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**PINELLAS PLANT SITE ENVIRONMENTAL REPORT
FOR CALENDAR YEAR 1989**

Environmental Health and Safety Programs

June 1990

This report was prepared in accordance with the requirements of U. S. Department of Energy Order 5400.1, "General Environmental Protection Programs," dated November 9, 1988.

The Pinellas Plant is operated
for the U. S. Department of Energy
Albuquerque Operations Office
Under Contract No. DE-AC04-76DP00656

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REPORT APPROVAL

The Pinellas Plant Site Environmental Report for Calendar Year 1989 was prepared in accordance with the reporting requirements of DOE Order 5400.1, "General Environmental Protection Programs," dated November 9, 1988 [1].

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Department of Energy Albuquerque Operations Office Environmental Policy Statement

It is the policy and practice of the Albuquerque Operations Office (AL), as an operating unit of the U.S. Department of Energy (DOE), to conduct its operations in a safe and environmentally sound manner. The protection of the environment and the public are responsibilities of paramount importance in the daily operation of our laboratories and facilities.

To this end, it is AL's policy to conduct our operations in compliance with the letter and spirit of applicable environmental statutes, regulations, and standards. AL is committed to good environmental management of all our programs at our facilities and to correcting existing environmental problems before they deviate from regulatory requirements or pose a threat to the quality of the environment or public welfare.

AL is striving for a complex that is second to none in exercising its responsibilities for protecting the environment and ensuring the health and safety of our employees and the general public. AL is firmly committed to ensuring incorporation of all Departmental and national environmental protection goals in the daily conduct of our business. We have an equal commitment to advance the goals of restoring and enhancing environmental quality and ensuring public health.

It is AL's goal to create an environmental protection and pollution prevention ethic within the work place. Thus, we are committed to undertake appropriate measures to minimize the generation of contaminants, waste, and other residual materials requiring disposal or release to the environment through source reduction, recycling, and treatment. The objective is to put into place a management system that places the proper line management emphasis on environmental protection, pollution prevention, and waste management, as well as production goals.

In the final analysis, reaching the goals that have been established for the Department will depend upon each and every employee's contribution. We need your help and expect your full support as we strive to achieve environmental excellence throughout the AL complex.

*Bruce G. Twining, Manager
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SECTION 1. INTRODUCTION

The Pinellas Plant is a government-owned facility operated for the U. S. Department of Energy (DOE) by the GE Neutron Devices (GEND). The plant's work force of approximately 1700 employees is engaged in the design, development, and manufacture of special electronic and mechanical nuclear weapon components. The DOE Pinellas Area Office (PAO) maintains a staff of approximately 27 employees at the site.

POLICY

GE Neutron Devices is committed to operate the Pinellas Plant and conduct all activities at the Pinellas site to meet or, where technically and economically feasible, exceed all requirements of federal, state, and local law and the spirit and motivations behind such law.

SITE DESCRIPTION

The Pinellas Plant is located on an approximately 99-acre site in the center of Pinellas County, Florida. The county itself is a peninsula bordered on the west by the Gulf of Mexico and on the east and south by Tampa Bay (Figure 1-1). The plant site is centrally located between the county's major municipalities of Clearwater and St. Petersburg (Figure 1-2). The population estimate for Pinellas County as of April 1988 was 839,891. Latest population estimates for the major cities shown in Figure 1-2 are: Dunedin - 34,687; Clearwater - 99,866; Largo - 64,593; Pinellas Park - 41,643; and St. Petersburg - 243,306 [2].

The plant site is bordered on the east by Belcher Road (County Road 27), on the south by Bryan Dairy Road (County Road 135), and on the west by the CSX Line Railroad tracks (Figure 1-3). A southeast aerial view of the Pinellas Plant, taken in August 1989, is shown in Figure 1-4. Approximately 35 percent of the site is occupied by structures and paved areas. The remaining 65 percent is open space. Included in the open acreage are three storm water retention ponds having a combined surface area of approximately 5 acres. Some light industry and warehousing operations are conducted in the area immediately surrounding the site. The closest residential areas are approximately 0.3 miles from the plant.

