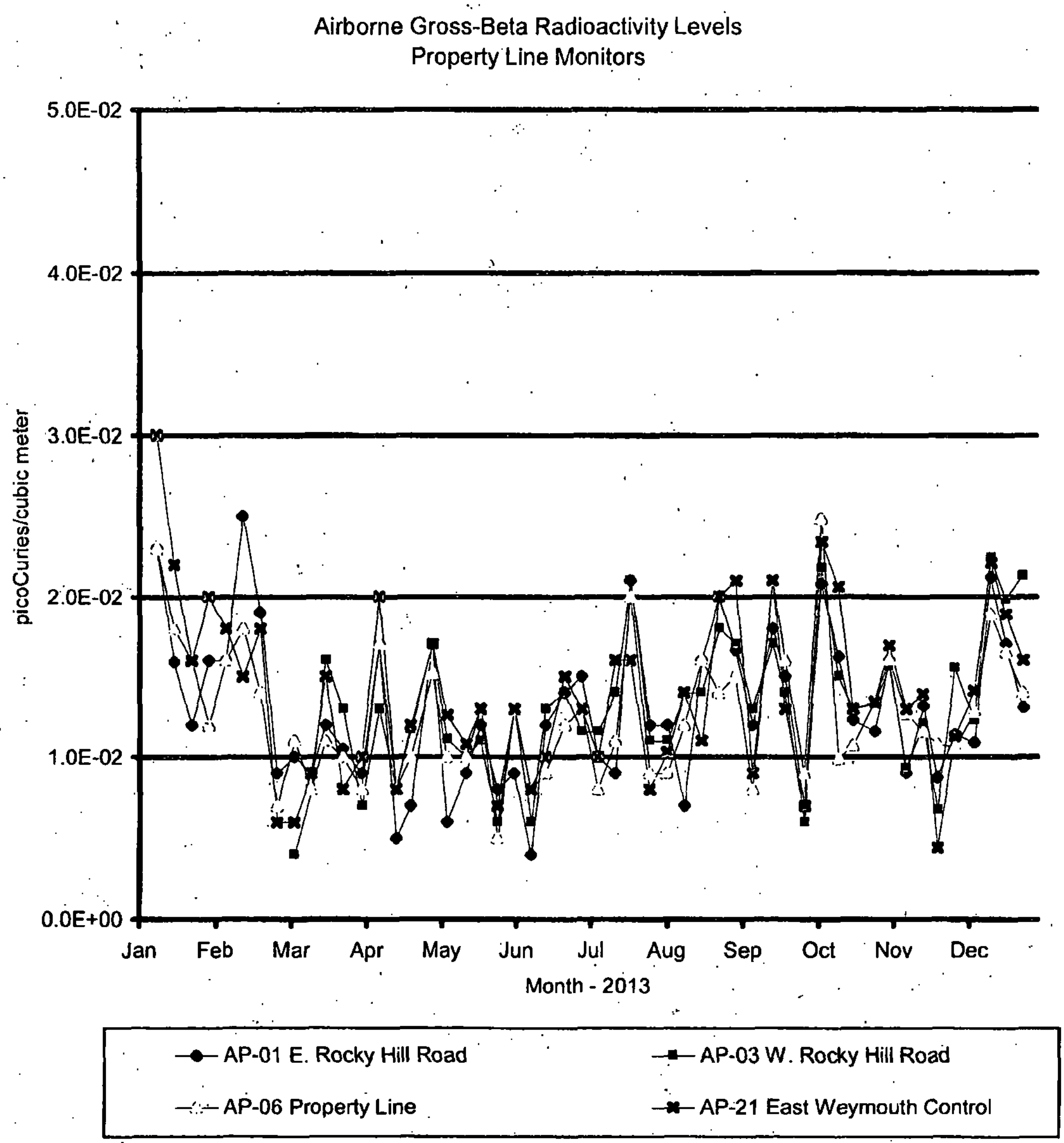


Figure 2.5-2
Airborne Gross-Beta Radioactivity Levels: Property Line Monitors

Airborne Gross-Beta Radioactivity Levels
Offsite Monitors

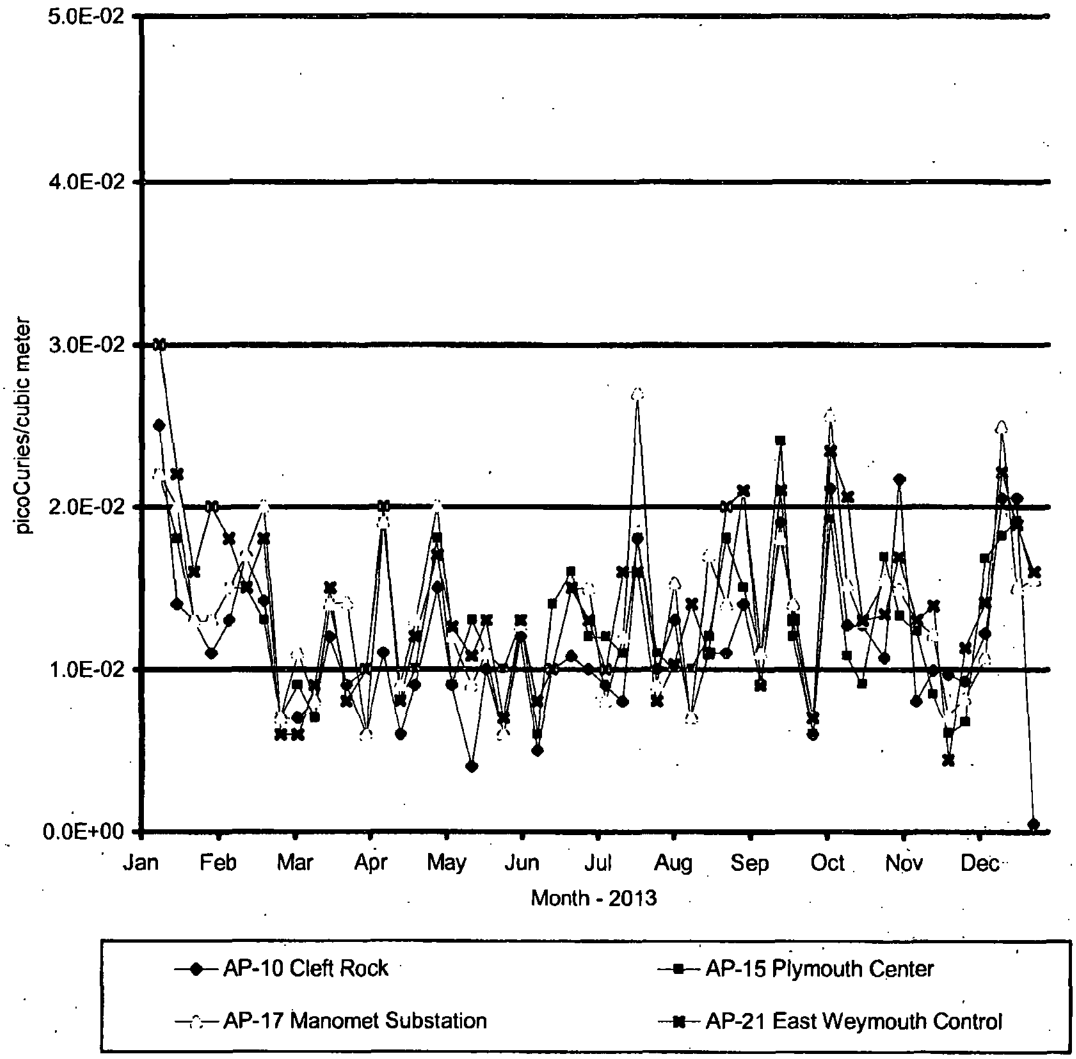


Figure 2.5-3
Airborne Gross-Beta Radioactivity Levels: Offsite Monitors

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 2013 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 Release Report" for the period of January 1 through December 31, 2013 (Reference 17).

Table 3.0-1

Radiation Doses from 2013 Pilgrim Station Operations

Receptor	Maximum Individual Dose From Exposure Pathway - mrem/yr			
	Gaseous Effluents*	Liquid Effluents	Ambient Radiation**	Total
Total Body	0.032	0.0027	0.43	0.47
Thyroid	0.037	0.00027	0.43	0.47
Max. Organ	0.066	0.0021	0.43	0.50

* 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 sources of radiation. Such radiation doses are summarized in Table 1.2-1. The typical American receives about 620 mrem/yr from such sources.

As can be seen from the doses resulting from Pilgrim Station Operations during 2013, 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 9, June 2003.

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.

17) Pilgrim Nuclear Power Station, "Annual Radioactive Effluent Release Report", May 2013.

APPENDIX A

SPECIAL STUDIES

There were no environmental samples collected during 2013 that contained plant-related radioactivity. Therefore, no special studies were required to estimate dose from plant-related activity.

APPENDIX B

Effluent Release Information

Table B.1
Pilgrim Nuclear Power Station
Annual Radioactive Effluent Release Report
Supplemental Information
January-December 2013

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 2013	Apr-Jun 2013	Jul-Sep 2013	Oct-Dec 2013	Jan-Dec 2013
a. Liquid Effluents					
1. Total number of releases:	5.00E+00	1.20E+01	N/A	4.00E+00	2.10E+01
2. Total time period (minutes):	6.29E+02	1.18E+03	N/A	2.36E+03	4.16E+03
3. Maximum time period (minutes):	1.70E+02	1.22E+02	N/A	6.35E+02	6.35E+02
4. Average time period (minutes):	1.26E+02	9.81E+01	N/A	5.89E+02	2.71E+02
5. Minimum time period (minutes):	9.90E+01	7.50E+01	N/A	5.20E+02	7.50E+01
6. Average stream flow during periods of release of effluents into a flowing stream (Liters/min):	1.20E+06	9.39E+05	N/A	1.17E+06	1.11E+06
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
Annual Radioactive Effluent Release Report
Gaseous Effluents - Summation of All Releases
January-December 2013

RELEASE PERIOD	Jan-Mar 2013	Apr-Jun 2013	Jul-Sep 2013	Oct-Dec 2013	Jan-Dec 2013	Est. Total Error
A. FISSION AND ACTIVATION GASES						
Total Release: Ci	0.00E+00	0.00E+00	2.91E-01	0.00E+00	2.91E-01	±22%
Average Release Rate: μCi/sec	0.00E+00	0.00E+00	3.69E-02	0.00E+00	9.23E-03	
Percent of Effluent Control Limit*	*	*	*	*	*	
B. IODINE-131						
Total Iodine-131 Release: Ci	1.84E-04	9.29E-05	5.91E-05	1.71E-04	5.08E-04	±20%
Average Release Rate: μCi/sec	2.34E-05	1.18E-05	7.50E-06	2.17E-05	1.61E-05	
Percent of Effluent Control Limit*	*	*	*	*	*	
C. PARTICULATES WITH HALF-LIVES > 8 DAYS						
Total Release: Ci	2.78E-04	1.72E-04	5.50E-05	1.62E-04	6.67E-04	±21%
Average Release Rate: μCi/sec	3.53E-05	2.18E-05	6.97E-06	2.05E-05	2.12E-05	
Percent of Effluent Control Limit*	*	*	*	*	*	
Gross Alpha Radioactivity: Ci	NDA	NDA	NDA	NDA	NDA	
D. TRITIUM						
Total Release: Ci	6.24E+00	6.44E+00	2.34E+01	2.79E+01	6.40E+01	±20%
Average Release Rate: μCi/sec	7.91E-01	8.17E-01	2.97E+00	3.53E+00	2.03E+00	
Percent of Effluent Control Limit*	*	*	*	*	*	
E. CARBON-14						
Total Release: Ci	1.51E+00	9.73E-01	1.90E+00	1.87E+00	6.26E+00	N/A
Average Release Rate: μCi/sec	1.91E-01	1.23E-01	2.41E-01	2.38E-01	1.98E-01	
Percent of Effluent Control Limit*	*	*	*	*	*	

Notes for Table B.2-A:

* Percent of Effluent Control Limit values based on dose assessments are provided in Section 6 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.
3. N/A stands for not applicable.

Table B.2-B
Pilgrim Nuclear Power Station
Annual Radioactive Effluent Release Report
Gaseous Effluents – Elevated Release
January-December 2013

CONTINUOUS MODE RELEASES FROM ELEVATED RELEASE POINT					
Nuclide Released	Jan-Mar 2013	Apr-Jun 2013	Jul-Sep 2013	Oct-Dec 2013	Jan-Dec 2013
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	0.00E+00	0.00E+00
Kr-87	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-133m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-135	0.00E+00	0.00E+00	2.91E-01	0.00E+00	2.91E-01
Xe-135m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for Period	0.00E+00	0.00E+00	2.91E-01	0.00E+00	2.91E-01
2. IODINES: Ci					
I-131	1.24E-05	1.52E-06	4.34E-06	3.90E-06	2.21E-05
I-133	1.14E-05	0.00E+00	0.00E+00	0.00E+00	1.14E-05
Total for Period	2.38E-05	1.52E-06	4.34E-06	3.90E-06	3.35E-05
3. PARTICULATES WITH HALF-LIVES > 8 DAYS: Ci					
Cr-51	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mn-54	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe-59	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-58	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-60	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zn-65	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-134	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	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4. TRITIUM: Ci					
H-3	1.53E-02	2.97E-02	5.30E-02	3.77E-02	1.36E-01
5. CARBON-14: Ci					
C-14	1.46E+00	9.43E-01	1.85E+00	1.82E+00	6.07E+00

Notes for Table B.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
Annual Radioactive Effluent Release Report
Gaseous Effluents – Elevated Release
January-December 2013

BATCH MODE RELEASES FROM ELEVATED RELEASE POINT					
Nuclide Released	Jan-Mar 2013	Apr-Jun 2013	Jul-Sep 2013	Oct-Dec 2013	Jan-Dec 2013
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
Ru-103	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
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
5. CARBON-14: Ci					
C-14	N/A	N/A	N/A	N/A	N/A

Notes for Table B.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
Annual Radioactive Effluent Release Report
Gaseous Effluents – Ground-Level Release
January-December 2013

CONTINUOUS MODE RELEASES FROM GROUND-LEVEL RELEASE POINT					
Nuclide Released	Jan-Mar 2013	Apr-Jun 2013	Jul-Sep 2013	Oct-Dec 2013	Jan-Dec 2013
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	0.00E+00	0.00E+00
Kr-87	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-133m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-135	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-135m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total for period	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. IODINES: Ci					
I-131	1.72E-04	9.14E-05	5.48E-05	1.68E-04	4.85E-04
I-133	6.23E-04	1.39E-04	1.80E-04	5.21E-04	1.46E-03
Total for period	7.94E-04	2.30E-04	2.35E-04	6.89E-04	1.95E-03
3. PARTICULATES WITH HALF-LIVES > 8 DAYS: Ci					
Cr-51	0.00E+00	2.10E-05	0.00E+00	0.00E+00	2.10E-05
Mn-54	2.84E-06	1.56E-05	5.08E-06	1.42E-05	3.77E-05
Fe-59	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-58	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-60	0.00E+00	6.34E-05	1.63E-05	2.74E-05	1.07E-04
Zn-65	0.00E+00	1.73E-05	0.00E+00	6.14E-06	2.34E-05
Sr-89	0.00E+00	0.00E+00	1.02E-05	1.96E-05	2.98E-05
Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-103	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-134	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	2.75E-04	5.47E-05	2.34E-05	9.45E-05	4.48E-04
Total for period	2.78E-04	1.72E-04	5.50E-05	1.62E-04	6.67E-04
4. TRITIUM: Ci					
H-3	6.22E+00	6.41E+00	2.34E+01	2.78E+01	6.38E+01
5. CARBON-14: Ci					
C-14	4.53E-02	2.92E-02	5.71E-02	5.62E-02	1.88E-01

Notes for Table B.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
Annual Radioactive Effluent Release Report
Gaseous Effluents – Ground-Level Release
January-December 2013

BATCH MODE RELEASES FROM GROUND-LEVEL RELEASE POINT					
Nuclide Released	Jan-Mar 2013	Apr-Jun 2013	Jul-Sep 2013	Oct-Dec 2013	Jan-Dec 2013
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
Ru-103	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
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
5. CARBON-14: Ci					
C-14	N/A	N/A	N/A	N/A	N/A

Notes for Table B.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
Annual Radioactive Effluent Release Report
Liquid Effluents - Summation of All Releases
January-December 2013

RELEASE PERIOD	Jan-Mar 2013	Apr-Jun 2013	Jul-Sep 2013	Oct-Dec 2013	Jan-Dec 2013	Est. Total Error
A. FISSION AND ACTIVATION PRODUCTS						
Total Release (not including tritium, gases, alpha): Ci	3.98E-06	1.89E-02	N/A	2.93E-05	1.89E-02	±12%
Average Diluted Concentration During Period: µCi/mL	2.73E-14	1.74E-10	N/A	1.89E-13	3.36E-11	
Percent of Effluent Concentration Limit*	9.11E-08%	2.47E-03%	N/A	1.32E-05%	4.81E-04%	
B. TRITIUM						
Total Release: Ci	8.10E-01	5.25E+00	N/A	1.57E-01	6.21E+00	±9.4%
Average Diluted Concentration During Period: µCi/mL	5.57E-09	4.81E-08	N/A	1.01E-09	1.10E-08	
Percent of Effluent Concentration Limit*	5.57E-04%	4.81E-03%	N/A	1.01E-04%	1.10E-03%	
C. DISSOLVED AND ENTRAINED GASES						
Total Release: Ci	NDA	NDA	N/A	NDA	NDA	±16%
Average Diluted Concentration During Period: µCi/mL	NDA	NDA	N/A	NDA	NDA	
Percent of Effluent Concentration Limit*	0.00E+00%	0.00E+00%	N/A	0.00E+00%	0.00E+00%	
D. GROSS ALPHA RADIOACTIVITY						
Total Release: Ci	NDA	N/A	N/A	N/A	NDA	±34%
E. VOLUME OF WASTE RELEASED PRIOR TO DILUTION						
Waste Volume: Liters	2.11E+05	8.30E+05	N/A	1.37E+05	1.18E+06	±5.7%
F. VOLUME OF DILUTION WATER USED DURING PERIOD						
Dilution Volume: Liters	1.46E+11	1.09E+11	1.55E+11	1.55E+11	5.65E+11	±10%

Notes for Table B.3-A:

* Additional percent of Effluent Control Limit values based on dose assessments are provided in Section 6 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
Annual Radioactive Effluent Release Report
Liquid Effluents
January-December 2013

CONTINUOUS MODE RELEASES					
Nuclide Released	Jan-Mar 2013	Apr-Jun 2013	Jul-Sep 2013	Oct-Dec 2013	Jan-Dec 2013
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 B.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
Annual Radioactive Effluent Release Report
Liquid Effluents
January-December 2013

BATCH MODE RELEASES					
Nuclide Released	Jan-Mar 2013	Apr-Jun 2013	Jul-Sep 2013	Oct-Dec 2013	Jan-Dec 2013
1. FISSION AND ACTIVATION PRODUCTS: Ci					
Na-24	0.00E+00	0.00E+00	N/A	0.00E+00	0.00E+00
Cr-51	0.00E+00	4.50E-03	N/A	0.00E+00	4.50E-03
Mn-54	3.98E-06	3.73E-03	N/A	3.02E-06	3.74E-03
Fe-55	0.00E+00	5.72E-04	N/A	0.00E+00	5.72E-04
Fe-59	0.00E+00	1.11E-03	N/A	0.00E+00	1.11E-03
Co-58	0.00E+00	4.89E-04	N/A	0.00E+00	4.89E-04
Co-60	0.00E+00	5.73E-03	N/A	8.86E-06	5.74E-03
Zn-65	0.00E+00	1.57E-03	N/A	0.00E+00	1.57E-03
Zn-69m	0.00E+00	0.00E+00	N/A	0.00E+00	0.00E+00
Sr-89	0.00E+00	0.00E+00	N/A	0.00E+00	0.00E+00
Sr-90	0.00E+00	0.00E+00	N/A	0.00E+00	0.00E+00
Zr/Nb-95	0.00E+00	4.69E-05	N/A	0.00E+00	4.69E-05
Mo/Tc-99	0.00E+00	0.00E+00	N/A	0.00E+00	0.00E+00
Ag-110m	0.00E+00	1.08E-03	N/A	0.00E+00	1.08E-03
Sb-124	0.00E+00	9.60E-05	N/A	0.00E+00	9.60E-05
I-131	0.00E+00	0.00E+00	N/A	0.00E+00	0.00E+00
I-133	0.00E+00	0.00E+00	N/A	0.00E+00	0.00E+00
Cs-134	0.00E+00	0.00E+00	N/A	0.00E+00	0.00E+00
Cs-137	0.00E+00	0.00E+00	N/A	1.74E-05	1.74E-05
Ba/La-140	0.00E+00	0.00E+00	N/A	0.00E+00	0.00E+00
Ce-141	0.00E+00	0.00E+00	N/A	0.00E+00	0.00E+00
Ce-144	0.00E+00	0.00E+00	N/A	0.00E+00	0.00E+00
Total for period	3.98E-06	1.89E-02	N/A	2.93E-05	1.89E-02
2. DISSOLVED AND ENTRAINED GASES: Ci					
Xe-133	NDA	NDA	N/A	NDA	NDA
Xe-135	NDA	NDA	N/A	NDA	NDA
Total for period	NDA	NDA	N/A	NDA	NDA

Notes for Table B.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 September 09 and September 20, 2013. 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 30 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 2013 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
Rocky Hill Road	1.8 km SSE
Clay Hill Road	1.6 km W

Additional samples of naturally-growing vegetation were collected at the site boundary in the ESE and SE sectors to monitor for atmospheric deposition in the vicinity of the nearest resident in the SE sector.

In addition to these special sampling locations identified and sampled in conjunction with the 2013 land use census, samples were also collected at or near the Plymouth County Farm (5.6 km W), and from control locations in Bridgewater (31 km W), Sandwich (21 km SSE), and Norton (49 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. Although milk sampling is not performed at Plimoth Plantation, effluent dose calculations are performed for this location assuming the presence of a milk ingestion pathway, as part of the Annual Radioactive Effluent Release Report (Reference 17).

APPENDIX D

ENVIRONMENTAL MONITORING PROGRAM DISCREPANCIES

There were a number of instances during 2013 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 2013, nine offsite thermoluminescent dosimeters (TLD) were not recovered from their assigned locations during the quarterly retrieval process. Degradation of the plastic cages housing the TLDs resulted in the loss of the following TLDs: Emerson & Priscilla - EP (Qtr 1); Greenwood House – GH (Qtr 3); Warren & Clifford – WC (Qtr 3); Hall's Bog – HB (Qtr 4); Manomet Elementary – ME (Qtr 4); and College Pond – CP (Qtr 4). In each of these cases, the plastic cage holding the TLD were replaced and a new TLD posted. The TLD at Hyannis Road – HR was vandalized during both the 1st and 2nd quarters of 2013. The TLD at this location was relocated a short distance to be less conspicuous. Turing the 4th Quarter exchange of TLDs in early January- 2014, the TLD at Valley Road – VR could not be retrieved due to snow-covered roads leading to this remote location. The TLD was recovered during the retrieval of 1st Quarter 2014 TLDs in April 2014, and will be analyzed to determine the average dose at that location during the two periods represented by that TLD. Despite these losses, the 431 TLDs that were collected (98.0%) 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 2013. 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 lower limits of detection (LLDs) were met for both airborne particulates and iodine-131 on 563 of the 563 filters/cartridges collected.

Out of 572 filters (11 locations * 52 weeks), 563 samples were collected and analyzed during 2013. A problem occurred at location WR when tree trimming activities on 14-Aug-2012 resulted in damage to the electrical service and sampling station. The sampler was not repaired until 28-Feb-2013, resulting in the loss of sampling capabilities at this location for the last 21 weeks of 2012, and the first eight weeks of 2013. This event is described in Condition Report CR-PNP-2012-3545. There were also 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. All required LLDs were achieved on these samples. Winter Storm Nemo resulted in wide-scale loss of power during the week of 05-Feb through 12-Feb-2103. Power interruptions of greater than 24-hours occurred from this storm at Property Line, Pedestrian Bridge, Cleft Rock, Manomet Substation, East Rocky Hill Road, East Breakwater; and Medical Building.

The configuration of air samplers that had been in use at Pilgrim Station since the early 1980s, was replaced between June and August of 2012. Both the pumps and dry gas meters were replaced, and operating experience since changing over to the new configuration has been favorable. Although the occurrence of pump failures and gas meter problems have been largely eliminated, the new configuration is still subject to trips of the ground fault interrupt circuit (GFCI). Such problems can be encountered at air samplers located at the East Breakwater and Pedestrian Bridge. Both of these locations are immediately adjacent to the shoreline and are subject to significant wind-blown salt water, and are prone to tripping of the GFCI. The following table contains a listing of larger problems encountered with air sampling stations during 2013, many of which resulted in loss of more than 24 hours in a sampling period.

Location	Sampling Period	Sampling Hours Lost	Problem Description
WR	01/02 to 02/28	1375 of 1375	Sampling station damaged during tree trimming activities in Aug-2012; condition report CR-PNP-2012-3545; repaired 02/28/2013
PL	02/05 to 02/12	36.1 of 174.9	Power loss from Winter Storm Nemo
PB	02/05 to 02/12	57.4 of 170.3	Power loss from Winter Storm Nemo
CR	02/05 to 02/12	33.3 of 170.5	Power loss from Winter Storm Nemo
MS	02/05 to 02/12	30.7 of 170.3	Power loss from Winter Storm Nemo
ER	02/05 to 02/12	90.8 of 173.9	Power loss from Winter Storm Nemo
EB	02/05 to 02/12	36.1 of 170.5	Power loss from Winter Storm Nemo
WS	02/05 to 02/12	36.1 of 168.8	Power loss from Winter Storm Nemo
OA	04/22 to 05/01	72.1 of 220	Load shed activity of power feed from Main Stack during refueling outage.
WS	06/11 to 06/17	139 of 139	Faulty circuit breaker feeding power to sampling station.
WR	6/25 to 07/09	None 0.0 of 336.5	Filter left on for 2-week period due to inaccessibility at location of sampler
PB	10/14 to 10/21	39.3 of 156.3	Loss of offsite power caused GFCI outlet to trip
PB	10/21 to 10/29	23.1 of 191.2	Trip of GFCI outlet
PB	12/10 to 12/17	60.5 of 168.0	Trip of GFCI outlet
CR	12/10 to 12/23	None 0.0 of 311.3	Filter left on for 2-week period due to inaccessibility at location of sampler
PB	12/17 to 12/23	134.5 of 143.3	Pump experienced mechanical failure

Despite the lower-than-normal sampling volumes in the various instances involving power interruptions and equipment failures, required LLDs were met on 563 of the 563 particulate filters, and 563 of the 563 of the iodine cartridges collected during 2013. When viewed collectively during the entire year of 2013, the following sampling recoveries were achieved in the airborne sampling program:

Location	Recovery	Location	Recovery	Location	Recovery
WS	98.7%	PB	96.1%	PC	99.9%
ER	98.9%	OA	98.0%	MS	99.6%
WR	84.2%	EB	99.6%	EW	99.9%
PL	99.5%	CR	99.5%		

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 2006, 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. Additional samples of naturally-occurring vegetation were collected from distant control locations in Sandwich and Norton. As expected for control samples, vegetables and vegetation collected at these locations only contained naturally-occurring radioactivity (Be-7, K-40, and Ac/Th-228).

Some problems were encountered in collection of crop samples during 2013. Crops which had normally been sampled in the past (lettuce, tomatoes, potatoes, and onions) were not grown at the Plymouth County Farm (CF) during 2013. Leafy material from pumpkin plants and corn plants were substituted for the lettuce to analyze for surface deposition of radioactivity on edible plants. Samples of squash, tomatoes, cucumbers, zucchini, and grape leaves were also collected from two other locations in the immediate vicinity of Pilgrim Station. No radionuclides attributed to PNPS operations were detected in any of the 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.

