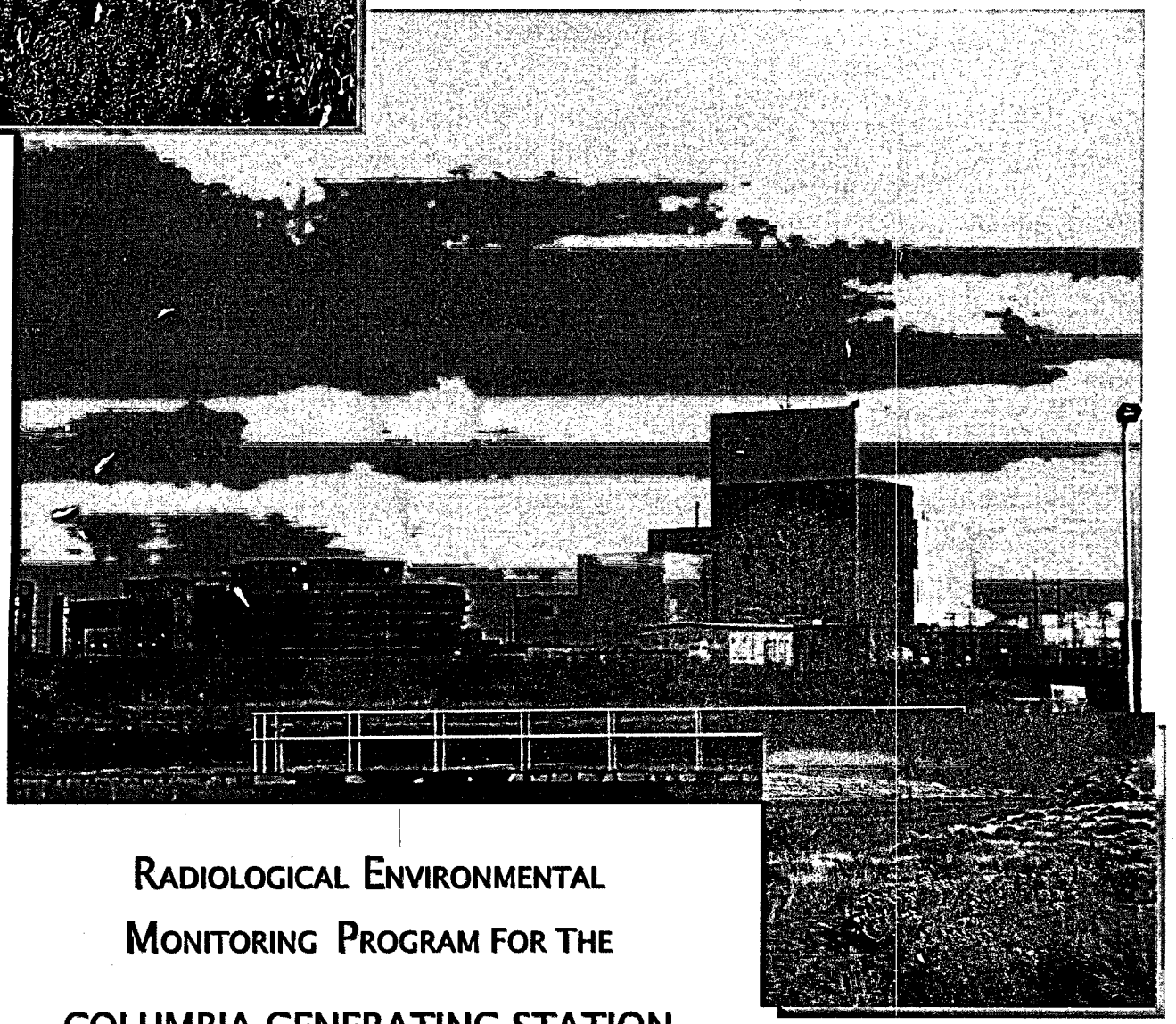
COLUMBIA GENERATING STATION

2005 Annual Radiological Environmental Operating Report



Radiological Environmental Monitoring Program for the

COLUMBIA GENERATING STATION

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COLUMBIA GENERATING STATION

2005 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

Calendar Year 2005

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

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1.0 EXECUTIVE SUMMARY

1.0 EXECUTIVE SUMMARY

This report describes the radiological environmental monitoring program (REMP) for Columbia Generating Station (CGS) and its associated Independent Spent Fuel Storage Installation (ISFSI) for calendar year 2005. The REMP is administered by the Energy Northwest Environmental Services group. The purpose of the REMP is to assess the potential radiological impacts of CGS activities on the environment through the monitoring of various exposure pathways.

The Offsite Dose Calculation Manual (ODCM) requires monitoring of direct radiation exposure levels, and of the inhalation and ingestion radiation exposure pathways. Direct radiation levels were monitored continuously with thermoluminescent dosimeters (TLDs). The inhalation pathway was monitored by collecting air particulate and air iodine samples and analyzing them to quantify the concentrations of radiation, and radioisotopes. The ingestion pathway was monitored by collecting samples of water, milk, soil, sediment, fish, and garden produce throughout the year and evaluating them for radioactivity that might be present as a result of plant emissions.

Results from the offsite direct radiation monitoring conducted in 2005 for CGS indicate that there was no measurable dose contribution from plant operations. No new casks were placed in the ISFSI during 2005 and radiation levels nearby showed a gradual decrease in the quarterly monitoring results. No measurable increases in the dose rates were seen inside controlled areas at CGS relative to the previous year.

Results of the offsite monitoring of the other exposure pathways indicate that there is no measurable radiological impact on the environment from CGS. The vast majority of the activity that was detected in environmental samples was the result of naturally occurring radionuclides. Small amounts of Cs-137 were measured in some of the samples collected; the concentrations were consistent with levels found in the surrounding environment as a result of atmospheric nuclear weapons test fallout and past activities on the Hanford Site. The results seen in the samples taken this year are consistent with the results obtained in the previous operational and preoperational years.

No significant trends or changes in the environmental radiological levels in the vicinity of CGS were observed in 2005.

2.0 DEFINITIONS

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Airborne Activity Sampling: Continuous sampling of air through the collection of particulates and radionuclides on filter media. Periodic soil samples are collected for gamma isotopic analysis to provide information on deposition to the soil from airborne releases.

Alpha Particle (α): A charged particle emitted from the nucleus of an atom having a mass and charge equal in magnitude of a helium nucleus.

Becquerel (Bq): One disintegration per second. One picocurie (pCi) equals 0.037 becquerel.

Beta Particle (β): Charged particle emitted from the nucleus of an atom with a mass and charge equal in magnitude to that of an electron.

Blank Sample: A sample of the same media as the field sample being analyzed but without any radionuclide(s) being measured. It enables correction for the inherent sample background.

Composite Sample: A series of single collected portions (aliquots) analyzed as one sample. The aliquots making up the sample are collected at time intervals that are very short compared to the composite period.

Control Station: A sampling station in a location not likely to be affected by plant effluents due to its distance and/or direction from the Columbia Generating Station.

Counting Error: An estimate of the two-sigma uncertainty associated with the sample results based on respective count times.

$$+/- 2\sqrt{(SampleCPM/CountTime + BkgCPM/CountTime)}$$

Curie (Ci): A measure of radioactivity; equal to 3.7×10^{10} disintegrations per second, or 2.22×10^{12} disintegrations per minute.

Direct Radiation Monitoring: The measurement of radiation dose at various distances from the plant is assessed using thermoluminescent dosimeters and pressurized ionization chambers.

DOE: U.S. Department of Energy.

DOH: Washington State Department of Health.

EFSEC: Energy Facility Site Evaluation Council.

FFTF: Fast Flux Test Facility, also referred to as the DOE 400 area.

Flow Proportional Sampling: Sample collection volume or frequency determined as a function of the flow rate of the water being sampled.

Grab Sample: A single discrete sample drawn at one point in time.

Indicator Station: A sampling location that is likely to be affected by plant effluents due to its proximity and/or direction from the Columbia Generating Station.

Ingestion Pathway Monitoring: The ingestion pathway includes milk, soil, fish, and garden produce. Also sampled (under special circumstances) are other media such as vegetation and animal products such as eggs and meat when additional information about particular radionuclides is needed.

ISFSI: Independent Spent Fuel Storage Installation.

Lower Limit of Detection (LLD): The smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability with a 5% probability of a false conclusion that a blank observation represents "real" signal.

MAPEP: Mixed Analyte Performance Evaluation Program.

Mean: The average, i.e., the sum of results divided by the number of results.

Microcurie: 3.7×10^4 disintegrations per second, or 2.22×10^6 disintegrations per minute.

Milliroentgen (mR): 1/1000 Roentgen; a unit of exposure to X or gamma radiation.

MDA: Minimum Detectable Activity.

NIST: National Institute of Standards and Technology.

NPDES: National Pollutant Discharge Elimination System.

NRC: U.S. Nuclear Regulatory Commission.

ODCM: Offsite Dose Calculation Manual. Licensing document that contains the offsite radiological requirements.

Picocurie (pCi): 1 x 10^{-12} Curie or 2.22 disintegrations per minute; one millionth of a microcurie.

REMP: Radiological Environmental Monitoring Program.

Range: The difference between the smallest and largest results.

Restricted Area: Any area to which access is controlled for purposes of protection of individuals from exposure to radiation and radioactive materials.

Roentgen: Unit of exposure to ionizing radiation in air.

Site Certification Agreement (SCA): The Columbia Generating Station licensing agreement with the State of Washington.

Spiked Sample: A sample that has had a known quantity of radionuclide(s) added for the purposes of assessing analytical performance.

Standard Deviation: A measure of the scatter of a set of observations (or samples) around their mean value. Indicated by "σ".

Standard Error of the Mean: An estimate of the uncertainty associated with the mean of observation (or sample) averages. Also known as the standard deviation.

$$SE = \sqrt{\frac{S^2}{n}}$$

where S^2, the variance is

$$S_m^2 = \frac{1}{(n-1)} \sum^n (Xi - X)^2$$

SWTF: Sanitary Waste Treatment Facility; sanitary waste processing facility for the Columbia Generating Station, industrial development complex and the Department of Energy's 400 Area.

TEDA: triethylene diamine

Thermoluminescent Dosimeter (TLD): A TLD is a phosphor that stores energy from exposure to radiation and emits that energy in the form of light when heated.

3.0 INTRODUCTION

3.0 INTRODUCTION

3.1 Site Description

Columbia Generating Station (CGS) is a 1200 MWe commercial nuclear power plant that achieved initial criticality on January 19, 1984. The plant is located in a sparsely populated shrub-steppe region within the Department of Energy (DOE) Hanford Site in southeastern Washington. The plant is approximately three miles west of the Columbia River and is surrounded on all sides by uninhabited desert land. The nearest large population centers are Richland, Pasco, and Kennewick; which are 12 miles south, 18 miles southeast, and 21 miles southeast, respectively. The nearest privately owned lands are located approximately four miles east-northeast of the plant, across the Columbia River. The site has a bimodal wind pattern with winds primarily from the northwest and south.[20] The primary region of focus for REMP sampling is the farming region east of the plant.

Naturally occurring radionuclides exist in detectable quantities throughout the world and are seen in many of the samples collected for the REMP. Some examples of naturally occurring radionuclides that are frequently seen in samples are K-40, Be-7, Ac-228 (present as a decay product of Ra-228), and Ra-226. Additionally, some relatively long lived anthropogenic radioisotopes, such as Sr-90 and Cs-137, are also periodically seen in some REMP samples; these radionuclides exist in measurable quantities throughout the world as a result of fallout from atmospheric nuclear weapons testing.[21]

Due to the location of CGS on the Hanford Site, there are other sources of reactor produced radionuclides in close proximity to the plant. Hanford related radionuclides, which are sometimes measured in CGS REMP samples, are distinguishable from those that may be present as a result of CGS activities by the improper ratios of several characteristic shorter-lived radionuclides. The DOE has an active REMP for the Hanford Site that overlaps the CGS REMP.

3.2 Program Background

The CGS REMP is designed to conform to the Nuclear Regulatory Commission (NRC) Regulatory Guides 4.1,[1] 4.8,[2] and the Radiological Assessment Branch Technical Position.[3] In addition, the REMP also meets the requirements of 10CFR72.44(d)(2) for coverage of the ISFSI.

The quality assurance aspects of the sampling program and the thermoluminescent dosimetry are conducted in accordance with Regulatory Guides 4.15[4] and 4.13.[5] The REMP also adheres to the requirements of the Washington Energy Facility Site Evaluation Council (EFSEC),[6] the Columbia Generating Station Technical Specifications[7] and the Offsite Dose Calculation Manual (ODCM).[8] These requirements cover the environmental sampling and sample analysis aspects of the program, and also the reporting and quality assurance requirements.

The preoperational phase of the program, which lasted from March 1978 until initial criticality in January 1984, provided a baseline of background environmental data. The variability in the background levels of radioactivity is due to differences in geologic composition, meteorological conditions, and seasonal changes.

Teledyne Brown Engineering-Environmental Services was contracted to perform analyses of REMP samples for the first three quarters of 2005. The Energy Northwest Environmental Services Laboratory performed the analysis of REMP samples towards the end of 2005. The Pacific Northwest National Laboratory processed the thermoluminescent dosimeters used for the REMP in 2005.

Quarterly averages of the monitoring results are compared to the NRC non-routine reporting levels listed in the ODCM. In addition to evaluating the environmental concentrations against regulatory limits, the REMP also compares the results to state standards.[11, 12, 13] The results are also evaluated by comparing them to similar measurements made during the preoperational and previous operational periods and to the detection capabilities associated with the current methods of analysis.

3.3 Program Objectives

The REMP provides a mechanism for determining whether the levels of radioactivity in the plant environs are within established limits and to ensure that the accumulation of radionuclides in the environment will not become significant as a result of station operations.

While in-plant monitoring programs are used to ensure that 10 CFR 20[9] and 10 CFR 50[10] criteria for releases of radioactive effluents are met, the REMP provides verification of the effectiveness of these programs and confirms that the concentrations of radionuclides in the environment are not greater than anticipated.

4.0 PROGRAM DESCRIPTION

4.0 PROGRAM DESCRIPTION

The CGS ODCM defines the requirements for the REMP. The sampling plan presented in Table 4-1 in this report shows which samples are required by the ODCM and the Site Certification Agreement (SCA). The table also provides a summary of the sample locations, collection frequency, and types of analyses performed. The methods of sampling and sampling frequencies utilized in the program have been determined by such factors as the half-lives and major exposure pathways for the radionuclides potentially released from the plant to the surrounding environment.

4.1 Sample Locations

Ninety-five sampling locations (referred to as 'stations') are included in the monitoring program. Eighty-five indicator and three control stations are located within a 10-mile radius of CGS. Three additional control stations and four indicator stations are located outside of a 10-mile radius from the plant. Sample stations are listed in Table 4-2.

The locations of most of the stations used for sampling have been selected on the basis of an exposure pathway analysis. The exposure pathway analysis was based on factors such as weather patterns, anticipated emissions, likely receptors, and land use in the surrounding areas. Additional samples are collected at locations as specified by the SCA with the State of Washington Energy Facility Site Evaluation Council (EFSEC). Samples for the REMP collected from stations in areas that are likely to be influenced by CGS are used as indicators. Other samples collected from stations in areas that are not likely to be influenced by CGS serve as controls. The results from the indicator stations are compared to the results at the control stations, and also to the results obtained during the previous operational and preoperational years of the program.

The REMP sampling locations listed in Tables 4-1 and 4-2 are shown in Figures 4-1 and 4-2. Figure 4-3 shows the relative locations of the storm drain outfall and pond (Station 101) and the Sanitary Waste Treatment Facility (Station 102). Also shown are the cooling tower sediment disposal area (Station 119B and Station 119-Control) and the spray pond drainfield (Station 120), which are special interest stations.

4.2 Independent Spent Fuel Storage Installation (ISFSI)

The Independent Spent Fuel Storage Installation (ISFSI) was constructed to provide additional storage capacity for spent fuel. The spent fuel is stored in HI-STORM dry storage casks, which are placed on one of two concrete pads, each measuring 30-feet wide by 135-feet long. The ISFSI is located approximately 500 meters north-northwest of the reactor building.

REMP monitoring of the ISFSI is performed with a set of quarterly and annual TLDs located at 10 stations on the isolation fence surrounding the pads. In addition, two other stations are located on other fence lines. Station 121 is located on a fence line approximately 200 meters north of the turbine building and Station 122 is located on the fence approximately 100 meters north of the ISFSI. Figure 4-4 shows the ISFSI location in relation to CGS. Figure 4-5 shows the location of the 10 TLD stations located around the ISFSI. This arrangement of TLDs in conjunction with the other monitoring activities that are conducted in support of CGS REMP, satisfies the monitoring requirements listed in 10 CFR 72.44(d)(2) for the ISFSI.

4.3 Land Use Census

A land use census for areas within five miles of CGS is performed annually. The objectives of the land use census are to identify the locations of the nearest milk animal, residence, and garden greater than 50 m^2 (approximately 500 ft^2) producing broadleaf vegetation. This information is used to determine whether any site located during the census has a calculated dose or dose commitment greater than the sites currently monitored for the same exposure pathway. If a new location with a higher dose commitment were found, routine sampling of that dose pathway would be initiated at that new site.

The results of the 2005 land use census within five miles of CGS are presented in Table 4-3. No significant changes from the 2004 land use census were observed.

4.4 Sampling Methods

Energy Northwest personnel collect environmental samples in accordance with the program plan in Table 4-1. Procedures for sample collection and TLD handling are contained in the department instruction manual. Samples that were collected for the REMP in 2005 were either shipped to Teledyne, or transported to the Energy Northwest Environmental Services Laboratory shortly after collection. Generic descriptions of the sample analysis methods that are employed for the analysis of CGS REMP samples are described in section 4.5. This section describes the sampling methods and sample locations.

4.4.1 Direct Radiation

Direct radiation dose levels are monitored with Harshaw Model 8807 thermoluminescent dosimeters (TLDs). Two sets of TLDs are placed in the field approximately three feet above the ground at each monitoring station. One set of TLDs is exchanged on a quarterly basis (Quarterly TLDs); the other is exchanged on an annual basis (Annual TLDs).

The locations of the TLD stations are listed in Table 4-2, and are shown in Figures 4-1, and 4-2. Station 9A in Sunnyside, serves as a control for CGS TLDs. Station 119-Control serves as the control for Station 119B (the cooling tower/system sediment disposal basin). The remaining TLDs deployed in the field serve as indicator TLDs.

The TLDs are arranged in a series of rings that encircle CGS. The innermost ring of TLD stations, which are located inside the fence line at distances that range from 0.3-0.8 miles from the reactor centerline, are referred to as the 'S stations.' The next group of TLDs, which are located outside of the fence line, are called the inner ring. The inner ring TLDs are located at distances that range from around 1-2 miles from the reactor. The outer ring of TLDs are located at distances that range from a little under three (3) miles out to around ten (10) miles.

A Reuter-Stokes pressurized ion chamber (PIC) is maintained as a backup monitoring system to provide additional capability for measuring direct radiation exposure. This unit is no longer part of the routine monitoring program, but may be used in special monitoring situations.

4.4.2 Airborne - Particulate/Iodine

Air particulate and air radioiodine (I-131) samples are obtained through the use of low volume (1.5 cfm), constant flow-rate sampling units at 12 locations. The samples drawn at Station 9A (Figure 4-2) are considered controls, the samples drawn at the other locations (Figure 4-1) are indicators. Air particulate samples are collected by drawing air through a 47-mm diameter glass fiber filter. Air iodine samples are collected by drawing air through Radeco CP-100 TEDA impregnated charcoal cartridges. The air particulate filter and charcoal cartridge are placed in tandem, particulate filter first, in a holder that attaches to the air inlet of the sampler unit. The sampler units are placed in ventilated metal weatherproof housings mounted on elevated platforms at each air sample location. The filter media are changed weekly.

4.4.3 Water

There are nine locations where water sampling is performed for the REMP. They are categorized as follows:

- Intake-River/Drinking Water; two locations (Stations 26, and 29)
- Groundwater; three locations (Stations 52, 31, and 32)
- Plant Discharge Water; one location (Station 27)
- Storm Drain Water; one location (Station 101)
- Sanitary Wastewater; two locations (Stations 102A, and 102B)

The sample at Station 26 is drawn from the plant intake water which comes from the Columbia River. Station 26 is upstream from the plant discharge so it is the background, or control. The drinking water for CGS comes from this intake water so this sample also serves as a drinking water sample. Station 29 is located at the Richland Water Treatment Plant, 11 miles downstream from the discharge and is the indicator station for both river and drinking water.