SITE OPERATIONS AND ACTIVITIES

The primary mission of the Pinellas Plant is the small-volume manufacture of selected high technology electronic and mechanical nuclear weapon components for the DOE. This work involves the handling of small quantities of radioactive material, including tritium, krypton-85, and plutonium. Sealed plutonium oxide capsules are used as heat sources in one of the manufacturing processes at the Pinellas Plant. These heat sources are produced at another DOE facility and are triply encapsulated in metal. The encapsulation was designed and rigorously tested to ensure complete containment of the plutonium under the most extreme potential accident conditions. The manufacturing operations of the Pinellas Plant fall into the metal finishing category as defined by the U. S. Environmental Protection Agency (EPA). A list of manufacturing processes at the plant include: electroplating, electroless plating, encapsulation, etching and chemical cleaning, machining, grinding, burnishing, impact deformation, shearing, thermal cutting, welding, brazing, soldering, flame spraying, sand blasting, solvent degreasing, painting, calibration, and testing.

Figure 1-1. Location of Pinellas County in Florida

Figure 1-2. Location of the Pinellas Plant in Pinellas County

Figure 1-4. Aerial View of the Pinellas Plant from the Southeast Looking Northwest (August 1989)

GEOLOGY AND HYDROLOGY

Since the earliest geologic era, the Florida Peninsula has been part of a much broader land mass known as the Floridan Plateau (Figure 1-5). This plateau presently consists of the extant peninsula and a broad submerged shelf of equivalent size and shape which extends the length of the state and into the Gulf of Mexico and the Atlantic Ocean. Subsiding and uplifting ocean levels over past geologic eras have resulted in the formation of the Florida Peninsula through the repeated deposition of differing limestone, clay, and sand layers. The Floridan Plateau is one of the world's most stable areas. For millions of years, it has been a basically carbonate plate form on which thousands of feet of limestones and dolomites have accumulated.

Figure 1-5. The Floridan Plateau and the Emerged Florida Peninsula

The area in which the Pinellas Plant is underlain to significant depths by a number of layers of limestone deposited during the Cretaceous Period, the Oligocene Age, and the Miocene Age. These limestone layers are covered by a sandstone and clay layer known as the Hawthorn Formation. This in turn is overlain by a surface layer of Myakka and Wabasso shelly sands. The Hawthorn Formation, which has a thickness of 50 to 90 feet in the southern part of the county, acts as a confining layer between the deeper limestone layers referred to as the Floridan and Shallow Aquifers. The Floridan Aquifer extends to a depth of 600 feet within the county. The Shallow Aquifer is highly variable in distribution and thickness throughout the region. A geologic profile of Pinellas County is shown in Figure 1-6.

The surficial aquifer is nonartesian and is separated from the Floridan Aquifer by the clays, silts, and marls that comprise the Hawthorn Formation. The Shallow Aquifer is generally considered a poor water source. The supply available is relatively small, and the quality is commonly objectionable due to high concentrations of iron and sulfates and organic coloring. The Hawthorn Formation acts as the upper boundary of the Floridan Aquifer and the lower boundary of the Shallow Aquifer. Some slow permeation through the Hawthorn Formation does occur. Where this formation is nonexistent--in the northern part of Pinellas County (see Figure 1-6)--the Shallow Aquifer is the main recharge source for the Floridan Aquifer. The Floridan Aquifer is of the artesian type and is very thick and widespread (Figure 1-7). This porous limestone aquifer contains an abundant supply of water and is the principal supply source for all municipal, industrial, and agricultural requirements in the area. It is one of the most prolific aquifers in the United States. Water in the aquifer has a high degree of hardness, containing calcium, magnesium and sulfates, but is otherwise of very good quality. Because the entire Floridan Peninsula is underlain with salt water, potable water can be obtained only to certain depths. The depth to the base of the potable water table ranges from near sea level along the coast to approximately 2000 feet below grade in an area 45 miles inland northeast of the plant site. The greatest amount of water utilized in Pinellas County comes from well fields which tap the Floridan Aquifer. These fields are located northeast of Pinellas County some distance from the plant site in the two adjacent counties, Pasco (north) and Hillsborough (east).