As presented in Table 2.9-1, several samples of naturally-occurring vegetation (leaves from trees, bushes, and herbaceous plants) were collected at a number of locations where the highest atmospheric deposition would be predicted to occur. Some of these samples indicated Cs-137 at concentrations ranging from non-detectable up to 61 pCi/kg. The highest concentration of 61 pCi/kg was detected in a sample of natural vegetation collected from the Pine Hills area of the Pine Hills south of PNPS. This Cs-137 result is within of the normal range of _average_ values expected for weapons-testing fallout (75 to 145 pCi/kg as projected from the pre-operational sampling program). It should be noted that natural vegetation samples collected in the 1990s often showed detectable Cs-137 from nuclear weapons tests up into the range of 300 to 400 pCi/kg, whereas soil samples often indicated concentrations in excess of 2000 pCi/kg. Cs-137 has a 30-year half-life, and measureable concentrations still remain in soil and vegetation as a result of atmospheric nuclear weapons testing performed during the 1950s through 1970s. A review of effluent data presented in Appendix B indicates that there were no measurable airborne releases of Cs-137 from Pilgrim Station during 2013 that could have attributed to these detectable levels. The sample with the highest level of Cs-137 also contained high levels of Ra-226 and AcTh-228, indicating appreciable soil content on the vegetation. This sample of natural vegetation was analyzed "as is" without any measure to clean the samples as normally would be performed prior to consuming vegetables, and would have detected any Cs-137 in soil adhering to those leaves collected. Certain species of plants such as sassafras are also known to concentrate chemical elements like cesium, and this higher-than-expected level is likely due to a combination of external soil contamination and bioconcentration in the leaves of the plants sampled. These levels are not believed to be indicative of any releases associated with Pilgrim Station. No radioactivity attributable to Pilgrim Station was detected in any of the vegetable samples collected during 2013, and results of any detectable naturally-occurring radioactivity were similar to those observed in the preoperational monitoring program.

The cranberry bog at Pine Street Bog in Halifax was not in production during 2013, so a sample could not be obtained from this location. A substitute sample was collected from a bog (Hollow Bog) in Kingston, beyond the influence of Pilgrim Station. In addition, the cranberry bog along Bartlett Road suspended operation during 2013, and was not producing cranberries. Samples were collected from a single indicator location located along Beaverdam Road.

During the week of 05-Feb through 12-Feb-2013, water samples could not be collected from the sampling locations at the Pedestrian Bridge and Bartlett Pond. Both areas were inaccessible due to damage from Winter Storm Nemo.

Additional problems were encountered with composite water samples collected from the Discharge Canal during the weeks of 12-Feb to 19-Feb-2013, and 16-Apr to 22-Apr-2013 when the lift pump suspended in the Discharge Canal failed and water was not provided to the composite sampler. Grab samples were obtained at the time of filter collection to substitute for the normal composite samples that would have been collected during the week. No radioactive liquid discharges were occurring during either of these two periods.

Failure of the peristaltic tubing in the composite sampler also occurred during the weeks of 18-Mar to 25-Mar, and 01-May to 07-May-2013, and grab samples were also substituted for the composite samples. One radioactive liquid discharge of 9686 gallons containing 0.086 Curies of tritium occurred during the week of 18-Mar to 25-Mar, but the dilution in the discharge canal would have resulted in a tritium concentration of about 7.3 pCi/L, which is well below the detection sensitivity for tritium in REMP samples. No tritium was detected in the quarterly composite for the second quarter of 2013. No radioactive liquid discharges occurred during the period covered by the composite sample for the week of 01-Mat to 07-May.

Group I fishes, consisting of winter flounder or yellow-tail flounder are normally collected twice each year in the spring and in the autumn from the vicinity of the Discharge Canal Outfall. When fish sampling occurred in the September to November collection period, no samples of Group I fish could be collected, as the species had already moved to deeper water for the upcoming winter. Repeated and concerted efforts were made to collect these species, but failed to produce any samples.

In summary, the various problems encountered in collecting and analyzing environmental samples during 2013 were relatively minor when viewed in the context of the entire monitoring program. These discrepancies were promptly corrected when issue was identified. None of the discrepancies resulted in an adverse impact on the overall monitoring program.

APPENDIX E

ENVIRONMENTAL DOSIMETRY COMPANY

Annual Quality Assurance Status Report

January – December 2013

ENVIRONMENTAL DOSIMETRY COMPANY

ANNUAL QUALITY ASSURANCE STATUS REPORT

January - December 2013

Prepared By: James R. [signature] Jr Date: 3/19/14

Approved By: [signature] Date: 3/19/14

Environmental Dosimetry Company
10 Ashton Lane
Sterling, MA 01564

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EXECUTIVE SUMMARY

Routine quality control (QC) testing was performed for dosimeters issued by the Environmental Dosimetry Company (EDC).

During this annual period, 100% (72/72) of the individual dosimeters, evaluated against the EDC internal performance acceptance criteria (high-energy photons only), met the criterion for accuracy and 100% (72/72) met the criterion for precision (Table 1). In addition, 100% (12/12) of the dosimeter sets evaluated against the internal tolerance limits met EDC acceptance criteria (Table 2) and 100% (6/6) of independent testing passed the performance criteria (Table 3). Trending graphs, which evaluate performance statistic for high-energy photon irradiations and co-located stations are given in Appendix A.

One internal assessment was performed in 2013. There were no findings.

I. INTRODUCTION

The TLD systems at the Environmental Dosimetry Company (EDC) are calibrated and operated to ensure consistent and accurate evaluation of TLDs. The quality of the dosimetric results reported to EDC clients is ensured by in-house performance testing and independent performance testing by EDC clients, and both internal and client directed program assessments.

The purpose of the dosimetry quality assurance program is to provide performance documentation of the routine processing of EDC dosimeters. Performance testing provides a statistical measure of the bias and precision of dosimetry processing against a reliable standard, which in turn points out any trends or performance changes. Two programs are used:

A. QC Program

Dosimetry quality control tests are performed on EDC Panasonic 814 Environmental dosimeters. These tests include: (1) the in-house testing program coordinated by the EDC QA Officer and (2) independent test perform by EDC clients. In-house test are performed using six pairs of 814 dosimeters, a pair is reported as an individual result and six pairs are reported as the mean result. Results of these tests are described in this report.

Excluded from this report are instrumentation checks. Although instrumentation checks represent an important aspect of the quality assurance program, they are not included as process checks in this report. Instrumentation checks represent between 5-10% of the TLDs processed.

B. QA Program

An internal assessment of dosimetry activities is conducted annually by the Quality Assurance Officer (Reference 1). The purpose of the assessment is to review procedures, results, materials or components to identify opportunities to improve or enhance processes and/or services.

II. PERFORMANCE EVALUATION CRITERIA

A. Acceptance Criteria for Internal Evaluations

1. Bias

For each dosimeter tested, the measure of bias is the percent deviation of the reported result relative to the delivered exposure. The percent deviation relative to the delivered exposure is calculated as follows:

$$\frac{H_i' - H_i}{H_i} 100$$

where:

H_i' = the corresponding reported exposure for the i^{th} dosimeter (i.e., the reported exposure)

H_i = the exposure delivered to the i^{th} irradiated dosimeter (i.e., the delivered exposure)

2. Mean Bias

For each group of test dosimeters, the mean bias is the average percent deviation of the reported result relative to the delivered exposure. The mean percent deviation relative to the delivered exposure is calculated as follows:

$$\sum\left(\frac{H_i' - H_i}{H_i}\right)100\left(\frac{1}{n}\right)$$

where:

H_i' = the corresponding reported exposure for the i^{th} dosimeter (i.e., the reported exposure)

H_i = the exposure delivered to the i^{th} irradiated test dosimeter (i.e., the delivered exposure)

n = the number of dosimeters in the test group

3. Precision

For a group of test dosimeters irradiated to a given exposure, the measure of precision is the percent deviation of individual results relative to the mean reported exposure. At least two values are required for the determination of precision. The measure of precision for the i^{th} dosimeter is:

$$\left(\frac{H_i' - \bar{H}}{\bar{H}}\right)100$$

where:

H_i' = the reported exposure for the i^{th} dosimeter (i.e., the reported exposure)

$\bar{H}$ = the mean reported exposure; i.e., $\bar{H} = \sum H_i'\left(\frac{1}{n}\right)$

n = the number of dosimeters in the test group

4. EDC Internal Tolerance Limits

All evaluation criteria are taken from the "EDC Quality System Manual," (Reference 2). These criteria are only applied to individual test dosimeters irradiated with high-energy photons (Cs-137) and are as follows for Panasonic Environmental dosimeters: ± 15% for bias and ± 12.8% for precision.

B. QC Investigation Criteria and Result Reporting

EDC Quality System Manual (Reference 2) specifies when an investigation is required due to a QC analysis that has failed the EDC bias criteria. The criteria are as follows:

1. No investigation is necessary when an individual QC result falls outside the QC performance criteria for accuracy.

2. Investigations are initiated when the mean of a QC processing batch is outside the performance criterion for bias.

C. Reporting of Environmental Dosimetry Results to EDC Customers

1. All results are to be reported in a timely fashion.

2. If the QA Officer determines that an investigation is required for a process, the results shall be issued as normal. If the QC results, prompting the investigation, have a mean bias from the known of greater than ±20%, the results shall be issued with a note indicating that they may be updated in the future, pending resolution of a QA issue.

3. Environmental dosimetry results do not require updating if the investigation has shown that the mean bias between the original results and the corrected results, based on applicable correction factors from the investigation, does not exceed ±20%.

III. DATA SUMMARY FOR ISSUANCE PERIOD JANUARY-DECEMBER 2013

A. General Discussion

Results of performance tests conducted are summarized and discussed in the following sections. Summaries of the performance tests for the reporting period are given in Tables 1 through 3 and Figures 1 through 4.

Table 1 provides a summary of individual dosimeter results evaluated against the EDC internal acceptance criteria for high-energy photons only. During this period, 100% (72/72) of the individual dosimeters, evaluated against these criteria met the tolerance limits for accuracy and 100% (72/72) met the criterion for precision. A graphical interpretation is provided in Figures 1 and 2.

Table 2 provides the Bias + Standard deviation results for each group (N=6) of dosimeters evaluated against the internal tolerance criteria. Overall,100% (12/12) of the dosimeter sets evaluated against the internal tolerance performance criteria met these criteria. A graphical interpretation is provided in Figures 3

Table 3 presents the independent blind spike results for dosimeters processed during this annual period. All results passed the performance acceptance criterion. Figure 4 is a graphical interpretation of Seabrook Station blind co-located station results.

B. Result Trending

One of the main benefits of performing quality control tests on a routine basis is to identify trends or performance changes. The results of the Panasonic environmental dosimeter performance tests are presented in Appendix A. The results are evaluated against each of the performance criteria listed in Section II, namely: individual dosimeter accuracy, individual dosimeter precision, and mean bias.

All of the results presented in Appendix A are plotted sequentially by processing date.

IV. STATUS OF EDC CONDITION REPORTS (CR)

No condition reports were issued during this annual period.

V. STATUS OF AUDITS/ASSESSMENTS

A. Internal

EDC Internal Quality Assurance Assessment was conducted during the fourth quarter 2013. There were not any findings as a result of this assessment.

B. External

No external assessments were conducted in 2013.

VI. PROCEDURES AND MANUALS REVISED DURING JANUARY - DECEMBER 2013

No procedures or manuals were revised in 2013.

VII. CONCLUSION AND RECOMMENDATIONS

The quality control evaluations continue to indicate the dosimetry processing programs at the EDC satisfy the criteria specified in the Quality System Manual. The EDC demonstrated the ability to meet all applicable acceptance criteria.

VIII. REFERENCES

1. EDC Quality Control and Audit Assessment Schedule, 2013.

2. EDC Manual 1, Quality System Manual, Rev. 3, August 1, 2012.

TABLE 1

PERCENTAGE OF INDIVIDUAL DOSIMETERS THAT PASSED EDC INTERNAL CRITERIA JANUARY – DECEMBER 2013[(1), (2)]

Dosimeter Type	Number Tested	% Passed Bias Criteria	% Passed Precision Criteria
Panasonic Environmental	72	100	100

[(1)]This table summarizes results of tests conducted by EDC.
[(2)]Environmental dosimeter results are free in air.

TABLE 2

MEAN DOSIMETER ANALYSES (N=6) JANUARY – DECEMBER 2013[(1), (2)]

Process Date	Mean Bias %	Standard Deviation %	Tolerance Limit +/-15%
4/22/2013	4.1	1.9	Pass
4/24/2013	4.5	1.2	Pass
5/23/2013	-1.1	1.9	Pass
7/24/2013	0.8	1.0	Pass
8/4/2013	-1.1	1.6	Pass
8/6/2013	0.1	2.3	Pass
10/31/2013	1.5	1.2	Pass
11/10/2013	0.1	1.7	Pass
11/15/2013	-1.8	1.0	Pass
1/27/2014	3.7	2.3	Pass
1/31/2014	2.6	0.9	Pass
2/5/2014	0.7	0.6	Pass

[(1)]This table summarizes results of tests conducted by EDC for TLDs issued in 2013.
[(2)]Environmental dosimeter results are free in air.

TABLE 3
SUMMARY OF INDEPENDENT DOSIMETER TESTING JANUARY – DECEMBER 2013[(1), (2)]

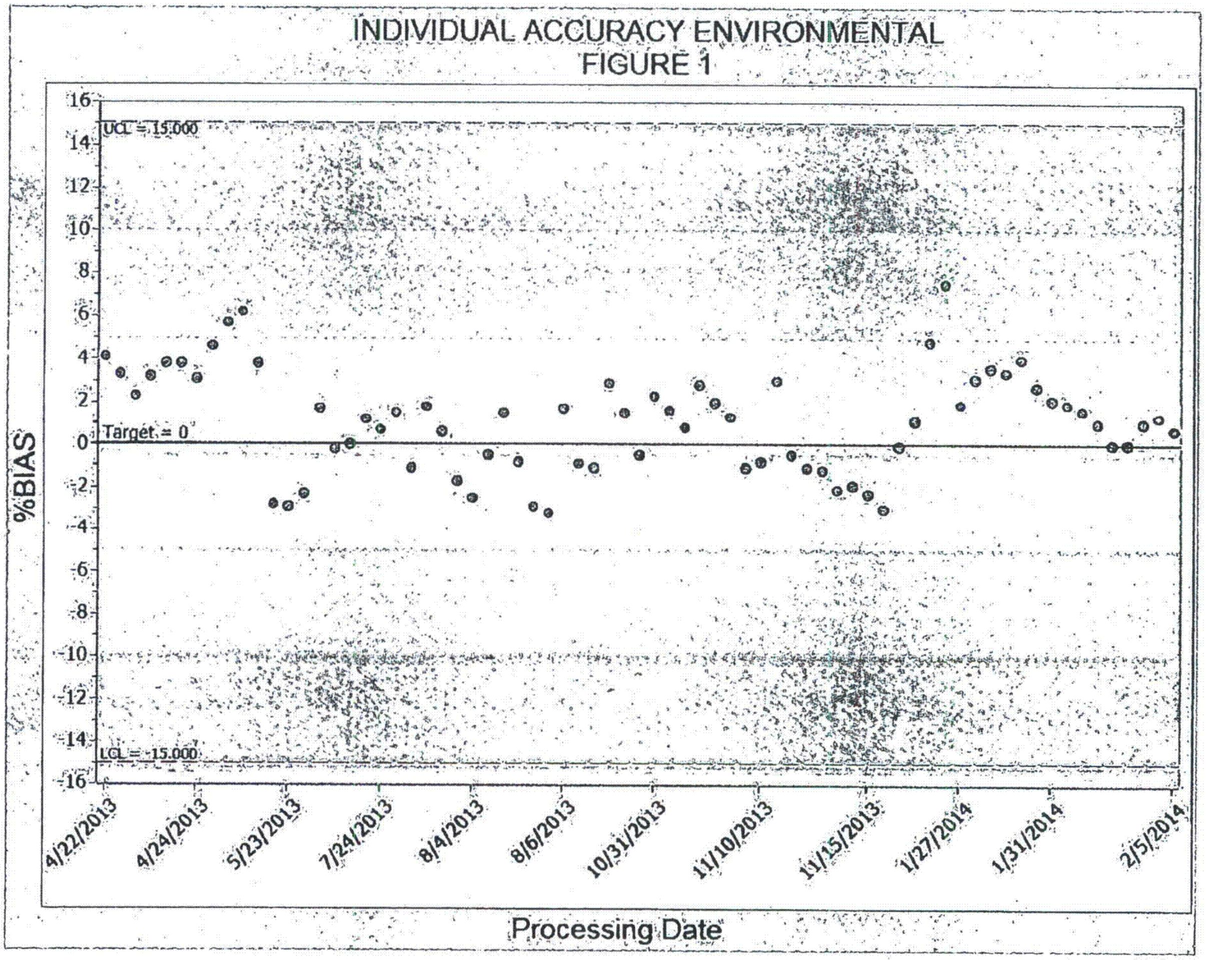
Issuance Period	Client	Mean Bias %	Standard Deviation %	Pass / Fail
2nd Qtr.2013	Millstone	0.7	1.5	Pass
2nd Qtr.2013	Seabrook	-2.3	2.7	Pass
3rd Qtr. 2013	Millstone	-4.7	4.0	Pass
4th Qtr.2013	Seabrook	-0.9	0.9	Pass

[(1)]Performance criteria are +/- 30%.
[(2)]Blind spike irradiations using Cs-137

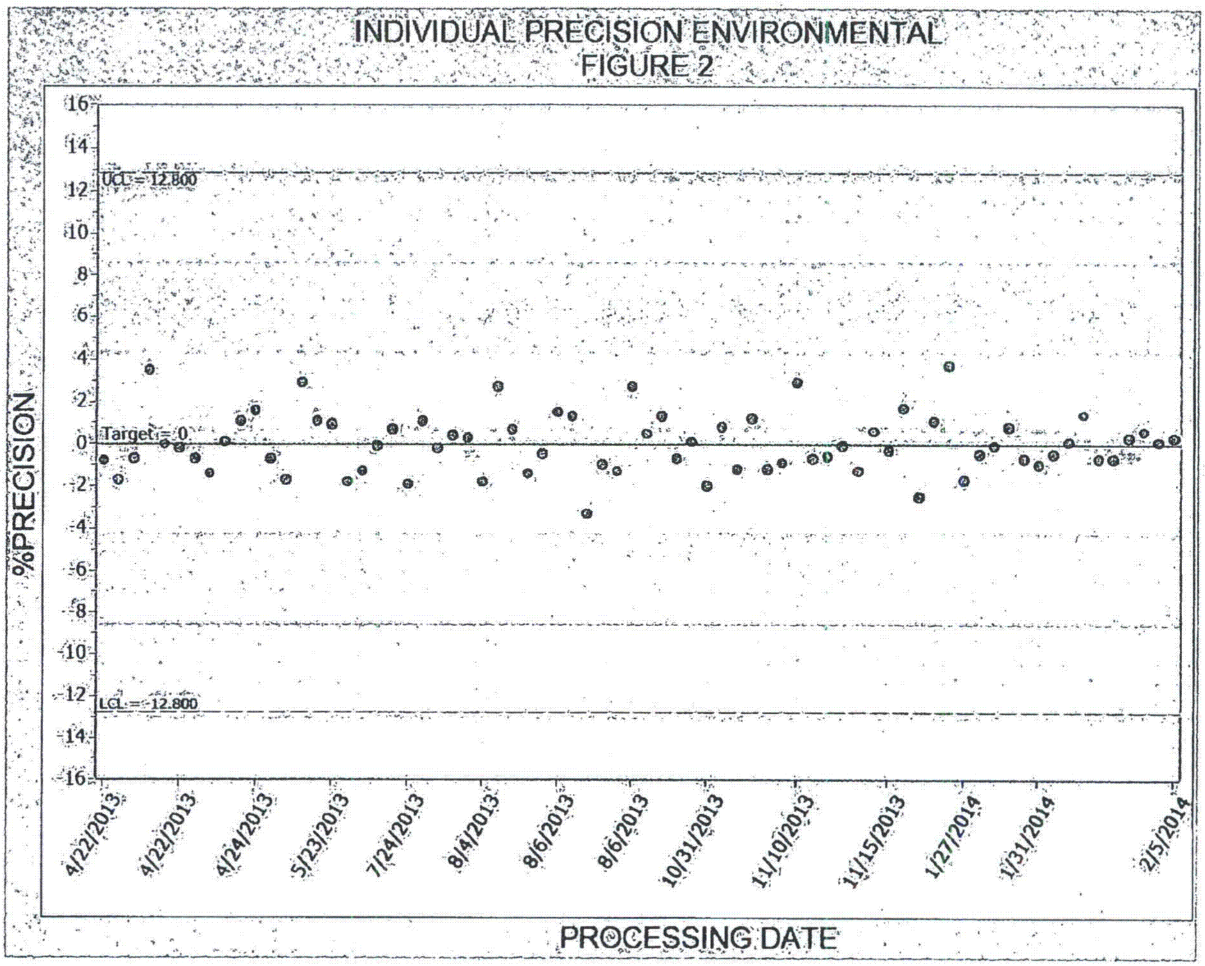
APPENDIX A

DOSIMETRY QUALITY CONTROL TRENDING GRAPHS

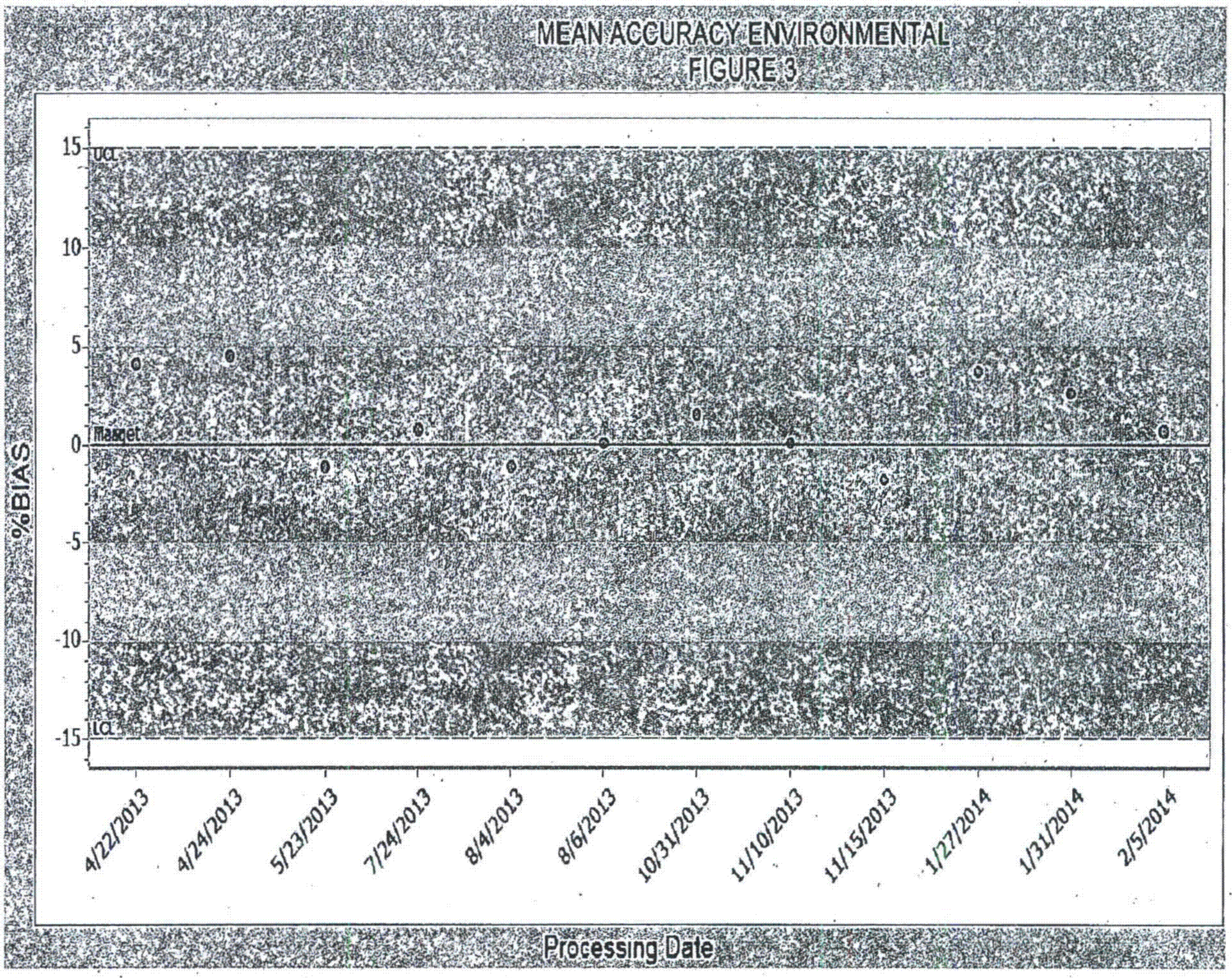
ISSUE PERIOD JANAURY - DECEMBER 2013



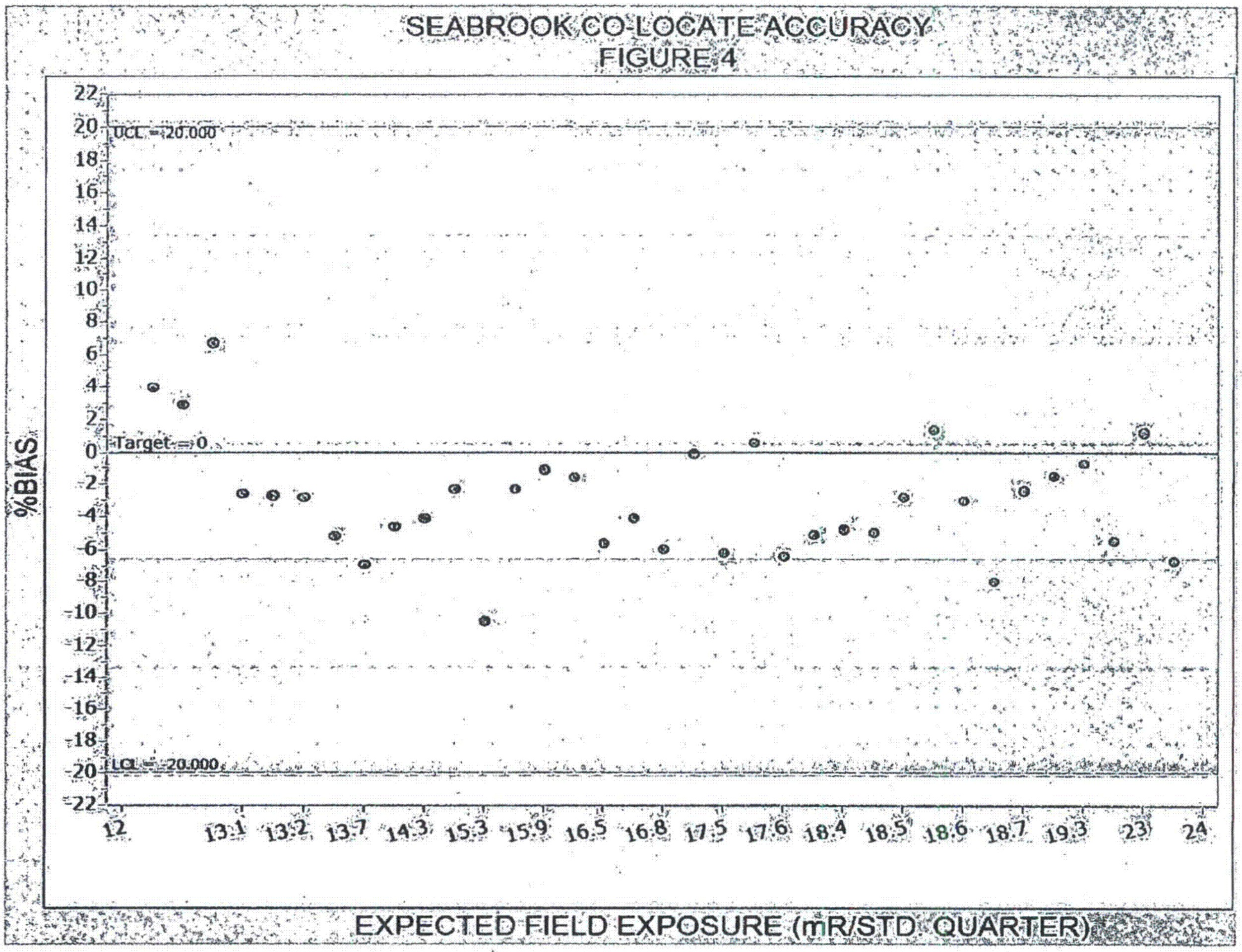
INDIVIDUAL ACCURACY ENVIRONMENTAL
FIGURE 1
%BIAS
UCL = 15.000
Target = 0
LCL = -15.000
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
4/22/2013
4/24/2013
5/23/2013
7/24/2013
8/4/2013
8/6/2013
10/31/2013
11/10/2013
11/15/2013
1/27/2014
1/31/2014
2/5/2014
Processing Date



INDIVIDUAL PRECISION ENVIRONMENTAL
FIGURE 2
%PRECISION
UCL = 12.800
Target = 0
LCL = -12.800
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
4/22/2013
4/22/2013
4/24/2013
5/23/2013
7/24/2013
8/4/2013
8/6/2013
8/6/2013
10/31/2013
11/10/2013
11/15/2013
1/27/2014
1/31/2014
2/5/2014
PROCESSING DATE



MEAN ACCURACY ENVIRONMENTAL
FIGURE 3
%BIAS
15
10
5
0
-5
-10
-15
UCL
Target
LCL
4/22/2013
4/24/2013
5/23/2013
7/24/2013
8/4/2013
8/6/2013
10/31/2013
11/10/2013
11/15/2013
1/27/2014
1/31/2014
2/5/2014
Processing Date


SEABROOK CO-LOCATE ACCURACY
FIGURE 4
UCL = 20.000
Target = 0
LCL = -20.000
%BIAS
12
13.1
13.2
13.7
14.3
15.3
15.9
16.5
16.8
17.5
17.6
18.4
18.5
18.6
18.7
19.3
23
24
EXPECTED FIELD EXPOSURE (mR/STD QUARTER)

APPENDIX F

J.A. Fitzpatrick Interlaboratory Comparison Program

January – December 2013

8.0 QUALITY ASSURANCE / QUALITY CONTROL PROGRAM

8.1 PROGRAM DESCRIPTION

The Offsite Dose Calculation Manual (ODCM), Part 1, Section 5.3 requires that the licensee participate 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 James A. FitzPatrick Nuclear Power Plant (JAF) Environmental Laboratory has engaged the services of Eckert & Ziegler Analytics, Incorporated in Atlanta, Georgia.

