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10 CFR 50 Appendix I

May 14, 2025

Attn: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Pilgrim Nuclear Power Station
Renewed Facility Operating License No. DPR-35
Docket No. 50-293 and 72-1044

Subject: Annual Radiological Environmental Operating Report, January 1 through December 31, 2024 for Pilgrim Station.

In accordance with the requirements of Pilgrim Station Defueled Safety Analysis Report, Appendix B-5.6.2, and 10 CFR 50 Appendix I, Holtec Decommissioning International LLC (HDI), on behalf of Pilgrim Nuclear Power Station, hereby submits the Annual Radiological Environmental Operating Report for calendar year 2024.

This letter contains no new regulatory commitments.

Should you have any questions or require further information, please contact Mark Lawson, Radiation Protection and Chemistry Manager, at (508) 830-7109 or me at (856) 797-0900, ext. 3587.

Respectfully,

William Noval

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William Noval
Director of Regulatory Affairs
Holtec Decommissioning International

Enclosure: Annual Radiological Environmental Operating Report, January 1st through December 31st, 2024

cc:
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Director, Massachusetts Department of Public Health Radiation Control Program

PILGRIM NUCLEAR POWER STATION

Facility Operating License DPR-35

Annual Radiological Environmental Operating Report

January 1 through December 31, 2024

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PILGRIM NUCLEAR POWER STATION
Facility Operating License DPR-35

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

JANUARY 01 THROUGH DECEMBER 31, 2024

Prepared by: _____ 5/12/25
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Reviewed by: _____ 5/13/25
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Chemistry/ Radiation Protection Manager

Pilgrim Nuclear Power Station
Annual Radiological Environmental Operating Report
January-December 2024

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INTRODUCTION

This report summarizes the results of the Holtec Decommissioning International (HDI) 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, 2024. This document has been prepared in accordance with the requirements of PNPS Facility Licensing Basis.

The REMP has been established to monitor the radiation and radioactivity released to the environment as a result of previous 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. The results from the REMP are used also to validate dose modeling and concentration prediction results in the effluent dose model.

SAMPLING AND ANALYSIS

The environmental sampling media collected in the vicinity of PNPS and at distant locations include air particulate filters, seawater, sediment, shellfish, American lobster, and fishes. Some sample media such as soil, forage, Irish moss, vegetation and cranberries were removed from the discussion of this report as they are no longer a pathway and therefore removed from the Offsite Dose Calculation Manual (ODCM) and sampling program. Soil sampling had been previously removed in 2003 in favor of more extensive TLD monitoring.

During 2024, there were 381 samples collected from the atmospheric, aquatic, and terrestrial environments. In addition, 192 exposure measurements were obtained using environmental thermoluminescent dosimeters (TLDs).

312 of 312 air particulate were collected and analyzed as required with no equipment failures or power outages as is usually the case in an area in the Northeast US, but a mild winter and close monitoring of equipment has helped to prevent sample losses. Charcoal cartridge collection was discontinued in the beginning of December 2019 when Iodines had decayed away following the permanent shutdown of PNPS on May 31, 2019. A full description of any discrepancies encountered with the environmental monitoring program is presented in Appendix D of this report.

Analyses on environmental samples were performed by Teledyne Brown Engineering Laboratory in Knoxville, TN. Samples were analyzed as required by the PNPS ODCM.

LAND USE CENSUS

The annual land use census in the vicinity of Pilgrim Station is no longer conducted. All crop-based foods no longer exist within a 5 mile radius of the plant. Cranberries and Irish Moss crops were removed from the ODCM in revision 14. The collection of broad leaf vegetation was to account for deposition of iodine on a type of cattle feed in lieu of sampling for milk. There are no milk farms withing 5 miles. The need to account for changes in new or old gardens diminished once the plant shutdown and not only was no new

iodine created, but that which had been created all decayed after 10 half lives for I-131 had passed (1 calendar quarter).
Broadleaf vegetation may still be consumed by humans, and it will be projected and accounted for in dose modeling for all nuclides remaining that are released off site, but the only radionuclide detected in REMP samples while the plant was operating was Cs-137 from fall out (recently – Chernobyl and Fukushima) which is deposited on and absorbed through the roots of plants and trees and has a 30-year half-life. The current dose model for gaseous release dose calculations utilizes a garden at the site boundary in the predominant downwind direction. As this is the most conservative scenario, no land use census will produce an alternate garden with higher off-site dose potential.

The wind rose maps for Pilgrim RBV mixed mode releases and ground releases show the predominant wind direction from the SSW in both frequency and wind speed. This means the predominant wind direction is from the land out to sea from the SSW to the NNE with SSW the most frequent compass point wind comes from toward the station. Essentially, gaseous effluents from the plant, however minor in quantity compared to when operating, are blown out to sea.

RADIOLOGICAL IMPACT TO THE ENVIRONMENT

During 2024, samples collected as part of the REMP at Pilgrim Station continued to contain detectable amounts of naturally-occurring 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 38 and 130 milliRoentgens (1 mR=0.933 mrem) per year. The range of ambient radiation levels observed with the TLDs is consistent with natural background radiation levels for Massachusetts.

It was identified in the preparation of the last report that the TLD location previously used for one of the control locations increased roughly 15mR within the past two years. As this TLD location is roughly 40km away from Pilgrim station in a less prevalent wind direction the increase was not caused by plant operations. After some investigation including the addition of temporary TLDs and satellite image reviews, evidence points instead to the re-paving activities of an adjacent roadway.

RADIOLOGICAL IMPACT TO THE GENERAL PUBLIC

During 2024, radiation doses to the general public as a result of previous 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 2024 was approximately 0.62 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 2024 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 decommissioning operations.

1.0 INTRODUCTION

The Radiological Environmental Monitoring Program for 2024 performed by Holtec Decommissioning International (HDI), owned by Holtec for Pilgrim Nuclear Power Station (PNPS) is discussed in this report. This report, which is required to be published annually by Pilgrim Station's Facility Licensing Basis, 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, 2024.

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, seawater, sediment, 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, 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 previous 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 plants are cesium-137, iodine-131, strontium-90, and cobalt-60. Iodine is no longer an active Pilgrim station isotope as the station no longer produces iodine and that which was previously produced has decayed away.

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 approximately 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 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 approximately 30 mrem of radiation dose per year.

Additionally, natural radioactivity is in our body and in the food we eat (approximately 30 millirem/yr), the ground we walk on (approximately 20 millirem/yr) and the air we breathe (approximately 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 approximately 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 approximately 300 mrem. Consumer activities, such as smoking, commercial air travel, and building materials contribute approximately 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 approximately 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 was an operating boiling water reactor whose nuclear steam supply system was provided by General Electric Co. The nuclear station is located on a 1600-acre site approximately eight kilometers (five miles) east-southeast of the downtown area of Plymouth, Massachusetts. Commercial operation began in December 1972. Pilgrim Station was operational until May 31, 2019 before the decision to permanently shut down and decommission the station. The following information is no longer contemporary, but provides a description of radioactive material production, containment, and release during the station's operational period for understanding.

Nuclear-generated electricity was 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), 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.

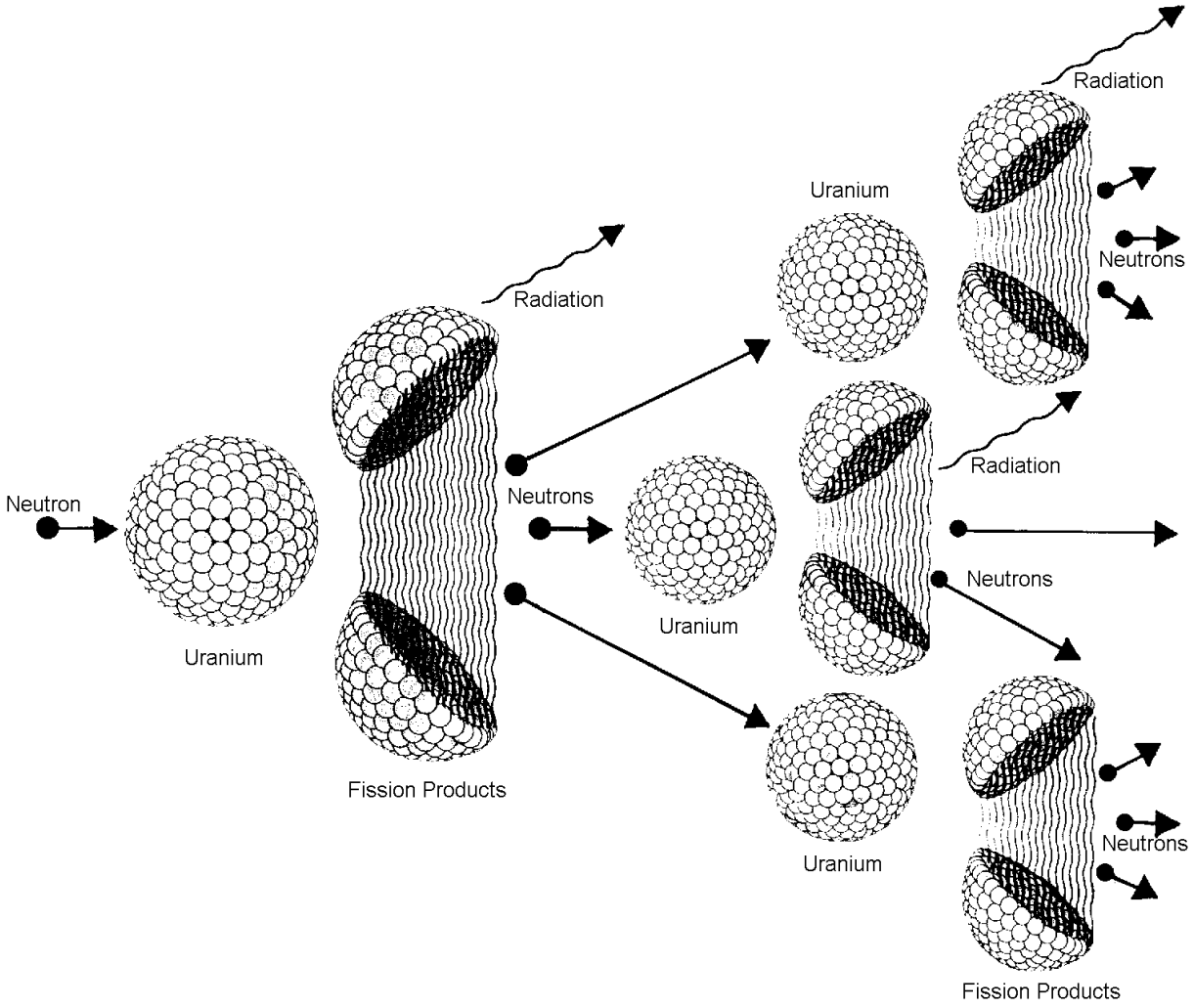


Figure 1.3-1
Radioactive Fission Product Formation

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).

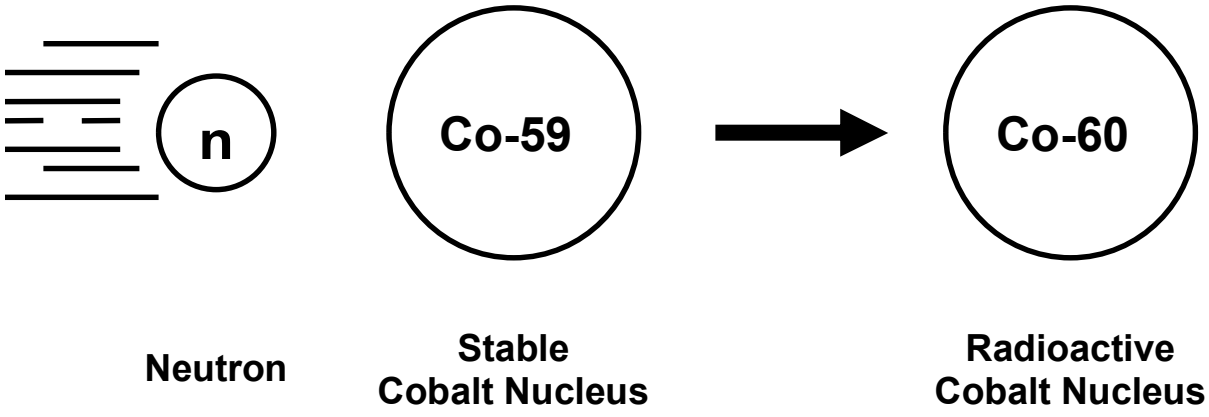


Figure 1.3-2
Radioactive Activation Product Formation

At Pilgrim Nuclear Power Station there were five independent protective barriers that confined radioactive materials during operation. These five barriers, which are shown in Figure 1.3-3 (Reference 5). Following the permanent shutdown and decommissioning of the plant in May of 2019 the only source of released radioactivity is that of the decay of radioactive activation products. Barriers like fuel pellets and cladding are no longer applicable. Building structures still play a part in shielding as discussed below.

SIMPLIFIED DIAGRAM OF A BOILING WATER REACTOR

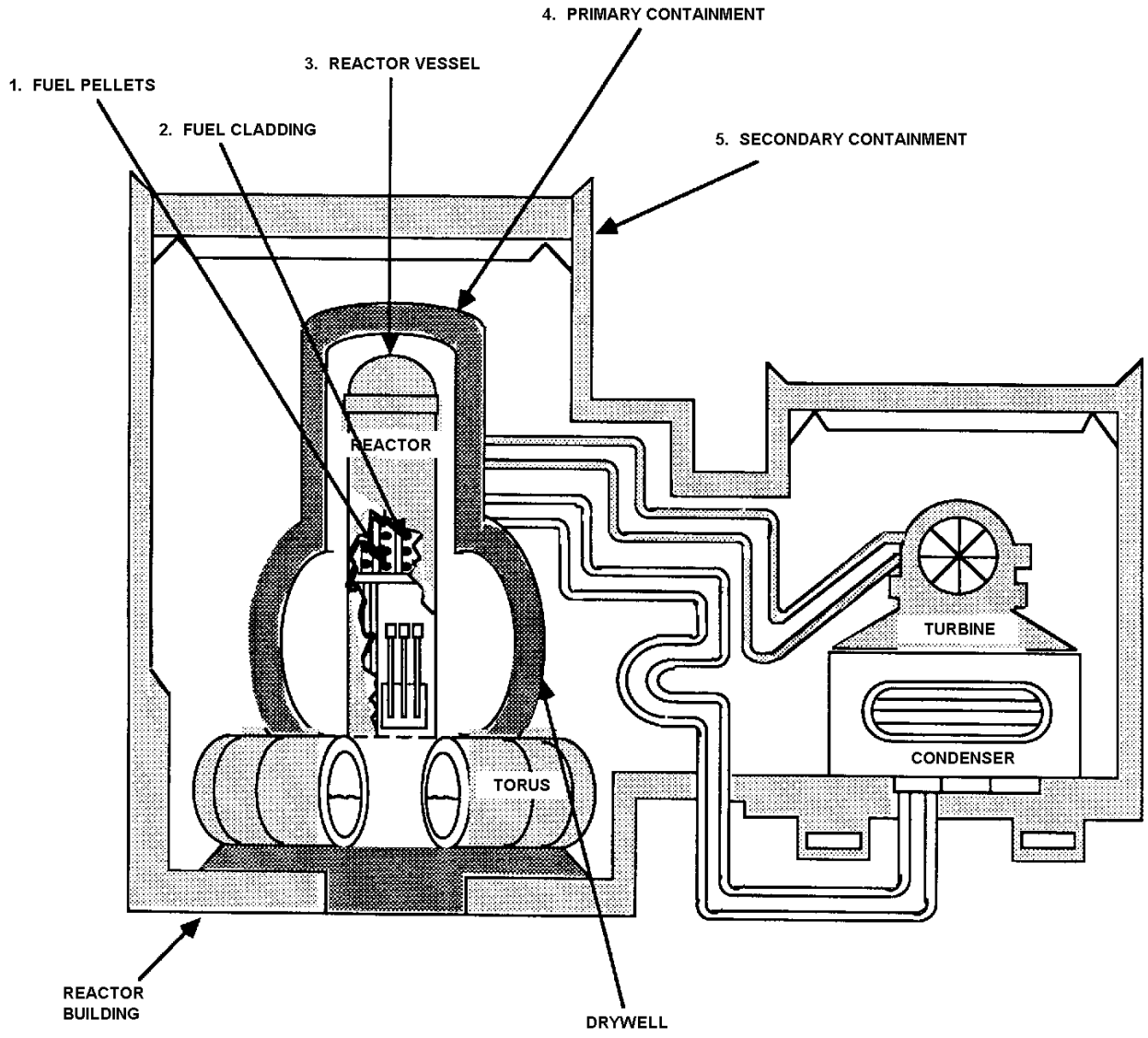


Figure 1.3-3
Barriers To Confine Radioactive Materials

Barrier consisting of the reactor vessel, steel piping and equipment still confine the reactor water. The reactor vessel, which once held the reactor fuel, is a 65-foot high by 19-foot diameter tank with steel walls approximately nine inches thick. This provides containment for radioactivity in the water once used as primary coolant. However, during the course of decommissioning 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 last barrier is the reactor building. This reactor building is equipped with a controlled filtered ventilation system that is used to keep the building at a negative pressure.

These barriers confine most of the remaining activation products. However, small amounts of radioactivity do escape via mechanical failures and maintenance on valves, piping, and equipment associated with the reactor/fuel pool systems. 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. Prior to a release to the environment, control systems collect and purify the radioactive effluents in order to reduce releases to the environment to as low as is reasonably achievable (ALARA). 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 that might escape the barriers are processed in the liquid waste treatment system, monitored for radioactivity, and released only if the radioactivity levels are below the federal release limits as permitted.

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

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

Water used previously for reactor or spent fuel cooling 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.

More recently the option has been added to the ODCM (rev. 15) to be able to utilize the torus as a “tank” (as it no longer serves its original purpose to aid in reactor level/ pressure control) to hold water and process through means other than the established radwaste treatment system (e.g. Demineralizers previously used with in the condensate system) for purification prior to release.

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 released 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 radiation levels exceed pre-established thresholds, 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 released.

Another means for adjusting liquid effluent concentrations to below federal limits is by mixing plant cooling water (salt service water) 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;
- sampling and analysis of reactor building vent effluents

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. A sample stream of the plenum flows through a sampling rack equipped with a particulate filter. Air samples are continuously sampled with the filter changeout on a weekly frequency as well as a weekly tritium composite from the reactor building vent and are analyzed to quantify the total amount of tritium and radioactive particulate effluents released. This plenum, which vents to the atmosphere, was previously equipped with a gaseous radiation detector. The gaseous radiation monitor was removed from the ODCM in revision 15. All Noble gases have decayed away, save Kr-85 which is sealed in dry storage casks on the Independent Spent Fuel Storage Installation (ISFSI) II pad.

Therefore, for both liquid and gaseous releases, radioactive treatment systems exist, such as pre-filtration and negative ventilation to collect and purify the radioactive effluents, to reduce releases to the environment to as low as is reasonably achievable (ALARA). 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 the liquid radwaste discharge line flow path will automatically shut to stop the release, or responsible personnel 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 in the Annual Radiological Effluent Release Report (ARERR). 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

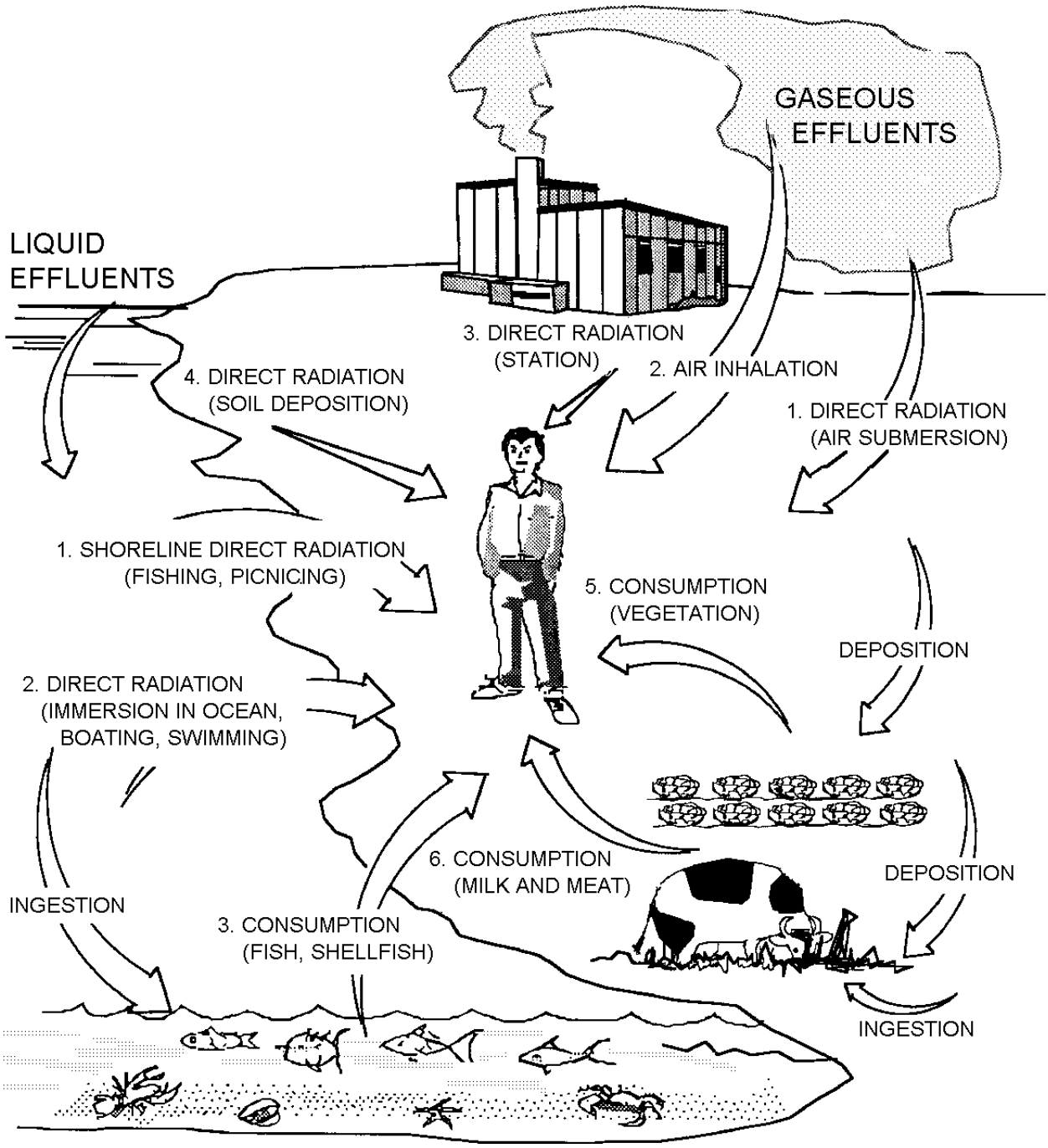


Figure 1.5-1
Radiation Exposure Pathways

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. 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 resulted 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 station 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 (ODCM) (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.

- Note: There are no noble gas release at Pilgrim due to gases having decayed away

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.

- Note: There are no iodine release at Pilgrim due to no more production of that isotope and that which has been produced by the plant operation having decayed away.

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.

- Note: There is no longer a “fuel cycle, as normal operations ceased on May 31, 2019.

The summary of the 2024 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 2024 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 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 2024 included air particulate filters, seawater, sediment, shellfish (mussels and clams), 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, seawater, and monitoring devices are collected by station personnel. The aquatic samples are collected by Normandeau Associates, Inc. The radioactivity analysis of samples are performed by the Teledyne Brown Engineering Laboratory, and the environmental dosimeters are analyzed by Stanford Dosimetry.

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 air sample 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. NRC guidance (Reference 14) contains provisions for collection of vegetation in lieu of milk sampling. Such samples have historically been collected near Pilgrim Station as part of the routine REMP program. With the permanent shut down of the plant and the decay of Iodine the need for milk or vegetation samples is no longer necessary. Sample collection requirements have since been removed from the 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. When the ODCM was revised in 1999 in accordance with NRC Generic Letter 89-01, the sampling program description was relocated to the ODCM. 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 approximately 150 to 180 pCi/kg were established for sediment, as opposed to the specialized LLDs of 50 pCi/kg.
- Specialized analysis of sediment for plutonium isotopes was removed.
- Sampling of Irish moss, shellfish, and fish was rescheduled to a semiannual period, as opposed to a specialized quarterly sampling interval.
- Analysis of only the edible portions of shellfish (mussels and clams), as opposed to specialized additional analysis of the shell portions.
- Standard LLD levels of 130 to 260 pCi/kg were established for edible portions of shellfish, as opposed to specialized LLDs of 5 pCi/kg.

Upon receipt of the analysis results from the analytical laboratories, the PNPS staff reviews the results. If the radioactivity concentrations are above the reporting levels, the NRC must be notified within 30 days. For radioactivity that is detected that is attributable to Pilgrim Station's operation, calculations are performed to determine the cumulative dose contribution for the current year. Most importantly, if radioactivity levels in the environment become elevated as a result of the station's operations, 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.
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 HDI Quality Assurance Audits.

The Teledyne Brown Engineering Laboratory conducts extensive quality assurance and quality control programs. The 2024 results of these programs are summarized in Appendix E. These results indicate that the analyses and measurements performed during 2024 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 2024. 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 locations within the range of influence of Pilgrim Station and which could conceivably be affected by its activities are called "indicator" stations. Distant stations, which are beyond plant influence, are called "control" stations. As stated previously for ambient radiation monitoring locations, they are no longer broken down into four separate zones to aid in data analysis based on distance, but instead are each compared to its own individual location. Those locations that were once considered "control" still serve the same function, to show values in an area unimpacted by plant activities, but are not used to subtract a background "zone" average from impacted locations.

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 measurements with results greater than the Minimum Detectable Activity (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 $\pm$ 21 pCi/kilogram would be considered "positive" (detectable Cs-137), whereas another sample with a concentration of 60 $\pm$ 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.

The analytical laboratory that analyzes the various REMP samples employs a background subtraction correction for each analysis. A blank sample that is known not to contain any plant-related activity is

analyzed for radioactivity, and the count rate for that analysis is used as the background correction. That background correction is then subtracted from the results for the analyses in that given set of samples. For example, if the blank/background sample produces 50 counts, and a given sample being analyzes produces 47 counts, then the net count for that sample is reported as -3 counts. That negative value of -3 counts is used to calculate the concentration of radioactivity for that particular analysis. Such a sample result is technically more valid than reporting a qualitative value such as "<LLD" (Lower limit of Detection) or "NDA" (No Detectable Activity)".

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 (Table 2.5-1). Gross beta (GR-B) analyses were performed on 312 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 five indicator stations, 260 out of 260 samples indicated detectable gross beta activity at the three-sigma (standard deviation) level. The mean concentration of gross beta activity in these 260 indicator station samples was 0.017 $\pm$ 0.0037 (1.7E-2 ± 3.7E-3) pCi/m^3. Individual values ranged from 0.0073 to 0.028 (7.3E-3 – 2.8E-2) pCi/m^3

The monitoring station which yielded the highest mean concentration was the sample location ER (East Rocky Hill Rd), which yielded a mean concentration of 0.018 $\pm$ 0.0039 pCi/m^3, based on 52 detectable indications out of 52 samples observations. Individual values ranged from 0.010 to 0.028 pCi/m^3.

At the control location, 52 out of 52 samples yielded detectable gross beta activity, for an average concentration of 0.017 $\pm$ 0.004 pCi/m^3. Individual samples at the East Weymouth control location ranged from 0.011 to 0.026 pCi/m^3.

Analyses for cesium-137 (Cs-137) were performed 24 times (quarterly composites for 6 stations * 4 quarters). No samples exceeded ten times the mean control station concentration. The required LLD value Cs-137 in the PNPS ODCM is 0.06 pCi/m^3.

At the indicator stations, all 20 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.

Analyses for Beryllium-7 (Be-7) are used to indicate representative sampling for air samplers in environmental applications.

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 47 locations are monitored using this technique. The number of TLD were reduced in April 2020 after the permanent shut down of the Pilgrim station, then again in 2021 to collapse the outer ring to 3km from the plant. Only the 4 locations, Division of Marine Fisheries (DMF), East Weymouth (EW), Manomet Elementary (ME) and Manomet Substation (MS) remain outside of the 3km distance. In addition, 4 of the 47 TLDs are currently located onsite, within the PNPS protected/restricted area, as well as 15 out of 47 are currently located outside the protected area but

inside the site boundary and area used for business purposes only where the general public does not have access.

Though the “business area only” or “exclusion zone” could *physically* be accessed, jersey barriers, signage and security tours would drastically limit the stay of a person with out proper authorization to be within the areas.

With this reporting period, Pilgrim station has adopted the NRC endorsed environmental TLD reporting method of ANSI N13.37. The basic idea is that instead of breaking environmental TLDs into geographic “zones” based on distance from the plant, each location is compared only to itself and its own baseline background for that location. The Minium differential dose (MDD) is the smallest amount of facility-related dose at each monitored location in a specified time period (MDDq- quarterly, MDDa-annually) above the baseline background dose that can be reliably detected by an environmental dosimetry system. The extraneous (facility) dose calculated with the amount of time a MEMBER OF THE PUBLIC could be in that location (occupancy factor) would equal the dose a MEMBER OF THE PUBLIC could receive.
This method is slightly different from the previous reporting idea of “control” and “indicator” locations, subtracting the “control” zone average from other zone averages to get a dose that would be applied to a MEMBER OF THE PUBLIC based on occupancy. Table 2.4-1 now includes a column labeled “Annual Dose to MEMBER OF THE PUBLIC” and reports “ND” for stations where “ND” means not detected above a quarterly MDD of 5 mrem, an annual facility MDD of 10 mrem, and an annual MEMBER OF THE PUBLIC MRD (minimum reportable dose) of 1 mrem.

Out of the 188 TLDs posted in the environment during 2024, 188 were retrieved and processed for calculation of dose. The results for environmental TLDs are presented in Table 2.4-1. Baseline background results are presented in Table 2.4-2. All of the listed exposure results represent continuous occupancy (2190 hr/qtr or 8760 hr/yr).

Annual exposure rates measured at locations beyond the PNPS protected area boundary ranged from 38 to 119 mR/yr. The location if East Weymouth (EW) was identified in the previous year, to have increased by roughly 15mR over the previous two years. The cause was identified to be a recently re-paved road that ran parallel to the station access road as well as access road maintenance to fill in low spots with rock fill. The remaining unused rock was piled near the TLD location. New road materials including, granite rock fill can have an effect on TLD values and therefore increase the monitored and baseline results.

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 69 and 89 mR/yr. The results for all TLDs within 15 km (excluding those TLDs posted within the site boundary) ranged from 48 to 82 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 the movement of station components into dry casks as well as radwaste material for storage or shipment.

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 proximity to the onsite fuel storage pad (e.g., locations OA, TC, 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.

In conclusion, measurements of ambient radiation exposure around Pilgrim Station do not indicate any significant increase in exposure levels. Although some increases and decreases in ambient radiation exposure level were apparent on site property very close to Pilgrim Station especially in areas where decommissioning components move between storage locations, there were no measurable increases at areas beyond the site's control. Calculations in accordance with ANSI N13.37 show there are no TLD locations with facility dose above "ND" (Non- detect) specifications.

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 locations in the Plymouth area, along with the control location in East Weymouth. At the start and end of 2024 six locations were monitored on a weekly basis.

Out of 312 filters (6 locations * 52 weeks), 312 samples were collected and analyzed during 2024. There were no instances where power was lost or pumps failed during the course of the sampling period, which would result in lower than normal sample volumes. Sample discrepancies are noted in Appendix D.

The results of the analyses performed on these 312 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 312 of the filter samples collected, including 52 of the 52 control location samples. This gross beta activity arises from naturally-occurring radionuclides such as radon decay daughter products. Naturally-occurring beryllium-7 was detected in 40 out of 40 of the quarterly composites analyzed with gamma spectroscopy. No airborne radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2024, and results of any detectable naturally-occurring radioactivity were similar to those observed in the preoperational monitoring program.

2.6 Milk Radioactivity Analyses

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, but due to plant condition the requirement for sampling no longer applies. Sample requirements and sample locations were removed in ODCM revision 15.

2.7 Vegetable/Vegetation Radioactivity Analyses

Vegetation sampling as well as the Land Use census was discontinued, removed from the ODCM in revision 15 as described in the milk section above. Crop based foodstuffs no longer exist within a 5 mile radius on the plant (previously cranberries and Irish Moss) and were previously removed from the ODCM. The use of broadleaf vegetation was to account for the deposition of iodine on a type of cattle feed in lieu of sampling for milk. As there are no milk farms within the influence of the plant and the need to account

for changes in new or old gardens has diminished with the shutdown and fuel removal at the plant, the requirement was removed.

Broadleaf vegetation may still be consumed by humans, and it will be projected and accounted for in the dose modelling for all nuclides remaining that are released off site, but the only radionuclide detected in REMP samples while the plant was operating was Cs-137 from fall out (recently – Chernobyl and Fukashima) which is deposited on and absorbed thru the roots of plants and trees and has a 30-year half-life.

The current dose model for gaseous release dose calculations utilizes a garden at the site boundary in the predominant downwind direction. As this is the most conservative scenario, no land use census will produce an alternate garden with higher off-site dose potential.

2.8 Surface Water Radioactivity Analyses

Samples of surface water are routinely collected from the discharge canal onsite and from the control location at Powder Point Bridge in Duxbury. Grab samples are collected weekly from the Powder Point Bridge location. The discharge canal is continuously composited (every 15 minutes) to comprise a weekly composite. Weekly samples of surface water are composited every four week period and analyzed by gamma spectroscopy. These monthly composites are further composited on a quarterly basis and tritium analysis is performed on these quarterly samples.

A total of 32 samples of surface water were collected and analyzed as required during 2024. Bartlett Pond sample point was removed from the ODCM in the fourth Quarter 2019. Results of the analyses of water samples are summarized in Table 2.12-1. Naturally-occurring potassium-40 was detected in all monthly composite samples, especially those composed primarily of seawater. No radioactivity attributable to Pilgrim Station was detected in any of the surface water samples collected during 2024.

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.

2.9 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 by marine sampling vendor (Normandeau) and are analyzed by gamma spectroscopy.

Twelve of twelve planned program samples of sediment were collected during 2024. Gamma analyses were performed on these samples. Results of the gamma analyses of sediment samples are summarized in Table 2.13-1. Naturally-occurring potassium-40 was detected in all of the samples and actinium/thorium-228 were detected in 11 out of 12 samples. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2024, and results of any detectable naturally-occurring radioactivity were similar to those observed in the preoperational monitoring program.

2.10 Shellfish Radioactivity Analyses

Samples of blue mussels and soft-shell clams 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.

Thirteen samples of shellfish meat scheduled for collection during 2024 were obtained and analyzed. Results of the gamma analyses of these samples are summarized in Table 2.15-1. Naturally-occurring potassium-40 was detected in thirteen of the thirteen the samples. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2024, and results of any detectable naturally-occurring radioactivity were similar to those observed in the preoperational monitoring program.

2.11 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. 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 2024. Results of the gamma analyses of these samples are summarized in Table 2.16-1. Naturally-occurring potassium-40 was detected in five of the five of the samples. No radioactivity attributable to Pilgrim Station was detected in any of the samples collected during 2024, and results of any detectable naturally-occurring radioactivity were similar to those observed in the preoperational monitoring program.

2.12 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.

Seven samples of fish were collected during 2024. The seasonal sample of Group III fish (alewife, smelt, striped bass) from the Discharge Outfall continues to be difficult to obtain. Many fish species gravitate to the warmer waters. With the shutdown of the station the discharge flow and heat was reduced. These discrepancies are discussed in Appendix D. Results of the gamma analyses of fish samples collected are summarized in Table 2.17-1. The only radionuclide detected in any of the fish samples was naturally-occurring potassium-40. No radioactivity attributable to Pilgrim Station was detected in any of the fish samples collected during 2024, 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			
East Rocky Hill Road	ER	0.9 km	SE
Property Line	PL	0.5 km	NNW
Pedestrian Bridge	PB	0.2 km	N
East Breakwater	EB	0.5 km	ESE
Cleft Rock	CR	1.3 km	SSW
East Weymouth (Control)	EW	40 km	NW
Surface Water			
Discharge Canal	DIS	0.2 km	N
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
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
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

Environmental TLD Results

#	Location	Occupancy Factor	Distance** Correction	Distance (km) and Direction	Quarterly Baseline (mrem)	2024 Quarterly Results (mrem)				Baseline Adjusted 2024 Quarterly Results (mrem)				Annual Baseline (mrem)	Annual Monitoring Data (mrem)	Annual Facility Dose (mrem)	Annual* Dose to Member of Public (mrem)
						1	2	3	4	1	2	3	4				
BLW	BOAT LAUNCH WEST	0.011	1.000	0.11 E	16.8	28.4	27.6	25.7	30.4	11.6	10.8	8.9	13.6	67.2	112.1	44.9	ND
OA	OVERLOOK AREA	0.011	1.000	0.15 W	16.8	26.6	28.0	26.5	25.9	9.8	11.2	9.7	9.1	67.2	107.0	39.8	ND
TC	HEALTH CLUB	0.011	1.000	0.15 WSW	16.8	22.9	22.7	22.6	22.9	6.1	5.9	5.8	6.1	67.2	91.1	23.9	ND
BLE	BOAT LAUNCH EAST	0.011	1.000	0.16 ESE	16.8	21.8	20.3	19.4	21.7	5.0	ND	ND	ND	67.2	83.2	16.0	ND
P01	SHOREFRONT SECURITY	0.011	1.000	0.22 NNW	16.8	17.2	17.4	17.7	17.4	ND	ND	ND	ND	67.2	69.7	ND	ND
ISF-2	ISFSI-2	0.011	1.000	0.29 W	16.8	30.8	30.2	29.5	28.8	14.0	13.4	12.7	12.0	67.2	119.3	52.1	ND
ISF-1	ISFSI-1	0.057	1.000	0.35 SW	16.8	20.3	19.0	19.7	19.0	ND	ND	ND	ND	67.2	78.1	10.9	ND
PA	SHOREFRONT PARKING	0.011	1.000	0.35 NNW	16.8	18.3	17.5	18.7	17.2	ND	ND	ND	ND	67.2	71.8	ND	ND
A	STATION A	0.004	1.000	0.37 WSW	15.9	17.1	16.8	17.8	17.2	ND	ND	ND	ND	63.4	68.9	ND	ND
EB	EAST BREAKWATER	0.011	1.000	0.44 ESE	16.8	18.9	19.0	19.7	19.4	ND	ND	ND	ND	67.2	77.1	ND	ND
B	STATION B	0.004	1.000	0.44 S	21.0	21.1	22.6	21.9	21.7	ND	ND	ND	ND	84.0	87.4	ND	ND
PMT	PNPS MET TOWER	0.011	1.000	0.44 WNW	16.8	17.9	17.1	17.9	17.5	ND	ND	ND	ND	67.2	70.5	ND	ND
L	STATION L	0.011	1.000	0.50 ESE	16.8	16.2	16.3	16.4	16.5	ND	ND	ND	ND	67.2	65.4	ND	ND
G	STATION G	0.004	1.000	0.53 W	15.0	16.5	17.1	17.1	17.0	ND	ND	ND	ND	60.1	67.7	ND	ND
PL	PROPERTY LINE	0.011	1.000	0.54 NNW	17.3	19.9	19.9	21.1	19.6	ND	ND	ND	ND	69.3	80.5	11.2	ND
HB	HALL'S BOG	1.000	1.000	0.63 SE	18.7	19.3	19.6	20.3	19.8	ND	ND	ND	ND	74.8	79.1	ND	ND
GH	GREENWOOD HOUSE	1.000	1.000	0.65 ESE	17.4	16.8	17.6	17.7	17.3	ND	ND	ND	ND	69.7	69.4	ND	ND
WR	W ROCKY HILL ROAD	1.000	1.000	0.83 WNW	19.8	20.3	21.2	21.2	20.8	ND	ND	ND	ND	79.4	83.5	ND	ND
ER	E ROCKY HILL ROAD	1.000	1.000	0.89 SE	15.6	16.2	15.9	17.9	16.5	ND	ND	ND	ND	62.6	66.4	ND	ND
CR	CLEFT ROCK	1.000	1.000	1.27 SSW	17.6	19.2	18.8	19.3	18.9	ND	ND	ND	ND	70.6	76.2	ND	ND
BD	BAYSHORE/GATE RD	1.000	1.000	1.34 WNW	17.9	18.8	18.7	19.1	18.9	ND	ND	ND	ND	71.4	75.6	ND	ND
EM	EMERSON ROAD	1.000	1.000	1.53 SSE	16.7	16.3	17.2	15.3	15.6	ND	ND	ND	ND	66.8	64.5	ND	ND
EP	EMERSON/PRISCILLA	1.000	1.000	1.55 SE	16.3	15.5	15.7	16.7	16.5	ND	ND	ND	ND	65.1	64.5	ND	ND
BS	BAYSHORE	1.000	1.000	1.76 W	18.8	18.1	18.1	18.5	19.0	ND	ND	ND	ND	75.2	73.7	ND	ND
JG	JOHN GAULEY	1.000	1.000	1.99 W	17.2	16.1	17.2	16.1	16.1	ND	ND	ND	ND	68.9	65.5	ND	ND
J	STATION J	1.000	1.000	2.04 SSE	15.8	15.4	15.1	17.0	15.7	ND	ND	ND	ND	63.0	63.2	ND	ND
RC	PLYMOUTH YMCA	1.000	1.000	2.09 WSW	15.8	15.5	15.7	16.6	16.0	ND	ND	ND	ND	63.0	63.8	ND	ND
TT	TAYLOR/THOMAS	1.000	1.000	2.26 SE	15.8	16.0	15.3	15.4	15.5	ND	ND	ND	ND	63.0	62.2	ND	ND
YV	YANKEE VILLAGE	1.000	1.000	2.28 WSW	17.0	15.8	15.2	16.6	16.5	ND	ND	ND	ND	68.0	64.2	ND	ND
GN	GOODWIN PROPERTY	1.000	1.000	2.38 SW	12.6	12.2	12.4	12.9	12.6	ND	ND	ND	ND	50.4	50.1	ND	ND
RW	RIGHT OF WAY	1.000	1.000	2.83 S	13.2	13.3	13.3	13.5	13.3	ND	ND	ND	ND	52.9	53.4	ND	ND
TP	TAYLOR/PEARL	1.000	1.000	2.98 SE	15.5	14.8	14.8	14.9	14.9	ND	ND	ND	ND	62.2	59.4	ND	ND

Note (1) 'Missing' indicates that TLD data is not available at this location for the quarter. Where possible the annual result is based on averaging the available quarterly data and multiplying by 4.

(2) Results are in absorbed dose unit of mrem using ANSI/HPS N13.37-2014 conversion factor of:1.05 mrem/mR

(3) 'ND' means not detected above a quarterly MDD of 5 mrem, an annual facility MDD of 10 mrem, and an annual member of public MRD of 1 mrem.

* Annual dose to member of the public is based on a default occupancy time.

Table 2.4-1 (Continued) Table 2.4-2

Environmental TLD Results

#	Location	Occupancy Factor	Distance (km) and Direction	Quarterly Baseline (mrem)	2024 Quarterly Results (mrem)				Baseline Adjusted 2024 Quarterly Results (mrem)				Annual Baseline (mrem)	Annual Monitoring Data (mrem)	Annual Facility Dose (mrem)	Annual* Dose to Member of Public (mrem)
					1	2	3	4	1	2	3	4				
ME	MANOMET ELEM	1.000	3.29 SE	16.9	17.0	16.7	16.8	16.9	ND	ND	ND	ND	67.6	67.4	ND	ND
MS	MANOMET SUBSTATION	1.000	3.60 SSE	18.2	17.8	17.2	17.8	17.6	ND	ND	ND	ND	72.7	70.4	ND	ND
DMF	DIV MARINE FISH	1.000	20.97 SSE	19.6	19.7	20.1	20.3	20.1	ND	ND	ND	ND	78.5	80.2	ND	ND
EW	E WEYMOUTH SUBST	1.000	39.69 NW	22.1	21.1	22.1	21.7	20.8	ND	ND	ND	ND	88.2	85.7	ND	ND
UP-1	UPPER PARKING LOT-1	0.011	0.09 SW	16.8	25.8	25.7	25.5	25.8	9.0	8.9	8.7	9.0	67.2	102.8	35.6	ND
P17	FENCE-EXEC.BUILDING	0.011	0.11 W	16.8	27.4	27.7	25.8	25.2	10.6	10.9	9.0	8.4	67.2	106.1	38.9	ND
P11	FENCE-TCF GATE	0.0114	0.18 ESE	16.8	32.0	30.2	27.6	40.4	15.2	13.4	10.8	23.6	67.2	130.1	62.94	ND
P27	FENCE-TCF/BOAT RAMP	0.011	0.19 ESE	16.8	21.2	19.9	19.8	22.4	ND	ND	ND	5.6	67.2	83.3	16.1	ND
P10	FENCE-TCF/INTAKE BAY	0.011	0.22 E	16.8	21.8	20.9	20.7	21.0	ND	ND	ND	ND	67.2	84.4	17.2	ND
UP-2	UPPER PARKING LOT-2	0.011	0.24 WSW	16.8	24.3	24.3	23.8	23.7	7.5	7.5	7.0	6.9	67.2	96.0	28.8	ND
UP-3	UPPER PARKING LOT-3	0.011	0.25 WSW	16.8	28.7	28.2	28.1	28.0	11.9	11.4	11.3	11.2	67.2	113.0	45.8	ND
LS-01	LEGIO STORAGE 1	1.000		17.0	16.4	17.6	18.1	17.7	ND	ND	ND	ND	68.0	69.8	ND	ND
ISF-4	ISFSI-4	0.057	0.35 WSW	16.8	20.4	19.7	20.5	20.1	ND	ND	ND	ND	67.2	80.8	13.6	ND
ISF-5	ISFSI-5	0.057	0.37 WSW	16.8	18.6	19.6	19.2	18.9	ND	ND	ND	ND	67.2	76.4	ND	ND
ISF-6	ISFSI-6	0.057	0.41 WSW	16.8	19.9	19.7	19.8	18.9	ND	ND	ND	ND	67.2	78.4	11.2	ND
ISF-7	ISFSI-7	0.057	0.45 W	16.8	16.8	17.0	17.7	16.6	ND	ND	ND	ND	67.2	68.1	ND	ND
CTRL A	CONTROL SET A	1.000		8.3	10.2	10.0	9.3	10.3	ND	ND	ND	ND	33.2	39.8	ND	ND
CTRL B	CONTROL SET B	1.000		8.3	10.1	9.8	9.3	9.9	ND	ND	ND	ND	33.2	39.1	ND	ND
CTRL C	CONTROL SET C	1.000		8.3	9.5	10.1	9.0	9.5	ND	ND	ND	ND	33.2	38.0	ND	ND
CTRL D	CONTROL SET D	1.000		8.3	9.5	9.9	8.9	9.7	ND	ND	ND	ND	33.2	37.9	ND	ND

Note (1) 'Missing' indicates that TLD data is not available at this location for the quarter. Where possible the annual result is based on averaging the available quarterly data and multiplying by 4.

(2) Results are in absorbed dose unit of mrem using ANSI/HPS N13.37-2014 conversion factor of:1.05 mrem/mR

(3) 'ND' means not detected above a quarterly MDD of 5 mrem, an annual facility MDD of 10 mrem, and an annual member of public MRD of 1 mrem.

* Annual dose to member of the public is based on a default occupancy time.

Table 2.5-1
Air Particulate Filter Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2024)

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	312 0	0.01	1.7E-2 ± 3.7E-3 7.3E-3 – 2.8E-2 260 / 260	ER: 1.8E-2 ± 3.9E-3 1.0E-2 – 2.8E-2 52 / 52	1.7E-2 ± 4.0E-3 1.1E-2 – 2.6E-2 52 / 52
Be-7	24 0		8.7E-2 ± 1.6E-2 5.6E-2 - 1.2E-1 20 / 20	PL: 9.4E-2 ± 1.7E-2 7.6E-2 - 1.1E-1 4 / 4	9.2E-2 ± 2.8E-2 6.0E-2 - 1.2E-1 4 / 4
Cs-134	24 0	0.05	2.3E-5 ± 1.0E-3 -2.0E-3 – 2.8E-3 0 / 20	EB: 7.0E-4 ± 1.5E-3 -5.2E-4 – 2.8E-3 0 / 4	-7.0E-4 ± 1.7E-4 -3.0E-3 – 8.3E-4 0 / 4
Cs-137	24 0	0.06	-5.2E-5 ± 5.3E-4 -9.5E-4 – 9.8E-4 0 / 20	ER: 3.3E-4 ± 8.9E-4 -9.5E-4 – 9.8E-4 0 / 4	2.3E-4 ± 4.5E-4 -1.6E-4 – 6.8E-4 0 / 4

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

Table 2.7-1
Vegetable/Vegetation Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2024)

As stated in summary sections earlier in this report, vegetation sampling has been discontinued.