Sinkholes are common in Florida. The flow of water through limestone formations slowly dissolves the limestone, creating caverns and voids; when these caverns collapse, sinkholes occur. This occurs most often during periods of drought when water levels recede, emptying the caverns; thus, sinkholes tend to occur in areas where the limestone layers are close to the surface (Figure 1-6). They have occurred in the northern part of the county, but not as frequently in the southern part (where the Pinellas Plant is located) due to the depth of the limestone layers beneath the Hawthorn Formation. The Florida Sinkhole Research Institute lists six sinkholes reported within a 5-mile radius of the plant. Also, numerous small circular depressions which are characteristic of sinkholes have been identified in the vicinity of the plant; however, no such features have been noted on plant property [3]. The on-site East and West Stormwater Retention Ponds are classified as wetlands by the U. S. Department of Interior "Natural Wetlands Survey."

CH2M Hill, 1987

Figure 1-6. Generalized Geologic Cross Section in the Vicinity of the Pinellas Plant

Figure 1-7. Areal Extent of the Floridan Aquifer

THE LOCAL ENVIRONMENT

The climate in the Pinellas County area is subtropical marine, characterized by long, humid summers and short, mild winters. Average summer temperatures range between 70° to 90°F, while average winter temperatures range between 50° to 70°F. Freezes may occur once or twice in a season, although many winters have none. The local temperature throughout the year is modified by the waters of the Gulf of Mexico and Tampa Bay [4].

The outstanding feature of the local climate is the summer thundershower season. Thunder-showers occur 90 days a year, on average, mostly in the late afternoons during June, July, August, and September. This thundershower season, which occurs between a dry spring and a dry fall, accounts for about 30 inches of the normal annual rainfall of 49 inches [4]. The prevailing winds (as measured at Tampa International Airport) are from the north and northeast during the winter months; during the rest of the year, they are predominantly from the east and

The conditions result in a fairly uniform overall distribution of wind directions. The most frequent wind is from the east, occurring 10% of the time (Table 1-1), and the average wind speed is 8.8 miles/hour [5].

Table 1-1. Frequency of Wind Direction and Speed Over a 10-Year Period [5]

Direction	Frequency (%)	Average Wind Speed (mph)
N	8	8.7
NNE	8	9.2
NE	8	8.4
ENE	9	8.9
E	10	8.2
ESE	6	8.5
SE	5	8.4
SSE	5	9.2
S	6	10.0
SSW	4	10.3
SW	4	8.9
WSW	5	9.6
W	5	9.9
WNW	5	10.6
NW	4	10.0
NNW	4	9.5
Calm	4	-0-

The potential for hurricanes does exist in this area. Based on records from 1866 through 1981, the relative frequency of a hurricane passing within a 50-mile radius of the plant site is one in every 8.6 years [6]. The most recent hurricanes in the Tampa Bay area, Elena and Katie, occurred in 1985 and were greater than 100 nautical miles away. Hurricane tidal flooding causes the greatest amount of damage. The Corps of Engineers has examined the Pinellas Plant site in relation to the design hurricane (once in 100+ years) for this area. The maximum anticipated high tide would be approximately 14 feet above mean sea level. Since the plant is located several miles inland and has a minimum floor height of 18.5 feet above sea level, no damage would be expected to occur from tidal flooding.