Eckert & Ziegler 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 by the JAF Environmental Laboratory using standard laboratory procedures. Eckert & Ziegler Analytics issues a statistical summary report of the results. The JAF Environmental Laboratory uses predetermined acceptance criteria methodology for evaluating the laboratory's performance.

The JAF Environmental Laboratory also analyzes laboratory blanks. The analysis of laboratory blanks provides a means to detect and measure radioactive contamination of analytical samples. The analysis of analytical blanks also provides information on the adequacy of background subtraction. Laboratory blank results are analyzed using control charts.

8.2 PROGRAM SCHEDULE

Table 8-1

SAMPLE MEDIA	LABORATORY ANALYSIS	SAMPLE PROVIDER ECKERT & ZIEGLER ANALYTICS
Water	Gross Beta	3
Water	Tritium	3
Water	I-131	2
Water	Mixed Gamma	2
Air	Gross Beta	2
Air	I-131	2
Air	Mixed Gamma	2
Milk	I-131	2
Milk	Mixed Gamma	2
Soil	Mixed Gamma	1
Vegetation	Mixed Gamma	1
TOTAL SAMPLE INVENTORY		**22**

8.3 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.

8.3.1 SAMPLE RESULTS EVALUATION

Samples provided by Eckert & Ziegler Analytics 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.

$$\text{The error resolution} = \frac{\text{Reference Result}}{\text{Reference Results Error (1 sigma)}}$$

Using the appropriate row under the Error Resolution column in Table 8.3.1 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 8-2

ERROR RESOLUTION	RATIO OF AGREEMENT
< 4	No Comparison
4 to 7	0.5 to 2.0
8 to 15	0.6 to 1.66
16 to 50	0.75 to 1.33
51 to 200	0.8 to 1.25
>200	0.85 to 1.18

This acceptance test is generally referred to as the "NRC" method. The acceptance criteria are contained in Procedure EN-CY-102, Laboratory Analytical Quality Control. The NRC method generally results in an acceptance range of approximately ± 25% of the Known value when applied to sample results from the Eckert & Ziegler Analytics Interlaboratory Comparison Program. This method is used as the procedurally required assessment method and requires the generation of a deviation from QA/QC program report when results are unacceptable.

8.4 PROGRAM RESULTS SUMMARY

The Interlaboratory Comparison Program numerical results are provided on Table 8-3.

8.4.1 ECKERT & ZIEGLER ANALYTICS QA SAMPLES RESULTS

Twenty two QA blind spike samples were analyzed as part of Eckert & Ziegler Analytics 2013 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 86 individual analyses on the 22 QA samples. Of the 86 analyses performed, 86 were in agreement using the NRC acceptance criteria for a 100 % agreement ratio.

TABLE 8-3
INTERLABORATORY INTERCOMPARISON PROGRAM
Gross Beta Analysis of Air Particulate Filter

DATE	SAMPLE ID NO.	MEDIUM	ANALYSIS	JAF ELAB RESULTS pCi ±1 sigma	REFERENCE LAB* pCi ±1 sigma	RATIO (1)	
06/13/2013	E10568	Filter	GROSS BETA	98.9 ± 1.0 101.3 ± 1.0 98.5 ± 1.0 **Mean = 99.6 ± 0.6**	94.6 ± 1.58	1.05	A
12/05/2013	E10751A	Filter	GROSS BETA	102.5 ± 1.0 102.2 ± 1.0 100.7 ± 1.0 **Mean = 101.8 ± 0.6**	96 ± 1.6	1.06	A

(1) Ratio = Reported/Analytics.
* Sample provided by Analytics, Inc.
A=Acceptable
U=Unacceptable

TABLE 8-3 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Tritium Analysis of Water

DATE	SAMPLE ID NO.	MEDIUM	ANALYSIS	JAF ELAB RESULTS pCi/liter ±1 sigma	REFERENCE LAB* pCi/liter ±1 sigma	RATIO (1)	
3/14/2013	E10490	Water	H-3	4305 ± 158 4490 ± 156 4781 ± 161 **Mean = 4525 ± 91**	4920 ± 82.2	0.92	A
6/13/2013	E10567	Water	H-3	1106 ± 124 919 ± 122 965 ± 123 **Mean = 997 ± 71**	948 ± 15.8	1.05	A
9/12/2013	E10614	Water	H-3	830 ± 122 765 ± 122 700 ± 120 828 ± 118 871 ± 119 800 ± 118 1024 ± 122 908 ± 120 889 ± 120 **Mean = 846 ± 40**	965 ± 16.1	0.88	A

(1) Ratio = Reported/Analytics.
* Sample provided by Analytics, Inc.
A=Acceptable
U=Unacceptable

TABLE 8-3 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gross Beta Analysis of Water

DATE	SAMPLE ID NO.	MEDIUM	ANALYSIS	JAF ELAB RESULTS pCi/liter ±1 sigma	REFERENCE LAB* pCi/liter ±1 sigma	RATIO (1)	
03/14/2013	E10493	Water	GROSS BETA	276.5 ± 2.6 279.2 ± 2.6 276.4 ± 2.6 **Mean = 277.4 ± 1.5**	300.0 ± 5.0	0.92	A
06/13/2013	E10573	Water	GROSS BETA	264.6 ± 2.6 265.3 ± 2.6 266.0 ± 2.6 **Mean = 265.3 ± 1.5**	294.0 ± 4.9	0.90	A
09/12/2013	E10619	Water	GROSS BETA	244.4 ± 2.3 244.4 ± 2.3 241.3 ± 2.3 **Mean = 243.4 ± 1.3**	267.0 ± 4.5	0.91	A

(1) Ratio = Reported/Analytics.
* Sample provided by Analytics, Inc.
A=Acceptable
U=Unacceptable

INTERLABORATORY INTERCOMPARISON PROGRAM
I-131 Gamma Analysis of Air Charcoal

DATE	SAMPLE ID NO.	MEDIUM	ANALYSIS	JAF ELAB RESULTS pCi ±1 sigma	REFERENCE LAB* pCi ±1 sigma	RATIO (1)	
6/13/2013	E10571	Air	I-131	92.8 ± 2.57 96.8 ± 3.1 89.5 ± 3.02 **Mean = 93.0 ± 1.68**	89.5 ± 1.49	1.04	A
9/12/2013	E10618	Air	I-131	81.9 ± 3.21 78.1 ± 2.99 77.8 ± 3.03 **Mean = 79.3 ± 1.78**	79.8 ± 1.33	0.99	A

(1) Ratio = Reported/Analytics.
* Sample provided by Analytics, Inc.
A=Acceptable
U=Unacceptable

TABLE 8-3 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis of Water

DATE	SAMPLE ID NO.	MEDIUM	ANALYSIS	JAF ELAB RESULTS pCi/liter ±1 sigma	REFERENCE LAB* pCi/liter ±1 sigma	RATIO (1)	
3/14/2013	E10491	Water	Ce-141	95 ± 5.94 102 ± 7.24 100 ± 5.57 **Mean = 99 ± 3.63**	97 ± 1.62	1.02	A
			Cr-51	260 ± 26.30 245 ± 32.10 254 ± 25.50 **Mean = 253 ± 16.24**	244 ± 4.07	1.04	A
			Cs-134	107 ± 7.58 95 ± 10.80 107 ± 8.34 **Mean = 103 ± 5.20**	110.0 ± 1.84	0.94	A
			Cs-137	137 ± 4.53 129 ± 5.88 134 ± 4.73 **Mean = 133 ± 2.93**	137 ± 2.29	0.97	A
			Co-58	105 ± 4.12 113 ± 5.74 113 ± 4.46 **Mean = 110.3 ± 2.79**	107.0 ± 1.79	1.03	A
			Mn-54	116 ± 4.27 105 ± 5.76 110 ± 4.56 **Mean = 110.3 ± 2.83**	107 ± 1.79	1.03	A
			Fe-59	138 ± 5.51 141 ± 7.36 146 ± 5.89 **Mean = 141.7 ± 3.64**	130.0 ± 2.17	1.09	A
			Zn-65	162 ± 7.98 165 ± 10.60 175 ± 8.86 **Mean = 167.3 ± 5.32**	155 ± 2.59	1.08	A
			Co-60	207 ± 4.12 196 ± 5.44 212 ± 4.47 **Mean = 205.0 ± 2.72**	206 ± 3.44	1.00	A
			I-131**	60.3 ± 1.02 58.2 ± 1.10 61 ± 1.02 **Mean = 59.8 ± 0.60**	50.0 ± 0.835	1.20	A

(1) Ratio = Reported/Analytics.
* Sample provided by Analytics, Inc.
** Result determined by Resin Extraction/Gamma Spectral Analysis.
A=Acceptable
U=Unacceptable

TABLE 8-3 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis of Water

DATE	SAMPLE ID NO.	MEDIUM	ANALYSIS	JAF ELAB RESULTS pCi/liter ±1 sigma	REFERENCE LAB* pCi/liter ±1 sigma	RATIO (1)	
9/12/2013	E10615	Water	Cr-51	244 ± 22.4 233 ± 23.6 267 ± 22.2 206 ± 26.1 **Mean = 237.5 ± 11.8**	2.51E+02 ± 4.18E+00	0.95	A
			Cs-134	133 ± 7.2 147 ± 6.8 145 ± 7.3 151 ± 5.7 **Mean = 144.0 ± 3.4**	1.56E+02 ± 2.60E+00	0.92	A
			Cs-137	117 ± 3.5 123 ± 3.6 111 ± 3.6 109 ± 4.5 **Mean = 115.0 ± 1.9**	1.18E+02 ± 1.97E+00	0.97	A
			Co-58	98 ± 3.5 98 ± 3.2 102 ± 3.6 96 ± 4.3 **Mean = 98.7 ± 1.8**	9.73E+01 ± 1.62E+00	1.01	A
			Mn-54	141 ± 3.8 142 ± 3.9 131 ± 3.9 126 ± 4.9 **Mean = 135.0 ± 2.1**	1.25E+02 ± 2.09E+00	1.08	A
			Fe-59	135 ± 4.4 130 ± 4.4 127 ± 4.7 131 ± 5.9 **Mean = 130.8 ± 2.4**	1.18E+02 ± 1.97E+00	1.11	A
			Zn-65	246 ± 7.8 263 ± 7.4 269 ± 8.2 257 ± 10.6 **Mean = 258.8 ± 4.3**	2.41E+02 ± 4.02E+00	1.07	A
			Co-60	186 ± 3.2 180 ± 3.2 188 ± 3.4 179 ± 4.3 **Mean = 183.3 ± 1.8**	1.77E+02 ± 2.96E+00	1.04	A
			I-131	100 ± 4.8 109 ± 4.7 100 ± 4.3 101 ± 6.1 **Mean = 102.4 ± 2.5**	9.79E+01 ± 1.63E+00	1.05	A
			I-131**	111 ± 1.4 109 ± 1.6 111 ± 1.7 **Mean = 110.3 ± 0.9**	9.79E+01 ± 1.63E+00	1.13	A

(1) Ratio = Reported/Analytics.
* Sample provided by Analytics, Inc.
** Result determined by Resin Extraction/Gamma Spectral Analysis.

A=Acceptable
U=Unacceptable

TABLE 8-3 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis of Milk

DATE	SAMPLE ID NO.	MEDIUM	ANALYSIS	JAF ELAB RESULTS pCi/liter ±1 sigma	REFERENCE LAB* pCi/liter ±1 sigma	RATIO (1)	
6/13/2013	E10569	MILK	Ce-141	88 ± 5.4 95 ± 6.1 89 ± 6.0 74 ± 7.4 93 ± 5.8 **Mean = 87.6 ± 2.8**	90 ± 1.51	0.97	A
			Cr-51	265 ± 26.3 260 ± 27.4 261 ± 28.4 267 ± 34.0 265 ± 28.6 **Mean = 263.6 ± 13.0**	250 ± 4.18	1.05	A
			Cs-134	121 ± 8.7 119 ± 8.1 123 ± 8.4 118 ± 11.1 127 ± 8.4 **Mean = 121.6 ± 4.0**	125 ± 2.09	0.97	A
			Cs-137	139 ± 4.8 147 ± 4.7 157 ± 4.8 137 ± 6.0 140 ± 5.0 **Mean = 144.0 ± 2.3**	151 ± 2.52	0.95	A
			Co-58	95 ± 4.3 100 ± 4.2 101 ± 4.1 88 ± 5.5 94 ± 4.4 **Mean = 95.7 ± 2.0**	94 ± 1.57	1.02	A
			Mn-54	175 ± 5.4 184 ± 5.2 177 ± 5.2 175 ± 6.8 171 ± 5.4 **Mean = 176.4 ± 2.5**	172 ± 2.87	1.03	A
			Fe-59	126 ± 5.8 139 ± 5.5 122 ± 5.3 121 ± 7.5 129 ± 5.9 **Mean = 127.4 ± 2.7**	120 ± 2	1.06	A

(Continued)

TABLE 8-3 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis of Milk

DATE	SAMPLE ID NO.	MEDIUM	ANALYSIS	JAF ELAB RESULTS pCi/liter ± 1 sigma	REFERENCE LAB* pCi/liter ±1 sigma	RATIO (1)	
6/13/2013	E10569 (Continued)	MILK	ZN-65	244 ± 9.4 228 ± 9.4 187 ± 12.2 218 ± 10.3 **Mean = 221.8 ± 4.6**	217 ± 3.63	1.02	A
			Co-60	182 ± 4.2 182 ± 3.9 175 ± 3.9 168 ± 5.2 187 ± 4.3 **Mean = 178.8 ± 1.9**	175 ± 2.93	1.02	A
			I-131	91 ± 5.1 102 ± 5.3 90 ± 5.0 91 ± 6.3 96 ± 5.3 **Mean = 94.0 ± 2.4**	96 ± 1.59	0.98	A
			I-131**	99 ± 1.2 101 ± 1.3 104 ± 1.4 **Mean = 101 ± 0.8**	96 ± 1.59	1.06	A

(1) Ratio = Reported/Analytics.
* Sample provided by Analytics, Inc.
** Result determined by Resin Extraction/Gamma Spectral Analysis.
A=Acceptable
U=Unacceptable

TABLE 8-3 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis of Milk

DATE	SAMPLE ID NO.	MEDIUM	ANALYSIS	JAF ELAB RESULTS pCi/liter ±1 sigma	REFERENCE LAB* pCi/liter ±1 sigma	RATIO (1)	
9/12/2013	E10617	MILK	Cr-51	253 ± 36.60 222 ± 34.90 313 ± 31.50 **Mean = 262.7 ± 19.86**	277 ± 4.63	0.95	A
			Cs-134	173 ± 12.30 171 ± 12.20 164 ± 9.30 **Mean = 169.3 ± 6.55**	172 ± 2.88	0.98	A
			Cs-137	131 ± 5.97 125 ± 5.99 135 ± 4.70 **Mean = 130.3 ± 3.23**	131 ± 2.19	0.99	A
			Co-58	101 ± 5.59 113 ± 6.11 110 ± 4.22 **Mean = 108.0 ± 3.10**	108 ± 1.8	1.00	A
			Mn-54	147 ± 6.50 164 ± 6.59 138 ± 4.82 **Mean = 149.7 ± 3.48**	139 ± 2.32	1.08	A
			Fe-59	135 ± 7.78 152 ± 7.96 147 ± 5.97 **Mean = 144.7 ± 4.21**	130 ± 2.18	1.11	A
			Zn-65	274 ± 13.50 244 ± 13.60 314 ± 10.50 **Mean = 277.3 ± 7.28**	266 ± 4.45	1.04	A
			Co-60	200 ± 5.64 199 ± 5.68 204 ± 4.15 **Mean = 201.0 ± 3.01**	196 ± 3.27	1.03	A
			I-131	99 ± 7.19 94 ± 7.49 103 ± 6.29 **Mean = 98.7 ± 4.05**	98.3 ± 1.64	1.00	A
			I-131**	102 ± 1.38 103 ± 1.79 106 ± 1.86 **Mean = 103.7 ± 0.98**	98.3 ± 1.64	1.05	A

(1) Ratio = Reported/Analytics.
* Sample provided by Analytics, Inc.
** Result determined by Resin Extraction/Gamma Spectral Analysis.
A=Acceptable
U=Unacceptable

TABLE 8-3 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis of Air Particulate Filter

DATE	SAMPLE ID NO.	MEDIUM	ANALYSIS	JAF ELAB RESULTS pCi ±1 sigma	REFERENCE LAB* pCi ±1 sigma	RATIO (1)	
3/14/2013	E10492A	FILTER	Ce-141	118 ± 3.62 113 ± 3.49 115 ± 3.41 **Mean = 115.3 ± 2.03**	105 ± 1.76	1.10	A
			Cr-51	296 ± 20.00 284 ± 19.00 319 ± 21.00 **Mean = 299.7 ± 11.56**	265 ± 4.43	1.13	A
			Cs-134	115 ± 8.27 105 ± 8.12 113 ± 9.24 **Mean = 111.0 ± 4.94**	120 ± 2.01	0.93	A
			Cs-137	155 ± 4.36 154 ± 4.40 155 ± 4.84 **Mean = 154.7 ± 2.62**	149 ± 2.49	1.04	A
			Co-58	123 ± 4.34 121 ± 4.27 132 ± 4.99 **Mean = 125.3 ± 2.62**	117 ± 1.95	1.07	A
			Mn-54	142 ± 4.50 135 ± 4.40 139 ± 4.98 **Mean = 138.7 ± 2.68**	117 ± 1.95	1.19	A
			Fe-59	178 ± 5.90 170 ± 5.85 169 ± 6.89 **Mean = 172.3 ± 3.60**	142 ± 2.37	1.21	A
			Zn-65	193 ± 8.30 194 ± 8.78 206 ± 10.10 **Mean = 197.7 ± 5.25**	169 ± 2.82	1.17	A
			Co-60	237 ± 4.39 232 ± 4.43 240 ± 5.09 **Mean = 236.3 ± 2.68**	225.0 ± 3.75	1.05	A

(1) Ratio = Reported/Analytics.
* Sample provided by Analytics, Inc.
A=Acceptable
U=Unacceptable

TABLE 8-3 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis of Air Particulate Filter

DATE	SAMPLE ID NO.	MEDIUM	ANALYSIS	JAF ELAB RESULTS pCi ±1 sigma	REFERENCE LAB* pCi ±1 sigma	RATIO (1)	
9/12/2013	E10616	FILTER	Cr-51	274 ± 18.00 284 ± 19.00 252 ± 18.90 280 ± 21.10 **Mean = 272.5 ± 9.64**	254 ± 4.25	1.07	A
			Cs-134	147 ± 8.41 135 ± 8.48 141 ± 9.24 142 ± 8.78 **Mean = 141.3 ± 4.37**	158 ± 2.64	0.89	A
			Cs-137	122 ± 4.00 131 ± 4.07 129 ± 4.21 125 ± 3.95 **Mean = 126.8 ± 2.03**	120 ± 2	1.06	A
			Co-58	109 ± 3.87 103 ± 3.82 109 ± 4.22 102 ± 3.86 **Mean = 105.8 ± 1.97**	99 ± 1.65	1.07	A
			Mn-54	140 ± 4.44 137 ± 4.48 146 ± 4.85 143 ± 4.50 **Mean = 141.5 ± 2.29**	127 ± 2.13	1.11	A
			Fe-59	153 ± 5.73 142 ± 5.54 148 ± 6.28 147 ± 5.66 **Mean = 147.5 ± 2.90**	120 ± 2	1.23	A
			Zn-65	292 ± 10.10 291 ± 10.20 299 ± 10.90 294 ± 10.10 **Mean = 294.0 ± 5.17**	244 ± 4.08	1.20	A
			Co-60	187 ± 4.06 192 ± 4.09 200 ± 4.49 194 ± 4.02 **Mean = 193.3 ± 2.08**	180 ± 3	1.07	A

(1) Ratio = Reported/Analytics.
* Sample provided by Analytics, Inc.
A=Acceptable
U=Unacceptable

TABLE 8-3 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis of Soil

DATE	SAMPLE ID NO.	MEDIUM	ANALYSIS	JAF ELAB RESULTS pCi/g ±1 sigma	REFERENCE LAB* pCi/g ±1 sigma	RATIO (1)	
6/13/2013	E10570	SOIL	Ce-141	0.081 ± 0.018	0.098 ± 0.002	1.00	A
				0.121 ± 0.020			
				0.097 ± 0.020			
				0.092 ± 0.021			
				0.082 ± 0.025			
				Mean = 0.098 ± 0.009			
			Cr-51	0.215 ± 0.082	0.271 ± 0.005	0.92	A
				0.283 ± 0.083			
				0.297 ± 0.011			
				0.166 ± 0.099			
				Mean = 0.249 ± 0.032			
			Cs-134	0.132 ± 0.029	0.136 ± 0.002	1.11	A
				0.155 ± 0.013			
				0.142 ± 0.015			
				0.135 ± 0.024			
				0.171 ± 0.027			
				Mean = 0.151 ± 0.010			
			Cs-137	0.218 ± 0.017	0.248 ± 0.005	0.92	A
				0.242 ± 0.016			
				0.193 ± 0.016			
				0.242 ± 0.016			
				0.232 ± 0.016			
				Mean = 0.227 ± 0.007			
			Co-58	0.095 ± 0.013	0.102 ± 0.002	0.77	A
				0.063 ± 0.012			
				0.074 ± 0.012			
				0.098 ± 0.013			
				0.079 ± 0.013			
				Mean = 0.078 ± 0.006			
			Mn-54	0.019 ± 0.016	0.186 ± 0.003	1.08	A
				0.207 ± 0.015			
				0.178 ± 0.015			
				0.214 ± 0.016			
				0.204 ± 0.015			
				Mean = 0.201 ± 0.007			
			Fe-59	0.135 ± 0.018	0.130 ± 0.002	1.03	A
				0.131 ± 0.018			
				0.115 ± 0.017			
				0.146 ± 0.018			
				0.141 ± 0.020			
				Mean = 0.133 ± 0.008			

(Continued)

TABLE 8-3 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis of Soil (Continued)

DATE	SAMPLE ID NO.	MEDIUM	ANALYSIS	JAF ELAB RESULTS pCi/g ±1 sigma	REFERENCE LAB* pCi/g ±1 sigma	RATIO (1)	
6/13/2013	E10570 (Continued)	SOIL	Zn-65	0.221 ± 0.029	0.236 ± 0.004	1.06	A
				0.230 ± 0.024			
				0.284 ± 0.026			
				0.240 ± 0.024			
				0.243 ± 0.026			
				Mean = 0.249 ± 0.012			
			Co-60	0.172 ± 0.013	0.190 ± 0.003	0.93	A
				0.175 ± 0.011			
				0.181 ± 0.011			
				0.163 ± 0.010			
				0.190 ± 0.011			
				Mean = 0.177 ± 0.005			

(1) Ratio = Reported/Analytics.
* Sample provided by Analytics, Inc.
A=Acceptable
U=Unacceptable

TABLE 8-3 (Continued)
INTERLABORATORY INTERCOMPARISON PROGRAM
Gamma Analysis of Vegetation

DATE	SAMPLE ID NO.	MEDIUM	ANALYSIS	JAF ELAB RESULTS pCi/g ±1 sigma	REFERENCE LAB* pCi/g ±1 sigma	RATIO (1)	
6/13/2013	E10572	VEG	Ce-141	0.190 ± 0.013 0.186 ± 0.015 0.197 ± 0.011 0.177 ± 0.013 **Mean = 0.188 ± 0.007**	0.215 ± 0.004	0.87	A
			Cr-51	0.583 ± 0.074 0.569 ± 0.081 0.443 ± 0.062 0.482 ± 0.071 **Mean = 0.519 ± 0.036**	0.596 ± 0.010	0.87	A
			Cs-134	0.256 ± 0.029 0.259 ± 0.025 0.260 ± 0.023 0.262 ± 0.028 **Mean = 0.259 ± 0.013**	0.298 ± 0.005	0.87	A
			Cs-137	0.337 ± 0.015 0.311 ± 0.014 0.318 ± 0.012 0.287 ± 0.014 **Mean = 0.313 ± 0.007**	0.259 ± 0.006	1.21	A
			Co-58	0.216 ± 0.014 0.216 ± 0.012 0.199 ± 0.011 0.212 ± 0.014 **Mean = 0.211 ± 0.006**	0.224 ± 0.004	0.94	A
			Mn-54	0.429 ± 0.017 0.374 ± 0.015 0.369 ± 0.014 0.387 ± 0.017 **Mean = 0.390 ± 0.008**	0.409 ± 0.007	0.95	A
			Fe-59	0.295 ± 0.019 0.285 ± 0.018 0.297 ± 0.015 0.273 ± 0.018 **Mean = 0.288 ± 0.009**	0.285 ± 0.005	1.01	A
			Zn-65	0.494 ± 0.032 0.495 ± 0.028 0.510 ± 0.027 0.509 ± 0.031 **Mean = 0.502 ± 0.015**	0.518 ± 0.009	0.97	A
			Co-60	0.373 ± 0.013 0.402 ± 0.012 0.398 ± 0.011 0.361 ± 0.013 **Mean = 0.384 ± 0.006**	0.417 ± 0.007	0.92	A

(1) Ratio = Reported/Analytics.
* Sample provided by Analytics, Inc.
A=Acceptable
U=Unacceptable

8.5 REFERENCES

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

APPENDIX G

GEL Laboratories LLC
2013 ANNUAL QUALITY ASSURANCE REPORT
FOR THE
RADIOLOGICAL ENVIRONMENTAL
MONITORING PROGRAM (REMP)

GEL Laboratories LLC

2013 ANNUAL QUALITY ASSURANCE REPORT

FOR THE

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)

GEL LABORATORIES, LLC
P.O. Box 30712, Charleston, SC 29417
843.556.8171

2013 ANNUAL QUALITY ASSURANCE REPORT

FOR THE

RADIOLOGICAL ENVIRONMENTAL

MONITORING PROGRAM (REMP)

Approved By: [signature] February 11, 2013
Robert L. Pullano — Date
Director, Quality Systems

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2013 ANNUAL QUALITY ASSURANCE REPORT FOR THE RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)

1. Introduction

GEL Laboratories, LLC (GEL) is a privately owned environmental laboratory dedicated to providing personalized client services of the highest quality. GEL was established as an analytical testing laboratory in 1981. Now a full service lab, our analytical divisions use state of the art equipment and methods to provide a comprehensive array of organic, inorganic, and radiochemical analyses to meet the needs of our clients.