Table 2.8-1
Surface Water Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2024)

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

Radionuclide	No. Analyses Non-routine*	Required LLD	Indicator Stations Mean ± Std.Dev. Range Fraction>LLD	Station with Highest Mean Station: Mean ± Std.Dev. Range Fraction>LLD	Control Stations Mean ± Std.Dev. Range Fraction>LLD
H-3	12 0	3000	1.4E+1 ± 4.1E+1 -4.7E+1 – 4.0E+1 0 / 8	1.2E+2 ± 3.6E+2 -2.0E+2 - 6.4E+2 0 / 4	1.2E+0 ± 3.6E+2 -2.0E+2 – 6.4E+2 0 / 4
K-40	24 0		3.1E+2 ± 5.3E+1 2.4E+2 - 4.0E+2 12 / 12	3.1E+2 ± 5.3E+1 2.4E+2 – 4.0E+2 12 / 12	2.9E+2 ± 3.5E+1 2.4E+2 - 3.6E+2 12 / 12
Mn-54	24 0	15	-1.1E-0 ± 1.8E+0 -3.1E+0 - 3.1E+0 0 / 12	7.9E-2 ± 1.5E+0 -2.5E+0 - 2.4E+0 0 / 12	7.9E-2 ± 1.5E+0 -2.5E+0 - 2.4E+0 0 / 12
Fe-59	24 0	30	1.2E-0 ± 3.5E+0 -3.0E+0 – 7.1E+0 0 / 12	3.9E-0 ± 4.7E+0 -5.9E+0 – 1.1E+1 0 / 12	3.9E-0 ± 4.7E+0 -5.9E+0 – 1.1E+1 0 / 12
Co-58	24 0	15	-3.3E-1 ± 2.0E+0 -5.6E+0 - 2.8E+0 0 / 12	-2.3E-1 ± 1.7E+0 -2.6E+0 - 2.6E+0 0 / 12	-2.3E-1 ± 1.7E+0 -2.6E+0 – 2.6E+0 0 / 12
Co-60	24 0	15	-4.0E-1 ± 2.2E+0 -5.9E+0 – 1.6E+0 0 / 12	3.8E-1 ± 2.1E+0 -3.0E+0 – 3.7E+0 0 / 12	3.8E-1 ± 2.1E+0 -3.0E+0 - 3.7E+0 0 / 12
Zn-65	24 0	30	-6.0E+0 ± 6.4E+0 -2.0E+1 – 1.1E+0 0 / 12	-3.3E+0 ± 4.3E+0 -1.2E+1 – 2.3E+0 0 / 12	-3.3E+0 ± 4.3E+0 -1.2E+1 – 2.3E+0 0 / 12
Zr-95	24 0	30	-5.4E-1 ± 2.5E+0 -5.1E+0 – 2.6E+0 0 / 12	-5.4E-1 ± 2.5E+0 -5.1E+0 – 2.6E+0 0 / 12	-1.6E+0 ± 2.9E+0 -7.2E+0 – 2.0E+0 0 / 12
Nb-95	24 0	15	-1.2E-1 ± 2.6E+0 -3.6E+0 – 4.1E+0 0 / 12	3.0E-1 ± 1.7E+0 -3.1E+0 – 1.9E+0 0 / 12	3.0E-1 ± 1.7E+0 -3.1E+0 – 1.9E+0 0 / 12
Cs-134	24 0	15	4.5E-1 ± 2.7E+0 -5.8E+0 – 4.5E+0 0 / 12	4.5E-1 ± 2.7E+0 -5.8E+0 – 4.5E+0 0 / 12	4.5E-2 ± 1.1E+0 -1.7E+0 – 2.2E+0 0 / 12
Cs-137	24 0	18	-2.8E-1 ± 1.9E+0 -4.4E+0 – 2.2E+0 0 / 12	-1.8E-1 ± 1.5E+0 -2.6E+0 – 2.2E+0 0 / 12	-1.8E-1 ± 1.5E+0 -2.6E+0 – 2.4E+0 0 / 12
Ba-140	24 0	60	-8.5E+0 ± 1.2E+1 -2.8E+1 - 3.3E+0 0 / 12	-1.1E+0 ± 1.4E+1 -3.6E+1 – 1.8E+1 0 / 12	-1.1E+0 ± 1.4E+1 -3.6E+1 – 1.8E+1 0 / 12
La-140	24 0	15	-6.7E-1 ± 6.1E+0 -1.3E+1 – 1.1E+1 0 / 12	-6.7-1 ± 6.1E+0 -1.3E+1 – 1.1E+1 0 / 12	-2.0E+0 ± 2.8E+0 -8.8E+0 – 7.8E-1 0 / 12

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

Table 2.9-1
Sediment Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2024)

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
K-40	12 0		1.1E+4 ± 2.4E+3 7.8E+3 - 1.4E+4 8 / 8	Dis:1.2E+4 ± 2.7E+3 1.1E+4 - 1.4E+4 2 / 2	1.0E+4 ± 1.3E+3 9.0E+3 - 1.2E+4 4/ 4
Cs-134	12 0	150	2.1E+1 ± 2.6E+1 -1.1E+0 – 5.1E+1 0/ 8	PlyHrb: 4.9E+1 ± 1.1E+1 4.7E+1 - 5.1E+1 0 / 2	1.6E+1 ± 6.6E+0 1.5E+1 – 1.8E+1 0 / 4
Cs-137	12 0	180	-4.9E+0 ± 1.4E+1 -1.9E+1 - 1.8E+1 0 / 8	GrnHrb: 4.7E+0 ± 2.2E+1 -1.4E+1 – 3.3E+1 0 / 2	4.7E+0 ± 2.2E+1 -1.4E+1 – 3.3E+1 0 / 4
AcTh-228	12 0		5.4E+2 ± 1.0E+2 5.4E+2 – 5.4E+2 0 / 8	PlyHrb: 5.4E+2 ± 1.0E+2 5.4E+2 – 5.4E+2 0/ 2	**0.0E+0 ± 0.0E+0 0.0E+0 – 0.0E+0 0/ 4

* Non-Routine refers to those radionuclides that exceeded the Reporting Levels in ODCM Table 3.5-4.
** None of the Control samples contained AcTh-228 results.

Table 2.10-1
Shellfish Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2024)

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
K-40	13 0		1.7E+3 ± 4.0E+2 1.3E+3 - 2.1E+3 7/ 7	Dis: 1.8E+3 ± 4.2E+3 1.4E+3 - 2.1E+3 3 / 3	1.5E+3 ± 5.8E+2 8.1E+2 - 2.3E+3 6 / 6
Mn-54	13 0	130	5.8E+0 ± 8.1E+0 -6.5E+0 - 1.2E+1 0 / 7	GrnHrb: -6.1E+0 ± 1.5E+1 -2.6E+1 – 8.1E+0 0 / 3	3.0E+0 ± 1.2E+1 -1.4E+1 – 1.6E+1 0 / 6
Fe-59	13 0	260	-2.8E+1 ± 2.8E+1 -6.0E+1 – 2.2E+1 0 / 7	GrnHrb: 2.2E+0 ± 4.0E+1 -2.2E+1 – 4.7E+1 0 / 3	-1.4E+1 ± 3.5E+1 -5.7E+1 – 4.7E+1 0 / 6
Co-58	13 0	130	-6.9E+0 ± 1.1E+1 -2.1E+1 – 1.2E+1 0 / 7	Dis: -4.8E-1 ± 1.3E+1 -1.0E+1 - 1.2E+1 0 / 3	-2.1E+0 ± 7.7E+0 -1.1E+1 – 6.6E+0 0 / 6
Co-60	13 0	130	2.1E+1 ± 1.1E+1 2.6E+0 – 4.6E+1 0 / 7	PlyHrb: 2.8E+1 ± 1.4E+1 2.0E+1 – 4.6E+1 0 / 4	1.6E+0 ± 1.6E+1 -2.5E+1 – 1.8E+1 0 / 6
Zn-65	13 0	260	-1.2E+1 ± 6.3E+1 -1.0E+2 – 7.1E+1 0 / 7	PlyHrb: 1.1E+1 ± 6.8E+1 -8.3E+1 – 7.1E+1 0 / 4	-4.6E+1 ± 2.7E+1 -7.3E+1 - -1.3E+1 0 / 6
Cs-134	13 0	130	-1.4E+1 ± 2.1E+1 -4.0E+1 – 2.1E+1 0 / 7	DuxBay:2.9E+0 ± 2.4E+1 -2.4E+1 - 1.7E+1 0 / 3	-2.1E+0 ± 1.7E+1 -2.4E+1 - 1.7E+1 0 / 6
Cs-137	13 0	150	2.8E+0 ± 1.8E+1 -1.9E+1 – 2.4E+1 0 / 7	Dis: 1.3E+1 ± 9.6E+0 4.9E+0 – 1.9E+1 0 / 3	-3.8E+0 ± 1.7E+1 -1.7E+1 – 2.4E+1 0 / 6

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

Table 2.11-1
Lobster Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2024)

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
K-40	5 0		2.7E+3 ± 4.6E+2 2.3E+3 – 3.1E+3 4 / 4	Dis: 2.7E+3 ± 4.6E+2 2.3E+3 – 3.1E+3 4 / 4	2.3E+3 ± 2.7E+2 2.3E+3 - 2.3E+3 1 / 1
Mn-54	5 0	130	-1.5E+1 ± 1.2E+1 -2.4E+1 - -5.7E-1 0 / 4	CcBay: 1.1E+1 ± 1.4E+1 1.1E+1 – 1.1E+1 0 / 1	1.1E+1 ± 1.4E+1 1.1E+1 – 1.1E+1 0 / 1
Fe-59	5 0	260	-3.4E+1 ± 5.3E+1 -1.0E+2 – 1.1E+1 0 / 4	CcBay: 4.5E-1 ± 3.2E+1 4.5E-1 - 4.5E-1 0 / 1	4.5E-1 ± 3.2E+1 4.5E-1 – 4.5E-1 0 / 1
Co-58	5 0	130	-7.5E+0 ± 1.2E+1 -1.4E+1 – 8.3E+0 0 / 4	Dis: -7.5E+0 ± 1.2E+1 -1.4E+1 – 8.3E+0 0 / 1	-1.2E+1 ± 1.5E+1 -1.2E+1 - -1.2E+1 0 / 1
Co-60	5 0	130	2.0E+0 ± 9.7E+0 -5.4E+0 – 1.3E+1 0 / 4	Dis: 2.0E+0 ± 9.7E+0 -5.4E+0 – 1.3E+1 0 / 4	-4.3E+0 ± 8.9E+0 -4.3E+0 - -4.3E+0 0 / 1
Zn-65	5 0	260	-5.0E+1 ± 4.0E+1 -8.3E+1 – 5.4E+0 0 / 4	Dis: -5.0E+1 ± 4.0E+1 -8.3E+1 – 5.4E+0 0 / 4	-4.6E+0 ± 1.7E+1 -4.6E+0 - -4.6E+0 0 / 1
Cs-134	5 0	130	1.9E+1 ± 2.8E+1 -1.1E+1 – 4.7E+1 0 / 4	Dis: 1.9E+1 ± 2.8E+1 -1.1E+1 – 4.7E+1 0 / 1	-2.6E+0 ± 1.7E+1 -2.6E+0 - -2.6E+0 0 / 1
Cs-137	5 0	150	9.8E+0 ± 1.2E+1 -3.6E+0 – 2.2E+1 0 / 4	CcBay: 1.1E+1 ± 1.2E+1 1.1E+1 - 1.1E+1 0 / 1	1.1E+1 ± 1.2E+1 1.1E+1 - 1.1E+1 0 / 1

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

Table 2.12-1
Fish Radioactivity Analyses

Radiological Environmental Program Summary
Pilgrim Nuclear Power Station, Plymouth, MA
(January - December 2024)

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
K-40	7 0		3.6E+3 ± 8.5E+2 2.7E+3 - 4.4E+3 3 / 3	CcBay: 4.2E+3 ± 4.3E+2 4.2E+3 - 4.2E+3 1 / 1	3.7E+3 ± 1.0E+3 2.6E+3 - 4.9E+3 4 / 4
Mn-54	7 0	130	2.8E+1 ± 1.7E+1 1.0E+1 – 4.0E+1 0 / 3	Dis: 2.8E+1 ± 1.7E+1 1.0E+1 – 4.0E+1 0 / 3	1.3E+0 ± 9.4E+0 -5.3E+0 – 7.9E+0 0 / 4
Fe-59	7 0	260	-9.8E-1 ± 3.6E+1 -2.4E+1 – 3.7E+1 0 / 3	Dis: -9.8E-1 ± 3.6E+1 -2.4E+1 – 3.7E+1 0 / 3	-4.8E+1 ± 3.2E+1 -8.0E+1 - -1.1E+1 0 / 4
Co-58	7 0	130	-8.6E+0 ± 1.0E+1 -1.9E+1 - -3.2E+0 0 / 3	Dis: 2.4E+0 ± 1.6E+1 -7.1E+0 - 1.2E+1 0 / 3	-1.4E+0 ± 1.6E+1 -2.0E+1 - 1.2E+1 0 / 4
Co-60	7 0	130	1.4E+1 ± 7.7E+0 8.9E+0 – 1.6E+1 0 / 3	Dis: 1.4E+0 ± 7.7E+0 8.9E+0 – 1.6E+1 0 / 3	-1.6E+0 ± 3.4E+1 -4.4E+1 – 3.6E+1 0 / 4
Zn-65	7 0	260	-1.7E+1 ± 3.4E+1 -5.1E+1 – 3.0E+0 0 / 3	BuzBay: -1.4E+0 ± 6.4E+1 -7.2E+1 – 4.1E+1 0 / 3	-4.6E+0 ± 5.3E+1 -7.2E+1 – 4.1E+1 0 / 4
Cs-134	7 0	130	-1.4E+0 ± 2.6E+1 -2.5E+1 – 2.5E+1 0 / 3	CcBay: 3.3E+1 ± 1.2E+1 3.3E+1 – 3.3E+1 0 / 1	1.0E+1 ± 2.8E+1 -2.7E+1 – 3.3E+1 0 / 4
Cs-137	7 0	150	1.3E+1 ± 1.8E+1 2.0E+0 – 3.2E+1 0 / 3	Dis: 1.3E+1 ± 1.8E+1 2.0E+0 – 3.2E+1 0 / 3	-4.1E+0 ± 8.9E+0 -1.2E+1 – 2.4E+0 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		
FENCE-EXEC.BUILDING	P17	107 m W
FENCE-TCF GATE	P11	183 m ESE
FENCE-TCF/BOAT RAMP	P27	185 m ESE
FENCE-TCF/INTAKE BAY	P10	223 m E

* 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
TLDs: 0-3 km					
BOAT LAUNCH WEST	BLW	0.11 km E	PEDESTRIAN BRIDGE	PB	0.21 km N
OVERLOOK AREA	OA	0.15 km W	EAST BREAKWATER	EB	0.44 km ESE
HEALTH CLUB	TC	0.15 km WSW	PROPERTY LINE	PL	0.54 km NNW
BOAT LAUNCH EAST	BLE	0.16 km ESE	E ROCKY HILL ROAD	ER	0.89 km SE
ISFSI DOSE #3	ISF-3	0.21 km W			
UPPER PARKING LOT #1	UP-1	0.22 km SW			
SHOREFRONT SECURITY	P01	0.22 km NNW			
UPPER PARKING LOT #2	UP-2	0.24 km WSW			
UPPER PARKING LOT #3	UP-3	0.25 km WSW			
ISFSI DOSE #2	ISF-2	0.29 km W			
ISFSI DOSE #1	ISF-1	0.35 km SW			
SHOREFRONT PARKING	PA	0.35 km NNW			
ISFSI DOSE #4	ISF-4	0.35 km WSW			
ISFSI DOSE #5	ISF-5	0.37 km WSW			
STATION A	A	0.37 km WSW			
ISFSI DOSE #6	ISF-6	0.41 km WSW			
STATION B	B	0.44 km S			
EAST BREAKWATER	EB	0.44 km ESE			
PNPS MET TOWER	PMT	0.44 km WNW			
ISFSI DOSE #7	ISF-7	0.45 km W			
STATION L	L	0.50 km ESE			
STATION G	G	0.53 km W			
PROPERTY LINE	PL	0.54 km NNW			
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

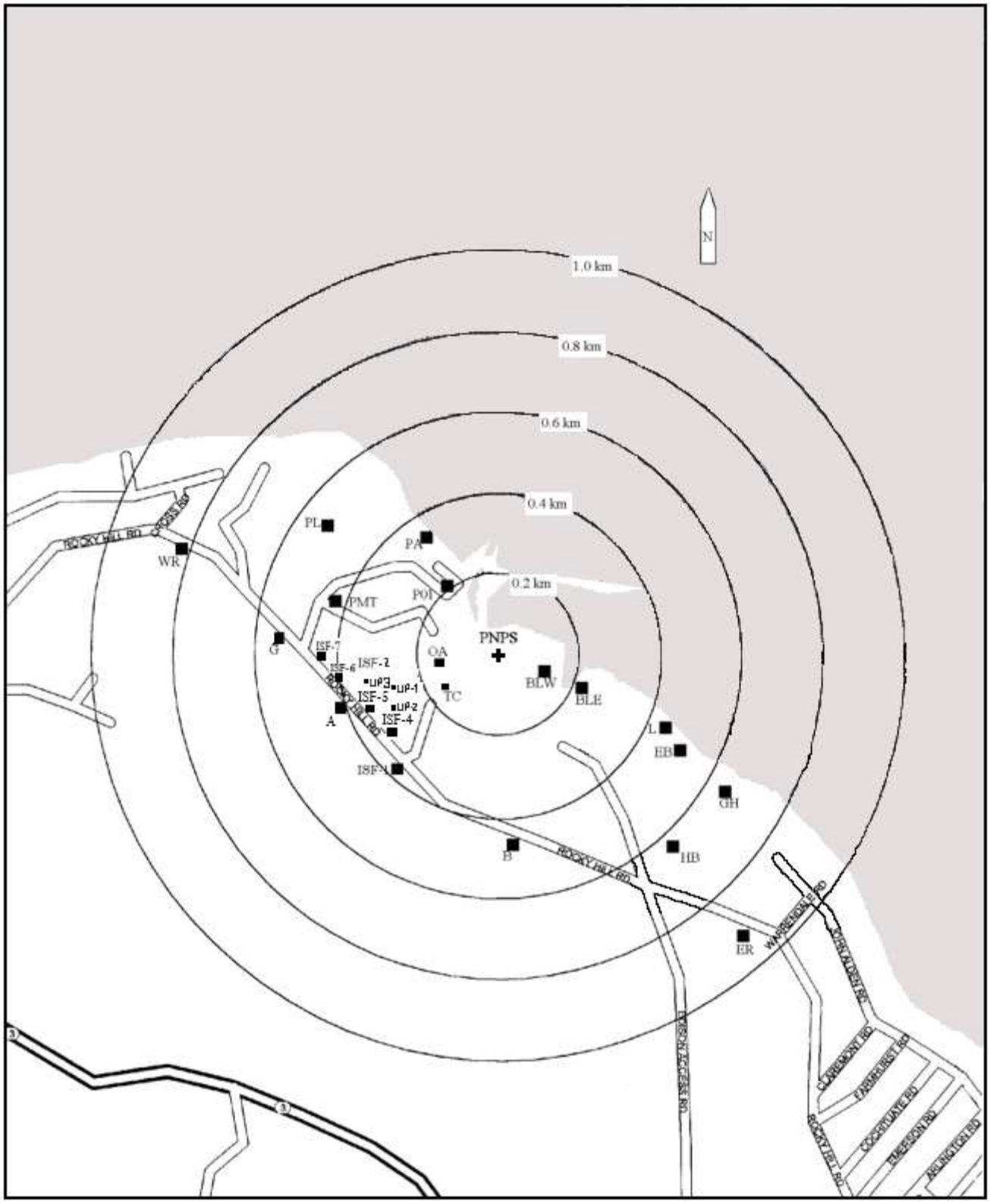


Figure 2.2-3

TLD and Air Sampling Locations: 1 to 5 Kilometers

TLD Station		Location*	Air Sampling Station		Location*
Description	Code	Distance/Direction	Description	Code	Distance/Direction
TLDs: 0-3 km			CLEFT ROCK	CR	1.27 km SSW
CLEFT ROCK	CR	1.27 km SSW			
BAYSHORE/GATE RD	BD	1.34 km WNW			
EMERSON ROAD	EM	1.53 km SSE			
EMERSON/PRISCILLA	EP	1.55 km SE			
BAYSHORE	BS	1.76 km W			
JOHN GAULEY	JG	1.99 km W			
STATION J	J	2.04 km SSE			
PLYMOUTH YMCA	RC	2.09 km WSW			
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			
TLDs: 3-8 km					
MANOMET ELEM	ME	3.29 km SE			

* 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

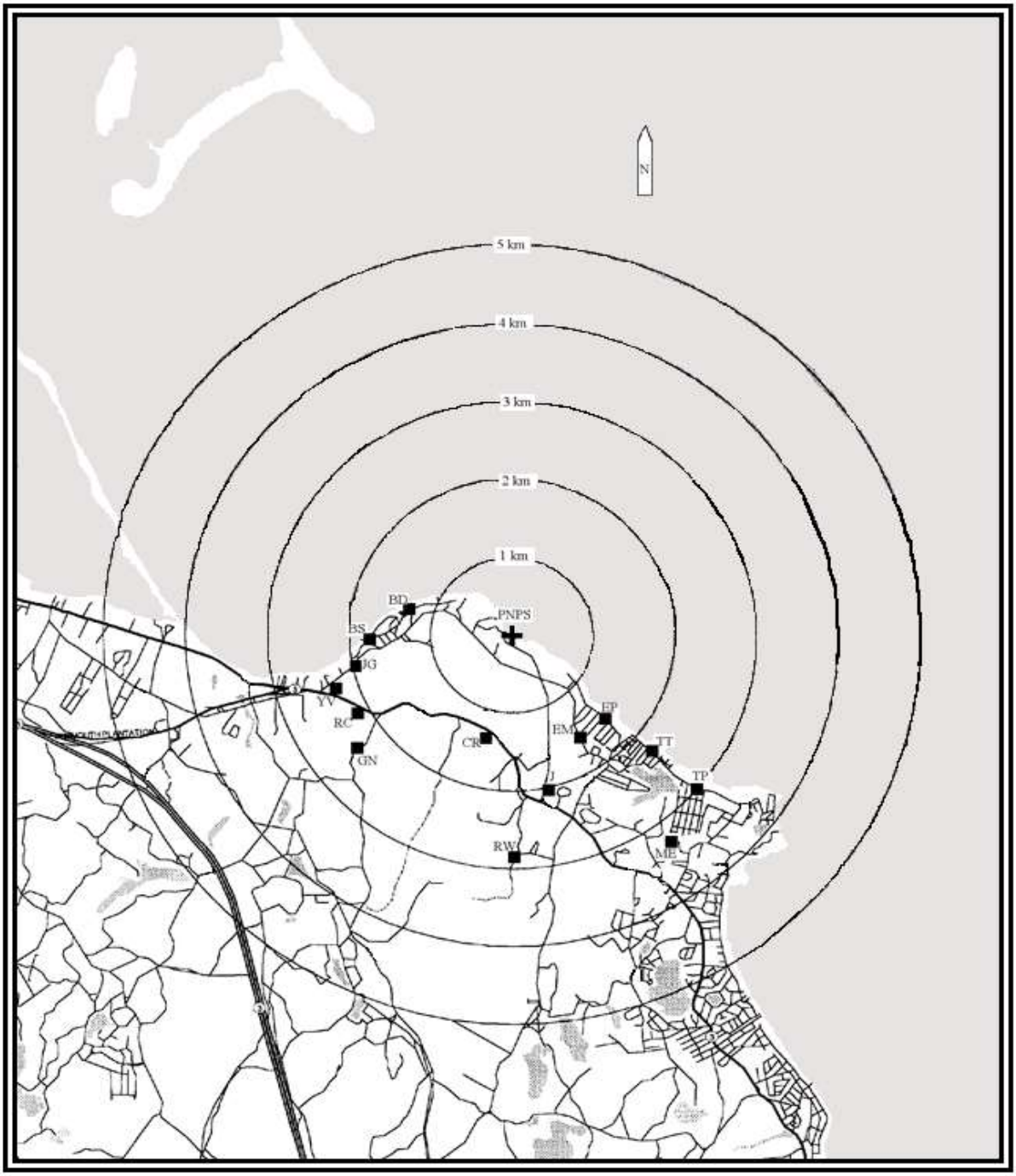


Figure 2.2-4

TLD and Air Sampling Locations: 5 to 25 Kilometers

TLD Station		Location*	Air Sampling Station		Location*
Description	Code	Distance/Direction	Description	Code	Distance/Direction
TLDs: >15 km			EAST WEYMOUTH SUBST	EW	39.69 km NW
DIV MARINE FISH	DMF	20.97 km SSE			
EAST WEYMOUTH SUBST	EW	39.69 km NW			

* 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

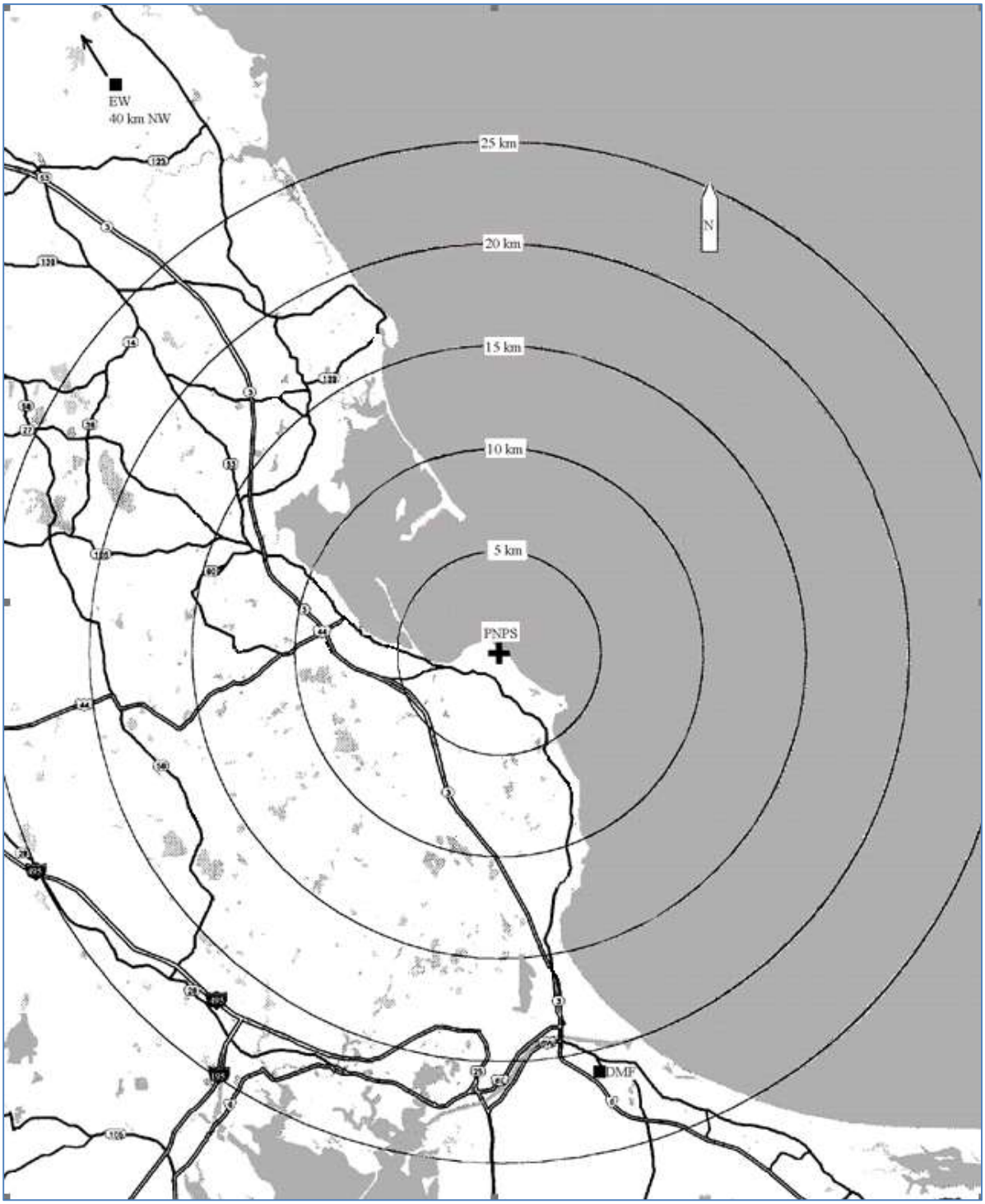


Figure 2.2-5

Marine/ Aquatic Sampling Locations

Description	Code	Distance/Direction*
SURFACE WATER		
Discharge Canal	DIS	0.2 km N
Powder Point Control	PP	13 km NNW
SEDIMENT		
Discharge Canal Outfall	DIS	0.8 km NE
Manomet Point	MP	3.3 km ESE
Plymouth Beach	PLB	4.0 km WNW
Plymouth Harbor	PLY-H	4.1 km W
Green Harbor Control	GH	16 km NNW
MUSSELS		
Discharge Canal Outfall	DIS	0.7 km NNE
Plymouth Harbor	PLY-H	4.1 km W
Green Harbor Control	GH	16 km NNW
SOFT-SHELLED CLAMS		
Plymouth Harbor	PLY-H	4.1 km W
Duxbury Bay Control	DUX-BAY	13 km NNW
LOBSTER		
Discharge Canal Outfall	DIS	0.5 km N
Duxbury Bay Control	DUX-BAY	11 km NNW
FISHES		
Discharge Canal Outfall	DIS	0.5 km N
Cape Cod Bay Control	CC-BAY	24 km ESE
Buzzards Bay Control	BB	40 km SSW
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)

Marine/Aquatic Sampling Locations

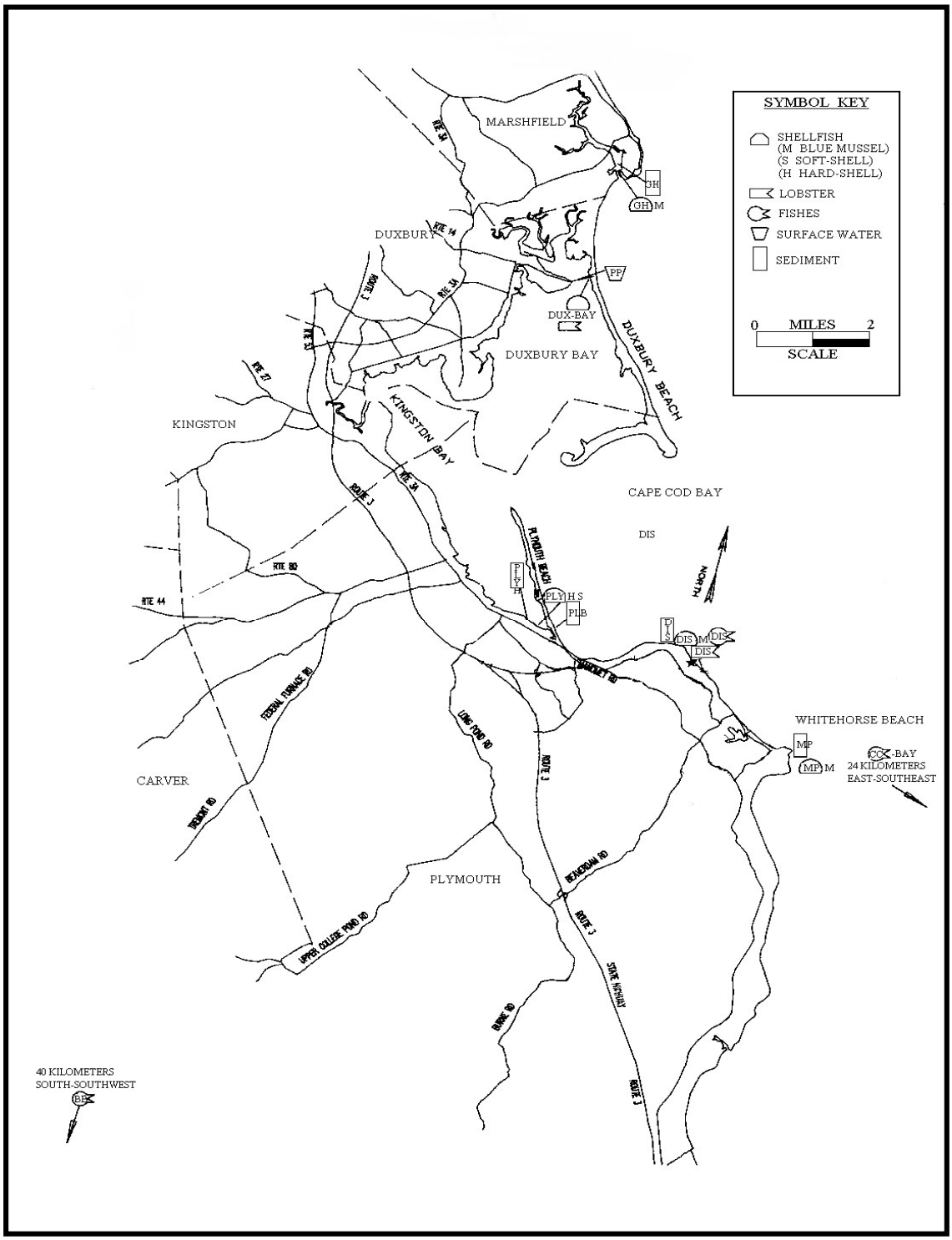


Figure 2.2-6

Environmental Sampling And Measurement Control Locations

Description	Code	Distance/Direction*
TLD (Controls)		
Div. Marine Fisheries	DMF	21 km SSE
East Weymouth Substation	EW	40 km NW
AIR SAMPLING (Control)		
East Weymouth Substation	EW	40 km NW

Description	Code	Distance/Direction*
SURFACE WATER		
Powder Point Control	PP	13 km NNW
SEDIMENT		
Green Harbor Control	GH	16 km NNW
MUSSELS		
Green Harbor Control	GH	16 km NNW
SOFT-SHELLED CLAMS		
Duxbury Bay Control	DUX-BAY	13 km NNW
LOBSTER		
Duxbury Bay Control	DUX-BAY	11 km NNW
FISHES		
Cape Cod Bay Control	CC-BAY	24 km ESE
Buzzards Bay Control	BB	40 km SSW
Vineyard Sound Control	MV	64 km SSW

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

Figure 2.2-6 (continued)

Environmental Sampling And Measurement Control Locations

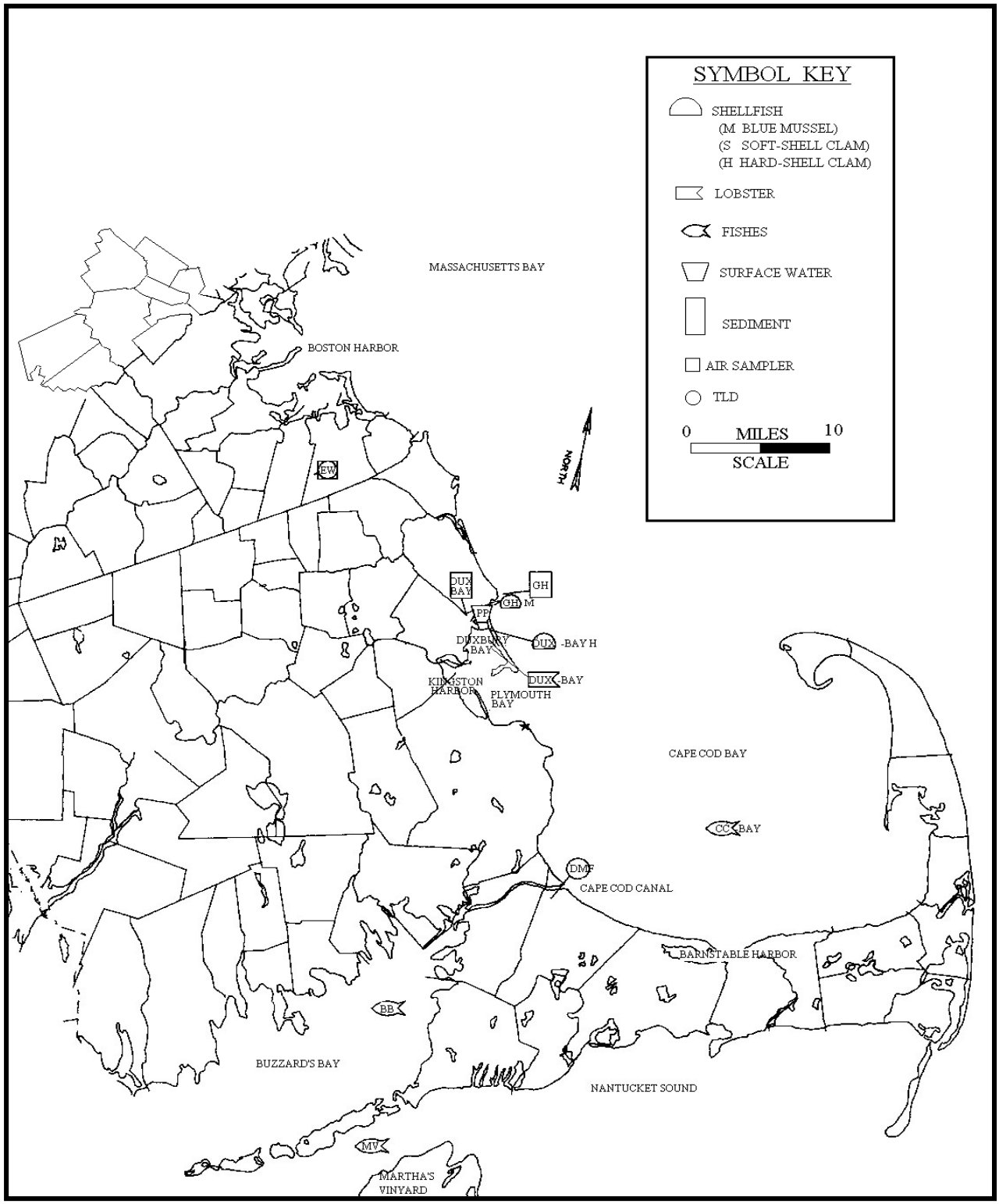


Figure 2.5-1
Airborne Gross-Beta Radioactivity Levels: Near Station Monitors

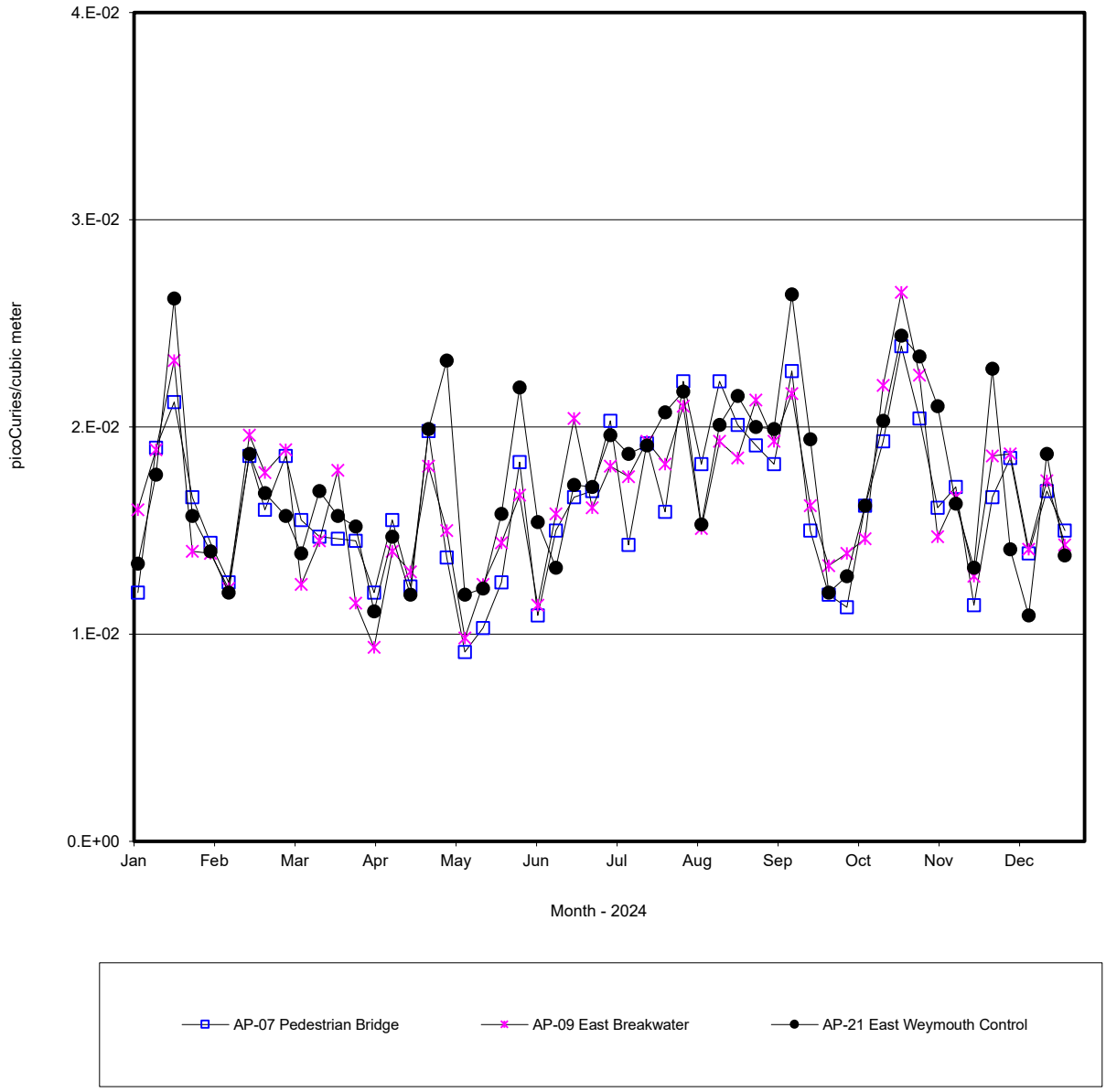


Figure 2.5-2
Airborne Gross-Beta Radioactivity Levels: Property Line Monitors

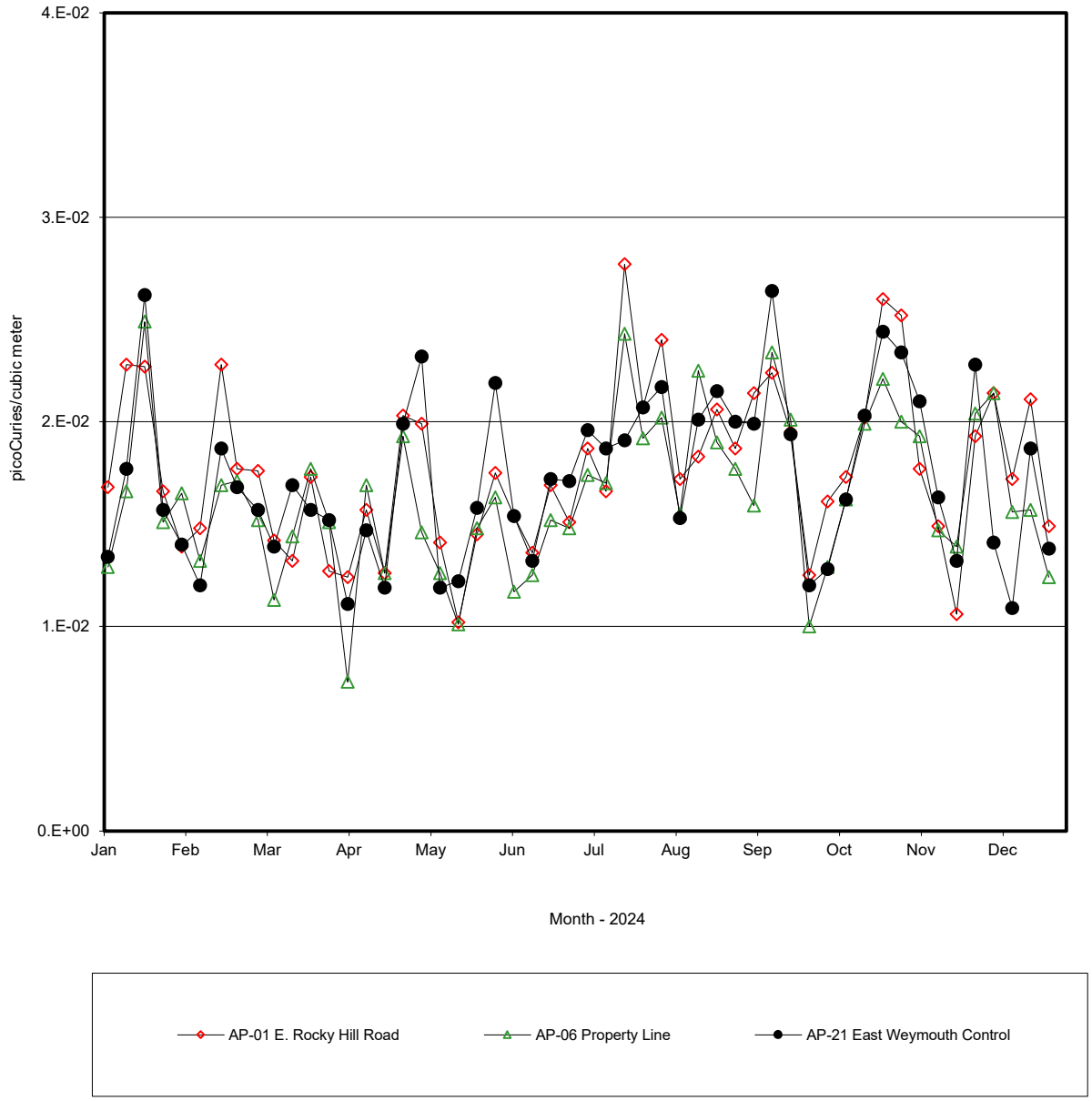
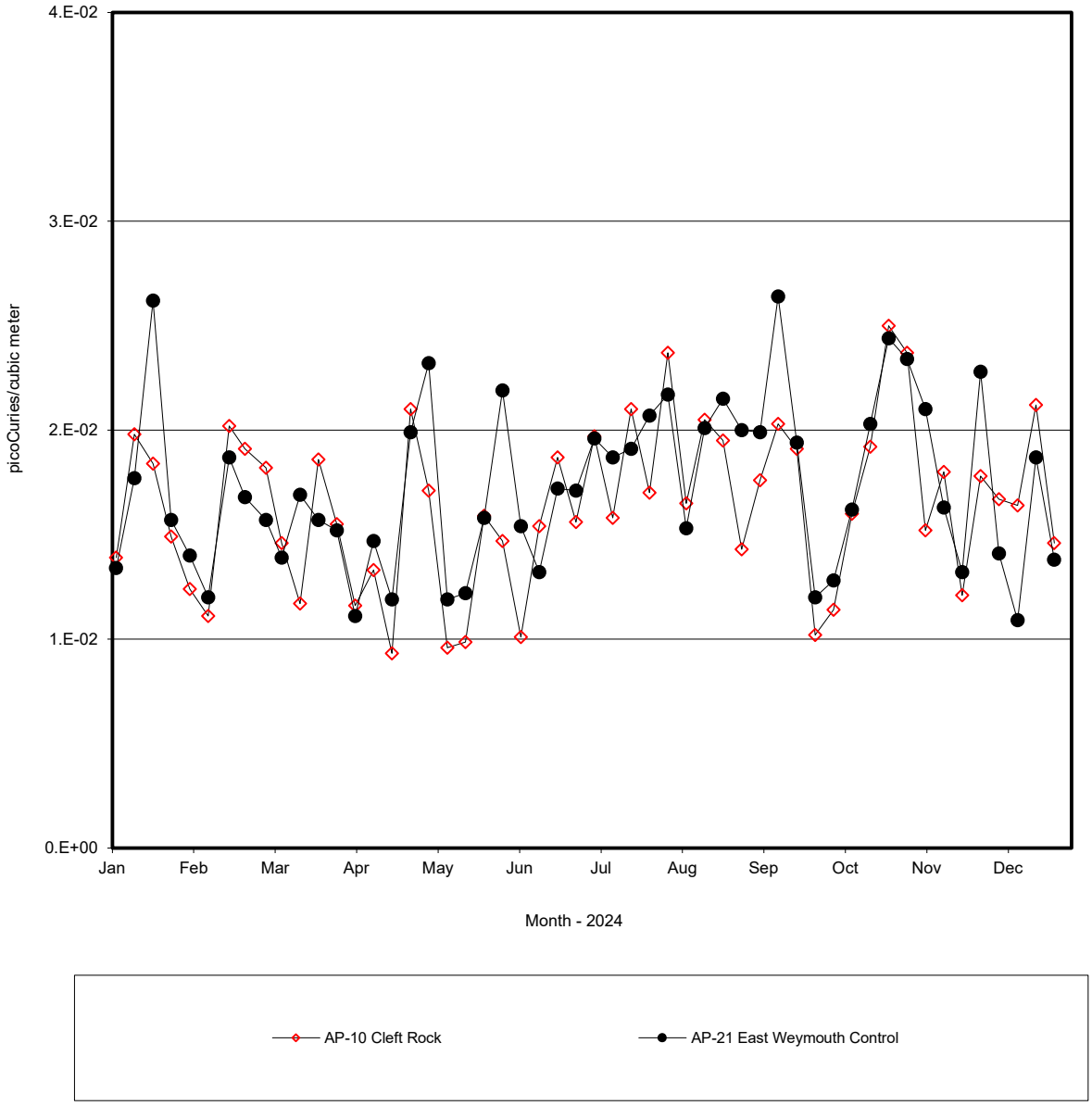


Figure 2.5-3
Airborne Gross-Beta Radioactivity Levels: Offsite Monitors



* Manomet substation collection was discontinued after the ODCM revision 15 collapsed the outer sampling ring to 3km.

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 2024 were reported to the Nuclear Regulatory Commission within the station's Annual Radiological Effluent Release Report (ARERR). The measured levels of radioactivity in the special studies environmental samples that required dose calculations are listed in Appendix A.

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

- shoreline external radiation during fishing and recreation at the Pilgrim Station Shorefront; Note: there is no actual access to the shorefront allowed to a MEMBER of the PUBLIC. Recreational areas were closed to unauthorized personnel after 9/11.
- 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. Note: There are no milk/ meat animals in the vicinity Pilgrim Station

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, 2024 (Reference 17).

Table 3.0-1

Radiation Doses from 2024 Pilgrim Station Operations

Receptor	Maximum Individual Dose From Exposure Pathway - mrem/yr			
	Gaseous Effluents*	Liquid Effluents	Ambient Radiation**	Total
Total Body	0.00019	N/A	0.62	0.62
Max. Organ	0.00047	N/A	0.62	0.62

* Gaseous effluent exposure pathway includes combined dose from particulates and tritium, calculated at the nearest residence or receptor location yielding the highest projected dose from all exposure pathways.

** Ambient radiation dose for the hypothetical maximum-exposed individual at a location (ISF-1) beyond the PNPS “business-only” area or “exclusion zone” yielding a typical ambient radiation exposure value to a MEMBER OF THE PUBLIC 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 approximately 620 mrem/yr from such sources.

As can be seen from the doses resulting from Pilgrim Station decommissioning operations during 2024, 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 decommissioning 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 17, December 2023.

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 2024.

APPENDIX A

SPECIAL STUDIES

There were no environmental samples collected during 2024 that contained plant-related radioactivity. Therefore, no special studies were required to estimate dose from plant-related radioactivity.

APPENDIX B

LAND USE CENSUS RESULTS

The annual land use census requirement for gardens and milk and meat animals, as well as the broadleaf vegetation collection in the vicinity of Pilgrim Station was discontinued in 2021 with Revision 15 of the ODCM. As stated earlier in this report the broadleaf vegetation collection was in lieu of milk sampling as a type of cattle feed to account for iodine deposition. At the plant is permanently in a shutdown and decommissioned status no new iodine is produced and that which was produced has decayed away.

No new milk or meat animals were identified during the last 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 C

ENVIRONMENTAL MONITORING PROGRAM DISCREPANCIES

In any given year there were a number of instances in which inadvertent issues can be encountered in the collection of environmental samples. All of these issues are usually minor in nature and do not have an adverse effect on the results or integrity of the monitoring program. The PNPS TLD placement still exceeds that prescribed by NUREG-1302. Details of these various problems are given below.

Within the air sampling program, there were no instances in which continuous sampling was interrupted at airborne sampling locations during 2024. Lower limits of detection (LLDs) were met for airborne particulates on 312 filters collected. In the fourth quarter of 2019, following the permanent shutdown of the station, the analysis of charcoal cartridges from air sample locations was discontinued as iodine had decayed away.

In accordance with ODCM Table 3.5-1, offsite REMP air particulate filters are to be collected at a weekly interval. Weekly is defined as once every seven days with a one-day grace period before and after the scheduled date. occasionally samples are collected with a longer than seven day interval due to access (especially in the winter) or some other issue. It must be emphasized that the stations continue to sample during the duration and monitoring time was not lost for any sample location in 2024.

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. In 2021 the air sample station at the Pedestrian Bridge was modified to increase the capabilities of collecting a representative sample after observations during an NRC inspection of the REMP program. The following table contains a listing the discrepancies encountered with air sampling stations during 2024.

Location	Sampling Period	Sampling Hours Lost	Problem Description/Resolution

Group III fishes, consisting of alewife, smelt, or striped bass are normally collected once each year in the summer from the vicinity of the Discharge Canal Outfall. Since the shut down of Pilgrim station the warm water plume of the discharge, which drew in fish species like the Striped Bass, has dissipated and is no longer present. Fish species once in such abundance to bring in harbor seals and sharks behind them are no longer found in the plant area. Repeated and concerted efforts were made to collect these species, but failed to produce all required samples. Group III (annual) and Group IV (annual) fish could not be collected.

In summary, the various problems encountered in collecting and analyzing environmental samples during 2024 were relatively minor when viewed in the context of the entire monitoring program. These discrepancies were promptly corrected when issue was identified, where possible. None of the discrepancies resulted in an adverse impact on the overall monitoring program.

APPENDIX D

Environmental Dosimetry Company
Annual 2024 Quality Assurance Status Report

ENVIRONMENTAL DOSIMETRY COMPANY

ANNUAL QUALITY ASSURANCE STATUS REPORT

January - December 2024

Prepared By: James R DiaMo Date: 2/27/25

Approved By: [signature] Date: 2/27/25

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 period100% (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% 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 2024.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

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:

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

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

3. 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 unless if the QC results prompting the investigation have a mean bias from the known of greater than ±20%, then 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 ±15%.