The ODCM requirement for a downstream water sample "near but beyond the mixing zone" is conservatively met by sampling water from Station 27, the cooling tower discharge line to the Columbia River. This sample reflects the radioactivity present in the plant discharge prior to any river dilution, rather than the concentrations that would be found after dilution in the mixing zone. The Station 27 sample is an indicator. Composite samplers are used to collect samples at Stations 26, 27, and 29. The samplers collect 25-ml aliquots of water at regular intervals. Samples are collected monthly at each of these stations and are analyzed for gamma, gross beta, and tritium.

Three wells within the vicinity of CGS are used as groundwater sampling locations. These include a deep well on CGS site (Station 52, 0.1 mile north of the reactor building) and two wells on the WNP-1 site (Station 31 and Station 32, 1.2 miles downgradient from CGS). Water from CGS well can be used as a backup source for drinking water and fire protection. The WNP-1 wells supply water for drinking and fire protection at the WNP-1 site. All of these wells are considered indicator locations. Quarterly grab samples are collected from each of these wells and are analyzed for gamma emitting radionuclides and tritium.

Water samples are collected monthly from the storm drain outfall (Station 101) using a flow-proportional composite sampler. These samples are analyzed for gross beta, gamma, and tritium.

The SWTF receives wastewater from the DOE 400 Area. A flow meter and composite sampler is located on the 400 Area sewer line just above the 400 Area/Plant Support Facility (PSF) intertie (Station 102A). The sampler collects aliquots of the effluent on a timed basis, the composite sample that is produced is analyzed monthly as required by EFSEC Resolution No. 300.[15] A portion of the water used in the 400 Area is drawn from aquifers that are contaminated with tritium as a result of DOE activities on the Hanford Site, consequently, the water sampled at Station 102A has tritium concentrations above 2000 pCi/L. Another automatic water sampler is located at the headworks of the SWTF (Station 102B) where a monthly composite sample is taken. Both sample locations are analyzed for gross alpha, gross beta, tritium, and gamma emitting radionuclides.

4.4.4 Soil

Annual soil samples are collected at the indicator Stations 1, 7, 21, and 23 as required by the SCA (EFSEC Resolution No. 260[6]). A sample is also collected at the control location, Station 9A (Figure 4-2). Each sample is collected from an area of approximately one square foot to a depth of approximately one inch. About two kilograms of soil are collected for each sample.

Soil samples are analyzed for gamma activity. If the Cs-137 level in an indicator sample exceeds ten (10) times the level in the control sample, strontium analysis is required.

4.4.5 Sediment

River sediment samples are collected in the spring and fall. The upstream sediment sample location (Station 33) is approximately two miles upriver from the plant discharge. The downstream sample (Station 34) is collected approximately one mile downstream from the plant discharge. Each sample consists of approximately two kilograms of the shallow surface sediment scooped from below the waterline.

Cooling tower sediment samples are collected, dried, and analyzed per EFSEC Resolution No. 299[16] (Station 119B, Figure 4-3) within thirty days of the completion of cleaning the cooling towers.

Wastewater sludge/sediment samples are collected annually at Station 102D (the SWTF). All sediment samples are analyzed for gamma activity.

4.4.6 Fish

Annual fish sampling is performed in the late summer and fall. Fish samples collected from the Columbia River (Station 30 in Figure 4-1) are indicator samples, whereas fish collected on the Snake River (Stations 38 and 38A in Figure 4-2) serve as control samples.

Three categories of fish samples are collected; an anadromous species (either a salmon or steelhead), and the two other species generally considered edible or potentially edible (such as carp, catfish, sucker, and whitefish) are collected at each location. Electro-shocking and netting is used for fish collection, except for the samples of the anadromous species, which are collected at the fish hatcheries.

4.4.7 Milk

Milk samples are collected monthly during the fall and winter months (October through December). During the spring and summer months when cows are likely to be grazing, or on fresh feed, milk samples are collected twice each month. Enough raw milk is collected from each sampling location to obtain a one-gallon sample after the cream has been skimmed off. The milk samples are chilled and then either taken to the laboratory for analysis or shipped to the analytical contractor within a day of collection.

Milk samples were collected in 2005 from two locations, Station 36, and Station 9B. Station 36 is in Franklin County and is the only dairy within a ten mile radius of CGS that will allow REMP personnel to obtain samples; Station 9B is in the Sunnyside/Grandview area (Figure 4-2). Station 9B has been used primarily as a control location; at times it was also an indicator station, because a portion of the feed used there came from Franklin County which is downwind from CGS. To account for this discrepancy of having some feed grown in the indicator location being fed to the control location cows, samples of feed grown at Station 9B were collected monthly when it was available and labeled as 'Station 9G' to serve as the control. In June of 2005, the dairy where the control sample feed and indicator/control milk samples had been collected closed, however, at the same time a new milk sampling location a short distance from the old 9B was obtained. There are no other dairies available for sampling within the 10-mile radius of the plant.

4.4.8 Garden Produce

Samples of local garden produce are collected monthly during the growing season when the produce is readily available. When possible, three types of produce samples (a root crop, fruit, and a leafy vegetable) are collected at each location. The indicator samples are collected from a region in the predominantly downwind direction (Station 37) where crops are irrigated with Columbia River water. The control samples are obtained from produce stands in the Sunnyside area (Station 9C in Figure 4-2), the direction least likely to be affected by plant effluents. Apples are collected in late summer or early fall from Station 91, the Rio Vista Farms orchard, which is irrigated with Columbia River water.

During 2005, a broadleaf vegetable sample was grown in a garden that was planted next to the SWTF. The garden was named Station 102G, and was planted specifically to produce samples that could be analyzed for the REMP. The garden does not meet the criteria in the ODCM to make it a required sampling location, however, a sample was collected from it and analyzed.

4.5 Sample Analyses

General descriptions of the procedures used for the analysis of the REMP TLDs and samples are provided in the following sections. The REMP TLDs are processed by Battelle at the Pacific Northwest National Laboratory (PNNL). Sample analyses for the REMP were performed by Teledyne Brown Engineering - Environmental Services for the first eight (8) months of the year; analyses for the last four (4) months of the year were performed by Energy Northwest Environmental Services. The analysis methods for REMP samples used by Teledyne and Energy Northwest are almost identical. Details of the differences between the laboratories are provided in the following text. Sample holding times prior to analysis for most sample types are kept as short as possible in order to ensure that the LLD requirements for shorter lived radionuclides are met with reasonable counting times. In samples where very long lived isotopes are the only isotopes of concern, longer sample holding times are permitted.

4.5.1 Analysis of TLDs

The REMP TLDs are measured at the Pacific Northwest National Laboratory (PNNL) on a Harshaw Model 8800 hot gas reader. The reader is calibrated weekly and immediately prior to processing the environmental TLDs. The reader is calibrated with TLDs that have been given a known exposure from a Cs-137 source. Each group of environmental TLDs is processed with blank (freshly annealed) TLDs and spiked TLDs that have been given a known exposure. Exposure received by the field TLDs during transport is monitored with a set of 'trip' control dosimeters that accompany the field dosimeters to and from the field locations and while they are in storage. Another set of TLDs, the building controls, are used to determine the exposure of the TLDs at the storage location. The TLD exposure during transport to and from the field was determined from the difference between the building control results and the trip control results.

4.5.2 Gross Beta Activity on Air Particulate Filters

Air particulate filters are counted in a gas flow-proportional counter after a delay of several days to allow for the decay of radon and its progeny. Air particulate filters are counted directly with a sufficient count time to meet the LLD requirements. However, the LLD for air particulate samples is generally not applicable as all valid air samples collected have yielded measurable beta results.

4.5.3 Measurement of Gamma Emitting Radionuclides

Shielded, high purity germanium (HPGe) detectors are used to assay environmental samples to quantitatively determine concentrations of gamma emitting radionuclides. Samples are counted in a standardized geometry; some samples are measured directly and others are loaded into Marinelli beakers. Samples are counted for a sufficient time to reach the required LLDs.

- **Liquids** – Measured aliquots of liquid samples are poured into appropriately sized Marinelli beakers. Results are reported in pCi/L.

- **Solids** – Soils, sludges, and sediments are dried and if needed ground. Foodstuff, biota (fish), and vegetation, are chopped finely or pureed and then analyzed wet (no drying is done). For foodstuff (including fish), only the edible portion of the sample is used. Measured aliquots of the solid samples (0.5 or 1.0 liter depending on sample type and sample quantity) are placed into tared Marinelli beakers and weighed. Results are reported in pCi/kg.

- **Charcoal Cartridges** – As many as five charcoal cartridges may be counted simultaneously with one positioned on the face of the detector and up to four on the sides of the detector in a cartridge holder. The detector is calibrated for both positions. The reportable sample activity for each charcoal cartridge is calculated (assuming no positive I-131) uniquely for each cartridge from the volume of air that passed through it, and the reported activity for the group of cartridges. If I-131 is measured in the assay of a group, each charcoal cartridge in the group would then be assayed separately. A collection efficiency of 98% for iodine is used in the activity calculations. Results are reported in pCi/m^3.

- **Air Particulate Filters** – At the end of each quarter, AP filters from each station are composited on a station by station basis. The filters are stacked in a Petri dish and assayed. Results are reported in pCi/m^3 and represent the total quarterly gamma activity collected at each station.

4.5.4 Gross Alpha and Gross Beta Activity in Water

A measured aliquot of each sample is evaporated to a small volume in a beaker and rinsed into a 2-inch diameter stainless steel planchet that is stamped with a concentric ring pattern to distribute residue evenly. The final evaporation of the sample is done under heat lamps, on a hot plate, or in a drying oven. Residue mass is determined by weighing the planchet before and after mounting the sample. The planchet may be counted for alpha and beta activity, or for just beta activity depending on the required results for the sample. An automatic proportional counter is used for gross alpha and gross beta measurements. The results are calculated using self-absorption curves that correct for the change of effective counting efficiency caused by the sample residue.

4.5.5 Tritium in Water

The sample is distilled and the distillate is collected for analysis with a liquid scintillation counter. Approximately 10 ml of the distillate is mixed with 10-15 ml of liquid scintillation cocktail. The mixture is then counted in an automatic liquid scintillation analyzer.

4.5.6 Strontium-89 and 90 in Soil

The sample is first dried under heat lamps and an aliquot is taken. Stable strontium carrier is added and the sample is leached in hydrochloric acid. After filtering the mixture, strontium is precipitated from the liquid portion as phosphate. Strontium is precipitated as $Sr(NO_3)_2$ using fuming (90%) nitric acid. A barium chromate scavenge and an iron (ferric hydroxide) scavenge are then performed. Stable yttrium carrier is added and the sample is allowed to stand for five days or more for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchet and counted in a low-level beta counter to infer Sr-90 activity. Sr-89 activity is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchet and covered with an 80 mg/cm^2 aluminum absorber for low-level beta counting.

4.5.7 Low Level Iodine-131 in Milk and Water

Up to four (4) liters of sample are first equilibrated with stable iodide carrier. A batch treatment with an anion exchange resin is used to remove iodine from the sample. At the Energy Northwest laboratory, the resin is loaded into a four (4) oz. container and counted directly by gamma spectroscopy. At Teledyne, the iodine is eluted from the resin with a sodium hypochlorite solution, reduced with hydroxylamine hydrochloride, and extracted into carbon tetrachloride as free iodine. It is then back-extracted as iodide into a sodium bisulfite solution and precipitated as palladium iodide. The precipitate is weighed for chemical yield and mounted on a nylon planchet for low-level beta counting. The chemical yield is corrected by measuring the stable iodide content of the milk with a specific ion electrode.

4.6 Data Analysis Methods

Since mid-1984, the results of the REMP analyses have been presented as net results calculated from the gross or total counts determined for each radionuclide minus the background counts of the counting or detection instrument. Consequently, the results range from negative to positive numbers in samples where the analytes of interest are sometimes not detected. This manner of presenting environmental data prevents the positive bias and loss of individual results inherent in the use of "less than" (<) values.

A listing of the Teledyne and Energy Northwest nominal target LLDs for each sample type is provided in Table 4-4; the ODCM required LLDs are also included for a comparison. The actual LLDs may vary due to sample holding time and available sample volumes. In most cases Energy Northwest LLDs have been selected to match those of Teledyne; in some cases the LLDs for Energy Northwest are lower.

Plots of the sample results versus time are used to represent the results for analyses such as gross beta on air particulate filters, where the results are normally above the detection limit. In such cases, the indicator station results are plotted with the control station results for easy comparison. Other data analysis techniques are also used to evaluate whether trends that could be attributed to CGS operations are evident.

Thermoluminescent dosimeter (TLD) data is presented in terms of the net mrem/day exposure rate. These results are determined from the total exposure (in mrem) calculated for each TLD minus the TLD background and any transit (or trip) exposure received during distribution and retrieval, and divided by the number of days the TLD was in the field. The total mrem/standard quarter and mrem/year values are also reported.

The quarterly TLD results are compared with the annual TLD results and expressed as a ratio by dividing the sum of the quarterly results over the annual results. The agreement between the two sets is usually within plus or minus ten percent (10%); occasionally fade can be more significant than expected in the annual set and the results may be lower than the sum of the quarterly data.

4.7 Changes to the Sampling Program in 2005

A new control sampling location for milk in Sunnyside was obtained a short distance from where feed sampling had been performed in lieu of milk sampling previously. The number designation for the new control station was retained (9B); the reference name for it changed from "Meeker" to "Scheenstra." The old control location was terminated when the farm got rid of the last cow. The new control station is a significant improvement; the sample collected there is milk produced by cattle that feed exclusively on material grown in the control area. Milk samples were collected at the previous location (Meeker), but the feed that the cows were given there was sometimes grown in the indicator location; this made the milk samples obtained there ambiguous and not consistently representative of either a control or an indicator. As a result of this ambiguity, feed was collected to use as the control.

TABLE 4-1
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM PLAN

	SAMPLE TYPE[a]	SAMPLE STATION[b] NUMBER	SAMPLING AND COLLECTION FREQUENCY[c]	TYPE AND FREQUENCY OF ANALYSIS
1.	**AIRBORNE**			
	Particulates and radioiodine (6/12)[d]	1, 4-8, 9A, 21, 23, 40, 48, and 57	Continuous sampling; weekly collection	Particulate: Weekly gross beta[e]; gamma isotopic[f] of quarterly composite (by location) Iodine: Weekly gamma analysis.
	Soil[g](0/5)	9A, 1, 7, 21 and 23	Annually	Gamma isotopic[f]; Sr-90[h]
2.	**DIRECT RADIATION**			
	TLD[i](34/72)	1-8, 9A, 10-25, 40-47, 49-51, 53-56, 65, 71-86 (1S-16S)[j], 119B, 119-Control, 120, 121-129, 136A-138A	Quarterly, annually	Thermoluminescent output; quarterly and annual processing.
	PIC	Various locations, as needed[k]	Continuous recording, as needed	Exposure rate accumulated in internal memory
3.	**WATERBORNE**			
	River/Drinking Water[l] (3/4)	26, 27 and 29	Composite aliquots[m]; monthly collection	Gamma isotopic[f], gross beta, quarterly; tritium composite; Sr-90[n]; I-131[o]
	Storm Drain Water (0/1)	101	Composite aliquots[m], monthly collection; grab samples	Gamma isotopic[f], tritium, gross beta
	Sanitary Waste Treatment Facility Water (0/2)	102A, 102B	Composite aliquots[m], monthly collection	Gamma isotopic[f], gross beta, gross alpha, tritium
	Ground Water (2/3)[p]	31, 32, and 52	Quarterly	Gamma isotopic[f]; tritium
	River Sediment (1/2)[q]	33 and 34	Semiannually	Gamma isotopic[f]
	Sanitary Waste Treatment Facility Sediment (0/1)	102D	Annually	Gamma Isotopic[f]
	Cooling Tower Sediment Disposal Area (0/1)	119B	Within 30 days following Cooling Tower cleaning event	Gamma Isotopic[f]
4.	**INGESTION**			
	Milk[r] (3/3)	9B[s], 9G[t], 36	Semimonthly during grazing season, monthly at other times	Gamma isotopic[f]; I-131; Sr-90[f]
	Fish[u] (2/2)	30, 38	Annually [v]	Gamma isotopic[f]
	Garden Produce[w] (1/4)	9C, 91,[x] 37, 102G[y]	Monthly during growing season in the Riverview area of Pasco and a control near Grandview; annual collection at Station 91.	Gamma isotopic[f]

FOOTNOTES:

(a) The fraction in parentheses for each sample type indicates the ratio of ODCM-required sample locations to the total number of sample locations currently being monitored in the surveillance program. The SCA also requires certain numbers of sampling stations for each type of media.

(b) The underlined sample location designates a control station.

(c) Deviations are permitted if samples are unobtainable due to hazardous conditions, seasonal availability, malfunction of automatic sampling equipment, or other legitimate reasons. Such deviations are documented in Section 5.

FOOTNOTES (cont):

(d) The SCA requires nine or more air sampling stations.

(e) If gross beta activity is greater than 10 times the mean of the result for the control, Station 9A, gamma isotopic analysis shall be performed on the individual sample.

(f) Gamma isotopic means identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents of CGS.

(g) Soil samples are collected to satisfy the requirements of the SCA for CGS. The SCA requires that soil samples be collected at five air-sampling locations.

(h) Sr-90 analysis shall be performed on any indicator soil sample having cesium results greater than ten times the result for the control location.

(i) TLD an abbreviation for thermoluminescent dosimeter.

(j) TLD Stations 71-86 are not included among the 34 routine TLD stations required by the ODCM Table 6.3.1-1. Their alternate designations are 1S-16S. The SCA requires 25 or more TLD stations to be located within a 10-mile radius of the plant.

(k) Pressurized ion chambers (PICs) are required by EFSEC Resolution No. 260 to be maintained as a supplemental or backup system.

(l) The term "river/drinking water" is used throughout this report because the drinking water is taken from the Columbia River. Station 26, CGS makeup water intake from the Columbia River is both an upstream water sample and the drinking water sample location. Station 29 is a downstream drinking water sample. The Station 27 sample, which is drawn from the plant discharge line, is taken in place of a "downstream" water sample near but beyond the mixing zone. It reflects the radioactivity present in the plant discharge prior to any river dilution. The SCA requires two drinking water locations downstream from the plant discharge and requires sampling from the plant intake and discharge water. Only one drinking water station is now sampled after DOE closed the intake at the 300 Area (Station 28) in 1998.

(m) Composite samples are collected with equipment that collects an aliquot at time intervals that are short relative to the compositing period.

(n) When the gross beta activity in drinking water exceeds 8 pCi/liter, a Sr-90 analysis is performed.

(o) When the dose calculated via ODCM methodology for consumption of water exceeds 1 mrem per year, low level I-131 analyses are performed on the drinking water samples.

(p) The SCA requires sampling from wells used for fire protection and as backup drinking water sources.

(q) The SCA requires sediment sample collection upstream and downstream of the plant discharge.

(r) Milk samples will be obtained from farms or individual milk animals that are located in the most prevalent wind directions from CGS. The SCA requires at least three milk locations within the 10-mile radius of the plant and one in a control location, however, Energy Northwest currently has access to only one dairy within a 10-mile radius of the plant (Station 36) and one control location at 30 miles. Broadleaf vegetation is sampled in lieu of milk when available.

(s) Samples of feed for dairy animals were collected in lieu of milk at a control station (Station 9G) for the first half of 2005. The dairy cattle at Station 9B were not suitable for use as a control prior to June of 2005 because a portion of their feed came from a portion of Franklin County which is an indicator region for CGS. Station 9B was moved a short distance in June of 2005 and became the new sample control location for milk; at the new location dairy cattle are only given feed grown in the control location (Sunnyside).

(t) If Cs-134 or Cs-137 is measured in an individual milk sample in excess of 30 pCi/1, then the Sr-90 analysis will be performed.

(u) There are no species fished commercially in the Hanford Reach of the Columbia River. The most recreationally important species in the area are anadromous, which ascend rivers from the ocean for breeding. Anadromous fish species are normally obtained from hatcheries; Snake River samples are obtained from the Lyons Ferry Fish Hatchery, and Columbia River samples are obtained at the Ringold Fish Hatchery.