At GEL, quality is emphasized at every level of personnel throughout the company. Management's ongoing commitment to good professional practice and to the quality of our testing services to our customers is demonstrated by their dedication of personnel and resources to develop, implement, assess, and improve our technical and management operations.

The purpose of GEL's quality assurance program is to establish policies, procedures, and processes to meet or exceed the expectations of our clients. To achieve this, all personnel that support these services to our clients are introduced to the program and policies during their initial orientation, and annually thereafter during company-wide training sessions.

GEL's primary goals are to ensure that all measurement data generated are scientifically and legally defensible, of known and acceptable quality per the data quality objectives (DQOs), and thoroughly documented to provide sound support for environmental decisions. In addition, GEL continues to ensure compliance with all contractual requirements, environmental standards, and regulations established by local, state and federal authorities.

GEL administers the QA program in accordance with the Quality Assurance Plan, GL-QS-B-001. Our Quality Systems include all quality assurance (QA) policies and quality control (QC) procedures necessary to plan, implement, and assess the work we perform. GEL's QA Program establishes a quality management system (QMS) that governs all of the activities of our organization.

This report entails the quality assurance program for the proficiency testing and environmental monitoring aspects of GEL for 2013. GEL's QA Program is designed to monitor the quality of analytical processing associated with environmental, radiobioassay, effluent (10 CFR Part 50), and waste (10 CFR Part 61) sample analysis.

This report covers the category of Radiological Environmental Monitoring Program (REMP) and includes:

- Intra-laboratory QC results analyzed during 2013.
- Inter-laboratory QC results analyzed during 2013 where known values were available.

2. Quality Assurance Programs for Inter-laboratory, Intra-laboratory and Third Party Cross-Check

In addition to internal and client audits, our laboratory participates in annual performance evaluation studies conducted by independent providers. We routinely participate in the following types of performance audits:

- Proficiency testing and other inter-laboratory comparisons
- Performance requirements necessary to retain Certifications
- Evaluation of recoveries of certified reference and in-house secondary reference materials using statistical process control data.
- Evaluation of relative percent difference between measurements through SPC data.

We also participate in a number of proficiency testing programs for federal and state agencies and as required by contracts. It is our policy that no proficiency evaluation samples be analyzed in any special manner. Our annual performance evaluation participation generally includes a combination of studies that support the following:

- US Environmental Protection Agency Discharge Monitoring Report, Quality Assurance Program (DMR-QA). Annual national program sponsored by EPA for laboratories engaged in the analysis of samples associated with the NPDES monitoring program. Participation is mandatory for all holders of NPDES permits. The permit holder must analyze for all of the parameters listed on the discharge permit. Parameters include general chemistry, metals, BOD/COD, oil and grease, ammonia, nitrates, etc.

- Department of Energy Mixed Analyte Performance Evaluation Program (MAPEP). A semiannual program developed by DOE in support of DOE contractors performing waste analyses. Participation is required for all laboratories that perform environmental analytical measurements in support of environmental management activities. This program includes radioactive isotopes in water, soil, vegetation and air filters.

- ERA's MRAD-Multimedia Radiochemistry Proficiency test program. This program is for labs seeking certification for radionuclides in wastewater and solid waste. The program is conducted in strict compliance with USEPA National Standards for Water Proficiency study.

- ERA's InterLaB RadCheM Proficiency Testing Program for radiological analyses. This program completes the process of replacing the USEPA EMSL-LV Nuclear Radiation Assessment Division program discontinued in 1998. Laboratories seeking certification for radionuclide analysis in drinking water also use the study. This program is conducted in strict compliance with the USEPA National Standards for Water Proficiency Testing Studies. This program encompasses Uranium by EPA method 200.8 (for drinking water certification in Utah/Primary NELAP), gamma emitters, Gross Alpha/Beta, Iodine-131, naturally occurring radioactive isotopes, Strontium-89/90, and Tritium.

- ERA's Water Pollution (WP) biannual program for waste methodologies includes parameters for both organic and inorganic analytes.

- ERA's Water Supply (WS) biannual program for drinking water methodologies includes parameters for organic and inorganic analytes.

- Environmental Cross-Check Program administered by Eckert & Ziegler Analytics, Inc. This program encompasses radionuclides in water, soil, milk, naturally occurring radioactive isotopes in soil and air filters.

GEL procures single-blind performance evaluation samples from Eckert & Ziegler Analytics to verify the analysis of sample matrices processed at GEL. Samples are received on a quarterly basis. GEL's Third-Party Cross-Check Program provides environmental matrices encountered in a typical nuclear utility REMP. The Third-Party Cross-Check Program is intended to meet or exceed the inter-laboratory comparison program requirements discussed in NRC Regulatory Guide 4.15. Once performance evaluation samples have been prepared in accordance with the instructions provided by the PT provider, samples are managed and analyzed in the same manner as environmental samples from GEL's clients.

3. Quality Assurance Program for Internal and External Audits

During each annual reporting period, at least one internal assessment of each area of the laboratory is conducted in accordance with the pre-established schedule from Standard Operating Procedure for the Conduct of Quality Audits, GL-QS-E-001. The annual internal audit plan is reviewed for adequacy and includes the scheduled frequency and scope of quality control actions necessary to GEL's QA program. Internal audits are conducted at least annually in accordance with a schedule approved by the Quality Systems Director. Supplier audits are contingent upon the categorization of the supplier, and may or may not be conducted prior to the use of a supplier or subcontractor. Type I suppliers and subcontractors, regardless of how they were initially qualified, are re-evaluated at least once every three years.

In addition, prospective customers audit GEL during pre-contract audits. GEL hosts several external audits each year for both our clients and other programs. These programs include environmental monitoring, waste characterization, and radiobioassay. The following list of programs may audit GEL at least annually or up to every three years depending on the program.

- NELAC, National Environmental Laboratory Accreditation Program
- DOECAP, U.S. Department of Energy Consolidated Audit Program
- DOELAP, U.S. Department of Energy Laboratory Accreditation Program
- DOE QSAS, U.S. Department of Energy, Quality Systems for Analytical Services
- ISO/IEC 17025:2005
- A2LA, American Association for Laboratory Accreditation
- DOD ELAP, US Department of Defense Environmental Accreditation Program
- NUPIC, Nuclear Procurement Issues Committee
- South Carolina Department of Heath and Environmental Control (SC DHEC)

The annual radiochemistry laboratory internal audit (13-RAD-001) was conducted in August 2013. Three (3) findings, two (2) observations, and one (1) recommendations resulted from this

assessment. By October, 2013, each finding was closed and appropriate laboratory staff addressed each observation and recommendation.

4. Performance Evaluation Acceptance Criteria for Environmental Sample Analysis

GEL utilized an acceptance protocol based upon two performance models. For those inter-laboratory programs that already have established performance criteria for bias (i.e., MAPEP, and ERA/ELAP), GEL will utilize the criteria for the specific program. For intra-laboratory or third party quality control programs that do not have a specific acceptance criteria (i.e. the Eckert-Ziegler Analytics Environmental Cross-check Program), results will be evaluated in accordance with GEL's internal acceptance criteria.

5. Performance Evaluation Samples

Performance Evaluation (PE) results and internal quality control sample results are evaluated in accordance with GEL acceptance criteria. The first criterion concerns bias, which is defined as the deviation of any one result from the known value. The second criterion concerns precision, which deals with the ability of the measurement to be replicated by comparison of an individual result with the mean of all results for a given sample set.

At GEL, we also evaluate our analytical performance on a regular basis through statistical process control (SPC) acceptance criteria. Where feasible, this criterion is applied to both measures of precision and accuracy and is specific to sample matrix. We establish environmental process control limits at least annually.

For Radiochemistry analysis, quality control evaluation is based on static limits rather than those that are statistically derived. Our current process control limits are maintained in GEL's AlphaLIMS. We also measure precision with matrix duplicates and/or matrix spike duplicates. The upper and lower control limits (UCL and LCL respectively) for precision are plus or minus three times the standard deviation from the mean of a series of relative percent differences. The static precision criteria for radiochemical analyses are 0 - 20%, for activity levels exceeding the contract required detection limit (CRDL).

6. Quality Control Program for Environmental Sample Analysis

GEL's internal QA Program is designed to include QC functions such as instrumentation calibration checks (to insure proper instrument response), blank samples, instrumentation backgrounds, duplicates, as well as overall staff qualification analyses and statistical process controls. Both quality control and qualification analyses samples are used to be as similar as the matrix type of those samples submitted for analysis by the various laboratory clients. These performance test samples (or performance evaluation samples) are either actual sample submitted in duplicate in order to evaluate the precision of laboratory measurements, or fortified blank samples, which have been given a known quantity of a radioisotope that is in the interest to GEL's clients.

Accuracy (or Bias) is measured through laboratory control samples and/or matrix spikes, as well as surrogates and internal standards. The UCLs and LCLs for accuracy are plus or minus three times the standard deviation from the mean of a series of recoveries. The static limit for

radiochemical analyses is 75 - 125%. Specific instructions for out-of-control situations are provided in the applicable analytical SOP.

GEL's Laboratory Control Standard (LCS) is an aliquot of reagent water or other blank matrix to which known quantities of the method analytes are added in the laboratory. The LCS is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements. Some methods may refer to these samples as Laboratory Fortified Blanks (LFB). The requirement for recovery is between 75 and 125% for radiological analyses excluding drinking water matrix.

$$\text{Bias (\%)} = \frac{\text{(observed concentration)}}{\text{(known concentration)}} * 100\ \%$$

Precision is a data quality indicator of the agreement between measurements of the same property, obtained under similar conditions, and how well they conform to themselves. Precision is usually expressed as standard deviation, variance or range in either absolute or relative (percentage) terms.

GEL's laboratory duplicate (DUP or LCSD) is an aliquot of a sample taken from the same container and processed in the same manner under identical laboratory conditions. The aliquot is analyzed independently from the parent sample and the results are compared to measure precision and accuracy.

If a sample duplicate is analyzed, it will be reported as Relative Percent Difference (RPD). The RPD must be 20 percent or less, if both samples are greater than 5 times the MDC. If both results are less than 5 times MDC, then the RPD must be equal to or less than 100%. If one result is above the MDC and the other is below the MDC, then the RPD can be calculated using the MDC for the result of the one below the MDC. The RPD must be 100% or less. In the situation where both results are above the MDC but one result is greater than 5 times the MDC and the other is less than 5 times the MDC, the RPD must be less than or equal to 20%. If both results are below MDC, then the limits on % RPD are not applicable.

$$\text{Difference (\%)} = \frac{\text{(high duplicate result – low duplicate result)}}{\text{(average of results)}} * 100\ \%$$

7. Summary of Data Results

During 2013, forty-four (44) radioisotopes associated with seven (7) matrix types were analyzed under GEL's Performance Evaluation program in participation with ERA, MAPEP, and Eckert & Ziegler Analytics. Matrix types were representative of client analyses performed during 2012. Of the four hundred twenty-three (423) total results reported, 97% (410 of 423) were found to be acceptable. The list below contains the type of matrix evaluated by GEL.

- Air Filter
- Cartridge
- Water
- Milk
- Soil
- Liquid

- Vegetation

Graphs are provided in Figures 1-9 of this report to allow for the evaluation of trends or biases. These graphs include radioisotopes Cobalt-60, Cesium-137, Tritium, Strontium-90, Gross Alpha, Gross Beta, Iodine-131, Americium-241, and Plutonium-238.

8. Summary of Participation in the Eckert & Ziegler Analytics Environmental Cross-Check Program

Eckert & Ziegler Analytics provided samples for eighty-nine (89) individual environmental analyses. The accuracy of each result reported to Eckert & Ziegler Analytics, Inc. is measured by the ratio of GEL's result to the known value. All results fell within GEL's acceptance criteria (100%). .

9. Summary of Participation in the MAPEP Monitoring Program

MAPEP Series 27, 28 and 29 were analyzed by the laboratory. Of the one hundred thirty-eight (138) analyses, 96% (133 out of 138) of all results fell within the PT provider's acceptance criteria. Five analytical failures occurred: Uranium-238/235 and Total Uranium in vegetation by ICP/MS, and Uranium-234/233, and Urabuyn-238 by Alpha Spectroscopy.

For the corrective actions associated with MAPEP Series 28, refer to CARR130513-789 which is detailed in Table 8.

10. Summary of Participation in the ERA MRaD PT Program

The ERA MRad program provided samples (MRAD-18 and MRAD-19) for one hundred fifty (150) individual environmental analyses. One hundred forty-five (145) of the 150 analyses fell within the PT provider's acceptance criteria (97%). Five analytical failures occurred: Cesium-134, Cesium-137 and Zinc-65 in soil, and Uranium-234 and Total Uranium in vegetation.

For the corrective actions associated with MRAD-18 and MRAD-19, refer to CARR130522-791 and CARR131205-845 which are detailed in Table 8.

11. Summary of Participation in the ERA PT Program

The ERA program provided samples (RAD-92 and RAD-94) for forty-six (46) individual environmental analyses. Of the 44 analyses, 93% (43 out of 44) of all results fell within the PT provider's acceptance criteria. Two analytical failures occurred: Gross Alpha and Strontium-89 in water.

For the corrective actions associated with RAD-92 refer to corrective actions CARR130826-810 (Table 8).

12. Corrective Action Request and Report (CARR)

There are two categories of corrective action at GEL. One is corrective action implemented at the analytical and data review level in accordance with the analytical SOP. The other is formal corrective action documented by the Quality Systems Team in accordance with GL-QS-E-002. A

formal corrective action is initiated when a nonconformance reoccurs or is so significant that permanent elimination or prevention of the problem is required. Formal corrective action investigations include root cause analysis.

GEL includes quality requirements in most analytical standard operating procedures to ensure that data are reported only if the quality control criteria are met or the quality control measures that did not meet the acceptance criteria are documented. A formal corrective action is implemented according to GL-QS-E-002 for Conducting Corrective/Preventive Action and Identifying Opportunities for Improvement. Recording and documentation is performed following guidelines stated in GL-QS-E-012 for Client NCR Database Operation.

Any employee at GEL can identify and report a nonconformance and request that corrective action be taken. Any GEL employee can participate on a corrective action team as requested by the QS team or Group Leaders. The steps for conducting corrective action are detailed in GL-QS-E-002. In the event that correctness or validity of the laboratory's test results in doubt, the laboratory will take corrective action. If investigations show that the results have been impacted, affected clients will be informed of the issue in writing within five (5) calendar days of the discovery.

Table 8 provides the status of CARRs for radiological performance testing during 2013. **It has been determined that causes of the failures did not impact any data reported to our clients.**

13. References

1. GEL Quality Assurance Plan, GL-QS-B-001
2. GEL Standard Operating Procedure for the Conduct of Quality Audits, GL-QS-E-001
3. GEL Standard Operating Procedure for Conducting Corrective/Preventive Action and Identifying Opportunities for Improvement, GL-QS-E-002
4. GEL Standard Operating Procedure for AlphaLIMS Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items, GL-QS-E-004
5. GEL Standard Operating Procedure for Handling Proficiency Evaluation Samples, GL-QS-E-013
6. GEL Standard Operating Procedure for Quality Assurance Measurement Calculations and Processes, GL-QS-E-014
7. 40 CFR Part 136 Guidelines Establishing Test Procedures for the Analysis of Pollutants
8. ISO/IEC 17025-2005, General Requirements for the Competence of Testing and Calibration Laboratories
9. ANSI/ASQC E4-1994, Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs, American National Standard
10. 2003 NELAC Standard, National Environmental Laboratory Accreditation Program
11. 2009 TNI Standard, The NELAC Institute, National Environmental Accreditation Program
12. MARLAP, Multi-Agency Radiological Laboratory Analytical Protocols
13. 10 CFR Part 21, Reporting of Defects and Noncompliance
14. 10 CFR Part 50 Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants
15. 10 CFR Part 61, Licensing Requirements for Land Disposal and Radioactive Waste
16. NRC REG Guide 4.15 and NRC REG Guide 4.8

TABLE 1

2013 RADIOLOGICAL PROFICIENCY TESTING RESULTS AND ACCEPTANCE CRITERIA

PT Provider	Quarter / Year	Analytical Date	Sample Number	Sample Media	Unit	Analyte / Nuclide	GEL Value	Known value	Acceptance Range/ Ratio	Evaluation
MAPEP	1st/ 2013	02/27/13	GENE01-13-RdFR1	Filter	Bq/sample	Uranium-234/233	0.0143	0.0155	0.0109-0.0202	Acceptable
MAPEP	1st/ 2013	02/27/13	GENE01-13-RdFR1	Filter	Bq/sample	Uranium-238	0.0999	0.098	0.069-0.127	Acceptable
EZA	4th/2012	02/01/13	E10323	Cartridge	pCi	Iodine-131	7.31E+01	7.29E+01	1.00	Acceptable
EZA	4th/2012	02/01/13	E10324	Milk	pCi/L	Strontium-89	9.89E+00	1.38E+01	0.72	Acceptable
EZA	4th/2012	02/01/13	E10324	Milk	pCi/L	Strontium-90	9.83E+00	1.48E+01	1.02	Acceptable
EZA	4th/2012	02/01/13	E10325	Milk	pCi/L	Iodine-131	9.57E+01	9.00E+01	1.06	Acceptable
EZA	4th/2012	02/01/13	E10325	Milk	pCi/L	Chromium-51	3.67E+02	3.48E+02	1.06	Acceptable
EZA	4th/2012	02/01/13	E10325	Milk	pCi/L	Cesium-134	1.54E+02	1.65E+02	0.93	Acceptable
EZA	4th/2012	02/01/13	E10325	Milk	pCi/L	Cesium-137	1.18E+02	1.17E+02	1.01	Acceptable
EZA	4th/2012	02/01/13	E10325	Milk	pCi/L	Cobalt-58	9.85E+01	9.85E+01	1	Acceptable
EZA	4th/2012	02/01/13	E10325	Milk	pCi/L	Manganese-54	1.16E+02	1.16E+02	1	Acceptable
EZA	4th/2012	02/01/13	E10325	Milk	pCi/L	Iron-59	1.33E+02	1.16E+02	1.15	Acceptable
EZA	4th/2012	02/01/13	E10325	Milk	pCi/L	Zinc-65	3.19E+02	2.91E+02	1.09	Acceptable
EZA	4th/2012	02/01/13	E10325	Milk	pCi/L	Cobalt-60	1.73E+02	1.70E+02	1.02	Acceptable
EZA	4th/2012	02/01/13	E10325	Milk	pCi/L	Cesium-141	5.38E+01	5.10E+01	1.05	Acceptable
EZA	4th/2012	02/01/13	E10380	Water	pCi/L	Iodine-131	7.47E+01	7.25E+01	1.03	Acceptable
EZA	4th/2012	02/01/13	E10380	Water	pCi/L	Chromium-51	3.81E+02	3.62E+02	1.05	Acceptable
EZA	4th/2012	02/01/13	E10380	Water	pCi/L	Cesium-134	1.57E+02	1.73E+02	0.91	Acceptable
EZA	4th/2012	02/01/13	E10380	Water	pCi/L	Cesium-137	1.25E+02	1.22E+02	1.03	Acceptable
EZA	4th/2012	02/01/13	E10380	Water	pCi/L	Cobalt-58	1.02E+02	1.03E+02	0.99	Acceptable
EZA	4th/2012	02/01/13	E10380	Water	pCi/L	Manganese-54	1.28E+02	1.21E+02	1.06	Acceptable
EZA	4th/2012	02/01/13	E10380	Water	pCi/L	Iron-59	1.38E+02	1.21E+02	1.14	Acceptable
EZA	4th/2012	02/01/13	E10380	Water	pCi/L	Zinc-65	2.13E+02	1.94E+02	1.1	Acceptable
EZA	4th/2012	02/01/13	E10380	Water	pCi/L	Cobalt-60	1.80E+02	1.77E+02	1.01	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Barium-133	55.4	54.4	44.9-60.2	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Cesium-134	27.2	29.9	23.4-32.9	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Cesium-137	74.3	75.3	67.8-85.5	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Cobalt-60	89.0	97.7	87.9-110	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Zinc-65	126	114	103-136	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Gross Alpha	26.0	24.8	12.5-33.0	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Gross Beta	19.4	19.3	11.3-27.5	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Gross Alpha	31.4	24.8	12.5-33.0	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Radium-226	10.4	9.91	7.42-11.6	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Radium-228	4.84	5.22	3.14-6.96	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Uranium (Nat)	6.43	5.96	4.47-7.13	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	ug/L	Uranium (Nat) mass	9.59	8.69	6.50-10.4	Acceptable

ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Radium-226	11.60	9.91	7.42-11.6	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Radium-228	5.13	5.22	3.14-6.96	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Uranium (Nat)	5.95	5.96	4.47-7.13	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	ug/L	Uranium (Nat) mass	9.95	8.69	6.50-10.4	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Tritium	1430	1320	1040-1480	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Strontium-89	47.5	48	37.6-55.3	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Strontium-90	35.9	39.8	29.2-45.8	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Strontium-89	42.9	48	37.6-55.3	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Strontium-90	34.6	39.8	29.2-45.8	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Iodine-131	23.6	22.7	18.8-27.0	Acceptable
ERA	1st/ 2013	02/28/13	RAD - 92	Water	pCi/L	Iodine-131	27	22.7	18.8-27.0	Acceptable
EZA	1st/ 2013	04/25/13	E10469	Cartridge	pCi	Iodine-131	9.38E+01	9.27E+01	1.01	Acceptable
EZA	1st/ 2013	04/25/13	E10470	Milk	pCi/L	Strontium-89	1.07E+02	9.97E+01	1.07	Acceptable
EZA	1st/ 2013	04/25/13	E10470	Milk	pCi/L	Strontium-90	1.18E+01	1.10E+01	1.07	Acceptable
EZA	1st/ 2013	04/25/13	E10471	Milk	pCi/L	Iodine-131	3.54E+00	1.67E+00	1.12	Acceptable
EZA	1st/ 2013	04/25/13	E10471	Milk	pCi/L	Cerium-141	2.00E+01	1.87E+01	1.07	Acceptable
EZA	1st/ 2013	04/25/13	E10471	Milk	pCi/L	Chromium-51	5.09E+01	4.72E+01	1.08	Acceptable
EZA	1st/ 2013	04/25/13	E10471	Milk	pCi/L	Cesium-134	2.06E+02	2.14E+02	0.96	Acceptable
EZA	1st/ 2013	04/25/13	E10471	Milk	pCi/L	Cesium-137	2.83E+02	2.66E+02	1.07	Acceptable
EZA	1st/ 2013	04/25/13	E10471	Milk	pCi/L	Cobalt-58	2.19E+02	2.08E+02	1.05	Acceptable
EZA	1st/ 2013	04/25/13	E10471	Milk	pCi/L	Mn-54	2.21E+02	2.08E+02	1.06	Acceptable
EZA	1st/ 2013	04/25/13	E10471	Milk	pCi/L	Iron-59	2.78E+02	2.52E+02	1.1	Acceptable
EZA	1st/ 2013	04/25/13	E10471	Milk	pCi/L	Zinc-65	3.39E+02	3.01E+02	1.13	Acceptable
EZA	1st/ 2013	04/25/13	E10471	Milk	pCi/L	Cobalt-60	4.02E+02	4.00E+02	1.01	Acceptable
EZA	1st/ 2013	04/25/13	E10472	Water	pCi/L	Iodine-131	1.12E+02	9.28E+01	1.21	Acceptable
EZA	1st/ 2013	04/25/13	E10472	Water	pCi/L	Cerium-141	1.88E+02	1.79E+02	1.05	Acceptable
EZA	1st/ 2013	04/25/13	E10472	Water	pCi/L	Chromium-51	4.84E+02	4.52E+02	1.07	Acceptable
EZA	1st/ 2013	04/25/13	E10472	Water	pCi/L	Cesium-134	1.96E+02	2.05E+02	0.96	Acceptable
EZA	1st/ 2013	04/25/13	E10472	Water	pCi/L	Cesium-137	2.71E+02	2.54E+02	1.07	Acceptable
EZA	1st/ 2013	04/25/13	E10472	Water	pCi/L	Cobalt-58	2.03E+02	1.99E+02	1.02	Acceptable
EZA	1st/ 2013	04/25/13	E10472	Water	pCi/L	Mn-54	2.15E+02	1.99E+02	1.08	Acceptable
EZA	1st/ 2013	04/25/13	E10472	Water	pCi/L	Iron-59	2.67E+02	2.41E+02	1.11	Acceptable
EZA	1st/ 2013	04/25/13	E10472	Water	pCi/L	Zinc-65	3.14E+02	2.88E+02	1.09	Acceptable
EZA	1st/ 2013	04/25/13	E10472	Water	pCi/L	Cobalt-60	3.92E+02	3.83E+02	1.02	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-27-GrF28	Filter	Bq/sample	Gross Alpha	0.656	1.20	0.36-2.04	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-27-GrF29	Filter	Bq/sample	Gross Beta	0.954	0.85	0.43-1.28	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Americium-241	118	113	79-147	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Cesium-134	829	887	621-1153	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Cesium-137	623	587	411-763	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Cobalt-57	1.04	0	False Pos Test	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Cobalt-60	737	691	484-898	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Iron-55	-0.380	0	False Pos Test	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Manganese-54	0.760	0	False Pos Test	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Nickel-63	719	670	469-871	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Plutonium-238	0.571	0.52	Sens. Eval.	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Plutonium-	77.70	79.5	55.7-103.4	Acceptable

						239/240				
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Potassium-40	713	625	438-813	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Strontium-90	693.0	628	440-816	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Technetium-99	419.0	444	311-577	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Uranium-234/233	60.0	62.5	43.8-81.3	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Uranium-238	274	281	197-365	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Zinc-65	1130	995	697-1294	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Americium-241	0.690	0.689	0.428-0.896	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Cesium-134	21.1	24.4	17.1-31.7	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Cesium-137	0.10	0.0	False Pos Test	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Cobalt-57	31.0	30.9	21.6-40.2	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Cobalt-60	19.4	19.6	13.7-25.4	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Hydrogen-3	517	507	355-659	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Iron-55	39.7	44.0	30.8-57.2	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Manganese-54	28.0	27.4	19.2-35.6	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Nickel-63	32.9	33.4	23.4-43.4	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Plutonium-238	0.825	0.884	0.619-1.149	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Pu-239/240	0.0162	0.0096	Sens. Eval.	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Potassium-40	-0.471	0	False Pos Test	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Strontium-90	12.5	10.5	7.4-13.7	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Technetium-99	12.9	13.1	9.2-17.0	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Uranium-234/233	0.289	0.315	0.221-0.410	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Uranium-238	1.81	1.95	1.37-2.54	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-MaW28	Water	Bq/L	Zinc-65	32.8	30.4	21.3-39.5	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-GrW28	Water	Bq/L	Gross Alpha	2.60	2.31	0.69-3.93	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-GrW28	Water	Bq/L	Gross Beta	14.2	13.0	6.5-19.5	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-XaW28	Water	Bq/L	Iodine-129	5.94	6.06	4.24-7.88	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdF28	Filter	ug/sample	Uranium-235	0.036	0.036	0.025-0.047	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdF28	Filter	ug/sample	Uranium-238	18.0	18.6	13.0-24.2	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdF28	Filter	ug/sample	Uranium-Total	17.7	18.6	13.0-24.2	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdF28	Filter	ug/sample	Americium-241	0.106	0.104	0.073-0.135	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Cesium-134	1.75	1.78	1.25-2.31	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Cesium-137	2.71	2.60	1.82-3.38	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Cobalt-57	2.51	2.36	1.65-3.07	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Cobalt-60	0.005	0.00	False Pos Test	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Manganese-54	4.43	4.26	2.98-5.54	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Plutonium-238	0.124	0.127	0.089-0.165	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Pu-239/240	0.118	0.1210	0.085-0.157	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Strontium-90	1.54	1.49	1.04-1.94	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Uranium-234/233	0.0342	0.0318	0.0223-0.0413	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Uranium-238	0.230	0.231	0.162-0.300	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Zinc-65	3.38	3.13	2.19-4.07	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-GrF28	Filter	Bq/sample	Gross Alpha	0.656	1.20	0.36-2.04	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-GrF28	Filter	Bq/sample	Gross Beta	0.95	0.85	0.43-1.28	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Americium-241	0.106	0.104	0.073-0.135	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdV28	Vegetation	ug/sample	Uranium-235	0.0029	0.001	0.0009-0.0017	Not Accept.
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdV28	Vegetation	ug/sample	Uranium-238	0.419	0.180	0.13-0.23	Not Accept.
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdV28	Vegetation	ug/sample	Uranium-Total	0.4219	0.180	0.13-0.23	Not Accept.
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdV28	Vegetation	ug/sample	Americium-241	0.1350	0.140	0.098-0.182	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Cesium-134	0.0525	0.00	False Pos Test	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Cesium-137	7.13	6.87	4.81-8.93	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Cobalt-57	8.86	8.68	6.08-11.28	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Cobalt-60	6.07	5.85	4.10-7.61	Acceptable