III. DATA SUMMARY FOR ISSUANCE PERIOD JANUARY-DECEMBER 2024

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 period100% (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 and 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 Figure 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

1. Internal

EDC Internal Quality Assurance Assessment was conducted during the fourth quarter 2024. There were no findings identified.

2. External

None.

VI. PROCEDURES AND MANUALS REVISED DURING JANUARY - DECEMBER 2024

No procedures or manuals were revised in 2024.

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, 2024.

2. EDC Manual 1, Quality System Manual, Rev. 4, September 28, 2020.

TABLE 1

PERCENTAGE OF INDIVIDUAL DOSIMETERS THAT PASSED EDC INTERNAL CRITERIA JANUARY – DECEMBER 2024[(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 2024[(1), (2)]

Process Date	Exposure Level	Mean Bias %	Standard Deviation %	Tolerance Limit +/-15%
5/05/2024	37	-0.3	2.2	Pass
5/08/2024	51	2.2	1.5	Pass
5/15/2024	83	2.5	2.2	Pass
7/30/2024	27	1.1	1.8	Pass
8/06/2024	63	6.6	1.2	Pass
9/25/2024	95	-3.1	1.8	Pass
10/24/2024	42	4.9	2.6	Pass
10/30/2024	73	6.8	1.6	Pass
11/27/2024	107	-6.7	1.6	Pass
01/20/2025	32	1.9	1.0	Pass
01/26/2025	47	2.8	1.5	Pass
01/29/2025	117	2.6	2.1	Pass

[(1)]This table summarizes results of tests conducted by EDC for TLDs issued in 2024.
[(2)]Environmental dosimeter results are free in air.

TABLE 3
SUMMARY OF INDEPENDENT DOSIMETER TESTING JANUARY – DECEMBER 2024[(1), (2)]

Issuance Period	Client	Mean Bias %	Standard Deviation %	Pass / Fail
1st Qtr. 2024	Millstone	-.1	0.2	Pass
2nd Qtr.2024	Seabrook	1.7	2.8	Pass
2nd Qtr. 2024	Millstone	-4.3	0.9	Pass
3rd Qtr. 2024	SONGS	-9.7	1.4	Pass
3rd Qtr. 2024	Millstone	-1.4	2.5	Pass
4th Qtr.2024	Millstone	1.5	1.4	Pass
4th Qtr.2024	Seabrook	3.8	1.5	Pass

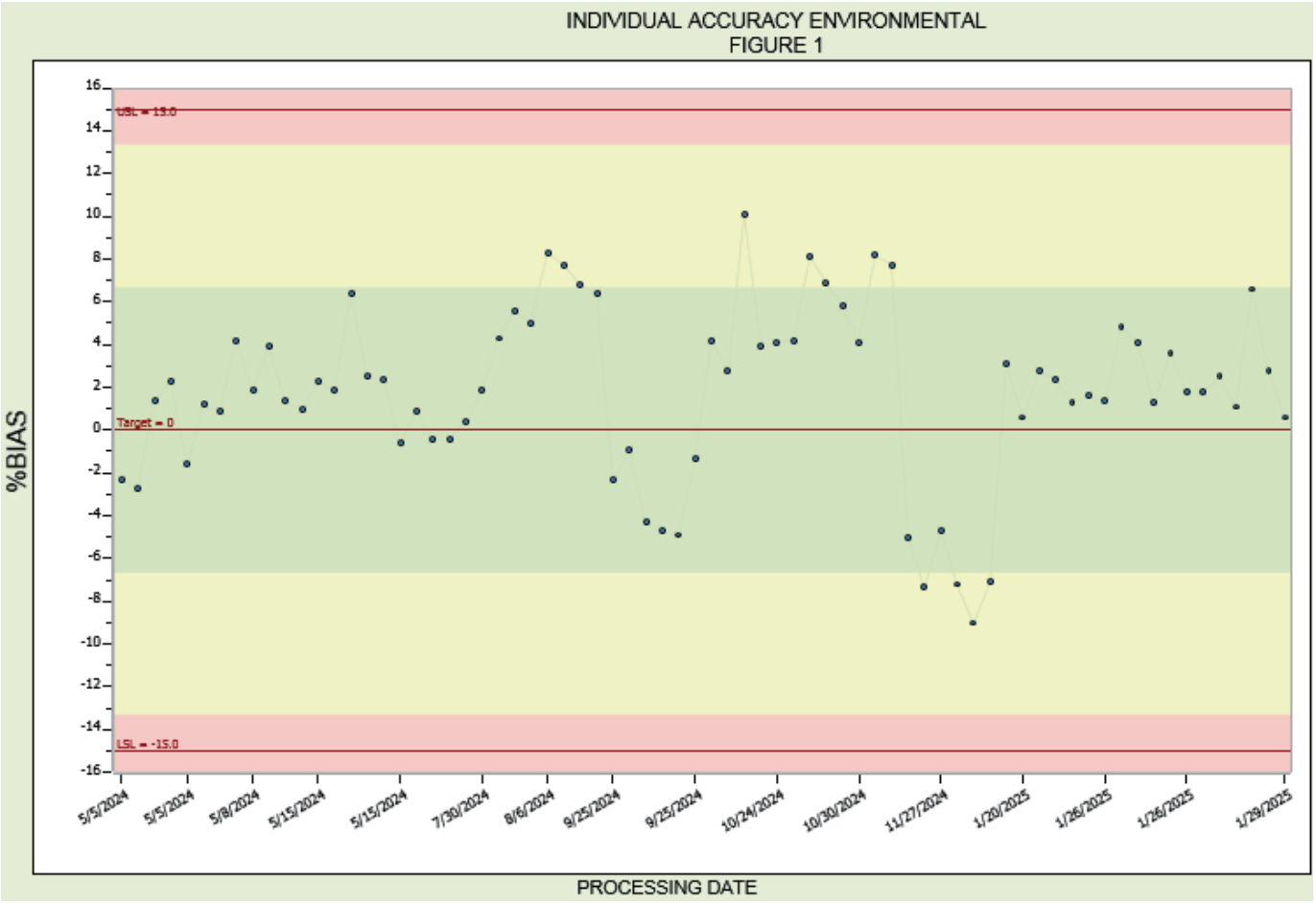
[(1)]Performance criteria are +/- 15%.
[(2)]Blind spike irradiations using Cs-137

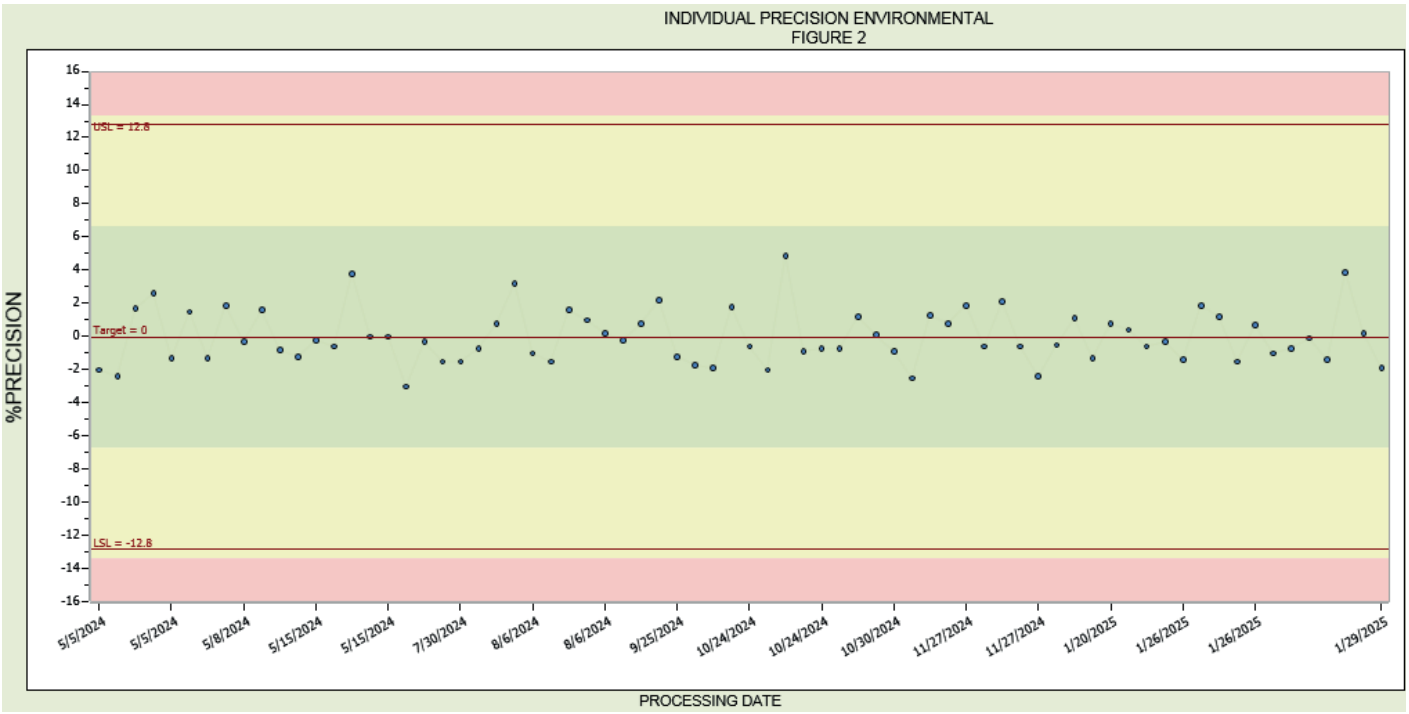
APPENDIX A

DOSIMETRY QUALITY CONTROL TRENDING GRAPHS

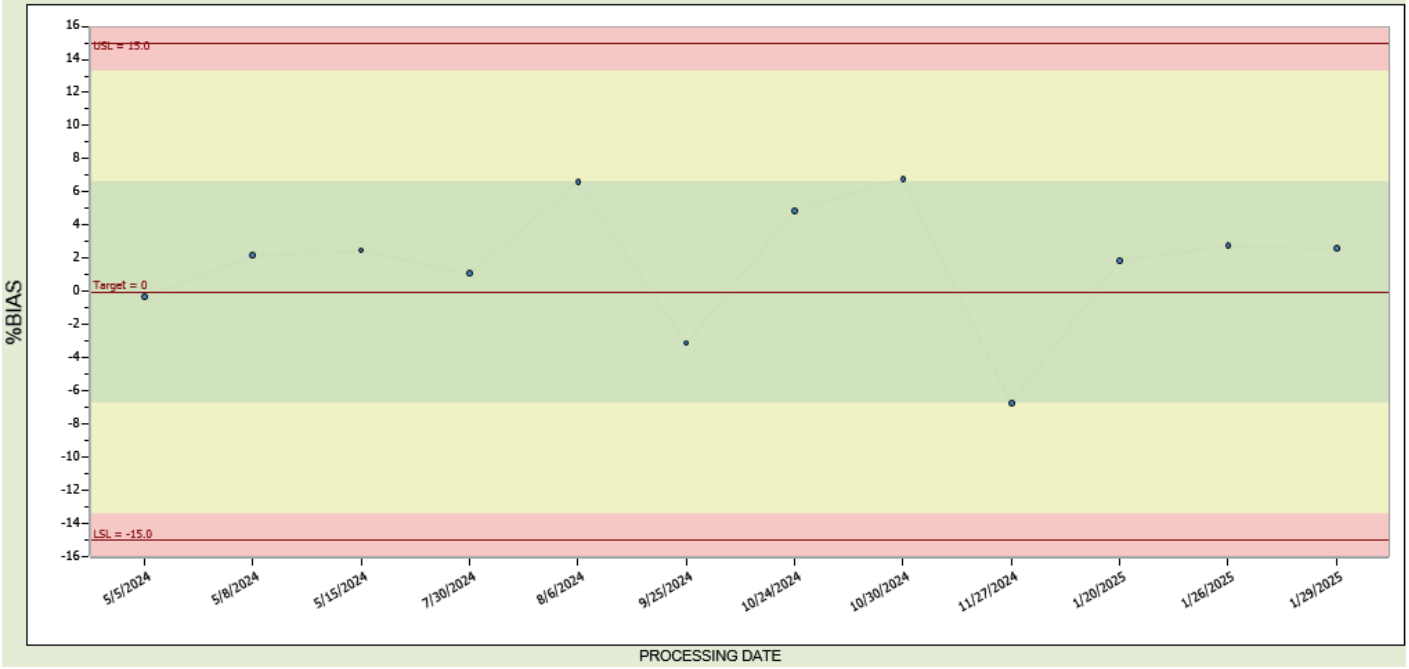
ISSUE PERIOD JANUARY - DECEMBER 2024

INDIVIDUAL ACCURACY ENVIRONMENTAL
FIGURE 1

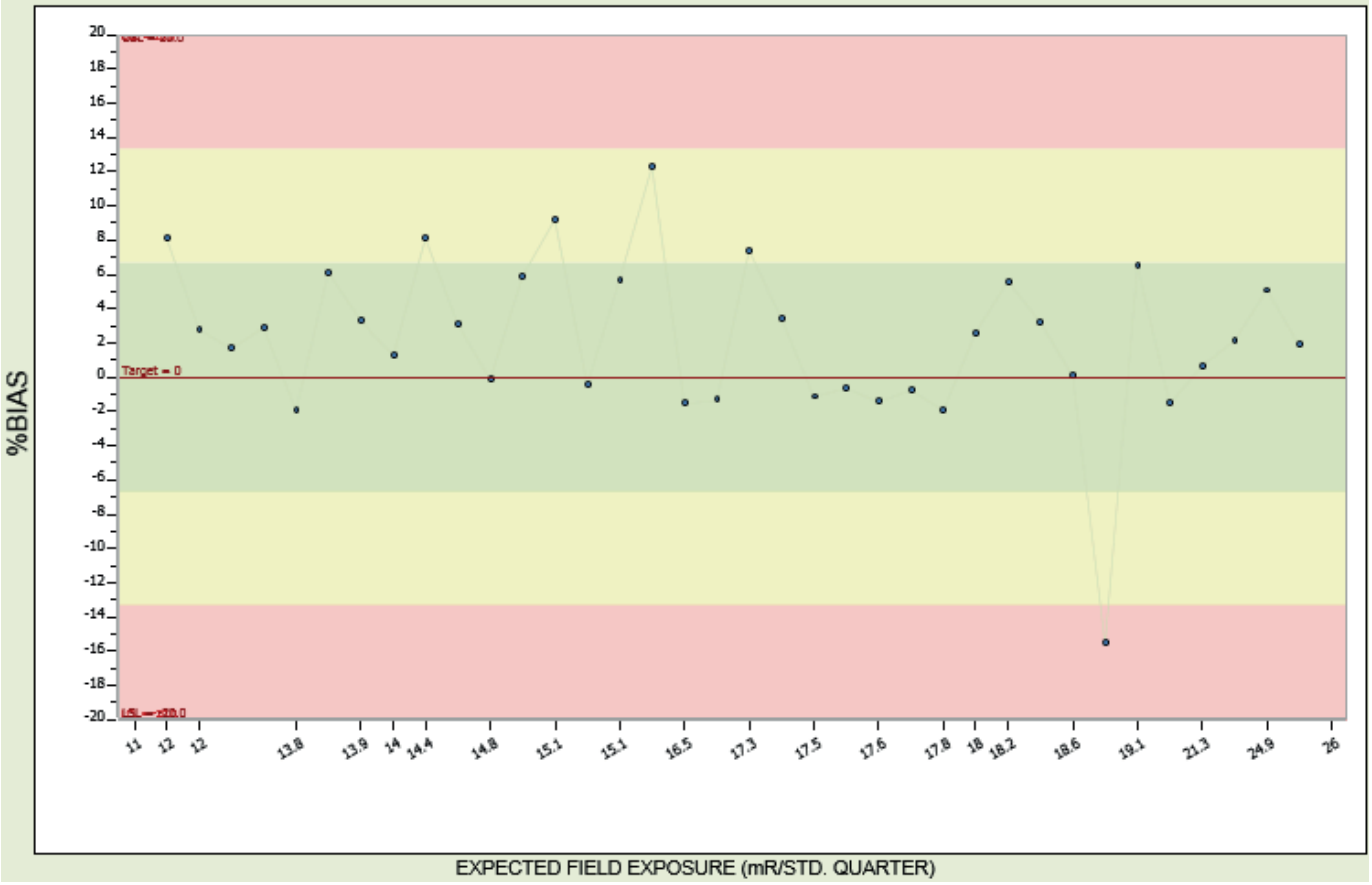



INDIVIDUAL PRECISION ENVIRONMENTAL
FIGURE 2
%PRECISION
USL = 12.8
Target = 0
LSL = -12.8
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
5/5/2024
5/5/2024
5/8/2024
5/15/2024
5/15/2024
7/30/2024
8/6/2024
8/6/2024
9/25/2024
10/24/2024
10/24/2024
10/30/2024
11/27/2024
11/27/2024
1/20/2025
1/26/2025
1/26/2025
1/29/2025
PROCESSING DATE

MEAN ACCURACY ENVIRONMENTAL
FIGURE 3



SEABROOK CO-LOCATE ACCURACY
FIGURE 4



EXPECTED FIELD EXPOSURE (mR/STD. QUARTER)

APPENDIX E

Teledyne Brown Engineering Environmental Services
Annual 2024 Quality Assurance Report

TELEDYNE
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TELEDYNE BROWN ENGINEERING
ENVIRONMENTAL SERVICES

Knoxville Laboratory

4th Quarter 2024
QUALITY ASSURANCE REPORT

January – December 2024

Teledyne Brown Engineering
2508 Quality Lane
Knoxville, TN 37931-3133

Contractual Review: Kristin Peacock; Kristin Peacock Date: 01/10/25
Quality Assurance Manager

Technical Review: Karli Arterburn; Karli Arterburn Date: 1/10/25
Laboratory Operations Manager

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TABLE OF CONTENTS

I. INTRODUCTION

This report covers the Quality Assurance (QA) Program for the Analytical Services function of the Teledyne Brown Engineering Environmental Services (TBE-ES) laboratory for January through December 2024.

A. Operational Quality Control Scope

The TBE-ES Laboratory Quality Control (QC) Program is designed to monitor the quality of analytical processing associated with environmental, effluent (USNRC Regulatory Guide 4.15), bioassay, industrial process, and waste characterization (10CFR Part 61) samples.

Quality Control of radioanalyses involves an internal process control program and participation in external independent third-party programs administered by Eckert & Ziegler Analytics (Analytics), Environmental Resource Associates (ERA) and the Department of Energy (DOE) Mixed Analyte Performance Evaluation Program (MAPEP).

NOTE: MAPEP is designed to evaluate specific analytical capabilities that are of importance for DOE analytical services. These types of performance evaluation samples may contain both radiological and non-radiological "mixed" analytes and are reflective of real-world samples seen from DOE monitoring sites. Although TBE-ES is not currently under contract to analyze samples for DOE sites, the laboratory chooses to participate in its Performance Evaluation Program as it offers a variety of matrices and nuclides that are analyzed by our facility on a routine basis (water, soil, air filters, etc.).

1. Interlaboratory

Results for third-party process checks prepared by Analytics, ERA, and MAPEP are not reported during the first quarter of the year.

Inter-laboratory cross-check samples are received and reported as follows:

- Analytics cross-check samples are analyzed by TBE two times per year, typically in April and September.
- MAPEP provides samples semi-annually in March and September with required reporting dates in May and November, respectively, following sample receipt.
- ERA cross-check samples are analyzed by TBE semi-annually in April and October with required reporting dates in May and November, respectively, following sample receipt.

2. Intralaboratory

The internal QC program is designed to include QC functions such as instrumentation checks (to ensure proper instrument response), use of blank samples (to which no analyte radioactivity has been added), contamination checks, and instrumentation backgrounds. Process controls (or process checks) are actual samples analyzed in duplicate (duplicates) to evaluate the precision of laboratory measurements. Accuracy of analyses is measured by analyzing blank samples which have been spiked with a known quantity of a radioisotope (spikes) that are of interest to laboratory clients. Some client samples are also spiked with a

known activity of target analyte (matrix spikes) and aid in evaluating analytical method performance.

QC samples are intended to evaluate the entire radiochemical and radiometric process. Process control and qualification analyses samples seek to mimic the media type of those samples submitted for analysis by laboratory clients. The magnitude of the process control program combines both internal and external sources targeted at 10% of the routine sample analysis load. A summary of blanks, spikes, and duplicates can be found in Attachments B.1 and B.2.

3. Quality Assurance Program

To provide direction and consistency in administering the quality assurance program, TBE-ES has developed and follows a Quality Manual and a set of Standard Operating Procedures (SOP). The plan describes the scheduled frequency and scope of Quality Assurance and Quality Control (QA/QC) considered necessary for an adequate QA/QC program conducted throughout the year.

Internal audits are performed on an annual schedule, usually during the 4th quarter. External audits are performed by prospective and/or existing clients in accordance with contractual specifications. State audits are conducted to maintain client-specific certification requirements and for accreditation by the National Environmental Laboratory Accreditation Program (NELAP). The Nuclear Procurement Issues Corporation (NUPIC) evaluates suppliers of laboratory services to nuclear utilities. TBE-ES is audited every 33-36 months by NUPIC as a function of the utilities' Radiological Environmental Monitoring Program (REMP).

The following external audits have been performed as of fourth quarter 2024:

- Annual Internal QA Audit performed by TBE Huntsville in August with zero reported findings.
- Perry Johnson Laboratory September Reassessment Audit with zero reported findings.
- NUPIC evaluation in November with zero reported findings.

B. Performance Characteristics

1. Interlaboratory Accuracy

TBE-ES has adopted a QC acceptance protocol based upon two external performance models. For the interlaboratory programs that have established performance criteria (e.g., established warning and failure limits), the laboratory uses those established criteria to evaluate QC sample results. For interlaboratory QC programs which report no pre-set acceptance (pass/fail) criteria (e.g. Analytics Cross Check Program), results are evaluated in accordance with TBE-ES internal acceptance criteria.

a) Analytics' Evaluation Criteria

Analytics' evaluation report provides a ratio of TBE's result and the Analytics known value. Since flag values are not assigned, TBE-ES evaluates the reported ratios based on internal QC requirements, which are based on the DOE MAPEP criteria.

b) MAPEP Evaluation Criteria

MAPEP evaluation criteria found in the *Handbook for the Department of Energy's Mixed Analyte Performance Evaluation Program (MAPEP)*, MAPEP-HB-1 Rev. 5 (August 07, 2024), pp. 9-11 & 30-32 and online at https://resl.id.energy.gov/MAPEP/MAPEP%20Handbook.pdf and contains the following information:

MAPEP's evaluation report provides a calculated relative bias for the lab's reported results, the acceptance range, and associated flag values. The relative bias places the laboratory result in one of three categories:

- *Acceptable (flag = A)* $|BIAS| \leq 20\%$
- *Acceptable with Warning (flag = W)* $20\% < |BIAS| \leq 30\%$
- *Not Acceptable (flag = N)* $|BIAS| > 30\%$

Radiological results must be reported with an associated uncertainty at one standard deviation. The uncertainty associated with a result is not currently used as part of the acceptance criteria, but an uncertainty evaluation is used to flag potential areas of concern. MAPEP assigns A (Acceptable), W (Acceptable with Warning) and N (Not Acceptable) uncertainty flags based upon the relative precision (RP) ratio:

RP = (Reported Uncertainty / Reported Result) x 100

Uncertainty flags are currently for information only, but reported total uncertainties are used to evaluate performance in false positive/ negative tests and sensitivity evaluations.

The MAPEP program uses false-positive testing in each session to identify laboratory results that indicate the presence of a particular radionuclide when, in fact, the actual activity of the radionuclide is far below the detection limit of the measurement. Not Acceptable (N) performance, and hence a false positive result, is indicated when the range encompassing the result, plus or minus the total uncertainty at three standard deviations, does not include zero (i.e. 2.5 ± 0.2; range of 1.9 –3.1). Statistically, the probability that a result can exceed the absolute value of its total uncertainty at three standard deviations by chance alone is less than 1%. MAPEP uses a three standard deviation criterion for the false positive test to ensure confidence about issuing a false-positive performance evaluation. A result that is greater than three times the total uncertainty of the measurement represents a statistically- positive detection with over 99% confidence.

Sensitivity evaluations are routinely performed to complement the false-positive tests. In a sensitivity evaluation, the radionuclide is present at or near the detection limit, and the difference between the reported result and the MAPEP reference value is compared to the propagated combined total uncertainties. The results are evaluated at three standard deviations. If the observed difference is greater than three times the combined total uncertainty, the sensitivity evaluation in "Not Acceptable". The probability that such a

difference can occur by chance alone is less than 1%. If the participant did not report a statistically-positive result, a "Not Detected" is noted in the text field of the MAPEP performance report. A non-detect is potentially a false-negative result, dependent upon the laboratory's detection limit for the radionuclide.

False-negative tests are also performed in combination with the sensitivity evaluations. In this scenario, the sensitivity of the reported measurement indicates that the known specific activity of the targeted radionuclide in the performance evaluation sample should have been detected, but was not, and a "Not Acceptable" performance evaluation is issued. The uncertainty of the MAPEP reference value and of the reported result at three standard deviations is used for the false-negative test.

The false-positive/negative and sensitivity evaluation tests are conducted in a manner that assists the participants with their measurement uncertainty estimates and helps ensure they are not underestimating or over inflating their total uncertainties. If the total uncertainty is over-inflated in order to pass a false-positive test, it will result in a "Not Detected" if the test is actually a sensitivity evaluation. The opposite is true for a false-positive test. False-negatives and failed sensitivity evaluations can also result from under-estimating the total uncertainty. An accurate estimate of measurement uncertainty is required for consistent performance at the acceptable level.

c) ERA Evaluation Criteria

The ERA evaluation report provides an acceptance range for control and warning limits with associated flag values. Acceptance limits for drinking/potable water are established per The NELAC Institute's (TNI) guidance. The TNI Standard uses Fields of Proficiency Testing (FoPT) Tables to calculate upper and lower acceptance limits set at the Mean ± 2 standard deviations (SD). ERA's acceptance limits for other matrices differ based on historical data from past studies.

d) NRC Verification Test Comparison Criteria

Some laboratory clients submit double-blind 10 CFR Part 50 performance evaluation samples. The lab processes these samples as routine client samples and sends the reports to the client, who then reports the result(s) to the sample's originator. This may be via an outside vendor (i.e. Analytics) or prepared by the client. After the results are received by the client, NRC Resolution Criteria is used to determine acceptance of results using a calculated resolution number (known value / 1-sigma uncertainty) and a calculated ratio (lab result of unknown/known value). Clients may or may not share the result with the laboratory and are therefore usually not included with this report.

2. Intralaboratory Accuracy Acceptance Criteria

a) Process Controls

The measure of accuracy for a group of test measurements to a given spike level is found by calculating the recovery of the spike activity found versus the added (known) spike activity. The percent recovery is calculated as follows:

% Recovery = (A_m / A_s) 100

Where: A_m = found spike activity amount

A_s = known spiked value

Internal Process Control sample results use acceptance criteria of 70%-130% for spike recovery. Warning limits are set from 70%-79% and 121%-130%. Results evaluated as "Warning" are assessed for trends of low or high bias and are used to detect potential problems. The laboratory's internal acceptance criteria are based on MAPEP's defined performance levels of bias greater than 30%.

Matrix spikes (MS) may be used to document the bias of a method in a sample matrix. MS acceptance criteria is 60% - 140% recovery.

b) Other Measures

Backgrounds, which represent the ambient signal response recorded by measuring instruments, are independent of radioactivity contributed by the radionuclides being measured in the sample. If possible, equivalent media for preparing laboratory processing blanks will be used.

Acceptable method blank sample results have no three-sigma statistically-positive activity for the target parameters. If all sample results associated with the blank are greater than the Minimum Detectable Concentration (MDC), then the blank MDC shall be less than the activity of the least active sample in the work order or it will be flagged with a qualifier in the client report with a case narrative.

Replicate/duplicate (DUP) and matrix spike duplicate (MSD) samples are produced by taking two aliquots from a single sample and assigning each aliquot a different Lab Sample Number. In cases of duplicate analyses where there are no "known" values, the analyses will be evaluated for precision only. All duplicates are carried through the complete sample preparation and analytical procedure. Precision is evaluated by calculating the Relative Percent Difference (RPD) between the two samples. Relative Percent Difference is calculated as the absolute difference between two values normalized to the average value, expressed as a percentage:

% RPD = (abs[orig – dup] / [orig + dup]/2) x 100

Matrix spike duplicates are split samples spiked with identical concentrations of a target analyte and are used to evaluate precision and bias. The matrix spike duplicate recovery is expressed as a percentage:

% MSD = (abs[orig activity* – dup activity]/spike activity) x 100

**If the original activity is not detected then the activity is considered zero (0)*

For purposes of analytical reporting, each result specifies the radionuclide concentration and the *a posteriori* Minimum Detectable Concentration (MDC). TBE-ES calculates the *a posteriori* MDC using the sample's actual measurement parameters

(i.e., sample volume, chemical recovery, instrument background, etc.) to demonstrate that the Nuclear Regulatory Commission's (NRC) *a priori* MDC has been met for each radionuclide/sample. By TBE-ES policy, the *a posteriori* MDC must be less than the required NRC *a priori* MDC.

3. Investigations and Nonconformance Reports

QC investigations are initiated when QC results fall outside of the QC criteria. Other investigations may arise from unanticipated situations which are not clearly defined in the procedures or bounded by pre-established performance criteria but have the potential of becoming QA-related issues. The QA investigation is the mechanism to quickly ascertain if there is "due cause" to issue a formal Non-Conformance Report (NCR).

An NCR is issued to formally document a QC investigation into the root cause of failure, the corrective action taken, and the action taken to prevent recurrence where applicable. Investigations may include review of procedures, interviews of personnel, review of laboratory and instrument logbooks, observation of analyst techniques and any other items identified as necessary to resolve the issue. For intercomparison performance evaluation samples, it is TBE's policy to issue an NCR for all unacceptable results for nuclides listed as part of the ICP program. Some nuclides are analyzed for internal information only.

II. ANALYTICAL SERVICES QUALITY CONTROL SYNOPSIS

A. Interlaboratory Cross-Check Program

During this reporting period, 29 nuclides associated with seven media types (Air Filter, Charcoal [Air Iodine], Milk, Soil, Urine, Vegetation and Water) were analyzed. Samples were obtained from Analytics, the Department of Energy's (DOE) Mixed Analyte Performance Evaluation Program (MAPEP) and Environmental Resource Associates (ERA). Media types representative of client analyses performed during this reporting period were selected. The results are presented in Attachment A and associated NCRs are in Attachment C.

1. Eckert & Zeigler Analytics Environmental Cross Check Program

Two new studies were added this year for a total of fourteen nuclides and evaluated in air particulate, charcoal filter, milk, soil, and water matrices. All analyses were within acceptable criteria except for 2 gamma nuclides, Co-60 (AP) and Ce-141 (soil). NCR 24-06 was initiated to address the failures (See Attachment C for NCR detail). Both nuclides were resolved and returned within acceptable criteria in a following study.

2. DOE's MAPEP Quality Assessment Program

Sixteen nuclides in water, soil, urine, and vegetation samples were evaluated in 2024. All of the environmental analyses performed were evaluated as within the 'acceptable'/'acceptable with warning' criteria except for Ni-63 and Fe-55 in soil, Zn-65 in urine, Tc-99 in water, and Sr-90 in vegetation. NCR's 24-08, 24-10, 24-11, 24-16, 24-17, and CAR 24-02 were initiated to

address the failures (See Attachment C for NCR detail). Zn-65 in urine and Tc-99 in water were resolved and returned within acceptable criteria in a following study.

3. ERA Environmental Cross Check Program (RAD/MRAD)

   Eighteen nuclides in water, soil, and air particulate samples were evaluated in 2024. All analyses performed were within acceptable criteria except for Am-241, Gr-B, and U-234/238 in air particulate, and Gr-A and Fe-55 in water. NCR's 24-02, 24-03, 24-05, 24-14, and 24-15 were initiated to address the failures (See Attachment C for NCR detail). Both Am-241 and GR-B in air particulate, and GR-A in water failures were resolved and returned within acceptable criteria in a following study.

B. Intralaboratory Cross-Check Program

During this reporting period, 21 nuclides (and numerous other gamma nuclides) in various matrices, including air particulate, charcoal, vegetation, milk, and water, were analyzed by means of the laboratory's internal process control program. A compilation of intralaboratory comparison data for this reporting period is summarized in Attachment B. *(Note: Only gamma nuclides that are typically seen in samples are included in the attachment – a complete list is available upon request).*

The TBE-ES laboratory's internal process control program evaluated 6,018 analyses for the 2024 year.

1. Blanks
   During this reporting period, 1661/1663 workgroup blanks analyzed were less than the MDC. There were two blanks that were positive due to high activity in the associated workgroup samples. Results were >5 times the blank value, which was documented in the case narrative with the sample results.

2. Spikes
   During this reporting period, all 1,650 workgroup and matrix spikes analyzed were within the acceptance criteria.

3. Duplicates
   During this reporting period, 2,704/2,705 duplicate sets analyzed were within acceptance criteria. One spike duplicate RPD was outside acceptance criteria, and a case narrative was provided with the sample results.

C. Non-Conformance Reports (NCRs)

There were 17 NCRs that were initiated during this period. All NCR's have been closed except for NCR's 24-14, 24-15, 24-16, 24-17. All NCRs can be referenced in Attachment C.

Please note that the NCR forms were updated and are reflected for these that remain open. Due to the nature of the form update, they will not be closed until completion of all components of the form, including root cause investigation and corrective action effectiveness confirmation.

D. Instrumentation

TBE-ES uses the statistical principle method of evaluation for instrument quality control check data based on the mean, 2-sigma and 3-sigma set point model or uses pre-set tolerance limits. Each detector is checked prior to use and the resulting data points are automatically compared to statistical baselines to determine the instrument's acceptability for counting. Control charts showing this data are available during audits or upon request. TBE-ES instrumentation includes:

1. Gamma Spectroscopy
   Gamma detectors are routinely monitored for energy, full width at half maximum, efficiency, and background. TBE-ES gamma detectors operated without incident during this reporting period. Occasional second runs (as allowed by our QA program) were necessary to verify acceptable operation. Some amplifier fine gain adjustments and liquid nitrogen addition to the dewars were also necessary when data trends indicate an energy drift on the detector.

2. Liquid Scintillation Counters (LSC)

   LSC instruments, used in tritium, carbon-14, nickel-63 and other low-energy beta-emitters, are monitored for background and efficiency. The reliability of these instruments is exceptional with zero instances of background or efficiency values outside of control limits.

3. Alpha/Beta Gas Flow Proportional (GFP) Counters

   GFP detectors used for gross alpha/beta, strontium-89/90, iodine-131 (low level) and other nuclides are monitored for background and efficiency. These detectors operated without incident during this reporting period. Occasionally, second runs (primarily for alpha due to the sensitivity of source placement) were necessary to verify acceptable operation or because of low P-10 pressure. After gas change-out and purging, control check values return to control norms.

4. Alpha Spectroscopy

   Alpha detectors are routinely monitored for energy, full width at half maximum, efficiency, and background. TBE-ES alpha detectors operated without incident during this reporting period. Occasional second runs (as allowed by our QA program) were necessary to verify acceptable operation.

ATTACHMENT A
Interlaboratory Quality Control Program Results

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A.1

Eckert & Ziegler Analytics

Environmental Radioactivity Cross Check Program

A.1 Analytics Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value [a]	Ratio of TBE to Analytics Result	Evaluation [b]
March 2024	E14089	Milk	Sr-89	pCi/L	79.6	78.2	1.02	A
			Sr-90	pCi/L	12.6	11.9	1.06	A
	E14090	Milk	Ce-141	pCi/L	75.6	85.0	0.89	A
			Co-58	pCi/L	-0.069	Not Measured		
			Co-60	pCi/L	139	158	0.88	A
			Cr-51	pCi/L	212	230	0.92	A
			Cs-134	pCi/L	167	198	0.84	A
			Cs-137	pCi/L	158	171	0.93	A
			Fe-59	pCi/L	81.1	86.5	0.94	A
			I-131	pCi/L	80.9	90.8	0.89	A
			Mn-54	pCi/L	173	183	0.95	A
			Zn-65	pCi/L	165	176	0.93	A
	E14091	Charcoal	I-131	pCi	90.1	90.3	1.00	A
	E14092	AP	Ce-141	pCi	68.1	67.5	1.01	A
			Co-58	pCi	1.73	Not Measured		
			Co-60	pCi	168	126	1.34	N[1]
			Cr-51	pCi	182	183	0.99	A
			Cs-134	pCi	157	157	1.00	A
			Cs-137	pCi	132	136.0	0.97	A
			Fe-59	pCi	70.3	68.6	1.02	A
			Mn-54	pCi	144	145	0.99	A
			Zn-65	pCi	125	140	0.89	A
	E14093	Soil	Ce-141	pCi/g	0.106	0.071	1.48	N[1]
			Co-58	pCi/g	-0.005	Not Measured		
			Co-60	pCi/g	0.121	0.133	0.91	A
			Cr-51	pCi/g	0.198	0.194	1.02	A
			Cs-134	pCi/g	0.206	0.166	1.24	W
			Cs-137	pCi/g	0.207	0.209	0.99	A
			Fe-59	pCi/g	0.063	0.073	0.87	A
			Mn-54	pCi/g	0.140	0.153	0.91	A
			Zn-65	pCi/g	0.149	0.148	1.01	A
	E14094	AP	Sr-89	pCi	83.9	90.6	0.93	A
			Sr-90	pCi	11.7	13.8	0.85	A
September 2024	E14095	Milk	Sr-89	pCi/L	88.0	92.3	0.95	A
			Sr-90	pCi/L	12.4	15.2	0.82	A
	E14096	Milk	Ce-141	pCi/L	124	124	1.00	A
			Co-58	pCi/L	154	150	1.03	A
			Co-60	pCi/L	232	236	0.98	A
			Cr-51	pCi/L	284	274	1.04	A
			Cs-134	pCi/L	180.0	187	0.96	A
			Cs-137	pCi/L	126	127	0.99	A
			Fe-59	pCi/L	127.0	113	1.12	A
			I-131	pCi/L	85.3	89.0	0.96	A
			Mn-54	pCi/L	162	162	1.00	A
			Zn-65	pCi/L	294	275	1.07	A
	E14097	Charcoal	I-131	pCi	98.8	92.6	1.07	A
	E14098	AP	Ce-141	pCi	82.0	76.7	1.07	A
			Co-58	pCi	91.0	92.6	0.98	A
			Co-60	pCi	180	146	1.23	W
			Cr-51	pCi	208	170	1.22	W
			Cs-134	pCi	116	116	1.00	A
			Cs-137	pCi	83.1	78.9	1.05	A
			Fe-59	pCi	75.6	70.2	1.08	A
			Mn-54	pCi	101	100	1.01	A
			Zn-65	pCi	167	170	0.98	A
	E14099	Soil	Ce-141	pCi/g	0.224	0.222	1.01	A
			Co-58	pCi/g	0.249	0.268	0.93	A
			Co-60	pCi/g	0.420	0.423	0.99	A
			Cr-51	pCi/g	0.492	0.492	1.00	A
			Cs-134	pCi/g	0.278	0.336	0.83	A
			Cs-137	pCi/g	0.276	0.295	0.94	A
			Fe-59	pCi/g	0.233	0.204	1.14	A
			Mn-54	pCi/g	0.279	0.290	0.96	A
			Zn-65	pCi/g	0.538	0.494	1.09	A
	E14100	AP	Sr-89	pCi	79.8	82.7	0.96	A
			Sr-90	pCi	12.0	13.6	0.88	A
	E14197	Liquid	Gr-A (Am241)	pCi/L	47.6	50.1	0.95	A
			Gr-B (Cs137)	pCi/L	248	270	0.92	A

(a) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) Analytics evaluation based on TBE internal QC limits:

A = Acceptable - reported result falls within ratio limits of 0.80-1.20

W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30

N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

A.2
DOE Mixed Analyte Performance Evaluation Program (MAPEP)

A.2 DOE's Mixed Analyte Performance Evaluation Program (MAPEP)
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value [a]	Acceptance Range	Evaluation [b]
February 2024	24-MaS50	Soil	Fe-55	Bq/kg	297	650	455 - 845	N[3]
			Ni-63	Bq/kg	1070	1530	1071 - 1989	N[4]
			Tc-99	Bq/kg	325	336	235 - 437	A
			Th-228	Bq/kg	34.6	48.8	34.2 - 63.4	W
			Th-230	Bq/kg	49.7	54.0	38.0 - 70.0	A
			Th-232	Bq/kg	36.4	45.1	31.6 - 58.6	A
	24-MaSU50	Urine	Cs-134	Bq/L	1.12	1.36	0.95-1.77	A
			Cs-137	Bq/L	2.00	2.23	1.56-2.90	A
			Co-57	Bq/L	1.06	1.26	0.88 - 1.64	A
			Co-60	Bq/L	2.26	2.38	1.67 - 3.09	A
			K-40	Bq/L	-1.80	NR	-	
			Mn-54	Bq/L	1.44	1.51	1.06 - 1.96	A
			U-234	Bq/L	0.00101		*(1)*	A
			U-238	Bq/L	0.00228		*(1)*	A
			Zn-65	Bq/L	-0.42	0.84	0.59-1.09	NE[5]
	24-MaW50	Water	Ni-63	Bq/L	0.338	0.80	*(2)*	A
			Tc-99	Bq/L	9.95	7.47	5.23 - 9.71	N[6]
	24-RdV50	Vegetation	Cs-134	Bq/sample	2.80	3.67	2.57 - 4.77	W
			Cs-137	Bq/sample	2.21	2.57	1.80 - 3.34	A
			Co-57	Bq/sample	2.23	2.53	1.77 - 3.29	A
			Co-60	Bq/sample	2.42	2.96	2.07 - 3.85	A
			Mn-54	Bq/sample	0.033		*(1)*	A
			Sr-90	Bq/sample	0.276	0.529	0.370 - 0.688	N[7]
			Zn-65	Bq/sample	6.83	8.02	5.61 - 10.43	A
August 2024	24-MaS51	Soil	Fe-55	Bq/kg	*(8)*	780	546-1014	N[9]
			Ni-63	Bq/kg	1140.00	1450.00	1015 - 1885	W
			Tc-99	Bq/kg	155.00	171.00	120 - 222	A
			Th-228	Bq/kg	38.00	43.30	30.3 - 56.3	A
			Th-230	Bq/kg	46.10	44.00	30.8 - 57.2	A
			Th-232	Bq/kg	38.90	42.60	29.8 - 55.4	A
	24-MaW51	Water	Ni-63	Bq/L	0.60	-	*(1)*	A
			Tc-99	Bq/L	11.90	11.20	7.8 - 14.6	A
	24-RdV51	Vegetation	Cs-134	Bq/sample	3.12	2.89	2.02 - 3.76	A
			Cs-137	Bq/sample	2.18	1.91	1.34 - 2.48	A
			Co-57	Bq/sample	0.00	-	*(1)*	A
			Co-60	Bq/sample	2.24	2.01	1.41 - 2.61	A
			Mn-54	Bq/sample	3.76	3.53	2.47 - 4.59	A
			Sr-90	Bq/sample	0.95	2.39	1.67 - 3.11	N[10]
			Zn-65	Bq/sample	10.30	9.13	6.39 - 11.87	A

(a) The MAPEP known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measureme made during standard preparation

(b) DOE/MAPEP evaluation:

A = Acceptable - reported result falls within ratio limits of 0.80-1.20

W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30

N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

(1) False positive test

(2) Sensitivity evaluation

(3) See **CAR 23-31**

(4) See **NCR 24-08**

(5) Not Evaluated, re-reported as Falst Pos by MAPEP

(6) See **NCR 24-10**

(7) See **NCR 24-11**

(8) Not Reported

(9) See **NCR 24-16**

(10) See **NCR 24-17**

Results Flags:

A = Result acceptable.....|Bias| <= 20%

W = Result acceptable with warning.....20% < |Bias| <= 30%

N = Result not acceptable.....|Bias| > 30%

RW = Report Warning

NR = Not Reported

Uncertainty Flags:

NOT ACCEPTABLE.....RP < 2%

ACCEPTABLE.....2% <= RP <= 15%

ACCEPTABLE WITH WARNING.....15% < RP <= 30%

NOT ACCEPTABLE.....RP > 30%

Relative Precision (RP) = (Reported Uncertainty / Reported Result) x 100

A.3
ERA Environmental Radioactivity
Cross Check Program

A.3 ERA Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value [a]	Acceptance Limits	Evaluation [b]
March 2024	MRAD-40	Water	Am-241	pCi/L	101	139	95.4 - 178	A
			Fe-55	pCi/L	2185	2480	1460- 3610	A
			Pu-238	pCi/L	62.0	70.4	42.3 - 91.2	A
			Pu-239	pCi/L	61.2	76.5	47.3 - 94.3	A
		Soil	Am-241	pCi/kg	NR	1880	1020 - 2660	
			Pu-238	pCi/kg	667	512	255 - 778	A
			Pu-239	pCi/kg	562	545	297 - 784	A
			Sr-90	pCi/kg	4050	3630	1130 - 5650	A
			U-234	pCi/kg	3040	4360	2040 - 5710	A
			U-238	pCi/kg	3270	4320	2370 - 5800	A
		AP	Am-241	pCi/filter	38.8	55.0	39.3 - 73.3	N(1)
			Fe-55	pCi/filter	387	386	141 - 616	A
			Pu-238	pCi/filter	45.9	41.1	31.0 - 50.5	A
			Pu-239	pCi/filter	54.9	56.1	41.9 - 67.7	A
			U-234	pCi/filter	11.1	11.6	8.60 - 13.6	A
			U-238	pCi/filter	12.8	11.5	8.68 - 13.7	A
			GR-A	pCi/filter	116	95.9	50.1 - 158	A
			GR-B	pCi/filter	42.1	22.2	13.5 - 33.5	N(2)
April 2024	RAD-137	Water	Ba-133	pCi/L	62.8	65.9	50.1 - 81.7	A
			Cs-134	pCi/L	51.0	57.8	42.8 - 72.8	A
			Cs-137	pCi/L	153	186	149 - 223	A
			Co-60	pCi/L	92.1	98.8	79.7 - 118	A
			Zn-65	pCi/L	208	240	188 - 292	A
			GR-A	pCi/L	35.2	52.6	39.6 - 65.6	N(3)
			GR-B	pCi/L	49	46.5	33.9 - 59.1	A
			U-Nat	pCi/L	56.0	59.3	52.8-65.8	A
			H-3	pCi/L	19,000	21,300	18,200 - 24,400	A
			Sr-89	pCi/L	48.9	52.2	37.8 - 66.6	A
			Sr-90	pCi/L	32.6	37.6	32.0 - 43.2	A
			I-131	pCi/L	21.8	25.1	21.7 - 28.5	A
September 2024	MRAD-41	Water	Am-241	pCi/L	108.0	117.0	80.3-150	A
			Fe-55	pCi/L	615	1230	723-1790	N(4)
			Pu-238	pCi/L	99	103	61.9-133	A
			Pu-239	pCi/L	123	133	82.3-164	A
		Soil	Am-241	pCi/kg	1320	1110	599-1570	A
			Pu-238	pCi/kg	1380	1860	928-2830	A
			Pu-239	pCi/kg	796	1030	561-1480	A
			Sr-90	pCi/kg	3240	4730	1470-7370	A
			U-234	pCi/kg	2540	2860	1340-3750	A
			U-238	pCi/kg	2390	2840	1560-3810	A
		AP	Am-241	pCi/filter	27.0	29.1	20.8-38.8	A
			Fe-55	pCi/filter	644	800	292-1280	A
			Pu-238	pCi/filter	22.3	21.5	16.2-26.4	A
			Pu-239	pCi/filter	30.6	32.4	24.2-39.1	A
			U-234	pCi/filter	14.0	31.1	23.1-36.4	N(5)
			U-238	pCi/filter	14.2	30.9	23.3-36.9	N(5)
			GR-A	pCi/filter	80.0	72.4	37.8-119	A
			GR-B	pCi/filter	57.5	47.9	29.0-72.4	A
October 2024	RAD-139	Water	Ba-133	pCi/L	30.3	27.4	15.5-39.3	A
			Cs-134	pCi/L	73.3	80.2	63.0-97.4	A
			Cs-137	pCi/L	46.6	46.3	23.3-69.3	A
			Co-60	pCi/L	44.2	45.3	31.6-59.0	A
			Zn-65	pCi/L	104	114.0	75.0-153	A
			GR-A	pCi/L	47.6	51.7	38.9-64.5	A
			GR-B	pCi/L	44.2	48.1	35.2-61.0	A
			U-Nat	pCi/L	28.3	26.90	23.6-30.2	A
			H-3	pCi/L	4,690	5,320	3870-6770	A
			Sr-89	pCi/L	57.5	44.2	30.6-57.8	A
			Sr-90	pCi/L	37.3	35.6	30.2-41.0	A
			I-131	pCi/L	28.3	26.3	22.7-29.9	A

(a) The ERA known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.

(b) ERA evaluation:

A = Acceptable - Reported value falls within the Acceptance Limits

N = Not Acceptable - Reported value falls outside of the Acceptance Limits

*(1) See **NCR 24-02***

*(2) See **NCR 24-03***

*(3) See **NCR 24-05***

*(4) See **NCR 24-15***

*(5) See **NCR 24-14***

A.4
Formal Interlaboratory Quality Control Program Results

ERA
A Waters Company

Sharon Northcutt
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Knoxville, TN 37931
USA

MRAD-40 Final Report

MRaD™ Proficiency Testing

MRaD™ Study

Reference Date: 03/18/2024

Open Date: 03/18/2024

Close Date: 05/17/2024

Report Issued Date: 05/21/2024

A Waters Company

May 21, 2024

Sharon Northcutt
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931

Enclosed is your final report for ERA's MRaD™ Multi-Media Radiochemistry Proficiency Testing (PT) study, MRAD-40. Your final report includes an evaluation of all results submitted by your laboratory to ERA.

Data Evaluation Protocols: All of the analytes in ERA's MRAD-40 Proficiency Testing study have been evaluated using the Acceptance Limits generated per ERA's Standard Operating Procedure for the Generation of Performance Acceptance Limits (SOP 730002268).

Corrective Action Help: As part of your ongoing Quality Assurance (QA) Program, you may want to identify the root cause of any "Not Acceptable" results, implement the necessary corrective actions, and then satisfy your QA requirements by participating in a Supplemental (QuiK™Response) study or a future MRaD™ Proficiency Testing Study. If you need help, ERA's technical staff is available to help your laboratory resolve any technical issues that may be impairing your PT performance and possibly affecting your routine data quality. Our laboratory and technical staff have many years of collective experience in performing the full range of environmental analyses. As part of our technical support, ERA offers QC samples that can be useful in helping you work through your technical issues.

Thank you for your participation in ERA's MRaD™ Multi-Media Radiochemistry Proficiency Testing (PT) study, MRAD-40. If you have any questions, please contact our Proficiency Testing Department at 1-800-372-0122.

Sincerely,

Craig Huff
Senior Technical Manager

attachments

A Waters Company

MRAD-40 Definitions & Study Discussion

Study Dates: 03/18/2024 - 05/17/2024 **Report Issued: 05/21/2024**

MRAD Study Definitions

The Reported Value is the value that the laboratory reported to ERA.

The ERA Assigned Values for the Multi-Media Radiochemistry Proficiency Testing Standards are established per the guidelines contained in the 2016 TNI Standard as applicable. The assigned values for the water and air filter standards are equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation as applicable. The assigned values for the soil and vegetation standards are equal to the maximum amount of the parameter available in the standard by applicable radiological methodologies. The assigned values are directly traceable to the commercially prepared starting materials used to manufacture the PT standards. Parameters not added to a standard may be given an assigned value of less than a minimum verified concentration as determined in the background matrix for applicable radiological methodologies.

The Acceptance Limits are established per ERA's SOP for the Generation of Performance Acceptance Limits™ as applicable.