(v) If an impact is indicated, sampling will be conducted semiannually.

(w) Garden produce will routinely be obtained from farms or gardens using Columbia River water for irrigation when available. One sample of a root crop, leafy vegetable, and a fruit is collected each sample period, if available. The variety of the produce obtained will be dependent on seasonal availability.

(x) Station 91 is an apple orchard irrigated with Columbia River water. The apple crop from Station 91 is sampled annually.

(y) Station 102G was used to collect one sample. This station does not meet the ODCM criteria for a garden which requires sampling; it was used to provide a broadleaf sample that was grown inside the 5-mile radius from the plant.

TABLE 4-2
REMP SAMPLE STATIONS AND REQUIREMENTS

SECTOR[a]	STATION[b] NUMBER	DISTANCE[c]	ODCM[d]	STATE[e]	OTHER[f]
N (1)	52	0.07	GW		
	71(1S)	0.28			TLD
	47	0.70		TLD	
	57	0.70	AP/AI		
	18	1.16	TLD	TLD	
	53	7.54	TLD		
NNE (2)	72(2S)	0.32			TLD
	2	1.45	TLD	TLD	
	54	6.08	TLD		
NE (3)	101	0.19			SW
	73(3S)	0.54			TLD
	19	1.74	TLD	TLD	
	48	4.59	AP/AI		
	46	4.99	TLD		
ENE (4)	74(4S)	0.38			TLD
	21	1.45		TLD, AP/AI, SO	
	20	1.93	TLD	TLD	
	11	3.16		TLD	
	33	3.44		SE	
	45	4.45	TLD		
	44	5.90	TLD		
E (5)	75(5S)	0.37			TLD
	22	2.08	TLD		
	10	3.16	TLD	TLD	
	26	3.19	SW, DW	SW	
	27	3.19		Dis W	
	30	3.28	FI	FI	
	43	5.16	TLD		
ESE (6)	76(6S)	0.42			TLD
	31	1.06	GW	GW	
	32	1.27		GW	
	51	2.14	TLD		
	23	3.03		TLD, AP/AI, SO	
	34	3.32	SE	SE	
	8	4.39	TLD, AP/AI	TLD, AP/AI	
	91	4.30		GP	
	42	5.85	TLD		
	36[g]	7.33	MI	MI	

TABLE 4-2 (cont.)
REMP SAMPLE STATIONS AND REQUIREMENTS

SECTOR[a]	STATION[b] NUMBER	DISTANCE[c]	ODCM[d]	STATE[e]	OTHER[f]
ESE (6)(cont.)	5	7.72	TLD	AP/AI	
	38	26.50	FI	FI	
SE (7)	77(7S)	0.57			TLD
	24	1.87	TLD	TLD	
	3	2.06		TLD	
	41	5.79	TLD		
	40	6.51	TLD, AP/AI		
SSE (8)	119-Control	0.28		TLD	
	120	0.32			TLD
	102B	0.50		SFW	
	102D	0.50			SFW, SE
	102G	0.56			GP
	78(8S)	0.81			TLD
	25	1.50	TLD	TLD	
	55	6.05	TLD		
	4	9.57	TLD, AP/AI	TLD, AP/AI	
	29	11.57	DW	DW	
	37B	14.79	GP	GP	
	37A	14.62		GP	
S (9)	119B	0.31		TLD, SE	
	102A	0.67		SFW	
	79(9S)	0.76			TLD
	1	1.25	TLD	TLD, AP/AI, SO	
	6	7.72	TLD	AP/AI	
	65	8.87			TLD
SSW (10)	80(10S)	0.83			TLD
	50	1.26	TLD	TLD	
	56	6.65	TLD		
SW (11)	13	1.26	TLD	TLD	
	81(11S)	0.74			TLD
WSW (12)	82(12S)	0.57			TLD
	14	1.26	TLD	TLD	
	9A	28.35	TLD, AP/AI	TLD, AP/AI	
	9B, 9G	32.82	MI, VE[h]	MI, VE[h]	
	9C	32.15	GP	GP	
W (13)	83(13S)	0.52			TLD
	15	1.24	TLD	TLD	
WNW (14)	84(14S)	0.55			TLD

TABLE 4-2 (cont.)
REMP SAMPLE STATIONS AND REQUIREMENTS

SECTOR[a]	STATION[b] NUMBER	DISTANCE[c]	ODCM[d]	STATE[e]	OTHER[f]
WNW(14) (cont.)	16	1.21	TLD	TLD	
	7	2.83	TLD	TLD, AP/AI, SO	
NW (15)	85 (15S)	0.43			TLD
	49	1.19	TLD	TLD	
NNW (16)	121	0.12		TLD	TLD
	122	0.31		TLD	TLD
	123	0.29		TLD	TLD
	124	0.28		TLD	TLD
	125	0.28		TLD	TLD
	126	0.28		TLD	TLD
	127	0.26		TLD	TLD
	128	0.25		TLD	TLD
	129	0.17		TLD	TLD
	136A	0.29		TLD	TLD
	137A	0.24		TLD	TLD
	138A	0.17		TLD	TLD
	86 (16S)	0.31			TLD
	17	1.19	TLD	TLD	
	12	6.74		TLD	

SAMPLE TYPE KEY:

AP/AI - Air Particulate/Air Iodine
Dis W - Discharge Water
GP - Garden/Orchard Produce
MI – Milk
SFW - Sanitation Facility Water
SW - Surface Water
VE - Vegetation
DW - Drinking Water
FI-Fish
GW - Ground Water
SE - Sediment
SO - Soil
TLD - Thermoluminescent Dosimeter

FOOTNOTES:

(a) The area in the vicinity of CGS is separated into 16 sectors for reporting purposes. The 16 sectors cover 360 degrees in equal 22.5 degree sections, beginning with sector 1 (N) at 348.75 to 11.25 degrees and continuing clockwise through sector 16 (NNW).

(b) The alternate designations for TLD Stations 71-86 are given in parentheses, i.e., 1S-16S.

(c) Distances are from GPS positions for each location as a radial distance from CGS reactor building.

(d) ODCM - Offsite Dose Calculation Manual Table 6.3.1-1 requirement.

(e) State of Washington SCA requirements.

(f) OTHER –Special study stations. TLD Stations 121 through 138A satisfy ISFSI monitoring requirements 10CFR72.44(d)(2).

(g) Duplicate samples, i.e., samples drawn at the same time as the routine samples and submitted for analysis as a quality control check, are collected at this location. The station designation for the duplicate of Station 36 is Station 37.

(h) Broadleaf vegetation collected in lieu of milk from a control station.

TABLE 4-3
2005 FIVE-MILE LAND USE CENSUS RESULTS

SECTOR[a]	NEAREST RESIDENT[b]	GARDEN (>50M^2)	DAIRY ANIMALS	LIVESTOCK
NE	4.47	none	none	none
ENE	4.01	none	none	4.96
E	4.59	none	none	none
ESE	4.24	none	none	none
SE	none	none	none	none

FOOTNOTES

(a) Within a five-mile radius of the plant, only 4.5 sq. miles of the land in the sixteen meteorological sectors is privately owned farmland. The remainder of the land is on the federally owned Hanford Site. Only those sectors containing points of interest are presented here.

(b) Estimated distances in miles from CGS Reactor Building based on GPS readings.

TABLE 4-4
COMPARISON OF LABORATORY NOMINAL LOWER LIMITS OF DETECTION WITH OFFSITE DOSE CALCULATION MANUAL[8] REQUIREMENTS

MEDIA (UNITS)	ANALYSIS	TELEDYNE LLDs[a]	ENERGY NORTHWEST LLDs[c]	ODCM REQUIRED LLDs
Air	Gross Beta	0.003	0.003	0.01
(pCi/m^3)	Gamma Spectrometry			
	Cs-134	0.001	0.001	0.05
	Cs-137	0.001	0.00	0.06
	I-131	0.01	0.05	0.07
Water:	Gross Beta	4	2	4
(pCi/L)	Tritium	300	300	2000[b]
	I-131	1	1	---
	Sr-90	1	1	---
	Gamma Spectrometry			
	Mn-54	10	10	15
	Fe-59	20	20	30
	Co-58	10	10	15
	Co-60	10	10	15
	Zn-65	20	20	30
	Zr-95	15	15	15
	Nb-95	10	10	15
	Cs-134	10	10	15
	Cs-137	10	10	18
	Ba-140	15	15	15
	La-140	10	10	15
Soil/Sediment:	Gamma Spectrometry			
(pCi/kg dry)	Co-57	120	120	---
	Co-60	30	30	---
	Zn-65	100	100	---
	Cs-134	30	30	150
	Cs-137	40	40	180
	Sr-90	10	10	---
Fish:	Gamma Spectrometry			
(pCi/kg wet)	Mn-54	20	20	130
	Fe-59	30	30	260
	Co-58	20	20	130
	Co-60	20	20	130
	Zn-65	30	30	260
	Cs-134	20	20	130
	Cs-137	20	20	150
Milk:	I-131	0.5	0.5	1
(pCi/L)	Gamma Spectrometry			
	Cs-134	10	10	15
	Cs-137	10	10	18
	Ba-140	15	15	15
	La-140	10	10	15
	Sr-90	1	1	---
Garden Produce:	Gamma Spectrometry			
(pCi/kg wet)	Cs-134	20	20	60
	Cs-137	20	20	80
	I-131	30	30	60

[a] These are the contract LLDs; actual LLDs may be higher or lower for specific samples.
[b] If no drinking water pathway exists, a value of 3,000 pCi/L may be used.
[c] These are the nominal target LLDs for the analyses performed in the Energy Northwest Environmental Services Laboratory.

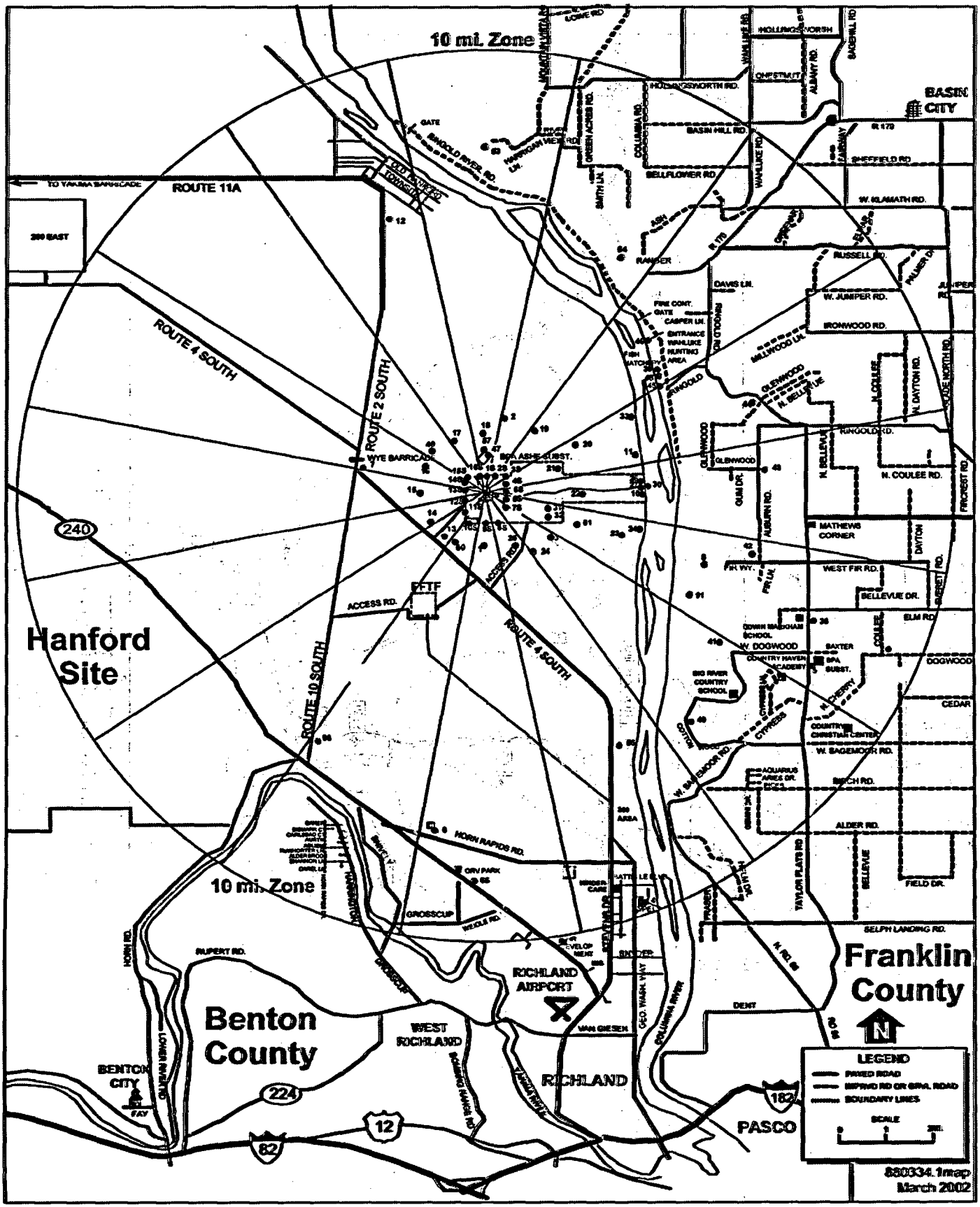


FIGURE 4-1 REMP SAMPLING LOCATIONS INSIDE THE 10 MILE RADIUS

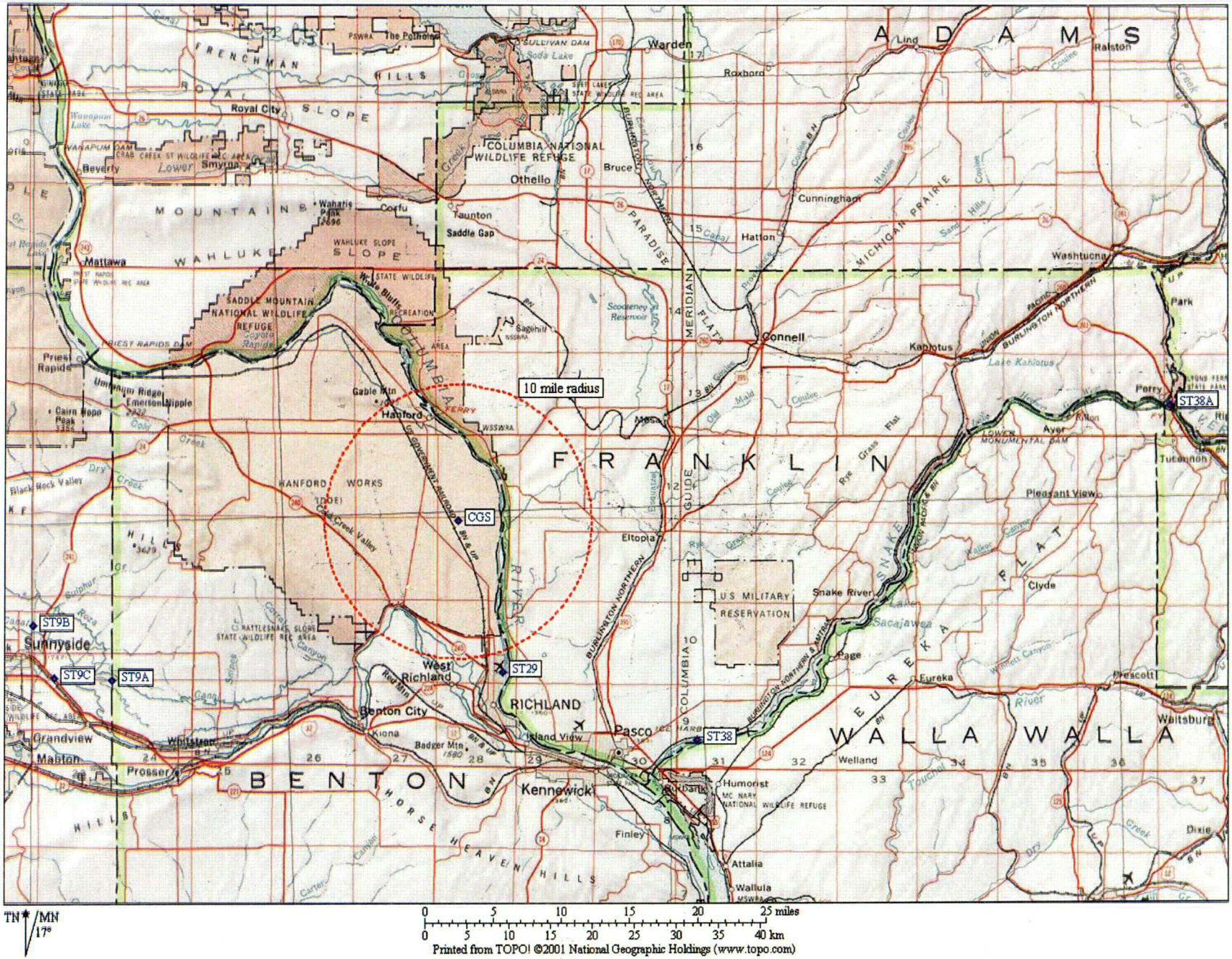


FIGURE 4-2 REMP SAMPLING LOCATIONS OUTSIDE THE 10-MILE RADIUS
(NOTE: Station 38A is the Lyons Ferry Hatchery)

C01

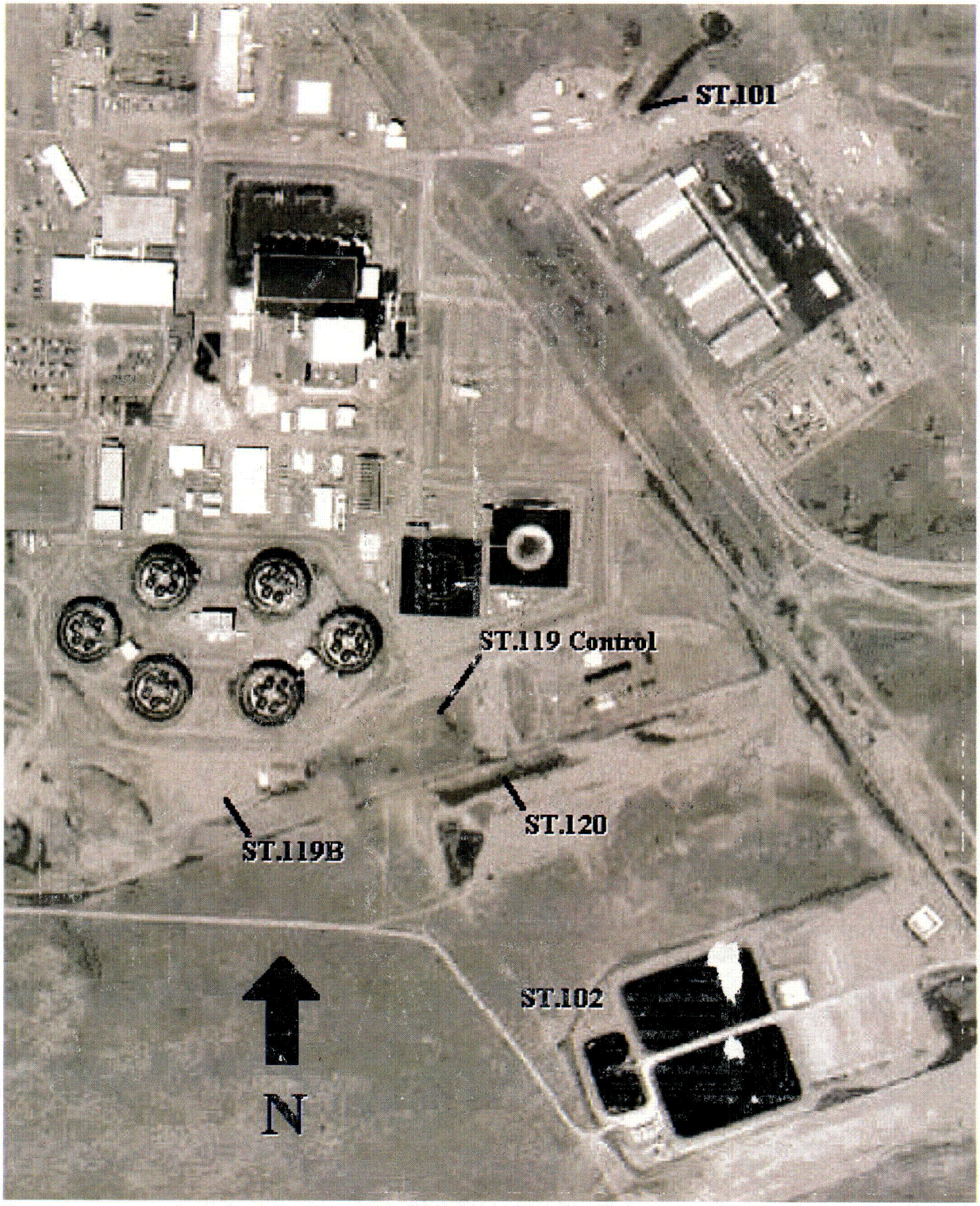


FIGURE 4-3 REMP NEAR PLANT SAMPLING LOCATIONS

STATION 102A (APPROXIMATELY 0.25 MI SOUTH). STATION 102 IN PICTURE IS BOTH 102B, 102D AND 102G.