MAPEP	2nd/2013	05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Manganese-54	-0.002	0.00	False Pos Test	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Plutonium-238	0.110	0.110	0.077-0.143	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Pu-239/240	0.113	0.123	0.086-0.160	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Strontium-90	1.358	1.64	1.15-2.13	Acceptable
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Uranium-234/233	0.0081	0.0038	Sens. Eval.	Not Accept.
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Uranium-238	0.00489	0.002	Sens. Eval.	Not Accept.
MAPEP	2nd/2013	05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Zinc-65	6.59	6.25	4.38-8.13	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Actinium-228	1500	1240	795-1720	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Americium-241	225	229	134-297	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Bismuth-212	1250	1240	330-1820	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Bismuth-214	4410	3660	2200-5270	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Cesium-134	7850	6370	4160-7650	Not Accept.
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Cesium-137	8070	6120	4690-7870	Not Accept.
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Cobalt-60	10300	7920	5360-10900	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Lead-212	1290	1240	812-1730	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Lead-214	4690	3660	2140-5460	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Manganese-54	<63.4	<1000	0-1000	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Plutonium-238	651	788.00	474-1090	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Plutonium-239	320	366.00	239-506	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Potassium-40	10300	10300	7520-13800	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Strontium-90	6730	8530	3250-13500	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Thorium-234	3290	1900	601-3570	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Zinc-65	1910	1400	1110-1860	Not Accept.
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Strontium-90	6730	8530	3250-13500	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Uranium-234	1210	1920	1170-2460	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Uranium-238	1630	1900	1180-2410	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	pCi/kg	Uranium-Total	2840	3920	2130-5170	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Soil	ug/kg	Uranium-Total(mass)	4150	5710	3150-7180	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Vegetation	pCi/kg	Americium-241	629	553	338-735	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Vegetation	pCi/kg	Cesium-134	1400	1240	797-1610	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Vegetation	pCi/kg	Cesium-137	687	544	394-757	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Vegetation	pCi/kg	Cobalt-60	2410	1920	1320-2680	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Vegetation	pCi/kg	Curium-244	1420	1340	657-2090	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Vegetation	pCi/kg	Manganese-54	<47.4	<300	0.00-300	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Vegetation	pCi/kg	Plutonium-238	2060	1980	1180-2710	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Vegetation	pCi/kg	Plutonium-239	2230	2260	1390-3110	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Vegetation	pCi/kg	Potassium-40	35600	31900	23000-44800	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Vegetation	pCi/kg	Strontium-90	3720	3840	2190-5090	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Vegetation	pCi/kg	Uranium-234	2650	2460	1620-3160	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Vegetation	pCi/kg	Uranium-238	2580	2440	1630-3100	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Vegetation	pCi/kg	Uranium-Total	5361	5010	3390-6230	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Vegetation	ug/kg	Uranium-Total(mass)	7740	7310	4900-9280	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Vegetation	pCi/kg	Zinc-65	1150	878	633-1230	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Filter	pCi/Filter	Americium-241	62.9	66.8	41.2-90.4	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Filter	pCi/Filter	Cesium-134	1080	1110	706-1380	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Filter	pCi/Filter	Cesium-137	971	940	706-1230	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Filter	pCi/Filter	Cobalt-60	217	214	166-267	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Filter	pCi/Filter	Iron-55	224	225	69.8-440	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Filter	pCi/Filter	Manganese-54	<5.27	<50.0	0-50.0	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Filter	pCi/Filter	Plutonium-238	48.0	50.1	34.3-65.9	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Filter	pCi/Filter	Plutonium-239	62.7	65.2	47.2-85.2	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Filter	pCi/Filter	Strontium-90	139	138	67.4-207	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Filter	pCi/Filter	Uranium-234	54.5	59.4	36.8-89.6	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Filter	pCi/Filter	Uranium-238	58.5	58.9	38.1-81.4	Acceptable

ERA	2nd/2013	05/22/13	MRAD-18	Filter	pCi/Filter	Uranium-Total	117	121	67.0-184	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Filter	ug/Filter	Uranium-Total(mass)	176	176	113-248	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Filter	pCi/Filter	Zinc-65	222	199	142-275	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Filter	pCi/Filter	Gross Alpha	55.5	42.3	14.2-65.7	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Filter	pCi/Filter	Gross Beta	31	25.1	15.9-36.6	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	pCi/L	Americium-241	118	118	79.5-158	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	pCi/L	Cesium-134	1320	1400	1030-1610	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	pCi/L	Cesium-137	1900	1880	1600-2250	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	pCi/L	Cobalt-60	2370	2270	1970-2660	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	pCi/L	Iron-55	812	712	424-966	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	pCi/L	Manganese-54	<7.6	<100	0.00-100	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	pCi/L	Plutonium-238	91	99	73.1-123	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	pCi/L	Plutonium-239	161	185	144-233	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	pCi/L	Strontium-90	144	137	89.2-181	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	pCi/L	Uranium-234	47.3	48.8	36.7-62.9	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	pCi/L	Uranium-238	50.8	48.4	36.9-59.4	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	pCi/L	Uranium-Total	98.1	99.5	73.1-129	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	ug/L	Uranium-Total(mass)	152	145	116-175	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	pCi/L	Zinc-65	428	384	320-484	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	pCi/L	Gross Alpha	138.0	130	46.2-201	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	pCi/L	Gross Beta	87	78.9	45.2-117	Acceptable
ERA	2nd/2013	05/22/13	MRAD-18	Water	pCi/L	Tritium	13100	12300	8240-17500	Acceptable
EZA	2nd/2013	08/02/13	E10577	Cartridge	pCi	Iodine-131	9.16E+01	9.55E+01	1.02	Acceptable
EZA	2nd/2013	08/02/13	E10578	Milk	pCi/L	Strontium-89	9.27E+01	9.04E+01	0.98	Acceptable
EZA	2nd/2013	08/02/13	E10578	Milk	pCi/L	Strontium-90	1.20E+01	1.70E+01	0.7	Acceptable
EZA	2nd/2013	08/02/13	E10579	Milk	pCi/L	Iodine-131	9.86E+01	9.55E+01	1.03	Acceptable
EZA	2nd/2013	08/02/13	E10579	Milk	pCi/L	Cerium-141	9.44E+01	9.04E+01	1.04	Acceptable
EZA	2nd/2013	08/02/13	E10579	Milk	pCi/L	Chromium-51	2.58E+02	2.50E+02	1.03	Acceptable
EZA	2nd/2013	08/02/13	E10579	Milk	pCi/L	Cesium-134	1.21E+02	1.25E+02	0.97	Acceptable
EZA	2nd/2013	08/02/13	E10579	Milk	pCi/L	Cesium-137	1.49E+02	1.51E+02	0.99	Acceptable
EZA	2nd/2013	08/02/13	E10579	Milk	pCi/L	Cobalt-58	9.44E+01	9.40E+01	1.00	Acceptable
EZA	2nd/2013	08/02/13	E10579	Milk	pCi/L	Manganese-54	1.80E+02	1.72E+02	1.05	Acceptable
EZA	2nd/2013	08/02/13	E10579	Milk	pCi/L	Iron-59	1.36E+02	1.20E+02	1.14	Acceptable
EZA	2nd/2013	08/02/13	E10579	Milk	pCi/L	Zinc-65	2.39E+02	2.17E+02	1.10	Acceptable
EZA	2nd/2013	08/02/13	E10579	Milk	pCi/L	Cobalt-60	1.77E+02	1.75E+02	1.01	Acceptable
EZA	2nd/2013	08/02/13	E10178	Water	pCi/L	Iodine-131	9.33E+01	9.54E+01	0.98	Acceptable
EZA	2nd/2013	08/02/13	E10178	Water	pCi/L	Cerium-141	1.15E+02	1.10E+02	1.04	Acceptable
EZA	2nd/2013	08/02/13	E10178	Water	pCi/L	Chromium-51	3.40E+02	3.06E+02	1.11	Acceptable
EZA	2nd/2013	08/02/13	E10178	Water	pCi/L	Cesium-134	1.48E+02	1.53E+02	0.97	Acceptable
EZA	2nd/2013	08/02/13	E10178	Water	pCi/L	Cesium-137	1.83E+02	1.84E+02	0.99	Acceptable
EZA	2nd/2013	08/02/13	E10178	Water	pCi/L	Cobalt-58	1.13E+02	1.15E+02	0.99	Acceptable
EZA	2nd/2013	08/02/13	E10178	Water	pCi/L	Manganese-54	2.09E+02	2.10E+02	1.00	Acceptable
EZA	2nd/2013	08/02/13	E10178	Water	pCi/L	Iron-59	1.51E+02	1.46E+02	1.03	Acceptable
EZA	2nd/2013	08/02/13	E10178	Water	pCi/L	Zinc-65	2.86E+02	2.65E+02	1.08	Acceptable
EZA	2nd/2013	08/02/13	E10178	Water	pCi/L	Cobalt-60	2.25E+02	2.14E+02	1.05	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Barium-133	76.4	740.5	62.4-82.0	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Cesium-134	68.7	72.4	59.1-79.6	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Cesium-137	154	155	140-172	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Cobalt-60	85.3	82.3	74.1-92.9	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Zinc-65	297	260	234-304	Acceptable
ERA	3rd /	08/22/13	RAD - 94	Water	pCi/L	Gross Alpha	74.3	57.1	29.8-71.2	Not

	2013									Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Gross Beta	34.3	41.8	27.9-49.2	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Gross Alpha	67.7	57.1	29.8-71.2	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Radium-226	16.9	17.2	12.8-19.7	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Radium-226	17	17.2	12.8-19.7	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Radium-228	3.53	3.86	2.18-5.4	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Uranium (Nat)	20.4	21.4	17.1-24.1	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	ug/L	Uranium (Nat) mass	30.4	31.2	25.0-35.2	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Radium-226	14.6	17.2	12.8-19.7	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Uranium (Nat)	21.6	21.4	17.1-24.1	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	ug/L	Uranium (Nat) mass	33.7	31.2	25-35.2	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Tritium	12500	13300	11600-14600	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Strontium-89	48.9	36.5	27.4-43.4	Not Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Strontium-90	14.3	19.8	14.1-23.4	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Strontium-89	44.3	36.5	27.4-43.4	Not Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Strontium-90	17.3	19.8	14.1-23.4	Acceptable
ERA	3rd / 2013	08/22/13	RAD - 94	Water	pCi/L	Iodine-131	26.1	24.3	20.2-28.8	Acceptable
ERA	3rd/2013	08/22/13	RAD - 94	Water	pCi/L	Iodine-131	23.3	24.3	20.2-28.8	Acceptable
EZA	3rd/2013	10/25/13	E10625	Cartridge	pCi	Iodine-131	8.57E+01	7.96E+01	1.08	Acceptable
EZA	3rd/2013	10/25/13	E10626	Milk	pCi/L	Strontium-89	9.33E+01	9.60E+01	0.97	Acceptable
EZA	3rd/2013	10/25/13	E10626	Milk	pCi/L	Strontium-90	1.09E+01	1.32E+01	0.83	Acceptable
EZA	3rd/2013	10/25/13	E10627	Milk	pCi/L	Iodine-131	1.00E+02	9.83E+01	1.02	Acceptable
EZA	3rd/2013	10/25/13	E10627	Milk	pCi/L	Chromium-51	3.09E+02	2.77E+02	1.11	Acceptable
EZA	3rd/2013	10/25/13	E10627	Milk	pCi/L	Cesium-134	1.46E+02	1.72E+02	0.85	Acceptable
EZA	3rd/2013	10/25/13	E10627	Milk	pCi/L	Cesium-137	1.33E+02	1.31E+02	1.02	Acceptable
EZA	3rd/2013	10/25/13	E10627	Milk	pCi/L	Cobalt-58	1.04E+02	1.08E+02	0.97	Acceptable
EZA	3rd/2013	10/25/13	E10627	Milk	pCi/L	Manganese-54	1.44E+02	1.39E+02	1.04	Acceptable
EZA	3rd/2013	10/25/13	E10627	Milk	pCi/L	Iron-59	1.43E+02	1.30E+02	1.1	Acceptable
EZA	3rd/2013	10/25/13	E10627	Milk	pCi/L	Zinc-65	2.86E+02	2.66E+02	1.07	Acceptable
EZA	3rd/2013	10/25/13	E10627	Milk	pCi/L	Cobalt-60	2.01E+02	1.96E+02	1.03	Acceptable
EZA	3rd/2013	10/25/13	E10628	Water	pCi/L	Iodine-131	1.01E+02	9.79E+01	1.03	Acceptable
EZA	3rd/2013	10/25/13	E10628	Water	pCi/L	Chromium-51	2.80E+02	2.51E+02	1.12	Acceptable
EZA	3rd/2013	10/25/13	E10628	Water	pCi/L	Cesium-134	1.42E+02	1.56E+02	0.91	Acceptable
EZA	3rd/2013	10/25/13	E10628	Water	pCi/L	Cesium-137	1.19E+02	1.18E+02	1.01	Acceptable
EZA	3rd/2013	10/25/13	E10628	Water	pCi/L	Cobalt-58	9.80E+01	9.73E+01	1.01	Acceptable
EZA	3rd/2013	10/25/13	E10628	Water	pCi/L	Manganese-54	1.29E+02	1.25E+02	1.05	Acceptable
EZA	3rd/2013	10/25/13	E10628	Water	pCi/L	Iron-59	1.23E+02	1.18E+02	1.04	Acceptable
EZA	3rd/2013	10/25/13	E10628	Water	pCi/L	Zinc-65	2.62E+02	2.41E+02	1.09	Acceptable
EZA	3rd/2013	10/25/13	E10628	Water	pCi/L	Cobalt-60	1.87E+02	1.77E+02	1.06	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-GrF29	Filter	Bq/sample	Gross Alpha	1.090	0.900	0.3-1.5	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-GrF29	Filter	Bq/sample	Gross Beta	1.730	1.630	0.82-2.45	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Americium-241	0.00	0	False Pos Test	Acceptable

MAPEP	4th/2013	11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Cesium-134	1090	1172	820-1524	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Cesium-137	1010	977	684-1270	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Cobalt-57	0.0	0	False Pos Test	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Cobalt-60	462.00	451.00	316-586	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Iron-55	887	820	574-1066	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Manganese-54	692	674	472-876	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Nickel-63	525.0	571	400-742	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Plutonium-238	60.8	62	43.1-80.0	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Plutonium-239/240	1.33	0.4	Sens. Eval.	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Potassium-40	638	633	443-823	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Strontium-90	458.0	460	322-598	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Technetium-99	0.0	0	False Pos Test	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Uranium-234/233	26.1	30	21.0-39.0	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Uranium-238	30.0	34	23.8-44.2	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Zinc-65	0.0	0	False Pos Test	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Americium-241	0.0001	0.000	False Pos Test	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Cesium-134	27.20	30.0	21.0-39.0	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Cesium-137	31.8	31.6	22.1-41.1	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Cobalt-57	0	0.0	False Pos Test	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Cobalt-60	23.60	23.6	16.51-30.65	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Hydrogen-3	-3.5	0	False Pos Test	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Iron-55	53.00	53.3	37.3-69.3	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Manganese-54	-0.009	0.0	False Pos Test	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Nickel-63	27.7	26.4	18.5-34.3	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Plutonium-238	1.070	1.216	0.851-1.581	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Plutonium-239/240	0.907	0.996	0.697-1.295	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Potassium-40	0.339	0	False Pos Test	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Strontium-90	6.65	7.22	5.05-9.39	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Technetium-99	15.4	16.20	11.3-21.1	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Uranium-234/233	0.065	0.07	Sens. Eval.	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Uranium-238	0.031	0.034	Sens. Eval.	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Zinc-65	36.500	34.60	24.2-45.0	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Gross Alpha	0.793	0.701	0.201-1.192	Acceptable

MAPEP	4th/2013	11/12/13	MAPEP-13-MaW29	Water	Bq/L	Gross Beta	6.220	5.94	2.97-8.91	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdF29	Filter	ug/sample	Uranium-235	0.034	0.032	0.0227-0.0421	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdF29	Filter	ug/sample	Uranium-238	15.8	16.5	11.6-21.5	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdF29	Filter	ug/sample	Uranium-Total	15.80	16.5	11.6-21.5	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdF29	Filter	ug/sample	Americium-241	0.0002	0.000	False Pos Test	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Cesium-134	-0.0016	0.00	False Pos Test	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Cesium-137	3.010	2.70	1.9-3.5	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Cobalt-57	3.530	3.40	2.4-4.4	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Cobalt-60	2.440	2.30	1.6-3.0	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Manganese-54	3.720	3.50	2.5-4.6	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Plutonium-238	0.128	0.124	0.087-0.161	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Plutonium-239/240	0.092	0.0920	0.064-0.12	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Strontium-90	1.690	1.81	1.27-2.35	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Uranium-234/233	0.027	0.0292	0.0204-0.038	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Uranium-238	0.020	0.021	0.144-0.267	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Zinc-65	3.050	2.70	1.9-3.5	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Americium-241	0.226	0.19	0.135-0.251	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Cesium-134	4.750	5.20	3.64-6.67	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Cesium-137	6.910	6.60	4.62-8.58	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Cobalt-57	-0.002	0.00	False Pos Test	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Cobalt-60	0.008	0.00	False Pos Test	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Manganese-54	7.980	7.88	5.52-10.24	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Plutonium-238	0.001	0.001	Sens. Eval.	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Plutonium-239/240	0.1510	0.171	0.120-0.222	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Strontium-90	2.330	2.32	1.62-3.02	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Uranium-234/233	0.046	0.047	0.0326-0.0606	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Uranium-238	0.332	0.324	0.227-0.421	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Zinc-65	2.850	2.63	1.84-3.42	Acceptable
MAPEP	4th/2013	11/12/13	MAPEP-13-XaW29	Water	Bq/L	Iodine-129	3.62	3.79	2.65-4.93	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Actinium-228	1200	1240	795-1720	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Americium-241	186	164	95.9-213	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Bismuth-212	1760	1220	325-1790	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Bismuth-214	4350	3740	2250-5380	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Cesium-134	2690	2820	1840-3390	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Cesium-137	3960	4130	3160-5310	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Cobalt-60	5490	5680	3840-7820	Acceptable

ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Lead-212	1260	1220	799-1700	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Lead-214	4700	3740	2180-5580	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Manganese-54	<55.2	<1000	0-1000	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Plutonium-238	576	658	396-908	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Plutonium-239	400	397	260-548	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Potassium-40	11200	12400	9080-16700	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Strontium-90	8220	6860	2620-10800	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Thorium-234	2870	3080	974-5790	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Zinc-65	3400	3160	2520-4200	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Uranium-234	2870	3080	974-5790	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Uranium-238	2979	3080	1910-3910	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	pCi/kg	Uranium-Total	6870	6320	3430-8340	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Soil	ug/kg	Uranium-Total(mass)	8460	9220	5080-11600	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	pCi/kg	Americium-241	3800	3630	2220-4830	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	pCi/kg	Cesium-134	907	859	552-1120	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	pCi/kg	Cesium-137	1220	1030	747-1430	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	pCi/kg	Cobalt-60	2100	1880	1300-2630	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	pCi/kg	Curium-244	1230	1250	612-1950	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	pCi/kg	Manganese-54	<53.3	<300	0-300	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	pCi/kg	Plutonium-238	1280	1290	769-1770	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	pCi/kg	Plutonium-239	2580	2770	1700-3810	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	pCi/kg	Potassium-40	33600	33900	24500-47600	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	pCi/kg	Strontium-90	5870	6360	3630-8430	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	pCi/kg	Uranium-234	674	654	430-840	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	pCi/kg	Uranium-234	1050	654	430-840	Not Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	pCi/kg	Uranium-238	655	648	432-823	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	pCi/kg	Uranium-Total	1364	1330	901-1660	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	pCi/kg	Uranium-Total	1773	1330	901-1660	Not Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	ug/kg	Uranium-Total(mass)	1960	1940	1300-2460	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Vegetation	pCi/kg	Zinc-65	1990	1540	1110-2160	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	pCi/Filter	Americium-241	75.2	66.4	40.9-89.9	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	pCi/Filter	Cesium-134	845	868.0	552-1080	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	pCi/Filter	Cesium-137	641	602	452-791	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	pCi/Filter	Cobalt-60	534	494	382-617	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	pCi/Filter	Iron-55	466	389.0	121-760	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	pCi/Filter	Manganese-54	<3.9	<50	0.00-50.0	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	ug/Filter	Plutonium-238	72.8	68.5	46.9-90.1	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	pCi/Filter	Plutonium-239	56.5	53.4	42.4-93.1	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	pCi/Filter	Strontium-90	130	125	61.1-187	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	pCi/Filter	Uranium-234	56	87	35.6-86.6	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	pCi/Filter	Uranium-238	58	56.90	36.8-78.7	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	pCi/Filter	Uranium-Total	116	117	64.8-178	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	ug/Filter	Uranium-Total(mass)	172	171	109-241	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	pCi/Filter	Zinc-65	514	419	300-578	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	ug/Filter	Uranium-Total(mass)	169	171	109-241	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	ug/Filter	Uranium-Total(mass)	150	171	109-241	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	pCi/Filter	Gross Alpha	100	83	27.8-129	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Filter	pCi/Filter	Gross Beta	65.7	56.3	35.6-82.2	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Americium-241	126	126	84.9-169	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Cesium-134	2060.0	2180	1600-2510	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Cesium-137	2730	2760	2340-3310	Acceptable

ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Cobalt-60	1960	1890	1640-2210	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Iron-55	721	689	411-935	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Manganese-54	<7.24	<100	0.00-100	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Plutonium-238	133	138	102-172	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Plutonium-239	98.7	109	84.6-137	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Strontium-90	726	788	513-1040	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Uranium-234	93	99	74.3-128	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Uranium-238	93	98.00	74.7-120	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Uranium-Total	186	201	148-260	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	ug/L	Uranium-Total(mass)	278	294	234-355	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Zinc-65	1560	1370	1140-1730	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Gross Alpha	105.0	97	34.3-150	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Gross Beta	78.8	84.5	48.4-125	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Tritium	8740	9150	6130-13000	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Uranium-234	92.4	98.9	74.3-128	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Uranium-238	96.1	98.0	74.7-120	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Uranium-Total	193	201	148-260	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	ug/L	Uranium-Total(mass)	288	294	234-355	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Uranium-234	95.2	98.9	74.3-128	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Uranium-238	115	98.00	74.7-120	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	pCi/L	Uranium-Total	215	201	148-260	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	ug/L	Uranium-Total(mass)	344	294	234-355	Acceptable
ERA	4th/2013	11/26/13	MRAD-19	Water	ug/L	Uranium-Total(mass)	258	294	234-355	Acceptable

TABLE 2

2013 ECKERT & ZIEGLER ANALYTICS PERFORMANCE EVALUATION RESULTS

Report Date	Sample Number	Sample Media	Unit	Analyte / Nuclide	GEL Value	Known value	Acceptance Range/ Ratio	Evaluation
02/01/13	E10323	Cartridge	pCi	Iodine-131	7.31E+01	7.29E+01	1.00	Acceptable
02/01/13	E10324	Milk	pCi/L	Strontium-89	9.89E+00	1.38E+01	0.72	Acceptable
02/01/13	E10324	Milk	pCi/L	Strontium-90	9.83E+00	1.48E+01	1.02	Acceptable
02/01/13	E10325	Milk	pCi/L	Iodine-131	9.57E+01	9.00E+01	1.06	Acceptable
02/01/13	E10325	Milk	pCi/L	Chromium-51	3.67E+02	3.48E+02	1.06	Acceptable
02/01/13	E10325	Milk	pCi/L	Cesium-134	1.54E+02	1.65E+02	0.93	Acceptable
02/01/13	E10325	Milk	pCi/L	Cesium-137	1.18E+02	1.17E+02	1.01	Acceptable
02/01/13	E10325	Milk	pCi/L	Cobalt-58	9.85E+01	9.85E+01	1	Acceptable
02/01/13	E10325	Milk	pCi/L	Manganese-54	1.16E+02	1.16E+02	1	Acceptable
02/01/13	E10325	Milk	pCi/L	Iron-59	1.33E+02	1.16E+02	1.15	Acceptable
02/01/13	E10325	Milk	pCi/L	Zinc-65	3.19E+02	2.91E+02	1.09	Acceptable
02/01/13	E10325	Milk	pCi/L	Cobalt-60	1.73E+02	1.70E+02	1.02	Acceptable
02/01/13	E10325	Milk	pCi/L	Cesium-141	5.38E+01	5.10E+01	1.05	Acceptable
02/01/13	E10380	Water	pCi/L	Iodine-131	7.47E+01	7.25E+01	1.03	Acceptable
02/01/13	E10380	Water	pCi/L	Chromium-51	3.81E+02	3.62E+02	1.05	Acceptable
02/01/13	E10380	Water	pCi/L	Cesium-134	1.57E+02	1.73E+02	0.91	Acceptable
02/01/13	E10380	Water	pCi/L	Cesium-137	1.25E+02	1.22E+02	1.03	Acceptable
02/01/13	E10380	Water	pCi/L	Cobalt-58	1.02E+02	1.03E+02	0.99	Acceptable
02/01/13	E10380	Water	pCi/L	Manganese-54	1.28E+02	1.21E+02	1.06	Acceptable
02/01/13	E10380	Water	pCi/L	Iron-59	1.38E+02	1.21E+02	1.14	Acceptable
02/01/13	E10380	Water	pCi/L	Zinc-65	2.13E+02	1.94E+02	1.1	Acceptable
02/01/13	E10380	Water	pCi/L	Cobalt-60	1.80E+02	1.77E+02	1.01	Acceptable
04/25/13	E10469	Cartridge	pCi	Iodine-131	9.38E+01	9.27E+01	1.01	Acceptable
04/25/13	E10470	Milk	pCi/L	Strontium-89	1.07E+02	9.97E+01	1.07	Acceptable
04/25/13	E10470	Milk	pCi/L	Strontium-90	1.18E+01	1.10E+01	1.07	Acceptable
04/25/13	E10471	Milk	pCi/L	Iodine-131	1.12E+02	1.00E+02	1.12	Acceptable
04/25/13	E10471	Milk	pCi/L	Cerium-141	2.00E+01	1.87E+01	1.07	Acceptable
04/25/13	E10471	Milk	pCi/L	Cr-51	5.09E+01	4.72E+01	1.08	Acceptable
04/25/13	E10471	Milk	pCi/L	Cesium-134	2.06E+02	2.14E+02	0.96	Acceptable
04/25/13	E10471	Milk	pCi/L	Cesium-137	2.83E+02	2.66E+02	1.07	Acceptable
04/25/13	E10471	Milk	pCi/L	Cobalt-58	2.19E+02	2.08E+02	1.05	Acceptable
04/25/13	E10471	Milk	pCi/L	Mn-54	2.21E+02	2.08E+02	1.06	Acceptable
04/25/13	E10471	Milk	pCi/L	Iron-59	2.78E+02	2.52E+02	1.1	Acceptable
04/25/13	E10471	Milk	pCi/L	Zinc-65	3.39E+02	3.01E+02	1.13	Acceptable
04/25/13	E10471	Milk	pCi/L	Cobalt-60	4.02E+02	4.00E+02	1.01	Acceptable
04/25/13	E10472	Water	pCi/L	Iodine-131	1.12E+02	9.28E+01	1.21	Acceptable
04/25/13	E10472	Water	pCi/L	Cerium-141	1.88E+02	1.79E+02	1.05	Acceptable
04/25/13	E10472	Water	pCi/L	Cr-51	4.84E+02	4.52E+02	1.07	Acceptable