The probability of a tornado striking any point in Pinellas County is $4.3E-04$ per year [7]. Waterspouts moving ashore are classed as tornadoes and were included in the calculation. Waterspouts almost always dissipate within a few blocks after reaching land and, thus, have no potential for reaching the site.

Earthquakes have occurred in Florida. The earliest recorded (and most severe) earthquake took place on January 12, 1879, near St. Augustine. The tremors lasted for 10 minutes and covered an area of 25,000 square miles, from Savannah, Georgia, in the north to Daytona Beach, Florida, in the south. The only damage reported was in St. Augustine (the oldest city in the United States) where some residents were showered with plaster from their ceilings. Several other events of lesser intensity have been reported since that time. Other smaller events probably have occurred and have escaped detection either because of the distance

from the nearest seismic station or because of the tendency of residents to identify these occurrences with rockets or airplanes. There is, however, no reasonable expectancy for a damaging earthquake to occur at the Pinellas Plant site. The seismic risk map of the United States shows central and south Florida to be in Zone 0. This is defined as a "no damage" zone.

The Pinellas Plant site is not in a flood prone area. These areas are defined as having a 1 in 100 chance of being inundated due to rainfall in any year. The East and West storm water retention ponds located on the plant site (see Figure 1-3) have been designated as wetlands in the National Wetlands Inventory by the U.S. Department of the Interior, Fish and Wildlife Service. There are no known historic or archaeological sites located on the Pinellas Plant site.

SECTION 2. ENVIRONMENTAL SUMMARY

The environmental monitoring programs maintained by the Pinellas Plant are designed to:

- (1) determine the efficiencies of treatment and control mechanisms for environmental releases,
- (2) provide measurements of discharge concentrations for comparison with applicable standards,
- (3) assess the concentrations of these discharges in the on-site and off-site environment, and
- (4) provide a data base for computer programs to calculate the potential dose to the public resulting from the operation of the Pinellas Plant.

The environmental effects of radiological and nonradiological effluents from the operation of the Pinellas Plant have been demonstrated to be insignificant.

NONRADIOACTIVE EFFLUENTS

Liquid Effluents

A total of 228,029,970 liters of combined effluent (sanitary flow plus the pH-neutralized industrial wastewater) was discharged to the Pinellas County Publicly Owned Treatment Works (POTW) in 1989. Analyses were performed for Biochemical Oxygen Demand (BOD), cadmium, total chromium, copper, cyanide, iron, lead, mercury, nickel, silver, suspended solids, zinc, and pH to monitor compliance. All results from these analyses were in compliance with the Pinellas County Sewer Use Ordinance [8] and the Industrial Wastewater Discharge Permit [9]. There is currently no NPDES Permit required for the Pinellas Plant.

RADIOACTIVE EFFLUENTS

Air effluents are monitored at the points of discharge (exhaust stacks), at the plant site perimeter monitoring stations and at off-site monitoring stations in the surrounding community. Water samples are monitored at the point of discharge to the POTW, at 3 on-site storm water retention ponds, and at 26 off-site fresh water ponds. In addition, both on- and off-site soil samples are analyzed by the Pinellas Plant Environmental Chemistry Laboratory throughout the year.

Environmental monitoring procedures and results are discussed in further detail in Section 5, "Radioactive Environmental Monitoring." On- and off-site air monitoring and water and soil sampling locations and schedules are also defined.

Gases and Airborne Particulates

Small quantities of tritium gas, tritium oxide, and krypton-85 gas were released from the plant exhaust stacks during the year. Calculated maximum ground level concentrations of these radioisotopes as a result of these discharges all were less than 0.01% of the DOE Derived Concentration Guides (DCG) for tritium oxide and krypton-85 in air [10]. The DCG defines the maximum permissible levels set by DOE. All DCG values used in this report are listed in Table 2-1 for clarity and convenience.