C02

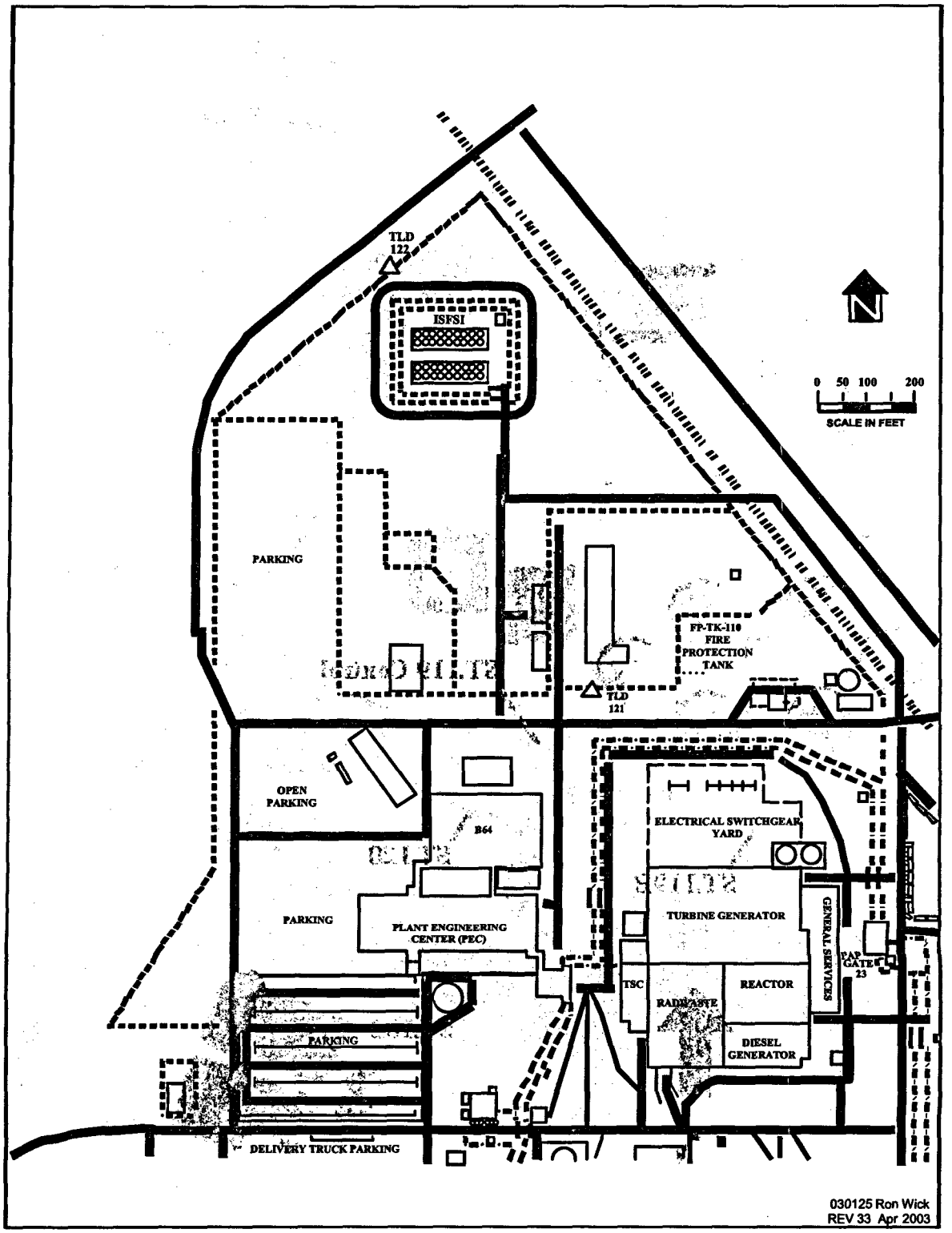


FIGURE 4-4 TLD STATIONS 121 AND 122

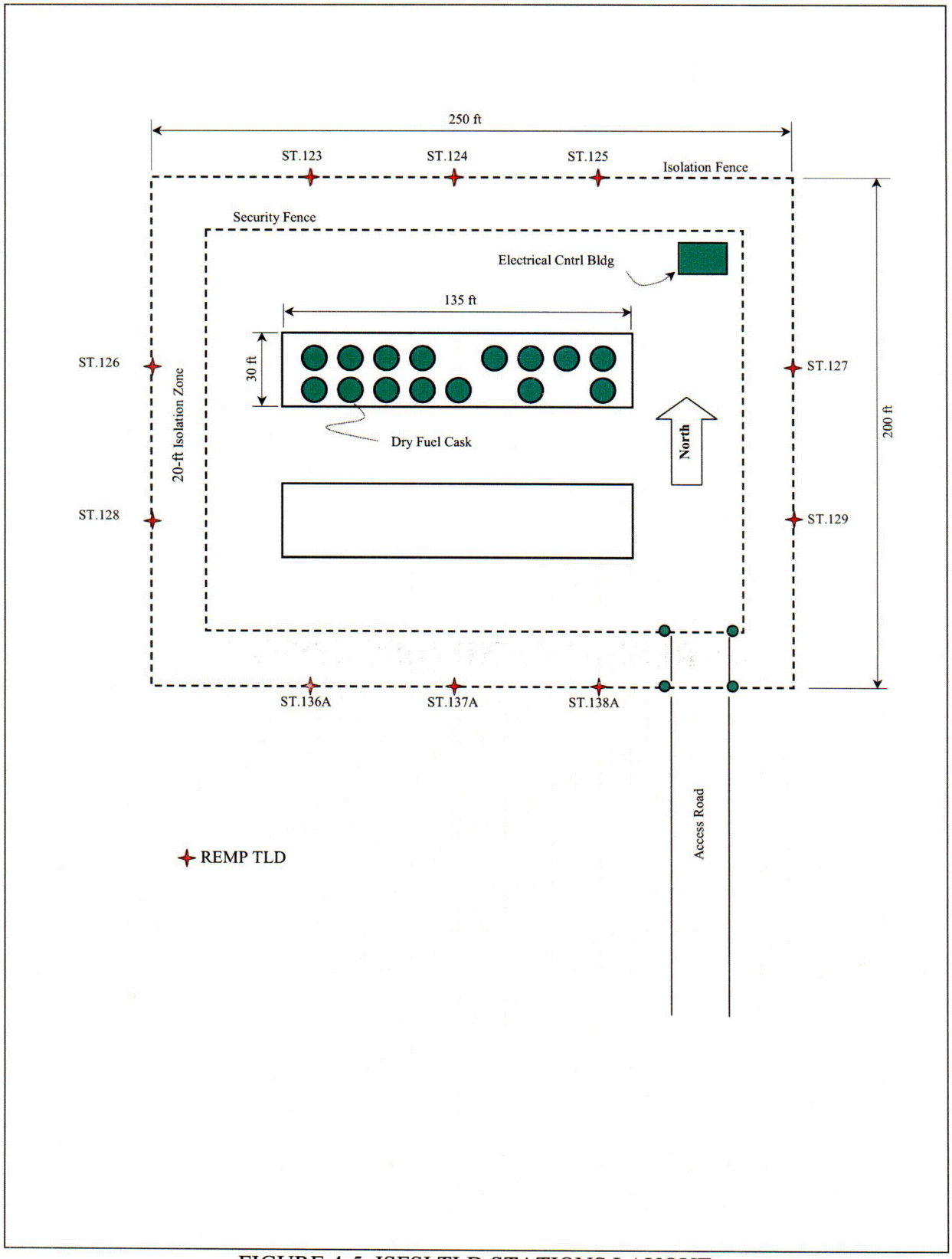


FIGURE 4-5 ISFSI TLD STATIONS LAYOUT

C03

5.0 RESULTS AND DISCUSSION

5.0 RESULTS AND DISCUSSION

For the first three quarters of 2005, REMP samples were analyzed by Teledyne Brown Engineering Environmental Services (TBE-ES) in Knoxville, Tennessee. For the latter portion of the third quarter and the fourth quarter of 2005, samples were analyzed in the Energy Northwest Environmental Services Laboratory using nearly identical methods to those employed by Teledyne to prevent any sudden shifts in the analysis results. The environmental TLDs were analyzed at the Pacific Northwest National Laboratory (PNNL). Table 5-2 provides a summary of the REMP results for 2005; the results for naturally occurring radionuclides that are not related to CGS operations have not been included in the summary table. The nominal lower limits of detection (LLDs) listed in Table 5-2 are the ODCM or EFSEC required detection limits and are not the method detection limits. The data tables of the 2005 results which include the measured naturally occurring radioisotopes comprise a separate volume that is available to interested parties upon request.

The analytical data for the preoperational period and the first six months of 1984 included "less than" (<) designations for results below the actual LLD, the contractual LLD, or the two-sigma error, depending upon the convention employed by the analytical contractor. Consequently, the data averages using "less than" values are biased high. Since mid-1984, REMP data have been reported as net results (i.e. the detector counting background is subtracted from the gross results).

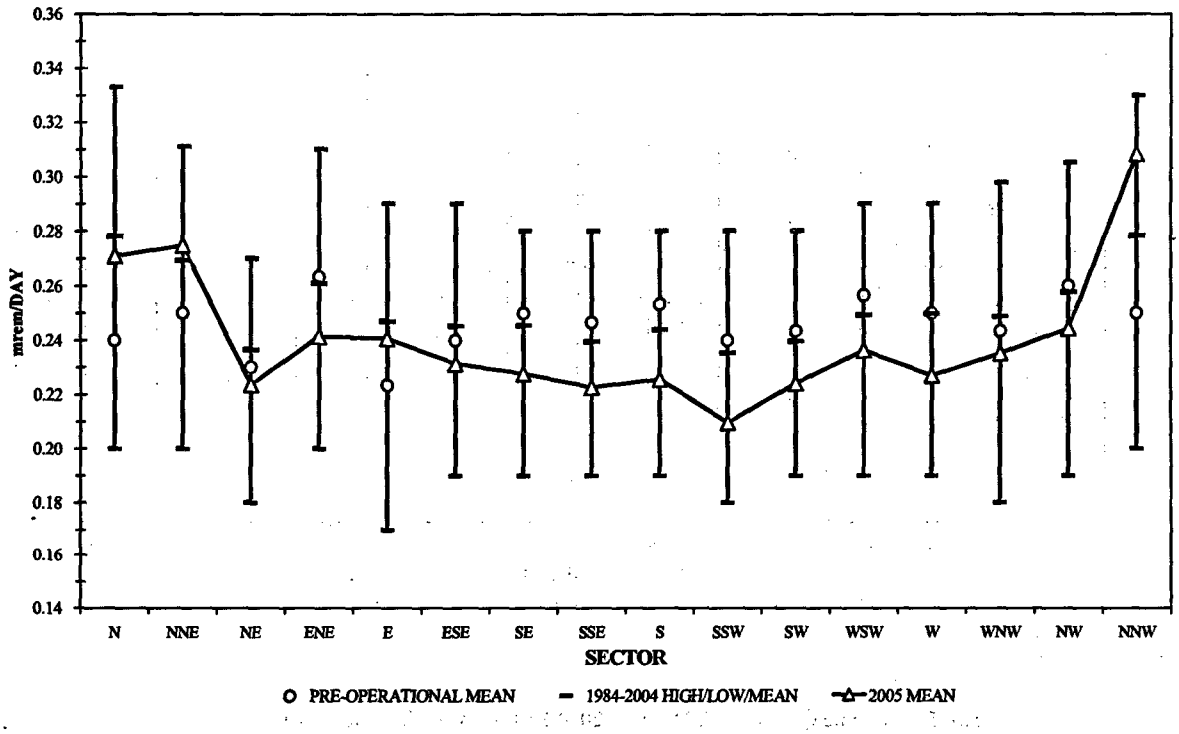
The analytical results for the REMP sampling locations during 2005 are very similar to the results reported for previous years. No significant trends indicating an environmental impact, or unexpected change in the environmental concentrations, or exposure levels at REMP monitoring stations were observed.

5.1 Direct Radiation

The environmental radiation exposure rates measured near the plant and at remote stations were consistent with the rates seen in previous years. The results for the NNW sector were above the long term average; this was also the case last year and is attributable to the ISFSI. No additional spent fuel storage casks were placed in the ISFSI during 2005 and a gradual decrease in the dose rates measured in the quarterly TLDs near the ISFSI was seen.

Figure 5-1 presents a plot of the 2005 mean quarterly TLD results for each of the sixteen meteorological sectors near the plant, the "S" stations are located at distances of 0.3-0.8 miles from the reactor and are all inside the property boundary. The chart also includes the high, low, and mean result in each sector for 1984 through 2004. The TLDs in the N, NNE, and NNW sectors show higher exposures rates than other "S" stations as a result of being physically closer to the plant and from the increases caused by the ISFSI.

Figure 5-1 Site Boundary Quarterly TLDs 1984-2004 Hi/Low/Mean vs. 2005 Mean by Sector



The 2005 TLD results are very similar to the results obtained during the previous operational periods in all sectors with the exception of NNW. The increase in the dose rate near the plant in the NNW sector (Station 86) is related to the ISFSI. Station 86 is inside the fence line; just outside of the fence line, at Station 17 in the same sector (see Figure 5-2), there was no increase in the dose rates relative to historical results.

Exposure rates from the inner circle of TLDs are presented in Figure 5-2. The exposure rates measured in the near plant TLDs, which are located at distances between 0.9 and 2.1 miles from the plant, are close to the preoperational mean in most sectors.

For the remote TLDs, Station 46 in the Wahluke Reserve (NE sector) remained the location with the highest exposure rate, as shown in Figure 5-3. Since the preoperational measurement phase, the results for this location have exceeded the results for all other locations except those located near the ISFSI. Variations in the soil and underlying rock composition most likely account for localized differences such as those shown in the TLD results for Station 46.

The environmental radiation exposure rates from 2005 and from the historical data are summarized in Tables 5-3 and 5-4. Presented in Table 5-5 is a comparison of the 2005 annual and summed quarterly TLD results.

Figure 5-2 Inner Circle Quarterly TLDs 1984-2004 Hi/Low/Mean vs. 2005 Mean by Sector

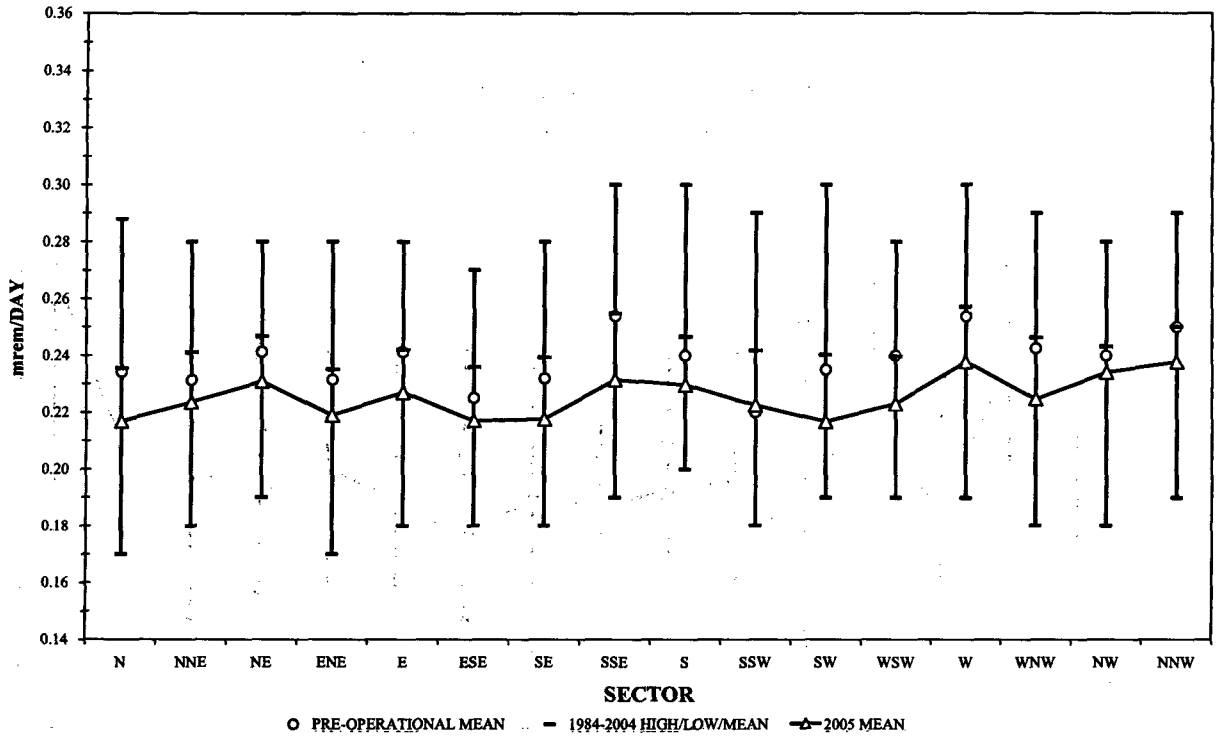
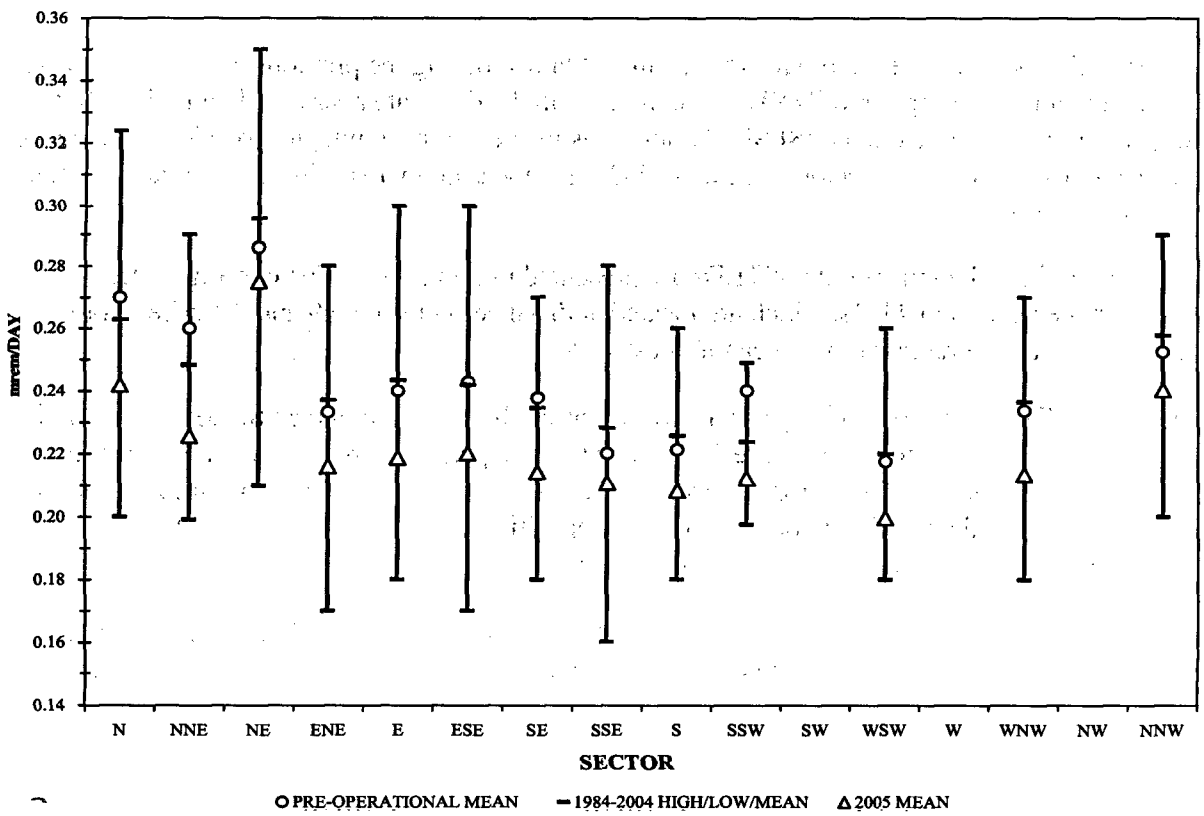


Figure 5-3 Remote Quarterly TLDs 1984-2004 Hi/Low/Mean vs. 2005 Mean By Sector



5.2 Airborne Particulate/Iodine

The 2005 mean weekly gross beta on particulate filter results for the inner ring indicator stations (within three miles) for CGS are plotted in Figure 5-4. The gross beta in air results for 2005 were within the ranges observed during the during previous operational periods. In Figures 5-4 and 5-5, the similarity between results from near-plant locations and those from remote locations can be seen. The control location (Station 9A) results follow a nearly identical pattern to the remote and near-plant locations. As observed previously, gross beta levels increased during periods of inversion occurring in the fall and winter months. Gross beta results plotted over a period of several years show a cyclical pattern of fall and winter increases.