The Performance Evaluation:

Acceptable	= Reported Value falls within the Acceptance Limits.
Not Acceptable	= Reported Value falls outside the Acceptance Limits.
No Evaluation	= Reported Value cannot be evaluated.
Not Reported	= No Value reported.

The Method Description is the method the laboratory reported to ERA.

MRAD Study Discussion

ERA's MRAD™Multi-Media Radiochemistry Proficiency Testing (PT) study, MRAD-40, has been reviewed by ERA senior management.

A full review of all homogeneity, stability and accuracy verification data was completed.

The MRAD-40 results were examined for any study anomalies. There were no anomalies observed during the statistical review of the data.

The data contained herein are confidential and intended for your use only.

If you have any questions or concerns regarding your assessment in ERA's MRAD™Multi-Media Radiochemistry Proficiency Testing program, please contact our Proficiency Testing Department at 1-800-372-0122.

MRAD-40 Final Evaluation Report

Sharon Northcutt
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EPA ID: **TN11387**
ERA Customer Number: **T200801**
Report Issued: **05/21/2024**
Study Dates: **03/18/2024 - 05/17/2024**

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
MRAD Soil Radionuclides (cat# 802, lot# A040-608)												
2700	Actinium-228	pCi/kg		1590	1050 - 2000	Not Reported				1570	165	
2755	Americium-241	pCi/kg		1880	1020 - 2660	Not Reported				1720	469	
2772	Bismuth-212	pCi/kg		1670	478 - 2490	Not Reported				1690	499	
2773	Bismuth-214	pCi/kg		786	377 - 1170	Not Reported				796	97.1	
2800	Cesium-134	pCi/kg		3500	2390 - 4180	Not Reported				3180	505	
2805	Cesium-137	pCi/kg		9150	6920 - 11600	Not Reported				9040	866	
2815	Cobalt-60	pCi/kg		8400	6620 - 10400	Not Reported				8310	1090	
2902	Lead-212	pCi/kg		1650	1150 - 2090	Not Reported				1650	203	
2903	Lead-214	pCi/kg		851	357 - 1340	Not Reported				843	103	
2905	Manganese-54	pCi/kg		< 555	0.00 - 555	Not Reported						
2930	Plutonium-238	pCi/kg	667	512	255 - 778	Acceptable	HASL 300 Pu-02 28th ED 1997	5/16/2024	0.331	593	222	Shannon Cooper
2932	Plutonium-239	pCi/kg	562	545	297 - 784	Acceptable	HASL 300 Pu-02 28th ED 1997	5/16/2024	-0.196	604	213	Shannon Cooper
2946	Potassium-40	pCi/kg		41800	28800 - 49900	Not Reported				41700	2860	
3005	Strontium-90	pCi/kg	4050	3630	1130 - 5650	Acceptable	HASL 300 Sr-03 28th ED 1997	4/30/2024	1.34	3480	427	Shannon Cooper
3028	Thorium-234	pCi/kg		4320	1630 - 7400	Not Reported				4650	1100	
3036	Uranium-234	pCi/kg	3040	4360	2040 - 5710	Acceptable	HASL 300 U-02 28th ED 1997	5/1/2024	-1.94	4980	1000	Shannon Cooper
3038	Uranium-238	pCi/kg	3270	4320	2370 - 5800	Acceptable	HASL 300 U-02 28th ED 1997	5/1/2024	-1.69	4880	952	Shannon Cooper
3055	Uranium-Total	pCi/kg		8880	4930 - 11500	Not Reported				10000	1500	
1184	Uranium (mass)	µg/kg		12900	5820 - 17400	Not Reported				14000	3010	
3070	Zinc-65	pCi/kg		4920	3930 - 6710	Not Reported				5120	856	

MRAD-40 Final Evaluation Report

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ERA Customer Number: **T200801**
Report Issued: **05/21/2024**
Study Dates: **03/18/2024 - 05/17/2024**

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
MRAD Air Filter Radionuclides (cat# 800, lot# A040-606)												
2755	Americium-241	pCi/Filter	38.8	55.0	39.3 - 73.3	Not Acceptable	HASL 300 Am-01 28th ED 1997	4/26/2024	-1.99	55.2	8.22	Shannon Cooper
2800	Cesium-134	pCi/Filter		273	177 - 335	Not Reported				248	32.3	
2805	Cesium-137	pCi/Filter		106	87.1 - 139	Not Reported				114	10.7	
2815	Cobalt-60	pCi/Filter		1120	952 - 1420	Not Reported				1190	85.4	
2885	Iron-55	pCi/Filter	387	386	141 - 616	Acceptable	TBE Proprietary	4/10/2024	1.06	332	52.3	Shannon Cooper
2905	Manganese-54	pCi/Filter		< 35.0	0.00 - 35.0	Not Reported						
2930	Plutonium-238	pCi/Filter	45.9	41.1	31.0 - 50.5	Acceptable	HASL 300 Pu-02 28th Ed 1997	4/25/2024	1.34	42.4	2.64	Shannon Cooper
2932	Plutonium-239	pCi/Filter	54.9	56.1	41.9 - 67.7	Acceptable	HASL 300 Pu-02 28th Ed 1997	4/25/2024	-0.337	55.8	2.57	Shannon Cooper
3005	Strontium-90	pCi/Filter		158	99.9 - 215	Not Reported				165	13.9	
3036	Uranium-234	pCi/Filter	11.1	11.6	8.60 - 13.6	Acceptable	HASL 300 U-02 28th ED 1997	4/25/2024	-0.857	11.5	0.499	Shannon Cooper
3038	Uranium-238	pCi/Filter	12.8	11.5	8.68 - 13.7	Acceptable	HASL 300 U-02 28th ED 1997	4/25/2024	1.47	11.8	0.697	Shannon Cooper
3055	Uranium-Total	pCi/Filter		23.6	17.2 - 28.0	Not Reported				23.6	0.741	
1184	Uranium (mass)	µg/Filter		34.4	27.6 - 40.3	Not Reported				35.5	1.76	
3070	Zinc-65	pCi/Filter		77.2	63.3 - 118	Not Reported				91.4	9.90	
MRAD Air Filter Gross Alpha/Beta (cat# 801, lot# A040-607)												
2830	Gross Alpha	pCi/Filter	116	95.9	50.1 - 158	Acceptable	EMSL-LV p. 1 1979	4/17/2024	1.20	100	13.3	Susan Ogletree
2840	Gross Beta	pCi/Filter	42.1	22.2	13.5 - 33.5	Not Acceptable	EMSL-LV p. 1 1979	4/17/2024	1.55	27.9	9.15	Susan Ogletree

MRAD-40 Final Evaluation Report

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EPA ID: **TN11387**
ERA Customer Number: **T200801**
Report Issued: **05/21/2024**
Study Dates: **03/18/2024 - 05/17/2024**

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
MRAD Water Radionuclides (cat# 804, lot# A040-617)												
2755	Americium-241	pCi/L	101	139	95.4 - 178	Acceptable	HASL 300 Am-01 29th ED 1997	4/30/2024	-1.17	129	23.7	Shannon Cooper
2800	Cesium-134	pCi/L		415	313 - 456	Not Reported				390	31.1	
2805	Cesium-137	pCi/L		2310	1980 - 2630	Not Reported				2310	115	
2815	Cobalt-60	pCi/L		1500	1290 - 1720	Not Reported				1540	35.4	
2885	Iron-55	pCi/L	2185	2480	1460 - 3610	Acceptable	TBE Proprietary	5/3/2024	0.118	2170	112	Shannon Cooper
2905	Manganese-54	pCi/L		< 71.0	0.00 - 71.0	Not Reported						
2930	Plutonium-238	pCi/L	62	70.4	42.3 - 91.2	Acceptable	HASL 300 Pu-02 28th ED 1997	4/25/2024	-1.16	70.4	7.22	Shannon Cooper
2932	Plutonium-239	pCi/L	61.2	76.5	47.3 - 94.3	Acceptable	HASL 300 Pu-02 28th ED 1997	4/25/2024	-1.30	76.5	11.7	Shannon Cooper
3005	Strontium-90	pCi/L		316	228 - 391	Not Reported				324	33.3	
3036	Uranium-234	pCi/L		181	138 - 207	Not Reported				168	22.6	
3038	Uranium-238	pCi/L		179	139 - 211	Not Reported				171	17.1	
3055	Uranium-Total	pCi/L		368	287 - 420	Not Reported				331	48.6	
1184	Uranium (mass)	µg/L		537	435 - 609	Not Reported				525	20.4	
3070	Zinc-65	pCi/L		503	448 - 635	Not Reported				532	25.2	

CERTIFICATE OF RECOGNITION

ERA congratulates

Teledyne Brown Engineering

MRAD-40

For your participation and successful evaluation, we recognize the performance of this laboratory for achieving acceptable evaluation in the following standards.

Soil Radionuclides

Water Radionuclides

Craig Huff
Senior Technical Manager

T200801

ERA
A Waters Company

Kristin Peacock
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
USA

MRAD-41 Final Report

MRaD™ Proficiency Testing

MRaD™ Study

Reference Date: 09/16/2024

Open Date: 09/16/2024

Close Date: 11/15/2024

Report Issued Date: 11/18/2024

ERA
A Waters Company

November 18, 2024

Kristin Peacock
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931

Enclosed is your final report for ERA's MRaD™ Multi-Media Radiochemistry Proficiency Testing (PT) study, MRAD-41. Your final report includes an evaluation of all results submitted by your laboratory to ERA.

Data Evaluation Protocols: All of the analytes in ERA's MRAD-41 Proficiency Testing study have been evaluated using the Acceptance Limits generated per ERA's Standard Operating Procedure for the Generation of Performance Acceptance Limits (SOP 730002268).

Corrective Action Help: As part of your ongoing Quality Assurance (QA) Program, you may want to identify the root cause of any "Not Acceptable" results, implement the necessary corrective actions, and then satisfy your QA requirements by participating in a Supplemental (QuiK™Response) study or a future MRaD™ Proficiency Testing Study. If you need help, ERA's technical staff is available to help your laboratory resolve any technical issues that may be impairing your PT performance and possibly affecting your routine data quality. Our laboratory and technical staff have many years of collective experience in performing the full range of environmental analyses. As part of our technical support, ERA offers QC samples that can be useful in helping you work through your technical issues.

Thank you for your participation in ERA's MRaD™ Multi-Media Radiochemistry Proficiency Testing (PT) study, MRAD-41. If you have any questions, please contact our Proficiency Testing Department at 1-800-372-0122.

Sincerely,

Craig Huff
Senior Technical Manager

attachments

MRAD-41 Final Evaluation Report

Kristin Peacock
Quality Assurance Manager
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
(865) 934-0374

EPA ID: **TN11387**
ERA Customer Number: **T200801**
Report Issued: **11/18/2024**
Study Dates: **09/16/2024 - 11/15/2024**

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
MRAD Soil Radionuclides (cat# 802, lot# A041-608)												
2700	Actinium-228	pCi/kg		1150	759 - 1450	Not Reported				1150	211	
2755	Americium-241	pCi/kg	1320	1110	599 - 1570	Acceptable	HASL 300 Am-01 28th ED 1997	9/30/2024	1.10	1080	218	Shannon Cooper
2772	Bismuth-212	pCi/kg		1120	321 - 1670	Not Reported				1120	291	
2773	Bismuth-214	pCi/kg		617	296 - 918	Not Reported				617	94.9	
2800	Cesium-134	pCi/kg		1810	1240 - 2160	Not Reported				1700	210	
2805	Cesium-137	pCi/kg		1370	1040 - 1730	Not Reported				1410	132	
2815	Cobalt-60	pCi/kg		4000	3150 - 4940	Not Reported				3910	352	
2902	Lead-212	pCi/kg		1160	809 - 1470	Not Reported				1160	257	
2903	Lead-214	pCi/kg		652	274 - 1020	Not Reported				652	103	
2905	Manganese-54	pCi/kg		< 555	0.00 - 555	Not Reported						
2930	Plutonium-238	pCi/kg	1380	1860	928 - 2830	Acceptable	HASL 300 Pu-02 28th ED 1997	10/24/2024	-1.42	1720	236	Shannon Cooper
2932	Plutonium-239	pCi/kg	796	1030	561 - 1480	Acceptable	HASL 300 Pu-02 28th ED 1997	10/24/2024	-1.25	963	134	Shannon Cooper
2946	Potassium-40	pCi/kg		35300	24300 - 42200	Not Reported				34100	2830	
3005	Strontium-90	pCi/kg	3240	4730	1470 - 7370	Acceptable	HASL 300 Sr-03 28th ED 1997	10/18/2024	-0.623	3620	603	Shannon Cooper
3028	Thorium-234	pCi/kg		2840	1070 - 4860	Not Reported				2700	481	
3036	Uranium-234	pCi/kg	2540	2860	1340 - 3750	Acceptable	HASL 300 U-02 28th ED 1997	10/24/2024	0.0122	2530	520	Shannon Cooper
3038	Uranium-238	pCi/kg	2390	2840	1560 - 3810	Acceptable	HASL 300 U-02 28th ED 1997	10/24/2024	-0.164	2460	456	Shannon Cooper
3055	Uranium-Total	pCi/kg		5830	3240 - 7540	Not Reported				4970	835	
1184	Uranium (mass)	µg/kg		8500	3840 - 11500	Not Reported				6400	1530	
3070	Zinc-65	pCi/kg		2860	2280 - 3900	Not Reported				2960	305	

MRAD-41 Final Evaluation Report

Kristin Peacock
Quality Assurance Manager
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
(865) 934-0374

EPA ID: **TN11387**
ERA Customer Number: **T200801**
Report Issued: **11/18/2024**
Study Dates: **09/16/2024 - 11/15/2024**

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
MRAD Air Filter Radionuclides (cat# 800, lot# A041-606)												
2755	Americium-241	pCi/Filter	27.0	29.1	20.8 - 38.8	Acceptable	HASL 300 Am-01 28th ED 1997	9/30/2024	-0.997	30.4	3.44	Shannon Cooper
2800	Cesium-134	pCi/Filter		581	377 - 712	Not Reported				514	65.2	
2805	Cesium-137	pCi/Filter		848	696 - 1110	Not Reported				898	67.4	
2815	Cobalt-60	pCi/Filter		839	713 - 1070	Not Reported				893	65.5	
2885	Iron-55	pCi/Filter	644	800	292 - 1280	Acceptable	TBE Proprietary	10/8/2024	-0.0240	651	292	Shannon Cooper
2905	Manganese-54	pCi/Filter		< 35.0	0.00 - 35.0	Not Reported						
2930	Plutonium-238	pCi/Filter	22.3	21.5	16.2 - 26.4	Acceptable	HASL 300 Pu-02 28th ED 1997	9/30/2024	-0.662	22.8	0.781	Shannon Cooper
2932	Plutonium-239	pCi/Filter	30.6	32.4	24.2 - 39.1	Acceptable	HASL 300 Pu-02 28th ED 1997	9/30/2024	-0.498	32.2	3.13	Shannon Cooper
3005	Strontium-90	pCi/Filter		105	66.4 - 143	Not Reported				113	13.1	
3036	Uranium-234	pCi/Filter	14.0	31.1	23.1 - 36.4	Not Acceptable	HASL 300 U-02 28th ED 1997	10/24/2024	-7.16	30.9	2.37	Shannon Cooper
3038	Uranium-238	pCi/Filter	14.2	30.9	23.3 - 36.9	Not Acceptable	HASL 300 U-02 28th ED 1997	10/24/2024	-10.7	30.0	1.47	Shannon Cooper
3055	Uranium-Total	pCi/Filter		63.4	46.3 - 75.2	Not Reported				62.0	3.14	
1184	Uranium (mass)	µg/Filter		92.5	74.2 - 108	Not Reported				93.0	8.07	
3070	Zinc-65	pCi/Filter		239	196 - 365	Not Reported				278	25.8	
MRAD Air Filter Gross Alpha/Beta (cat# 801, lot# A041-607)												
2830	Gross Alpha	pCi/Filter	80.0	72.4	37.8 - 119	Acceptable	EMSL-LV p. 1 1979	10/9/2024	0.583	74.6	9.30	Susan Ogletree
2840	Gross Beta	pCi/Filter	57.5	47.9	29.0 - 72.4	Acceptable	EMSL-LV p. 1 1979	10/9/2024	0.434	54.2	7.68	Susan Ogletree

MRAD-41 Final Evaluation Report

Kristin Peacock
Quality Assurance Manager
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
(865) 934-0374

EPA ID: **TN11387**
ERA Customer Number: **T200801**
Report Issued: **11/18/2024**
Study Dates: **09/16/2024 - 11/15/2024**

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
MRAD Water Radionuclides (cat# 804, lot# A041-617)												
2755	Americium-241	pCi/L	108	117	80.3 - 150	Acceptable	HASL 300 Am-01 28th ED 1997	10/7/2024	-0.378	112	11.4	Shannon Cooper
2800	Cesium-134	pCi/L		2190	1650 - 2410	Not Reported				2020	89.5	
2805	Cesium-137	pCi/L		1550	1330 - 1760	Not Reported				1540	55.3	
2815	Cobalt-60	pCi/L		1050	906 - 1200	Not Reported				1080	44.1	
2885	Iron-55	pCi/L	615	1230	723 - 1790	Not Acceptable	TBE Proprietary	10/7/2024	-1.57	1050	277	Shannon Cooper
2905	Manganese-54	pCi/L		< 71.0	0.00 - 71.0	Not Reported						
2930	Plutonium-238	pCi/L	99.3	103	61.9 - 133	Acceptable	HASL 300 Pu-02 28th ED 1997	11/7/2024	-0.0445	99.7	9.27	Shannon Cooper
2932	Plutonium-239	pCi/L	123	133	82.3 - 164	Acceptable	HASL 300 Pu-02 28th ED 1997	11/7/2024	0.195	120	17.4	Shannon Cooper
3005	Strontium-90	pCi/L		277	199 - 342	Not Reported				268	18.3	
3036	Uranium-234	pCi/L		176	134 - 201	Not Reported				165	9.11	
3038	Uranium-238	pCi/L		174	135 - 205	Not Reported				166	6.47	
3055	Uranium-Total	pCi/L		358	279 - 408	Not Reported				337	13.1	
1184	Uranium (mass)	µg/L		522	423 - 592	Not Reported				490	35.5	
3070	Zinc-65	pCi/L		526	468 - 664	Not Reported				555	16.1	

CERTIFICATE OF RECOGNITION

ERA congratulates

Teledyne Brown Engineering

MRAD-41

For your participation and successful evaluation, we recognize the performance of this laboratory for achieving acceptable evaluation in the following standards.

Air Filter Gross Alpha/Beta

Soil Radionuclides

Craig Huff
Senior Technical Manager

T200801

ERA
A Waters Company

Sharon Northcutt
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
USA

RAD-137 Final Report

RadCheM™ Proficiency Testing

RadCheM™ Study

Reference Date: 04/08/2024

Open Date: 04/08/2024

Close Date: 05/23/2024

Report Issued Date: 05/25/2024

A Waters Company

May 25, 2024

Sharon Northcutt
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931

Enclosed is your final report for ERA's RadCheM™ Proficiency Testing (PT) study, RAD-137. Your final report includes an evaluation of all results submitted by your laboratory to ERA.

Data Evaluation Protocols: All of the analytes in ERA's RAD-137 study have been evaluated by comparing the reported result to the acceptance limits generated using the criteria contained in the most current TNI Fields of Proficiency Testing (FoPT) table and the evaluation criteria contained in the 2016 TNI Standard, Volume 3.

Corrective Action Help: As part of your accreditation(s), you may be required to identify the root cause of any "Not Acceptable" results, implement the necessary corrective actions, and then satisfy your PT requirements by participating in a Supplemental (QuiK™Response) or future ERA PT study. If you need help, ERA's technical staff is available to help your laboratory resolve any technical issues that may be impairing your PT performance and possibly affecting your routine data quality. Our laboratory and technical staff have many years of collective experience in performing the full range of environmental analyses. As part of our technical support, ERA offers QC samples that can be useful in helping you work through your technical issues.

Thank you for your participation in ERA's RadCheM™ Proficiency Testing study, RAD-137. If you have any questions, please contact our Proficiency Testing Department at 1-800-372-0122.

Sincerely,

Craig Huff
Senior Technical Manager

attachments

RAD-137 Final Evaluation Report

Sharon Northcutt
QA Manager
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
(865) 934-0374

EPA ID: **TN11387**
ERA Customer Number: **T200801**
Report Issued: **05/25/2024**
Study Dates: **04/08/2024 - 05/23/2024**

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
RAD Gamma EmitterS™ (cat# 808, lot# R137-758)												
2765	Barium-133	pCi/L	62.8	65.9	50.1 - 81.7	Acceptable	EPA 901.1 1980	4/26/2024	-0.464	64.2	3.05	Shannon Cooper
2800	Cesium-134	pCi/L	51.0	57.8	42.8 - 72.8	Acceptable	EPA 901.1 1980	4/24/2024	-1.27	57.2	4.86	Shannon Cooper
2805	Cesium-137	pCi/L	153	186	149 - 223	Acceptable	EPA 901.1 1980	4/24/2024	-2.72	186	12.1	Shannon Cooper
2815	Cobalt-60	pCi/L	92.1	98.8	79.7 - 118	Acceptable	EPA 901.1 1980	4/26/2024	-1.77	100	4.57	Shannon Cooper
3070	Zinc-65	pCi/L	208	240	188 - 292	Acceptable	EPA 901.1 1980	4/24/2024	-2.22	244	16.1	Shannon Cooper
RAD GroSS™ Alpha/Beta (cat# 809, lot# R137-759)												
2830	Gross Alpha	pCi/L	35.2	52.6	39.6 - 65.6	Not Acceptable	EPA 900.0 (GPC) 1 2018	5/9/2024	-1.00	44.8	9.57	Susan Ogletree
2840	Gross Beta	pCi/L	49.0	46.5	33.9 - 59.1	Acceptable	EPA 900.0 (GPC) 1 2018	5/9/2024	1.84	41.2	4.26	Susan Ogletree
RAD NaturalS™ (cat# 811, lot# R137-751)												
2965	Radium-226	pCi/L		13.4	11.1 - 15.7	Not Reported				13.9	2.09	
2970	Radium-228	pCi/L		6.24	4.17 - 8.31	Not Reported				6.38	0.867	
3055	Uranium (activity)	pCi/L	55.99	59.3	52.8 - 65.8	Acceptable	EPA 908.0 1980	5/1/2024	-0.527	57.6	3.11	Shannon Cooper
1184	Uranium (mass)	µg/L		86.5	76.9 - 96.1	Not Reported				85.7	3.65	
RAD TritiuM™ (cat# 812, lot# R137-752)												
3030	Tritium	pCi/L	19000	21300	18200 - 24400	Acceptable	EPA 906.0 1980	4/16/2024	-1.88	20600	859	Susan Ogletree
RAD Strontium-89/90 (cat# 807, lot# R137-757)												
2995	Strontium-89	pCi/L	48.9	52.2	37.8 - 66.6	Acceptable	EPA 905.0 1980	4/24/2024	0.223	45.5	15.4	Shannon Cooper
3005	Strontium-90	pCi/L	32.6	37.6	32.0 - 43.2	Acceptable	EPA 905.0 1980	4/24/2024	-0.735	35.7	4.25	Shannon Cooper
RAD Iodine-131 (cat# 810, lot# R137-750)												
2875	Iodine-131	pCi/L	21.8	25.1	21.7 - 28.5	Acceptable	SM 7500-I C (GPC)-2000 2000	4/16/2024	-1.41	25.6	2.70	Shannon Cooper

CERTIFICATE OF RECOGNITION

ERA congratulates

Teledyne Brown Engineering

RAD-137

For your participation and successful evaluation, we recognize the performance of this laboratory for achieving acceptable evaluation in the following standards.

Gamma EmitterS™
Iodine-131
NaturalS™
Strontium-89/90
TritiuM™

Craig Huff
Senior Technical Manager

T200801

ERA
A Waters Company

Kristin Peacock
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
USA

RAD-139 Final Report

RadCheM™ Proficiency Testing

RadCheM™ Study

Reference Date: 10/04/2024

Open Date: 10/04/2024

Close Date: 11/18/2024

Report Issued Date: 11/20/2024

A Waters Company

November 20, 2024

Kristin Peacock
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931

Enclosed is your final report for ERA's RadCheM™ Proficiency Testing (PT) study, RAD-139. Your final report includes an evaluation of all results submitted by your laboratory to ERA.

Data Evaluation Protocols: All of the analytes in ERA's RAD-139 study have been evaluated by comparing the reported result to the acceptance limits generated using the criteria contained in the most current TNI Fields of Proficiency Testing (FoPT) table and the evaluation criteria contained in the 2016 TNI Standard, Volume 3.

Corrective Action Help: As part of your accreditation(s), you may be required to identify the root cause of any "Not Acceptable" results, implement the necessary corrective actions, and then satisfy your PT requirements by participating in a Supplemental (QuiK™Response) or future ERA PT study. If you need help, ERA's technical staff is available to help your laboratory resolve any technical issues that may be impairing your PT performance and possibly affecting your routine data quality. Our laboratory and technical staff have many years of collective experience in performing the full range of environmental analyses. As part of our technical support, ERA offers QC samples that can be useful in helping you work through your technical issues.

Thank you for your participation in ERA's RadCheM™ Proficiency Testing study, RAD-139. If you have any questions, please contact our Proficiency Testing Department at 1-800-372-0122.

Sincerely,

Craig Huff
Senior Technical Manager

attachments

RAD-139 Final Evaluation Report

Kristin Peacock
Quality Assurance Manager
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
(865) 934-0374

EPA ID: **TN11387**
ERA Customer Number: **T200801**
Report Issued: **11/20/2024**
Study Dates: **10/04/2024 - 11/18/2024**

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
RAD Gamma EmitterS™ (cat# 808, lot# R139-758)												
2765	Barium-133	pCi/L	30.3	27.4	15.5 - 39.3	Acceptable	EPA 901.1 1980	10/4/2024	0.758	28.0	3.07	Shannon Cooper
2800	Cesium-134	pCi/L	73.3	80.2	63.0 - 97.4	Acceptable	EPA 901.1 1980	10/4/2024	-0.489	76.5	6.62	Shannon Cooper
2805	Cesium-137	pCi/L	46.6	46.3	23.3 - 69.3	Acceptable	EPA 901.1 1980	10/4/2024	-0.457	48.1	3.39	Shannon Cooper
2815	Cobalt-60	pCi/L	44.2	45.3	31.6 - 59.0	Acceptable	EPA 901.1 1980	10/4/2024	-0.902	46.7	2.77	Shannon Cooper
3070	Zinc-65	pCi/L	104	114	75.0 - 153	Acceptable	EPA 901.1 1980	10/4/2024	-1.18	117	11.0	Shannon Cooper
RAD GroSS™ Alpha/Beta (cat# 809, lot# R139-759)												
2830	Gross Alpha	pCi/L	47.6	51.7	38.9 - 64.5	Acceptable	EPA 900.0 (GPC) 1 2018	10/25/2024	0.0739	46.9	9.58	Susan Ogletree
2840	Gross Beta	pCi/L	44.2	48.1	35.2 - 61.0	Acceptable	EPA 900.0 (GPC) 1 2018	10/25/2024	0.247	43.2	4.00	Susan Ogletree
RAD NaturalS™ (cat# 811, lot# R139-751)												
2965	Radium-226	pCi/L		8.50	6.73 - 10.3	Not Reported				9.04	1.11	
2970	Radium-228	pCi/L		3.36	1.87 - 4.85	Not Reported				3.13	0.824	
3055	Uranium (activity)	pCi/L	28.3	26.9	23.6 - 30.2	Acceptable	EPA 908.0 1980	11/6/2024	1.62	25.9	1.48	Shannon Cooper
1184	Uranium (mass)	µg/L		39.2	34.4 - 44.0	Not Reported				40.3	1.91	
RAD TritiuM™ (cat# 812, lot# R139-752)												
3030	Tritium	pCi/L	4690	5320	3870 - 6770	Acceptable	EPA 906.0 1980	10/29/2024	-1.41	5190	352	Susan Ogletree
RAD Strontium-89/90 (cat# 807, lot# R139-757)												
2995	Strontium-89	pCi/L	57.5	44.2	30.6 - 57.8	Acceptable	EPA 905.0 1980	10/30/2024	1.74	44.9	7.24	Shannon Cooper
3005	Strontium-90	pCi/L	37.3	35.6	30.2 - 41.0	Acceptable	EPA 905.0 1980	10/30/2024	1.59	33.8	2.22	Shannon Cooper
RAD Iodine-131 (cat# 810, lot# R139-750)												
2875	Iodine-131	pCi/L	28.3	26.3	22.7 - 29.9	Acceptable	SM 7500-I C (GPC)-2000 2000	10/8/2024	0.949	26.1	2.34	Shannon Cooper

CERTIFICATE OF EXCELLENCE

In recognition of the quality of your laboratory in proficiency testing for

RAD-139

Teledyne Brown Engineering

is issued this certificate of achievement by ERA. This laboratory has been recognized as a Laboratory of Excellence for achieving 100% acceptable data in this study which included 48 participating laboratories. This achievement is a demonstration of the superior quality of the laboratory in evaluation of the standards listed below.

Gamma EmitterS™	GroSS™ Alpha/Beta
Iodine-131	NaturalS™
Strontium-89/90	TritiuM™

Craig Huff
Senior Technical Manager

T200801

ERA
A Waters Company

Sharon Northcutt
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
USA

060324G Final Report

QuiK™ Response Proficiency Testing

July 22, 2024

Sharon Northcutt
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931

Fax: (865) 690-6187

Enclosed is your final report for ERA's QuiK™Response program. Your final report includes an evaluation of all results submitted by your laboratory to ERA. The assigned value(s) and acceptance limits were not available to your laboratory at or before the time of reporting.

All analytes in ERA's QuiK™Response program are evaluated using the following tiered approach. If the analyte is listed in the most current TNI Fields of Proficiency Testing (FoPT) tables the evaluation was completed by comparing the reported result to the acceptance limits generated using the criteria contained in the tables and the evaluation criteria contained in the 2016 TNI Standard, Volume 3. If the analyte is not included in the TNI FoPT tables, the reported result has been evaluated using the procedures outlined in ERA's Standard Operating Procedure for the Generation of Performance Acceptance Limits (SOP 730002268). All analytes are included in ERA's A2LA accreditation, certification number 1539.01.

The Study Dates listed for each standard in the report are the project ship date (open date) and the date the data was submitted for evaluation (close date). Please note there may be different close dates for different standards within a project.

All activities associated with this QuiK™Response project were performed by Waters/ERA with the exception of these samples/products which were manufactured for Waters/ERA by a subcontractor: Microbiology products with the following catalog numbers; 081, 084, 085, 078, 078A, 083, 083A and Volatiles in Gas Cylinder, catalog number 1100.

As part of your accreditation(s), you may be required to identify the root cause of any "Not Acceptable" results, implement the necessary corrective actions, and then satisfy your PT requirements by participating in a supplemental (QuiK™Response) or future ERA PT study. ERA's technical staff is available to help your laboratory resolve any technical issues that may be impairing your PT performance and possibly affecting the quality of your routine data.

The data contained herein are confidential and intended for your use only.

If you are using this report for DMRQA Corrective Action, please note the following: permittees must submit a copy of this report to your DMR-QA Coordinator, along with your corrective action documentation. Contract Laboratories should send a copy of this report to your permittees upon receipt.

Thank you for your participation in ERA's QuiK™Response program. If you have any questions, please contact our Proficiency Testing Department at 1-800-372-0122.

Sincerely,

Craig Huff
Senior Technical Manager

cc: Project File Number 060324G

060324G Final Evaluation Report

Sharon Northcutt
QA Manager
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
(865) 934-0374

EPA ID: **TN11387**
ERA Customer Number: **T200801**

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
RAD GroSS™ Alpha/Beta (cat# 759, lot# 060324G) Study Dates: 06/03/2024 - 07/22/2024 (NELAC: Results reported after 45 days.)												
2830	Gross Alpha	pCi/L	40.3	30.0	21.5 - 38.5	Not Acceptable	EPA 900.0 (GPC) 1 2018	7/4/2024				Susan Ogletree
2840	Gross Beta	pCi/L		16.5	9.92 - 23.1	Not Reported						

Eckert & Ziegler
Analytics

1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30318 U.S.A.

Tel 404-352-8677
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ANAB ACCREDITED ISO/IEC 17043 PROFICIENCY TESTING PROVIDER

RESULTS OF ENVIRONMENTAL CROSS CHECK PROGRAM

TELEDYNE BROWN

ENGINEERING

1st QUARTER 2024

(Ref. Date 14 Mar 2024, Rev. 0)

L. Tk

14 Jan 2025

Levan Tkavadze, Nuclear Metrologist

Sample	Analysis	ENGINEERING Value, pCi/L	EZA Value, pCi/L	Ratio ENGINEERING: EZA
E14089 Milk	Sr-89	7.96E+01	7.82E+01	1.02
	Sr-90	1.26E+01	1.19E+01	1.06

Sample	Analysis	ENGINEERING Value, pCi/L	EZA Value, pCi/L	Ratio ENGINEERING: EZA
E14090 Milk	Ce-141	7.56E+01	8.50E+01	0.89
	Co-58	-6.90E-02	Not Measured	---
	Co-60	1.39E+02	1.58E+02	0.88
	Cr-51	2.12E+02	2.30E+02	0.92
	Cs-134	1.67E+02	1.98E+02	0.84
	Cs-137	1.58E+02	1.71E+02	0.93
	Fe-59	8.11E+01	8.65E+01	0.94
	I-131	8.09E+01	9.08E+01	0.89
	K-40	1.28E+03	Not Measured	---
	Mn-54	1.73E+02	1.83E+02	0.95
	Zn-65	1.65E+02	1.76E+02	0.93

Sample	Analysis	ENGINEERING Value, pCi	EZA Value, pCi	Ratio ENGINEERING: EZA
E14091 Cartridge	I-131	9.01E+01	9.03E+01	1.00

Sample	Analysis	ENGINEERING Value, pCi	EZA Value, pCi	Ratio ENGINEERING: EZA
E14092 Filter	Ce-141	6.81E+01	6.75E+01	1.01
	Co-58	1.73E+00	Not Measured	---
	Co-60	1.68E+02	1.26E+02	1.34
	Cr-51	1.82E+02	1.83E+02	0.99
	Cs-134	1.57E+02	1.57E+02	1.00
	Cs-137	1.32E+02	1.36E+02	0.97
	Fe-59	7.03E+01	6.86E+01	1.02
	Mn-54	1.44E+02	1.45E+02	0.99
	Zn-65	1.25E+02	1.40E+02	0.89

Sample	Analysis	ENGINEERING Value, pCi/g	EZA Value, pCi/g	Ratio ENGINEERING: EZA
E14093 Soil	Ce-141	1.06E-01	7.14E-02	1.48
	Co-58	-5.40E-03	Not Measured	---
	Co-60	1.21E-01	1.33E-01	0.91
	Cr-51	1.98E-01	1.94E-01	1.02
	Cs-134	2.06E-01	1.66E-01	1.24
	Cs-137	2.07E-01	2.09E-01	0.99
	Fe-59	6.30E-02	7.26E-02	0.87
	K-40	1.05E+00	Not Measured	---
	Mn-54	1.40E-01	1.53E-01	0.91
	Zn-65	1.49E-01	1.48E-01	1.01

Sample	Analysis	ENGINEERING Value, pCi	EZA Value, pCi	Ratio ENGINEERING: EZA
E14094 Filter	Sr-89	8.39E+01	9.06E+01	0.93
	Sr-90	1.17E+01	1.38E+01	0.85

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ANAB ACCREDITED ISO/IEC 17043 PROFICIENCY TESTING PROVIDER

RESULTS OF ENVIRONMENTAL CROSS CHECK PROGRAM

TELEDYNE BROWN

ENGINEERING

3rd QUARTER 2024

(Ref. Date 12 Sep 2024, Rev. 1)

L. Tk

18 Nov 2024

Levan Tkavadze, Nuclear Metrologist

Sample	Analysis	ENGINEERING Value, pCi	Uncertainty (1 Sigma)	EZA Value, pCi	Uncertainty (1 Sigma)	Ratio ENGINEERING: EZA
E14100 Filter	Sr-89	7.98E+01	4.33E+00	8.27E+01	1.38E+00	0.96
	Sr-90	1.20E+01	1.21E+00	1.36E+01	2.28E-01	0.88

Sample	Analysis	ENGINEERING Value, pCi/L	Uncertainty (1 Sigma)	EZA Value, pCi/L	Uncertainty (1 Sigma)	Ratio ENGINEERING: EZA
E14197 Liquid	Alpha (Am-241)	4.76E+01	8.90E+00	5.01E+01	8.37E-01	0.95
	Beta (Cs-137)	2.48E+02	1.51E+01	2.70E+02	4.50E+00	0.92

A.5
Client-Supplied Cross Check Program Results

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40781 Liquid	Ni-63	7.04E-04	9.89E-04	0.71	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi	EZA Value, uCi	Ratio [redacted] / EZA	Resolution	Comparison
A40782 Filter	Sr-89	9.65E-04	1.07E-03	0.90	17	AGREEMENT
	Sr-90	1.53E-04	1.72E-04	0.89	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40124 Liquid	Gross Beta (Cs-137)	1.04E-03	1.00E-03	1.04	17	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40125 Liquid	Gross Alpha (Am-241)	7.68E-05	7.07E-05	1.09	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40132 Liquid	Sr-89	7.66E-03	8.01E-03	0.96	17	AGREEMENT
	Sr-90	7.38E-04	8.28E-04	0.89	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40134 Liquid	Fe-55	1.30E-03	1.50E-03	0.86	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40042 Liquid TBE	Fe-55	1.46E-03	1.50E-03	0.97	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40043 Liquid TBE	H-3	1.13E-03	1.50E-03	0.75	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi	EZA Value, uCi	Ratio [redacted] / EZA	Resolution	Comparison
A40044 Filter TBE	Gross Alpha (Am-241)	9.68E-04	1.49E-03	0.65	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40036 Liquid TBE	Gross Beta (Cs-137)	1.61E-03	2.00E-03	0.81	17	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40037 Liquid TBE	H-3	1.31E-03	1.84E-03	0.71	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi	EZA Value, uCi	Ratio [redacted] / EZA	Resolution	Comparison
A40038 Filter TBE	Fe-55	3.81E-04	6.96E-04	0.55	12.5	DISAGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40039 Liquid TBE	Ni-63	1.03E-03	9.16E-04	1.12	12.5	AGREEMENT
	Sr-89	6.47E-03	7.07E-03	0.92	17	AGREEMENT
	Sr-90	7.08E-04	7.99E-04	0.89	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40040 Liquid TBE	Gross Alpha (Am-241)	4.62E-05	5.00E-05	0.92	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi	EZA Value, uCi	Ratio [redacted] / EZA	Resolution	Comparison
A40041 Filter TBE	Ce-141	1.30E-02	1.37E-02	0.95	20	AGREEMENT
	Co-60	6.51E-02	7.06E-02	0.92	20	AGREEMENT
	Cr-51	1.10E-01	1.22E-01	0.90	20	AGREEMENT
	Cs-134	4.07E-02	4.44E-02	0.92	20	AGREEMENT
	Cs-137	3.73E-02	4.07E-02	0.92	20	AGREEMENT
	Fe-59	4.89E-02	5.22E-02	0.94	20	AGREEMENT
	Mn-54	3.61E-02	3.91E-02	0.92	20	AGREEMENT
	Zn-65	1.79E-02	1.94E-02	0.92	20	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40045 Liquid TBE	Ce-141	6.46E-03	6.61E-03	0.98	20	AGREEMENT
	Co-58	6.05E-03	5.85E-03	1.03	20	AGREEMENT
	Co-60	9.40E-03	9.52E-03	0.99	20	AGREEMENT
	Cr-51	1.88E-02	1.86E-02	1.01	20	AGREEMENT
	Cs-134	4.26E-03	5.11E-03	0.83	20	AGREEMENT
	Cs-137	5.83E-03	6.20E-03	0.94	20	AGREEMENT
	Fe-59	7.90E-03	7.76E-03	1.02	20	AGREEMENT
	Mn-54	4.59E-03	4.80E-03	0.96	20	AGREEMENT
	Zn-65	7.22E-03	7.33E-03	0.98	20	AGREEMENT

Sample	Analysis	[redacted] Value, uCi	EZA Value, uCi	Ratio [redacted] / EZA	Resolution	Comparison
A40046 Filter TBE	Ni-63	6.77E-04	8.11E-04	0.83	12.5	AGREEMENT
	Sr-89	1.98E-03	2.54E-03	0.78	17	AGREEMENT
	Sr-90	1.74E-04	2.30E-04	0.76	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi	EZA Value, uCi	Ratio [redacted] / EZA	Resolution	Comparison
A40047 Filter TBE	Gross Beta (Cs-137)	1.64E-03	1.83E-03	0.90	17	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40178 Liquid	Fe-55	1.94E-03	2.00E-03	0.97	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40181 Liquid	Gross Alpha (Am-241)	5.93E-05	5.97E-05	0.99	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi	EZA Value, uCi	Ratio [redacted] / EZA	Resolution	Comparison
A40182 Filter	Sr-89	2.75E-03	3.82E-03	0.72	17	DISAGREEMENT
	Sr-90	2.85E-04	3.65E-04	0.78	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40499 Liquid TBE L105440	Ni-63	1.18E-03	9.15E-04	1.29	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi	EZA Value, uCi	Ratio [redacted] / EZA	Resolution	Comparison
A40500 Filter TBE L105440	Gross Alpha (Am-241)	1.04E-03	9.65E-04	1.08	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40501 Liquid TBE L105440	Sr-89	4.32E-03	4.52E-03	0.96	17	AGREEMENT
	Sr-90	4.20E-04	4.46E-04	0.94	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40315 Liquid	Sr-89	8.67E-03	1.00E-02	0.87	17	AGREEMENT
	Sr-90	8.12E-04	9.56E-04	0.85	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi	EZA Value, uCi	Ratio [redacted] / EZA	Resolution	Comparison
A40317 Filter	Gross Alpha (Am-241)	7.51E-04	5.99E-04	1.25	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi	EZA Value, uCi	Ratio [redacted] / EZA	Resolution	Comparison
A40502 Filter TBE L106606	Sr-89	2.52E-03	2.74E-03	0.92	17	AGREEMENT
	Sr-90	2.52E-04	2.83E-04	0.89	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi	EZA Value, uCi	Ratio [redacted] / EZA	Resolution	Comparison
A40321 Filter	Sr-89	5.19E-04	5.50E-04	0.94	17	AGREEMENT
	Sr-90	4.76E-05	5.43E-05	0.88	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40452 Liquid	Sr-89	4.74E-03	4.52E-03	1.05	17	AGREEMENT
	Sr-90	4.20E-04	4.46E-04	0.94	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40453 Liquid	Fe-55	9.40E-04	1.00E-03	0.94	12.5	AGREEMENT

ATTACHMENT B
Intralaboratory Quality Control Program Results

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B.1
TBE-ES QC Program In-House Water
Blanks, Spikes, and Matrix Spikes

ATTACHMENT B.1
TBE - ES QC Program
In-House Water Blanks and Spikes

Nuclide	# of Samples Analyzed	Blank Results	Spike Recovery % (Range*)	% of Samples Within 20% of Known Value
Am-241	47	All < MDC	70.0 - 110	59.6
C-14	73	All < MDC	72.6 - 122	91.8
Ce-144 (RAD)	23	All < MDC	NA	
Cs-137 (RAD)	26	All < MDC	81-129	80.8
Fe-55	118	All < MDC	72.5 - 128	95.8
Gross Alpha	166	All < MDC	70.2 - 128	75.9
Gross Beta	124	All < MDC	71.8 - 130	96.8
H-3	382	All < MDC [1]	70.5 - 129.6	97.6
I-129/131	99	All < MDC	72.0 - 125	89.9
Ni-63	125	All < MDC [1]	74.6 - 129.4	96.0
P-32	13	All < MDC	NA	
Pu-239/240	45	All < MDC	80.3-118.9	100
S-35	1	All < MDC	N/A	
Sr-89	139	All < MDC	73.0 - 130	95.7
Sr-90	168	All < MDC	71.0 - 128.7	96.4
Tc-99	38	All < MDC	74.7 - 117	97
Th-230	23	All < MDC	81.3 - 102	100
U-238	53	All < MDC	77.1 - 109.6	98

*Internal Process Control results use TBE-ES acceptance criteria of 70 -130% recovery
[1]Except for one positive blank - qualified on report of analysis

Matrix Spikes

Nuclide	Count Date	Sample Result (pCi/L)	Spiked Result (pCi/L)	Spike Value (pCi/L)	% Recovery**
Fe-55	01/05/24	<70.6	2189	1740	126
Fe-55	04/25/24	<69.1	2020	1590	127
Fe-55	08/06/24	<109	1694	1490	114
Fe-55	11/4/2024	<121	1664	1400	119
Gr-A	04/18/24	1.96	42.3	42.8	94.3
Gr-A	07/25/24	2.50	39.4	42.7	86.4
Gr-A	10/31/2024	2.68	39.8	42.7	86.9
Gr-B	04/22/24	14.2	68.7	52.8	103
Gr-B	07/25/24	12.4	73.9	52.5	117
Gr-B	11/1/2024	15.7	68.9	52.2	102
H-3	04/20/24	<285	3540	3430	103
H-3	07/30/24	<299	4000	3380	118
H-3	11/4/2024	<293	3720	3330	112
Ni-63	01/08/24	13.3	939	855	108
Ni-63	04/30/24	<4.91	935	853	110
Ni-63	08/01/24	<4.04	670	851	79
Ni-63	11/6/2024	<4.71	811	850	95
Pb-210	10/1/2024	0.343	27.4	22.1	122.3
Sr-89	04/24/24	< 8.66	152	148	103
Sr-89	07/31/24	< 8.86	52.9	42.7	124
Sr-89	11/13/2024	<4.61	21.9	22.9	96
Sr-90	04/24/24	< 0.85	44.6	51.3	87
Sr-90	07/31/24	< 0.895	48.4	51.0	95
Sr-90	11/13/2024	<0.748	44	51	86.5

**Internal Process Control results use TBE-ES acceptance criteria of 60 -140% recovery

B.2
TBE-ES QC Program In-House
Duplicates

ATTACHMENT B.2

TBE - ES QC Program In-House Duplicates*

Matrix	Nuclide	# of Dups Analyzed	# Samples Evaluated for RPD**	RPD Range	RPD Upper Limit
Air Particulates	Be-7 (Gamma)	55	6	1.9 - 18.5	30
	Gross Alpha	75	30	0.3 - 25.1	30
	Gross Beta	500	256	0.0 - 29.1	30
	Sr-89	69	8	0.8 - 17.4	30
	Sr-90	69	7	4.9 - 8.5	30
Animals	Be-7 (Gamma)	1	0		50
	K-40 (Gamma)	1	1	21.9	50
Charcoal	I-131 (Gamma)	302	4	1.9	50
Feed/Food/Grass/Veg	Be-7 (Gamma)	48	14	1.9 - 28.7	50
	K-40 (Gamma)	52	52	0.7 - 21.3	50
Fish/Shellfish/SF	Be-7 (Gamma)	18	0		50
	K-40 (Gamma)	19	15	1.4 - 38.1	50
Milk	K-40 (Gamma)	58	58	0.5 - 27.8	30
Sediment/Solid	C-14	3	2	10.8 - 43.5	50
	H-3	4	2	2.4 - 3.8	50
	K-40 (Gamma)	22	17	0.3 - 29.7	50
Water/Liquid	Fe-55	7	3	3.4	30
	Gross Alpha	34	4	14.0 - 18.9	30
	Gross Beta	49	8	3.1 - 14.4	30
	H-3	268	35	0.2 - 19.5	30
	K-40 (Gamma)	103	15	0.1 - 25.5	30
	Ni-63	5	0		30
	Sr-89	6	2	2.8	30
	Sr-90	6	2	4.7	30
LO/LR	C-14	6	0		30
	H-3	15	5		30
LCSD's	Am-241 (AS)	42	42	0.0 - 20.4	30
	C-14	61	61	0.4 - 27.5	30
	Cs-137 (RAD)	26	26	0.6-85.1	30
	Fe-55	97	97	0.0 -26.4	30
	Gross Alpha	53	53	0.0 - 29.1	30
	Gross Beta	47	47	0.0 - 27.1	30
	H-3	112	112	0.4 - 24.5	30
	I-129	99	99	0.4 - 29.7	30
	Ni-63	110	110	0.0 - 23.0	30
	Pu-239/240 (AS)	37	37	0.1 - 26.8	30
	Sr-89	52	52	0.4 - 27.8	30
	Sr-90	76	76	0.0 - 28.9	30
	Tc-99	36	36	0.0 - 13.3	30
	Th-230 (AS)	15	26	0.4 - 13.9	30
	U-238 (AS)	46	46	0.2 - 16.9	30
MSD's	PB-210	1	1	17.3	*50*

**NOTE: Duplicates listed for Gamma analyses are only for nuclides reported in QC data packages (All Gamma nuclides are duplicated at the time of analysis)*

***Precision is not evaluated if results are < 5x MDC **or** if both results are non-detect*

ATTACHMENT C
Non-Conformance Reports (NCRs)

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TELEDYNE BROWN ENGINEERING

NONCONFORMANCE REPORT (NCR) FORM

NCR No.: 24-01

Responsible Manager: Victoria Leslie

PART 1. TO BE COMPLETED BY ORIGINATOR OF NCR	
Initiated due to: ☒ Customer Complaint ☐ Audit/Mgmt Rept ☒ XCHK Failure ☐ Staff Observation	
Process Area: Inplant lab	Client/Project Affected: Exelon: Peach Bottom
Requirement Reference: TBE-4006	Affected Data: L# L104169
NCR Description: Fe-55 crosscheck in disagreement with known results.	
Client Notification Needed: ☒ YES ☐ NO	Associated CAR or CC #: CC 24-01, CAR 24-01
Prepared By: Victoria Leslie	Date: 03/11/24

PART 2. TO BE COMPLETED BY ROOT CAUSE INVESTIGATOR	
Root Cause: The volume of carrier added to the sample was incorrectly entered into LIMS. See Supplemental Sheet attached	
Corrective Action Plan: See CAR 24-01 – LIMS programming – pop-up notification on the carrier tab of the aliquot volume screen to alert the lab technician entering the information to verify carrier volumes.	
Planned Completion Date(s) for Actions(s): ~~8/15/24~~ SW 08/15/24	
Prepared By: Karli Arterburn	Date: 06/28/24
Approved By: Sharon L Northcutt	Date: 07/02/24

PART 3. TO BE COMPLETED BY QUALITY ASSURANCE MANAGER	
Review and Verification of Corrective Action: ☑ Accepted ☐ Rejected ☐ Follow-up Needed (describe) ☐ Completed	
Prepared By: Sharon L Northcutt	Date: 07/02/24

PART 4. TO BE COMPLETED BY RESPONSIBLE MANAGER	
Client Follow-Up Notification: ☑ YES ☐ NO Description: emailed NCR	Date: 7/2/24
Prepared By:	Date: 7/2/24

Supplemental Sheet

NCR No: 24-01

Description of Nonconformance:

The 1Q24 client AP Fe-55 cross check result was not acceptable. TBE's reported result was 3.81E-04 µCi and the known value was 6.98E-04 (55% ratio). The acceptance range (12.5 resolution) was 4.19E-04 – 1.16E-03 µCi.

Root Cause Investigation:

All QC with the associated sample was reviewed and no anomalies were found. The original sample was run as WG44130 duplicate. The RPD was acceptable but higher between the two results and there was a request to recount and reanalyze the sample. The initial sample aliquot for the digested sample was 30% and 15% was used for the reanalysis so as to not consume the sample.