Table 2-1. U.S. Department of Energy Derived Concentration Guides [10]

Radionuclide	Matrix	DCG ($\mu\text{Ci}/\text{ml}^*$)
Tritium oxide	Air	1E-07
Tritium oxide	Water discharged to a POTW	1E-02**
Tritium oxide	Drinking water	2E-03
Krypton-85 gas	Air	3E-06
Plutonium-238	Air	3E-14
Plutonium-239	Air	2E-14

* Microcuries per milliliter for water discharges; microcuries per cubic centimeter for air discharges

**Maximum allowable concentration, not a DCG.

Maximum ground level concentrations were calculated and found to occur off-site at a distance of approximately 550 yards from the plant center. A total of 103.7 curies (Ci) of tritium (43.7 Ci of tritium gas plus 60.0 Ci of tritium oxide) and 12.9 Ci of krypton-85 gas (main stack only) were discharged in calendar year 1989 for a combined volume (from the four effluent stacks) of $8.2\text{E} + 11$ liters of air. No plutonium was discharged from the plant site. The monitoring station locations for on- and off-site tritium monitoring are illustrated in Figures 5-1 and 5-2.

Site perimeter and off-site monitoring for tritium was performed in 1989 to monitor compliance with the DCGs listed in Table 2-1. Average annual site perimeter and off-site tritium oxide values obtained from air samples were approximately 0.02% of the DOE DCG for tritium oxide in air. The highest value used in calculating the above percentages was 2900 times less than the value listed in the DOE DCG. The range of tritium levels detected during 1989 in both air and water is presented in Table 2-2. Expressed as a percentage of the applicable DCGs, these levels are exceedingly low.

The presence of plutonium was monitored on- and off-site in both air and soil samples during the year (Figures 5-3 and 5-4). Plutonium was not detected in any of the environmental samples analyzed during the year because no plutonium was discharged to the environment. Monitoring data for plutonium-239 showed only less than Minimum Detection Level (MDL) levels. The MDL, i.e., sampling background level, for plutonium in on-site or off-site air ranged from $1.6\text{E}-19$ to $2.5\text{E}-16$ $\mu\text{Ci}/\text{cc}$ (see Section 5, "Monitoring Procedures"). The MDL for all of the analyses was significantly less than the American National Standards Institute (ANSI) standard of $2\text{E}-12$ $\mu\text{Ci}/\text{cc}$ for plutonium-239 for on-site analysis instrumentation [11] and the DOE DCGs for plutonium-238 and plutonium-239 in air of $3\text{E}-14$ $\mu\text{Ci}/\text{cc}$ and $2\text{E}-14$ $\mu\text{Ci}/\text{cc}$ respectively. It should be noted that plutonium-239 is present in the environment as a result of past atmospheric nuclear weapons testing. Plutonium-238 is utilized in Building 400 as a sealed source, and has never been detected in the building effluent monitoring system.

Table 2-2. Range of Environmental Levels of Tritium Detected in Air and Water

Matrix	Sampling Site	Concentration			Percentage of DOE DCG*		
		Minimum Value	Average Value	Maximum Value	Minimum Value	Average Value	Maximum Value
Air**	On-Site Stations	8.3	11.70	34.2	0.0083	0.0117	0.034
	Off-Site Stations	7.6	9.8	21.6	0.0076	0.0098	0.072
Water***	Discharge to POTW	BMDL [†]	4.27	80.97	-	0.0427	0.810
	On-Site ^{††} Surface Water	BMDL	0.51	2.82	-	0.025	0.141
	Off-Site ^{†††} Surface Water	BMDL	BMDL	3.88	-	-	0.194

* DOE DCGs: tritium oxide in air - $1\text{E-}07$ $\mu\text{Ci/cc}$; tritium in drinking water - $2\text{E-}03$ $\mu\text{Ci/ml}$ (used as a DCG for surface water); tritium discharged to a POTW - $1\text{E-}02$ $\mu\text{Ci/ml}$ [maximum allowable concentration, not a DCG (see Table 2-1)].