A sharp increase was seen in the gross beta results for all of the air stations in weeks 50 and 51 as a result of an unusually strong temperature inversion. This increase was not caused by or related to any CGS activities or effluents. A smaller increase was also seen around week 9; this was likely also due to a temperature inversion and was seen at all stations including the control.

The quarterly gamma analyses of the particulate filter composites indicated only the presence of two naturally-occurring radionuclides, Be-7 and K-40, at levels above detection limits at indicator locations and the control location. All I-131 in air results for 2005 were below the LLD. There is no evidence of any measurable impact from plant operations on the environment in the air particulate filter and charcoal cartridge results for 2005.

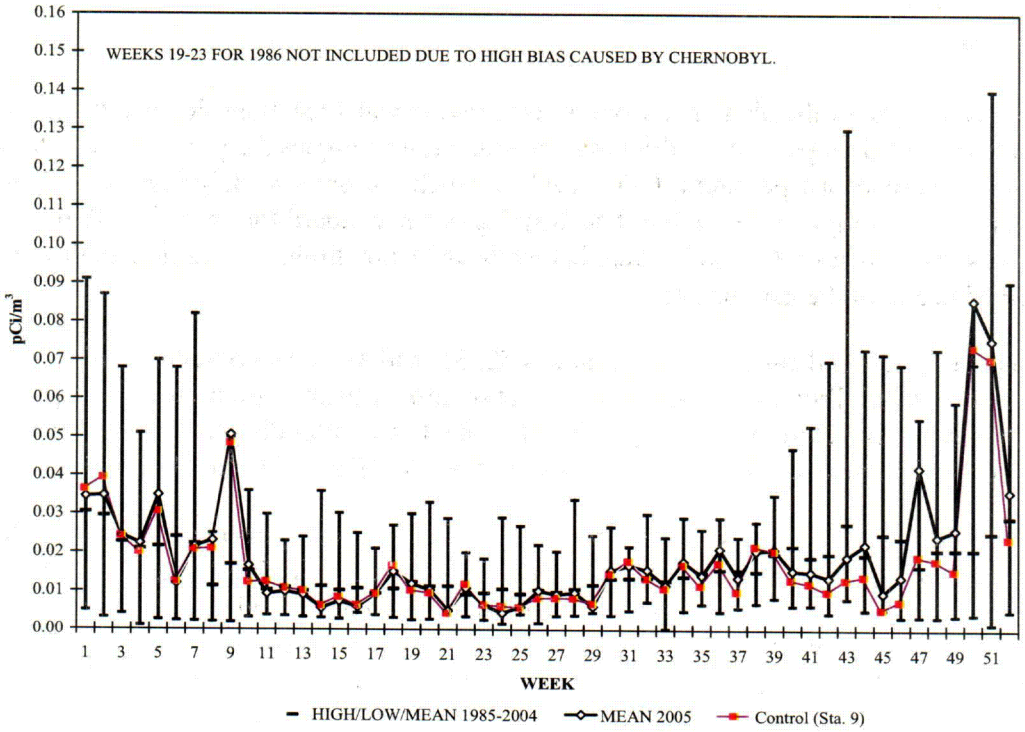


Figure 5-4 1985-2004 Weekly Hi/Low/Mean vs. 2005 Weekly Mean Gross Beta in Air - Near Plant Stations

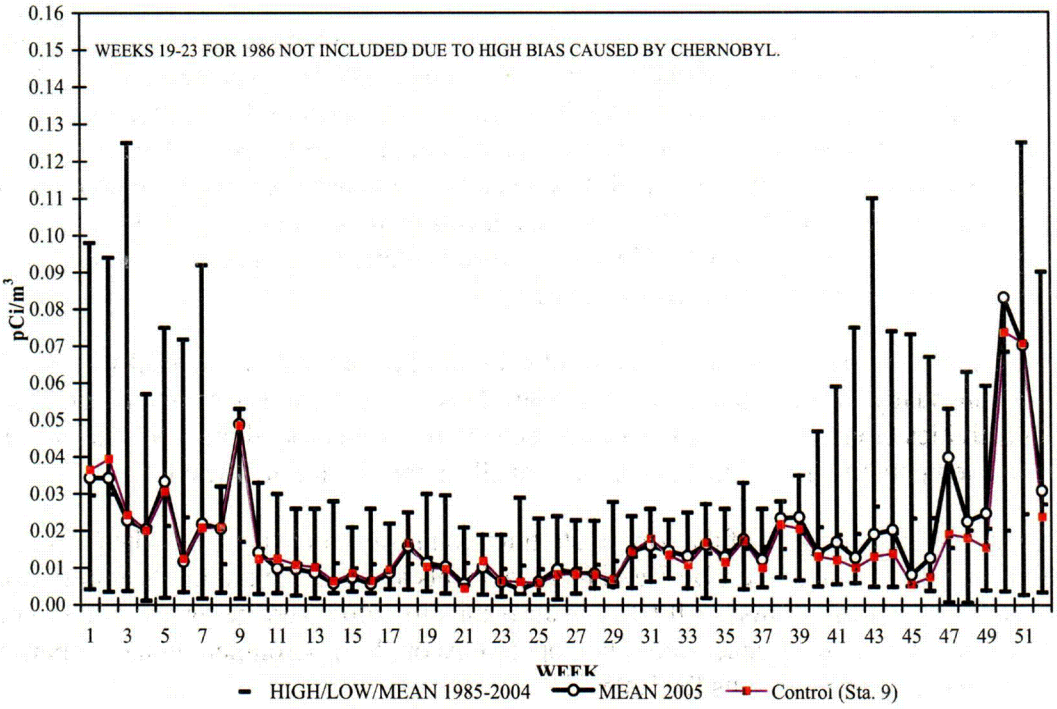


Figure 5-5 1985-2004 Weekly Hi/Low/Mean vs. 2005 Weekly Mean Gross Beta in Air - Remote Stations

5.3 Water

The gross beta results for the plant intake and river/drinking water (Stations 26, and 29) were within the normally observed ranges. In the drinking water and river samples the gross beta results were less than the eight picocurie per liter (pCi/L) level, at which a strontium analysis is required to be performed to verify compliance with the state drinking water standard for Sr-90.[11] Tritium levels in all samples from Stations 26, and 29 were below the detection limits. No radionuclides of interest were detected in any of the gamma assays.

The results of deep groundwater samples (Stations 52, 31, and 32) were consistent with the results seen in previous years; Tritium was below the detection limit. Shallow groundwater samples were not collected by Energy Northwest during 2005. The shallow aquifer directly below CGS is contaminated with high levels of Tritium as a result of past DOE activities on the Hanford Site[22].

The gross beta levels in the plant discharge water (Station 27) were typically a factor of 3-8 higher than the levels seen in the intake water (Station 26). This is the result of two causal factors; (1) the natural radioactivity in the water is concentrated through evaporation, and (2) the cooling towers scrub particulates from the air that contain naturally occurring radionuclides, and isotopes that are present from atmospheric weapons testing and past Hanford activities. The cooling water discharged from CGS is typically concentrated through 5 to 10 cycles. The discharge sample results are representative of the radioactivity present in plant discharges before any mixing with river water occurs. No radionuclides of interest were identified in any of the assays performed on the discharge water in 2005.

C05

5.4 Soil

The gamma assays performed on soil samples in 2005 indicated only a few naturally occurring radionuclides (Th-228, Ra-226, and K-40) and Cs-137 in some of the samples. Cs-137 was below the LLD at the background station (Station 9), but was measured in the samples from Stations 7, 21, and 23. When the Cs-137 at an indicator station exceeds ten (10) times the level in the control sample, Sr-90 analysis is required. Sr-90 analysis was performed for the samples from Stations 7, 21, and 23. The Sr-90 results were below the detection limits. Results from the gamma assays were consistent with those seen in previous years. The soil sample results did not indicate a measurable impact from CGS operations.

5.5 River Sediment

Gamma assays of river sediment showed several naturally occurring radionuclides (primarily Ac-228, K-40, Ra-226, and Th-228) and Cs-137. Cs-137 was detected in both the upstream (Station 33) and downstream (Station 34) samples (relative to the cooling tower discharge point) that were collected. The downstream concentrations were higher, but the levels are consistent with the values seen in the preoperational phase of the REMP and previous operational years. Cs-137 has been previously identified as a component of the Columbia River sediment originating from past weapons production activities at Hanford and operation of the now decommissioned Hanford reactors.[14]

5.6 Fish

The results of the gamma assays of fish samples collected in the near vicinity of CGS cooling water discharge and at the control location on the Snake River were below the detection limits for all radionuclides of interest; K-40, which is naturally occurring, was measured.

5.7 Milk

There were no detectable I-131 results in any of the milk samples collected in 2005. The gamma assay results of milk were less than the detection limits for all radionuclides of interest; K-40, which is naturally occurring, was measured.

Since August 1998, samples of feed grown by the owners of the dairy at Station 9 have been collected as a substitute for the control station. No dairy in the area of the control was located that did not use some feed grown downwind from the plant as supplemental feed. In June of 2005 a new control sample location was obtained that only uses feed grown in the control area; sampling of feed at the previous farm was discontinued and replaced with milk samples from the new location. No radionuclides of interest were detected in any of the control location feed or milk samples collected during 2005.

5.8 Garden Produce

The gamma assays of all of the root crops, fruit, and leafy vegetables collected in 2005 were below the detection limits for all radionuclides of interest; K-40, which is naturally occurring, was measured.

5.9 Special Interest Stations

The storm drain pond and the Sanitary Waste Treatment Facility (SWTF) were incorporated into the routine sampling schedule in 1992. In 1995, the cooling tower sediment disposal area was added. TLDs were placed around the spray pond drainfield (Station 120) in June 1995. TLDs were hung in the vicinity of the planned Independent Spent Fuel Storage Installation (ISFSI) during the first quarter of 1998 to collect background data and an additional ten TLDs were hung on the ISFSI fence after construction was completed in 2002. Discussions of the results from each of the locations are given in the following sections.

5.9.1 Storm Drain Pond (Station 101)

The storm drain pond is located approximately 1500 feet northeast of CGS. Water is sent to the pond through an 18-inch diameter pipe that discharges into a 300-foot long earthen channel that leads to a 100-foot diameter pond. The pond is a shallow, unlined percolation/evaporation basin.

Water at the storm drain outfall is sampled using a flow proportional automatic sampler to collect monthly composite samples. Samples were analyzed for tritium, gross beta, and gamma emitting radionuclides. Tritium was detected in just over half of the outfall water samples during 2005. The tritium concentrations were consistent with the levels that have been seen in previous years. In the sample from May, a higher than average gross beta result was measured. The concentration was reported at 38.3 pCi/L; this result was not supported by the gamma analysis results. All other beta measurements at Station 101 in 2005 were within the normal range. The September sample contained Co-60 at a concentration of 18.4 pCi/L. This value was within the range for Co-60 values measured previously, but Co-60 had not been seen at this station for several years. No other gamma emitting radionuclides of interest were measured at Station 101 in 2005.

5.9.2 Sanitary Waste Treatment Facility (Station 102)

The Sanitary Waste Treatment Facility (SWTF) is located approximately 0.5 miles south-southeast of CGS. The facility processes the sanitary wastewater from CGS, the WNP-1 and WNP-4 sites, the Kootenai Building, and the DOE 400 Area (since April 1997). Discharge standards and monitoring requirements for the SWTF are established in EFSEC Resolution No. 300[15].

The gross beta results in the monthly composite water samples of the 400 Area effluent were consistent with levels seen in previous years. The 400 Area effluent samples and SWTF headworks were also analyzed for gross alpha; all gross alpha results were below the detection limit. Due to contributions from the 400 Area effluent, tritium concentrations in SWTF samples were above the detection limit. The 400 Area draws part of its water from an unconfined aquifer that is contaminated with tritium as a result of effluents from the 200 Area on the Hanford Site.

All of the water samples collected at the SWTF received a gamma analysis; no radionuclides of interest were detected, but some naturally occurring radioisotopes were measured. The sediment sample collected from the north stabilization pond contained Cs-137 and Co-60 at concentrations that were within the ranges seen in previous years; several naturally occurring radionuclides were also measured. The Cs-137 levels were within the range of those seen in environmental soil and river sediment samples in the area.

5.9.3 Cooling Tower Sediment Disposal Area (Station 119)

EFSEC Resolution No. 299[16] authorized the onsite disposal of sediments from plant cooling systems containing very low levels of radionuclides. The disposal area for these sediments is located just south of the cooling towers. Resolution No. 299 requires the REMP to monitor the direct radiation dose using quarterly and annual TLDs in the vicinity of the disposal cells. Resolution 299 also requires the collection of a dry composite sediment sample from the disposal cell within thirty days following each cleaning to confirm that the disposal criteria outlined in the resolution have not been exceeded.

Cleaning of the cooling towers was done once in 2005. An estimated 85 cubic yards of sediment was placed in the disposal area in June. Using the estimated volume of 85 cubic yards and a density of 1.48 g/cm^3, along with the associated activities (the LLDs were used as the activity for all non-detected isotopes), the following quantities of radionuclides could have been placed in the disposal area in 2005:

Nuclide	Analytical Result (pCi/kg)	Limit (pCi/kg)	Total Curies
Co-60	<7.08E+01	5.0E+03	< 8.91E-06
Mn-54	<6.23E+01	3.0E+04	< 7.84E-06
Zn-65	<1.07E+02	5.0E+04	< 1.35E-05
Cs-134	<5.25E+01	1.0E+04	< 6.60E-06
Cs-137	2.51E+02	2.0E+04	3.16E-05

Of the above radionuclides, only the Cs-137 result was above the detection limit. The result for Cs-137 is similar to the concentrations found in many of the Columbia River sediment samples. Since the results for the other radionuclides were less than the lower limit of detection (LLD), the reported quantities disposed of in the table are conservative estimates.

Measurements of direct radiation at the disposal basin were taken using TLDs. Two locations were used, one next to the collection area (Station 119B) and the other approximately 100 yards to the east as the control (Station 119-Control). The mean quarterly and annual TLD results agree well with results from previous operational years. The difference between the indicator and the control TLD (Station 119-Control) indicate that there was no significant measurable dose above background.

5.9.4 Spray Pond Drain Field (Station 120)

There were no discharges to the Spray Pond Drain Field in 2005. The TLD results at Station 120 in 2005 are in agreement with those seen in previous operational years.

5.9.5 Independent Spent Fuel Storage Installation

The Independent Spent Fuel Storage Installation (ISFSI) is in an area immediately north of CGS. Station 121 is located approximately 0.1 mile north of the plant and is between the plant and the ISFSI. Station 122 is on the fence line approximately 0.3 mile north of the plant. Ten more TLD stations are located on the security fence surrounding the ISFSI. These stations are Stations 123-129 and Stations 136A-138A. These TLDs are located approximately 0.25 mile north of the plant.

No new spent fuel storage casks were added to the ISFSI in 2005. The dose rates in close proximity to the ISFSI are elevated, however, this is within the roped-off restricted area and personnel are not permitted to go near the installation without authorization. There is a barricade rope further out from the security fence; if individuals trespass into this roped off area without receiving prior permission, they will be moved away by security personnel.

5.10 2005 Sample Deviations

The majority of deviations for sampling were again connected with air sampling. Most of the air sampling deviations resulted from power outages, which were caused by maintenance work and blown fuses. A drastic decrease in the number of air sample deviations was seen in 2005. This is primarily attributable to more thorough preventive maintenance. A summary of the sample deviations from 2005 are listed in Table 5-1.

Table 5-1: Sample Deviations for 2005

SAMPLE MEDIA	DATE	LOCATION	PROBLEM
Air Particulate/Iodine	1/31/2005-2/7/2005	Stations 5 & 40	Power off 1 day at substation. Sample volume acceptable.
	2/7/2005-2/14/2005	Station 23	Unit failure due to loose wire. Sample volume unacceptable.
	2/14/2005-2/22/2005	Station 23	Unit failure. No sample sent in.
	5/23/2005	Station 1	Power turned off in support of refueling outage. Sample volume unacceptable.
	5/31/2005-6/8/2005	Station 1	Power turned off in support of refueling outage. Sample volume unacceptable.
	5/31/2005-6/6/2005	Station 21	Power turned off in support of refueling outage. Sample volume acceptable.
	6/27/2006	Station 57	Power off 1 day at substation. Sample volume acceptable.
	7/6/2005	Station 48	Power outage. Sample volume acceptable. Fish hatchery personnel turned off power.
	8/22/2005	Station 6	Blown fuse. Sample volume unacceptable.
	9/6/2005	Station 57	Blown fuse. Sample volume unacceptable.
	9/6/2005-9/12/2005	Station 21	Power off for three hours for scheduled maintenance. Sample acceptable.
Fish	4th Quarter 2005	Station 38	Unable to catch a carp on the Snake River to use as the control sample. Only 2 species of fish were available for collection.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: Environmental Direct Radiation (TLD) **Units: mrem/period**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
TLD Quarterly	228	—	20.69 (224 / 224) (16.6-29.91)	86 NNW 0.3 miles	28.06 (4/4) (26.84-29.91)	18.06 (4/4) (17.28-19.61)	0
TLD Annual	57	—	78.99 (56 / 56) (70.13-107.48)	86 NNW 0.3 miles	107.48 (1/1)	70.13 (1/1)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: ISFSI Direct Radiation (TLD) **Units: mrem/period**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
TLD Quarterly	48	—	85.20 (48 / 48) (34.34-194.12)	124 N 0.28 miles	182.02 (4 / 4) (174.53-194.12)	— (0 / 0)	0
TLD Annual	12	—	335.98 (12 / 12) (144.07-700.28)	124 N 0.28 miles	700.28 (1 / 1)	— (0 / 0)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: ST 119 Direct Radiation (TLD) **Units: mrem/period**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
TLD Quarterly	8	—	21.52 (4 / 4) (19.78-22.64)	119 SSE 0.3 Miles	21.52 (4 / 4) (19.78-22.64)	21.21 (4 / 4) (19.94-22.97)	0
TLD Annual	2	—	78.94 (1 / 1)	119 SSE 0.3 Miles	78.94 (1 / 1)	82.42 (1 / 1)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: ST 120 Direct Radiation (TLD) **Units: mrem/period**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
TLD Quarterly	4	—	21.93 (4 / 4) (20.69-22.65)	120 SSE 0.3 Miles	21.93 (4 / 4) (20.69-22.65)	— (0 / 0)	0
TLD Annual	1	—	83.66 (1 / 1)	120 SSE 0.3 Miles	83.66 (1 / 1)	— (0 / 0)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: Air Particulate/Air Radioiodine **Units: pCi/m^3**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
Gross Beta	619	1.00E-02	0.0186 (566/566) (0.0019-0.1145)	St. 4 SSE 9.9 miles	0.02062 (52/52) (0.00441-0.0954)	0.0167 (52/52) (0.0044-0.0736)	0
I-131	619	7.00E-02	— (0 / 567)	—	—	— (0 / 52)	0
Cs-134	48	5.00E-02	— (0 / 44)	—	—	— (0 / 4)	0
Cs-137	48	6.00E-02	— (0 / 44)	—	—	— (0 / 4)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: Water-River/Drinking **Units: pCi/L**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
Gross Beta	24	4.00E+00	1.48 (10 / 24)[b] (1.18-1.79)	29 SSE 11.6 miles	1.54 (5 / 12) (1.25-1.79)	1.74 (5 / 12) (1.18-1.74)	0
H-3	8	2.00E+03	— (0 / 8)[b]	—	—	— (0 / 4)	0
Mn-54	24	1.50E+01	— (0 / 24)[b]	—	—	— (0 / 12)	0
Fe-59	24	3.00E+01	— (0 / 24)[b]	—	—	— (0 / 12)	0
Co-58	24	1.50E+01	— (0 / 24)[b]	—	—	— (0 / 12)	0
Co-60	24	1.50E+01	— (0 / 24)[b]	—	—	— (0 / 12)	0
Zn-65	24	3.00E+01	— (0 / 24)[b]	—	—	— (0 / 12)	0
Zr-95	24	1.50E+01	— (0 / 24)[b]	—	—	— (0 / 12)	0
Nb-95	24	1.50E+01	— (0 / 24)[b]	—	—	— (0 / 12)	0
Cs-134	24	1.50E+01	— (0 / 24)[b]	—	—	— (0 / 12)	0
Cs-137	24	1.80E+01	— (0 / 24)[b]	—	—	— (0 / 12)	0
Ba/La-140	24	1.50E+01	— (0 / 24)[b]	—	—	— (0 / 12)	0
Sr-90	0	1.00E+00	— (0 / 0)[b]	—	—	— (0 / 0)	0

a. (f) is the number of positive measurements / total measurements at specified location.