The results were as follows:

Count Date	Aliquot	Sample ID	Result	Ratio to Known
02/22/24	30%	L104163-3	5.52E-04	79.1%
02/22/24	30%	WG44130 DUP	8.12E-04	116.4%
03/01/24	30%	WG44130 DUP C1	6.56E-04	93.9%
03/01/24	15%	L104163-3R1	3.81E-04	54.6%
03/01/24	15%	WG44197 DUP	3.43E-04	49.1%
03/01/24	15%	L104163-3R1	5.72E-04	81.9% (reprocessed 06/24)
03/01/24	15%	WG44197 DUP	5.15E-04	73.7% (reprocessed 06/24)

All of the original results would have been acceptable. In the course of the investigation, it was discovered that the carrier volume for the reanalysis sample and WG DUP were entered incorrectly. Our typical AP client samples include analysis for several nuclides. In this case, it was only for Fe-55 and the carrier is added during the digestion step. The LIMS does not enable the lab tech to enter the carrier volume until after the digestion is complete and the incorrect volume was inadvertently entered as the same volume as the other samples in the workgroup.

Corrective Action to Prevent Recurrence:

A request has been submitted to the LIMS programmer to add a pop-up screen to the aliquot tab that will not allow carrier volumes to be entered without confirmation by the lab tech when crosschecks are included in a workgroup..

Department Manager or Designee — Date: 6/28/24

Quality Assurance Manager or Designee — Date: 07/02/24

TELEDYNE BROWN ENGINEERING

NONCONFORMANCE REPORT (NCR) FORM

NCR No.: 24-02

Responsible Manager: Sharon Northcutt

PART 1. TO BE COMPLETED BY ORIGINATOR OF NCR	
Initiated due to: ☐ Customer Complaint ☐ Audit/Mgmt Rept ☒ XCHK Failure ☐ Staff Observation	
Process Area: Environmental Lab	Client/Project Affected: TBE XCHK
Requirement Reference: TBE-4006	Affected Data: L# 104697
NCR Description: Unacceptable XCHK result for AP Am-24	
Client Notification Needed: ☐ YES ☒ NO	Associated CAR or CC #: CAR 24-03
Prepared By: Sharon Northcutt	Date: 05/21/24

PART 2. TO BE COMPLETED BY ROOT CAUSE INVESTIGATOR	
Root Cause: Sample was not logged originally for Am-241. Therefore it was not prepped with Am-243 tracer.	
Corrective Action Plan: See CAR 24-07 (login / AM review)	
Planned Completion Date(s) for Actions(s): 06/05/24	
Prepared By: Sharon L Northcutt	Date:
Approved By: Keith Jeter	Date: 6/5/24

PART 3. TO BE COMPLETED BY QUALITY ASSURANCE MANAGER	
Review and Verification of Corrective Action: ☑ Accepted ☐ Rejected ☐ Follow-up Needed (describe) ☐ Completed	
Prepared By: Sharon L Northcutt	Date: 06/05/24

PART 4. TO BE COMPLETED BY RESPONSIBLE MANAGER	
Client Follow-Up Notification: ☐ YES ☑ NO Description:	Date:
Prepared By: Sharon L Northcutt	Date: 06/05/24

MRAD-40 Final Evaluation Report

A Waters Company

Sharon Northcutt
QA Manager
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
(865) 934-0374

EPA ID: TN11387
ERA Customer Number: T200801
Report Issued: 05/21/2024
Study Dates: 03/18/2024 - 05/17/2024

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
MRAD Air Filter Radionuclides (cat# 800, lot# A040-606)												
2755	Americium-241	pCi/Filter	38.8	55.0	39.3 - 73.3	Not Acceptable	HASL 300 Am-01 28th ED 1997	4/26/2024	-1.99	55.2	8.22	Shannon Cooper
2800	Cesium-134	pCi/Filter		273	177 - 335	Not Reported				248	32.3	
2805	Cesium-137	pCi/Filter		106	87.1 - 139	Not Reported				114	10.7	
2815	Cobalt-60	pCi/Filter		1120	962 - 1420	Not Reported				1190	85.4	
2885	Iron-55	pCi/Filter	387	386	141 - 616	Acceptable	TBE Proprietary	4/10/2024	1.06	332	52.3	Shannon Cooper
2905	Manganese-54	pCi/Filter		< 35.0	0.00 - 35.0	Not Reported						
2930	Plutonium-238	pCi/Filter	45.9	41.1	31.0 - 50.5	Acceptable	HASL 300 Pu-02 28th Ed 1997	4/25/2024	1.34	42.4	2.64	Shannon Cooper
2932	Plutonium-239	pCi/Filter	54.9	56.1	41.9 - 67.7	Acceptable	HASL 300 Pu-02 28th Ed 1997	4/25/2024	-0.337	55.8	2.57	Shannon Cooper
3005	Strontium-90	pCi/Filter		158	99.9 - 215	Not Reported				165	13.9	
3036	Uranium-234	pCi/Filter	11.1	11.6	8.60 - 13.6	Acceptable	HASL 300 U-02 28th ED 1997	4/25/2024	-0.857	11.5	0.499	Shannon Cooper
3038	Uranium-238	pCi/Filter	12.8	11.5	8.68 - 13.7	Acceptable	HASL 300 U-02 28th ED 1997	4/25/2024	1.47	11.8	0.697	Shannon Cooper
3055	Uranium-Total	pCi/Filter		23.6	17.2 - 28.0	Not Reported				23.6	0.741	
1184	Uranium (mass)	µg/Filter		34.4	27.6 - 40.3	Not Reported				35.5	1.76	
3070	Zinc-65	pCi/Filter		77.2	63.3 - 118	Not Reported				91.4	9.90	
MRAD Air Filter Gross Alpha/Beta (cat# 801, lot# A040-607)												
2830	Gross Alpha	pCi/Filter	116	95.9	50.1 - 158	Acceptable	EMSL-LV p. 1 1979	4/17/2024	1.20	100	13.3	Susan Ogletree
2840	Gross Beta	pCi/Filter	42.1	22.2	13.5 - 33.5	Not Acceptable	EMSL-LV p. 1 1979	4/17/2024	1.55	27.9	9.15	Susan Ogletree

TELEDYNE BROWN ENGINEERING

Corrective Action Request & Report

CAR NO.: 24-03

SECTION 1 (To be completed by initiator)

Initiator Name: Sharon Northcutt | **Date:** 05/21/24

Identified Through: ☒ Daily Operations ☐ Management Review ☐ Audit ☐ Client Feedback ☐ Other
(check one)

Corrective action is requested to address the following condition:

Failed cross-check for AP Am-241.

Manager Acknowledgement: | **Date:**

SECTION 2 (To be completed by Quality Assurance Manager)

Assigned to: Keith Jeter | **Priority:** ☐ High ☒ Medium ☐ Low | **Date:** 05/21/24

Requested date for root cause investigation: 06/21/24

NCR # 24-02 **(if applicable)**

Comments: Sample not logged for Am-241 originally and filter was not digested w/ Am-243 tracer.

SECTION 3 (To be completed by Assignee - attach additional information as necessary)

Relevant background information collected? ☐ Yes | **Existing processes investigated and understood?** ☐ Yes

Summary of Proposed Action(s): See CAR 24-07 – remind login to use most current sample to copy for log in template. QA/PM to review logins more carefully.

Documents Requiring Update: N/A

Solution approval signature(s): Sharon L Northcutt

SECTION 4 (To be completed by Quality Assurance Manager)

Documents Updated? ☐ Yes N/A | **Has the solution been effective?** ☐ Yes ☐ No | **Date Closed:**

Closing Comments: *(If the corrective action has not been effective, reference the new corrective action form to readdress the problem area.)*

TELEDYNE BROWN ENGINEERING

NONCONFORMANCE REPORT (NCR) FORM

NCR No.: 24-03

Responsible Manager: Sharon Northcutt

PART 1. TO BE COMPLETED BY ORIGINATOR OF NCR	
Initiated due to: ☐ Customer Complaint ☐ Audit/Mgmt Rept ☒ XCHK Failure ☐ Staff Observation	
Process Area: Count Room	Client/Project Affected: TBE XCHK
Requirement Reference: TBE-4006	Affected Data: L# 104697
NCR Description: Unacceptable XCHK result for AP Gr-B	
Client Notification Needed: ☐ YES ☒ NO	Associated CAR or CC #: CAR 24-04
Prepared By: Sharon Northcutt	Date: 05/21/24

PART 2. TO BE COMPLETED BY ROOT CAUSE INVESTIGATOR	
Root Cause: See Supplemental Sheet.	
Corrective Action Plan: See CAR 24-04	
Planned Completion Date(s) for Actions(s):	
Prepared By: Keith Geter	Date: 8/1/24
Approved By: Sharon Labarthcutt	Date: 08/01/24

PART 3. TO BE COMPLETED BY QUALITY ASSURANCE MANAGER	
Review and Verification of Corrective Action: ☑ Accepted ☐ Rejected ☐ Follow-up Needed (describe) ☐ Completed	
Prepared By: Sharon Labarthcutt	Date: 08/01/24

PART 4. TO BE COMPLETED BY RESPONSIBLE MANAGER	
Client Follow-Up Notification: ☐ YES ☑ NO Description:	Date:
Prepared By: Kristin Laacock	Date: 08/01/2024

MRAD-40 Final Evaluation Report

ERA
A Waters Company

Sharon Northcutt
QA Manager
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
(865) 934-0374

EPA ID: TN11387
ERA Customer Number: T200801
Report Issued: 05/21/2024
Study Dates: 03/18/2024 - 05/17/2024

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
MRAD Air Filter Radionuclides (cat# 800, lot# A040-606)												
2755	Americium-241	pCi/Filter	38.8	55.0	39.3 - 73.3	Not Acceptable	HASL 300 Am-01 28th ED 1997	4/26/2024	-1.99	55.2	8.22	Shannon Cooper
2600	Cesium-134	pCi/Filter		273	177 - 335	Not Reported				248	32.3	
2805	Cesium-137	pCi/Filter		106	87.1 - 139	Not Reported				114	10.7	
2815	Cobalt-60	pCi/Filter		1120	952 - 1420	Not Reported				1190	85.4	
2885	Iron-55	pCi/Filter	387	386	141 - 616	Acceptable	TBE Proprietary	4/10/2024	1.06	332	52.3	Shannon Cooper
2905	Manganese-54	pCi/Filter		< 35.0	0.00 - 35.0	Not Reported						
2930	Plutonium-238	pCi/Filter	45.9	41.1	31.0 - 50.5	Acceptable	HASL 300 Pu-02 28th Ed 1997	4/25/2024	1.34	42.4	2.64	Shannon Cooper
2932	Plutonium-239	pCi/Filter	54.9	56.1	41.9 - 67.7	Acceptable	HASL 300 Pu-02 28th Ed 1997	4/25/2024	-0.337	55.8	2.57	Shannon Cooper
3005	Strontium-90	pCi/Filter		158	99.9 - 215	Not Reported				165	13.9	
3036	Uranium-234	pCi/Filter	11.1	11.6	8.60 - 13.6	Acceptable	HASL 300 U-02 28th ED 1997	4/25/2024	-0.857	11.5	0.499	Shannon Cooper
3038	Uranium-238	pCi/Filter	12.8	11.5	8.68 - 13.7	Acceptable	HASL 300 U-02 28th ED 1997	4/25/2024	1.47	11.8	0.697	Shannon Cooper
3055	Uranium-Total	pCi/Filter		23.6	17.2 - 28.0	Not Reported				23.6	0.741	
1184	Uranium (mass)	µg/Filter		34.4	27.6 - 40.3	Not Reported				35.5	1.76	
3070	Zinc-65	pCi/Filter		77.2	63.3 - 118	Not Reported				91.4	9.90	
MRAD Air Filter Gross Alpha/Beta (cat# 801, lot# A040-607)												
2830	Gross Alpha	pCi/Filter	116	95.9	50.1 - 158	Acceptable	EMSL-LV p. 1 1979	4/17/2024	1.20	100	13.3	Susan Ogletree
2840	Gross Beta	pCi/Filter	42.1	22.2	13.5 - 33.5	Not Acceptable	EMSL-LV p. 1 1979	4/17/2024	1.55	27.9	9.15	Susan Ogletree

Supplemental Sheet

NCR No: 24-03

Description of Nonconformance:

The 1Q24 ERA MRAD cross-check for AP gross beta was not acceptable. The reported result was 42.1 pCi and the known value was 22.2 pCi (acceptance range of 13.5 – 33.5). The reported to known ratio was 190%.

Root Cause Investigation:

All QC associated with the original sample was acceptable and no anomalies were found. This sample was used as the WG duplicate with a result of 42.5 pCi. Both were counted on the same detector. Upon comparison to historical sample data, the alpha activity of this ERA submitted sample was the highest assigned result, and the beta activity was the lowest. Therefore, the alpha-to-beta crosstalk was more significant than normal, causing the beta activity to report falsely high data.

Corrective Action to Prevent Recurrence:

The counting room laboratory staff will adjust the alpha-to-beta crosstalk via correction calculation measures when high alpha activities are observed.

Keith Peter — 8/1/24

Department Manager or Designee — Date

Kristin Peacock — 08/01/2024

Quality Assurance Manager or Designee — Date

TELEDYNE BROWN ENGINEERING

Corrective Action Request & Report

CAR NO.: 24-04

SECTION 1 (To be completed by initiator)

Initiator Name: Sharon Northcutt | **Date:** 05/21/24

Identified Through: ☒ Daily Operations ☐ Management Review ☐ Audit ☐ Client Feedback ☐ Other (check one)

Corrective action is requested to address the following condition:

Failed cross-check for AP Gross Beta.

Manager Acknowledgement: Sharon L Northcutt | **Date:** 05/21/24

SECTION 2 (To be completed by Quality Assurance Manager)

Assigned to: Keith Jeter | **Priority:** ☐ High ☒ Medium ☐ Low | **Date:** 05/21/24

Requested date for root cause investigation: ~~06/21/24~~ moved to 08/01/24 due to staffing & longer investigation

NCR # 24-03 **(if applicable)**

Comments: See NCR 24-03 for investigation notes

SECTION 3 (To be completed by Assignee - attach additional information as necessary)

Relevant background information collected? ☑ Yes | **Existing processes investigated and understood?** ☑ Yes

Summary of Proposed Action(s):

Counting room laboratory staff will adjust the alpha-to-beta crosstalk via correction calculation measures when high alpha activities are observed.

Documents Requiring Update: N/A

Solution approval signature(s): Sharon L Northcutt

SECTION 4 (To be completed by Quality Assurance Manager)

Documents Updated? ☐ Yes N/A | **Has the solution been effective?** ☐ Yes ☐ No | **Date Closed:**

Closing Comments: *(If the corrective action has not been effective, reference the new corrective action form to readdress the problem area.)*

ERA MRAD 41 XCHK result for Gr B in AP returned "Acceptable"

MRAD-41 Final Evaluation Report

ERA
A Waters Company

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Knoxville, TN 37931
(865) 934-0374

EPA ID: TN11387
ERA Customer Number: T200801
Report Issued: 11/18/2024
Study Dates: 09/16/2024 - 11/15/2024

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
MRAD Air Filter Radionuclides (cat# 800, lot# A041-606)												
2755	Americium-241	pCi/Filter	27.0	29.1	20.8 - 36.8	Acceptable	HASL 300 Am-01 28th ED 1997	9/30/2024	-0.997	30.4	3.44	Shannon Cooper
2800	Cesium-134	pCi/Filter		581	377 - 712	Not Reported				514	65.2	
2805	Cesium-137	pCi/Filter		848	698 - 1110	Not Reported				898	67.4	
2815	Cobalt-60	pCi/Filter		839	713 - 1070	Not Reported				893	65.5	
2885	Iron-55	pCi/Filter	644	800	292 - 1280	Acceptable	TBE Proprietary	10/8/2024	-0.0240	651	292	Shannon Cooper
2905	Manganese-54	pCi/Filter		< 35.0	0.00 - 35.0	Not Reported						
2930	Plutonium-238	pCi/Filter	22.3	21.5	16.2 - 26.4	Acceptable	HASL 300 Pu-02 28th ED 1997	9/30/2024	-0.662	22.8	0.781	Shannon Cooper
2932	Plutonium-239	pCi/Filter	30.6	32.4	24.2 - 39.1	Acceptable	HASL 300 Pu-02 28th ED 1997	9/30/2024	-0.498	32.2	3.13	Shannon Cooper
3005	Strontium-90	pCi/Filter		105	66.4 - 143	Not Reported				113	13.1	
3036	Uranium-234	pCi/Filter	14.0	31.1	23.1 - 35.4	Not Acceptable	HASL 300 U-02 28th ED 1997	10/24/2024	-7.16	30.9	2.37	Shannon Cooper
3038	Uranium-238	pCi/Filter	14.2	30.9	23.3 - 36.9	Not Acceptable	HASL 300 U-02 28th ED 1997	10/24/2024	-10.7	30.0	1.47	Shannon Cooper
3065	Uranium-Total	pCi/Filter		63.4	46.3 - 75.2	Not Reported				62.0	3.14	
1184	Uranium (mass)	µg/Filter		92.5	74.2 - 108	Not Reported				93.0	8.07	
3070	Zinc-65	pCi/Filter		239	196 - 365	Not Reported				278	25.8	
MRAD Air Filter Gross Alpha/Beta (cat# 801, lot# A041-607)												
2830	Gross Alpha	pCi/Filter	80.0	72.4	37.8 - 119	Acceptable	EMSL-LV p. 1 1979	10/9/2024	0.583	74.6	9.30	Susan Ogletree
2840	Gross Beta	pCi/Filter	57.5	47.9	29.0 - 72.4	Acceptable	EMSL-LV p. 1 1979	10/9/2024	0.434	54.2	7.68	Susan Ogletree

TELEDYNE BROWN ENGINEERING

NONCONFORMANCE REPORT (NCR) FORM

NCR No.: 24-04

Responsible Manager: Victoria Leslie

PART 1. TO BE COMPLETED BY ORIGINATOR OF NCR	
Initiated due to: ☒ Customer Complaint ☐ Audit/Mgmt Rept ☐ XCHK Failure ☐ Staff Observation	
Process Area: Environmental Lab Prep	Client/Project Affected: P61 Braidwood
Requirement Reference: TBE-1018	Affected Data: L# L104399
NCR Description: C-14 reanalysis results are not confirming each other.	
Client Notification Needed: ☒ YES ☐ NO	Associated CAR or CC #: CC 24-02
Prepared By: Victoria Leslie	Date: 05/29/24

PART 2. TO BE COMPLETED BY ROOT CAUSE INVESTIGATOR	
Root Cause: Sample switching in count room	
Corrective Action Plan: N/A – See Supplemental Sheet	
Planned Completion Date(s) for Actions(s): N/A	
Prepared By: Sharon L Northcutt	Date: 07/03/24
Approved By: Keith Jete	Date: 7/16/24

PART 3. TO BE COMPLETED BY QUALITY ASSURANCE MANAGER	
Review and Verification of Corrective Action: ☑ Accepted ☐ Rejected ☐ Follow-up Needed (describe) ☐ Completed	
Prepared By: Sharon L Northcutt	Date: 07/03/24

PART 4. TO BE COMPLETED BY RESPONSIBLE MANAGER	
Client Follow-Up Notification: ☑ YES ☐ NO Description:	Date: 07/17/24
Prepared By: VL	Date: 07/17/24

Supplemental Sheet

NCR No: 24-04

Description of Nonconformance:

Client Complaint CC 24-02 was initiated due to two samples with unexpectedly high C-14 results. Both samples were reanalyzed and one (-4) confirmed the original result. With subsequent recounting and reanalyses, the second sample (-7) result did not agree with the original reported result.

Root Cause Investigation:

The two samples in question were counted originally on 03/15/24. After reviewing historical data, they were both reanalyzed prior to the final report being sent. The original result only for -4 was included on the client report. Part of TBE's review process is to compare results with prior historical results. The decision to report the R1 for -7 was due to a better historical match. After the client asked for a review of the analyses, the sample was reanalyzed twice and the reported sample was recounted. All results are as follows:

L104399-7	<5.88E-05	03/15/24	(Not included in original report)
L104399-7R1	2.04E-03	03/24/24	(Reported 03/28/24)
L104399-7R2	<4.16E-05	05/14/24	(Revision reported 05/29/24)
L104399-7R3	<2.62E-05	05/22/24	(Revision reported 05/29/24)
L104399-8R1C1	<2.62E-05	05/29/24	(Not included in revised report)

sw 7

After reviewing the data for all samples in each workgroup, it appears that the sample was inadvertently switched in the count room with another sample. It could not be determined how this happened as the recount result for the sample was consistent with all other counts done. All QC associated with all sample analyses was acceptable.

Corrective Action to Prevent Recurrence:

The count room technician was made aware of the sample switching issue. The count room processes approximately 50,000 analyses per year. This error has occurred 8 times since 2016, with only one prior to this event since 2020. The data reviewers did due diligence in comparing historical data and felt that the correct result was originally reported. Both areas of the lab are operating in a manner consistent with procedures and QA Manual requirements. No effective corrective action can be taken.

Keith Jeter — 7/16/24

Department Manager or Designee — Date

Sharon L Northcutt — 07/03/24

Quality Assurance Manager or Designee — Date

CUSTOMER COMPLAINT FORM

GENERAL INFORMATION

CC number: 24-02

Date of complaint: 05/08/24	Complaint logged by: Victoria Leslie
Associated L#/Work Group: L104399	Client Contact Name: Michael Gagnon
Related NCR (if applicable): 24-04	Client/Project Name: [redacted]

DETAILS

Complaint: -4 and -7 had higher than expected C-14 ratio to Co-60 (greater than 1:1)

Cause: Sample -4 confirmed on recount
Sample -7 didn't confirm (NCR 24-04) due to sample switching in count room

Resolution: Sample -7 recounted, reanalyzed and revised report sent to client.

REVIEW BY QUALITY ASSURANCE MANAGER

Reviewed by: Sharon L Northcutt	Date: 07/03/24

REVIEW BY LABORATORY OPERATIONS MANAGER

Reviewed by: Keith Gee	Date: 7/16/24

TELEDYNE BROWN ENGINEERING

NONCONFORMANCE REPORT (NCR) FORM

NCR No.: 24-05

Responsible Manager: Sharon Northcutt

PART 1. TO BE COMPLETED BY ORIGINATOR OF NCR	
Initiated due to: ☐ Customer Complaint ☐ Audit/Mgmt Rept ☒ XCHK Failure ☐ Staff Observation	
Process Area: Environmental Prep	Client/Project Affected: N/A
Requirement Reference: TBE-4006	Affected Data: L#104976
NCR Description: Failed cross-check for WO Gr-A	
Client Notification Needed: ☐ YES ☒ NO	Associated CAR or CC #: CAR 24-06
Prepared By: Sharon Northcutt	Date: 05/28/24

PART 2. TO BE COMPLETED BY ROOT CAUSE INVESTIGATOR	
Root Cause: See Supplemental Sheet	
Corrective Action Plan: Change aliquot volume. New Th-230 attenuation curve. Purchase additional XCHK for GR-A (Am-241)	
Planned Completion Date(s) for Actions(s): 09/01/24	
Prepared By: Sharon L Northcutt	Date: 07/26/24
Approved By: Keith Jeter	Date: 7/26/24

PART 3. TO BE COMPLETED BY QUALITY ASSURANCE MANAGER	
Review and Verification of Corrective Action: ☑ Accepted ☐ Rejected ☐ Follow-up Needed (describe) ☐ Completed	
Prepared By: Sharon L Northcutt	Date: 07/26/24

PART 4. TO BE COMPLETED BY RESPONSIBLE MANAGER	
Client Follow-Up Notification: ☐ YES ☑ NO QA Rept.	Date:
Description:	
Prepared By: Sharon L Northcutt	Date: 07/26/24

RAD-137 Final Evaluation Report

ERA
A Waters Company

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2508 Quality Ln.
Knoxville, TN 37931
(865) 934-0374

EPA ID: TN11387
ERA Customer Number: T200801
Report Issued: 05/25/2024
Study Dates: 04/08/2024 - 05/23/2024

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
RAD Gamma EmitterS™ (cat# 808, lot# R137-758)												
2765	Barium-133	pCi/L	62.8	65.9	50.1 - 81.7	Acceptable	EPA 901.1 1980	4/26/2024	-0.464	64.2	3.05	Shannon Cooper
2600	Cesium-134	pCi/L	51.0	57.8	42.8 - 72.8	Acceptable	EPA 901.1 1980	4/24/2024	-1.27	57.2	4.86	Shannon Cooper
2805	Cesium-137	pCi/L	153	186	149 - 223	Acceptable	EPA 901.1 1980	4/24/2024	-2.72	186	12.1	Shannon Cooper
2815	Cobalt-60	pCi/L	92.1	98.8	79.7 - 118	Acceptable	EPA 901.1 1980	4/26/2024	-1.77	100	4.57	Shannon Cooper
3070	Zinc-65	pCi/L	208	240	188 - 292	Acceptable	EPA 901.1 1980	4/24/2024	-2.22	244	16.1	Shannon Cooper
RAD GroSS™ Alpha/Beta (cat# 809, lot# R137-759)												
2830	Gross Alpha	pCi/L	35.2	52.6	39.6 - 65.6	Not Acceptable	EPA 900.0 (GPC) 1 2018	5/9/2024	-1.00	44.8	9.57	Susan Ogletree
2840	Gross Beta	pCi/L	49.0	46.5	33.9 - 59.1	Acceptable	EPA 900.0 (GPC) 1 2018	5/9/2024	1.84	41.2	4.26	Susan Ogletree
RAD NaturalS™ (cat# 811, lot# R137-751)												
2965	Radium-226	pCi/L		13.4	11.1 - 15.7	Not Reported				13.9	2.09	
2970	Radium-228	pCi/L		6.24	4.17 - 8.31	Not Reported				6.38	0.867	
3055	Uranium (activity)	pCi/L	55.99	59.3	52.8 - 65.8	Acceptable	EPA 908.0 1980	5/1/2024	-0.527	57.6	3.11	Shannon Cooper
1184	Uranium (mass)	µg/L		86.5	76.9 - 96.1	Not Reported				85.7	3.65	
RAD TritiuM™ (cat# 812, lot# R137-752)												
3030	Tritium	pCi/L	19000	21300	18200 - 24400	Acceptable	EPA 906.0 1980	4/16/2024	-1.88	20600	859	Susan Ogletree
RAD Strontium-89/90 (cat# 807, lot# R137-757)												
2995	Strontium-89	pCi/L	48.9	52.2	37.8 - 66.6	Acceptable	EPA 905.0 1980	4/24/2024	0.223	45.5	15.4	Shannon Cooper
3005	Strontium-90	pCi/L	32.6	37.6	32.0 - 43.2	Acceptable	EPA 905.0 1980	4/24/2024	-0.735	35.7	4.25	Shannon Cooper
RAD Iodine-131 (cat# 810, lot# R137-750)												
2875	Iodine-131	pCi/L	21.8	25.1	21.7 - 28.5	Acceptable	SM 7500-I C (GPC)-2000 2000	4/16/2024	-1.41	25.6	2.70	Shannon Cooper

060324G Final Evaluation Report

ERA
A Waters Company

Sharon Northcutt
QA Manager
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
(865) 934-0374

EPA ID: TN11387
ERA Customer Number: T200801

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
RAD GroSS™ Alpha/Beta (cat# 759, lot# 060324G) Study Dates: 06/03/2024 - 07/22/2024 (NELAC: Results reported after 45 days.)												
2830	Gross Alpha	pCi/L	40.3	30.0	21.5 - 38.5	Not Acceptable	EPA 900.0 (GPC) 1 2018	7/4/2024				Susan Ogletree
2840	Gross Beta	pCi/L		16.5	9.92 - 23.1	Not Reported						

Supplemental Sheet

NCR No: 24-05

Description of Nonconformance:

The 1Q24 ERA RAD cross-check for gross alpha water was not acceptable. The reported result was 35.2 pCi/L and the known value was 52.6 pCi/L (acceptance range of 39.6 – 65.6). The reported to known ratio was 67%. TBE reported the WG dup result – the original result would have been acceptable at 90% of the known. This is the 2nd unacceptable result in a row. The previous reported result was also low at 76%.

Root Cause Investigation:

The initial workgroup sample prep was unacceptable due to the unusually high mount weights and the workgroup had to be reprepped. The R1 WG had acceptable results for the blank, spike and duplicate (ERA crosscheck). The results for the sample and WG DUP were 30.6 ± 6.71 and 35.2 ± 7.09 pCi/L respectively. After receiving the "not acceptable" result on the report, the sample was logged in again with a result of 57.1 ± 11.5 pCi/L (which is in the passing range and 108% of the known). All of these samples were counted 50 minutes each.

A QuiKResponse cross check was ordered upon receiving the "not acceptable" result. The initial prep of this sample and workgroup also had unusually high mount weights and they were all reprepped using a 100-mL aliquot instead of 190 mL. The 2nd prep resulted in acceptable mount weights. The cross-check sample was used as a WG duplicate and was counted for 200 minutes. The results for the sample and WG DUP were 34.3 ± 6.61 and 40.3 ± 7.09 pCi/L. These samples were also counted on another detector with results of 34.1 ± 6.92 and 39.1 ± 7.40 pCi/L respectively. TBE chose to report the (higher) 40.3 result, which was not acceptable (134% ratio).The known result was 30.0 with an acceptance range of 21.5 - 38.5.

Summary: For the October, 2023 and QuiKResponse samples, TBE would have had acceptable results if the original sample result would have been reported.

Corrective Action to Prevent Recurrence:

After consulting with an ERA technical specialist, it is believed that there may be a couple of issues at play. The solids content for the ERA RAD samples are significantly higher than typical TBE client samples from the nuclear utilities. We had previously used a set aliquot volume (190 mL) for the ERA samples that did not account for recently increased solids content (see graph attached). Also, the Th-230 attenuation curve was updated in January, 2023 and the detector used for the drinking water Gr-A was changed from T-4 to one of the regularly-used gross alpha/beta counters. We only use this curve for ERA cross-check samples (our client samples are run against Am-241). Since the ERA RAD May, 2023 result was acceptable, we did not realize that there might be an issue going forward. We will make a new Th-230 attenuation curve that includes a broader range of salts/solids material used.

Regarding our typical client samples, we regularly receive cross-checks that use Am-241 as the gross alpha instead of Th-230. We have not had any issues with successfully passing these cross-checks historically. Results for 2023-2024 (E&Z Analytics) with results in uCi/mL are as follows:

Study ID	Date	TBE Result	Known Result	Ratio
A39527	2Q23	8.32E-05	9.01E-05	92%
A39249	3Q23	8.16E-05	8.02E-05	102%
A40181	1Q24	5.93E-05	5.97E-05	99%
A40040	2Q24	4.62E-05	5.00E-05	92%

Also reported with no disagreement were A39359 (1Q23), A39430 (3Q23), A39325 (4Q23), and A40499 (2Q24).

Going forward, we will continue to analyze the ERA RAD drinking water cross checks. We have ordered an additional water cross-check sample from E&Z Analytics that uses Am-241 instead of Th-230, which is more consistent with client samples.

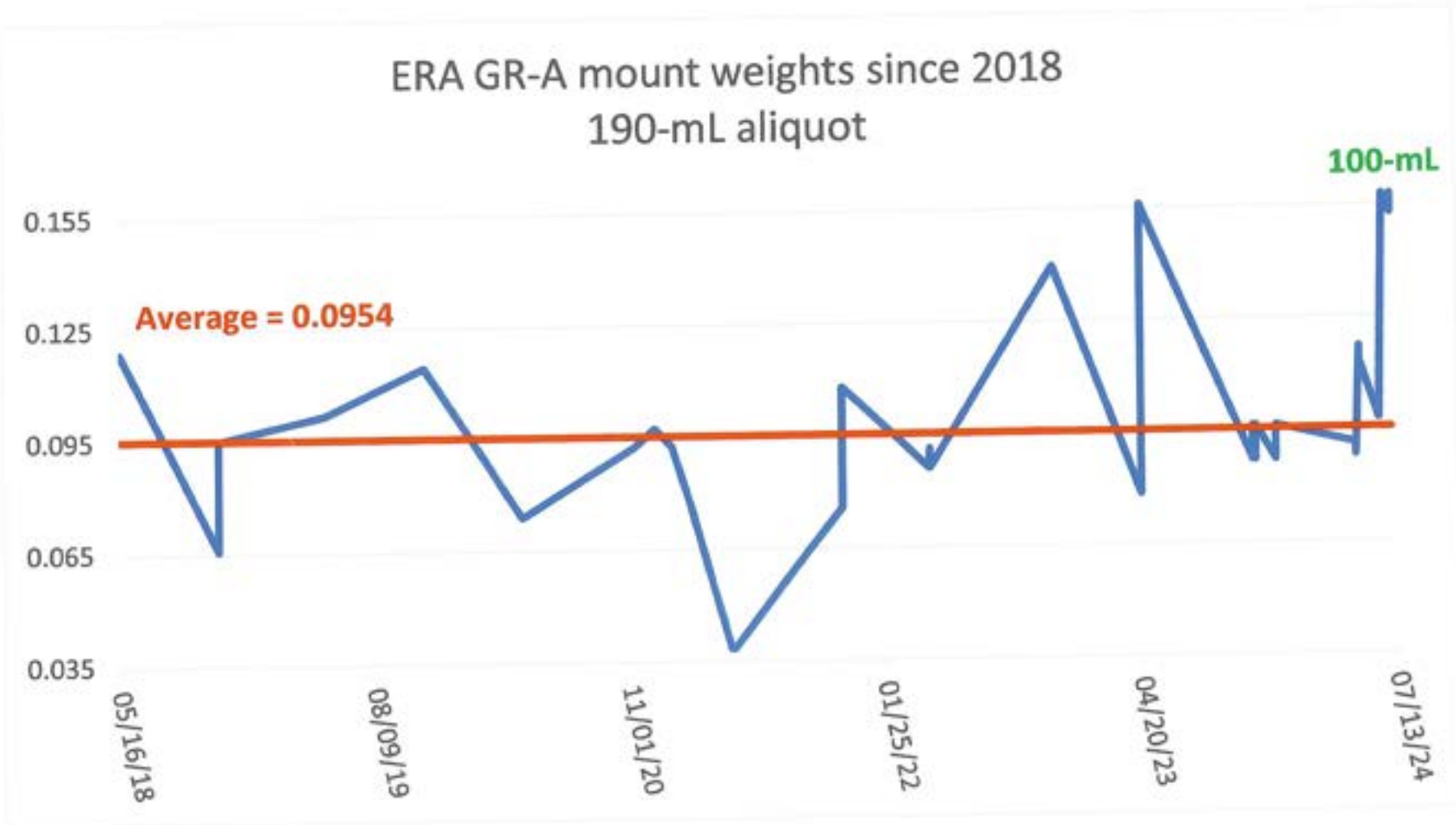
Keith Jeter — Department Manager or Designee — 7/26/24 — Date

Sharon L Northcutt — Quality Assurance Manager or Designee — 07/26/24 — Date

Summary of ERA results obtained

Pass/Fail	TBE ID	ERA ID	Count Date	Activity	Error	Known	Ratio	Range	Aliquot, mL	Detector
Pass	L91486-3	RAD 125	04/29/21	30.8	6.77	30.2	102.0%	15.4 - 39.4		190 T4
	WG36448-3	RAD 125	04/29/21	33.0	6.97	30.2	109.3%	15.4 - 39.4		190 T4
Pass	L93788-3	RAD 127	11/11/21	75.7	12.0	66.7	113.5%	35.0 - 82.5		190 T4
	WG37880-3	RAD 127	11/11/21	85.8	12.6	66.7	128.6%	35.0 - 82.5		190 T4
Pass	L95680-3	RAD 129	04/14/22	26.9	7.9	20.8	129.3%	10.4 - 28.3		190 T4
	WG39007-3	RAD 129	04/14/22	21.8	7.1	20.8	104.8%	10.4 - 28.3		190 T4
Pass	L98038-3	RAD 131	11/18/22	19.7	3.77	16.9	116.6%	8.28 - 23.7		190 T4
	WG40524-3		11/18/22	23.3	4.11	16.9	137.9%	8.28 - 23.7		190 T4
New TH-230 curve 01/09/23										
Pass	L100193-3	RAD 133	04/20/23	34.2	8.01	29.2	117.0%	14.9 - 38.2		190 G3D
	L100193-3	RAD 133	04/20/23	22.3	5.23	29.2	76.4%	14.9 - 38.2		190 G3D
	L102753-3	RAD 135	11/02/23	63.3	12.4	70.6	89.7%	54.0 - 87.2		190 G3A
Fail	WG43363-3	RAD 135	11/02/23	53.2	11.3	70.6	75.4%	54.0 - 87.2		190 G3A
	L102753-3C1	RAD 135	12/14/23	44.6	7.51	70.6	63.2%	54.0 - 87.2		190 G2B
	WG43363-3C1	RAD 135	12/14/23	41.9	7.15	70.6	59.3%	54.0 - 87.2		190 G2B
	WG44701-3	RAD 137	05/02/24	38.3	6.77	52.6	72.8%	39.6 - 65.6		190 G3B
	L104976-3R1	RAD 137	05/09/24	30.6	6.71	52.6	58.2%	39.6 - 65.6		190 G3D
Fail	WG44766-3	RAD 137	05/09/24	35.2	7.09	52.6	66.9%	39.6 - 65.6		190 G3D
	L104976-3R2	RAD 137	06/12/24	57.1	11.5	52.6	108.6%	39.6 - 65.6		190 G3D
	L105711-1	QR	07/04/24	34.3	6.61	30	114.3%	21.5 - 38.5		100 G3D
Fail	WG44983-3	QR	07/04/24	40.3	7.09	30	134.3%	21.5 - 38.5		100 G3D
	WG44983-3	QR	06/19/24	24.1	4.57	30	80.3%	21.5 - 38.5		100 T4

**REPORTED


ERA GR-A mount weights since 2018
190-mL aliquot
100-mL
Average = 0.0954
0.155
0.125
0.095
0.065
0.035
05/16/18
08/09/19
11/01/20
01/25/22
04/20/23
07/13/24

TELEDYNE BROWN ENGINEERING

Corrective Action Request & Report

CAR NO.: 24-06

SECTION 1 *(To be completed by initiator)*

Initiator Name: Sharon Northcutt	**Date:** 05/24/24

Identified Through: ☒ Daily Operations ☐ Management Review ☐ Audit ☐ Client Feedback ☐ Other
(check one)

Corrective action is requested to address the following condition:

Unacceptable ERA RAD Gr-A results (low) for the second time in a row. Prior results have consistently been over 100% since 2021, but have dipped to 75.4% 4Q23 and 66.9% 1Q24.

Manager Acknowledgement: Sharon Northcutt	**Date:** 05/28/24

SECTION 2 *(To be completed by Quality Assurance Manager)*

Assigned to: Keith Jeter	**Priority:** ☐ High ☒ Medium ☐ Low	**Date:** 05/24/24

Requested date for root cause investigation: 06/28/24 – extended due to QuikResponse failure

NCR # N/A (if applicable) NCR 24-05

Comments: QuikResponse result reported 40.3 ; Known 30.0 (range 21.5-38.5) (134% ratio)

SECTION 3 *(To be completed by Assignee - attach additional information as necessary)*

Relevant background information collected? ☑ Yes	**Existing processes investigated and understood?** ☑ Yes

Summary of Proposed Action(s):
Change typical aliquot from 190 mL (lower) to account for additional solid content. Make a new Th-230 attenuation curve for drinking water samples. Purchase an additional cross-check from Analytics that is Gross Alpha (Am-241) like client samples.

Documents Requiring Update: N/A

Solution approval signature(s): Sharon L Northcutt

SECTION 4 *(To be completed by Quality Assurance Manager)*

Documents Updated? ☐ Yes N/A	**Has the solution been effective?** ☒ Yes ☐ No	**Date Closed:** 11/18/2024

Closing Comments: *(If the corrective action has not been effective, reference the new corrective action form to readdress the problem area.)*

Both ERA-139 report & 3QE2 Analytics report had "acceptable" (attached). Emailed results to Max (Utah).

Northcutt, Sharon (US)

From: Northcutt, Sharon (US)
Sent: Friday, July 26, 2024 11:22 AM
To: Max Patterson (DHHS)
Cc: Peacock, Kristin (US); Jeter, Keith (US); Arterburn, Karli (US)
Subject: Gross Alpha XCHK
Attachments: TDS residues GR-A.pdf

Max,
Good morning! I reached out to ERA about getting a Gr-A cross check as Am-241 instead of Th-230 and they only offer the Th-230. Chad Lane, ERA Radiochemist, called me yesterday and we had a nice conversation for about 30 min. We are now under their technical assistance program to help us resolve this issue. I had told him that we only analyzed samples for nuclear utilities and that those samples are more like Am-241 than Th-230. He stated that since this is a "gross" analysis that it shouldn't matter about the standard, which I agreed with. But something has changed over the past year.

He said that the PT samples have significantly more solids added than what we see in our "regular" client samples. He asked what salt(s) we used for our attenuation curve – we use 2M Na2CO3. He said that they use a "special" mixed salt solution for TDS. So that could be one issue. He said that they offer the solution for commercial use and we've ordered that to make a new curve just for the Th-230. He also asked about the TDS range we used to make the curve (comparing the Am-241 vs. Th-230). The Am-241 range was 0 – 1.2 g and the Th-230 was 0 – 0.16 g. He suggested that even though Th-230 results were within the curve, they may be a little skewed because the TDS ranges are narrower.

We also discussed the sample volume we were using. The QA Mgr. before me instructed the technician (in 2011) to always use a 190-mL aliquot based on an average solids residue. I'm attaching a graph to show that the solid amounts have increased since last year and so I think we probably need to re-evaluate the sample volumes going forward. On the last QuiKResponse, we ended up using 100 due to the solids content.

Also a change at our lab fairly recently was that we created new attenuation curves last January. I think that it may be a combination of this new curve and the increased solids in the XCHKs that are the heart of the issue. As soon as we receive the salt solution from ERA, we will create another Th-230 curve. Chad offered to send a blind sample to verify that we've solved the problem before we try another actual cross-check.

Below is a table that is part of the NCR investigation showing our results from last fall and this spring. If we would have reported the original result last fall and for the QuiKResponse, we would have passed just fine. It seems we just chose the "wrong" result to report. With the error, we would have been in range I think.

I will update you just as soon as we have been able to resolve this issue. Again, thank you for your patience. Hope you have a lovely weekend!

Thanks!
Sharon L Northcutt
Quality Assurance Manager
Teledyne Brown Engineering
2508 Quality Lane
Knoxville, TN 37931
865 934-0374

Please click the link below and rate your satisfaction with our service.

Eckert & Ziegler

Confirmation

Sales order CO-059570-3

Date 30 Jul 2024

Your customer no. TELBRO01 - 396
Your order
Reference PO00179309 CO 1

	Item number / Description	Ship date	Quantity Unit	Sales price	Amount USD
4	**ECC-MIXAF-GF-FP** Gamma Emitters 47mm dia glass fiber filter in tape, 43mm AD, Environmental Cross Check sample Quantity : 1.00 Site : ATL1 Warehouse : MainA1 Serial number : E14098	12 Sep 2024 P.O. Line No.:10	1.00 ea	1,151.00	1,151.00
5	**ECC-MIXAF-EG-SOI** Gamma Emitters 500mL fill in 500mL wide mouth HDPE bottle, 1.55g/cc sieved Macon soil matrix, 775g soil, Environmental Cross Check sample Quantity : 1.00 Site : ATL1 Warehouse : MainA1 Serial number : E14099	12 Sep 2024 P.O. Line No.:11	1.00 ea	1,521.00	1,521.00
6	**ECC-8990-EAB-FP** Beta Particle Emitters (Sr-89/90) 47mm dia glass fiber filter between two blank filters in plastic bag, 43mm AD, Environmental Cross Check sample Quantity : 1.00 Site : ATL1 Warehouse : MainA1 Serial number : E14100	12 Sep 2024 P.O. Line No.:12	1.00 ea	1,521.00	1,521.00
7	**ECC-MIXA/B-1L** Gross Alpha/Beta 1.0L in 1L plastic bottle 0.1M HNO3 Environmental Cross Check sample Quantity : 1.00 Site : ATL1 Warehouse : MainA1 Serial number : E14197	12 Sep 2024 P.O. Line No.:13	1.00 ea NEW	1,217.00	1,217.00

A review of your regulatory documents is required prior to processing this order. Please be aware that the transfer of products is not guaranteed until all applicable regulations are met in accordance with the US NRC, US BIS, OFAC, and other national and/or country requirements as appropriate.

Net amount	10,018.00 USD
Sales tax	0.00 USD
Total	**10,018.00 USD**

Sample	Analysis	ENGINEERING Value, pCi	Uncertainty (1 Sigma)	EZA Value, pCi	Uncertainty (1 Sigma)	Ratio ENGINEERING: EZA
E14100 Filter	Sr-89	7.98E+01	4.33E+00	8.27E+01	1.38E+00	0.96
	Sr-90	1.20E+01	1.21E+00	1.36E+01	2.28E-01	0.88

Sample	Analysis	ENGINEERING Value, pCi/L	Uncertainty (1 Sigma)	EZA Value, pCi/L	Uncertainty (1 Sigma)	Ratio ENGINEERING: EZA
E14197 Liquid	Alpha (Am-241)	4.76E+01	8.90E+00	5.01E+01	8.37E-01	0.95
	Beta (Cs-137)	2.48E+02	1.51E+01	2.70E+02	4.50E+00	0.92

Outlook

TBE-ES GRA/GRB Water Crosscheck Results

From Peacock, Kristin (US) <Kristin.Peacock@Teledyne.com>
Date Fri 12/6/2024 9:17 AM
To Max Patterson (DHHS) <mpatterson@utah.gov>

1 attachment (103 KB)
TELEDYNE BROWN_Env_Crosscheck_(3rd_QTR_-_2024)_Ref_Date_12_Sep_2024 GRA GRB results.pdf;

Good morning, Max
Please accept the following attachment as part of our corrective action for the previous crosscheck failures. These successful results support our method using the Americium curve.
Please feel free to contact me if you have any questions or concerns.

Thank you!

Kristin Peacock
Quality Assurance Manager
Teledyne Brown Engineering
2508 Quality Lane
Knoxville, TN 37931
865 934-0374

Please click the link below and rate your satisfaction with our service.

★★★★★

ERA
A Waters Company

RAD-139 Laboratory Exception Report

Kristin Peacock
Quality Assurance Manager
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
(865) 934-0374

EPA ID:	**TN11387**
ERA Customer Number:	**T200801**
Report Issued:	**11/20/2024**
Study Dates:	**10/04/2024 - 11/18/2024**

Not Acceptable Evaluations

There were no Not Acceptable evaluations for this study.

RAD-139 Final Evaluation Report

A Waters Company

Kristin Peacock
Quality Assurance Manager
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
(865) 934-0374

EPA ID: TN11387
ERA Customer Number: T200801
Report Issued: 11/20/2024
Study Dates: 10/04/2024 - 11/18/2024

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
RAD Gamma EmitterS™ (cat# 808, lot# R139-758)												
2765	Barium-133	pCi/L	30.3	27.4	15.5 - 39.3	Acceptable	EPA 901.1 1980	10/4/2024	0.758	28.0	3.07	Shannon Cooper
2800	Cesium-134	pCi/L	73.3	80.2	63.0 - 97.4	Acceptable	EPA 901.1 1980	10/4/2024	-0.489	76.5	6.62	Shannon Cooper
2805	Cesium-137	pCi/L	46.6	46.3	23.3 - 69.3	Acceptable	EPA 901.1 1980	10/4/2024	-0.457	48.1	3.39	Shannon Cooper
2815	Cobalt-60	pCi/L	44.2	45.3	31.6 - 59.0	Acceptable	EPA 901.1 1980	10/4/2024	-0.902	46.7	2.77	Shannon Cooper
3070	Zinc-65	pCi/L	104	114	75.0 - 153	Acceptable	EPA 901.1 1980	10/4/2024	-1.18	117	11.0	Shannon Cooper
RAD GroSS™ Alpha/Beta (cat# 809, lot# R139-759)												
2830	Gross Alpha	pCi/L	47.6	51.7	38.9 - 64.5	Acceptable	EPA 900.0 (GPC) 1 2018	10/25/2024	0.0739	46.9	9.58	Susan Ogletree
2840	Gross Beta	pCi/L	44.2	48.1	35.2 - 61.0	Acceptable	EPA 900.0 (GPC) 1 2018	10/25/2024	0.247	43.2	4.00	Susan Ogletree
RAD NaturalS™ (cat# 811, lot# R139-751)												
2965	Radium-226	pCi/L		8.50	6.73 - 10.3	Not Reported				9.04	1.11	
2970	Radium-228	pCi/L		3.36	1.87 - 4.85	Not Reported				3.13	0.824	
3055	Uranium (activity)	pCi/L	28.3	26.9	23.6 - 30.2	Acceptable	EPA 908.0 1980	11/6/2024	1.62	25.9	1.48	Shannon Cooper
1184	Uranium (mass)	µg/L		39.2	34.4 - 44.0	Not Reported				40.3	1.91	
RAD TritiuM™ (cat# 812, lot# R139-752)												
3030	Tritium	pCi/L	4690	5320	3870 - 6770	Acceptable	EPA 906.0 1980	10/29/2024	-1.41	5190	352	Susan Ogletree
RAD Strontium-89/90 (cat# 807, lot# R139-757)												
2995	Strontium-89	pCi/L	57.5	44.2	30.6 - 57.8	Acceptable	EPA 905.0 1980	10/30/2024	1.74	44.9	7.24	Shannon Cooper
3005	Strontium-90	pCi/L	37.3	35.6	30.2 - 41.0	Acceptable	EPA 905.0 1980	10/30/2024	1.59	33.8	2.22	Shannon Cooper
RAD Iodine-131 (cat# 810, lot# R139-750)												
2875	Iodine-131	pCi/L	28.3	26.3	22.7 - 29.9	Acceptable	SM 7500-I C (GPC)-2000 2000	10/8/2024	0.949	26.1	2.34	Shannon Cooper

TELEDYNE
BROWN ENGINEERING

NONCONFORMANCE REPORT (NCR) FORM

NCR No.: 24-06

Responsible Manager: Sharon Northcutt

PART 1. TO BE COMPLETED BY ORIGINATOR OF NCR	
Initiated due to: ☐ Customer Complaint ☐ Audit/Mgmt Rept ☒ XCHK Failure ☐ Staff Observation	
Process Area: Count Room	Client/Project Affected: TBE Analytics
Requirement Reference: TBE-4006	Affected Data: L# 104596
NCR Description: Failed cross check for gamma nuclides Co-60 (AP) and Ce-141 (S)	
Client Notification Needed: ☐ YES ☒ NO	Associated CAR or CC #:
Prepared By: Sharon Northcutt	Date: 06/05/24

PART 2. TO BE COMPLETED BY ROOT CAUSE INVESTIGATOR	
Root Cause: See Supplemental Sheet	
Corrective Action Plan: N/A	
Planned Completion Date(s) for Actions(s): 07/05/24	
Prepared By: Sharon L Northcutt	Date: 07/05/24
Approved By: Keith Gotz	Date: 7/16/24

PART 3. TO BE COMPLETED BY QUALITY ASSURANCE MANAGER	
Review and Verification of Corrective Action: ☑ Accepted ☐ Rejected ☐ Follow-up Needed (describe) ☐ Completed	
Prepared By: Sharon L Northcutt	Date: 07/16/24

PART 4. TO BE COMPLETED BY RESPONSIBLE MANAGER	
Client Follow-Up Notification: ☐ YES ☑ NO Description:	Date:
Prepared By: Sharon L Northcutt	Date: 07/16/24

Supplemental Sheet

NCR No: 24-06

Description of Nonconformance:

The 1Q24 Analytics ~~water~~ gamma results for Co-60 (AP matrix) and Ce-141 (soil matrix) were not acceptable. The reported result for the AP Co-60 was 168 ± 12.7 and the known value was 126 ± 2.1 (134% ratio); the reported result for the soil Ce-141 was 0.106 and the known value was 0.0714 ± 0.0013 pCi/g (148% ratio).