04/25/13	E10472	Water	pCi/L	Cesium-134	1.96E+02	2.05E+02	0.96	Acceptable
04/25/13	E10472	Water	pCi/L	Cesium-137	2.71E+02	2.54E+02	1.07	Acceptable
04/25/13	E10472	Water	pCi/L	Cobalt-58	2.03E+02	1.99E+02	1.02	Acceptable
04/25/13	E10472	Water	pCi/L	Mn-54	2.15E+02	1.99E+02	1.08	Acceptable
04/25/13	E10472	Water	pCi/L	Iron-59	2.67E+02	2.41E+02	1.11	Acceptable
04/25/13	E10472	Water	pCi/L	Zinc-65	3.14E+02	2.88E+02	1.09	Acceptable
04/25/13	E10472	Water	pCi/L	Cobalt-60	3.92E+02	3.83E+02	1.02	Acceptable
08/02/13	E10577	Cartridge	pCi	Iodine-131	9.16E+01	9.55E+01	1.02	Acceptable
08/02/13	E10578	Milk	pCi/L	Strontium-89	9.27E+01	9.04E+01	0.98	Acceptable
08/02/13	E10578	Milk	pCi/L	Strontium-90	1.20E+01	1.70E+01	0.7	Acceptable
08/02/13	E10579	Milk	pCi/L	Iodine-131	9.86E+01	9.55E+01	1.03	Acceptable
08/02/13	E10579	Milk	pCi/L	Cerium-141	9.44E+01	9.04E+01	1.04	Acceptable
08/02/13	E10579	Milk	pCi/L	Chromium-51	2.58E+02	2.50E+02	1.03	Acceptable
08/02/13	E10579	Milk	pCi/L	Cesium-134	1.21E+02	1.25E+02	0.97	Acceptable
08/02/13	E10579	Milk	pCi/L	Cesium-137	1.49E+02	1.51E+02	0.99	Acceptable
08/02/13	E10579	Milk	pCi/L	Cobalt-58	9.44E+01	9.40E+01	1.00	Acceptable
08/02/13	E10579	Milk	pCi/L	Manganese-54	1.80E+02	1.72E+02	1.05	Acceptable
08/02/13	E10579	Milk	pCi/L	Iron-59	1.36E+02	1.20E+02	1.14	Acceptable
08/02/13	E10579	Milk	pCi/L	Zinc-65	2.39E+02	2.17E+02	1.10	Acceptable
08/02/13	E10579	Milk	pCi/L	Cobalt-60	1.77E+01	1.75E+02	1.01	Acceptable
08/02/13	E10178	Water	pCi/L	Iodine-131	9.33E+01	9.54E+01	0.98	Acceptable
08/02/13	E10178	Water	pCi/L	Cerium-141	1.15E+02	1.10E+02	1.04	Acceptable
08/02/13	E10178	Water	pCi/L	Chromium-51	3.40E+02	3.06E+02	1.11	Acceptable
08/02/13	E10178	Water	pCi/L	Cesium-134	1.48E+02	1.53E+02	0.97	Acceptable
08/02/13	E10178	Water	pCi/L	Cesium-137	1.83E+02	1.84E+02	0.99	Acceptable
08/02/13	E10178	Water	pCi/L	Cobalt-58	1.13E+02	1.15E+02	0.99	Acceptable
08/02/13	E10178	Water	pCi/L	Manganese-54	2.09E+02	2.10E+02	1.00	Acceptable
08/02/13	E10178	Water	pCi/L	Iron-59	1.51E+02	1.46E+02	1.03	Acceptable
08/02/13	E10178	Water	pCi/L	Zinc-65	2.86E+02	2.65E+02	1.08	Acceptable
08/02/13	E10178	Water	pCi/L	Cobalt-60	2.25E+02	2.14E+02	1.05	Acceptable
10/25/13	E10625	Cartridge	pCi	Iodine-131	8.57E+01	7.96E+01	1.08	Acceptable
10/25/13	E10626	Milk	pCi/L	Strontium-89	9.33E+01	9.60E+01	0.97	Acceptable
10/25/13	E10626	Milk	pCi/L	Strontium-90	1.09E+01	1.32E+01	0.83	Acceptable
10/25/13	E10627	Milk	pCi/L	Iodine-131	1.00E+02	9.83E+01	1.02	Acceptable
10/25/13	E10627	Milk	pCi/L	Chromium-51	3.09E+02	2.77E+02	1.11	Acceptable
10/25/13	E10627	Milk	pCi/L	Cesium-134	1.46E+02	1.72E+02	0.85	Acceptable
10/25/13	E10627	Milk	pCi/L	Cesium-137	1.33E+02	1.31E+02	1.02	Acceptable
10/25/13	E10627	Milk	pCi/L	Cobalt-58	1.04E+02	1.08E+02	0.97	Acceptable
10/25/13	E10627	Milk	pCi/L	Manganese-54	1.44E+02	1.39E+02	1.04	Acceptable
10/25/13	E10627	Milk	pCi/L	Iron-59	1.43E+02	1.30E+02	1.1	Acceptable
10/25/13	E10627	Milk	pCi/L	Zinc-65	2.86E+02	2.66E+02	1.07	Acceptable
10/25/13	E10627	Milk	pCi/L	Cobalt-60	2.01E+02	1.96E+02	1.03	Acceptable
10/25/13	E10628	Water	pCi/L	Iodine-131	1.01E+02	9.79E+01	1.03	Acceptable
10/25/13	E10628	Water	pCi/L	Chromium-51	2.80E+02	2.51E+02	1.12	Acceptable

10/25/13	E10628	Water	pCi/L	Cesium-134	1.42E+02	1.56E+02	0.91	Acceptable
10/25/13	E10628	Water	pCi/L	Cesium-137	1.19E+02	1.18E+02	1.01	Acceptable
10/25/13	E10628	Water	pCi/L	Cobalt-58	9.80E+01	9.73E+01	1.01	Acceptable
10/25/13	E10628	Water	pCi/L	Manganese-54	1.29E+02	1.25E+02	1.05	Acceptable
10/25/13	E10628	Water	pCi/L	Iron-59	1.23E+02	1.18E+02	1.04	Acceptable
10/25/13	E10628	Water	pCi/L	Zinc-65	2.62E+02	2.41E+02	1.09	Acceptable
10/25/13	E10628	Water	pCi/L	Cobalt-60	1.87E+02	1.77E+02	1.06	Acceptable

TABLE 3

2013 DEPARTMENT OF ENERGY MIXED ANALYTE PERFORMANCE EVALUATION PROGRAM (MAPEP) RESULTS

Report Date	Sample Number	Sample Media	Unit	Analyte / Nuclide	GEL Value	Known value	Acceptance Range/ Ratio	Evaluation
02/27/13	GENE01-27-RdFR1	Filter	Bq/sample	U-234/233	0.0143	0.0155	0.0109-0.0202	Acceptable
02/27/13	GENE01-27-RdFR1	Filter	Bq/sample	Uranium-238	0.0999	0.098	0.069-0.127	Acceptable
05/13/13	MAPEP-13-GrF28	Filter	Bq/sample	Gross Alpha	0.656	1.20	0.36-2.04	Acceptable
05/13/13	MAPEP-13-GrF28	Filter	Bq/sample	Gross Beta	0.954	0.85	0.43-1.28	Acceptable
05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Americium-241	118	113	79-147	Acceptable
05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Cesium-134	829	887	621-1153	Acceptable
05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Cesium-137	623	587	411-763	Acceptable
05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Cobalt-57	1.04	0	False Pos Test	Acceptable
05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Cobalt-60	737	691	484-898	Acceptable
05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Iron-55	-0.380	0	False Pos Test	Acceptable
05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Manganese-54	0.760	0	False Pos Test	Acceptable
05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Nickel-63	719	670	469-871	Acceptable
05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Plutonium-238	0.571	0.52	Sens. Eval.	Acceptable
05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Plutonium-239/240	77.70	79.5	55.7-103.4	Acceptable
05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Potassium-40	713	625	438-813	Acceptable
05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Strontium-90	693.0	628	440-816	Acceptable
05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Technetium-99	419.0	444	311-577	Acceptable
05/13/13	MAPEP-13-MaS28	Soil	mg/kg	U-234/233	60.0	62.5	43.8-81.3	Acceptable
05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Uranium-238	274	281	197-365	Acceptable
05/13/13	MAPEP-13-MaS28	Soil	mg/kg	Zinc-65	1130	995	697-1294	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	Am-241	0.690	0.689	0.428-0.896	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	Cesium-134	21.1	24.4	17.1-31.7	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	Cesium-137	0.10	0.0	False Pos Test	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	Cobalt-57	31.0	30.9	21.6-40.2	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	Cobalt-60	19.4	19.6	13.7-25.4	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	Hydrogen-3	517	507	355-659	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	Iron-55	39.7	44.0	30.8-57.2	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	Manganese-54	28.0	27.4	19.2-35.6	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	Nickel-63	32.9	33.4	23.4-43.4	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	Plutonium-238	0.825	0.884	0.619-1.149	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	Pu-239/240	0.0162	0.0096	Sens. Eval.	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	Potassium-40	-0.471	0	False Pos Test	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	Strontium-90	12.5	10.5	7.4-13.7	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	Technetium-99	12.9	13.1	9.2-17.0	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	U-234/233	0.289	0.315	0.221-0.410	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	Uranium-238	1.81	1.95	1.37-2.54	Acceptable
05/13/13	MAPEP-13-MaW28	Water	Bq/L	Zinc-65	32.8	30.4	21.3-39.5	Acceptable

05/13/13	MAPEP-13-GrW28	Water	Bq/L	Gross Alpha	2.60	2.31	0.69-3.93	Acceptable
05/13/13	MAPEP-13-GrW28	Water	Bq/L	Gross Beta	14.2	13.0	6.5-19.5	Acceptable
05/13/13	MAPEP-13-XaW28	Water	Bq/L	Iodine-129	5.94	6.06	4.24-7.88	Acceptable
05/13/13	MAPEP-13-RdF28	Filter	ug/sample	Uranium-235	0.036	0.036	0.025-0.047	Acceptable
05/13/13	MAPEP-13-RdF28	Filter	ug/sample	Uranium-238	18.0	18.6	13.0-24.2	Acceptable
05/13/13	MAPEP-13-RdF28	Filter	ug/sample	Uranium-Total	17.7	18.6	13.0-24.2	Acceptable
05/13/13	MAPEP-13-RdF28	Filter	ug/sample	Americium-241	0.106	0.104	0.073-0.135	Acceptable
05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Cesium-134	1.75	1.78	1.25-2.31	Acceptable
05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Cesium-137	2.71	2.60	1.82-3.38	Acceptable
05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Cobalt-57	2.51	2.36	1.65-3.07	Acceptable
05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Cobalt-60	0.005	0.00	False Pos Test	Acceptable
05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Manganese-54	4.43	4.26	2.98-5.54	Acceptable
05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Plutonium-238	0.124	0.127	0.089-0.165	Acceptable
05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Pu-239/240	0.118	0.1210	0.085-0.157	Acceptable
05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Strontium-90	1.54	1.49	1.04-1.94	Acceptable
05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	U-234/233	0.0342	0.0318	0.0223-0.0413	Acceptable
05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Uranium-238	0.230	0.231	0.162-0.300	Acceptable
05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Zinc-65	3.38	3.13	2.19-4.07	Acceptable
05/13/13	MAPEP-13-GrF28	Filter	Bq/sample	Gross Alpha	0.656	1.20	0.36-2.04	Acceptable
05/13/13	MAPEP-13-GrF28	Filter	Bq/sample	Gross Beta	0.95	0.85	0.43-1.28	Acceptable
05/13/13	MAPEP-13-RdF28	Filter	Bq/sample	Americium-241	0.106	0.104	0.073-0.135	Acceptable
05/13/13	MAPEP-13-RdV28	Vegetation	ug/sample	Uranium-235	0.0029	0.001	0.0009-0.0017	Not Accept.
05/13/13	MAPEP-13-RdV28	Vegetation	ug/sample	Uranium-238	0.419	0.180	0.13-0.23	Not Accept.
05/13/13	MAPEP-13-RdV28	Vegetation	ug/sample	Uranium-Total	0.4219	0.180	0.13-0.23	Not Accept.
05/13/13	MAPEP-13-RdV28	Vegetation	ug/sample	Americium-241	0.1350	0.140	0.098-0.182	Acceptable
05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Cesium-134	0.0525	0.00	False Pos Test	Acceptable
05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Cesium-137	7.13	6.87	4.81-8.93	Acceptable
05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Cobalt-57	8.86	8.68	6.08-11.28	Acceptable
05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Cobalt-60	6.07	5.85	4.10-7.61	Acceptable
05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Manganese-54	-0.002	0.00	False Pos Test	Acceptable
05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Plutonium-238	0.110	0.110	0.077-0.143	Acceptable
05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Pu-239/240	0.113	0.123	0.086-0.160	Acceptable
05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Strontium-90	1.358	1.64	1.15-2.13	Acceptable
05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	U-234/233	0.0081	0.0038	Sens. Eval.	Not Accept.
05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Uranium-238	0.00489	0.002	Sens. Eval.	Not Accept.
05/13/13	MAPEP-13-RdV28	Vegetation	Bq/sample	Zinc-65	6.59	6.25	4.38-8.13	Acceptable
11/12/13	MAPEP-13-GrF29	Filter	Bq/sample	Gross Alpha	1.090	0.900	0.3-1.5	Acceptable
11/12/13	MAPEP-13-GrF29	Filter	Bq/sample	Gross Beta	1.730	1.630	0.82-2.45	Acceptable
11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Americium-241	0.00	0	False Pos Test	Acceptable
11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Cesium-134	1090	1172	820-1524	Acceptable
11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Cesium-137	1010	977	684-1270	Acceptable
11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Cobalt-57	0.0	0	False Pos Test	Acceptable
11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Cobalt-60	462.00	451.00	316-586	Acceptable
11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Iron-55	887	820	574-1066	Acceptable

11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Manganese-54	692	674	472-876	Acceptable
11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Nickel-63	525.0	571	400-742	Acceptable
11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Plutonium-238	60.8	62	43.1-80.0	Acceptable
11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Plutonium-239/240	1.33	0.4	Sens. Eval.	Acceptable
11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Potassium-40	638	633	443-823	Acceptable
11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Strontium-90	458.0	460	322-598	Acceptable
11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Technetium-99	0.0	0	False Pos Test	Acceptable
11/12/13	MAPEP-13-MaS29	Soil	mg/kg	U-234/233	26.1	30	21.0-39.0	Acceptable
11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Uranium-238	30.0	34	23.8-44.2	Acceptable
11/12/13	MAPEP-13-MaS29	Soil	mg/kg	Zinc-65	0.0	0	False Pos Test	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Americium-241	0.0001	0.000	False Pos Test	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Cesium-134	27.20	30.0	21.0-39.0	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Cesium-137	31.8	31.6	22.1-41.1	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Cobalt-57	0	0.0	False Pos Test	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Cobalt-60	23.60	23.6	16.51-30.65	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Hydrogen-3	-3.5	0	False Pos Test	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Iron-55	53.00	53.3	37.3-69.3	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Manganese-54	-0.009	0.0	False Pos Test	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Nickel-63	27.7	26.4	18.5-34.3	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Plutonium-238	1.070	1.216	0.851-1.581	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Plutonium-239/240	0.907	0.996	0.697-1.295	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Potassium-40	0.339	0	False Pos Test	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Strontium-90	6.65	7.22	5.05-9.39	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Technetium-99	15.4	16.20	11.3-21.1	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Uranium-234/233	0.065	0.07	Sens. Eval.	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Uranium-238	0.031	0.034	Sens. Eval.	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Zinc-65	36.500	34.60	24.2-45.0	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Gross Alpha	0.793	0.701	0.201-1.192	Acceptable
11/12/13	MAPEP-13-MaW29	Water	Bq/L	Gross Beta	6.220	5.94	2.97-8.91	Acceptable
11/12/13	MAPEP-13-RdF29	Filter	ug/sample	Uranium-235	0.034	0.032	0.0227-0.0421	Acceptable
11/12/13	MAPEP-13-RdF29	Filter	ug/sample	Uranium-238	15.8	16.5	11.6-21.5	Acceptable
11/12/13	MAPEP-13-RdF29	Filter	ug/sample	Uranium-Total	15.80	16.5	11.6-21.5	Acceptable
11/12/13	MAPEP-13-RdF29	Filter	ug/sample	Americium-241	0.0002	0.000	False Pos Test	Acceptable
11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Cesium-134	-0.0016	0.00	False Pos Test	Acceptable
11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Cesium-137	3.010	2.70	1.9-3.5	Acceptable
11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Cobalt-57	3.530	3.40	2.4-4.4	Acceptable
11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Cobalt-60	2.440	2.30	1.6-3.0	Acceptable
11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Manganese-54	3.720	3.50	2.5-4.6	Acceptable
11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Plutonium-238	0.128	0.124	0.087-0.161	Acceptable
11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Plutonium-239/240	0.092	0.0920	0.064-0.12	Acceptable
11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Strontium-90	1.690	1.81	1.27-2.35	Acceptable

11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Uranium-234/233	0.027	0.0292	0.0204-0.038	Acceptable
11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Uranium-238	0.020	0.021	0.144-0.267	Acceptable
11/12/13	MAPEP-13-RdF29	Filter	Bq/sample	Zinc-65	3.050	2.70	1.9-3.5	Acceptable
11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Americium-241	0.226	0.19	0.135-0.251	Acceptable
11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Cesium-134	4.750	5.20	3.64-6.67	Acceptable
11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Cesium-137	6.910	6.60	4.62-8.58	Acceptable
11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Cobalt-57	-0.002	0.00	False Pos Test	Acceptable
11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Cobalt-60	0.008	0.00	False Pos Test	Acceptable
11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Manganese-54	7.980	7.88	5.52-10.24	Acceptable
11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Plutonium-238	0.001	0.001	Sens. Eval.	Acceptable
11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Plutonium-239/240	0.1510	0.171	0.120-0.222	Acceptable
11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Strontium-90	2.330	2.32	1.62-3.02	Acceptable
11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Uranium-234/233	0.046	0.047	0.0326-0.0606	Acceptable
11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Uranium-238	0.332	0.324	0.227-0.421	Acceptable
11/12/13	MAPEP-13-RdV29	Vegetation	Bq/sample	Zinc-65	2.850	2.63	1.84-3.42	Acceptable
11/12/13	MAPEP-13-XaW29	Water	Bq/L	Iodine-129	3.62	3.79	2.65-4.93	Acceptable

TABLE 4

2013 ERA PROGRAM PERFORMANCE EVALUATION RESULTS

Report Date	Sample Number	Sample Media	Unit	Analyte / Nuclide	GEL Value	Known value	Acceptance Range/ Ratio	Evaluation
02/28/13	RAD - 92	Water	pCi/L	Barium-133	55.4	54.4	44.9-60.2	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Cesium-134	27.2	29.9	23.4-32.9	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Cesium-137	74.3	75.3	67.8-85.5	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Cobalt-60	89.0	97.7	87.9-110	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Zinc-65	126	114	103-136	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Gross Alpha	26.0	24.8	12.5-33.0	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Gross Beta	19.4	19.3	11.3-27.5	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Gross Alpha	31.4	24.8	12.5-33.0	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Radium-226	10.4	9.91	7.42-11.6	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Radium-228	4.84	5.22	3.14-6.96	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Uranium (Nat)	6.43	5.96	4.47-7.13	Acceptable
02/28/13	RAD - 92	Water	ug/L	Uranium (Nat) mass	9.59	8.69	6.50-10.4	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Radium-226	11.60	9.91	7.42-11.6	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Radium-228	5.13	5.22	3.14-6.96	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Uranium (Nat)	5.95	5.96	4.47-7.13	Acceptable
02/28/13	RAD - 92	Water	ug/L	Uranium (Nat) mass	9.95	8.69	6.50-10.4	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Tritium	1430	1320	1040-1480	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Strontium-89	47.5	48	37.6-55.3	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Strontium-90	35.9	39.8	29.2-45.8	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Strontium-89	42.9	48	37.6-55.3	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Strontium-90	34.6	39.8	29.2-45.8	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Iodine-131	23.6	22.7	18.8-27.0	Acceptable
02/28/13	RAD - 92	Water	pCi/L	Iodine-131	27	22.7	18.8-27.0	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Barium-133	76.4	740.5	62.4-82.0	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Cesium-134	68.7	72.4	59.1-79.6	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Cesium-137	154	155	140-172	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Cobalt-60	85.3	82.3	74.1-92.9	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Zinc-65	297	260	234-304	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Gross Alpha	74.3	57.1	29.8-71.2	Not Acceptable
08/22/13	RAD - 94	Water	pCi/L	Gross Beta	34.3	41.8	27.9-49.2	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Gross Alpha	67.7	57.1	29.8-71.2	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Radium-226	16.9	17.2	12.8-19.7	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Radium-226	17	17.2	12.8-19.7	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Radium-228	3.53	3.86	2.18-5.4	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Uranium (Nat)	20.4	21.4	17.1-24.1	Acceptable
08/22/13	RAD - 94	Water	ug/L	Uranium (Nat) mass	30.4	31.2	25.0-35.2	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Radium-226	14.6	17.2	12.8-19.7	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Uranium (Nat)	21.6	21.4	17.1-24.1	Acceptable
08/22/13	RAD - 94	Water	ug/L	Uranium (Nat) mass	33.7	31.2	25-35.2	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Tritium	12500	13300	11600-14600	Acceptable

08/22/13	RAD - 94	Water	pCi/L	Strontium-89	48.9	36.5	27.4-43.4	Not Acceptable
08/22/13	RAD - 94	Water	pCi/L	Strontium-90	14.3	19.8	14.1-23.4	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Strontium-89	44.3	36.5	27.4-43.4	Not Acceptable
08/22/13	RAD - 94	Water	pCi/L	Strontium-90	17.3	19.8	14.1-23.4	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Iodine-131	26.1	24.3	20.2-28.8	Acceptable
08/22/13	RAD - 94	Water	pCi/L	Iodine-131	23.3	24.3	20.2-28.8	Acceptable

TABLE 5

2013 ERA PROGRAM (MRAD) PERFORMANCE EVALUATION RESULTS

Report Date	Sample Number	Sample Media	Unit	Analyte / Nuclide	GEL Value	Known value	Acceptance Range/ Ratio	Evaluation
05/22/13	MRAD-18	Soil	pCi/kg	Actinium-228	1500	1240	795-1720	Acceptable
05/22/13	MRAD-18	Soil	pCi/kg	Americium-241	225	229	134-297	Acceptable
05/22/13	MRAD-18	Soil	pCi/kg	Bismuth-212	1250	1240	330-1820	Acceptable
05/22/13	MRAD-18	Soil	pCi/kg	Bismuth-214	4410	3660	2200-5270	Acceptable
05/22/13	MRAD-18	Soil	pCi/kg	Cesium-134	7850	6370	4160-7650	Not Accept.
05/22/13	MRAD-18	Soil	pCi/kg	Cesium-137	8070	6120	4690-7870	Not Accept.
05/22/13	MRAD-18	Soil	pCi/kg	Cobalt-60	10300	7920	5360-10900	Acceptable
05/22/13	MRAD-18	Soil	pCi/kg	Lead-212	1290	1240	812-1730	Acceptable
05/22/13	MRAD-18	Soil	pCi/kg	Lead-214	4690	3660	2140-5460	Acceptable
05/22/13	MRAD-18	Soil	pCi/kg	Manganese-54	<63.4	<1000	0-1000	Acceptable
05/22/13	MRAD-18	Soil	pCi/kg	Plutonium-238	651	788.00	474-1090	Acceptable
05/22/13	MRAD-18	Soil	pCi/kg	Plutonium-239	320	366.00	239-506	Acceptable
05/22/13	MRAD-18	Soil	pCi/kg	Potassium-40	10300	10300	7520-13800	Acceptable
05/22/13	MRAD-18	Soil	pCi/kg	Strontium-90	6730	8530	3250-13500	Acceptable
05/22/13	MRAD-18	Soil	pCi/kg	Thorium-234	3290	1900	601-3570	Acceptable
05/22/13	MRAD-18	Soil	pCi/kg	Zinc-65	1910	1400	1110-1860	Not Accept.
05/22/13	MRAD-18	Soil	pCi/kg	Strontium-90	6730	8530	3250-13500	Acceptable
05/22/13	MRAD-18	Soil	pCi/kg	Uranium-234	1210	1920	1170-2460	Acceptable
05/22/13	MRAD-18	Soil	pCi/kg	Uranium-238	1630	1900	1180-2410	Acceptable
05/22/13	MRAD-18	Soil	pCi/kg	Uranium-Total	2840	3920	2130-5170	Acceptable
05/22/13	MRAD-18	Soil	ug/kg	Uranium-Total(mass)	4150	5710	3150-7180	Acceptable
05/22/13	MRAD-18	Vegetation	pCi/kg	Am-241	629	553	338-735	Acceptable
05/22/13	MRAD-18	Vegetation	pCi/kg	Cesium-134	1400	1240	797-1610	Acceptable
05/22/13	MRAD-18	Vegetation	pCi/kg	Cesium-137	687	544	394-757	Acceptable
05/22/13	MRAD-18	Vegetation	pCi/kg	Cobalt-60	2410	1920	1320-2680	Acceptable
05/22/13	MRAD-18	Vegetation	pCi/kg	Curium-244	1420	1340	657-2090	Acceptable
05/22/13	MRAD-18	Vegetation	pCi/kg	Manganese-54	<47.4	<300	0.00-300	Acceptable
05/22/13	MRAD-18	Vegetation	pCi/kg	Plutonium-238	2060	1980	1180-2710	Acceptable
05/22/13	MRAD-18	Vegetation	pCi/kg	Plutonium-239	2230	2260	1390-3110	Acceptable
05/22/13	MRAD-18	Vegetation	pCi/kg	Potassium-40	35600	31900	23000-44800	Acceptable
05/22/13	MRAD-18	Vegetation	pCi/kg	Strontium-90	3720	3840	2190-5090	Acceptable
05/22/13	MRAD-18	Vegetation	pCi/kg	Uranium-234	2650	2460	1620-3160	Acceptable
05/22/13	MRAD-18	Vegetation	pCi/kg	Uranium-238	2580	2440	1630-3100	Acceptable
05/22/13	MRAD-18	Vegetation	pCi/kg	Uranium-Total	5361	5010	3390-6230	Acceptable
05/22/13	MRAD-18	Vegetation	ug/kg	Uranium-Total(mass)	7740	7310	4900-9280	Acceptable
05/22/13	MRAD-18	Vegetation	pCi/kg	Zinc-65	1150	878	633-1230	Acceptable
05/22/13	MRAD-18	Filter	pCi/Filter	Americium-241	62.9	66.8	41.2-90.4	Acceptable
05/22/13	MRAD-18	Filter	pCi/Filter	Cesium-134	1080	1110	706-1380	Acceptable
05/22/13	MRAD-18	Filter	pCi/Filter	Cesium-137	971	940	706-1230	Acceptable
05/22/13	MRAD-18	Filter	pCi/Filter	Cobalt-60	217	214	166-267	Acceptable
05/22/13	MRAD-18	Filter	pCi/Filter	Iron-55	224	225	69.8-440	Acceptable
05/22/13	MRAD-18	Filter	pCi/Filter	Manganese-54	<5.27	<50.0	0-50.0	Acceptable