b. This includes the control sample for this group; the control (Station 26) is also a drinking water sample.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: Water-Discharge **Units: pCi/L**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
Gross Beta	24	4.00E+00	12.30 (10 / 12) (5.09-22.5)	27 E 3.2 miles	12.30 (10 / 12) (5.09-22.5)	1.425 (5 / 12) (1.17-1.74)	0
H-3	8	2.00E+03	— (0 / 4)	—	—	— (0 / 4)	0
Mn-54	24	1.50E+01	— (0 / 12)	—	—	— (0 / 12)	0
Fe-59	24	3.00E+01	— (0 / 12)	—	—	— (0 / 12)	0
Co-58	24	1.50E+01	— (0 / 12)	—	—	— (0 / 12)	0
Co-60	24	1.50E+01	— (0 / 12)	—	—	— (0 / 12)	0
Zn-65	24	3.00E+01	— (0 / 12)	—	—	— (0 / 12)	0
Zr-95	24	1.50E+01	— (0 / 12)	—	—	— (0 / 12)	0
Nb-95	24	1.50E+01	— (0 / 12)	—	—	— (0 / 12)	0
Cs-134	24	1.50E+01	— (0 / 12)	—	—	— (0 / 12)	0
Cs-137	24	1.80E+01	— (0 / 12)	—	—	— (0 / 12)	0
Ba/La-140	24	1.50E+01	— (0 / 12)	—	—	— (0 / 12)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: Water- Deep Ground **Units: pCi/L**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
H-3	12	2.00E+03	— (0 / 12)	—	—	— (0 / 0)	0
Mn-54	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Fe-59	12	3.00E+01	— (0 / 12)	—	—	— (0 / 0)	0
Co-58	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Co-60	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Zn-65	12	3.00E+01	— (0 / 12)	—	—	— (0 / 0)	0
Zr-95	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Nb-95	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Cs-134	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Cs-137	12	1.80E+01	— (0 / 12)	—	—	— (0 / 0)	0
Ba/La-140	12	—	— (0 / 12)	—	—	— (0 / 0)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: Water-SWTF (102B) **Units: pCi/L**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
Gross Alpha	12	—	(0 / 12)	—	—	— (0 / 0)	0
Gross Beta	12	4.00E+00	27.70 (12 / 12) (13.76-36.25)	102B SSE 0.5 miles	27.70 (12 / 12) (13.76-36.25)	— (0 / 0)	0
H-3	12	2.00E+03	813.9 (12 / 12) (239-1123)	102B SSE 0.5 miles	813.9 (12 / 12) (239-1123)	— (0 / 0)	0
Mn-54	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Fe-59	12	3.00E+01	— (0 / 12)	—	—	— (0 / 0)	0
Co-58	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Co-60	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Zn-65	12	3.00E+01	— (0 / 12)	—	—	— (0 / 0)	0
Zr-95	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Nb-95	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Cs-134	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Cs-137	12	1.80E+01	— (0 / 12)	—	—	— (0 / 0)	0
Ba/La-140	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: Water-FFTF Sewage (102A) **Units: pCi/L**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
Gross Alpha	12	—	(0 / 12)	—	—	— (0 / 0)	0
Gross Beta	12	4.00E+00	26.40 (12 / 12) (18.20-37.08)	102A SSE 0.7 miles	26.40 (12 / 12) (18.20-37.08)	— (0 / 0)	0
H-3	12	2.00E+03	2843 (12 / 12) (2325-3230)	102A SSE 0.7 miles	2843 (12 / 12) (2325-3230)	— (0 / 0)	0
Mn-54	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Fe-59	12	3.00E+01	— (0 / 12)	—	—	— (0 / 0)	0
Co-58	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Co-60	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Zn-65	12	3.00E+01	— (0 / 12)	—	—	— (0 / 0)	0
Zr-95	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Nb-95	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Cs-134	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Cs-137	12	1.80E+01	— (0 / 12)	—	—	— (0 / 0)	0
Ba/La-140	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: Stormwater Outfall (101) **Units: pCi/L**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
Gross Beta	12	4.00E+00	8.87 (8 / 12) (1.32-38.30)	101 ENE 0.2 miles	8.87 (8 / 12) (1.32-38.30)	— (0 / 0)	0
H-3	12	2.00E+03	3478 (7 / 12) (353-17100)	101 ENE 0.2 miles	3478 (7 / 12) (353-17100)	— (0 / 0)	0
Mn-54	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Fe-59	12	3.00E+01	— (0 / 12)	—	—	— (0 / 0)	0
Co-58	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Co-60	12	1.50E+01	18.4 (1 / 12)	101 ENE 0.2 miles	18.4 (1 / 12)	— (0 / 0)	0
Zn-65	12	3.00E+01	— (0 / 12)	—	—	— (0 / 0)	0
Zr-95	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Nb-95	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Cs-134	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0
Cs-137	12	1.80E+01	— (0 / 12)	—	—	— (0 / 0)	0
Ba/La-140	12	1.50E+01	— (0 / 12)	—	—	— (0 / 0)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: River Sediment **Units: pCi/kg**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
Cs-134	4	1.50E+02	— (0 / 2)	—	—	— (0 / 2)	0
Cs-137	4	1.80E+02	134.65 (2 / 2) (70.3-199)	34	134.65 (2 / 2) (70.3-199)	135.2 (2 / 2) (112.4-158)	0
Co-60	4	1.00E+02	— (0 / 2)	—	—	— (0 / 2)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: Soil **Units: pCi/kg**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
Cs-134	5	1.50E+02	— (0 / 4)	—	—	— (0 / 1)	0
Cs-137	5	1.80E+02	62.47 (3 / 4) (42.99-83.20)	23 ESE 3.0 Miles	83.20 (1 / 1)	— (0 / 1)	0
Sr-90	3	1.00E+01	— (0 / 3)	—	—	— (0 / 0)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**
Benton County, Washington **Calendar Year 2005**

Medium: Cooling Tower Sediment **Units: pCi/kg**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
Co-60	1	—	— (0 / 1)	—	—	— (0 / 0)	0
Mn-54	1	—	— (0 / 1)	—	—	— (0 / 0)	0
Zn-65	1	—	— (0 / 1)	—	—	— (0 / 0)	0
Cs-134	1	1.50E+02	— (0 / 1)	—	—	— (0 / 0)	0
Cs-137	1	1.80E+02	251 (1/1)	119 SSE 0.3 Miles	251 (1/1)	— (0 / 0)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**
Benton County, Washington **Calendar Year 2005**

Medium: Sanitary Waste Treatment Facility Sediment **Units: pCi/kg**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
Co-60	1	—	144 (1 / 1)	102D SSE 0.5 miles	144 (1 / 1)	— (0 / 0)	0
Mn-54	1	—	— (0 / 1)	—	—	— (0 / 0)	0
Zn-65	1	—	— (0 / 1)	—	—	— (0 / 0)	0
Cs-134	1	1.50E+02	— (0 / 1)	—	—	— (0 / 0)	0
Cs-137	1	1.80E+02	133 (1/1)	102D SSE 0.5 miles	133.0 (1/1)	— (0 / 0)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: Roots **Units: pCi/kg**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
I-131	8	6.00E+01	— (0 / 4)	—	—	— (0 / 4)	0
Cs-134	8	6.00E+01	— (0 / 4)	—	—	— (0 / 4)	0
Cs-137	8	8.00E+01	— (0 / 4)	—	—	— (0 / 4)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: Fruits **Units: pCi/kg**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
I-131	9	6.00E+01	— (0 / 5)	—	—	— (0 / 4)	0
Cs-134	9	6.00E+01	— (0 / 5)	—	—	— (0 / 4)	0
Cs-137	9	8.00E+01	— (0 / 5)	—	—	— (0 / 4)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: Vegetables **Units: pCi/kg**

Analysis Type	Total Analyses Performed	ODCM Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
I-131	12	6.00E+01	— (0 / 6)	—	—	— (0 / 6)	0
Cs-134	12	6.00E+01	— (0 / 6)	—	—	— (0 / 6)	0
Cs-137	12	8.00E+01	— (0 / 6)	—	—	— (0 / 6)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: Fish **Units: pCi/kg**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
Mn-54	5	1.30E+02	— (0 / 3)	—	—	— (0 / 2)	0
Fe-59	5	2.60E+02	— (0 / 3)	—	—	— (0 / 2)	0
Co-58	5	1.30E+02	— (0 / 3)	—	—	— (0 / 2)	0
Co-60	5	1.30E+02	— (0 / 3)	—	—	— (0 / 2)	0
Zn-65	5	2.60E+02	— (0 / 3)	—	—	— (0 / 2)	0
Cs-134	5	1.30E+02	— (0 / 3)	—	—	— (0 / 2)	0
Cs-137	5	1.50E+02	— (0 / 3)	—	—	— (0 / 2)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: Milk **Units: pCi/L**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
I-131	36	1.00E+00	— (0 / 18)	—	—	— (0 / 18)	0
Cs-134	36	1.50E+01	— (0 / 18)	—	—	— (0 / 18)	0
Cs-137	36	1.80E+01	— (0 / 18)	—	—	— (0 / 18)	0
Ba/La-140	36	1.50E+01	— (0 / 18)	—	—	— (0 / 18)	0

a. (f) is the number of positive measurements / total measurements at specified location.

TABLE 5-2

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

COLUMBIA GENERATING STATION **DOCKET NO. 50-397**

Benton County, Washington **Calendar Year 2005**

Medium: Broadleaf in Lieu of Milk **Units: pCi/kg**

Analysis Type	Total Analyses Performed	Nominal Lower Limit of Detection (LLD)	Indicator Locations Mean (f)[a] Range	Location With Highest Annual Mean		Control Locations Mean (f)[a] Range	Number of Nonroutine Measurements
				Location Information	Mean (f)[a] Range		
I-131	10	6.00E+01	— (0 / 0)[b]	—	—	— (0 / 10)	0
Cs-134	10	6.00E+01	— (0 / 0)[b]	—	—	— (0 / 10)	0
Cs-137	10	8.00E+01	— (0 / 0)[b]	—	—	— (0 / 10)	0
Ba/La-140	10	6.00E+01	— (0 / 0)[b]	—	—	— (0 / 10)	0

a. (f) is the number of positive measurements / total measurements at specified location.
b. Collected at control location only.

TABLE 5-3
QUARTERLY TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS
Results in mrem/Standard Quarter

	PREOPERATIONAL[a]			1984 – 2004 OPERATIONAL			2005 OPERATIONAL		
STATION	LOW	HIGH	MEAN	LOW	HIGH	MEAN	LOW	HIGH	MEAN
1	19.16	23.73	21.90	18.25	27.38	22.54	19.80	21.72	20.99
2	17.34	22.81	21.08	16.43	25.55	21.99	18.98	22.72	20.44
3	18.25	21.90	20.44	16.43	24.64	21.35	18.62	20.71	19.25
4	15.51	23.73	19.98	14.60	22.81	19.89	16.61	19.07	18.25
5	18.25	22.81	20.81	16.43	23.73	20.44	17.61	20.62	18.62
6	18.25	21.90	20.17	16.43	23.73	20.62	17.98	20.17	18.62
7	19.16	22.81	21.35	16.43	24.64	21.63	18.62	20.81	19.44
8	21.90	25.55	23.82	15.51	27.38	23.73	20.90	22.72	21.63
9	15.51	21.90	19.89	16.43	23.73	20.08	17.34	19.71	18.07
10	19.16	22.81	20.99	16.43	24.64	21.35	18.52	21.17	19.53
11	19.16	22.81	21.44	16.43	24.64	21.81	19.98	21.72	20.44
12	20.99	24.64	23.09	18.25	26.46	23.54	20.90	22.63	21.90
13	19.16	22.81	21.44	17.34	27.38	21.90	18.98	21.35	19.80
14	19.16	24.64	21.90	17.34	25.55	21.90	19.71	21.72	20.35
15	20.99	25.55	23.18	17.34	27.38	23.45	20.99	23.00	21.72
16	20.08	23.73	22.17	16.43	26.46	22.45	19.71	21.63	20.53
17	19.16	23.73	22.81	17.34	26.46	22.81	20.90	23.27	21.72
18	20.08	23.73	22.17	16.43	25.55	22.36	19.89	21.26	20.71
19	20.08	23.73	21.99	17.34	25.55	22.54	20.44	22.08	21.08
20	19.16	23.73	21.44	17.34	25.55	22.17	20.08	22.45	20.81
21	19.16	21.90	20.71	15.51	23.73	20.71	18.43	20.35	19.16
22	19.16	23.73	21.99	16.43	25.55	22.08	20.08	21.90	20.71
23	20.08	23.73	21.63	17.34	25.55	21.63	18.62	21.26	19.44
24	20.99	23.73	21.90	17.34	50.46	22.72	19.07	21.35	20.44
25	20.99	24.64	23.18	17.34	27.38	23.27	20.62	22.17	21.08
40	17.34	21.90	19.98	15.51	24.64	20.62	17.61	20.17	18.89
41	20.08	25.55	23.73	17.34	27.38	23.00	19.71	22.17	20.71
42	20.08	23.73	22.36	17.34	26.46	22.54	19.16	22.36	20.35
43	20.99	24.64	23.09	16.43	27.38	23.09	19.44	22.63	20.35
44	19.16	22.81	21.08	15.51	24.64	21.35	17.43	20.26	19.07
45	19.16	22.81	21.26	16.43	25.55	21.72	18.98	21.08	19.62
46	22.81	28.29	26.10	19.16	31.94	27.01	24.00	25.92	25.09
47	17.34	20.99	19.89	15.51	26.28	20.62	17.79	20.35	18.80
49	-	-	21.90	16.43	25.55	22.17	20.44	23.27	21.35
50	-	-	20.08	16.43	26.46	22.08	18.80	21.72	20.26
51	19.16	21.90	20.53	16.43	24.64	21.54	18.62	21.54	19.80
53	-	-	24.64	18.25	29.57	24.00	21.08	23.54	22.08
54	-	-	23.73	18.16	26.46	22.63	19.35	22.17	20.62
55	-	-	20.99	16.43	25.55	21.72	18.62	21.81	20.26
56	-	-	21.90	16.43	25.55	22.27	19.07	21.63	20.26

TABLE 5-3 (cont)
QUARTERLY TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS
Results in mrem/Standard Quarter

	PREOPERATIONAL[a]			1984 - 2004 OPERATIONAL			2005 OPERATIONAL		
STATION	LOW	HIGH	MEAN	LOW	HIGH	MEAN	LOW	HIGH	MEAN
65	-	-	(b)	18.07	22.72	20.44	18.16	20.53	19.35
71(1S)	20.08	22.81	21.90	18.25	30.39	25.37	22.90	26.74	24.73
72(2S)	21.90	23.73	22.81	18.25	28.38	24.55	21.72	29.66	25.09
73(3S)	20.08	21.90	20.99	16.43	24.64	21.54	19.25	22.72	20.44
74(4S)	23.73	24.64	24.00	18.25	28.29	23.82	21.26	23.82	21.99
75(5S)	19.16	21.90	20.35	15.51	26.46	22.54	20.53	23.18	21.99
76(6S)	20.99	22.81	21.90	17.34	26.46	22.36	20.35	23.45	21.08
77(7S)	21.90	23.73	22.81	17.34	25.55	22.36	19.98	22.08	20.81
78(8S)	21.90	23.73	22.54	17.34	25.55	21.90	18.62	21.54	20.35
79(9S)	22.81	23.73	23.09	17.34	25.55	22.27	19.35	21.99	20.62
80(10S)	20.99	22.81	21.90	16.43	25.55	21.44	18.07	20.81	19.16
81(11S)	20.08	23.73	22.17	17.34	25.55	21.90	19.25	21.81	20.44
82(12S)	21.90	24.64	23.45	17.34	26.46	22.72	20.62	22.72	21.54
83(13S)	21.90	23.73	22.81	17.34	26.46	22.81	19.35	22.90	20.71
84(14S)	20.99	22.81	22.17	16.43	27.19	22.72	20.53	23.00	21.44
85(15S)	21.90	24.64	23.73	17.34	27.83	23.54	20.71	25.37	22.27
86(16S)	21.90	23.73	22.81	18.25	30.11	25.37	26.92	30.02	28.11
119B	-	-	(c)	19.35	25.64	22.45	19.80	22.72	21.54
119Ctrl	-	-	(c)	19.53	26.55	22.08	19.98	23.00	21.26
120	-	-	(c)	19.80	31.12	22.72	20.71	22.72	21.99
121 (ISFSI)	-	-	(d)	20.81	110.78	73.00	53.20	99.10	78.66
122 (ISFSI)	-	-	(d)	19.62	39.24	24.55	34.40	38.05	35.77
123 (ISFSI)	-	-	(e)	25.00	159.23	73.18	133.77	153.48	141.62
124 (ISFSI)	-	-	(e)	26.92	201.02	91.89	175.02	194.64	182.50
125 (ISFSI)	-	-	(e)	26.46	131.77	69.35	114.88	130.58	122.37
126 (ISFSI)	-	-	(e)	26.01	79.94	50.46	68.07	80.21	72.27
127 (ISFSI)	-	-	(e)	29.02	64.51	44.90	56.21	65.24	59.59
128 (ISFSI)	-	-	(e)	25.64	84.13	46.63	73.27	86.69	78.02
129 (ISFSI)	-	-	(e)	30.11	69.26	44.80	60.59	69.90	63.42
136A (ISFSI)	-	-	(e)	29.02	65.24	41.34	57.94	66.80	60.68
137A (ISFSI)	-	-	(e)	29.47	73.18	43.80	63.33	75.37	67.71
138A (ISFSI)	-	-	(e)	28.29	82.40	44.17	58.22	70.26	62.60

(a) The preoperational mean is from 1982-1983 data.
(b) Station 65 was added in 1997.
(c) Stations 119B, 119Ctrl, and 120 were added in 1995.
(d) Stations 121 and 122 were added in 1998 for the ISFSI.
(e) Stations 123-129 and 136A-138A were added in the 2nd quarter of 2002.