Root Cause Investigation:

The AP sample was recounted on another detector with a Co-60 result of 131 (104%). The original result was counted with a beaker geometry and the lower value was counted with a face geometry. The gamma results for Co-60 in this same study and that were run generally at the same were 88% for milk and 91% for soil. A water cross-check with a different vendor resulted in a ratio of 93%. All QC associated with this sample was acceptable.

The soil sample was recounted on another detector with a Ce-141 result of 0.085 (119%). The gamma results for Ce-141 in this same study and that were run generally at the same were 89% for milk and 101% for AP. All QC associated with this sample was acceptable.

Corrective Action to Prevent Recurrence:

No effective corrective action can be taken at this time. Historically, the AP Co-60 and soils Ce-141 the results have been well within TBE QC acceptance ranges. TBE has successfully passed cross-check results (including client cross checks) and it appears that these two results are anomalous. If there is a recurrence, a root cause investigation will be done promptly.

Keith Foster — Department Manager or Designee — 7/16/24 — Date

Sharon L Northcutt — Quality Assurance Manager or Designee — 07/16/24 — Date

Sample	Analysis	ENGINEERING Value, pCi	Uncertainty (1 Sigma)	EZA Value, pCi	Uncertainty (1 Sigma)	Ratio ENGINEERING: EZA
E14092 Filter	Ce-141	6.81E+01	1.08E+01	6.75E+01	1.13E+00	1.01
passed ↗	Co-58	1.73E+00	5.16E+00	Not Measured	--	---
	Co-60	1.68E+02	1.27E+01	1.26E+02	2.10E+00	1.34
	Cr-51	1.82E+02	6.63E+01	1.83E+02	3.05E+00	0.99
	Cs-134	1.57E+02	8.05E+00	1.57E+02	2.62E+00	1.00
	Cs-137	1.32E+02	1.16E+01	1.36E+02	2.26E+00	0.97
	Fe-59	7.03E+01	1.40E+01	6.86E+01	1.15E+00	1.02
	Mn-54	1.44E+02	1.37E+01	1.45E+02	2.42E+00	0.99
	Zn-65	1.25E+02	2.09E+01	1.40E+02	2.34E+00	0.89

Sample	Analysis	ENGINEERING Value, pCi/g	Uncertainty (1 Sigma)	EZA Value, pCi/g	Uncertainty (1 Sigma)	Ratio ENGINEERING / EZA
E14093 Soil	Ce-141	1.06E-01	2.00E-02	7.14E-02	1.19E-03	1.48
	Co-58	-5.40E-03	7.61E-03	Not Measured	--	---
passed->	Co-60	1.21E-01	1.30E-02	1.33E-01	2.22E-03	0.91
	Cr-51	1.98E-01	9.50E-02	1.94E-01	3.23E-03	1.02
	Cs-134	2.06E-01	2.00E-02	1.66E-01	2.77E-03	1.24
	Cs-137	2.07E-01	1.80E-02	2.09E-01	3.50E-03	0.99
	Fe-59	6.30E-02	2.30E-02	7.26E-02	1.21E-03	0.87
	K-40	1.05E+00	2.17E-01	Not Measured	--	---
	Mn-54	1.40E-01	1.70E-02	1.53E-01	2.56E-03	0.91
	Zn-65	1.49E-01	2.40E-02	1.48E-01	2.48E-03	1.01

Sample	Analysis	ENGINEERING Value, pCi	Uncertainty (1 Sigma)	EZA Value, pCi	Uncertainty (1 Sigma)	Ratio ENGINEERING / EZA
E14094 Filter	Sr-89	8.39E+01	4.34E+00	9.06E+01	1.51E+00	0.93
	Sr-90	1.17E+01	1.03E+00	1.38E+01	2.30E-01	0.85

Sample	Analysis	ENGINEERING Value, pCi/L	Uncertainty (1 Sigma)	EZA Value, pCi/L	Uncertainty (1 Sigma)	Ratio ENGINEERING: EZA
E14089 Milk	Sr-89	7.96E+01	2.15E+00	7.82E+01	1.31E+00	1.02
	Sr-90	1.26E+01	5.00E-01	1.19E+01	1.99E-01	1.06

Sample	Analysis	ENGINEERING Value, pCi/L	Uncertainty (1 Sigma)	EZA Value, pCi/L	Uncertainty (1 Sigma)	Ratio ENGINEERING: EZA
E14090 Milk	Ce-141	7.56E+01	7.83E+00	8.50E+01	1.42E+00	0.89
passed	Co-58	-6.90E-02	3.38E+00	Not Measured	--	---
	Co-60	1.39E+02	6.70E+00	1.58E+02	2.64E+00	0.88
	Cr-51	2.12E+02	3.88E+01	2.30E+02	3.85E+00	0.92
	Cs-134	1.67E+02	9.49E+00	1.98E+02	3.30E+00	0.84
	Cs-137	1.58E+02	8.21E+00	1.71E+02	2.85E+00	0.93
	Fe-59	8.11E+01	8.63E+00	8.65E+01	1.44E+00	0.94
	I-131	8.09E+01	5.85E+00	9.08E+01	1.52E+00	0.89
	K-40	1.28E+03	9.05E+01	Not Measured	--	---
	Mn-54	1.73E+02	8.54E+00	1.83E+02	3.05E+00	0.95
	Zn-65	1.65E+02	1.57E+01	1.76E+02	2.95E+00	0.93

Sample	Analysis	ENGINEERING Value, pCi	Uncertainty (1 Sigma)	EZA Value, pCi	Uncertainty (1 Sigma)	Ratio ENGINEERING: EZA
E14091 Cartridge	I-131	9.01E+01	1.71E+00	9.03E+01	1.51E+00	1.00

RAD-137 Final Evaluation Report

ERA
A Waters Company

Sharon Northcutt
QA Manager
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
(865) 934-0374

EPA ID: TN11387
ERA Customer Number: T200801
Report Issued: 05/25/2024
Study Dates: 04/08/2024 - 05/23/2024

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
RAD Gamma EmitterS™ (cat# 808, lot# R137-758)												
2765	Barium-133	pCi/L	62.8	65.9	50.1 - 81.7	Acceptable	EPA 901.1 1980	4/26/2024	-0.464	64.2	3.05	Shannon Cooper
2800	Cesium-134	pCi/L	51.0	57.8	42.8 - 72.8	Acceptable	EPA 901.1 1980	4/24/2024	-1.27	57.2	4.86	Shannon Cooper
2805	Cesium-137	pCi/L	153	186	149 - 223	Acceptable	EPA 901.1 1980	4/24/2024	-2.72	186	12.1	Shannon Cooper
2815	Cobalt-60 passed	pCi/L	92.1	98.8	79.7 - 118	Acceptable	EPA 901.1 1980	4/26/2024	-1.77	100	4.57	Shannon Cooper
3070	Zinc-65	pCi/L	208	240	188 - 292	Acceptable	EPA 901.1 1980	4/24/2024	-2.22	244	16.1	Shannon Cooper
RAD GroSS™ Alpha/Beta (cat# 809, lot# R137-759)												
2830	Gross Alpha	pCi/L	35.2	52.6	39.6 - 65.6	Not Acceptable	EPA 900.0 (GPC) 1 2018	5/9/2024	-1.00	44.8	9.57	Susan Ogletree
2840	Gross Beta	pCi/L	49.0	46.5	33.9 - 59.1	Acceptable	EPA 900.0 (GPC) 1 2018	5/9/2024	1.84	41.2	4.26	Susan Ogletree
RAD NaturalS™ (cat# 811, lot# R137-751)												
2965	Radium-226	pCi/L		13.4	11.1 - 15.7	Not Reported				13.9	2.09	
2970	Radium-228	pCi/L		6.24	4.17 - 8.31	Not Reported				6.38	0.867	
3055	Uranium (activity)	pCi/L	55.99	59.3	52.8 - 65.8	Acceptable	EPA 908.0 1980	5/1/2024	-0.527	57.6	3.11	Shannon Cooper
1184	Uranium (mass)	µg/L		86.5	76.9 - 96.1	Not Reported				85.7	3.65	
RAD TritiuM™ (cat# 812, lot# R137-752)												
3030	Tritium	pCi/L	19000	21300	18200 - 24400	Acceptable	EPA 906.0 1980	4/16/2024	-1.88	20600	859	Susan Ogletree
RAD Strontium-89/90 (cat# 807, lot# R137-757)												
2995	Strontium-89	pCi/L	48.9	52.2	37.8 - 66.6	Acceptable	EPA 905.0 1980	4/24/2024	0.223	45.5	15.4	Shannon Cooper
3005	Strontium-90	pCi/L	32.6	37.6	32.0 - 43.2	Acceptable	EPA 905.0 1980	4/24/2024	-0.735	35.7	4.25	Shannon Cooper
RAD Iodine-131 (cat# 810, lot# R137-750)												
2875	Iodine-131	pCi/L	21.8	25.1	21.7 - 28.5	Acceptable	SM 7500-I C (GPC)-2000 2000	4/16/2024	-1.41	25.6	2.70	Shannon Cooper

TELEDYNE
BROWN ENGINEERING

NONCONFORMANCE REPORT (NCR) FORM

NCR No.: 24-07

Responsible Manager: Kim Thurman

PART 1. TO BE COMPLETED BY ORIGINATOR OF NCR	
Initiated due to: ☒ Customer Complaint ☐ Audit/Mgmt Rept ☒ XCHK Failure ☐ Staff Observation	
Process Area:	Client/Project Affected: [redacted]
Requirement Reference:	Affected Data: L# 104544-7
NCR Description: Failed crosscheck, AP for Sr-89.	
Client Notification Needed: ☒ YES ☐ NO	Associated CAR or CC #:
Prepared By: Kim Thurman	Date: 06/06/24

PART 2. TO BE COMPLETED BY ROOT CAUSE INVESTIGATOR	
Root Cause: See Supplemental Sheet	
Corrective Action Plan: N/A	
Planned Completion Date(s) for Actions(s): N/A	
Prepared By: Sharon L Northcutt	Date: 06/28/24
Approved By: Keith Gotz	Date: 7/16/24

PART 3. TO BE COMPLETED BY QUALITY ASSURANCE MANAGER	
Review and Verification of Corrective Action: ☑ Accepted ☐ Rejected ☐ Follow-up Needed (describe) ☐ Completed	
Prepared By: Sharon L Northcutt	Date: 06/28/24

PART 4. TO BE COMPLETED BY RESPONSIBLE MANAGER	
Client Follow-Up Notification: ☑ YES ☐ NO Description: NCR to be provided to client	Date: 07/17/24
Prepared By: Kimberly Thurman	Date: 07/16/24

Supplemental Sheet

NCR No: 24-07

Description of Nonconformance:

A client AP cross-check result was in disagreement for Sr-89. The reported result was 2.75E-03 ± 1.03E-04 µCi and the known was 3.82E-03 (72% ratio). The Analytics resolution for this sample was 17, which equates to an acceptance range of 75%-133%. TBE's' QC acceptance range is 70% - 130%.

Root Cause Investigation:

All QC associated with the original sample was acceptable and no anomalies were found. The sample was reanalyzed and used as the workgroup duplicate with agreement results of 2.91E-03 ± 2.02E-04 µCi (R1) and 3.29E-03 ± 2.11E-04 (WG). The ratio of reported/known for the R1 was 76% and the WG Dup was 86%. TBE's results were reproducible in that the original sample and reanalysis had an RPD of 5.7% and overlapped well with the counting error. The R1 & WG results had an RPD of 12.3%.

In addition, TBE analyzed an Analytics AP Sr-89 cross-check sample for the 1st quarter with a 93% ratio in agreement with the known result. This reported result was the WG DUP and the original result was also in agreement with the known at 77%.

Corrective Action to Prevent Recurrence:

No effective corrective action can be taken at this time as the known result ratio falls within the TBE acceptance range and all other associated sample results were in agreement. The lab should take advantage of using the cross-check sample as the WG duplicate going forward.

Keith Jeter — 7/16/24

Department Manager or Designee — Date

Shawn L Abbott — 06/28/24

Quality Assurance Manager or Designee — Date

QC Summary Report for WG44987

TE511-LABQC

06/27/2024 15:29

SR-89

Method Blank Summary

TBE Sample ID	Radionuclide	Matrix	Count Date/Time	Blank Result	Units	Qualifier	P/F
WG44987-1	SR-89	WO	06/12/2024 11:37	< 3.550E+00	pCi/Total	U	P

LCS Sample Summary

TBE Sample ID	Radionuclide	Matrix	Count Date/Time	Count Date Spike Value	LCS Result	Units	Spike Recovery	Range	Qualifier	P/F
WG44987-2	SR-89	WO	06/12/2024 11:37	3.09E+01	2.430E+04	pCi/Total	110.2	70-130	+	P

Spike ID: **89SR-032123-2** Spike Reference Date: **03/06/2023 12:00**

Spike Conc: **4.41E+04** Spike Vol: **5.00E-01**

Duplicate Summary

TBE Sample ID	Radionuclide	Matrix	Count Date/Time	Original Result	DUP Result	Units	RPD	Range	Qualifier	P/F
WG44987-3 L104544-7R1	SR-89	AP	06/12/2024 11:37	2.910E-03	3.290E-03	uCi/Total	12.3	<30	+	P

SR-89

Associated Samples for WG44987

Sample #	Client ID
WG44987-1	Blank Samples
WG44987-2	Laboratory Control Samples
WG44987-3	A40182

+	Positive Result
U	Compound/analyte was analyzed, peak not identified and/or not detected above MDC
*	< 5 times the MDC are not evaluated
**	Nuclide not detected
***	Spiking level < 5 times activity
P	Pass
F	Fail
NE	Not evaluated

QC Summary Report for WG44987

TE511-LABQC

06/27/2024 15:29

SR-90

Method Blank Summary

TBE Sample ID	Radionuclide	Matrix	Count Date/Time	Blank Result	Units	Qualifier	P/F
WG44987-1	SR-90	WO	06/12/2024 11:37	< 1.560E+00	pCi/Total	U	P

LCS Sample Summary

TBE Sample ID	Radionuclide	Matrix	Count Date/Time	Count Date Spike Value	LCS Result	Units	Spike Recovery	Range	Qualifier	P/F
WG44987-2	SR-90	WO	06/12/2024 11:37	4.08E+01	8.040E+01	pCi/Total	114.8	70-130	+	P

Spike ID: **90SR-030521** Spike Reference Date: **02/26/2002 00:00**

Spike Conc: **2.80E+02** Spike Vol: **2.50E-01**

Duplicate Summary

TBE Sample ID	Radionuclide	Matrix	Count Date/Time	Original Result	DUP Result	Units	RPD	Range	Qualifier	P/F
WG44987-3 L104544-7R1	SR-90	AP	06/12/2024 11:37	3.180E-04	3.340E-04	uCi/Total	4.9	<30	+	P

SR-90

Associated Samples for WG44987

Sample #	Client ID
WG44987-1	Blank Samples
WG44987-2	Laboratory Control Samples
WG44987-3	A40182

+	Positive Result
U	Compound/analyte was analyzed, peak not identified and/or not detected above MDC
*	< 5 times the MDC are not evaluated
**	Nuclide not detected
***	Spiking level < 5 times activity
P	Pass
F	Fail
NE	Not evaluated

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40178 Liquid	Fe-55	1.94E-03	2.00E-03	0.97	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi	EZA Value, uCi	Ratio [redacted] / EZA	Resolution	Comparison
A40180 Cartridge	I-131	3.01E-01	3.02E-01	1.00	20	AGREEMENT

Sample	Analysis	[redacted] Value, uCi	EZA Value, uCi	Ratio [redacted] / EZA	Resolution	Comparison
A40180 Cartridge Position 2	I-131	2.97E-01	3.02E-01	0.98	20	AGREEMENT

Sample	Analysis	[redacted] Value, uCi	EZA Value, uCi	Ratio [redacted] / EZA	Resolution	Comparison
A40180 Cartridge Position 3	I-131	1.89E-01	3.02E-01	0.63	20	DISAGREEMENT

Sample	Analysis	[redacted] Value, uCi	EZA Value, uCi	Ratio [redacted] / EZA	Resolution	Comparison
A40180 Cartridge Position 4	I-131	2.95E-01	3.02E-01	0.98	20	AGREEMENT

Sample	Analysis	[redacted] Value, uCi/ml	EZA Value, uCi/ml	Ratio [redacted] / EZA	Resolution	Comparison
A40181 Liquid	Gross Alpha (Am-241)	5.93E-05	5.97E-05	0.99	12.5	AGREEMENT

Sample	Analysis	[redacted] Value, uCi	EZA Value, uCi	Ratio [redacted] / EZA	Resolution	Comparison
A40182 Filter	Sr-89	2.75E-03	3.82E-03	0.72	17	DISAGREEMENT
	Sr-90	2.85E-04	3.65E-04	0.78	12.5	AGREEMENT

Sample	Analysis	ENGINEERING Value, pCi/g	Uncertainty (1 Sigma)	EZA Value, pCi/g	Uncertainty (1 Sigma)	Ratio ENGINEERING: EZA
E14093 Soil	Ce-141	1.06E-01	2.00E-02	7.14E-02	1.19E-03	1.48
	Co-58	-5.40E-03	7.61E-03	Not Measured	--	---
	Co-60	1.21E-01	1.30E-02	1.33E-01	2.22E-03	0.91
	Cr-51	1.98E-01	9.50E-02	1.94E-01	3.23E-03	1.02
	Cs-134	2.06E-01	2.00E-02	1.66E-01	2.77E-03	1.24
	Cs-137	2.07E-01	1.80E-02	2.09E-01	3.50E-03	0.99
	Fe-59	6.30E-02	2.30E-02	7.26E-02	1.21E-03	0.87
	K-40	1.05E+00	2.17E-01	Not Measured	--	---
	Mn-54	1.40E-01	1.70E-02	1.53E-01	2.56E-03	0.91
	Zn-65	1.49E-01	2.40E-02	1.48E-01	2.48E-03	1.01

Sample	Analysis	ENGINEERING Value, pCi	Uncertainty (1 Sigma)	EZA Value, pCi	Uncertainty (1 Sigma)	Ratio ENGINEERING: EZA
E14094 Filter	Sr-89	8.39E+01	4.34E+00	9.06E+01	1.51E+00	0.93
	Sr-90	1.17E+01	1.03E+00	1.38E+01	2.30E-01	0.85

TBE's

CUSTOMER COMPLAINT FORM

GENERAL INFORMATION

CC number: CC-24-03

Date of complaint: 06/04/24	Complaint logged by: Kim Thurman
Associated L#/Work Group: L104544-7	Client Contact Name: [redacted]
Related NCR (if applicable): NCR-24-07	Client/Project Name: [redacted]

DETAILS

Complaint: TBE cross-check for AP/Sr-89 result disagrees with known value.

Cause: No root cause could be found. See NCR 24-07 supplement

Resolution: No effective correction can be taken. See NCR 24-07 supplement

REVIEW BY QUALITY ASSURANCE MANAGER

Reviewed by: Sharon L Northcutt	Date: 06/28/24

REVIEW BY LABORATORY OPERATIONS MANAGER

Reviewed by: Keith Jett	Date: 7/16/24

TELEDYNE BROWN ENGINEERING

NONCONFORMANCE REPORT (NCR) FORM

NCR No.: 24-08

Responsible Manager: Sharon Northcutt

PART 1. TO BE COMPLETED BY ORIGINATOR OF NCR	
Initiated due to: ☐ Customer Complaint ☐ Audit/Mgmt Rept ☒ XCHK Failure ☐ Staff Observation	
Process Area: In-Plant Prep	Client/Project Affected: TBE MAPEP
Requirement Reference: TBE-4004	Affected Data: L# 104633
NCR Description: Failed crosscheck Ni-63 (soil matrix)	
Client Notification Needed: ☒ YES ☐ NO	Associated CAR or CC #: CAR 24-09
Prepared By: Sharon Northcutt	Date: 06/26/24

PART 2. TO BE COMPLETED BY ROOT CAUSE INVESTIGATOR	
Root Cause: added interferences in MAPEP sample (atypical of regular client samples)	
Corrective Action Plan: Update TBE-2013 to include addition of Ni-59 tracer for yield calculation.	
Planned Completion Date(s) for Actions(s): 09/01/24	
Prepared By: Keith Jeter	Date: 8/1/24
Approved By: Sharon L Northcutt	Date: 08/01/24

PART 3. TO BE COMPLETED BY QUALITY ASSURANCE MANAGER	
Review and Verification of Corrective Action: ☑ Accepted ☐ Rejected ☐ Follow-up Needed (describe) ☐ Completed	
Prepared By: Sharon L Northcutt	Date: 08/01/24

PART 4. TO BE COMPLETED BY RESPONSIBLE MANAGER	
Client Follow-Up Notification: ☐ YES ☑ NO (QA Rept) Description:	Date:
Prepared By: Sharon L Northcutt	Date: 08/01/24

Supplemental Sheet

NCR No: 24-08

Description of Nonconformance:

TBE's cross-check result for Ni-63 was unacceptable (low). The reported result was 1070 ± 91.3 Bq/L and the known was 1530 (69.9% ratio). The acceptance range was 1071 – 1989. With the associated errors, TBE's result was within the acceptable range.

Root Cause Investigation:

All QC associated with the original sample was acceptable and no anomalies were found. The sample was reanalyzed and used as the workgroup duplicate with agreement results of 1160 ± 29.9 Bq (R1) and 1270 ± 33.1 (WG dup). The ratio of reported/known for the R1 was 76% and the WG Dup was 83%. TBE's results were reproducible in that the original sample and reanalysis had an RPD of 8.1% and overlapped well with the counting error. The R1 & WG results had an RPD of 9.1%. The reanalysis and WG DUP were counted on a different LSC detector (different efficiency) than the original sample. Also the yield of the original sample was higher than the R1, which led to a lower calculated value. The counts for all of the samples were consistent at 135.2 (original), 123.63 (R1) and 121.43 (WG Dup).

Corrective Action to Prevent Recurrence:

For samples that have suspected interferences added (not found in typical client samples), TBE-2013 procedure will be modified to include the addition of Ni-59 tracer to determine the yield in calculating sample results.

Keith Jete — 8/1/24

Department Manager or Designee — Date

Sharon L Northcutt — 08/01/24

Quality Assurance Manager or Designee — Date

MAPEP Mixed Analyte Performance Evaluation Program

Department of Energy RESL - 1955 Fremont Ave, MS4149 - Idaho Falls, ID 83415

Laboratory Results For MAPEP Series 50
(TELE01) Teledyne Brown Engineering - Environmental Services
2508 Quality Lane
Knoxville, TN 37931-6819

MAPEP-24-MaS50: Radiological and inorganic combined soil standard

Inorganic

Units: (mg/kg)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Antimony	NR	8.4				5.9 - 10.9		
Arsenic	NR	24.5				17.2 - 31.9		
Barium	NR	197				138 - 256		
Beryllium	NR	23.0				16.1 - 29.9		
Cadmium	NR	4.74				3.32 - 6.16		
Chromium	NR	11.7				8.2 - 15.2		
Cobalt	NR	29.1				20.4 - 37.8		
Copper	NR	46.3				32.4 - 60.2		
Lead	NR	23.6				16.5 - 30.7		
Mercury	NR	0.257				0.180 - 0.334		
Nickel	NR	33.3				23.3 - 43.3		
Selenium	NR	8.26				5.78 - 10.74		
Silver	NR	5.42				3.79 - 7.05		
Technetium-99	NR	5.32E-04				3.72E-4 - 6.92E-4		
Thallium	NR	2.85				2.00 - 3.71		
Uranium-235	NR	0.0317				0.0222 - 0.0412		
Uranium-238	NR	8.8				6.2 - 11.4		
Uranium-Total	NR	8.9				6.2 - 11.6		
Vanadium	NR	55.0				38.5 - 71.5		
Zinc	NR	70				49 - 91		

Radiological

Units: (Bq/kg)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR					False Positive Test		
Cesium-134	NR	404				283 - 525		
Cesium-137	NR	1550				1085 - 2015		
Cobalt-57	NR	401				281 - 521		
Cobalt-60	NR	660				462 - 858		
Iron-55	297	650	N		-54.3	455 - 845	60.27	W
Manganese-54	NR	332				232 - 432		
Nickel-63	1070	1530	N		-30.1	1071 - 1989	91.3	A
Plutonium-238	NR	34.7				24.3 - 45.1		
Plutonium-239/240	NR	0.37				Sensitivity Evaluation		
Potassium-40	NR	485				340 - 631		
Strontium-90	NR	440				308 - 572		
Technetium-99	325	336	A		-3.3	235 - 437	34.6	A
Thorium-228	34.6	48.8	W		-29.1	34.2 - 63.4	12.2	N
Thorium-230	49.7	54	A		-8.0	38 - 70	14.9	W
Thorium-232	36.4	45.1	A		-19.3	31.6 - 58.6	12.1	N
Uranium-234	NR	40.7				28.5 - 52.9		
Uranium-238	NR	110				77 - 143		
Zinc-65	NR	703				492 - 914		

Laboratory Results For MAPEP Series 50
(TELE01) Teledyne Brown Engineering - Environmental Services
2508 Quality Lane
Knoxville, TN 37931-6819

MAPEP-24-MaSU50: Radiological urine standard

Mass

Units: (ng/L)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Uranium-235	NR					False Positive Test		
Uranium-238	NR					False Positive Test		
Uranium-Total	NR					False Positive Test		

Printed 06/25/2024

MAPEP Mixed Analyte Performance Evaluation Program
Department of Energy RESL - 1955 Fremont Ave, MS4149 - Idaho Falls, ID 83415

Sample Statistical Summary

Analyte	T(1)	A(2)	Grand(3) Mean	Std Dev	Ref Value	Ref Unc	Acceptance Range
Inorganic							Units: (mg/kg)
Antimony	10	6			8.4	0.2	5.9 - 10.9
Arsenic	11	11	23.0	1.4	24.5	0.4	17.2 - 31.9
Barium	10	10	200	11	197	4	138 - 256
Beryllium	11	11	23.1	2.3	23.0	0.4	16.1 - 29.9
Cadmium	11	11	4.80	0.31	4.74	0.09	3.32 - 6.16
Chromium	11	9	13.1	1.8	11.7	0.3	8.2 - 15.2
Cobalt	11	11	28.9	1.9	29.1	0.5	20.4 - 37.8
Copper	11	11	47.6	4.2	46.3	0.8	32.4 - 60.2
Lead	11	11	25.4	1.8	23.6	0.3	16.5 - 30.7
Mercury	10	9	0.237	0.031	0.257	0.005	0.180 - 0.334
Nickel	11	11	33.6	2.3	33.3	0.6	23.3 - 43.3
Selenium	10	10	7.76	1.14	8.26	0.16	5.78 - 10.74
Silver	10	9	5.05	0.43	5.42	0.11	3.79 - 7.05
Technetium-99	3	3			5.32E-4	1E-05	3.72E-4 - 6.92E-4
Thallium	11	9	2.75	0.18	2.85	0.05	2.00 - 3.71
Uranium-235	11	9	0.0309	0.0043	0.0317	0.0009	0.0222 - 0.0412
Uranium-238	11	11	8.5	1.2	8.8	0.3	6.2 - 11.4
Uranium-Total	14	13	8.4	1.3	8.9	0.3	6.2 - 11.6
Vanadium	11	11	54.0	3.4	55.0	1.1	38.5 - 71.5
Zinc	11	10	80	8	70	2	49 - 91

Analyte	T(1)	A(2)	Grand(3) Mean	Std Dev	Ref Value	Ref Unc	Acceptance Range
Radiological							Units: (Bq/kg)
Americium-241	27	25					False Positive Test
Cesium-134	51	47	380	34	404	8	283 - 525
Cesium-137	51	48	1555	122	1550	20	1085 - 2015
Cobalt-57	51	49	399	43	401	8	281 - 521
Cobalt-60	51	49	654	56	660	10	462 - 858
Iron-55	6	3			650	14	455 - 845
Manganese-54	51	49	337	29	332	7	232 - 432
Nickel-63	8	6	1503	211	1530	30	1071 - 1989
Plutonium-238	26	23	34.8	3.6	34.7	0.8	24.3 - 45.1
Plutonium-239/240	25	22	0.55	0.53	0.37	0.04	Sensitivity Evaluation
Plutonium-241	2						
Potassium-40	51	44	487	45	485	15	340 - 631
Strontium-90	22	18	393	37	440	9	308 - 572
Technetium-99	14	12	305	29	336	7	235 - 437
Thorium-228	17	15	47.1	7.0	48.8	1.9	34.2 - 63.4
Thorium-230	17	15	49	5	54	2	38 - 70
Thorium-232	18	17	43.1	5.6	45.1	1.5	31.6 - 58.6
Uranium-234	25	19	41.0	4.2	40.7	1.2	28.5 - 52.9
Uranium-238	28	25	105	11	110	4	77 - 143
Zinc-65	51	49	721	65	703	14	492 - 914

Note: (1) T = Total number of laboratories reporting analyte.
(2) A = Number of laboratories with 'Acceptable' performance.
(3) Mean excludes values derived as total metals and values indicated as "Not Acceptable".

Results Flags:

A = Result acceptable..... [Bias]

W = Result acceptable with warning..... 20% < [Bias]

N = Result not acceptable..... [Bias] > 30%

RW = Report Warning

Printed 06/28/2024

TELEDYNE BROWN ENGINEERING

Corrective Action Request & Report

CAR NO.: 24-09

SECTION 1 *(To be completed by initiator)*

Initiator Name: Sharon Northcutt | **Date:** 07/15/24

Identified Through: ☒ Daily Operations ☐ Management Review ☐ Audit ☐ Client Feedback ☐ Other
(check one)

Corrective action is requested to address the following condition:

Unacceptable MAPEP Ni-63 in soil results (low). Prior XCHK passed at 92% after failing low 1H2023. Inconsistent results.

Manager Acknowledgement: Sharon Northcutt | **Date:** 07/15/24

SECTION 2 *(To be completed by Quality Assurance Manager)*

Assigned to: Keith Jeter | **Priority:** ☐ High ☒ Medium ☐ Low | **Date:** 07/15/24

Requested date for root cause investigation: 08/15/24

NCR # N/A **(if applicable)**

Comments: It appears that there is interference added to the sample which cannot be accounted for by typical separation.

SECTION 3 *(To be completed by Assignee - attach additional information as necessary)*

Relevant background information collected? ☑ Yes | **Existing processes investigated and understood?** ☑ Yes

Summary of Proposed Action(s):

Update TBE-2013 to include addition of Ni-59 tracer if sample is suspected to have unusual added matrix interference. Yield calculation will be determined upon Ni-59 result.

Documents Requiring Update: TBE-2013

Solution approval signature(s): Sharon L Northcutt

SECTION 4 *(To be completed by Quality Assurance Manager)*

Documents Updated? ☐ Yes | **Has the solution been effective?** ☐ Yes ☐ No | **Date Closed:**

Closing Comments: *(If the corrective action has not been effective, reference the new corrective action form to readdress the problem area.)*

MAPEP 24.ma551 Ni-63 in soil results returned as "warning" & did not fail. 12/13/24

TELEDYNE
BROWN ENGINEERING

NONCONFORMANCE REPORT (NCR) FORM

NCR No.: 24-09

Responsible Manager: Sharon Northcutt

PART 1. TO BE COMPLETED BY ORIGINATOR OF NCR	
Initiated due to: ☒ Customer Complaint ☐ Audit/Mgmt Rept ☒ XCHK Failure ☐ Staff Observation	
Process Area: Count Room	Client/Project Affected: TBE MAPEP
Requirement Reference: TBE-4004	Affected Data: L# 104633
NCR Description: Failed crosscheck Zn-65 (urine matrix)	
Client Notification Needed: ☒ YES ☐ NO	Associated CAR or CC #: CAR 24-08
Prepared By: Sharon Northcutt	Date: 06/26/24

PART 2. TO BE COMPLETED BY ROOT CAUSE INVESTIGATOR	
Root Cause: MAPEP spiked sample lower than TBE typical det. limit. Clients looking for Co-60 or Cs-137 (not Zn-65)	
Corrective Action Plan: Contact MAPEP to question result. See CAR 24-08	
Planned Completion Date(s) for Actions(s): 07/17/24	
Prepared By: Sharon L Northcutt	Date: 07/17/24
Approved By: Keith Jeter	Date: 7/17/24

PART 3. TO BE COMPLETED BY QUALITY ASSURANCE MANAGER	
Review and Verification of Corrective Action: ☑ Accepted ☐ Rejected ☐ Follow-up Needed (describe) ☐ Completed	
Prepared By: Sharon L Northcutt	Date: 07/17/24

PART 4. TO BE COMPLETED BY RESPONSIBLE MANAGER	
Client Follow-Up Notification: ☐ YES ☑ NO Description:	Date:
Prepared By: Sharon L Northcutt	Date: 07/17/24

MAPEP Mixed Analyte Performance Evaluation Program

Department of Energy RESL - 1955 Fremont Ave, MS4149 - Idaho Falls, ID 83415

[Original]

Laboratory Results For MAPEP Series 50
(TELE01) Teledyne Brown Engineering - Environmental Services
2508 Quality Lane
Knoxville, TN 37931-6819

MAPEP-24-MaS50: Radiological and inorganic combined soil standard

Inorganic — Units: (mg/kg)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Antimony	NR	8.4				5.9 - 10.9		
Arsenic	NR	24.5				17.2 - 31.9		
Barium	NR	197				138 - 256		
Beryllium	NR	23.0				16.1 - 29.9		
Cadmium	NR	4.74				3.32 - 6.16		
Chromium	NR	11.7				8.2 - 15.2		
Cobalt	NR	29.1				20.4 - 37.8		
Copper	NR	46.3				32.4 - 60.2		
Lead	NR	23.6				16.5 - 30.7		
Mercury	NR	0.257				0.180 - 0.334		
Nickel	NR	33.3				23.3 - 43.3		
Selenium	NR	8.26				5.78 - 10.74		
Silver	NR	5.42				3.79 - 7.05		
Technetium-99	NR	5.32E-04				3.72E-4 - 6.92E-4		
Thallium	NR	2.85				2.00 - 3.71		
Uranium-235	NR	0.0317				0.0222 - 0.0412		
Uranium-238	NR	8.8				6.2 - 11.4		
Uranium-Total	NR	8.9				6.2 - 11.6		
Vanadium	NR	55.0				38.5 - 71.5		
Zinc	NR	70				49 - 91		

Radiological — Units: (Bq/kg)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR					False Positive Test		
Cesium-134	NR	404				283 - 525		
Cesium-137	NR	1550				1085 - 2015		
Cobalt-57	NR	401				281 - 521		
Cobalt-60	NR	660				462 - 858		
Iron-55	297	650	N		-54.3	455 - 845	60.27	W
Manganese-54	NR	332				232 - 432		
Nickel-63	1070	1530	N		-30.1	1071 - 1989	91.3	A
Plutonium-238	NR	34.7				24.3 - 45.1		
Plutonium-239/240	NR	0.37				Sensitivity Evaluation		
Potassium-40	NR	485				340 - 631		
Strontium-90	NR	440				308 - 572		
Technetium-99	325	336	A		-3.3	235 - 437	34.6	A
Thorium-228	34.6	48.8	W		-29.1	34.2 - 63.4	12.2	N
Thorium-230	49.7	54	A		-8.0	38 - 70	14.9	W
Thorium-232	36.4	45.1	A		-19.3	31.6 - 58.6	12.1	N
Uranium-234	NR	40.7				28.5 - 52.9		
Uranium-238	NR	110				77 - 143		
Zinc-65	NR	703				492 - 914		

Laboratory Results For MAPEP Series 50
(TELE01) Teledyne Brown Engineering - Environmental Services
2508 Quality Lane
Knoxville, TN 37931-6819

MAPEP-24-MaSU50: Radiological urine standard

Mass — Units: (ug/L)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Uranium-235	NR					False Positive Test		
Uranium-238	NR					False Positive Test		
Uranium-Total	NR					False Positive Test		

Printed 06/25/2024

Radiological								Units: (Bq/L)
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR	0.278				0.195 - 0.361		
Cesium-134	1.12	1.36	A		-17.6	0.95 - 1.77	0.10	A
Cesium-137	2.00	2.23	A		-10.3	1.56 - 2.90	0.24	A
Cobalt-57	1.06	1.26	A		-15.9	0.88 - 1.64	0.15	A
Cobalt-60	2.26	2.38	A		-5.0	1.67 - 3.09	0.19	A
Curium-244	NR					False Positive Test		
Manganese-54	1.44	1.51	A		-4.6	1.06 - 1.96	0.23	W
Nickel-63	NR					False Positive Test		
Plutonium-238	NR	0.0035				Sensitivity Evaluation		
Plutonium-239/240	NR	0.0051				Sensitivity Evaluation		
Potassium-40	-1.8						0.1	N
Strontium-90	NR	1.80				1.26 - 2.34		
Technetium-99	NR					False Positive Test		
Uranium-234	0.001012		A			False Positive Test	0.00144	
Uranium-238	0.00228		A			False Positive Test	0.00293	
Zinc-65	-0.423	0.84	N		-150.4	0.59 - 1.09	0.274	N

Laboratory Results For MAPEP Series 50
(TELE01) Teledyne Brown Engineering - Environmental Services
2508 Quality Lane
Knoxville, TN 37931-6819

MAPEP-24-MaW50: Radiological and inorganic combined water standard

Inorganic								Units: (mg/L)
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Antimony	NR	5.71				4.00 - 7.42		
Arsenic	NR	2.73				1.91 - 3.55		
Barium	NR	0.0561				0.0393 - 0.0729		
Beryllium	NR	2.87				2.01 - 3.73		
Cadmium	NR	0.854				0.598 - 1.110		
Chromium	NR	1.09				0.76 - 1.42		
Cobalt	NR	8.99				6.29 - 11.69		
Copper	NR	7.47				5.23 - 9.71		
Lead	NR	1.25				0.88 - 1.63		
Mercury	NR					False Positive Test		
Nickel	NR					False Positive Test		
Selenium	NR	0.247				0.173 - 0.321		
Technetium-99	NR	1.18E-05				8.30E-6 - 1.53E-5		
Thallium	NR	3.38				2.37 - 4.39		
Uranium-235	NR	6.04E-04				4.23E-4 - 7.85E-4		
Uranium-238	NR	0.0827				0.0579 - 0.1075		
Uranium-Total	NR	0.0833				0.0583 - 0.1083		
Vanadium	NR	5.76				4.03 - 7.49		
Zinc	NR	7.40				5.18 - 9.62		

Radiological								Units: (Bq/L)
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR					False Positive Test		
Cesium-134	NR					False Positive Test		
Cesium-137	NR	9.7				6.8 - 12.6		
Cobalt-57	NR	25.4				17.8 - 33.0		
Cobalt-60	NR	10.27				7.19 - 13.35		
Hydrogen-3	NR	637				446 - 828		
Iron-55	NR	19.7				13.8 - 25.6		
Manganese-54	NR	7.36				5.15 - 9.57		
Nickel-63	0.338	0.8	A	(17)		Sensitivity Evaluation	0.769	
Plutonium-238	NR	0.745				0.522 - 0.969		
Plutonium-239/240	NR	0.769				0.538 - 1.000		
Potassium-40	NR					False Positive Test		
Radium-226	NR	0.310				0.217 - 0.403		
Strontium-90	NR	3.68				2.58 - 4.78		
Technetium-99	9.95	7.47	N		33.2	5.23 - 9.71	1.01	A
Uranium-234	NR	0.990				0.693 - 1.287		
Uranium-238	NR	1.028				0.720 - 1.336		
Zinc-65	NR					False Positive Test		

Laboratory Results For MAPEP Series 50
(TELE01) Teledyne Brown Engineering - Environmental Services

Printed 06/25/2024

2508 Quality Lane
Knoxville, TN 37931-6819

MAPEP-24-RdV50: Radiological vegetation

Inorganic							Units: (Bq/sample)	
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Uranium-235	NR	0.0383				0.0268 - 0.0498		
Uranium-238	NR	5.6				3.9 - 7.3		
Uranium-Total	NR	5.6				3.9 - 7.3		

Radiological							Units: (Bq/sample)	
Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR					False Positive Test		
Cesium-134	2.80	3.67	W		-23.7	2.57 - 4.77	0.23	A
Cesium-137	2.21	2.57	A		-14.0	1.80 - 3.34	0.23	A
Cobalt-57	2.23	2.53	A		-11.9	1.77 - 3.29	0.12	A
Cobalt-60	2.42	2.96	A		-18.2	2.07 - 3.85	0.16	A
Manganese-54	0.033		A			False Positive Test	0.096	
Plutonium-238	NR	0.0413				0.0289 - 0.0537		
Plutonium-239/240	NR	0.0431				0.0302 - 0.0560		
Strontium-90	0.276	0.529	N		-47.8	0.370 - 0.688	0.012	A
Uranium-234	NR	0.067				0.047 - 0.087		
Uranium-238	NR	0.070				0.049 - 0.091		
Zinc-65	6.83	8.02	A		-14.8	5.61 - 10.43	0.49	A

Notes:

(17) = NOT DETECTED - reported a statistically zero result

MAPEP Mixed Analyte Performance Evaluation Program
Department of Energy RESL - 1955 Fremont Ave, MS4149 - Idaho Falls, ID 83415

Sample Statistical Summary

Analyte	T(1)	A(2)	Grand(3) Mean	Std Dev	Ref Value	Ref Unc	Acceptance Range
Mass							Units: (ng/L)
Uranium-235	3	3					False Positive Test
Uranium-238	3	2					False Positive Test
Uranium-Total	2	1					False Positive Test
Analyte	T(1)	A(2)	Grand(3) Mean	Std Dev	Ref Value	Ref Unc	Acceptance Range
Radiological							Units: (Bq/L)
Americium-241	8	7	0.258	0.022	0.278	0.006	0.195 - 0.361
Cesium-134	9	8	1.29	0.09	1.36	0.04	0.95 - 1.77
Cesium-137	9	8	2.22	0.10	2.23	0.07	1.56 - 2.90
Cobalt-57	9	8	1.17	0.07	1.26	0.04	0.88 - 1.64
Cobalt-60	9	8	2.34	0.13	2.38	0.08	1.67 - 3.09
Curium-244	3	3					False Positive Test
Manganese-54	9	8	1.54	0.12	1.51	0.05	1.06 - 1.96
Nickel-63	2	2					False Positive Test
Plutonium-238	7	6	0.0056	0.0197	0.0035	0.0003	Sensitivity Evaluation
Plutonium-239/240	7	7	0.0138	0.0222	0.0051	0.0004	Sensitivity Evaluation
Potassium-40	5						
Strontium-90	6	5			1.80	0.05	1.26 - 2.34
Technetium-99	1	1					False Positive Test
Uranium-234	7	6					False Positive Test
Uranium-238	7	7					False Positive Test
Zinc-65	9	6	0.80	0.10	0.84	0.03	0.59 - 1.09

TBE – 0.423, 0.666, 0383

Note:
(1) T = Total number of laboratories reporting analyte.
(2) A = Number of laboratories with 'Acceptable' performance.
(3) Mean excludes values indicated as "Not Acceptable".

+/- 0,274 ± 0.226 ± 0.321

RESL measured a K-40 value in the background urine of 52 +/- 3 Bq/L. [TBE's – 54.1 ± 3.4] ✓

RESL did not add a Uranium-234/238 spike to the MaSU50 Sample Matrix.

We thought this was a < result. It's Actually spiked really low for us.

DL Zn 65
Det 13 - 0.55
Det 23 - 0.422
Det 8 - 0.416

Printed 06/27/2024

TELEDYNE BROWN ENGINEERING

Corrective Action Request & Report

CAR NO.: 24-08

SECTION 1 (To be completed by initiator)

Initiator Name: Sharon Northcutt	**Date:** 06/28/24

Identified Through: ☒ Daily Operations ☐ Management Review ☐ Audit ☐ Client Feedback ☐ Other
(check one)

Corrective action is requested to address the following condition:
Failed crosscheck for Zn-65 urine matrix

Manager Acknowledgement: Sharon Northcutt	**Date:** 06/28/24

SECTION 2 (To be completed by Quality Assurance Manager)

Assigned to: Sharon Northcutt	**Priority:** ☐ High ☒ Medium ☐ Low	**Date:** 06/28/24

Requested date for root cause investigation: 06/28/24

NCR # 24-09 **(if applicable)**

Comments:

SECTION 3 (To be completed by Assignee - attach additional information as necessary)

Relevant background information collected? ☑ Yes	**Existing processes investigated and understood?** ☑ Yes

Summary of Proposed Action(s): Contact MAPEP to question result.
* MAPEP sent a revised report after dialoguing about our typical det. lims & client needs.

Documents Requiring Update: N/A

Solution approval signature(s): Sharon L Northcutt

SECTION 4 (To be completed by Quality Assurance Manager)

Documents Updated? ☐ Yes	**Has the solution been effective?** ☑ Yes ☐ No	**Date Closed:** 07/17/24

Closing Comments: *(If the corrective action has not been effective, reference the new corrective action form to readdress the problem area.)*

Northcutt, Sharon (US)

From: Northcutt, Sharon (US)
Sent: Friday, June 28, 2024 1:41 PM
To: Steidley, Shane D
Subject: RE: MAPEP Series 50 Urine Matrix

Shane,
Thanks for responding so quickly! Here's how our average info breaks out since 2022:

	Volume, mL	Count Time, hrs	Detection Limit (pCi/L)
Typical Urine Sample	201	8.6	344
MAPEP Urine Sample	949	15.0	15

So as you can see, the Series 50 sample was a non-detect in comparison to our typical values.

Incidentally, for the urine matrix, our clients are only looking for Co-60 and Cs-137, so we only count long enough to meet the those MDC values.

Let me know what kind of resolution we can come to – I'm doing an non-conformance on the failure.
Hope you have a great weekend!

Thanks!
Sharon L Northcutt
Quality Assurance Manager
Teledyne Brown Engineering
2508 Quality Lane
Knoxville, TN 37931
865 934-0374

Please click the link below and rate your satisfaction with our service.

From: Steidley, Shane D <steidlsd@id.doe.gov>
Sent: Friday, June 28, 2024 11:38 AM
To: Northcutt, Sharon (US) <Sharon.Northcutt@Teledyne.com>
Subject: RE: MAPEP Series 50 Urine Matrix

External Email

Sharon,

What's your detection limit (count time & sample size) for Zn-65 analysis in Urine? The MAPEP does not set a count time & sample size. Perhaps this Zn-65 (~20 pCi) is below your routine Zn-65 detection limit for urine as we are testing at somewhat lower levels.

Let me know and I can take a look at these at more of sensitivity levels evaluation which may be more appropriate for your labs' routine analytical workload.

V/r,

Shane

From: Northcutt, Sharon (US) <Sharon.Northcutt@Teledyne.com>
Sent: Thursday, June 27, 2024 2:47 PM
To: Steidley, Shane D <steidlsd@id.doe.gov>
Subject: MAPEP Series 50 Urine Matrix

Shane,
Good afternoon! I'm reviewing our results for Series 50 and am puzzled about the Zn-65 result for urine that was not acceptable. We actually counted this sample on 3 different detectors and all 3 results were comparable (0.383, 0.666 and -4.23) as non-detects. Do you have any suggestions as to why this might be? We have never had an issue with passing Zn-65 on urine or other matrices before. Any insight would be most appreciated.

Thanks!
Sharon L Northcutt
Quality Assurance Manager
Teledyne Brown Engineering
2508 Quality Lane
Knoxville, TN 37931
865 934-0374

Please click the link below and rate your satisfaction with our service.

TELEDYNE BROWN ENGINEERING

NONCONFORMANCE REPORT (NCR) FORM

NCR No.: 24-10

Responsible Manager: Sharon Northcutt

PART 1.	TO BE COMPLETED BY ORIGINATOR OF NCR	
Initiated due to: ☒ Customer Complaint ☐ Audit/Mgmt Rept ☒ XCHK Failure ☐ Staff Observation		
Process Area: In-Plant Prep	Client/Project Affected: TBE MAPEP	
Requirement Reference: TBE-4004	Affected Data: L# 104633	
NCR Description: Failed crosscheck Tc-99 (WO matrix)		
Client Notification Needed: ☒ YES ☐ NO	Associated CAR or CC #: CAR 24-10	
Prepared By: Sharon Northcutt	Date: 06/26/24	

PART 2.	TO BE COMPLETED BY ROOT CAUSE INVESTIGATOR	
Root Cause:	Possible added Th interference not removed during Column separation.	
Corrective Action Plan:	Revise TBE-2021 to include extra rinse of Column during separation.	
Planned Completion Date(s) for Actions(s):	09/01/24	
Prepared By:	Keith Jeter	Date: 8/1/24
Approved By:	Sharon L Northcutt	Date: 08/01/24

PART 3.	TO BE COMPLETED BY QUALITY ASSURANCE MANAGER	
Review and Verification of Corrective Action: ☑ Accepted ☐ Rejected ☐ Follow-up Needed (describe) ☐ Completed		
Prepared By:	Sharon L Northcutt	Date: 08/01/24

PART 4.	TO BE COMPLETED BY RESPONSIBLE MANAGER	
Client Follow-Up Notification: ☐ YES ☑ NO Description:		Date:
Prepared By:	Sharon L Northcutt	Date: 08/01/24

Supplemental Sheet

NCR No: 24-10

Description of Nonconformance:

TBE's cross-check result for Tc-99 was unacceptable (high). The reported result was 9.95 ± 1.01Bq/L and the known was 7.47 ± 0.15 (133% ratio). The acceptance range was 5.23 – 9.71. With the associated errors, TBE's result was within the acceptable range.

Root Cause Investigation:

All QC associated with the original sample was acceptable and no anomalies were found. The sample was reanalyzed and used as the workgroup duplicate. Both results were 9.81 ± 0.992 Bq/L (131%). All TBE results are reproducible in that the original sample and reanalysis had an RPD of 1.42%. The same technicians prepped and counted both the original and the reanalysis and all procedures were followed as written.

Corrective Action to Prevent Recurrence:

This is the first result since 2020 that was not within the known/reported value range of 96%-109% (except for one "statistical failure" which in essence is a non-detect with a larger error value). We feel that the procedure is effective for Tc-99 separation as written for regular client samples. However, after receiving some guidance from a MAPEP representative, we will revise our procedure to include an additional 5-mL rinse with 0.1M HNO_3 to the TEVA-spec ® column to remove possible residual Th.