05/22/13	MRAD-18	Filter	pCi/Filter	Plutonium-238	48.0	50.1	34.3-65.9	Acceptable
05/22/13	MRAD-18	Filter	pCi/Filter	Plutonium-239	62.7	65.2	47.2-85.2	Acceptable
05/22/13	MRAD-18	Filter	pCi/Filter	Strontium-90	139	138	67.4-207	Acceptable
05/22/13	MRAD-18	Filter	pCi/Filter	Uranium-234	54.5	59.4	36.8-89.6	Acceptable
05/22/13	MRAD-18	Filter	pCi/Filter	Uranium-238	58.5	58.9	38.1-81.4	Acceptable
05/22/13	MRAD-18	Filter	pCi/Filter	Uranium-Total	117	121	67.0-184	Acceptable
05/22/13	MRAD-18	Filter	ug/Filter	Uranium-Total(mass)	176	176	113-248	Acceptable
05/22/13	MRAD-18	Filter	pCi/Filter	Zinc-65	222	199	142-275	Acceptable
05/22/13	MRAD-18	Filter	pCi/Filter	Gross Alpha	55.5	42.3	14.2-65.7	Acceptable
05/22/13	MRAD-18	Filter	pCi/Filter	Gross Beta	31	25.1	15.9-36.6	Acceptable
05/22/13	MRAD-18	Water	pCi/L	Americium-241	118	118	79.5-158	Acceptable
05/22/13	MRAD-18	Water	pCi/L	Cesium-134	1320	1400	1030-1610	Acceptable
05/22/13	MRAD-18	Water	pCi/L	Cesium-137	1900	1880	1600-2250	Acceptable
05/22/13	MRAD-18	Water	pCi/L	Cobalt-60	2370	2270	1970-2660	Acceptable
05/22/13	MRAD-18	Water	pCi/L	Iron-55	812	712	424-966	Acceptable
05/22/13	MRAD-18	Water	pCi/L	Manganese-54	<7.6	<100	0.00-100	Acceptable
05/22/13	MRAD-18	Water	pCi/L	Plutonium-238	91	99	73.1-123	Acceptable
05/22/13	MRAD-18	Water	pCi/L	Plutonium-239	161	185	144-233	Acceptable
05/22/13	MRAD-18	Water	pCi/L	Strontium-90	144	137	89.2-181	Acceptable
05/22/13	MRAD-18	Water	pCi/L	Uranium-234	47.3	48.8	36.7-62.9	Acceptable
05/22/13	MRAD-18	Water	pCi/L	Uranium-238	50.8	48.4	36.9-59.4	Acceptable
05/22/13	MRAD-18	Water	pCi/L	Uranium-Total	98.1	99.5	73.1-129	Acceptable
05/22/13	MRAD-18	Water	ug/L	Uranium-Total(mass)	152	145	116-175	Acceptable
05/22/13	MRAD-18	Water	pCi/L	Zinc-65	428	384	320-484	Acceptable
05/22/13	MRAD-18	Water	pCi/L	Gross Alpha	138.0	130	46.2-201	Acceptable
05/22/13	MRAD-18	Water	pCi/L	Gross Beta	87	78.9	45.2-117	Acceptable
05/22/13	MRAD-18	Water	pCi/L	Tritium	13100	12300	8240-17500	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Actinium-228	1200	1240	795-1720	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Americium-241	186	164	95.9-213	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Bismuth-212	1760	1220	325-1790	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Bismuth-214	4350	3740	2250-5380	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Cesium-134	2690	2820	1840-3390	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Cesium-137	3960	4130	3160-5310	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Cobalt-60	5490	5680	3840-7820	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Lead-212	1260	1220	799-1700	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Lead-214	4700	3740	2180-5580	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Manganese-54	<55.2	<1000	0-1000	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Plutonium-238	576	658	396-908	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Plutonium-239	400	397	260-548	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Potassium-40	11200	12400	9080-16700	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Strontium-90	8220	6860	2620-10800	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Thorium-234	2870	3080	974-5790	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Zinc-65	3400	3160	2520-4200	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Uranium-234	2870	3080	974-5790	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Uranium-238	2979	3080	1910-3910	Acceptable
11/26/13	MRAD-19	Soil	pCi/kg	Uranium-Total	6870	6320	3430-8340	Acceptable
11/26/13	MRAD-19	Soil	ug/kg	Uranium-Total(mass)	8460	9220	5080-11600	Acceptable

11/26/13	MRAD-19	Vegetation	pCi/kg	Am-241	3800	3630	2220-4830	Acceptable
11/26/13	MRAD-19	Vegetation	pCi/kg	Cesium-134	907	859	552-1120	Acceptable
11/26/13	MRAD-19	Vegetation	pCi/kg	Cesium-137	1220	1030	747-1430	Acceptable
11/26/13	MRAD-19	Vegetation	pCi/kg	Cobalt-60	2100	1880	1300-2630	Acceptable
11/26/13	MRAD-19	Vegetation	pCi/kg	Curium-244	1230	1250	612-1950	Acceptable
11/26/13	MRAD-19	Vegetation	pCi/kg	Manganese-54	<53.3	<300	0-300	Acceptable
11/26/13	MRAD-19	Vegetation	pCi/kg	Plutonium-238	1280	1290	769-1770	Acceptable
11/26/13	MRAD-19	Vegetation	pCi/kg	Plutonium-239	2580	2770	1700-3810	Acceptable
11/26/13	MRAD-19	Vegetation	pCi/kg	Potassium-40	33600	33900	24500-47600	Acceptable
11/26/13	MRAD-19	Vegetation	pCi/kg	Strontium-90	5870	6360	3630-8430	Acceptable
11/26/13	MRAD-19	Vegetation	pCi/kg	Uranium-234	674	654	430-840	Acceptable
11/26/13	MRAD-19	Vegetation	pCi/kg	Uranium-234	1050	654	430-840	Not Acceptable
11/26/13	MRAD-19	Vegetation	pCi/kg	Uranium-238	655	648	432-823	Acceptable
11/26/13	MRAD-19	Vegetation	pCi/kg	Uranium-Total	1364	1330	901-1660	Acceptable
11/26/13	MRAD-19	Vegetation	pCi/kg	Uranium-Total	1773	1330	901-1660	Not Acceptable
11/26/13	MRAD-19	Vegetation	ug/kg	Uranium-Total(mass)	1960	1940	1300-2460	Acceptable
11/26/13	MRAD-19	Vegetation	pCi/kg	Zinc-65	1990	1540	1110-2160	Acceptable
11/26/13	MRAD-19	Filter	pCi/Filter	Americium-241	75.2	66.4	40.9-89.9	Acceptable
11/26/13	MRAD-19	Filter	pCi/Filter	Cesium-134	845	868.0	552-1080	Acceptable
11/26/13	MRAD-19	Filter	pCi/Filter	Cesium-137	641	602	452-791	Acceptable
11/26/13	MRAD-19	Filter	pCi/Filter	Cobalt-60	534	494	382-617	Acceptable
11/26/13	MRAD-19	Filter	pCi/Filter	Iron-55	466	389.0	121-760	Acceptable
11/26/13	MRAD-19	Filter	pCi/Filter	Manganese-54	<3.9	<50	0.00-50.0	Acceptable
11/26/13	MRAD-19	Filter	ug/Filter	Plutonium-238	72.8	68.5	46.9-90.1	Acceptable
11/26/13	MRAD-19	Filter	pCi/Filter	Plutonium-239	56.5	53.4	42.4-93.1	Acceptable
11/26/13	MRAD-19	Filter	pCi/Filter	Strontium-90	130	125	61.1-187	Acceptable
11/26/13	MRAD-19	Filter	pCi/Filter	Uranium-234	56	87	35.6-86.6	Acceptable
11/26/13	MRAD-19	Filter	pCi/Filter	Uranium-238	58	56.90	36.8-78.7	Acceptable
11/26/13	MRAD-19	Filter	pCi/Filter	Uranium-Total	116	117	64.8-178	Acceptable
11/26/13	MRAD-19	Filter	ug/Filter	Uranium-Total(mass)	172	171	109-241	Acceptable
11/26/13	MRAD-19	Filter	pCi/Filter	Zinc-65	514	419	300-578	Acceptable
11/26/13	MRAD-19	Filter	ug/Filter	Uranium-Total(mass)	169	171	109-241	Acceptable
11/26/13	MRAD-19	Filter	ug/Filter	Uranium-Total(mass)	150	171	109-241	Acceptable
11/26/13	MRAD-19	Filter	pCi/Filter	Gross Alpha	100	83	27.8-129	Acceptable
11/26/13	MRAD-19	Filter	pCi/Filter	Gross Beta	65.7	56.3	35.6-82.2	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Americium-241	126	126	84.9-169	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Cesium-134	2060	2180	1600-2510	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Cesium-137	2730	2760	2340-3310	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Cobalt-60	1960	1890	1640-2210	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Iron-55	721	689	411-935	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Manganese-54	<7.24	<100	0.00-100	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Plutonium-238	133	138	102-172	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Plutonium-239	98.7	109	84.6-137	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Strontium-90	726	788	513-1040	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Uranium-234	93	99	74.3-128	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Uranium-238	93	98.00	74.7-120	Acceptable

11/26/13	MRAD-19	Water	pCi/L	Uranium-Total	186	201	148-260	Acceptable
11/26/13	MRAD-19	Water	ug/L	Uranium-Total(mass)	278	294	234-355	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Zinc-65	1560	1370	1140-1730	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Gross Alpha	105.0	97	34.3-150	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Gross Beta	78.8	84.5	48.4-125	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Tritium	8740	9150	6130-13000	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Uranium-234	92.4	98.9	74.3-128	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Uranium-238	96.1	98.0	74.7-120	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Uranium-Total	193	201	148-260	Acceptable
11/26/13	MRAD-19	Water	ug/L	Uranium-Total(mass)	288	294	234-355	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Uranium-234	95.2	98.9	74.3-128	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Uranium-238	115	98.00	74.7-120	Acceptable
11/26/13	MRAD-19	Water	pCi/L	Uranium-Total	215	201	148-260	Acceptable
11/26/13	MRAD-19	Water	ug/L	Uranium-Total(mass)	344	294	234-355	Acceptable
11/26/13	MRAD-19	Water	ug/L	Uranium-Total(mass)	258	294	234-355	Acceptable

FIGURE 1

COBALT-60 PERFORMANCE EVALUATION RESULTS AND % BIAS

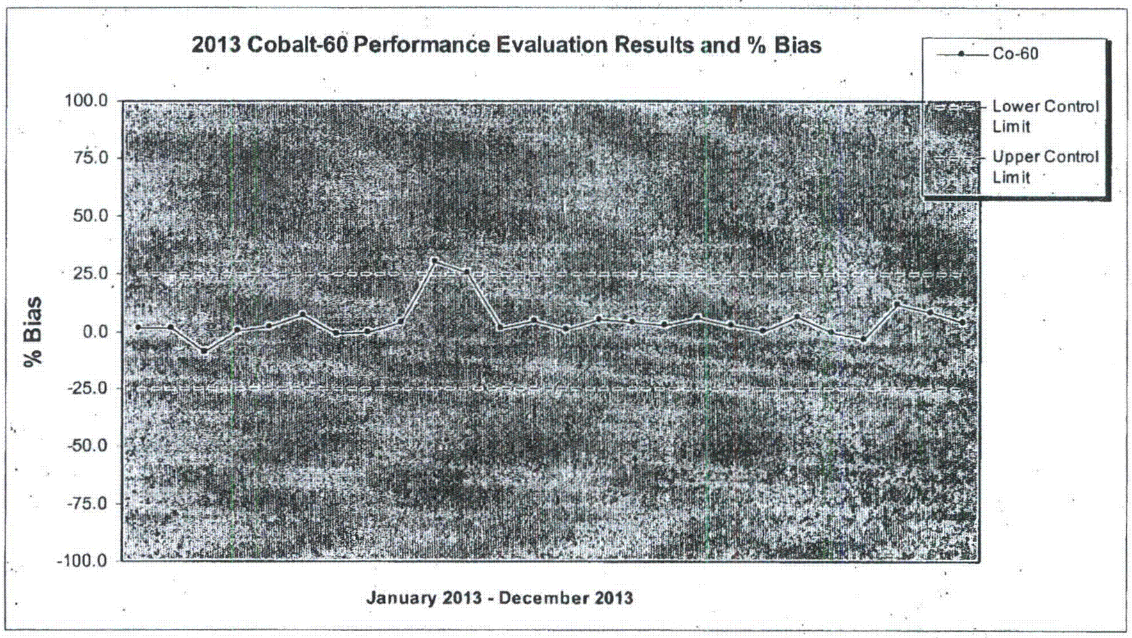

FIGURE 2

CESIUM-137 PERFORMANCE EVALUATION RESULTS AND % BIAS

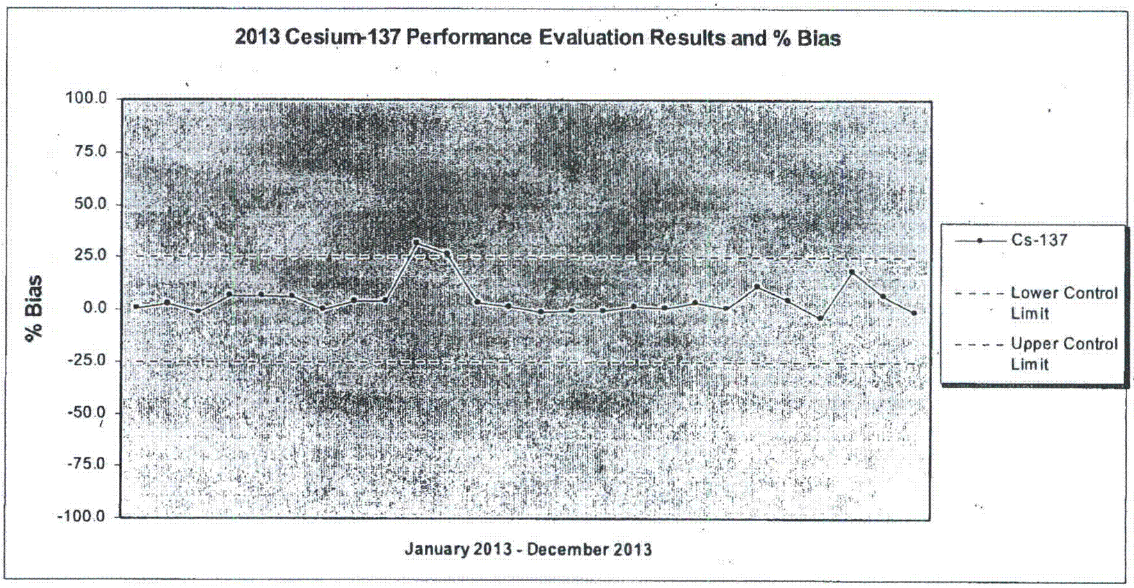

FIGURE 3

TRITIUM PERFORMANCE EVALUATION RESULTS AND % BIAS

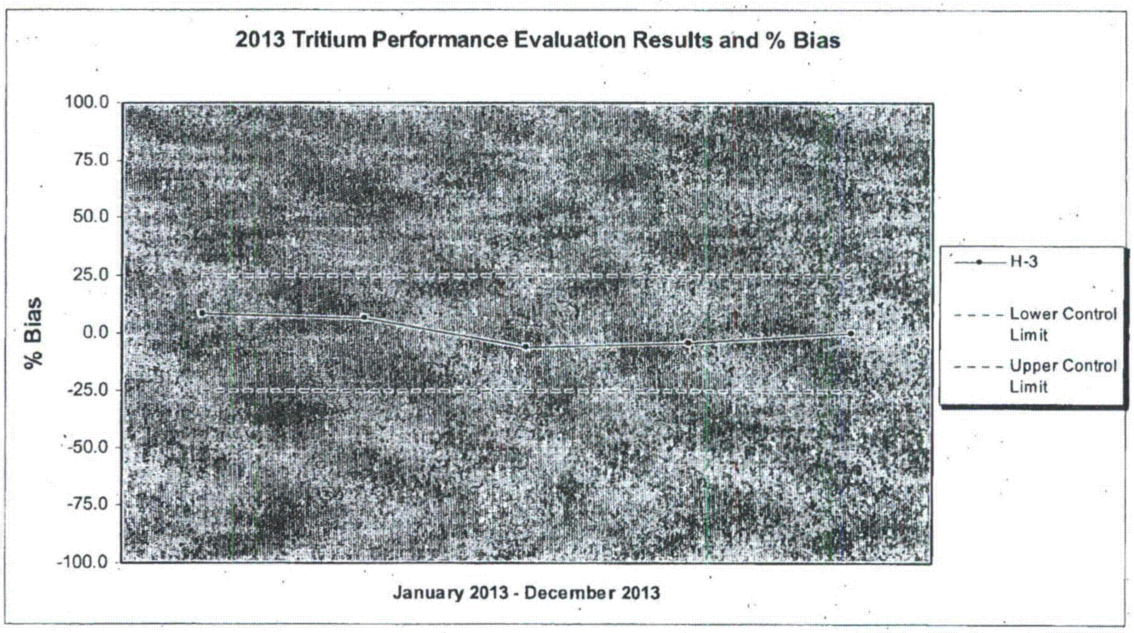

FIGURE 4

STRONTIUM-90 PERFORMANCE EVALUATION RESULTS AND % BIAS

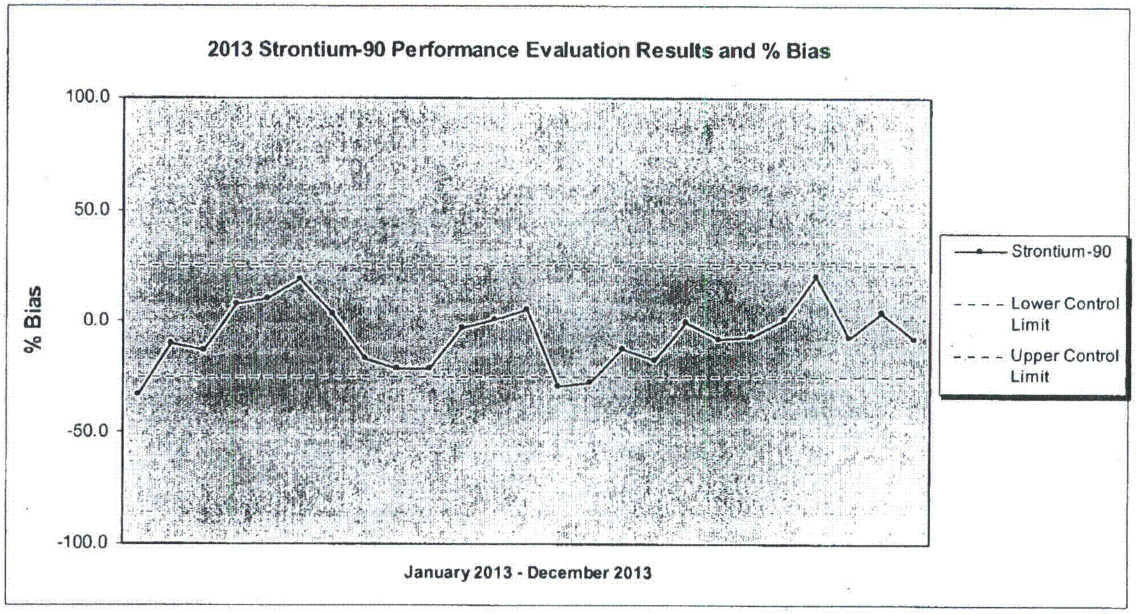

FIGURE 5

GROSS ALPHA PERFORMANCE EVALUATION RESULTS AND % BIAS

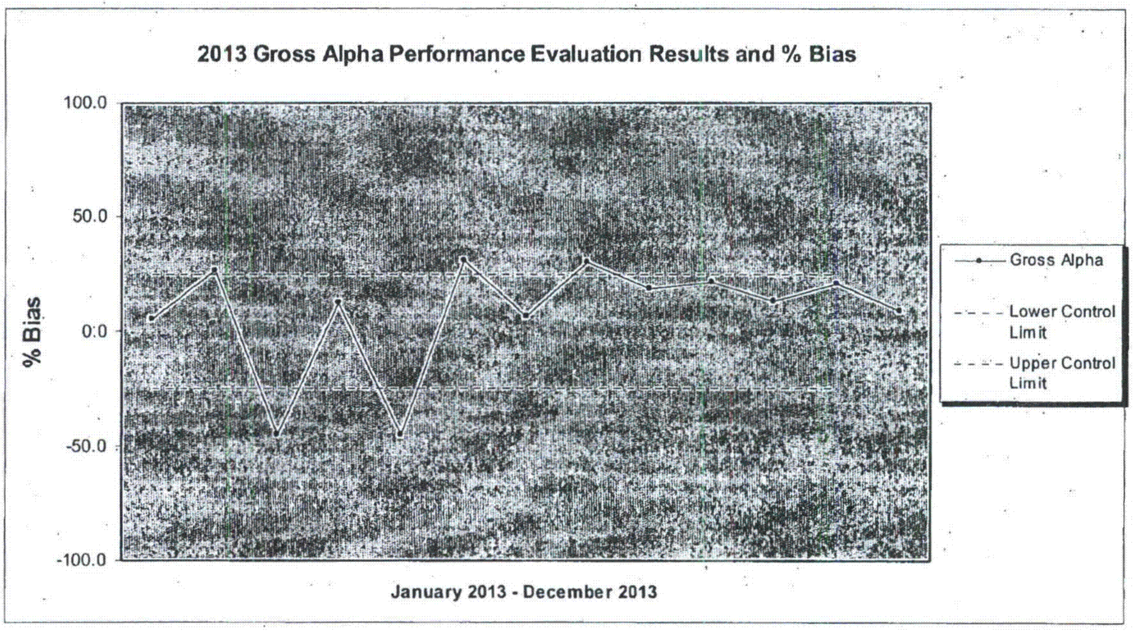

FIGURE 6

GROSS BETA PERFORMANCE EVALUATION RESULTS AND % BIAS

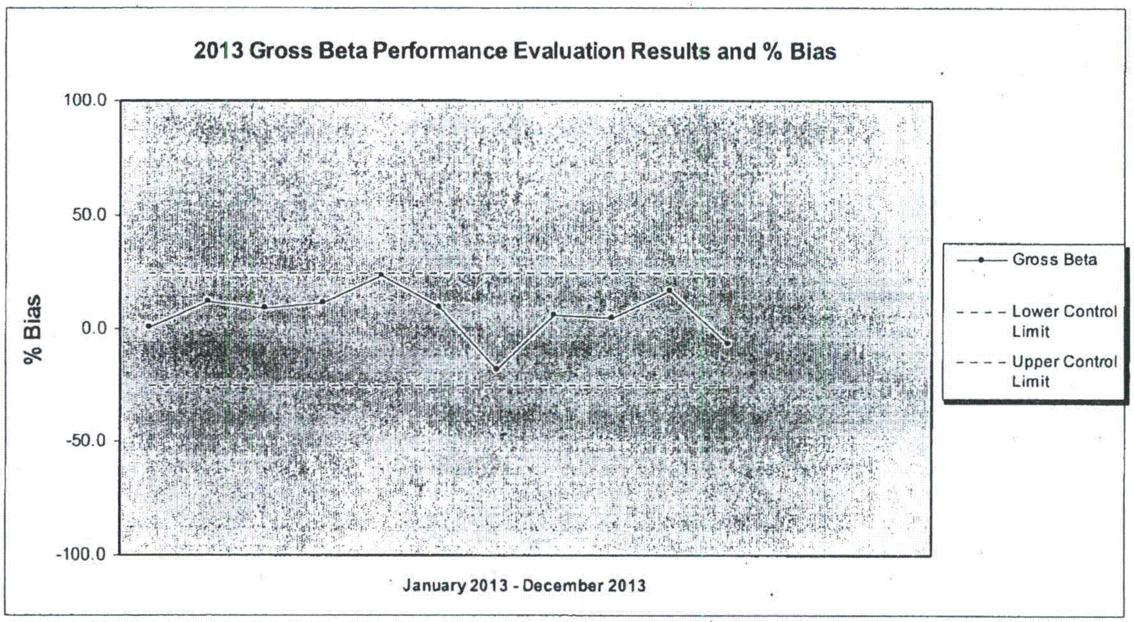

FIGURE 7

IODINE-131 PERFORMANCE EVALUATION RESULTS AND % BIAS

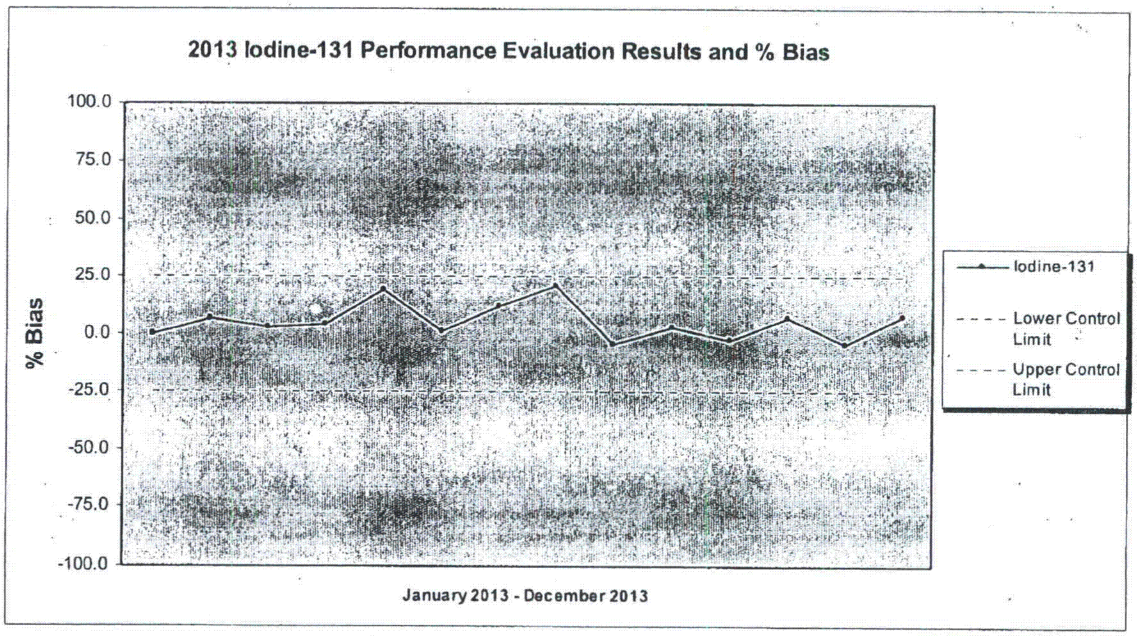

FIGURE 8

AMERICIUM-241 PERFORMANCE EVALUATION RESULTS AND % BIAS

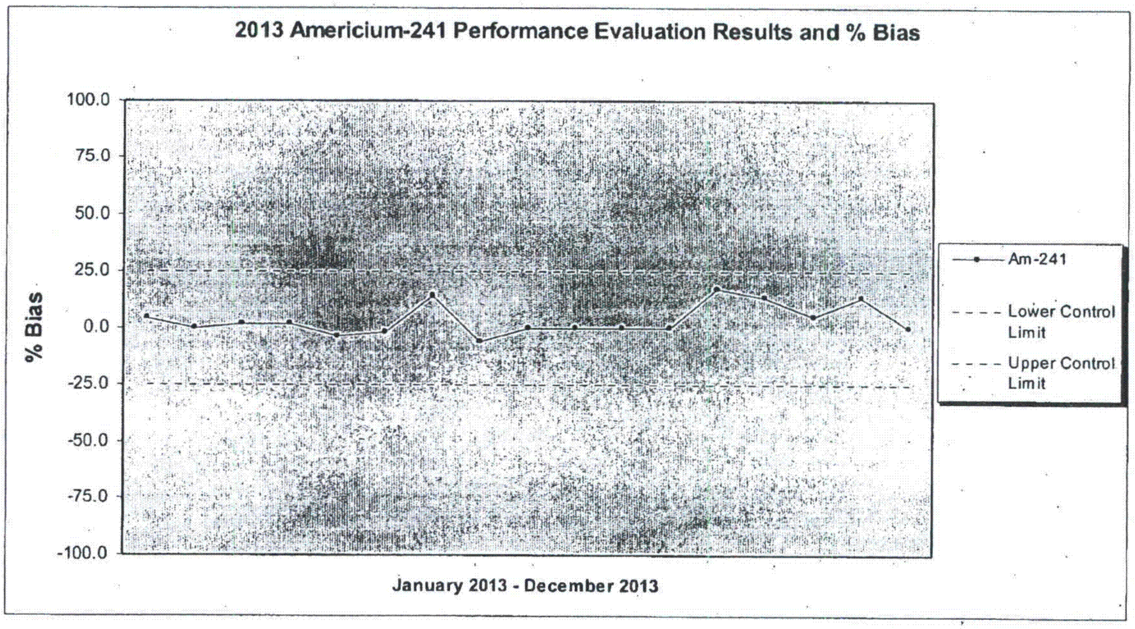

FIGURE 9

PLUTONIUM-238 PERFORMANCE EVALUATION RESULTS AND % BIAS

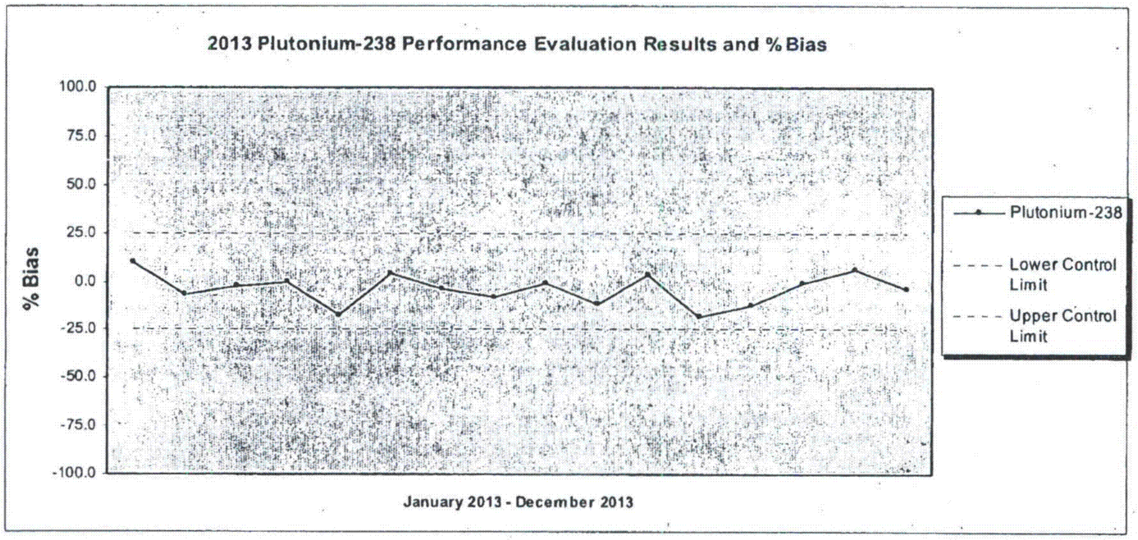

TABLE 6

REMP INTRA-LABORATORY DATA SUMMARY: BIAS AND PRECISION BY MATRIX

REMP 2013	Bias Criteria (+ / - 25%)		Precision Criteria (Note 1)	
	WITHIN CRITERIA	OUTSIDE CRITERIA	WITHIN CRITERIA	OUTSIDE CRITERIA
MILK				
Gamma Iodine-131	41	0	131	0
Gas Flow Sr 2nd count	46	0	49	0
Gas Flow Total Strontium	35	0	35	0
Gamma Spec Liquid RAD A-013 with Ba, La	61	0	120	0
SOLID				
LSC Iron-55	5	0	5	0
Gamma Spec Solid RAD A-013	28	0	31	0
LSC Nickel 63	5	0	5	0
Gas Flow Sr 2nd count	4	0	4	0
Gas Flow Total Strontium	8	0	8	0
Gamma Spec Solid RAD A-013 with Ba, La	7	0	10	0
Gamma Spec Solid RAD A-013 with Iodine	6	0	7	0
FILTER				
Gamma Spec Filter RAD A-013	4	0	4	0
Gas Flow Sr 2nd Count	5	0	5	0
Alpha Spec Am241Curium	3	0	3	0
Gas Flow Total Strontium	3	0	3	0
Gross A & B	526	0	527	0
Gamma Spec Filter	45	0	51	0
LIQUID				
Alpha Spec Uranium	8	0	9	0
Tritium	336	0	337	0
Plutonium	1	0	1	0
LSC Iron-55	40	0	42	0
LSC Nickel 63	41	0	43	0
Gamma Spec Liquid RAD A-013	7	0	7	0
Gamma Iodine-131	33	0	33	0
Alpha Spec Plutonium	10	0	10	0
Gas Flow Sr 2nd count	20	0	20	0
Alpha Spec Am241 Curium	17	0	17	0
Gas Flow Total Strontium	161	0	163	0
Gross Alpha Non Vol Beta	102	0	104	0
Gamma Spec Liquid RAD A-013 with Ba, La	129	0	209	0
Gamma Spec Liquid RAD A-013 with Iodine	56	0	85	0
TISSUE				