** $\mu\text{Ci/cc}$ E-12

*** $\mu\text{Ci/ml}$ E-06

[†] Below the MDL of $0.45\text{E-}06$ $\mu\text{Ci/ml}$.

^{††} 3 sites

^{†††} 26 sites

Liquid Effluents

Small quantities of radioactive tritium were released in the plant's combined effluent to the POTW. The combined effluent is composed of the plant's sanitary flow and the flow from the plant's Industrial Wastewater pH Neutralization Facility which automatically adds acid or caustic to the industrial waste stream in response to needed pH adjustments. The maximum tritium concentration detected in samples of the combined effluent released to the POTW was $8.1\text{E-}05$ $\mu\text{Ci/ml}$. This tritium level is approximately 125 times lower than the standard maximum allowable concentration for tritium discharge to public sewers [10] (Table 2-1). A total of 1.15 Ci of tritium oxide was discharged to the POTW in 1989 in a volume of 228,029,970 liters of combined water effluent.

Environmental sampling and analyses for tritium were conducted in the on-site East, West, and South storm water retention ponds as a precautionary measure. The overflows from the East and South Ponds ultimately discharge off-site into the Pinellas County storm water system; the West Pond does not discharge off-site. The maximum tritium concentration detected in samples of water from the East, West, and South Ponds was $2.82\text{E-}06$ $\mu\text{Ci/ml}$.

1.48E-06 $\mu\text{Ci/ml}$, and 1.84E-06 $\mu\text{Ci/ml}$ respectively. The highest of these tritium levels is approximately 700 times lower than the standard maximum allowable concentration set in the DCG for tritium in drinking water (Table 2-2). Average annual values for tritium in water samples obtained at the East, West, and South storm water retention ponds were 4.9E-07 $\mu\text{Ci/ml}$, 4.9E-07 $\mu\text{Ci/ml}$, and 5.5E-07 $\mu\text{Ci/ml}$ respectively. The largest of these values is 3600 times less than the DOE DCG for tritium in drinking water. Results of off-site water samples obtained to a distance of 8 miles from the plant site were all below the analysis technique MDL of 0.45E-06 $\mu\text{Ci/ml}$. This value is 0.023 percent of the DCG for tritium in drinking water. The DCG for tritium in drinking water is used as a standard for tritium in surface waters. Surface waters are not, however, a drinking water source in the vicinity of the Pinellas Plant.

The area surrounding the plant was divided into eight equal, pie-shaped sectors, with the center line of each being one of the major compass points. These sectors were further divided by arcs at distances of 2, 4, 6, and 8 miles, resulting in a total of 32 areas. Samples of surface water from ponds, lakes, and ditches are collected during the year from 26 locations and are analyzed by liquid scintillation counting for tritium content. The location of these sample points is shown in Figure 5-2.

Evaluation of Potential Dose to the Public

Calculations were made to estimate the radiation doses resulting from releases of tritium oxide, tritium gas, and krypton-85 on: 1) a maximally exposed individual at the site boundary, 2) individuals in the closest residential area, and 3) the population within 50 miles of the plant site. The calculated doses are extremely small when compared to the DOE standard of 100 mrem effective dose equivalent [10]. The total dose commitment to the population (estimated at 2.5 million) residing within 50 miles for one year was determined to be 9.95 man-rem as compared to the annual dose from natural radiation of 902,000 man-rem. (Calculation of the annual dose from natural radiation is outlined in Section 6.) Expressed as an average dose equivalent, this corresponds to a dose of 4.0E-03 mrem per person when compared to an annual dose equivalent of 360 mrem from natural sources [12]. The calculated dose to the maximally exposed individual within the 50-mile area was 7.5E-02 mrem. The dose to an individual remaining at the closest site boundary continuously for one year was calculated to be 6.35E-03 mrem. The dose to an individual residing in the closest residential area for one year was calculated to be 1.7E-02 mrem. When compared to the dose from natural sources, the dose received by persons residing in a 50-mile area surrounding the plant (including the site boundary) as a result of plant operations is very low.