Keith Jeter — 8/1/24

Department Manager or Designee — Date

Sharon L Abbott — 08/01/24

Quality Assurance Manager or Designee — Date

Radiological

Units: (Bq/L)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR	0.278				0.195 - 0.361		
Cesium-134	1.12	1.36	A		-17.6	0.95 - 1.77	0.10	A
Cesium-137	2.00	2.23	A		-10.3	1.56 - 2.90	0.24	A
Cobalt-57	1.06	1.26	A		-15.9	0.88 - 1.64	0.15	A
Cobalt-60	2.26	2.38	A		-5.0	1.67 - 3.09	0.19	A
Curium-244	NR					False Positive Test		
Manganese-54	1.44	1.51	A		-4.6	1.06 - 1.96	0.23	W
Nickel-63	NR					False Positive Test		
Plutonium-238	NR	0.0035				Sensitivity Evaluation		
Plutonium-239/240	NR	0.0051				Sensitivity Evaluation		
Potassium-40	-1.8						0.1	N
Strontium-90	NR	1.80				1.26 - 2.34		
Technetium-99	NR					False Positive Test		
Uranium-234	0.001012		A			False Positive Test	0.00144	
Uranium-238	0.00228		A			False Positive Test	0.00293	
Zinc-65	-0.423	0.84	N		-150.4	0.59 - 1.09	0.274	N

Laboratory Results For MAPEP Series 50
(TELE01) Teledyne Brown Engineering - Environmental Services
2508 Quality Lane
Knoxville, TN 37931-6819

MAPEP-24-MaW50: Radiological and inorganic combined water standard

Inorganic

Units: (mg/L)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Antimony	NR	5.71				4.00 - 7.42		
Arsenic	NR	2.73				1.91 - 3.55		
Barium	NR	0.0561				0.0393 - 0.0729		
Beryllium	NR	2.87				2.01 - 3.73		
Cadmium	NR	0.854				0.598 - 1.110		
Chromium	NR	1.09				0.76 - 1.42		
Cobalt	NR	8.99				6.29 - 11.69		
Copper	NR	7.47				5.23 - 9.71		
Lead	NR	1.25				0.88 - 1.63		
Mercury	NR					False Positive Test		
Nickel	NR					False Positive Test		
Selenium	NR	0.247				0.173 - 0.321		
Technetium-99	NR	1.18E-05				8.30E-6 - 1.53E-5		
Thallium	NR	3.38				2.37 - 4.39		
Uranium-235	NR	6.04E-04				4.23E-4 - 7.85E-4		
Uranium-238	NR	0.0827				0.0579 - 0.1075		
Uranium-Total	NR	0.0833				0.0583 - 0.1083		
Vanadium	NR	5.76				4.03 - 7.49		
Zinc	NR	7.40				5.18 - 9.62		

Radiological

Units: (Bq/L)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR					False Positive Test		
Cesium-134	NR					False Positive Test		
Cesium-137	NR	9.7				6.8 - 12.6		
Cobalt-57	NR	25.4				17.8 - 33.0		
Cobalt-60	NR	10.27				7.19 - 13.35		
Hydrogen-3	NR	637				446 - 828		
Iron-55	NR	19.7				13.8 - 25.6		
Manganese-54	NR	7.36				5.15 - 9.57		
Nickel-63	0.338	0.8	A	(17)		Sensitivity Evaluation	0.769	
Plutonium-238	NR	0.745				0.522 - 0.969		
Plutonium-239/240	NR	0.769				0.538 - 1.000		
Potassium-40	NR					False Positive Test		
Radium-226	NR	0.310				0.217 - 0.403		
Strontium-90	NR	3.68				2.58 - 4.78		
Technetium-99	9.95	7.47	N		33.2	5.23 - 9.71	1.01	A
Uranium-234	NR	0.990				0.693 - 1.287		
Uranium-238	NR	1.028				0.720 - 1.336		
Zinc-65	NR					False Positive Test		

Laboratory Results For MAPEP Series 50
(TELE01) Teledyne Brown Engineering - Environmental Services

Printed 06/25/2024

MAPEP Mixed Analyte Performance Evaluation Program
Department of Energy RESL - 1955 Fremont Ave, MS4149 - Idaho Falls, ID 83415

Sample Statistical Summary

Analyte	T(1)	A(2)	Grand(3) Mean	Std Dev	Ref Value	Ref Unc	Acceptance Range
Inorganic							Units: (mg/L)
Antimony	15	15	5.56	0.25	5.71	0.06	4.00 - 7.42
Arsenic	17	16	2.68	0.14	2.73	0.05	1.91 - 3.55
Barium	17	16	0.0566	0.0030	0.0561	0.0011	0.0393 - 0.0729
Beryllium	16	15	2.83	0.15	2.87	0.06	2.01 - 3.73
Cadmium	17	17	0.836	0.047	0.854	0.017	0.598 - 1.110
Chromium	17	17	1.07	0.06	1.09	0.02	0.76 - 1.42
Cobalt	17	16	9.00	0.83	8.99	0.18	6.29 - 11.69
Copper	17	17	7.32	0.35	7.47	0.15	5.23 - 9.71
Lead	17	17	1.25	0.06	1.25	0.03	0.88 - 1.63
Mercury	13	9					False Positive Test
Nickel	15	10					False Positive Test
Selenium	15	14	0.233	0.023	0.247	0.005	0.173 - 0.321
Technetium-99	3	3			1.18E-5	2E-07	8.30E-6 - 1.53E-5
Thallium	15	15	3.37	0.27	3.38	0.07	2.37 - 4.39
Uranium-235	15	15	5.90E-4	3.20E-5	6.04E-4	6E-06	4.23E-4 - 7.85E-4
Uranium-238	15	15	0.0824	0.0054	0.0827	0.0012	0.0579 - 0.1075
Uranium-Total	20	19	0.0842	0.0052	0.0833	0.0013	0.0583 - 0.1083
Vanadium	17	17	5.75	0.26	5.76	0.12	4.03 - 7.49
Zinc	17	17	7.34	0.81	7.40	0.15	5.18 - 9.62
Analyte	T(1)	A(2)	Grand(3) Mean	Std Dev	Ref Value	Ref Unc	Acceptance Range
Radiological							Units: (Bq/L)
Americium-241	32	29					False Positive Test
Cesium-134	49	44					False Positive Test
Cesium-137	56	54	10.1	0.7	9.7	0.2	6.8 - 12.6
Cobalt-57	56	54	24.7	1.7	25.4	0.5	17.8 - 33.0
Cobalt-60	56	53	10.19	0.51	10.27	0.17	7.19 - 13.35
Hydrogen-3	41	37	640	42	637	15	446 - 828
Iron-55	8	7	18.9	2.9	19.7	0.4	13.8 - 25.6
Manganese-54	56	53	7.42	0.43	7.36	0.15	5.15 - 9.57
Nickel-63	12	10	1.0	0.7	0.8	0.2	Sensitivity Evaluation
Plutonium-238	30	27	0.703	0.059	0.745	0.011	0.522 - 0.969
Plutonium-239/240	30	27	0.699	0.060	0.769	0.012	0.538 - 1.000
Potassium-40	49	40					False Positive Test
Radium-226	24	21	0.317	0.042	0.310	0.007	0.217 - 0.403
Strontium-90	33	30	3.63	0.32	3.68	0.07	2.58 - 4.78
Technetium-99	17	14	7.26	0.74	7.47	0.15	5.23 - 9.71
Uranium-234	30	26	0.986	0.075	0.990	0.015	0.693 - 1.287
Uranium-238	31	28	1.016	0.057	1.028	0.015	0.720 - 1.336
Zinc-65	48	46					False Positive Test

Note: (1) T = Total number of laboratories reporting analyte.
(2) A = Number of laboratories with 'Acceptable' performance.
(3) Mean excludes values derived as total metals and values indicated as "Not Acceptable".

Results Flags:

A = Result acceptable.....|Bias|

W = Result acceptable with warning.....20% < |Bias|

N = Result not acceptable.....|Bias| > 30%

RW = Report Warning

NR = Not Reported

Printed 06/27/2024

QC Summary Report for WG45158

TE511-LABQC

07/03/2024 14:22

TC-99

Method Blank Summary

BE Sample ID	Radionuclide	Matrix	Count Date/Time	Blank Result	Units	Qualifier	P/F
WG45158-1	TC-99	WO	06/28/2024 19:40	< 1.290E+00	pCi/Total	U	P

LCS Sample Summary

BE Sample ID	Radionuclide	Matrix	Count Date/Time	Count Date Spike Value	LCS Result	Units	Spike Recovery	Range	Qualifier	P/F
WG45158-2	TC-99	WO	06/28/2024 20:48	3.35E+02	3.570E+02	pCi/Total	106.7	70-130	+	P

Spike ID: **99TC-040314** Spike Reference Date: **09/01/1998 12:00**

Spike Conc: **6.69E+02** Spike Vol: **5.00E-01**

Duplicate Summary

BE Sample ID	Radionuclide	Matrix	Count Date/Time	Original Result	DUP Result	Units	RPD	Range	Qualifier	P/F
WG45158-3	TC-99	WO	06/28/2024 20:52	9.810E+00	9.810E+00	Bq/l	0.0	<30	+	P
104633-2R1										

TC-99

Associated Samples for WG45158

Sample #	Client ID
WG45158-1	Blank Samples
WG45158-2	Laboratory Control Samples
WG45158-3	MAPEP-24-MAW50

- Positive Result
J Compound/analyte was analyzed, peak not identified and/or not detected above MDC
< 5 times the MDC are not evaluated
* Nuclide not detected
** Spiking level < 5 times activity
Pass
Fail
NE Not evaluated

Northcutt, Sharon (US)

From: Steidley, Shane D <steidlsd@id.doe.gov>
Sent: Wednesday, July 3, 2024 3:13 PM
To: Northcutt, Sharon (US)
Subject: RE: Tc-99 Water question

External Email

Sharon,

Some analytical challenges that I've seen labs run into for Tc-99 analysis is residual Th on Eichrom TEVA's and/or not very solid LSC "backgrounds".

Do you see alpha and/or discriminate for alpha in LSC Tc-99 spectrum?

We've seen significant LSC "blank" background issues. Some of these issues were traced to Tc-99m that we've purchased from medical suppliers. So we are always careful checking the Tc-99m tracer each distribution to see what they might be contributing to our "blnk, background.

I'm not sure if you're using TEVA disks and/or Tc-99m as a tracer, but that's the first couple of area I'd start looking at.

I'll still take a look at the previous email thread on urine matrix, but haven't have a chance yet.

V/r,

Shane

From: Northcutt, Sharon (US) <Sharon.Northcutt@Teledyne.com>
Sent: Wednesday, July 3, 2024 12:41 PM
To: Steidley, Shane D <steidlsd@id.doe.gov>
Subject: Tc-99 Water question

Shane,
Hey! We have reanalyzed our Tc-99 water sample that was just barely over the acceptance range with similar results (reanalysis and workgroup duplicate) as originally reported. Historically we have been right around 100% submitting these results since 2020 (except for one "statistical failure" in 2022. Do you have any suggestions on why our result would all of a sudden be so much higher? All QC looked fine/normal of course.

Thanks!
Sharon L Northcutt
Quality Assurance Manager
Teledyne Brown Engineering
2508 Quality Lane
Knoxville, TN 37931
865 934-0374

Please click the link below and rate your satisfaction with our service.

★★★★★

TELEDYNE BROWN ENGINEERING

Corrective Action Request & Report

CAR NO.: 24-10

SECTION 1 *(To be completed by initiator)*

Initiator Name: Sharon Northcutt	**Date:** 07/15/24

Identified Through: ☒ Daily Operations ☐ Management Review ☐ Audit ☐ Client Feedback ☐ Other
(check one)

Corrective action is requested to address the following condition:

Unacceptable MAPEP WO Tc-99 results (high). This is the first failure for Tc-99 (except for one "statistical failure", which was a non-detect result.

Manager Acknowledgement: Sharon Northcutt	**Date:** 07/15/24

SECTION 2 *(To be completed by Quality Assurance Manager)*

Assigned to: Keith Jeter	**Priority:** ☐ High ☒ Medium ☐ Low	**Date:** 07/15/24

Requested date for root cause investigation: 08/15/24

NCR # N/A (if applicable)

Comments: Method works well for typical client samples. Possible Th interference for MAPEP sample.

SECTION 3 *(To be completed by Assignee - attach additional information as necessary)*

Relevant background information collected? ☐ Yes	**Existing processes investigated and understood?** ☐ Yes

Summary of Proposed Action(s):
Add an extra 5-mL rinse to TEVA column during separation to remove residual Th.

Documents Requiring Update: TBE-2021

Solution approval signature(s): Sharon L Northcutt

SECTION 4 *(To be completed by Quality Assurance Manager)*

Documents Updated? ☑ Yes	**Has the solution been effective?** ☑ Yes ☐ No	**Date Closed:** 12/13/2024

Closing Comments: *(If the corrective action has not been effective, reference the new corrective action form to readdress the problem area.)*

MAPEP-24-MaWS1 Technetium-99 results returned "Acceptable". See attached

MAPEP Mixed Analyte Performance Evaluation Program

Department of Energy RESL - 1955 Fremont Ave, MS4149 - Idaho Falls, ID 83415

Laboratory Results For MAPEP Series 51
MAPEP-24-MaS51: Radiological and inorganic combined soil standard
(TELE01) Teledyne Brown Engineering - Environmental Services
2508 Quality Lane
Knoxville, TN 37931-6819

Inorganic — Units: (mg/kg)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Antimony	NR	6.47				4.53 - 8.41		
Arsenic	NR	26.5				18.6 - 34.5		
Barium	NR	218				153 - 283		
Beryllium	NR	12.9				9.0 - 16.8		
Cadmium	NR	3.14				2.20 - 4.08		
Chromium	NR	45.6				31.9 - 59.3		
Cobalt	NR	27.3				19.1 - 35.5		
Copper	NR	50.7				35.5 - 65.9		
Lead	NR	22.0				15.4 - 28.6		
Mercury	NR	0.182				0.127 - 0.237		
Nickel	NR	42.8				30.0 - 55.6		
Selenium	NR	5.65				3.96 - 7.35		
Silver	NR	3.37				2.36 - 4.38		
Technetium-99	NR	2.73E-04				1.91E-4 - 3.55E-4		
Thallium	NR	2.02				1.41 - 2.63		
Uranium-235	NR	0.0407				0.0285 - 0.0529		
Uranium-238	NR	13.2				9.2 - 17.2		
Uranium-Total	NR	13.3				9.3 - 17.3		
Vanadium	NR	44.7				31.3 - 58.1		
Zinc	NR	110				77 - 143		

Radiological — Units: (Bq/kg)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR	0.26				Sensitivity Evaluation		
Cesium-134	NR	417				292 - 542		
Cesium-137	NR	1650				1155 - 2145		
Cobalt-57	NR	330				231 - 429		
Cobalt-60	NR	700				490 - 910		
Iron-55	NR	780	N	(28)		546 - 1014		
Manganese-54	NR	113				79 - 147		
Nickel-63	1140	1450	W		-21.4	1015 - 1885	21.5	N
Plutonium-238	NR	17.8				12.5 - 23.1		
Plutonium-239/240	NR	50.0				35.0 - 65.0		
Potassium-40	NR	525				368 - 683		
Strontium-90	NR	487				341 - 633		
Technetium-99	155	171	A		-9.4	120 - 222	22.7	A
Thorium-228	38.0	43.3	A		-12.2	30.3 - 56.3	8.21	W
Thorium-230	46.1	44.0	A		4.8	30.8 - 57.2	9.27	W
Thorium-232	38.9	42.6	A		-8.7	29.8 - 55.4	8.11	W
Uranium-234	NR	50.0				35.0 - 65.0		
Uranium-238	NR	165				116 - 215		
Zinc-65	NR	415				291 - 540		

Laboratory Results For MAPEP Series 51
MAPEP-24-MaW51: Radiological and inorganic combined water standard
(TELE01) Teledyne Brown Engineering - Environmental Services
2508 Quality Lane
Knoxville, TN 37931-6819

Inorganic — Units: (mg/L)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Antimony	NR					False Positive Test		
Arsenic	NR	2.13				1.49 - 2.77		
Barium	NR	2.82				1.97 - 3.67		
Beryllium	NR	4.91				3.44 - 6.38		
Cadmium	NR					False Positive Test		
Chromium	NR					False Positive Test		

Printed 12/13/2024

Cobalt	NR	10.2			7.1 - 13.3
Copper	NR	2.50			1.75 - 3.25
Lead	NR	1.54E-04			Sensitivity Evaluation
Mercury	NR	0.087			0.061 - 0.113
Nickel	NR	6.19			4.33 - 8.05
Selenium	NR	0.624			0.437 - 0.811
Technetium-99	NR	1.79E-05			1.25E-5 - 2.33E-5
Thallium	NR	2.290			1.603 - 2.977
Uranium-235	NR	2.18E-04			1.53E-4 - 2.83E-4
Uranium-238	NR	0.0310			0.0217 - 0.0403
Uranium-Total	NR	0.0312			0.0218 - 0.0406
Vanadium	NR				False Positive Test
Zinc	NR	2.28			1.60 - 2.96

Radiological — Units: (Bq L)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR	0.363				0.254 - 0.472		
Cesium-134	NR	22.3				15.6 - 29.0		
Cesium-137	NR					False Positive Test		
Cobalt-57	NR	26.4				18.5 - 34.3		
Cobalt-60	NR	15.0				10.5 - 19.5		
Hydrogen-3	NR	374				262 - 486		
Iron-55	NR	48.1				33.7 - 62.5		
Iron-59	NR	57.5				40.3 - 74.8		
Manganese-54	NR					False Positive Test		
Nickel-63	0.60		A			False Positive Test	3.19	
Plutonium-238	NR	0.439				0.307 - 0.571		
Plutonium-239/240	NR	0.437				0.306 - 0.568		
Potassium-40	NR					False Positive Test		
Radium-226	NR	0.360				0.252 - 0.468		
Strontium-90	NR	11.2				7.8 - 14.6		
Technetium-99	11.9	11.2	A		6.3	7.8 - 14.6	1.83	W
Uranium-234	NR	0.380				0.266 - 0.494		
Uranium-238	NR	0.385				0.270 - 0.501		
Zinc-65	NR	22.8				16.0 - 29.6		

Laboratory Results For MAPEP Series 51
MAPEP-24-RdV51: Radiological vegetation
(TELE01) Teledyne Brown Engineering - Environmental Services
2508 Quality Lane
Knoxville, TN 37931-6819

Inorganic — Units: (ug/sample)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Uranium-235	NR	0.040				0.028 - 0.052		
Uranium-238	NR	5.51				3.86 - 7.16		
Uranium-Total	NR	5.51				3.86 - 7.16		

Radiological — Units: (Bq/sample)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR	0.087				0.061 - 0.113		
Cesium-134	3.12	2.89	A		8.0	2.02 - 3.76	0.223	A
Cesium-137	2.18	1.91	A		14.1	1.34 - 2.48	0.166	A
Cobalt-57	0.0013		A			False Positive Test	0.058	
Cobalt-60	2.24	2.01	A		11.4	1.41 - 2.61	0.117	A
Manganese-54	3.76	3.53	A		6.5	2.47 - 4.59	0.244	A
Plutonium-238	NR	0.0368				0.0258 - 0.0478		
Plutonium-239/240	NR	0.0356				0.0249 - 0.0463		
Strontium-90	0.95	2.39	N		-60.3	1.67 - 3.11	0.028	A
Uranium-234	NR	0.0660				0.0462 - 0.0858		
Uranium-238	NR	0.0685				0.0480 - 0.0891		
Zinc-65	10.3	9.13	A		12.8	6.39 - 11.87	0.496	A

Notes:

(28) = Not Reporting Previously Reported Analyte

TELEDYNE BROWN ENGINEERING

NONCONFORMANCE REPORT (NCR) FORM

NCR No.: 24-11

Responsible Manager: Sharon Northcutt

PART 1. TO BE COMPLETED BY ORIGINATOR OF NCR	
Initiated due to: ☒ Customer Complaint ☐ Audit/Mgmt Rept ☒ XCHK Failure ☐ Staff Observation	
Process Area: Environmental Prep	Client/Project Affected: TBE MAPEP
Requirement Reference: TBE-4004	Affected Data: L# 104633
NCR Description: Failed crosscheck Sr-90 (VEG matrix) TBE reported value 0.276 ± 0.012 Bq; Known value 0.529 Bq. Acceptance range 0.370 – 0.688	
Client Notification Needed: ☒ YES ☐ NO (QA Report)	Associated CAR or CC #: N/A
Prepared By: Sharon Northcutt	Date: 06/26/24

PART 2. TO BE COMPLETED BY ROOT CAUSE INVESTIGATOR	
Root Cause: Lab accident during prep with the original sample (small volume) and had to use the other (larger volume) sample to perform the analysis. The prep instructions stated to use the entire volume for analysis – this is significantly larger than typical samples and suggested volume for the method. QC was reviewed with no anomalies and carrier yield was acceptable at 97.6%.	
Corrective Action Plan: No effective corrective action at this time, as it was a lab accident that led to the unusually low result. This was the first unacceptable result (except for 2 "statistical failures") since 2018.	
Planned Completion Date(s) for Actions(s): N/A	
Prepared By: Sharon L Northcutt	Date: 06/27/24
Approved By: Keith Jete	Date: 7/16/24

PART 3. TO BE COMPLETED BY QUALITY ASSURANCE MANAGER	
Review and Verification of Corrective Action: ☑ Accepted ☐ Rejected ☐ Follow-up Needed (describe) ☐ Completed	
Prepared By: Sharon L Northcutt	Date: 06/27/24

PART 4. TO BE COMPLETED BY RESPONSIBLE MANAGER	
Client Follow-Up Notification: ☐ YES ☑ NO (QA Rept) Description:	Date:
Prepared By: Sharon L Northcutt	Date: 06/27/24

2508 Quality Lane
Knoxville, TN 37931-6819

MAPEP-24-RdV50: Radiological vegetation

Inorganic — Units: (ug/sample)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Uranium-235	NR	0.0383				0.0268 - 0.0498		
Uranium-238	NR	5.6				3.9 - 7.3		
Uranium-Total	NR	5.6				3.9 - 7.3		

Radiological — Units: (Bq/sample)

Analyte	Result	Ref Value	Flag	Notes	Bias (%)	Acceptance Range	Unc Value	Unc Flag
Americium-241	NR					False Positive Test		
Cesium-134	2.80	3.67	W		-23.7	2.57 - 4.77	0.23	A
Cesium-137	2.21	2.57	A		-14.0	1.80 - 3.34	0.23	A
Cobalt-57	2.23	2.53	A		-11.9	1.77 - 3.29	0.12	A
Cobalt-60	2.42	2.96	A		-18.2	2.07 - 3.85	0.16	A
Manganese-54	0.033		A			False Positive Test	0.096	
Plutonium-238	NR	0.0413				0.0289 - 0.0537		
Plutonium-239/240	NR	0.0431				0.0302 - 0.0560		
Strontium-90	0.276	0.529	N		-47.8	0.370 - 0.688	0.012	A
Uranium-234	NR	0.067				0.047 - 0.087		
Uranium-238	NR	0.070				0.049 - 0.091		
Zinc-65	6.83	8.02	A		-14.8	5.61 - 10.43	0.49	A

Notes:

(17) = NOT DETECTED - reported a statistically zero result

MAPEP Mixed Analyte Performance Evaluation Program
Department of Energy RESL - 1955 Fremont Ave, MS4149 - Idaho Falls, ID 83415

Sample Statistical Summary

Analyte	T(1)	A(2)	Grand(3) Mean	Std Dev	Ref Value	Ref Unc	Acceptance Range
Inorganic							Units: (ug/sample)
Uranium-235	4	4			0.0383	0.0010	0.0268 - 0.0498
Uranium-238	4	4			5.6	0.2	3.9 - 7.3
Uranium-Total	2	2			5.6	0.3	3.9 - 7.3
Analyte	T(1)	A(2)	Grand(3) Mean	Std Dev	Ref Value	Ref Unc	Acceptance Range
Radiological							Units: (Bq/sample)
Americium-241	16	13					False Positive Test
Cesium-134	36	33	3.48	0.41	3.67	0.07	2.57 - 4.77
Cesium-137	37	33	2.61	0.27	2.57	0.04	1.80 - 3.34
Cobalt-57	36	31	2.52	0.30	2.53	0.05	1.77 - 3.29
Cobalt-60	37	34	2.94	0.30	2.96	0.06	2.07 - 3.85
Manganese-54	30	27					False Positive Test
Plutonium-238	16	13	0.0400	0.0058	0.0413	0.0013	0.0289 - 0.0537
Plutonium-239/240	16	14	0.0417	0.0046	0.0431	0.0016	0.0302 - 0.0560
Strontium-90	16	11	0.478	0.049	0.529	0.012	0.370 - 0.688
Uranium-234	16	12	0.066	0.006	0.067	0.003	0.047 - 0.087
Uranium-238	17	13	0.066	0.008	0.070	0.003	0.049 - 0.091
Zinc-65	36	34	8.16	0.83	8.02	0.16	5.61 - 10.43

Note: (1) T = Total number of laboratories reporting analyte.
(2) A = Number of laboratories with 'Acceptable' performance.
(3) Mean excludes values derived as total metals, from large vegetation sample size and values indicated as "Not Acceptable".
(4) Uranium Reference values shown for small vegetation sample size only.

Results Flags:

A = Result acceptable.....|Bias|

W = Result acceptable with warning.....20% < |Bias|

N = Result not acceptable.....|Bias| > 30%

RW = Report Warning

NR = Not Reported

Uncertainty Flags:

NOT ACCEPTABLE.....RP < 2%

ACCEPTABLE.....2%

ACCEPTABLE WITH WARNING.....15% < RP

NOT ACCEPTABLE.....RP > 30%

Relative Precision (RP) = (Reported Uncertainty / Reported Result) x 100

TELEDYNE BROWN ENGINEERING

NONCONFORMANCE REPORT (NCR) FORM

NCR No.: NCR-24-12

Responsible Manager: Victoria Leslie

PART 1. TO BE COMPLETED BY ORIGINATOR OF NCR	
Initiated due to: ☒ Customer Complaint ☐ Audit/Mgmt Rept ☐ XCHK Failure ☐ Staff Observation	
Process Area: Inplant lab	Client/Project Affected: [redacted]
Requirement Reference: TBE-1018	Affected Data: L# 105563-2
NCR Description: Fe-55 results for original and R1 did not confirm	
Client Notification Needed: ☒ YES ☐ NO	Associated CAR or CC #: CC 24-05
Prepared By: Victoria Leslie	Date: 07/15/24

PART 2. TO BE COMPLETED BY ROOT CAUSE INVESTIGATOR	
Root Cause: See Supplemental Sheet	
Corrective Action Plan: No effective CA due to low percentage of errors of this type.	
Planned Completion Date(s) for Actions(s): N/A	
Prepared By: Sharon L Northcutt	Date: 07/17/24
Approved By: Keith Jett	Date: 7/17/24

PART 3. TO BE COMPLETED BY QUALITY ASSURANCE MANAGER	
Review and Verification of Corrective Action: ☑ Accepted ☐ Rejected ☐ Follow-up Needed (describe) ☐ Completed	
Prepared By: Sharon L Northcutt	Date: 07/17/24

PART 4. TO BE COMPLETED BY RESPONSIBLE MANAGER	
Client Follow-Up Notification: ☐ YES ☒ NO Description:	Date: 7/18/24
Prepared By: [signature]	Date: 7/18/24

Supplemental Sheet

NCR No: 24-12

Description of Nonconformance:

Client complaint CC 24-05 was initiated due to Fe-55 and Co-60 ratios not comparing well to historical results. The sample was reprepped and the R1 did not confirm the original result.

Root Cause Investigation:

All QC associated with the original sample was acceptable and no anomalies were found. The original sample was recounted and reprepped. A summary of the results are as follows:

Sample ID	Result (uCi)
L105563-2	1.716E-01 ± 8.999E-03
L105563-2 C1	1.347E-01 ± 5.586E-03
L105563-2 R1	2.184E-02 ± 2.054E-03

Because the recount result confirmed the original result, the issue was in the prep lab and not as a result of count room technician error. Looking at all of the samples in the associated workgroup, there were a couple of sample ID's that were very similar (L105562-2 and L105563-2) and there was a possibility that the sample was mislabeled. The more likely possibility is that sample L105562-2 was inadvertently aliquotted twice. The same technician prepped the original and R1 and all procedures were followed as written.

Corrective Action to Prevent Recurrence:

Because this was due to a human error, no effective corrective action will be taken at this time. Historically, there have been 21 of these type errors since 2016 for > 291600 samples processed, or about 2.5 per year. This was the first error of this type by this technician. If this is repeated, further investigation will occur.

Keith Jeter — 7/17/24

Department Manager or Designee — Date

Sharon L Northcutt — 07/17/24

Quality Assurance Manager or Designee — Date

CUSTOMER COMPLAINT FORM

GENERAL INFORMATION

CC number: 24-05	
Date of complaint: 07/05/24	Complaint logged by: Victoria Leslie
Associated L#/Work Group: L105563	Client Contact Name: [redacted]
Related NCR (if applicable): NCR 24-12	Client/Project Name: [redacted]

DETAILS

Complaint: The Fe-55 and Co-60 abundance for L105563-2 were vastly different compared to previous years.

Cause: Possible sample switching in prep lab or double aliquot of the sample.

Resolution: Sample reprepped, original sample and reprep recounted. Reprep result was more in line with Client expectations.

REVIEW BY QUALITY ASSURANCE MANAGER

Reviewed by: Sharon L Northcutt	Date: 07/17/24

REVIEW BY LABORATORY OPERATIONS MANAGER

Reviewed by: Keith Jett	Date: 7/17/24

TELEDYNE BROWN ENGINEERING

NONCONFORMANCE REPORT (NCR) FORM

NCR No.: 24-13

NCR Initiator: Kim Thurman

PART 1. TO BE COMPLETED BY ORIGINATOR OF NCR	
Initiated due to: ☒ Customer Complaint ☐ Audit/Mgmt Rept ☐ XCHK Failure ☐ Staff Observation	
Process Area: Count Room	Client/Project Affected: [redacted]
Requirement Reference: TBE-6001	Affected Data: L# 105978-1
NCR Description: Incorrect EDI data provided to client.	
Client Notification Needed: ☒ YES ☐ NO	Associated CAR or CC #: CC 24-06
Prepared By: Kimberly O'Dell	**Date:** 7/29/2024

PART 2. TO BE COMPLETED BY ROOT CAUSE INVESTIGATOR	
Root Cause: The first ROA generated listed a sample testing result of 3.74 pCi/L. After the generation of this report and prior to its submission to the client, data was inadvertently replaced with earlier count results for the same sample. Consequently, the EDI displayed a result of 47.1 pCi/L. Client contacted PM on 7/28/24 requesting review of sample results. Recount and Reanalysis were performed on 7/30/24 with results that confirmed initial analysis result; with the ROA needing no changes. The client was notified, and a revised EDI file was submitted.	
Corrective Action Plan: LIMS programming to prevent overwrite of files after data has been uploaded from instrument to LIMS.	
Planned Completion Date(s) for Actions(s): 8/29/2024	
Prepared By: Kimberly O'Dell	**Date:** 8/29/24
Approved By: Keith Jeter	**Date:** 8/29/24

PART 3. TO BE COMPLETED BY QUALITY ASSURANCE MANAGER	
Review and Verification of Corrective Action: ☑ Accepted ☐ Rejected ☐ Follow-up Needed (describe in space below) ☒ Completed	
Prepared By: Kristi Peacock	Date: 8/29/24

PART 4. TO BE COMPLETED BY RESPONSIBLE MANAGER	
Client Follow-Up Notification: ☑ YES ☐ NO Description: Emailed client update of closed investigation.	Date: 8/29/24
Prepared By: Kimberly O'Dell	Date: 8/29/24

TELEDYNE BROWN ENGINEERING

Corrective Action Request & Report

CAR NO.: 24 8P 21-11

SECTION 1 *(To be completed by initiator)*

Initiator Name: Sharon Northcutt	**Date:** 07/29/24

Identified Through: ☒ Daily Operations ☐ Management Review ☐ Audit ☐ Client Feedback ☐ Other
(check one)

Corrective action is requested to address the following condition:

RPD's are not normally evaluated for client reports if one or both results are < 5x MDC. We ran into a situation where the results were different by a factor of 10 but not evaluated. The result was an RPD of 173%. Even though these results aren't evaluated for clients, we still need to monitor and be aware of duplicate results that are not even close – to reprep or recount or as project managers, just be aware prior to reports going to clients. We need a LIMS notification sent to all PM's, QA and Lab Manager(s) for any duplicate that has a calculated RPD > 50%.

Manager Acknowledgement: Sharon L Northcutt	**Date:** 07/21/24

SECTION 2 *(To be completed by Quality Assurance Manager)*

Assigned to: Jim Wright	**Priority:** ☐ High ☐ Medium ☒ Low	**Date:** 07/29/24

Requested date for root cause investigation:

NCR # ~~N/A~~ 24-13 **(if applicable)**

Comments:

SECTION 3 *(To be completed by Assignee - attach additional information as necessary)*

Relevant background information collected? ☑ Yes	**Existing processes investigated and understood?** ☑ Yes

Summary of Proposed Action(s):
LIMS programming to send alert to all managers if RPD > 50.

Documents Requiring Update: NA

Solution approval signature(s): Sharon L Northcutt

SECTION 4 *(To be completed by Quality Assurance Manager)*

Documents Updated? ☐ Yes NA	**Has the solution been effective?** ☑ Yes ☐ No	**Date Closed:** 09/01/24

Closing Comments: *(If the corrective action has not been effective, reference the new corrective action form to readdress the problem area.)*

NONCONFORMANCE REPORT (NCR)

NCR No.: 24-14

NCR Initiator: Kristin Peacock
(Print Name)

PART 1. Statement of Nonconformance

Nonconformance Trigger:

☐ Client Feedback	☐ Internal Audit	☒ XCHK Failure	☐ LM Review
☐ Management Report	☐ External Audit	☐ Staff Observation	☐ PM Review
			☐ QM Review

Process Area:

☐ Quality Assurance	☐ Sample Receipt	☒ InPlant Lab	☐ Count Room
☐ Lab Management	☐ Sample Prep	☐ Environmental Lab	☐ Other_____
☐ Project Management			

QSM 6.0 Impact Category:

Module 1: Proficiency Testing
- ☒ 4.0 Requirements for Accreditation
- ☐ 5.2 PT Study Frequency; Continued Accred.
- ☐ 6.0 Corrective Action
- ☐ 7.0 Complaint Resolution

Module 2: Quality Systems Gen Requirements
- ☐ 4.1 Impartiality
- ☐ 4.2 Confidentiality
- ☐ 6.2 Personnel
- ☐ 6.3 Facilities/Env Conditions
- ☐ 6.4 Equipment
- ☐ 6.5 Metrological Traceability
- ☐ 6.6 External products/ services
- ☐ 7.1 Review of requests/ tenders/contracts
- ☒ 7.3 Sampling
- ☐ 7.4 Handling of test/calibration items
- ☐ 7.5 Technical Records

Module 2: Quality Systems Gen Requirements
- ☐ 7.6 Eval of MUs
- ☐ 7.7 Validity of Results
- ☐ 7.8 Reporting
- ☐ 7.9 Complaints
- ☐ 7.10 Nonconforming work
- ☐ 7.11 Control of Data and Info. Mgmt.
- ☐ 8.2 Mgmt. Sys Documentation (MSD)
- ☐ 8.3 Control of MSD
- ☐ 8.4 Control of Records
- ☐ 8.5 Risk/Opp Actions
- ☐ 8.6 Improvement
- ☐ 8.7 CAs
- ☐ 8.8 Internal Audits
- ☐ 8.9 Mgmt. Review

Module 6: Quality Systems for RadChem testing
- ☐ 5.0 Method Validation
- ☐ 6.0 Demonstration of Capability (DOC)
- ☐ 7.1 Instrument Requirements
- ☐ 7.2 Quality Control
- ☐ 7.3 Data Eval/Reporting
- ☐ 7.4 Sample Handling
- ☐ 8.0 Method Specific Directions

☐ Other _____

Project # Affected: ERA MRAD-41	**Was data affected?** ☒ Yes ☐ No	**Was data recalled?** ☐ Yes ☒ No	**Rerun/Recount Required?** ☒ Yes ☐ No
Requirement Reference: TBE-4006, TBE-2001		**Affected Data:** L107082	

Impact Rate: (Appendix A of TBE-1018)	☐ 1-Very Low ☐ 2-Low ☐ 3-Moderate ☒ 4-High ☐ 5-Very High	**Probability:** (Appendix A of TBE-1018)	☐ 1-Rare ☐ 2-Unlikely ☒ 3-Possible ☐ 4-Likely ☐ 5-Almost Certain	**Risk Rate Level:** (Multiply impact by probability)	*Number Value: 12 ☐ 1-Low (1-4) ☐ 2-Moderate (5-10) ☒ 3-High (11-15) ☐ 4-Extreme (16-25)

NCR Description: ERA MRAD-41 Internal Crosscheck results failures. AP U-234 reported 14.0 with an assigned 31.1 at 45%. AP U-238 reported 14.2 with an assigned 30.9 at 46%. The acceptance range is between 70-130%. This is not a repeat failure with no related NCRs in 2024.

Client Notification: ☒ YES Client notified of results via ERA Waters.	**Date of Notification:** 11/18/2024
Initiator Signature: Kristin Peacock	**Part 1 Date Completed:** 11/18/2024

PART 2. Root Cause (RC) Investigation

Were past results impacted by nonconforming event? ☐ Yes ☒ No ☐ N/A	If **yes**, explain: N/A
RC Investigator: Karli Arterburn	
Investigation Start Date: 11/19/2024	**Expected/Actual Completion Date:** 12-19-2024 / 11-22-2024

RC Summary: The Investigator reviewed the data in LIMS and by doubling the tracer amount manually, where only half of the amount was reported, determined that the technician placed double the amount of tracer in the sample in error. The original digestion had tracer placed. Upon completion of the digestion process, the technician aliquoted the sample, placing tracer into the sample, forgetting that tracer was already present.
Had the reported amount been accurate to the amount of tracer placed in the sample versus what was documented in LIMS, the crosscheck sample for Uranium would have passed the ERA study.

Reviewed By: (QM signature) Kristi Peacock	**Date:** 11/22/2024
Reviewed By: (LM signature) Karli Arterburn	**Date:** 11/22/2024

PART 3. Corrective Action (CA) Plan

Recommended CA:
Samples that have been digested/leached with carrier/tracer added will have a label placed over the cap indicating it has already been added. Additionally, the beaker that aliquot is put in should have markings to indicate carrier/tracer has already been added to the sample.

Implemented by: Karli Arterburn	**Implementation Date:** 01/21/2025
Approved By: (QM signature) Kristi Peacock	**Date:** 01/14/2025
Approved By: (LM signature) Karli Arterburn	**Date:** 1/14/2025

CA Monitoring Required?	☒Yes ☐No	**Monitored By:**	Karli Arterburn	**Monitoring Completed on Date:** 03/31/2025
CA Effective?	☐Yes ☐No	**Explain:**		
Effectiveness Reviewed by: (QM Signature)				**Date:**

PART 4. Client Follow-up

Client Follow-Up Notification: ☐ YES ☒ Not Required

Details of notification (by what means): Notification not required unless requested by Regulatory Agency; no regulatory agencies placed any requests.

Completed By: (print and signature) Kristin Peacock Kristi Peacock	**Date:** 11/22/2024

NCR Closed:_____
(date/ QM Initials)

ERA
A Waters Company

MRAD-41 Laboratory Exception Report

Kristin Peacock
Quality Assurance Manager
Teledyne Brown Engineering
2508 Quality Ln.
Knoxville, TN 37931
(865) 934-0374

EPA ID: TN11387
ERA Customer Number: T200801
Report Issued: 11/18/2024
Study Dates: 09/16/2024 - 11/15/2024

Not Acceptable Evaluations

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description
MRAD Air Filter Radionuclides (cat# 800, lot# A041-606)							
3036	Uranium-234	pCi/Filter	14.0	31.1	23.1 - 38.4	Not Acceptable	HASL 300 U-02 28th ED 1997
3038	Uranium-238	pCi/Filter	14.2	30.9	23.3 - 36.9	Not Acceptable	HASL 300 U-02 28th ED 1997
MRAD Water Radionuclides (cat# 804, lot# A041-617)							
2885	Iron-55	pCi/L	615	1230	723 - 1790	Not Acceptable	TBE Proprietary

NONCONFORMANCE REPORT (NCR)

NCR No.: 24-15

NCR Initiator: Kristin Peacock
(Print Name)

PART 1. Statement of Nonconformance

Nonconformance Trigger:

☐ Client Feedback	☐ Internal Audit	☒ XCHK Failure	☐ LM Review
☐ Management Report	☐ External Audit	☐ Staff Observation	☐ PM Review
			☐ QM Review

Process Area:

☐ Quality Assurance	☐ Sample Receipt	☒ InPlant Lab	☐ Count Room
☐ Lab Management	☐ Sample Prep	☐ Environmental Lab	☐ Other_____
☐ Project Management			

QSM 6.0 Impact Category:

Module 1: Proficiency Testing
- ☒ 4.0 Requirements for Accreditation
- ☐ 5.2 PT Study Frequency; Continued Accred.
- ☐ 6.0 Corrective Action
- ☐ 7.0 Complaint Resolution

Module 2: Quality Systems Gen Requirements
- ☐ 4.1 Impartiality
- ☐ 4.2 Confidentiality
- ☐ 6.2 Personnel
- ☐ 6.3 Facilities/Env Conditions
- ☐ 6.4 Equipment
- ☐ 6.5 Metrological Traceability
- ☐ 6.6 External products/ services
- ☐ 7.1 Review of requests/ tenders/contracts
- ☒ 7.3 Sampling
- ☐ 7.4 Handling of test/calibration items
- ☐ 7.5 Technical Records

Module 2: Quality Systems Gen Requirements
- ☐ 7.6 Eval of MUs
- ☐ 7.7 Validity of Results
- ☐ 7.8 Reporting
- ☐ 7.9 Complaints
- ☐ 7.10 Nonconforming work
- ☐ 7.11 Control of Data and Info. Mgmt.
- ☐ 8.2 Mgmt. Sys Documentation (MSD)
- ☐ 8.3 Control of MSD
- ☐ 8.4 Control of Records
- ☐ 8.5 Risk/Opp Actions
- ☐ 8.6 Improvement
- ☐ 8.7 CAs
- ☐ 8.8 Internal Audits
- ☐ 8.9 Mgmt. Review

Module 6: Quality Systems for RadChem testing
- ☐ 5.0 Method Validation
- ☐ 6.0 Demonstration of Capability (DOC)
- ☐ 7.1 Instrument Requirements
- ☐ 7.2 Quality Control
- ☐ 7.3 Data Eval/Reporting
- ☐ 7.4 Sample Handling
- ☐ 8.0 Method Specific Directions

☐ Other _____

Project # Affected: ERA MRAD-41	**Was data affected?**	☒ Yes ☐ No	**Was data recalled?**	☐ Yes ☒ No	**Rerun/Recount Required?** ☒ Yes ☐ No

Requirement Reference: TBE-4006, TBE-2006 | **Affected Data:** L107082

Impact Rate: (Appendix A of TBE-1018)	☐ 1-Very Low ☐ 2-Low ☐ 3-Moderate ☒ 4-High ☐ 5-Very High	**Probability:** (Appendix A of TBE-1018)	☐ 1-Rare ☐ 2-Unlikely ☒ 3-Possible ☐ 4-Likely ☐ 5-Almost Certain	**Risk Rate Level:** (Multiply impact by probability)	*Number Value: 12 ☐ 1-Low (1-4) ☐ 2-Moderate (5-10) ☒ 3-High (11-15) ☐ 4-Extreme (16-25)

NCR Description: ERA MRAD-41 Internal Crosscheck results failures. Water Fe-55 reported 615 with an assigned 1230 at 50%. The acceptance range is between 70-130%.
This is not a repeat failure with no related NCRs in 2024.

Client Notification: ☒ YES Client notified of results via ERA Waters. | **Date of Notification:** 11/18/2024

Initiator Signature: Kristin Peacock | **Part 1 Date Completed:** 11/18/2024

PART 2. Root Cause (RC) Investigation

Were past results impacted by nonconforming event? ☐ Yes ☒ No ☐ N/A	**If yes**, explain: N/A
RC Investigator: Karli Arterburn	
Investigation Start Date: 11/19/2024	**Expected/Actual Completion Date:** 12/19/2024 /

RC Summary: 12/19/24- Investigation continues.
1/19/24- Investigation continues.

Reviewed By: (QM signature)	**Date:**
Reviewed By: (LM signature)	**Date:**

PART 3. Corrective Action (CA) Plan

Recommended CA: Pending Root Cause Investigation results.

Implemented by:	**Implementation Date:**
Approved By: (QM signature)	**Date:**
Approved By: (LM signature)	**Date:**

CA Monitoring Required?	☐ Yes ☐ No	**Monitored By:**		**Monitoring Completed on Date:**
CA Effective?	☐ Yes ☐ No	**Explain:**		
Effectiveness Reviewed by: (QM Signature)				**Date:**

PART 4. Client Follow-up

Client Follow-Up Notification: ☐ YES ☒ Not Required

Details of notification (by what means): Notification not required unless requested by Regulatory Agency; no regulatory agencies placed any requests.

Completed By: (print and signature)	**Date:**

NCR Closed:_____
(date/ QM Initials)

NONCONFORMANCE REPORT (NCR)

NCR No.: 24-16

NCR Initiator: Kristin Peacock
(Print Name)

PART 1. Statement of Nonconformance

Nonconformance Trigger:

☐ Client Feedback	☐ Internal Audit	☒ XCHK Failure	☐ LM Review
☐ Management Report	☐ External Audit	☐ Staff Observation	☐ PM Review
			☐ QM Review

Process Area:

☐ Quality Assurance	☐ Sample Receipt	☒ InPlant Lab	☐ Count Room
☐ Lab Management	☐ Sample Prep	☐ Environmental Lab	☐ Other_____
☐ Project Management			

QSM 6.0 Impact Category:

Module 1: Proficiency Testing
- ☒ 4.0 Requirements for Accreditation
- ☐ 5.2 PT Study Frequency; Continued Accred.
- ☐ 6.0 Corrective Action
- ☐ 7.0 Complaint Resolution

Module 2: Quality Systems Gen Requirements
- ☐ 4.1 Impartiality
- ☐ 4.2 Confidentiality
- ☐ 6.2 Personnel
- ☐ 6.3 Facilities/Env Conditions
- ☐ 6.4 Equipment
- ☐ 6.5 Metrological Traceability
- ☐ 6.6 External products/ services
- ☐ 7.1 Review of requests/ tenders/contracts
- ☒ 7.3 Sampling
- ☐ 7.4 Handling of test/calibration items
- ☐ 7.5 Technical Records

Module 2: Quality Systems Gen Requirements
- ☐ 7.6 Eval of MUs
- ☐ 7.7 Validity of Results
- ☐ 7.8 Reporting
- ☐ 7.9 Complaints
- ☐ 7.10 Nonconforming work
- ☐ 7.11 Control of Data and Info. Mgmt.
- ☐ 8.2 Mgmt. Sys Documentation (MSD)
- ☐ 8.3 Control of MSD
- ☐ 8.4 Control of Records
- ☐ 8.5 Risk/Opp Actions
- ☐ 8.6 Improvement
- ☐ 8.7 CAs
- ☐ 8.8 Internal Audits
- ☐ 8.9 Mgmt. Review

Module 6: Quality Systems for RadChem testing
- ☐ 5.0 Method Validation
- ☐ 6.0 Demonstration of Capability (DOC)
- ☐ 7.1 Instrument Requirements
- ☐ 7.2 Quality Control
- ☐ 7.3 Data Eval/Reporting
- ☐ 7.4 Sample Handling
- ☐ 8.0 Method Specific Directions

☐ Other _____

Project # Affected: MAPEP	**Was data affected?**	☒ Yes ☐ No	**Was data recalled?**	☐ Yes ☒ No	**Rerun/Recount Required?** ☐ Yes ☒ No

Requirement Reference: TBE-2006, TBE-4006 | **Affected Data:** L106994

Impact Rate: (Appendix A of TBE-1018)	☐ 1-Very Low ☐ 2-Low ☐ 3-Moderate ☒ 4-High ☐ 5-Very High	**Probability:** (Appendix A of TBE-1018)	☐ 1-Rare ☐ 2-Unlikely ☐ 3-Possible ☒ 4-Likely ☐ 5-Almost Certain	**Risk Rate Level:** (Multiply impact by probability)	16 ☐ 1-Low (1-4) ☐ 2-Moderate (5-10) ☐ 3-High (11-15) ☒ 4-Extreme (16-25)

NCR Description: Laboratory Operations Manager elected to not report FE-55 in soil due to ongoing investigation and undesired results from corrective action of CAR 23-31 and CAR 24-02. This is the third failure.

Client Notification: ☐ YES ☒ NO ☐ Not Required	**Date of Notification:** N/A
Initiator Signature: Kristin Peacock	**Part 1 Date Completed:** 12/13/2024

PART 2. Root Cause (RC) Investigation

Were past results impacted by nonconforming event? ☒ Yes ☐ No ☐ N/A	If **yes**, explain: Prior failed MAPEP cross-check. See CAR 24-02.
RC Investigator: Karli Arterburn	
Investigation Start Date: Ongoing since CAR 24-02	**Expected/Actual Completion Date:** 01/13/2024 /

RC Summary: Efforts of CAR 24-02 Corrective Action ineffective. Undesired test results from cross-check. 01/13/2024- investigation continues

Reviewed By: (QM signature)	**Date:**
Reviewed By: (LM signature)	**Date:**

PART 3. Corrective Action (CA) Plan

Recommended CA: Pending root cause investigation results.

Implemented by:	**Implementation Date:**
Approved By: (QM signature)	**Date:**
Approved By: (LM signature)	**Date:**

CA Monitoring Required?	☐ Yes ☐ No	**Monitored By:**		**Monitoring Completed on Date:**
CA Effective?	☐ Yes ☐ No	**Explain:**		
Effectiveness Reviewed by: (QM Signature)				**Date:**

PART 4. Client Follow-up

Client Follow-Up Notification: ☐ YES ☒ Not Required

Details of notification (by what means)**:** N/A

Completed By: (print and signature)	**Date:**

NCR Closed:_____
(date/ QM Initials)

NONCONFORMANCE REPORT (NCR)

NCR No.: 24-17

NCR Initiator: Kristin Peacock, QAM
(Print Name)

PART 1. Statement of Nonconformance

Nonconformance Trigger:

☐ Client Feedback	☐ Internal Audit	☒ XCHK Failure	☐ LM Review
☐ Management Report	☐ External Audit	☐ Staff Observation	☐ PM Review
			☐ QM Review

Process Area:

☐ Quality Assurance	☐ Sample Receipt	☐ InPlant Lab	☐ Count Room
☐ Lab Management	☐ Sample Prep	☒ Environmental Lab	☐ Other_____
☐ Project Management			

QSM 6.0 Impact Category:

Module 1: Proficiency Testing
- ☒ 4.0 Requirements for Accreditation
- ☐ 5.2 PT Study Frequency; Continued Accred.
- ☐ 6.0 Corrective Action
- ☐ 7.0 Complaint Resolution

Module 2: Quality Systems Gen Requirements
- ☐ 4.1 Impartiality
- ☐ 4.2 Confidentiality
- ☐ 6.2 Personnel
- ☐ 6.3 Facilities/Env Conditions
- ☐ 6.4 Equipment
- ☐ 6.5 Metrological Traceability
- ☐ 6.6 External products/ services
- ☐ 7.1 Review of requests/ tenders/contracts
- ☒ 7.3 Sampling
- ☐ 7.4 Handling of test/calibration items
- ☐ 7.5 Technical Records

Module 2: Quality Systems Gen Requirements
- ☐ 7.6 Eval of MUs
- ☐ 7.7 Validity of Results
- ☐ 7.8 Reporting
- ☐ 7.9 Complaints
- ☐ 7.10 Nonconforming work
- ☐ 7.11 Control of Data and Info. Mgmt.
- ☐ 8.2 Mgmt. Sys Documentation (MSD)
- ☐ 8.3 Control of MSD
- ☐ 8.4 Control of Records
- ☐ 8.5 Risk/Opp Actions
- ☐ 8.6 Improvement
- ☐ 8.7 CAs
- ☐ 8.8 Internal Audits
- ☐ 8.9 Mgmt. Review

Module 6: Quality Systems for RadChem testing
- ☐ 5.0 Method Validation
- ☐ 6.0 Demonstration of Capability (DOC)
- ☐ 7.1 Instrument Requirements
- ☐ 7.2 Quality Control
- ☐ 7.3 Data Eval/Reporting
- ☐ 7.4 Sample Handling
- ☐ 8.0 Method Specific Directions

☐ Other _____

Project # Affected: MAPEP	**Was data affected?** ☒Yes ☐ No	**Was data recalled?** ☐Yes ☒No	**Rerun/Recount Required?** ☐Yes ☒No
Requirement Reference: TBE-4006, TBE-2018		**Affected Data:** L106994	

Impact Rate: (Appendix A of TBE-1018)	**Probability:** (Appendix A of TBE-1018)	**Risk Rate Level:** (Multiply impact by probability)	16
☐ 1-Very Low	☐ 1-Rare		☐ 1-Low (1-4)
☐ 2-Low	☐ 2-Unlikely		☐ 2-Moderate (5-10)
☐ 3-Moderate	☐ 3-Possible		☐ 3-High (11-15)
☒ 4-High	☒ 4-Likely		☒ 4-Extreme (16-25)
☐ 5-Very High	☐ 5-Almost Certain		

NCR Description: MAPEP August 24-RdV51 vegetation study Sr-90 evaluated as "Not Acceptable." TBE reported 0.95Bg/sample and the known value returned 2.39Bg/sample (range 1.67-3.11). This is the second failure this year and the third overall. See NCRs 23-09 and 24-11.