TABLE 5-4
ANNUAL TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS

Results in mrem/year

	PREOPERATIONAL[a]			1984 - 2004 OPERATIONAL			2005 OPERATIONAL
STATION	LOW	HIGH	MEAN	LOW	HIGH	MEAN	RESULT
1	85.41	98.55	91.98	73.00	102.20	84.73	78.26
2	83.59	84.68	83.95	73.00	98.19	82.93	76.92
3	82.13	85.78	83.95	72.27	94.17	79.34	70.99
4	74.46	100.38	87.60	65.70	87.24	75.19	72.04
5	81.40	93.81	87.60	69.75	88.33	76.70	71.66
6	79.94	83.95	81.76	69.35	90.52	77.10	71.72
7	84.32	86.51	85.41	72.92	97.09	81.74	71.58
8	94.54	98.55	96.73	80.34	108.04	91.11	80.57
9	78.11	81.76	79.94	68.99	91.98	76.14	70.13
10	82.13	86.87	84.32	69.35	93.81	80.43	75.73
11	83.22	88.33	85.78	73.00	99.28	82.56	76.15
12	92.35	94.17	93.08	80.30	102.57	88.41	84.21
13	85.41	87.97	86.87	76.65	97.46	83.56	77.63
14	84.68	86.14	85.41	69.35	97.09	81.98	78.88
15	83.95	94.90	89.43	76.65	104.03	88.90	82.48
16	89.79	91.98	90.89	76.65	101.47	85.32	80.54
17	85.78	91.62	88.70	76.65	101.84	86.54	81.10
18	86.51	97.82	91.98	76.65	101.47	85.95	80.24
19	-	-	85.78[b]	76.65	104.03	85.28	78.80
20	85.41	90.16	87.60	76.58	101.84	84.58	80.27
21	79.57	84.32	82.13	69.35	91.25	77.38	72.80
22	84.68	87.97	86.51	75.37	97.09	83.20	74.98
23	83.59	87.24	85.41	73.00	94.90	81.08	72.65
24	85.41	87.97	86.51	74.28	100.01	83.67	75.85
25	90.52	95.27	93.08	76.65	104.03	88.37	85.15
40	-	-	76.65[b]	68.99	91.25	76.48	71.29
41	94.90	97.46	96.36	75.19	102.20	86.46	77.60
42	-	-	85.78[b]	75.92	104.03	84.38	77.00
43	-	-	88.33[b]	71.18	107.68	85.48	76.27
44	83.59	89.43	86.51	71.91	94.17	80.32	74.22
45	82.49	86.14	84.32	72.64	96.36	81.58	76.01
46	102.57	107.68	105.12	94.90	123.37	103.50	97.72
47	-	-	80.30[b]	69.35	95.27	78.81	73.45
49	-	-	(c)	76.65	100.74	83.40	78.44
50	-	-	(c)	73.00	100.01	82.38	75.38
51	-	-	(c)	73.00	97.46	81.03	77.08
53	-	-	(c)	77.75	104.03	90.98	83.69
54	-	-	(c)	77.16	100.38	86.07	78.08
55	-	-	(c)	73.00	96.36	81.10	75.17
56	-	-	(c)	71.18	101.47	84.43	79.23
65	-	-	(d)	72.77	86.51	76.75	72.58

TABLE 5-4 (cont.)
ANNUAL TLD DATA SUMMARY FOR THE PREOPERATIONAL AND OPERATIONAL PERIODS
Results in mrem/Year

	PREOPERATIONAL[a]			1984 - 2004 OPERATIONAL			2005 OPERATIONAL
STATION	LOW	HIGH	MEAN	LOW	HIGH	MEAN	RESULT
71 (1S)	-	-	87.97[b]	83.95	112.06	96.90	95.47
72 (2S)	-	-	91.62[b]	83.95	110.96	94.19	90.04
73 (3S)	-	-	83.59[b]	73.00	94.90	81.02	74.70
74 (4S)	-	-	89.06[b]	80.30	106.22	90.34	86.47
75(5S)	-	-	86.51[b]	73.00	100.74	84.93	80.85
76(6S)	-	-	88.33[b]	76.65	101.47	85.01	83.11
77 (7S)	-	-	89.79[b]	73.00	99.28	84.58	78.28
78 (8S)	-	-	89.79[b]	73.00	97.71	83.39	78.11
79 (9S)	-	-	91.98[b]	73.00	101.11	83.59	84.47
80 (10S)	-	-	85.41[b]	69.42	97.09	81.40	75.19
81 (11S)	-	-	82.86[b]	73.00	96.36	81.94	75.50
82 (12S)	-	-	89.79[b]	74.83	101.47	85.84	79.78
83 (13S)	-	-	91.25[b]	76.65	99.65	87.10	80.16
84 (14S)	-	-	83.95[b]	76.03	99.28	85.25	81.21
85 (15S)	-	-	91.98[b]	80.30	105.85	90.23	86.80
86 (16S)	-	-	87.97[b]	87.60	112.79	97.77	107.48
119B	-	-	(e)	75.92	107.68	84.13	78.94
119Ctrl	-	-	(e)	77.75	101.84	86.09	82.42
120	-	-	(e)	78.11	112.79	88.63	83.66
121 (ISFSI)	-	-	(f)	177.76	365.37	284.39	306.72
122 (ISFSI)	-	-	(f)	76.29	138.20	92.55	144.07
123 (ISFSI)	-	-	(g)	126.22	543.99	287.12	567.27
124 (ISFSI)	-	-	(g)	128.66	681.34	347.78	700.28
125 (ISFSI)	-	-	(g)	119.59	460.66	263.84	499.10
126 (ISFSI)	-	-	(g)	123.06	284.89	195.52	288.46
127 (ISFSI)	-	-	(g)	120.60	233.40	172.99	235.81
128 (ISFSI)	-	-	(g)	112.96	287.67	182.58	302.81
129 (ISFSI)	-	-	(g)	121.78	240.98	169.55	244.35
136A (ISFSI)	-	-	(g)	119.31	229.44	160.11	237.05
137A (ISFSI)	-	-	(g)	124.36	258.38	172.42	262.61
138A (ISFSI)	-	-	(g)	122.70	239.26	164.01	243.27

(a) The preoperational mean is from 1982 - 1983 data.
(b) There was only one annual exchange during the preoperational period.
(c) Stations 49-56 were first monitored during the Fourth Quarter of 1983.
(d) Station 65 was added in 1997.
(e) Stations 119B, 119Ctrl, and 120 were added in 1995.
(f) Station 121 and 122 were added in 1998 to gather baseline data for the ISFSI.
(g) Stations 123-129 and 136A-138A were added in the 2nd quarter of 2002

TABLE 5-5
2005 QUARTERLY VERSUS ANNUAL TLD DATA
Results in mrem/Year

STATION	QUARTERLY TOTAL[a]	ANNUAL RESULTS	RATIO[b]
1	83.58	78.26	1.068
2	81.37	76.92	1.058
3	76.76	70.99	1.081
4	72.67	72.04	1.009
5	74.25	71.66	1.036
6	74.40	71.72	1.037
7	77.69	71.58	1.085
8	86.25	80.57	1.071
9	72.22	70.13	1.030
10	77.93	75.73	1.029
11	81.52	76.15	1.071
12	87.48	84.21	1.039
13	78.90	77.63	1.016
14	81.16	78.88	1.029
15	86.57	82.48	1.050
16	81.79	80.54	1.015
17	86.53	81.10	1.067
18	82.80	80.24	1.032
19	84.02	78.80	1.066
20	82.90	80.27	1.033
21	76.52	72.80	1.051
22	82.63	74.98	1.102
23	77.62	72.65	1.068
24	81.66	75.85	1.077
25	84.25	85.15	0.989
40	75.26	71.29	1.056
41	82.77	77.60	1.067
42	81.28	77.00	1.056
43	81.29	76.27	1.066
44	76.18	74.22	1.026
45	78.23	76.01	1.029
46	100.14	97.72	1.025
47	75.09	73.45	1.022
49	85.21	78.44	1.086
50	80.98	75.38	1.074
51	78.99	77.08	1.025
53	88.07	83.69	1.052
54	82.15	78.08	1.052
55	80.75	75.17	1.074
56	80.74	79.23	1.019
65[c]	77.25	72.58	1.064
71 (1S)	98.67	95.47	1.033

TABLE 5-5 (cont.)
2005 QUARTERLY VERSUS ANNUAL TLD DATA
Results in mrem/Year

STATION	QUARTERLY TOTAL[a]	ANNUAL RESULTS	RATIO[b]
72 (2S)	100.09	90.04	1.112
73 (3S)	81.39	74.70	1.089
74 (4S)	87.90	86.47	1.017
75 (5S)	87.60	80.85	1.083
76 (6S)	84.22	83.11	1.013
77 (7S)	82.88	78.28	1.059
78 (8S)	81.05	78.11	1.038
79 (9S)	82.10	84.47	0.972
80 (10S)	76.30	75.19	1.015
81 (11S)	81.56	75.50	1.080
82 (12S)	86.02	79.78	1.078
83 (13S)	82.62	80.16	1.031
84 (14S)	85.64	81.21	1.054
85 (15S)	88.91	86.80	1.024
86 (16S)	112.24	107.48	1.044
119B[d]	86.06	78.94	1.090
119Ctrl[d]	84.83	82.42	1.029
120[d]	87.71	83.66	1.048
121 (ISFSI)[e]	313.71	306.72	1.023
122 (ISFSI)[e]	142.58	144.07	0.990
123 (ISFSI)[f]	564.96	567.27	0.996
124 (ISFSI)[f]	728.06	700.28	1.040
125 (ISFSI)[f]	487.97	499.10	0.978
126 (ISFSI)[f]	288.42	288.46	1.000
127 (ISFSI)[f]	237.76	235.81	1.008
128 (ISFSI)[f]	311.15	302.81	1.028
129 (ISFSI)[f]	253.04	244.35	1.036
136A (ISFSI)[f]	242.07	237.05	1.021
137A (ISFSI)[f]	270.12	262.61	1.029
138A (ISFSI)[f]	249.67	243.27	1.026

(a) Sum of the quarterly results.
(b) Quarterly result/Annual result.
(c) Station 65 added in 1997.
(d) Stations 119B, 119Ctrl, and 120 were added in 1995.
(e) Station 121 and 122 were added in 1998 to gather baseline data for the ISFSI.
(f) Stations 123-129 and 136A-138A were added in the 2nd quarter of 2002 for the ISFSI.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

The REMP is designed to meet the quality assurance and quality control criteria of the NRC Regulatory Guide 4.15[4]. To accomplish this, the REMP requires that its analytical contractors also meet these criteria. The Energy Northwest Quality group performs audits of the REMP records and activities and the records and activities of its support organizations at least annually.

Quality assurance and technical audits of the analytical contractor (Teledyne Brown Engineering) are also conducted periodically to verify their compliance to regulatory and contractual requirements. The adequacy of their quality assurance program is also assessed during the audits.

The following sections summarize the quality assurance and quality control aspects of the TLD, sample collection, and sample analysis components of the REMP.

6.1 Quality Control for the Energy Northwest Environmental TLD Program

The Quality Control program for the Energy Northwest REMP TLDs covers the preparation, transportation, deployment, collection, storage, processing, and evaluation.

From the time the TLDs are annealed to the time they are placed in the field, they are stored and transported with control TLDs. Two sets of control TLDs are used, the building controls and the transportation (trip) controls. The building controls monitor the exposure that the TLDs receive while being transported to and from the TLD vendor and while in storage awaiting deployment and analysis. The trip controls accompany the field TLD set while they are being transported to and from the vendor and also while they are being deployed and collected in the field. The building controls and trip controls are stored in a low background lead shield while the field TLDs are deployed. If the trip control results are greater than the building control results, the difference between the two is subtracted from the field dosimeters to account for exposure during transit.

Reader QC dosimeters are prepared by Battelle at the Pacific Northwest National Laboratory and serve as indicators that the reader calibration is satisfactory and that the TLDs were processed correctly. These TLDs are annealed and then given a known exposure (typically 100 mR) to a cesium-137 source. The number of QC dosimeters used during each processing is generally 10% of the number of field dosimeters. Evaluation of the 2005 reader QC dosimeter results indicated satisfactory agreement for all four quarters and the annual processing results.

Spiked TLDs are submitted by Energy Northwest for processing along with the environmental TLDs. The processing results from these QA TLDs are used to demonstrate reader performance during environmental TLD processing. Quarterly spikes receive a target exposure of 25 mR and annual spikes receive a target exposure of approximately 90 mR. The spiked dosimeters are processed with the field dosimeters to verify the accuracy and consistency of the environmental TLD evaluations. All results were within ±10% of the known exposure and are provided in Table 6-1.

6.2 Quality Control for the Environmental Sample Program

Quality control for the environmental sample program involves two components: the quality control activities performed for the sample collection aspects of the program and the quality control activities conducted to ensure accurate and reliable sample analyses. Both of these components are described in the following sections.

6.2.1 Quality Control Activities for Sample Collection

Duplicate samples are periodically collected and submitted to the sample analysis laboratories (Teledyne or Energy Northwest). The duplicate samples are in some cases blind, and in others they may be of a known origin. Duplicate samples are used primarily to assess the repeatability of the sample collection process, but may also be used to help assess the precision in the results produced by analytical laboratories.

Chain of custody forms are produced and kept with samples when they are transported or shipped to analytical laboratories to maintain sample control and traceability.

6.2.2 Teledyne Brown Engineering Quality Control Program

The goal of the quality control program at Teledyne Brown Engineering – Environmental Services is to produce analytical results that are accurate, precise and supported by adequate documentation. The program is based on the requirements of 10CFR50 Appendix B[10], Regulatory Guide 4.15[4] and the program as described in Teledyne's Quality Assurance Quality Control Manual.

All measuring equipment is calibrated for efficiency at least annually using standard reference material traceable to the National Institute of Standards and Technology (NIST). For alpha and beta counting, check sources are counted each weekday the counter is in use. Control charts are maintained with three-sigma limits specified. Backgrounds are usually measured at least once per week.[17] Gamma spectrometers are calibrated annually with a NIST-traceable standard reference material selected to cover the energy range of the nuclides to be monitored for all of the geometries measured. Backgrounds are determined every other week and check sources are counted weekly. The energy resolution and efficiency are plotted at two energy levels (59.5 and 1332 KeV) and held within three-sigma control limits.[18]

The efficiency of the liquid scintillation counters is determined at least annually by counting NIST traceable standards which have been diluted in a known amount of distilled water and various amounts of quenching agent.[19] The background of each counter is measured with each batch of samples. A control chart is maintained for the background and check source measurements as a stability check.

Results are reviewed before being entered into the data system by the Quality Assurance and/or the Department Manager for reasonableness of the parameters (background, efficiency, decay, etc.). Any sample results that are suspect, are returned to the laboratory for recount. If a longer count, decay check, recount on another system or recalculation does not give acceptable results based on experience, a new aliquot is analyzed.

6.2.3 Energy Northwest Environmental Services Quality Control

The Energy Northwest – Environmental Services Laboratory maintains a quality control program to ensure that analytical results are accurate, precise, and defensible. The program is based on the requirements of 10CFR50 Appendix B[10], Regulatory Guide 4.15,[4] and the Energy Northwest – Environmental Services Laboratory Quality Assurance Manual. A summary of the various key aspects to the Energy Northwest quality control program are provided below.

Laboratory Sample Preparations - Analytical balances used in the laboratory for sample preparations are calibrated every six months. Daily checks are performed prior to use on all analytical balances; these checks are documented on sample preparation forms and should span the range of intended use when checked. Devices used for volumetric measurements of samples are periodically verified for accuracy with reagent grade water; if they are found to be out of specifications they are removed from use.

Analytical Instruments – Analytical instruments used for determining radioactive emissions in samples are calibrated for efficiency at least annually using standard reference material traceable to the National Institute of Standards and Technology (NIST). Specific requirements for radiation measuring instrument QC are described below.

- Gas-flow proportional counters used for alpha and beta counting are checked for performance daily when in use. Control charts are maintained with two and three-sigma limits specified; the checks must fall within the two-sigma warning limits prior to use. End of batch performance checks are also performed. Background checks are performed daily when in use and must fall below the two-sigma upper limit prior to use. Background measurements are performed weekly.
- Gamma spectrometers are checked daily for efficiency, the energy per channel relationship, and for resolution. The checks are performed and plotted at two energy levels 59.5 and 1332 KeV. Efficiency checks are held within two-sigma control limits. The energy checks are plotted and are held within statistical control limits that are based on the known energy for the peak of interest. Resolution checks are plotted and are held within statistical limits. Background checks for gross contamination are performed daily. Backgrounds are determined every other week.
- Liquid scintillation counters are subjected to instrument performance assessment checks each day that they are in use. The performance checks verify the instrument efficiency for two nuclides and assess the background. The background is measured with each batch of samples with a sample blank. The efficiency of the instrument is also assessed with each batch of samples by measuring several known addition standards that are made from NIST traceable standard solutions. Control charts are maintained for the background and performance check measurements.

Results are reviewed by the radiochemistry lead and/or the laboratory lead for reasonableness, acceptability of performance checks and recovery on known-addition samples, and for data entry errors. Any sample results that are suspect, are returned to the laboratory for recount. If reanalyzed results are still suspect, a new aliquot is analyzed. The information about the sample is contained on the sample processing forms.

6.3 Sample Batch Quality Control

Sample batches are analyzed along with sample blanks and known-addition samples (or spiked samples) as appropriate, and as dictated by the sample type, primary analytes of interest, and method being used. The following is a summary of sample batch QC activities that were performed in 2005. Teledyne and Energy Northwest generally follow the same QC/QA protocols for analysis batches; differences will be specified in the following texts when they exist along with general descriptions of the QC activities performed for batches of samples.

Iodine-131 Cartridges - At least one blank charcoal cartridge was analyzed with each batch of samples assayed. All blanks were below the detection levels. Energy Northwest assayed at least one known-addition sample with each batch and also performed at least one replicate measurement (usually on the known-addition sample) inside of each batch. For the known-addition samples at Energy Northwest, the 356 keV peak from Ba-133 was evaluated. At least one replicate assay is performed inside each batch at Energy Northwest.

Gross Beta Filters - One or more blank filters were measured with each set of filters assayed. The blanks were below or slightly above the detection limit. Energy Northwest counted at least one unused blank AP filter and at least one known-addition AP filter (or spiked laboratory control sample) with each batch. At least one replicate measurement is performed inside each batch at Energy Northwest.

I-131 in Milk - Teledyne analyzed several blank milk samples during 2005. Energy Northwest analyzed milk samples collected from the control location as blanks. The Energy Northwest method for I-131 in milk is a gamma spectroscopy method, so the QC requirements are different. Energy Northwest analyzed a known-addition sample with each batch of I-131 in milk samples. At least one replicate assay is performed inside of each batch at Energy Northwest.

Gross Beta in Water - Blank samples were prepared from reagent grade water with each batch of samples and analyzed. Energy Northwest analyzed at least one known addition sample with each batch of gross alpha and gross beta samples. At least one replicate sample is prepared and analyzed inside of each batch at Energy Northwest.

Tritium in Water - Blank samples were analyzed with each batch. At Energy Northwest known addition samples were also measured with each batch. At least one replicate sample is prepared and analyzed inside of each batch at Energy Northwest.

Gamma Spectroscopy - Background counts were performed semimonthly for gamma spectrometers. All nuclides of interest were less than the level of detection indicating no contamination. Spiked samples were prepared and measured using Cs-137 with a peak at 662 keV at Teledyne, ad the Cs-137 results were within the ± 3 sigma limits. Energy Northwest measured known addition samples containing a mixtures of radionuclides, the results were within the acceptance limits for all analyses. At least one replicate assay is performed inside of each batch of samples at Energy Northwest.

6.4 Laboratory Intercomparison Program Participation

Participation in laboratory intercomparison studies is mandatory for all laboratories performing analyses of CGS REMP samples. Intercomparison studies provide a consistent and effective means to evaluate laboratory performance on sample analyses. Results from studies should fall within the control limits specified for the study or corrective actions are to be performed.

Teledyne participated in the following intercomparison programs in 2005:

- Analytics, Inc. Cross Check Program
- Environmental Resource Associates (ERA) RadCheM Proficiency Testing Program
- Department of Energy Mixed Analyte Performance Evaluation Program (MAPEP).

MAPEP distributed radiological performance test samples for gross alpha/beta measurements of water and air particulate filters beginning in the latter part of July 2005

The results for Teledyne in the intercomparison studies done in 2005 are shown in Tables 6-2 through 6-4.

Energy Northwest participated in the following intercomparison programs in 2005:

- Analytics, Inc. Cross Check Program
- Environmental Resource Associates (ERA) RadCheM Proficiency Testing Program

The results of Energy Northwest's participation in intercomparison studies done in 2005 are shown in Tables 6-5 through 6-6.