Gamma Spec Solid RAD A-013	45	0	48	0
LSC Nickel 63	2	0	2	0
Gas Flow Sr 2nd count	10	0	10	0
Gas Flow Total Strontium	17	0	17	0
Gamma Spec Solid RAD A-013 with Ba, La	6	0	5	0
Gamma Spec Solid RAD A-013 with Iodine	17	0	17	0
SEA WATER				
LSC Iron-55	2	0	2	0
LSC Nickel 63	2	0	2	0
Gas Flow Total Strontium	1	0	1	0
Gross Alpha Non Vol Beta	1	0	1	0
Gamma Spec Liquid RAD A-013 with Iodine	1	0	1	0
VEGETATION				
Gas Flow Sr 2nd count	9	0	9	0
Gamma Spec Solid RAD A-013 with Iodine	91	0	93	0
AIR CHARCOAL				
Gamma Iodine 131 RAD A-013	623	0	645	0
Carbon-14 (Ascarite/Soda Lime Filter per Liter)	46	0	47	0
DRINKING WATER				
Tritium	51	0	52	0
LSC Iron-55	24	0	22	0
LSC Nickel 63	23	0	21	0
Gamma Iodine-131	38	0	38	0
Gas Flow Sr 2nd count	16	0	16	0
Gas Flow Total Strontium	31	0	31	0
Gross Alpha Non Vol Beta	103	0	103	0
Gamma Spec Liquid RAD A-013 with Ba, La	44	0	98	0
Total	**2996**		**3359**	

Note 1: The RPD must be 20 percent or less, if both samples are greater than 5 times the MDC. If both results are less than 5 times MDC, then the RPD must be equal to or less than 100%. If one result is above the MDC and the other is below the MDC, then the RPD can be calculated using the MDC for the result of the one below the MDC. The RPD must be 100% or less. In the situation where both results are above the MDC but one result is greater than 5 times the MDC and the other is less than 5 times the MDC, the RPD must be less than or equal to 20%. If both results are below MDC, then the limits on % RPD are not applicable.

TABLE 7
ALL RADIOLOGICAL INTRA-LABORATORY DATA SUMMARY:
BIAS AND PRECISION BY MATRIX

	Bias Criteria (+ / - 25%		Precision Criteria (Note 1)	
ENVIRONMENTAL 2013	**WITHIN CRITERIA**	**OUTSIDE CRITERIA**	**WITHIN CRITERIA**	**OUTSIDE CRITERIA**
MILK				
Gamma Spec Liquid RAD A-013	8	0	8	0
Gamma Iodine-129	1	0	1	0
Gamma Iodine-131	41	0	131	0
Gas Flow Sr 2nd count	50	0	51	0
Gas Flow Strontium 90	10	0	10	0
Gas Flow Total Strontium	35	0	35	0
Gamma Spec Liquid RAD A-013 with Ba, La	61	0	120	0
Gamma Spec Liquid RAD A-013 with Iodine	5	0	3	0
SOLID				
Gas Flow Radium 228	29	0	29	0
Tritium	266	0	312	0
Carbon-14	136	0	227	0
LSC Iron-55	146	0	165	0
Alpha Spec Polonium Solid	19	0	22	0
Gamma Nickel 59 RAD A-022	138	0	157	0
LSC Chlorine-36 in Solids	8	0	13	0
Gamma Spec Ra226 RAD A-013	35	0	42	0
Gamma Spec Solid RAD A-013	701	0	893	0
LSC Nickel 63	176	0	201	0
LSC Plutonium	223	0	245	0
Technetium-99	309	0	339	0
Gamma Spec Liquid RAD A-013	4	0	4	0
ICP-MS Technetium-99 in Soil	75	0	74	0
LSC Selenium 79	5	0	5	0
Total Activity,	2	0	3	0
Tritium	5	0	5	0
Alpha Spec Am243	33	0	42	0
Gamma Iodine-129	172	0	199	0
Gas Flow Lead 210	18	0	19	0
Total Uranium KPA	10	0	18	0
Alpha Spec Uranium	278	0	380	0
LSC Promethium 147	4	0	4	0
LSC, Rapid Strontium 89 and 90	106	0	120	0
Alpha Spec Thorium	207	0	288	0
Gas Flow Radium 228	2	0	2	0
ICP-MS Uranium-233, 234 in Solid	6	0	5	0

Alpha Spec Plutonium	242	0	263	0
ICP-MS Technetium-99 Prep in Soil	78	0	74	0
LSC Calcium 45	2	0	2	0
Alpha Spec Neptunium	234	0	256	0
Alpha Spec Plutonium	157	0	195	0
Alpha Spec Radium 226	7	0	8	0
Gamma Spec Solid with Ra226, Ra228	5	0	6	0
Gas Flow Sr 2nd count	15	0	18	0
Gas Flow Strontium 90	187	0	207	0
Gas Flow Total Radium	1	0	1	0
Lucas Cell Radium 226	71	0	93	0
Total Activity Screen	10	0	13	0
Alpha Spec Am241 Curium	292	0	336	0
Alpha Spec Total Uranium	5	0	6	0
Gas Flow Total Strontium	40	0	44	0
Gross Alpha Non Vol Beta	3	0	3	0
ICP-MS Uranium-233, 234 Prep in Solid	5	0	5	0
ICP-MS Uranium-235, 236, 238 in Solid	7	0	8	0
Alpha Spec Polonium Solid	6	0	4	0
Gamma Spec Solid RAD A-013 with Ba, La	7	0	10	0
Gamma Spec Solid RAD A-013 with Iodine	6	0	7	0
Gamma Spec Solid RAD A-013 (pCi/Sample)	0	0	2	0
Tritium	3	0	3	0
ICP-MS Uranium-234, 235, 236, 238 in Solid	245	0	234	0
ICP-MS Uranium-235, 236, 238 Prep in Solid	5	0	5	0
Gross Alpha/Beta	297	0	405	0
Gross Alpha/Beta (Americium Calibration) Solid	0	0	1	0
ICP-MS Uranium-234, 235, 236, 238 Prep in Solid	122	0	115	0
Lucas Cell Radium 226 by DOE HASL 300 Ra-04 Solid	2	0	2	0
FILTER				
Alpha Spec Uranium	18	0	24	0
Alpha Spec Polonium	0	0	54	0
Gamma I-131, filter	4	0	4	0
LSC Plutonium Filter	143	0	169	3
Tritium	134	0	201	0
Carbon-14	82	0	140	0
Nickel-63	0	0	4	0
LSC Iron-55	147	0	161	0
Gamma Nickel 59 RAD A-022	140	0	159	0
Gamma Iodine 131 RAD A-013	2	0	2	0

LSC Nickel 63	138	0	162	0
Technetium-99	103	0	137	0
Gamma Spec Filter RAD A-013	195	0	245	0
Alphaspec Np Filter per Liter	30	0	42	0
Alphaspec Pu Filter per Liter	14	0	29	0
Gamma Iodine-125	13	0	0	0
Gamma Iodine-129	114	0	127	0
Gross Alpha/Beta	0	0	1	0
Alpha Spec Am243	13	0	42	0
Gas Flow Lead 210	0	0	4	0
LSC Plutonium Filter per Liter	36	0	43	0
Total Uranium KPA	11	0	18	0
Alpha Spec Uranium	83	0	114	0
LSC, Rapid Strontium 89 and 90	144	0	168	0
Alpha Spec Thorium	45	0	57	0
Gas Flow Radium 228	0	0	2	0
Alpha Spec Plutonium	107	0	123	0
Alpha Spec Neptunium	112	0	129	0
Alpha Spec Plutonium	142	0	183	0
Alpha Spec Polonium,(Filter/Liter)	0	0	10	0
Alpha Spec Radium 226	0	0	1	0
Gas Flow Sr 2nd Count	93	0	101	0
Gas Flow Strontium 90	59	0	78	0
Gas Flow Total Radium	0	0	4	0
Lucas Cell Radium-226	0	0	2	0
Alpha Spec Am241Curium	157	0	198	0
Gas Flow Total Strontium	5	0	5	0
Total Activity in Filter,	0	0	7	0
Alphaspec Am241 Curium Filter per Liter	33	0	42	0
Tritium	106	0	108	0
Gamma Spec Filter RAD A-013 Direct Count	7	0	8	0
Carbon-14	44	0	44	0
Direct Count-Gross Alpha/Beta	72	0	0	0
Gross Alpha/Beta	74	0	81	0
ICP-MS Uranium-234, 235, 236, 238 in Filter	8	0	4	0
Alpha Spec U	31	0	60	0
Gross A & B	639	0	584	0
LSC Iron-55	39	0	51	0
Technetium-99	37	0	55	0
Gas Flow Sr-90	29	0	35	0
LSC Nickel 63	37	0	44	0
Carbon-14 (Ascarite/Soda Lime Filter per Liter)	2	0	2	0
Gas Flow Pb-210	25	0	46	0
Gas Flow Ra-228	24	0	35	0

Gamma Iodine 129	47	0	47	0
ICP-MS Uranium-234, 235, 236, 238 Prep in Filter	6	0	3	0
Gamma Spec Filter	142	0	163	0
Lucas Cell Ra-226	32	0	47	0
Alpha Spec Thorium	27	0	46	0
LIQUID				
Alpha Spec Uranium	418	0	607	0
Alpha Spec Polonium	2	0	3	0
Electrolytic Tritium	19	0	29	0
Tritium	1415	0	1503	0
Tritium by Combustion	1	0	1	0
Carbon-14	181	0	204	0
Plutonium	81	0	89	0
Chlorine-36 in Liquids	2	0	3	0
Iodine-131	6	0	3	0
LSC Iron-55	290	0	347	0
Gamma Nickel 59 RAD A-022	29	0	33	0
Gamma Iodine 131 RAD A-013	3	0	3	0
Gamma Radium 228 RAD A-013	1	0	1	0
LSC Nickel 63	328	0	370	0
LSC Radon 222	5	0	12	0
Technetium-99	303	0	365	0
Gamma Spec Liquid RAD A-013	874	0	875	0
Alpha Spec Total U RAD A-011	0	0	2	0
LSC Selenium 79	1	0	1	0
Total Activity,	6	0	6	0
Alpha Spec Am243	12	0	20	0
Gamma Iodine-129	84	0	117	0
Gamma Iodine-131	33	0	33	0
ICP-MS Technetium-99 in Water	5	0	28	0
Gas Flow Lead 210	83	0	94	0
Total Uranium KPA	96	0	226	2
LSC Promethium 147	3	0	3	0
LSC, Rapid Strontium 89 and 90	15	0	15	0
Alpha Spec Thorium	205	0	278	0
Gas Flow Radium 228	244	0	318	0
Gas Flow Radium 228	36	0	35	0
Gas Flow Radium 228	1	0	1	0
Alpha Spec Plutonium	317	0	436	0
Alpha Spec Neptunium	110	0	127	0
Alpha Spec Plutonium	61	0	86	0
Alpha Spec Radium 226	0	0	1	0
Gas Flow Sr 2nd count	283	0	316	0
Gas Flow Strontium 90	499	0	568	0
Gas Flow Strontium 90	2	0	2	0
Gas Flow Total Radium	92	0	129	0
ICP-MS Technetium-99 Prep in Water	5	0	28	0

ICP-MS Uranium-233, 234 in Liquid	1	0	1	0
Lucas Cell Radium 226	372	0	487	0
Lucas Cell Radium-226	17	0	21	0
Total Activity Screen	3	0	3	0
Chlorine-36 in Liquids	4	0	10	0
Alpha Spec Am241 Curium	307	0	405	0
Gas Flow Total Strontium	231	0	241	0
Gross Alpha Non Vol Beta	1313	0	1554	0
LSC Phosphorus-32	2	0	2	0
Lucas Cell Radium 226 by Method Ra-04	3	0	3	0
ICP-MS Uranium-233, 234 Prep in Liquid	1	0	1	0
Tritium in Drinking Water by EPA 906.0	11	0	14	0
Gamma Spec Liquid RAD A-013 with Ba, La	131	0	211	0
Gamma Spec Liquid RAD A-013 with Iodine	159	0	205	0
Gas Flow Strontium 89 & 90	6	0	0	0
ICP-MS Uranium-235, 236, 238 in Liquid	2	0	2	0
Gas Flow Total Alpha Radium	13	0	11	0
Gross Alpha Co-precipitation	7	0	9	0
ICP-MS Uranium-235, 236, 238 Prep in Liquid	1	0	1	0
ICP-MS Uranium-234, 235, 236, 238 in Liquid	22	0	98	0
Gross Alpha Beta (Americium Calibration) Liquid	16	0	21	0
ICP-MS Uranium-234, 235, 236, 238 Prep in Liquid	14	0	51	0
Alpha/Beta (Americium Calibration) Drinking Water	5	0	4	0
TISSUE				
Carbon-14	2	0	2	0
LSC Iron-55	3	0	3	0
Gamma Nickel 59 RAD A-022	2	0	2	0
Gamma Spec Solid RAD A-013	71	0	79	0
LSC Nickel 63	4	0	4	0
LSC Plutonium	1	0	1	0
Technetium-99	2	0	2	0
Tritium	1	0	1	0
Gamma Iodine-129	2	0	2	0
Gas Flow Lead 210	2	0	2	0
Alpha Spec Uranium	5	0	5	0
Alpha Spec Thorium	2	0	2	0
Alpha Spec Plutonium	10	0	10	0
Alpha Spec Neptunium	4	0	4	0
Alpha Spec Plutonium	2	0	2	0
Gas Flow Sr 2nd count	10	0	10	0

Gas Flow Strontium 90	20	0	23	0
Alpha Spec Am241 Curium	9	0	9	0
Gas Flow Total Strontium	19	0	19	0
Gamma Spec Solid RAD A-013 with Ba, La	6	0	5	0
Gamma Spec Solid RAD A-013 with Iodine	17	0	17	0
Gross Alpha/Beta	2	0	2	0
SEA WATER				
LSC Iron-55	2	0	2	0
LSC Nickel 63	2	0	2	0
Gas Flow Total Strontium	1	0	1	0
Gross Alpha Non Vol Beta	1	0	1	0
Gamma Spec Liquid RAD A-013 with Iodine	1	0	1	0
VEGETATION				
Gamma Nickel 59 RAD A-022	3	0	3	0
Gamma Spec Solid RAD A-013	31	0	31	0
LSC Nickel 63	3	0	3	0
LSC Plutonium	1	0	1	0
Technetium-99	6	0	6	0
Tritium	9	0	9	0
Gamma Iodine-129	1	0	1	0
Gas Flow Lead 210	8	0	7	0
Total Uranium KPA	4	0	4	0
Alpha Spec Uranium	23	0	21	0
Alpha Spec Thorium	7	0	7	0
Alpha Spec Plutonium	15	0	12	0
Alpha Spec Neptunium	1	0	1	0
Alpha Spec Plutonium	1	0	1	0
Gas Flow Sr 2nd count	9	0	9	0
Gas Flow Strontium 90	19	0	18	0
Gas Flow Total Radium	2	0	3	0
Alpha Spec Am241 Curium	11	0	8	0
Gamma Spec Solid RAD A-013 with Iodine	91	0	93	0
Gamma Spec Solid RAD A-013 (pCi/Sample)	5	0	3	0
Alpha Spec Am241 (pCi/Sample)	3	0	2	0
ICP-MS Uranium-234, 235, 236, 238 in Solid	9	0	7	0
Alpha Spec Uranium	1	0	17	0
Gross Alpha/Beta	4	0	4	0
Alpha Spec Plutonium	2	0	2	0
Gas Flow Strontium 90	4	0	2	0
ICP-MS Uranium-234, 235, 236, 238 Prep in Solid	7	0	5	0
AIR CHARCOAL				
Gamma Iodine 131 RAD A-013	623	0	645	0

Gamma Iodine-129	0	0	1	0
Carbon-14 (Ascarite/Soda Lime Filter per Liter)	89	0	88	0
DRINKING WATER				
Alpha Spec Uranium	7	0	8	0
Tritium	51	0	52	0
Iodine-131	1	0	2	0
LSC Iron-55	24	0	22	0
LSC Nickel 63	23	0	21	0
LSC Radon 222	96	0	96	0
Gamma Spec Liquid RAD A-013	24	0	24	0
Total Activity,	2	0	2	0
Gamma Iodine-129	2	0	2	0
Gamma Iodine-131	38	0	38	0
Total Uranium KPA	15	0	28	0
Gas Flow Radium 228	42	0	42	0
Alpha Spec Plutonium	6	0	6	0
Gas Flow Sr 2nd count	16	0	16	0
Gas Flow Strontium 90	25	0	24	0
Lucas Cell Radium-226	58	6	78	0
Alpha Spec Am241 Curium	6	0	6	0
Gas Flow Total Strontium	31	0	31	0
Gross Alpha Non Vol Beta	343	0	287	0
Tritium in Drinking Water by EPA 906.0	37	0	34	0
Gamma Spec Liquid RAD A-013 with Ba, La	44	0	98	0
Gas Flow Strontium 89 & 90	20	0	13	0
Gas Flow Total Alpha Radium	1	0	1	0
Gross Alpha Co-precipitation	105	0	87	0
Alpha/Beta (Americium Calibration) Drinking Water	13	0	13	0
ECLS-R-GA NJ 48 Hr Rapid Gross Alpha	8	0	8	0
Total	**20148**		**23892**	

Note 1: The RPD must be 20 percent or less, if both samples are greater than 5 times the MDC. If both results are less than 5 times MDC, then the RPD must be equal to or less than 100%. If one result is above the MDC and the other is below the MDC, then the RPD can be calculated using the MDC for the result of the one below the MDC. The RPD must be 100% or less. In the situation where both results are above the MDC but one result is greater than 5 times the MDC and the other is less than 5 times the MDC, the RPD must be less than or equal to 20%. If both results are below MDC, then the limits on % RPD are not applicable.

TABLE 8.

2013 CORRECTIVE ACTION REPORT SUMMARY

CORRECTIVE ACTION ID# & PE FAILURE	DISPOSITION
CARR130513-789 ISO Documentation of PT Failures in MAPEP-13-RdV28 for Uranium in Vegetation by ICP/MS and Alpha Spec	**Root Cause Analysis of MAPEP-13-RdV28 Uranium-234/233, Uranium-235, Uranium-238 and Total Uranium** Following reviews of our process and data and conversations with personnel from the affected laboratories, it was determined that all failures were due to an analyst error during sample preparation. Glass instead of Teflon beakers were used during the sample digestion which contained Hydrofluoric (HF) acid. Per Standard Operating Procedure (SOP) GL-RAD-A-015 section 11.2.4, the sample should have been transferred to a Teflon beaker. In this instance, this step was omitted. The digestion was performed in glass beakers so trace amounts of Uranium were leached from the glass into the sample, resulting in high bias in the results. Normal procedure dictates that glass is not used when using HF in the digestion process due to the presence of natural Uranium in the glassware. In order to prove that this was an isolated incident and that our overall process is in control a series of digestions were performed in the glass beakers to confirm our conclusion. • HCL /HNO_3 only digestion - Uranium was not detected. • HCL, HNO_3, and HF digestion - Enough Uranium activity was detected to account for the high bias (as many as 70 counts in a 16 hour and 40 minute count). • HF only digestion - Results similar to HCL, HNO_3, and HF were observed **A second PT was successfully analyzed for this matrix.**
CARR130522-791 ISO Documentation of PT Failures in –MRAD-18 for Cesium-134, Cesium-137 and Zinc-65 in Soil	Following a review of our processes, the data and conversations with personnel from the affected laboratories, it was determined that our normal procedure for preparing soil samples is not sufficient for this soil matrix. Per the Standard Operating Procedure (SOP) GL-RAD-A-021, the sample was

	dried, homogenized, and passed through a 28 mesh sieve. However, approximately 20-30% of the sample consists of particles greater than the 28 mesh sieve size. These larger particles were not affected by our normal homogenization process. In accordance with the SOP, the larger particles were removed prior to preparing the container for gamma counting. Upon receipt of the graded report, the following steps were taken to prove that this was an isolated incident and that our overall process is in control. 1. A recount of the initially prepared sample performed and confirmed the originally reported results. 2. A new container was then prepared from the original sample but omitting the preparation step and counted. This produced acceptable results. 3. A second sample was prepared per the SOP; however, only a portion of the sample was removed during the sieving steps. This sample produced similar high biased results. An aliquot of the sample was then pulverized prior to gamma counting. This approach also produced acceptable results. **Permanent Corrective/Preventive Actions or Improvements** : In the future, these samples will be pulverized to ensure that all the material passes through the 28 mesh sieve; thus, eliminating the need to remove any of the original sample. A comment has been added to the set-up for the solid matrix. **A second PT was successfully analyzed for this matrix.**

CARR130826-810 For Failures of RAD-94 for Gross Alpha/Bea and Strontium 89/90 in Water	**Root Cause Analysis of Gross Alpha** After a review of the data, an apparent reason for this discrepancy could not be determined. The following steps were taken to prove that this high bias was an isolated occurrence and that our overall process is within control. 1. The batch quality control samples were reviewed and found to be compliant. The LCS recovered at 110%. While the recovery is slightly elevated, it is well within the 80%-120% acceptance range. 2. Laboratory control data were also reviewed for trends. None were noted. 3. The instrument calibrations were reviewed for positive biases that could have attributed to this failure. None were noted. 4. Two sample duplicates were also prepared and counted along with the reported result. Both results fell within the method's acceptance range for duplicate. One of the results also fell within the acceptance range of the study. 5. **The original sample was also recounted and the results fell within the acceptance range.** **Root Cause Analysis of Strontium-89 (Sr-89)** **LAB PBMS A-004** After a review of the data, an apparent reason for this discrepancy could not be determined. The following steps were taken to prove that this high bias was an isolated occurrence and that our overall process is within control. 1. The batch quality control samples were reviewed and found to be compliant. The LCS recovered at 98.1%. 2. Laboratory control data were also reviewed for trends. None were noted. 3. The instrument calibrations were reviewed for positive biases that could have attributed to this failure. None were noted. 4. Sample duplicates were also prepared and counted along with the reported result. Duplicate results fell within the acceptance range of the study. **Root Cause Analysis of Strontium-89 (Sr-89)** **EPA 905.0** After a review of the data, an apparent reason for this discrepancy could not be determined. The following steps were taken to prove that this high bias was an isolated

occurrence and that our overall process is within control.

1. The batch quality control samples were reviewed and found to be compliant. The LCS recovered at 102%.
2. Laboratory control data were also reviewed for trends. None was noted.
3. The instrument calibrations were reviewed for positive biases that could have attributed to this failure. None were noted.
4. Sample duplicates were also prepared and counted along with the reported result. All results fell within the method's acceptance range for duplicates.

Permanent Corrective/Preventive Actions or Improvements:

Gross Alpha

The laboratory must assume an unidentified random error caused the high bias because all quality control criteria were met for the batch. The lab will continue to monitor the recoveries of this radionuclide to ensure that there are no issues.

Strontium-89 (Sr-89)
LAB PBMS A-004 and EPA 905.0

To summarize our efforts (including the initial result), the laboratory had 3 analysts, two different methods, processed with 2 calibrations and two separate Y carriers used in the analysis of this sample and only one acceptable result for Sr-89. All LCS results have met acceptance criteria. This leads the laboratory to conclude that there is possibly an error in the original make-up of the PT sample. The instructions list stable Sr and Y as being included but they are not at levels greater than are normally listed so we suspect that the make up of the sample was the cause. The laboratory will continue to monitor the recoveries from these two methods to ensure that there are no issues.

CARR131205-845 For failures of MRAD-19 for Uranium-234 and Total Uranium in Vegetation	**Root Cause Analysis** These elevated results were obtained following our routine procedure. The reported result for U-234 was less than the MDA and had a elevated uncertainty. This high U-234 result also attributed to the high Total-U result. Upon receipt of the graded report, the following steps were taken to prove that this was an isolated incident and that our overall process is in control. • A recount of the initially prepared sample performed and confirmed the originally reported results. • The sample was reanalyzed using a larger aliquot and results that fell within the acceptance range were achieved. **Permanent Corrective/Preventive Actions or Improvements** In the future when the result is below the MDA and are not compatible with other analytical technologies, the laboratory will attempt to use a larger sample aliquot with hopes of achieve a result above the MDA or with a lower uncertainty. If the matrix and larger sample size do not provide useable data, the results may not be report.