Client Notification: ☐ YES ☒ NO ☐ Not Required	**Date of Notification:** N/A
Initiator Signature: Kristi Peacock	**Part 1 Date Completed:** 12/13/2024

PART 2. Root Cause (RC) Investigation

Were past results impacted by nonconforming event? ☐ Yes ☒ No ☐ N/A	If **yes**, explain: N/A
RC Investigator: Karli Arterburn	
Investigation Start Date: 12/13/2024	**Expected/Actual Completion Date:** 01/13/2024 /

RC Summary: 1/13/24- investigation continues.

Reviewed By: (QM signature)	**Date:**
Reviewed By: (LM signature)	**Date:**

PART 3. Corrective Action (CA) Plan

Recommended CA: Pending root cause investigation results.

Implemented by:	**Implementation Date:**
Approved By: (QM signature)	**Date:**
Approved By: (LM signature)	**Date:**

CA Monitoring Required?	☐ Yes ☐ No	**Monitored By:**		**Monitoring Completed on Date:**
CA Effective?	☐ Yes ☐ No	**Explain:**		
Effectiveness Reviewed by: (QM Signature)				**Date:**

PART 4. Client Follow-up

Client Follow-Up Notification: ☐ YES ☐ Not Required

Details of notification (by what means):

Completed By: (print and signature)	**Date:**

NCR Closed:_____
(date/ QM Initials)

ATTACHMENT D
Audit Results

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D.1
Internal Audits

INTERNAL AUDIT REPORT

Audit Plan

Auditor: Cheryl Larson (lead) *Cheryl Larson*	Audit Date: 12-14 August	Audit No.: 2024-016
Auditee(s): Sharon Northcutt, Kristen Peacock	Methods: Review of objective evidence, documentation, and through interview of personnel	
Scope: TBE Knoxville Lab Operations Criteria: TBE Knoxville Quality Manual and Procedures ISO 17025	Tools: ISO 17025 Standard (or other standard as noted in Scope & Criteria), Quality Manual, Procedures, Internal Audit Checklists, associated forms, and other tools as needed	

Date	Time	Area / Department / Process / Function	Key Contact
12-14 Aug	TBD	Lab functions	Sharon Northcutt, Kristen Peacock,

Process Effectiveness Assessment Report (PEAR)

Process Name: Quality Process #6Process Name: QMS Process #6 Quality, TBE Knoxville Quality Systems and Operations

Process details, including associated process interfaces:

Personnel training, Contracts management, method verification, handling of tests, results reporting, nonconformances, audit reports, corrective actions.

Applicable AS9100 clause(s): This annual internal audit is conducted for the purpose of assessing TBE Knoxville Lab's quality system as documented in the Quality Assurance Manual for Teledyne Brown Engineering Environmental Services, Document K-QAM-1, Rev 37, effective July xx, 202x, and associated implementing Procedures. A specific checklist was developed and used for this audit. The completed checklist is attached to this form.

Organization's method for determining process effectiveness:

- Audit results
- NCRs generated
- Other external audits
- Customer Complaints
- Internal process documentation

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INTERNAL AUDIT REPORT

Auditor observations and comments supporting process effectiveness determination:

The quality program and lab operations of TBE Lab Knoxville were well documented, organized and implemented. All required information was readily available, and all involved in the audit were very helpful and knowledgeable.

Statement of Effectiveness Level:

The process is:

☐ 1. Not implemented; planned results are not achieved.

☐ 2. Implemented; planned results are not achieved, and appropriate actions not taken.

☐ 3. Implemented; planned results are not achieved, but appropriate actions being taken.

☒ 4. Implemented; planned results are achieved.

Auditor Name(s): Cheryl Larson (Lead)	Auditee Representative Acknowledgement Name: Sharon Northcutt, Kristen Peacock

Audit Summary

There were **zero (0) findings** noted during the course of this audit with **one (1) Opportunities for Improvement (OFI)** recommended.
Based on the results of this audit, TBE Knoxville Lab QA program and operations are determined to be effectively implemented.

Previous Year's Finding

REF	Requirements	Observation, Comments, Objective Evidence	ACC	REJ
	No findings in 2023			

Current Year Audit Findings and Opportunities for Improvement (OFI's)

REF	Requirements	Observation, Comments, Objective Evidence	ACC	REJ
K-QAM-1 Rev 37	Management Reviews… 8.9.2 The review includes: • results of risk identification	• OFI #1: "Results of risk identification" the organization uses NCR's and CAs to monitor risk. It would be clearer to include in the Report a statement summarizing the results of risk identification specifically.	X	

Checklist				
REF	Requirements	Observation, Comments, Objective Evidence	ACC	REJ
K-QAM-1 Rev 37	8.6.3.4 Lab quality performance is reviewed and summarized in a quarterly QA Report. Audits and nonconformance/corrective actions are also included in the report. This report is distributed to TBE management and is also available for clients. A summary of this report is included with the Annual Management Report.	*Review of 2nd quarter 2024 Quarterly Assurance Report (5/1/24) including, audits, nonconformances/CA.*	X	
K-QAM-1 Rev 37	8.7.1 Corrective action is taken as the result of a departure from specifications imposed by client contract, regulatory requirement or TBE stated policy or procedure. It is a measure taken to discover the source of a deviation and to avoid similar issues going forward. Corrective action is taken promptly and to a degree appropriate to the magnitude and risk of the issue. Conditions adverse to quality are documented and tracked with proposed and actual completion dates. (*TBE-1018 "Corrective/Preventative Action and Nonconformity Control"*)	• *Review of CAR # 24-01 showing investigation and corrective action.* • *Review of CAR #24-03 showing investigation and corrective action*	X	
K-QAM-1 Rev 37	8.8.4 An analytical procedure surveillance is scheduled to observe analysts as they perform a method to verify that it is being done as written and to note any changes that may need to be made to the written procedure. The results of the QC workgroup are included to show that the results are within control limits. All audit results are evaluated by the Operations Manager and any necessary changes are made where needed.	*Review Procedure Surveillance checklists* • *TBE-2007 Gamma Emitting Radioisotope analysis (Rev. 12)* • TBE-2008 Gross Alpha/Beta Activity in various matrices (Rev.13) Review of surveillance schedule for 2024	X	
K-QAM-1 Rev 37	6.5.1 In order to produce accurate data, TBE has established and maintains an unbroken chain of calibration records for all instruments used in analytical measurements that could affect the accuracy of results. These instruments are calibrated prior to use with NIST traceable reference standards which contribute to measurement uncertainty.	*Verified calibration records for items in use* • *Balance #15 traceable to NIST calibrated 3/27/24. Cal sticker showing cal due 3/31/25* • *Pipette #17 verified cal record dated 7/1/24* • *ENV- #16 verified cal record dated 7/1/24*	X	
K-QAM-1 Rev 37	6.5.4 Instrument calibration standards must originate from a different lot number or manufacturer than those used for quality control spike/matrix spike standards.	*Verified instrument calibration uses different lots.* • *241AM-071212 used to cal instrument & 241AM-82222 used for spike* • *239PU-091406 used to cal instrument and 239PU-112923-1 used for spike*	X	
K-QAM-1 Rev 37	6.6.3 New vendors are qualified by the QA Manager, based upon ISO/IEC accreditation, on-site or desktop audit and are maintained on the Approved Supplier List (ASL). The list is reviewed periodically, and vendors are requalified annually. Consideration is given to vendors who agree to applicable TBE quality codes, provide updated quality and/or accreditation information, and past customer experience. (TBE-1015 "Procurement Controls")	*Review of Supplier AVL date 8/1/24, shows all suppliers have current approvals* • *FLW INC re-assess 12/14/24* • *Pace Analytical Nat'l Center for testing re-assess 11/14/24*	X	

K-QAM-1 Rev 37	7.4.1 General Sample custody includes laboratory receipt, handling, processing, protection, storage, and disposal. The sample custody procedure outlines steps to protect sample integrity and minimize the possibility of deterioration, contamination, loss or damage during each stage of the analytical process. (TBE-4003 Sample Receipt and Control)	*TBE-4003 Rev 16* *receiving inspection sample L106619-1, samples are identified at receipt, the LIMS system generates the L# used to track the samples and traceability is maintained throughout the analytical process.*	X	
K-QAM-1 Rev 37	7.8.2 Required Items Sample results are compiled into a report and contain the following items: a. title (Report of Analysis or ROA) b. name and address of the laboratory (where analyses are performed) c. unique identification that correlates individual pages to the entirety of the report d. contact name/address of the client e. sample description information (ID, collection date/time) and lab ID information f. sample receipt date, condition and any sample acceptance criteria variance g. TBE Procedure (SOP) ID h. test result (activity) directly as obtained with appropriate number of significant figures, measurement uncertainty estimation, detection limit (MDC), measurement units, reference date, count date/time, and flagged values (results outside of technical specifications) i. notation for method changes (if applicable) j. name, title and signature of the person(s) authorizing the report k. statement that results relate only to the items tested l. statement that the report shall not be reproduced, except in full without approval of the laboratory m. clear identification of any subcontracted analyses and results	*The report is traceable by the LIMS number and contain the required items including chain of custody. Review the following reports* • *L105992 dated 7/10/24* • *L106018 dated 7/29/24* *Subcontract report* • *L106038 dated 7/8/24*	X	
K-QAM-1 Rev 37	8.4.2 Records are legible, systematically identified, maintained, stored, and scheduled for disposal based upon regulatory or contract requirement, but always at a minimum of seven (7) years. Records are controlled in a manner that ensures retrievability, confidentiality and protection from loss and/or damage.	*Project files are maintained in the Program Management office area. Quality records are maintained in the Quality Managers office. Files are maintained for 7 years and per contract requirements.*	X	
TBE-1003	5.2.1 All records shall be legible. All generated data, unless produced via automated data collection systems, shall be recorded legibly in permanent ink.	*All records reviewed were legible, the LIM system creates the documents and where hand written info is necessary its ink & legible.* • *CAR 24-06* • *CAR 24-01* • *#L106619*	X	
TBE-1003	5.2.3 Corrections are made by drawing a single line through the error/change. The individual making the correction signs (or initials) and dates the correction, then briefly describes the reason (if it is not self-evident). Corrections due to reasons other than transcription errors shall specify the reason for the correction.	*2 docs reviewed showing acceptable strike through corrections.* • *CAR 24-06* • *CAR 24-01*	X	
TBE-1003	5.4.2.1 Hard-copy records are stored in labelled filing cabinets to minimize the risk of loss, damage or destruction from natural disasters or severe environmental or other harmful conditions. Access to processing, storage and retrieval of these records is limited to authorized personnel.	*Program records are maintained in the Program managers office and the Quality records are maintained in the quality managers office.*	X	

TBE-1003	5.4.2.2 Hard-copy laboratory/quality assurance records are generated throughout the laboratory and are maintained by those responsible in that area. (See Section 5.3). When these records are no longer needed by the operational section, they are processed as quality assurance records, and are re-located to the TBE corporate records storage facility area in Lewisburg, TN.	*Archived records are sent to Lewisburg.*	X	
K-QAM-1 Rev 37	8.8.1 In order to detect actual or potential nonconformities before data quality could be affected, internal audits are planned and conducted. These audits verify conformance of lab operations and the management system to regulatory and accreditation requirements, and to the lab's own policies and procedures. (*TBE-1013 "Audits and Management Review"*)	*Kokila Topiwala at the Huntsville office is contacted to request annual internal audit.*	X	

K-QAM-1 Rev 37	8.8.2 An internal audit plan is generated annually and includes the procedures and surveillances that are planned during the year. The goal is to review each area of the lab in some fashion. The plan is maintained by the QA Manager, but audits may be performed by other staff. Auditors are trained in performing audits, have some technical background in the subject matter, and are independent of the activity to be audited (not directly involved or have supervisory responsibility).	*Reviewed the internal audit schedule and audits of* • *TBE-1001 Rev 6 5/15/24* • *TBE-1005 Rev 9 5/9/24*	X	
K-QAM-1 Rev 37	8.8.6 Audit findings of nonconformances are documented and timely corrective action is taken, tracked to closure, and evaluated for effectiveness. An audit response including corrective action is sent to the auditor, (and to the Director of Quality Management Systems for the annual Quality System audit). Any findings that could cast doubt on the validity of results are disclosed in writing to the affected client(s) within 7 days. The QA Manager (or designee) verifies that the client was contacted properly.	*No new/recent audit findings. reviewed a CAR generated for a NUPIC finding 23-17 dated 10/5/23*	X	
TBE-1013	5.1.1.4. Audits may only be performed by trained and qualified personnel who are independent of the activity to be audited. Internal audits of the Knoxville Laboratory Quality Program will be performed by personnel from another Teledyne Brown Engineering location (i.e., Huntsville office).	*Annual audits performed by TBE Huntsville.*	X	
K-QAM-1 Rev 37	Management Reviews 8.9.1 In conjunction with the Internal Audits (Section 8.9 above), the laboratory conducts an annual management review to ensure continuing suitability, adequacy, and effectiveness of stated policies and objectives in this Quality Manual. (*TBE-1013 "Audits and Management Review"*)	*Review of 2023 Management Review March 29, 2024*	X	
K-QAM-1 Rev 37	8.9.2 The review includes: • a summary of any changes to the QA program from the previous year • adequacy of staff and equipment resources • a list of staff specialty training certificates with expiration dates • highlights from the 4th Qtr (annual) QA Report (QC sample and proficiency results • and audits) • an analysis of QA results (indication of analytical bias) • internal/external audit results and associated investigations and corrective actions • commentary on effectiveness of corrective actions • a listing of current accreditations and/or plans for any changes • comparisons of sample volume and turnaround times to previous years • client feedback not included with the QA Report • observations by staff for improvements • results of risk identification • any changes/updates to methodology • radiological health/safety, waste and management functions • a statement of management system effectiveness and fulfillment of objectives	• *OFI #1: "Results of risk identification" the organization uses NCR's and CAs to monitor risk. It would be clearer to include in the Report a statement summarizing the results of risk identification specifically.* *The annual Management Review included the elements as listed.*	X	
ISO 17025	**6 Resource Requirements** 6.2.5 The laboratory shall have procedure(s) and retain records for: a) Determining the competence requirements: b) Selection of personnel c) Training of personnel d) Authorization of personnel	*TBE – 1007 7/26/22* *QA keeps all training records* *Review of the training matrix listing 19 employees and specific training records for Demonstration of Capability KQA-6 Rev 5 dated 6/14/19*	X	

	f) Monitoring competence of personnel	• *Kenny Cooper* • *Belinda Crouse*		
ISO 17025	6.3.3 The laboratory shall monitor, control, and record environmental conditions in accordance with relevant specifications, methods, or procedures or where they influence the validity of the results.	*Temp & RH is monitored and recorded in the counting room.* • *8/9/24 Temp 20.6 RH 72.9* • *8/8/24 Temp 21.1 RH 58.6*	X	
ISO 17025	6.4.8 All equipment requiring calibration, or which has a defined period of validity shall be labelled, coded, or otherwise identified to allow the user of the equipment to readily identify the status of calibration or period of validity.	* *Balance cal tag ID # 15* * *Pipette cal tag ID # 17* * *ENV cal tag ID # 6* *Verified label and calibration records*	X	

D.2
External Audits

Constellation

Supplier Audit Report
For
Teledyne Brown Engineering
Knoxville, TN

Constellation Energy Generation Supplier Number: 00019407
NUPIC Supplier Number: 2427
Constellation Energy Generation Audit Number: SR-2024-14
NUPIC Audit Number: 25559
Audit Dates: November 4-7, 2024

Prepared By:

Sarli-Prelle, Gwendolyn Vicktoria

Digitally signed by Sarli-Prelle, Gwendolyn Vicktoria
Date: 2024.11.21 09:52:40 -05'00'

Gwen Sarli-Prelle
Audit Team Lead

Approved By:

David Engle
Vendor Audit Manager

Confidentiality Statement

This report, including any attachments, contains or may contain confidential and privileged information solely for the use of the individual and/or supplier to whom they are addressed. Suppliers receiving a copy of the report directly from the lead utility are to consider the documents confidential and proprietary and shall consider the document for information only and may not disclose in whole or impart, by any means, to any third party without the written consent of the lead utility. Also note that this report does not constitute nor imply any industry-wide endorsement, certification, approval or disapproval of your Quality Assurance Program and the results shall not be used in any supplier advertising material.

Constellation Energy Generation Audit Number: SR-2024-14
NUPIC Audit Number: 25559

Audited Organization
Teledyne Brown Engineering
2508 Quality Lane
Knoxville, TN 37931

Audit Dates
November 4-7, 2024

Supplier Product or Services
Radiochemical Analysis of effluent and environmental samples; bioassay samples; and laboratory services.

Audit Scope / Purpose
This audit evaluated the Teledyne Brown Engineering (TBE) Quality Assurance Program to assure that it conformed to all applicable requirements of Regulatory Guide 4.15, revisions 1 and 2 and provides effective control of the Radiochemical Analysis of effluent and environmental samples; bioassay samples; and laboratory services. The audit also evaluated the effectiveness of the corrective actions implemented to address audit deficiencies issued during the Entergy NUPIC Joint Utilities audit 25265 led by Entergy. As stated, the previous audit deficiencies, industry issues, purchase orders and utility inputs were also considered in the scope of this audit. This audit was conducted utilizing NUPIC Checklist 45 Part 1, Revision 1. Activities that were audited include:

- Contract/ Purchase Order Review
- Organizational Structure and Personnel Responsibilities
- Qualification of Personnel
- Operating Procedures and Instructions
- Records
- Quality Control in the Radioanalytical Laboratory
- Data and Computer Software Verification and Validation
- Assessments and Audits
- Preventive and Corrective Actions

Quality Program Audited
The Teledyne Brown Engineering Nuclear Quality Assurance Manual, Revision 37, dated May 31, 2024, was developed to comply with regulatory guide 4.15 revisions 1 and 2. TBE's quality assurance manual has been reviewed and accepted in accordance with Constellation Energy Generation's (CEG) QA requirements for nuclear use. The quality assurance manual, along with TBE's implementing procedures were used as a guide to ensure depth and continuity of the audit.

Executive Summary

CEG was the lead utility with members participating from Entergy (ENT), Omaha Public Power District (OPP), Tennessee Valley Authority (TVA), and Xcel Energy (XEL). The Nuclear Procurement Issues Corporation (NUPIC) Audit Checklist, revision 22 was utilized to provide consistency and structure in executing the audit. The audit was performed using performance-based auditing techniques including, conducting interviews with TBE personnel in Quality, Information Technology (IT) and from the Laboratory. TBE performs Radiochemical Analysis of Effluent and Environmental Samples; Radiochemical Analysis of Radioactive Waste Samples; Bioassay; and Laboratory Services. It was evident during discussions with employees and observations made during the audit that TBE personnel exhibited a strong commitment and dedication to their Quality Assurance (QA) Program and documented any identified discrepancies in their corrective action program. The audit team determined through observation and interviews that TBE personnel were knowledgeable in their respective areas of responsibility concerning the QA program and TBE analysis. The audit resulted in three deficiencies which do not affect the quality of the products and services provided to nuclear utilities since the previous NUPIC audit. These three deficiencies will be evaluated by the TBE company corrective action program.

Program Effectiveness

The audit team concluded that Teledyne Brown Engineering - Knoxville is effectively implementing their Quality Assurance Program consistent with regulatory guide 4.15 revision 1 and 2. Teledyne Brown will be maintained on the CEG's Approved Suppliers List as a safety related supplier in the Radiochemical Analysis of effluent and environmental samples; bioassay; and laboratory services.

Findings and Deficiencies:

There were three deficiencies identified during this audit.

CEG defines a Finding as; "Any defect, characteristic, non-compliance, or activity that detracts from the quality of products and/or services and is a condition that could have a credible impact to the intended function of the products and/or services provided, including undesirable or abnormal pattern of events, failures, problems, and programmatic issues." The deficiencies did not meet the definition of a finding. Audit team follow-up is not required for deficiencies. The three deficiencies were entered into the TBE corrective action program. Corrective actions will be reviewed during the next NUPIC audit for adequacy and effectiveness.

1) The K-QAM and procedure TBE-7007, Radiation Protection Program Assessment and Records, was not updated when radworker refresher training was changed from annual to biannual. Impact: This is an administrative issue, the change was approved in February 2024 by the Radiation Safety Officer but had not been changed in the implementing procedures. (TBE CA-24-13)

2) Five procedures were found with outdated requirements or references that no longer applied or had not been updated with currently used forms. Impact: this is an administrative issue, however, incorrect procedural guidance could result in future errors when using the affected procedures. (TBE CA-24-14)

3) Methodology for performing interface corrections for Pu-241 provides correction factors for Co-60, Fe-55, and other beta/gamma emitting radionuclides. However, some nuclides may contain other gamma emitters, but not a beta emitter, and therefore, may not be included in the correction factors. Impact: This is an administrative issue. The staff understands the intent of the steps, and improved clarity for beta/gamma is needed to ensure consistent performance by personnel to ensure continued consistent results. (TBE CA-24-15)

Review of Corrective Actions to Resolve Audit Deficiencies from NUPIC Audit 25265

This audit also included a review and follow up of those areas found unsatisfactory during the last NUPIC audit. The previous audit was performed by Entergy, February 7-10, 2022 which resulted in two deficiencies. The corrective actions implemented by TBE to address these deficiencies were reviewed and found effective. No repeat issues were identified during this audit.

Unique Order Entry Requirements

There were no unique order entry requirements imposed on Teledyne Brown Engineering as a result of this audit.

Technical Specialist Summary

TBE-ES provides analytical services for nuclear utility customers. Primary services offered by TBE-ES include the analysis for radiological effluents, environmental samples, 10CFR61 radioactive waste stream samples, and personnel bioassay samples.
Areas reviewed included:

1. Sample Receipt Process Control
2. Laboratory Controls
3. Quality Control
4. Participation in a Laboratory Inter-Comparison Program

The audit process consisted of direct observation of work activities, documentation review, and interviews of applicable personnel. This audit produced satisfactory results on all four of the sections reviewed listed above with one deficiency noted. Procedure TBE-2001 has a methodology for performing interference corrections for Pu-241. The procedure provides correction factors for Co-60, Fe-55 and other beta/gamma emitting radionuclides. Some analyses may contain other gamma emitters, but not a beta emitter and not be included in the correction. The staff understands the intent of the step, but improved clarity for “beta/gamma” is needed to ensure consistent performance by personnel.

Observations of the lab personnel performing their assigned roles showed that all of them were proficient and knowledgeable in their assigned roles. A review of the H-3 Liquid Scintillation 72732-396, 1.887E5, Proportional Counter Eckert & Ziegler Sr-90 77407-396, Gamma Spec Eckert & Ziegler, multi energy line gamma source 116291, and Alpha Spectroscopy, US EPA, Pu-239, 62 nCi, 12.4 nCi/g were all confirmed to have traceability to NIST. TBE utilizes a Laboratory Information Management System (LIMS) to manage and store most of the information for the samples received from a customer. The LIMS system ensures that all samples are received and tracked with a unique identification

number. The information the LIMS stores includes the type/amount of sample received, the test plan that was assigned, as well as the results of the test that was performed.

The results of the audit were satisfactory.

1. Sample Receipt and Process Control

Sample Receipt, Identification, Control, and Storage
Sample receipt-TBE-4003 (Receipt of L107747, River composite 3H and principal gamma entities, Sample Custodian: Sarah Griffiths) Upon receipt of a package the tracking information is scanned into the system. Sample labels were then compared to the shipping paperwork to confirm received products matches the shipping documents. The shipping paperwork outlined the requested tests for L107747 samples. These tests had been completed before, so the receiver copied a previous project template that was stored in LIMS and applied it to L107747. The L-labels are placed on both the project folder and the samples. The sample labels contain which number sample it is and then the total number of samples for the project (ex. 1 of 2, 2 of 2).

In the project folder there is a V of V which has a list of questions that are filled out at sample receipt. On the V of V there are technical instruction that list the required tests for each of the sample barcodes that were received. In this case L107747-1 and L107747-2 require 2 GELI H-3 (DIST) testing.

Customer request form and data entry- The customer requested 2 GELI H-3 (DIST) testing on the shipping document. The shipping document is placed in the project folder along with the V of V that also outlines the test for each sample received. It is then the technician's responsibility to verify the requested testing matches the template that was assigned at receiving. Once this is confirmed the technician would then perform the specified tests.

Sample Preparation
Preparation activities were observed for separating Sr-90 from ground water samples. The lab technician had the procedure in hand in the lab and was followed each section. Various chemical additions and precipitation activities were performed to separate the Sr-90 chemical group from the water. Measurements of pH were also performed at a key step with values being in the acceptance range. The lab technician talked to portions of the procedure and was experienced in performing this form of analysis. Chemical handling and contamination control was also acceptable. The lab technician also had Blank, Spike, and Duplicate QC samples in the lot to be counted. Quality checks are performed each day prior to use of an instrument and the use of Blanks, Spikes, and Duplicates in each batch analyzed are key to identifying any irregularity during counting.

Sample Analysis

Results for four different types of analysis were reviewed. Analysis processes included 10CFR61 Radioactive Waste samples, Environmental tritium (H3) well samples, Urine Bioassay samples, and Fecal Bioassay samples. Machine outputs were compared to final reports to ensure no errors occurred. Machine count data transfers directly into the LIMS system which also generates the sample reports.

A deficiency was noted for procedure adequacy for performing interference corrections for Pu-241. (Deficiency 3) Procedure TBE-2001 has a methodology for performing interference corrections for Pu-241. The procedure provides correction factors for Co-60, Fe-55 and other beta/gamma emitting radionuclides. Some analyses may contain other gamma emitters, but not a beta emitter and not be included in the correction. The staff understands the intent of the step, but improved clarity for "beta/gamma" is needed to ensure consistent performance by personnel. The staff will also improve documentation in the packages to permit verification of the calculations in the data package. The original packages had the correction calculation and as-left Pu-241 value for an incomplete package which could not be validated. Going forward the staff will include the as-found Pu-241 value, correction calculations, and as-left Pu-241 value. While as-found Pu-241 values were not in the data packages, that data is retained in the instrument permitting retrieval. Calculations were verified to be correct once TBE personnel provided information stored in counters to complete the calculation.

Sample Analysis Review

LIMS ID	Service	Review
L106584	10CFR61 Radioactive Waste	The as-left Pu-241 liquid scintillation data sheet was given to the project manager with the gamma isotopic analyses for Co-60 and Fe-55 as interfering radionuclides. The project manager calculated the correction and provided a correction on the as left data sheet. A clarifying note would have made it clear that the correction was performed.
L107470	Environmental H3 Wells	Reviewed the data sheets and confirmed there were no issues that were averse to quality. The data sheet consisted of 18 samples for H3, one sample for SR-89 and SR-90.
L106808	Urine Bioassay	22 Urine alpha spectroscopy counts for different Uranium isotopes
L104985	Fecal Bioassay	Seven samples in total two urine and five fecal. It was validated that the right test was performed and that the required Pu-241 correction was applied.

This area was satisfactory.

Procedures

TBE-2001, Alpha Isotopic and Pu-241, Rev 19
TBE-2007, Gamma-Emitting Radioisotope Analysis, Rev 12
TBE-2008, Gross Alpha and/or Gross Beta Activity in Various Matrices, Rev 14

TBE-2018, Radiostrontium Analysis by Chemical Separation, Rev 15
TBE-2032, 10CFR61 Sample Preparation, Rev 6
TBE-4003, Sample Receipt and Control, Rev 16
TBE-4009, Detection Levels, Rev 4

2. Laboratory Controls

Control of Radionuclides

The facility is operated under Tennessee Radioactive Material License R-47173-G28 Revision 19 with an expiration date of 7/31/28. The license has facility limits for different radionuclides and chemical and physical forms. Sealed sources require a leak test with a detection sensitivity of 0.005 uCi if the source contains >100 uCi Beta or >10 uCi alpha. The sources used at TBE are low activity calibration and check sources not exceeding source check thresholds.

A report generates each day that has the current activity content and limit. If any receipt contains more than 1 mCi of any radionuclide, then an email is sent to staff for review.

Radioactive Materials License Activity and Limit

Radionuclide	Radionuclide Value (mCi)	Radionuclide Limit (mCi)
H-3	53.7	100
Co-60	22.8	40
Co-58	11.5	40
Fe-55	8.3	40

TBE provides General Laboratory Terms and Conditions to customers with sample limits. The document states, “The standard restriction on receiving samples for analysis is no more than 10 uCi/sample and 50 mrem/hr on contact. Samples above 10 uCi or 50-100 mrem/hr contact require prior approval before shipment.”

Cleanliness and Handling

Facility radiological surveys were reviewed. Surveys are performed on a weekly, monthly, and quarterly frequency. A weekly survey package was reviewed and surveys were clear and legible and no issues were noted. A lab technician was also observed performing liquid radiochemical separations. Multiple chemical additions and precipitations were performed and no issues were noted with handling or contamination control.

Traceability of Radiological Standards

The use and traceability of sources to NIST was reviewed. The staff was able to quickly produce NIST traceable source certifications for sources used for each of their detector types. Source traceable to NIST are purchased from an external vendor. Sources are then used as they are or may be diluted into another volume if a liquid source. Daughter source forms have the identifying number from the parent source and calibrations or

quality checks performed with those sources are traceable back to the original certification.

NIST Traceability Source Review

NIST Source ID	Daughter Source	Use
H3 Liquid Scintillation 72732-396, 1.887E5 dps, 4/11/06	3H-041706, all source act used, 50476 pCi/ml, 4.9857 g, 4/11/06	Liquid Scintillation counter calibration and source check
Proportional Counter, Eckert & Ziegler, Sr-90, 77407-396 3.728E4 Bq, 5/1/08	90SR-060208, 4030 pCi/ml, 5.0177 g, 4/11/06	Gas proportional counter calibration and source checks
Gamma Spec, Eckert & Ziegler, multi-energy line gamma source 116291, 4/1/20	Same calibration source is used for source checks. Checks are based upon Am-241, Cs-137, and Co-60	Gamma spectroscopy calibration and source check
Alpha Spectroscopy, Pu-239, 62 nCi, 12.4 nCi/g, 2/2/95, 9400201	239Pu-091406, 699 pCi/ml, 5.6395 g, diluted to 100 ml source 2/2/95 Th230-011205, 1988 pCi/ml x 25 ml = 1103 dpm 243AM-051303, 1037 pCi/ml x 0.4 ml = 920 dpm 241Am012216, 5284 pCi/ml 0.1 ml = 1173 dpm	Alpha spectroscopy calibration and source checks

Procedures

TBE-4019, Radioactive Reference Standard Solutions and Records, Rev 9
TBE-7001, Receiving Packaged Radioactive Materials, Rev 15
TBE-7002, Laboratory Contamination Control, Rev 7
TBE-7005, Facility Surveys, Rev 12

This area was satisfactory.

3. Quality Controls

Calibration and quality control activities were observed. Procedure 1009 says detectors are calibrated prior to initial use, when it fails performance metrics or when there is s predetermined frequency. Calibration packages for instruments in current operation were reviewed and associated quality control data.

Instrument Calibration Review

Calibration documents for different types of detectors were reviewed. Calibration documents for germanium gamma spectroscopy, gas proportional, liquid scintillation, and alpha spectroscopy were reviewed. Original Manufacturer sources or daughter sources traceable to NIST were used to calibrate instruments and perform quality checks.

Instrument Calibration Review

Instrument Type	Instrument	Review
Gamma Spec	Detector 14	Cal date 7/27/21Multi-energy line source with mix traditionally used for gamma spectroscopy instruments (Am-241, Cd-109, Co-57, Ce-139, Hg-203, Sn-113, Sr-85, Cs-137, Y-88, Co-60). Energy, FWHM and efficiency calibration performed with all efficiencies within the 10% acceptance criteria. Efficiency file name 1420ML25TWR72621 on calibration and count result.
Alpha Scint	Detector 17	Calibration consists of a Pu-239 source used to determine energy calibration and FWHM. A secondary source consisting of Th230, Pu-239, Am-243, and Am-241 are used to verify similar performance over a broad range of energy. The Pu-239 efficiency was 22.4%.
Liquid Scint	LS9	Calibration from 8/8/17 was reviewed. H-3 efficiency 20% for 10 ml water aliquots. Quench curve reviewed and continuous with little variance.
Prop Counter	16 detectors in single cabinet	calibration from 3/12/14, Sr-90/Y-90. Calibration frequency is performance based upon QC trends. Typical efficiency range of 43-48% for Y-90 for the 16 detectors

Instrument Quality Check

Instrument quality checks are performed prior to use each day. Some QC limits are absolute values or bounds test that might be set for a variable like maximum background count rate (cpm) and others might be set with 2 or 3 sigma statistical tests for a variable like determining the activity of a check source. Each machine will generate flags for recognition with some set at notification thresholds and some for action required. It is also common for samples to have a Blank, Spiked sample with known activity, and a duplicate of a sample for additional quality measured.

Instrument Quality Checks

Instrument Type	Instrument	Review
Gamma Spec	Detector 23	QC Package dated 11/5/24, Centroid-1332, FWHM-1332, Co-60 activity, Centroid-59, and Centroid-661. All QC checks passed with no flags. Scatter plots also reviewed with no issues noted.
Alpha Scintillator	Detector 17, 18, 19, 20	QC Package dated 11/5/24. All tests for Det 17, 18, and 19 passed. Det 20 NLACTIVITY-TH230 failed 3 sigma test, NLACTIVITY-AM243 failed 2 sigma test, and NLACTIVITY-AM241, failed- 2 sigma test. Test to be performed again for detector 20 to see if it was an anomaly or if further action is needed.
Liquid Scintillator	Detector LS9	QC Package dated 11/5/24 was reviewed in the monitor software and consisted of H3 efficiency plot from 2/5/24 to 11/5/24 with no issues noted
Gas Proportional Counter	Detector X1A, one of 16 detectors in the detector cabinet	QC Package dated 11/5/24. Looks at beta efficiencies with 2 and 3 sigma tests. No issued noted. Data range was 10/5/22 to 11/4/24.

Procedures
TBE-1009, Calibration Systems, Rev 7
TBE-3001, Calibration and Control of Gamma-Ray Spectrometers, Rev 9
TBE-3002, Calibration of Alpha Spectrometers
TBE-3003, calibration and Control of Alpha and Beta Counters, Rev 7
TBE-3004, Calibration and Control of Liquid Scintillation Counters, Rev 8
TBE-4002, Quality Control Checking of Analytical Data, Rev 8
TBE-4005, Quality Control Samples – Blanks, Spikes, and Duplicates, Rev 8
TBE-4011, Quality Calculations and Charting, Rev 4
TBE-4019, Radioactive Reference Standard Solutions and Records, Rev 9

This area was satisfactory.

4. Participation in Laboratory Comparison Program
The 3rd Quarter 24 Quality Assurance Report was reviewed. The purpose of the QC program is to monitor the quality of analytical services for environmental, effluent (NRC Reg Guide 4.15), bioassay, and waste characterization samples (10CFR61). Quality activities consist of analyzing samples from external organizations for the interlaboratory Cross-check program and the use of Blanks, Spiked Samples, and Duplicates for intra-laboratory Cross-check Program.

Interlaboratory Cross-Check Program
Interlaboratory cross-check Analytics Env Cross Check Program, DOE Mixed Analyte Performance Evaluation Program (MAPEP), Env Resource Associated (ERA)

Interlaboratory Cross-Check Program

QC Type	Review
Analytics Environmental Cross Check Program	All analyses were within acceptable criteria except for 2 gamma nuclides, Co-60 (AP) and Ce-141 (soil). NCR 24-06 was initiated to address the failures. No effective corrective action could be taken at this time. Historically, the Ap Co-60 and soils Ce-141 the results have been well within TBE QC acceptance ranges. TBE has successfully passed cross-check results (including client cross checks) and it appears that these two results are anomalous. If there is a recurrence, a root cause investigation will be done promptly.
DOE MAPEP Quality Assessment Program	All the environmental analyses performed were evaluated as within the acceptable warning criteria except for the soil Ni-63 & Fe-55, urine Zn-65, water Tc-99 and vegetation Sr-90. (NCRs 24-08 thru 24-11) NCR 24-08 The corrective action is to revise procedure TBE-2013 to include addition of Ni-59 tracer for yield calculations. As of 11/7/2024 this procedure is still in the process of being revised. NCR 24-09, NCR 24-10 Procedure TBE-2021 requires revision to include an additional 5-ml rinse with 0.1M HNO3 to the TEVA-spec column to remove possible residual Th. As of 11/7/2024 procedure TBE-2021 is still in the process of revision. NCR 24-11 No effective corrective action at this time as it was a lab accident that led to the unusually low result.
ERA Environmental Cross Check Program	All analyses performed were within acceptable criteria except for the AP Am-241 & Gr-B and water Gr-A. NCRs 24-02 A sample was received by copying an older template that did not include additional nuclides which was not caught during the review process. The corrective action was to remind the login/project managers to use the most recent sample if copying the template to ensure all analyses are logged. QA Mgr. will be more diligent when reviewing login. 24-03 The 1Q24 ERA MRAD cross-check for AP gross beta was not acceptable. The result was 42.1 pCi and the known value was 22.2 pCi. The corrective action for NCR 24-03 NCR 24-05 was to change the aliquot volume- new Th-230 attenuation curve. Also Purchased additional XCHK for GR-A (AM-241).

Intralaboratory Cross-check Program
This QA process consists of adding Blanks, Spiked Samples with known activity, or Duplicate samples in batches of samples being analyzed. This provides for real-time quality assessment during the measurement process in addition to the quality checks of the machines performed daily before use.

Intralaboratory Cross-Check Program

QC Type	Review
Blanks	During this reporting period, 1,220/1,222 workgroup blanks analyzed were less than the MDC. Two blanks were positive, and two case narratives were included with the sample reports.
Spikes	During this reporting period, all 1,203 workgroup and matrix spikes analyzed were within the acceptance criteria.
Duplicates	All the 2,251 duplicate sets analyzed were within acceptance criteria.

Procedure
TBE-4006, Inter-Laboratory Performance Evaluation Programs, Rev 13

This area was satisfactory with more than anticipated issues over the period. The staff has corrections for each issue and is monitoring for effectiveness.

Conclusion
After reviewing TBE procedures and data packets, observing lab analysis, walk downs of the labs and storage areas, and interviewing TBE personnel, it was confirmed that TBE is effectively analyzing radiological effluents, environmental samples, 10CFR61 radioactive waste stream samples, and personnel bioassay samples.

PBSA and Utility Input
Responses to a request for PBSA input were received from the following utilities: Entergy, Excel, and Nebraska Public Power.

Audit References
Regulatory Guide 4.15, revisions 1 and 2
TBE Quality Assurance Manual

Audit Team

Name (first/last)	Lead/Member/Tech Specialist	Utility
Gwen Sarli-Prelle	Lead	CEG
Nikki Mace	Member	TVA
Randy Hugenroth	Member	OPP
Herbert Mayes	Member	ENT
Josh Worley	Member	XEL
Glen Vickers	Technical Specialist	CEG
Jordan Brown	Technical Specialist	CEG

Personnel Contacted During Audit

Name (first/last)	Title	Entrance	During	Exit
Kristin Peacock	Quality Assurance Manager	X	X	X
John Newton	Director of Quality, TBE	X	X	X
Sharon Northcutt	Quality Assurance Manager	X	X	X
Karli Arterburn	Laboratory Supervisor	X	X	X
Keith Jeter	Laboratory Operations Manager	X	X	X
Jim Wright	Software Engineer		X	
Victoria Leslie	Project Manager		X	
Kim Thurman	Project Manager		X	
Sarah Griffiths	Receiving Technician		X	
Belinda Crouse	Lab Technician		X	

NRC Notices, Bulletins, Inspection Reports, and Industry Notifications

There had been no NRC inspections of Teledyne Brown and there have been no Part 21 notifications since the last audit.

Industry Issues (NUPIC/INPO)

An INPO ICES Database Report search did not identify an adverse condition or suggest a trend that should be examined by the audit. There were no industry issues posted for Teledyne Brown, on the NUPIC Website, since the completion of the previous audit.

Section Summary

Audit Section	Section Description	Status	Comments/Findings
1	Contract/ Purchase Order Review	S	
2	Organizational Structure and Personnel Responsibilities	S	
3	Qualification of Personnel	D	Deficiency 1 (TBE CA- 24-13)
4	Operating Procedures and Instructions	D	Deficiency 2 (TBE CA-24-14)
5	Records	S	
6	Quality Control in the Radioanalytical Laboratory	D	Deficiency 3 (TBE CA-24-15)
7	Data and Computer Software Verification and Validation	S	
8	Assessments and Audits	S	
9	Preventive and Corrective Actions	S	
S – Satisfactory	F / D – Finding / Deficiency	N/A – Not Applicable	

Attachments

1. NUPIC Checklist: (NUPIC distribution only)
2. PBSA Worksheet: (NUPIC distribution only)
3. Technical Specialist Qualification, Resume, EPRI CBT: (NUPIC distribution only)

November 13, 2024

Kristin Peacock
Quality Assurance Manager
Teledyne Brown Engineering
2508 Quality Lane
Knoxville, TN 37931

Subject: Constellation Energy Generation Audit No: SR-2024-14
NUPIC Audit No. 25559

Dear Ms. Peacock:

Attached is the report of the November 4-7, 2024 audit performed at the Teledyne Brown Engineering (TBE) facility located in Knoxville, TN. The audit was led by Constellation Energy Generation (CEG) with team members from Entergy (ENT), Omaha Public Power District (OPP), Tennessee Valley Authority (TVA), and Xcel Energy (XEL). The team assessed the adequacy, effectiveness, and implementation of the TBE Quality Assurance Program.

Three deficiencies were issued during the performance of this audit. Deficiencies were not documented by Constellation Energy but were entered in your corrective action program. No written response is required for deficiencies. The actions that you take for the deficiencies will be reviewed during the next NUPIC audit.

Since there are no follow-up actions required, this audit is considered closed based on the issuance of this report.

The results of this audit will be made available to all interested utility members. It is the responsibility of each member utility to determine the acceptability of the audit report relative to the requirements of their own Quality Assurance Program. TBE will be maintained on CEG's approved suppliers list for supplying radiochemical analysis of effluent and environmental samples; bioassay samples; and laboratory services to the nuclear industry.

I thank you and your staff on behalf of the audit team for the courtesy, professionalism, and cooperation extended to us in support of the audit. If you have any questions regarding the audit, please contact me at (815) 600-2686 or Gwen.Sarli-Prelle@constellation.com.

Sincerely:

Sarli-Prelle, Gwendolyn Vicktoria
Digitally signed by Sarli-Prelle, Gwendolyn Vicktoria
Date: 2024.11.21 09:52:07 -05'00'

Gwen Sarli-Prelle
Audit Team Lead

CONFORMITY ASSESSMENT BODY (CAB) ASSESSMENT REPORT

ASSESSMENT INFORMATION	
Assessment Number	**Date(s)**
A2024-01495	September 11 – 12, 2024
CAB name:	Teledyne Brown Engineering
Standard(s):	ISO/IEC 17025:2017; DoD/DOE QSM 5.4
Lead Assessor:	Maurice Downer (LA)
Team Members:	Salima Haniff (AL) & Cara Mills (Observer),
☐ Accreditation Assessment ☒ Reassessment	
Location of Assessment: ☒ Onsite ☐ Virtual	

CONTACT(S)	SCOPE(s)	SITE LOCATION (List Headquarters first, add rows as needed)
Sharon Northcutt	Teledyne L22-882 (DOD) and Teledyne L22-883 (DOE)	2508 Quality Lane, Knoxville, TN 37931

SCOPE(S)	
For details of specific scope items assessed, see appropriate supplement(s).	
Scope(s) have changes:	☐ YES ☒ NO
Scope Expansion (SE):	☐ YES ☒ NO
PJLA HQ Notified of SE if not part of the LF-21:	☐ YES ☐ NO ☒ N/A
HQ Staff Notified:	N/A
Details of SE not on LF-21:	N/A
Details of Other Scope Changes:	N/A
Flexible Scope:	☐ YES ☒ NO

Activities Assessed at CAB Customer Location
☐ YES ☒ NO The CAB performs activities within its scope of accreditation at its customers locations.
☐ YES ☒ NO If yes above, the assessment included activities at the CABs customer location.
☐ YES ☒ NO If yes above, the assessment included simulated activities outside of the CABs fixed location, in lieu of at the CABs customer location.
Reason why customer location was not witnessed: N/A
Describe scope items assessed at CABs customer location/simulated outside of CABs fixed location: N/A

Activities Assessed at Mobile Facilities
☐ YES ☒ NO The CAB performs activities within its scope of accreditation from a mobile facility.
☐ YES ☒ NO If yes above, the assessment included activities at the CABs mobile facility.
Reason why CABs mobile facility was not witnessed: N/A
Describe scope items assessed at CABs mobile facility: N/A

ASSESSMENT ACTIVITIES
See standard checklist(s) and relevant supplement(s) for additional details.
Comments on Competence (of conformity assessment activity) and Conformity (of standards and PJLA policies assessed) Management and personnel performing accredited activities demonstrated an understanding of the requirements and commitment to quality data. Personnel witnessed and/or interviewed demonstrated good laboratory practices and competency in the applicable activities.

Laboratory protocols, Data Integrity and Ethics, proficiency testing reports, Analyst training (DOC) records, control charts, internal audit review checklist, certificates, traceability records, reports, preparation data sheets, Management review record, QC check sheet, working logbooks, equipment list, laboratory forms, test procedures, personnel training documentation and verification/calibration records were all reviewed prior to or during the audit.

The lab is not currently analyzing DoD/DOE samples – there was sufficient signs of the capability to meet these requirements.

Additional Observations to Support Conclusions and Recommendation

General Requirements
Personnel demonstrated an understanding of the requirements of the standards assessed and commitment to quality data. Personnel witnessed and/or interviewed demonstrated good laboratory practices and competency in the applicable activities. Objective evidence indicated the system is maintained in compliance with the standards assessed. Pre-assessment materials were provided in a timely manner and requested documents and records were readily available. All procedures and SOPs were evaluated against ISO/IEC 17025:2017/DoD-ELAP QSM 5.4/Option A/Testing.

Structural Requirements
The laboratory is secure and controlled, properly conditioned with appropriate segregation of activities to prevent contamination. Facilities and equipment are appropriate for the tests on the scope.

Resource Requirements
Person(s) interviewed and/or witnessed during the assessment were expressive and knowledgeable in their respective areas and were demonstrably competent in the testing methods observed.

Process Requirements
Personnel are qualified by method with periodic re-evaluation and ongoing training – both in-house and through interaction with industry-recognized expertise.

Management System Requirements
All resource requirements are identified in Quality Manual, Master Document List, Non-Technical & Technical SOPs, Control Charts, Laboratory protocols, proficiency testing study results, Analyst training records, internal audit review, certificates, traceability records, reports, preparation data sheets, Management review record, QC check sheet, working logbooks, equipment list, laboratory forms, Data Packages, Level IV Data Packages, Complaints, Corrective Actions, etc.

Previous assessment NCRs: 2	Total #: 2
Results of evaluation from previous assessment's NCRs: All previous NCRs have been effectively addressed and implemented	

Proficiency Testing		
Proficiency Testing Applicable to CAB:	☒ Yes ☐ No	
If not, explain:	N/A	
PT plan appropriate and followed:	☒ Yes ☐ No	
PJLA Approval of Alternatives to PT:	☐ Yes ☐ No ☒ N/A PJLA Approval Record Available	
Approach to PT:	☒ ISO/IEC 17043 accredited PTP	
	☐ PJLA Approved Approach Non-accredited third-party PTP	
	☐ PJLA Approved Approach (Industry Accepted Interlaboratory Comparison ILC)	
	☐ PJLA Approved Approach (Other Interlaboratory Comparison ILC)	
	☐ PJLA Approved Approach (Intralaboratory Comparison)	
	☐ PJLA Approved Approach (Repeatability)	
Performance	Number of studies:	13
	Number of studies requiring CA:	5

CONFORMITY ASSESSMENT BODY (CAB) ASSESSMENT REPORT

Comments: PT participation is evident from the provided reports; E_Z 1Q23; E_Z 1Q24; E_Z 3Q23, E_Z L103093 extra, LF-81 Crosscheck schedule 2024-2025, MAPEP Series 48, MAPEP Series 49, MAPEP Series 50, MRAD-38, MRAD-39, MRAD-40, RAD-133, RAD-135 R1, RAD-137, Spikes Reproducibility				
NONCONFORMITIES/OBSERVATIONS				
See LF-08 for additional details.				
There were:	0	Nonconformities, including:	0	Repeat Nonconformities
	0	Observations		

SCOPE(S) of ACCREDITATION
See Scope(s) or Scope Supplement(s) for additional details.
☒ CAB and Assessor are in agreement on the scope(s)/ proposed scope(s) of accreditation.

ASSESSOR'S ACCREDITATION RECOMMENDATION
☒ CAB is recommended for accreditation to standards identified above, without nonconformities.
☐ CAB is recommended for accreditation to standards identified above, with receipt of acceptable corrective actions to nonconformities identified.
☐ CAB is recommended for accreditation to standards identified above, with receipt of acceptable corrective actions to nonconformities identified, and a follow-up assessment to verify implementation.
Reasons for requesting follow-up assessment: N/A
☐ CAB is recommended for suspension of a ☐ Partial Scope ☐ Full scope of accreditation and standards identified above, requiring receipt of acceptable corrective actions to nonconformities identified, and a follow-up assessment to verify implementation.
Partial Scope items recommended for suspension: N/A
Reasons for recommending suspension: N/A
Accreditation Assessments Only ☐ CAB is not recommended for accreditation to standards identified above, explanation identified below. ☐ PJLA was notified of pending recommendation (prior to closing meeting) to discuss options available to CAB (i.e., Preassessment).
Reasons for not recommending accreditation: N/A
Offsite Surveillance Considerations
☐ Yes ☐ No: Eligible for offsite surveillance (After 1st RA)
☒ Offsite recommended for next surveillance
☐ Offsite not recommended (provide explanation). Offsite recommended for next surveillance, unless lab is desirous of migrating to DoD/DOE QSM 6.0
Areas of concern or recommendations for next visit. (Issues may include, but not be limited to issues related to instrumentation, witnessing of additional staff or inspectors) For aspects that could not be verified/confirmed due to lab not testing DoD/DOE samples, it is recommended that these be verified during the next visit.
Ownership of this report lies with PJLA and CAB. A third party can only obtain right of perusal after permission from the CAB. Distribution: PJLA, CAB and as required by program/state specific requirements. Additional reports may be distributed as necessary upon permission of the laboratory and as required by program specific requirements and/or by the state requirements. If a revision report is required based on PJLA Headquarters or program/state review, one will be issued within 30 days from the receipt of this report, upon final review by PJLA. Acknowledgment: PJLA wishes to thank the CAB for their assistance and cooperation during this assessment.

CONFORMITY ASSESSMENT BODY (CAB)
ASSESSMENT REPORT

Report Competed by:	Maurice Downer Salima Haniff	Date report submitted to CAB:	September 12, 2024
		Date report submitted to PJLA:	September 12, 2024

Amended report ☐ No ☐ Yes	Date:	N/A
N/A		

END OF DOCUMENT