TABLE 6-1
2005 ENVIRONMENTAL SPIKED DOSIMETER RESULTS

DISTRIBUTION PERIOD	GIVEN EXPOSURE (mR)	REPORTED EXPOSURE (mR)	BIAS (%)
First Quarter	26	25.47	-2.04%
		24.74	-4.83%
		25.88	-0.47%
Second Quarter	26	25.97	-0.10%
		26.31	1.20%
		25.63	-1.42%
Third Quarter	22	21.27	-3.33%
		20.37	-7.42%
		21.53	-2.15%
Fourth Quarter	22	22.39	1.79%
		22.65	2.94%
		22.02	0.09%
Annual	88	84.21	-4.31%
		82.75	-5.97%
		80.91	-8.05%

TABLE 6-2
TELEDYNE BROWN ENGINEERING RESULTS
2005 ANALYTICS, INC. CROSS CHECK COMPARISON PROGRAM

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
March 2005	E4522-396	Milk	Sr-89	pCi/L	96.9	107	0.91	A
			Sr-90	pCi/L	16.9	17.9	0.94	A
	E4523-396	Milk	I-131	pCi/L	82.7	92.3	0.90	A
			Ce-141	pCi/L	217	229	0.95	A
			Cr-51	pCi/L	314	334	0.94	A
			Cs-134	pCi/L	123	139	0.89	A
			Cs-137	pCi/L	125	130	0.96	A
			Co-58	pCi/L	110	115	0.96	A
			Mn-54	pCi/L	158	160	0.99	A
			Fe-59	pCi/L	118	111	1.06	A
			Zn-65	pCi/L	191	198	0.96	A
			Co-60	pCi/L	140	144	0.97	A
	E4525-396	AP	Ce-141	pCi	150	172	0.87	A
			Cr-51	pCi	278	250	1.11	A
			Cs-134	pCi	105	104	1.01	A
			Cs-137	pCi	95.6	97.1	0.98	A
			Co-58	pCi	84.4	86.3	0.98	A
			Mn-54	pCi	112	120	0.93	A
			Fe-59	pCi	92.8	83.2	1.12	A
			Zn-65	pCi	162	148	1.09	A
			Co-60	pCi	102	108	0.94	A
	E4524-396	Charcoal	I-131	pCi	67.4	60.7	1.11	A
June 2005	E4630-396	Milk	Sr-89	pCi/L	89.4	88.1	1.01	A
			Sr-90	pCi/L	11.6	11.4	1.02	A
	E4631-396	Milk	I-131	pCi/L	82.3	86.9	0.95	A
			Ce-141	pCi/L	91.6	92.4	0.99	A
			Cr-51	pCi/L	278	303	0.92	A
			Cs-134	pCi/L	81.1	95.0	0.85	A
			Cs-137	pCi/L	180	189	0.95	A
			Mn-54	pCi/L	124	125	0.99	A
			Fe-59	pCi/L	61.1	63.9	0.96	A
			Zn-65	pCi/L	156	155	1.01	A
			Co-60	pCi/L	136	145	0.94	A
	E4633-396	AP	Ce-141	pCi	79.2	64.2	1.23	W
			Cr-51	pCi	263	210	1.25	W
			Cs-134	pCi	69.7	66.1	1.05	A
			Cs-137	pCi	135	131	1.03	A
			Mn-54	pCi	94.9	87.0	1.09	A
			Fe-59	pCi	48	44.4	1.09	A
			Zn-65	pCi	120	108	1.11	A
			Co-60	pCi	104	101	1.03	A
	E4632-396	Charcoal	I-131	pCi	88.9	92.5	0.96	A

TABLE 6-2 (cont.)
TELEDYNE BROWN ENGINEERING RESULTS
2005 ANALYTICS, INC. CROSS CHECK COMPARISON PROGRAM

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
September 2005	E4766-396	Milk	Sr-89	pCi/L	135.0	146.0	0.92	A
			Sr-90	pCi/L	9.7	11.5	0.84	A
	E4767-396	Milk	I-131	pCi/L	87.5	94.3	0.93	A
			Ce-141	pCi/L	203	233	0.87	A
			Cr-51	pCi/L	279	338	0.83	A
			Cs-134	pCi/L	102	122.0	0.84	A
			Cs-137	pCi/L	178	195	0.91	A
			Co-58	pCi/L	55.3	63.4	0.87	A
			Mn-54	pCi/L	81.8	92.0	0.89	A
			Fe-59	pCi/L	59.9	61.0	0.98	A
			Zn-65	pCi/L	120	123	0.98	A
			Co-60	pCi/L	146	167	0.87	A
	E4769-396	AP	Ce-141	pCi	193	169	1.14	A
			Cr-51	pCi	267	246	1.09	A
			Cs-134	pCi	78.4	88.8	0.88	A
			Cs-137	pCi	166	142	1.17	A
			Co-58	pCi	53.7	46.0	1.17	A
			Mn-54	pCi	81.6	66.8	1.22	W
			Fe-59	pCi	59.6	44.3	1.35	N (1)
			Zn-65	pCi	107	89.6	1.19	A
			Co-60	pCi	133	122	1.09	A
	E4768-396	Charcoal	I-131	pCi	63.9	64.2	1.00	A
December 2005	E4766-396	Milk	Sr-89	pCi/L	114	128	0.89	A
			Sr-90	pCi/L	11.6	10.3	1.13	A
	E4767-396	Milk	I-131	pCi/L	79.6	74.6	1.07	A
			Ce-141	pCi/L	202	224	0.90	A
			Cr-51	pCi/L	185	193	0.96	A
			Cs-134	pCi/L	74.9	87.3	0.86	A
			Cs-137	pCi/L	177	189	0.94	A
			Co-58	pCi/L	73.9	77.5	0.95	A
			Mn-54	pCi/L	152	152	1.00	A
			Fe-59	pCi/L	97.5	82.4	1.18	A
			Zn-65	pCi/L	161	154	1.05	A
			Co-60	pCi/L	102	111	0.92	A
	E4633-396	AP	Ce-141	pCi	221	201	1.10	A
			Cr-51	pCi	195	173	1.13	A
			Cs-134	pCi	68.4	78.3	0.87	A
			Cs-137	pCi	194	170	1.14	A
			Co-58	pCi	77.4	69.4	1.12	A
			Mn-54	pCi	171	137	1.25	W
			Fe-59	pCi	94.2	73.9	1.27	W
			Zn-65	pCi	173	138	1.25	W
			Co-60	pCi	109	99.1	1.10	A

TABLE 6-2 (cont.)
TELEDYNE BROWN ENGINEERING RESULTS
2005 ANALYTICS, INC. CROSS CHECK COMPARISON PROGRAM

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
December 2005	E4632-396	Charcoal	I-131	pCi	73.3	73.3	1.00	A

(1) New technician - AP not counted in petri dish resulted in high Fe-59 activity. Counting in petri dish, the Fe-59 would have been acceptable as evidenced by the 4Q05 AP recount data. NCR 06-01

(a) Teledyne Brown Engineering reported result.

(b) 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.

(c) Ratio of Teledyne Brown Engineering to Analytics results.

(d) 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.

TABLE 6-3
TELEDYNE BROWN ENGINEERING RESULTS
2005 MAPEP ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM

Month/Year	Identification Number	Media	Nuclide	Units	Reported Value (a)	Known Value (b)	Acceptance Range	Evaluation (c)
April 2005	05-MaW13	Water	Cs-134	Bq/L	108	127	88.90 - 165.10	A
			Cs-137	Bq/L	305	332	232.40 - 461.60	A
			Co-57	Bq/L	215	227	158.90 - 295.10	A
			Co-60	Bq/L	241	251	175.70 - 326.30	A
			H-3	Bq/L	283	280	196.00 - 364.00	A
			Mn-54	Bq/L	314	331	231.70 - 430.30	A
			Sr-90	Bq/L	0.093		no range given	A
			Zn-65	Bq/L	509	496	347.20 - 644.80	A
	MaS13	Soil	Cs-134	Bq/L	655	759	531.30 - 986.70	A
			Cs-137	Bq/L	310	315	220.50 - 409.50	A
			Co-57	Bq/L	234	242	169.40 - 314.60	A
			Co-60	Bq/L	219	212	148.40 - 275.60	A
			Mn-54	Bq/L	512	485	339.50 - 630.50	A
			K-40	Bq/L	642	604	422.80 - 785.20	A
			Zn-65	Bq/L	890	810	567.00 - 1053	A
	GrW13	Water	Gr-A	Bq/L	0.601	0.525	>0.0 - 1.05	A
			Gr-B	Bq/L	1.54	1.67	0.84 - 2.51	A
	RdF13	AP	Cs-134	Bq/sample	3.26	3.51	2.46 - 4.56	A
			Cs-137	Bq/sample	2.05	2.26	1.58 - 2.94	A
			Co-57	Bq/sample	4.78	4.92	3.44 - 6.40	A
			Co-60	Bq/sample	3.02	3.03	2.12 - 3.94	A
			Mn-54	Bq/sample	3.31	3.33	2.33 - 4.33	A
			Sr-90	Bq/sample	1.15	1.35	0.95 - 1.76	A
			Zn-65	Bq/sample	3.14	3.14	2.20 - 4.08	A
	GrF13	AP	Gr-A	Bq/sample	0.0764	0.232	>0.0 - 0.46	A
			Gr-B	Bq/sample	0.305	0.297	0.15 - 0.45	A
April 2005	RdV13	Vegetation	Cs-134	Bq/kg	5.45	5	3.50 - 6.50	A
			Cs-137	Bq/kg	4.80	4.1	2.88 - 5.34	A
			Co-57	Bq/kg	13.4	9.88	6.92 - 12.84	A
			Co-60	Bq/kg	3.67	3.15	2.21 - 4.10	A
			Mn-54	Bq/kg	6.45	5.18	3.63 - 6.73	A
			Sr-90	Bq/kg	1.49	1.65	1.16 - 2.15	A
			Zn-65	Bq/kg	7.71	6.29	4.40 - 8.18	A
October 2005	05-MaW14	Water	Cs-134	Bq/L	142	167	116.90 - 217.10	A
			Cs-137	Bq/L	302	333	233.10 - 432.90	A
			Co-57	Bq/L	251	272	190.40 - 353.60	A
			Co-60	Bq/L	243	261	182.70 - 339.30	A
			H-3	Bq/L	547	527	368.90 - 685.10	A
			Mn-54	Bq/L	383	418	292.60 - 543.40	A
			Sr-90	Bq/L	8.75	8.98	6.29 - 11.67	A
			Zn-65	Bq/L	324	330	231.00 - 429.00	A

TABLE 6-3 (cont)
TELEDYNE BROWN ENGINEERING RESULTS
2005 MAPEP ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM

Month/Year	Identification Number	Media	Nuclide	Units	Reported Value (a)	Known Value (b)	Acceptance Range	Evaluation (c)
October 2005	MaS14	Soil	Cs-134	Bq/L	494	568	397.60 - 738.40	A
			Cs-137	Bq/L	446	439	307.30 - 570.70	A
			Co-57	Bq/L	506	524	366.80 - 681.20	A
			Co-60	Bq/L	289	287	200.90 - 373.10	A
			Mn-54	Bq/L	460	439	307.30 - 570.70	A
			K-40	Bq/L	626	604	422.80 - 785.20	A
			Sr-90	Bq/L	571	757	529.90 - 984.10	W (1)
			Zn-65	Bq/L	889	823	576.10 - 1070	A
	GrW14	Water	Gr-A	Bq/L	0.858	0.79	0.21 - 1.38	A
			Gr-B	Bq/L	1.22	1.35	0.85 - 1.92	A
October 2005	RdF14	AP	Cs-134	Bq/sample	4.11	3.85	2.70 - 5.01	A
			Cs-137	Bq/sample	3.16	3.23	2.26 - 4.20	A
			Co-57	Bq/sample	6.14	6.2	4.34 - 8.06	A
			Co-60	Bq/sample	2.86	2.85	2.00 - 3.71	A
			Mn-54	Bq/sample	4.54	4.37	3.06 - 5.68	A
			Sr-90	Bq/sample	2.12	2.25	1.58 - 2.93	A
			Zn-65	Bq/sample	4.28	4.33	3.03 - 5.63	A
	GrF14	AP	Gr-A	Bq/sample	0.304	0.482	>0.0 - 0.80	A
			Gr-B	Bq/sample	0.858	0.827	0.55 - 1.22	A
	RdV13	Vegetation	Cs-134	Bq/kg	4.35	4.09	2.86 - 5.32	A
			Cs-137	Bq/kg	5.99	5.4	3.80 - 7.06	A
			Co-57	Bq/kg	17.0	13.30	9.31 - 17.29	W
			Co-60	Bq/kg	4.87	4.43	3.10 - 5.76	A
			Mn-54	Bq/kg	7.40	6.57	4.60 - 8.54	A
			Sr-90	Bq/kg	2.03	2.42	1.69 - 3.15	A
			Zn-65	Bq/kg	11.8	10.2	7.14 - 13.26	A

(1) NCR 05-18 asigned to investigate low bias in Sr-90 in soil - pending fusion procedure development.

(a) Teledyne Brown Engineering reported result.

(b) The MAPEP 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.

(c) DOE/MAPEP evaluation: A=acceptable, W=acceptable with warning, N=not acceptable.

TABLE 6-4
TELEDYNE BROWN ENGINEERING RESULTS
2005 ERA CROSSCHECKS PERFORMANCE EVALUATION PROGRAM

Month/Year	Identification Number	Media	Nuclide	Units	Reported Value (a)	Known Value (b)	Control Limits	Evaluation (c)
May 2005	Rad 61	Water	Sr-89	pCi/L	37.5	41.3	32.6 - 50.0	A
			Sr-90	pCi/L	5.37	5.92	0.00 - 14.6	A
			Ba-133	pCi/L	88.6	88.4	73.1 - 104	A
			Cs-134	pCi/L	70.5	78.6	69.9 - 87.3	A
			Cs-137	pCi/L	201	201	184 - 218	A
			Co-60	pCi/L	37.5	37.0	28.3 - 45.7	A
			Zn-65	pCi/L	122	118	97.6 - 138	A
			Gr-A	pCi/L	35.5	37.0	21.0 - 53.0	A
			Gr-B	pCi/L	35.6	34.2	25.5 - 42.9	A
			H-3	pCi/L	24600	24400	20200 - 28600	A
	Rad 61	Water	I-131	pCi/L	13.6	15.5	10.3 - 20.7	A
November 2005	Rad 63	Water	Sr-89	pCi/L	18.0	19.0	10.3 - 27.7	A
			Sr-90	pCi/L	16.6	16.0	7.37 - 24.7	A
			Ba-133	pCi/L	31.7	31.2	22.5 - 39.9	A
			Cs-134	pCi/L	30.8	33.9	25.2 - 42.6	A
			Cs-137	pCi/L	26.8	28.3	19.6 - 37.0	A
			Co-60	pCi/L	83.9	84.1	75.4 - 92.8	A
			Zn-65	pCi/L	109	105	86.8 - 123	A
			Gr-A	pCi/L	19.5	23.3	13.2 - 33.4	A
			Gr-B	pCi/L	34.0	39.1	30.4 - 47.8	A
			H-3	pCi/L	12400	12200	10100 - 14300	A
	Rad 63	Water	I-131	pCi/L	17.8	17.4	12.2 - 22.6	A

(a) Teledyne Brown Engineering reported result.
(b) 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.
(c) ERA evaluation: A=acceptable. Reported result falls within the Warning Limits. NA=not acceptable. Reported result falls outside of the Control Limits. CE=check for Error. Reported result falls within the Control Limits and outside of the Warning Limit.

TABLE 6-5
ENERGY NORTHWEST RESULTS
2005 ERA CROSSCHECKS PERFORMANCE EVALUATION PROGRAM

Month/Year	Identification Number	Media	Nuclide	Units	Reported Value (a)	Known Value (b)	Control Limits	Evaluation (c)
March 2005	RAD 60	Water	H-3	pCi/L	30800	30200	25000 - 35400	A
	MRAD 002	AP	Am-241	pCi/Filter	24.8	22.7	15.9 - 53.1	A
			Cs-134	pCi/Filter	74.7	77.5	57.4 - 93.8	A
			Cs-137	pCi/Filter	806	650	520 - 858	CE
			Co-60	pCi/Filter	1090.0	1040.0	832 - 1310	A
		AP	Gr-B	pCi/Filter	74.2	76.4	58.1 - 104	A
			Gr-A	pCi/Filter	79.2	103	46.4 - 103	A
		Water	Am-241	pCi/L	68.7	75.6	59.7 - 107	A
			Cs-134	pCi/L	141	128	102 - 166	A
			Cs-137	pCi/L	2390.0	2250.0	1800 - 2740	A
			Co-60	pCi/L	3260	2950.0	2360 - 3540	A
		Water	Gr-A	pCi/L	7930	8500	4930 - 11000	A
			Gr-B	pCi/L	15300	17200	10500 - 24600	A
		Soil	Ac-228	pCi/kg	4420	4230	3380 - 5840	A
			Am-241	pCi/kg	3000	2700.0	1760 - 6160	A
			Bi-212	pCi/kg	4850.0	4910	2450 - 6580	A
			Bi-214	pCi/kg	2410	2080	1620 - 2950	A
			Cs-137	pCi/kg	49600	44700	35800 - 55900	A
			Pb-212	pCi/kg	4620	4330	3380 - 5720	A
			Pb-214	pCi/kg	2210	2070	1570 - 3020	A
			K-40	pCi/kg	29500.0	26800.0	21400 - 35400	A
			Th-234	pCi/kg	1920.0	1690.0	1060 - 3970	A
		Vegetation	Am-241	pCi/kg	297	267	195 - 539	A
			Cs-137	pCi/kg	25300	22700	18200 - 29700	A
			Co-60	pCi/kg	2280	2330	1860 - 3360	A
			K-40	pCi/kg	25600	22100.0	17500 - 30700	A
May 2005	RAD 61	Water	Ba-133	pCi/L	85.4	88.4	73.1 - 104	A
			Cs-134	pCi/L	80.7	78.6	69.9 - 87.3	A
			Cs-137	pCi/L	212	201	184 - 218	A
			Co-60	pCi/L	43.9	37	28.3 - 45.7	CE
			Zn-65	pCi/L	123	118	97.6 - 138	A
		Water	Gr-A	pCi/L	27.5	37	21.0 - 53.0	A
			Gr-B	pCi/L	33.4	34.2	25.5 - 42.9	A
		Milk[d]/Water	I-131	pCi/L	16.7	15.5	10.3 - 20.7	A
		Water	Ra-228	pCi/L	16.3	18.9	10.7 - 27.1	A
			U-Nat	pCi/L	10.2	10.1	4.90 - 15.3	A
			U-Mass	µg/L	14.5	15.1	7.34 - 22.9	A

TABLE 6-5 (cont)
ENERGY NORTHWEST RESULTS
2005 ERA CROSSCHECKS PERFORMANCE EVALUATION PROGRAM

Month/Year	Identification Number	Media	Nuclide	Units	Reported Value (a)	Known Value (b)	Control Limits	Evaluation (c)
September 2005	MRAD 003	AP	Gr-A	pCi/Filter	18.9	41.1	7.56 - 41.5	A
			Gr-B	pCi/Filter	21.8	24	18.2 - 32.6	A
		Water	Am-241	pCi/L	235	232	183 - 327	A
			Cs-134	pCi/L	1050	1070	856 - 1390	A
			Cs-137	pCi/L	267	269	215 - 328	A
			Co-60	pCi/L	5570	5320	4260 - 6380	A
		Water	Gr-A	pCi/L	28700	31900	18500 - 41200	A
			Gr-B	pCi/L	42600	48300	29500 - 69100	A
			H-3	pCi/L	12800	13400	10500 - 32800	A

(a) Energy Northwest reported result.

(b) 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.

(c) ERA evaluation: A=acceptable. Reported result falls within the Warning Limits. NA=not acceptable. Reported result falls outside of the Control Limits. CE=check for Error. Reported result falls within the Control Limits and outside of the Warning Limit.

(d) A milk was spiked instead of water to validate method.

TABLE 6-6
ENERGY NORTHWEST RESULTS
2005 ANALYTICS, INC. CROSS CHECK COMPARISON PROGRAM

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
December 2005	E4877-723	Charcoal	I-131	pCi	75.4	72.4	1.04	A

(a) Energy Nothwest reported result.

(b) 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.

(c) Ratio of Energy Nothwest to Analytics results.

(d) Analytics evaluation based on EN 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.

7.0 REFERENCES

7.0 REFERENCES

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