SECTION 3. COMPLIANCE SUMMARY

GENERAL

This compliance summary covers the period of January 1989 to May 1990.

WATER

Water effluents from the Pinellas Plant were in compliance with all applicable federal, state, and local regulations and standards during calendar year 1989. The Pinellas Plant received the Pinellas County Sewer System Industrial Wastewater Discharge Permit on August 28, 1989.

CERCLA

During the 1960s, a 4.5-acre portion of the plant site was used for the disposal of 55-gallon drums containing solvent and resinous waste. This 4.5-acre tract was sold by the General Services Administration to a private individual in 1972. In early 1984, DOE/AL initiated a program to identify potential environmental problems. Through interviews and discussions with former employees, the previous burial practices that had occurred on the 4.5-Acre Site became known. The presence of buried drums on the site was confirmed in 1985 during an electromagnetometer survey of the property conducted by the U.S. Department of the Interior, U.S. Geologic Survey.

In mid-1985, GEND contracted with a remediation firm, and 83 drums were excavated from the site. Of these 83 drums, 35 contained waste solvent material. The remainder of the drums were empty. The drums with contents, the empty drums, and 303 tons of potentially contaminated soil were disposed of off-site at an EPA permitted disposal facility. A verbal agreement with the FDER provided that the site be remediated under the state authority as a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site. A contamination assessment report was completed and submitted to the FDER in January 1987. This report identified the presence of residual surficial groundwater contamination at the site. Surficial groundwater is not considered to be a potable aquifer in the vicinity of the plant. In October 1987, a feasibility study was completed; installation of recovery wells and treatment of the ground water at the site was identified as the most practical and protective remedial activity. During the course of this study, it was discovered that the surficial groundwater contamination plume had apparently migrated and was potentially impacting adjacent property. In response to this change, PAO requested the approval of the FDER to implement an interim remedial action plan to draw the plume of contamination groundwater back onto the 4.5-Acre Site. The FDER granted approval of this plan.

At present, seven groundwater recovery wells have been installed on the site. The design of the air stripping tower to treat the recovered groundwater prior to discharge is complete. The treated effluent will be discharged through the plant's Industrial Wastewater pH Neutralization System to the Pinellas County Publicly Owned Treatment Works under an agreement with the Pinellas County Sewer System. Current schedules call for complete installation of the treatment system and initiation of interim remedial operation by May 1990. Following installation of the system, the extent of the contamination plume will be monitored to judge the effectiveness of the operation. Upon withdrawal of the contamination plume from the adjacent property, completion of the continuing assessment, and the approval of the FDER, cleanup of the site will proceed to the remedial action stage.

RCRA

A RFI is currently being conducted for the ER Program/Technical Support Office of LANL for the AL operations office. DOE instituted Environmental Restoration Program activities to investigate environmental concerns associated with the weapons installations of AL. After initial investigations, a draft report was issued in June 1988. As an early result of this effort, 14 SWMUs were designated for further verification under the RFI. On February 9, 1990, EPA Region IV, issued a RCRA permit for the U. S. DOE-Pinellas Plant, I.D. No. FL6 890 090 008.

The designation of the various sites as Solid Waste Management Units (SWMUs) was based on interviews and review of available material. The investigation is designed to identify possible contamination presence; identify types of contaminants, if present; determine levels of contamination and compare with regulatory standards, and determine the extent of contamination.

AIR

In December 1989, the Pinellas Plant was inspected by the Pinellas County Air Quality Board. This agency administers the Clean Air Act in Pinellas County for the State of Florida. As a result of this inspection, several of the plant's exhaust systems may need permits. The Pinellas Plant will complete any permit applications in 1990 as necessary for the county.

SECTION 4. NONRADIOACTIVE ENVIRONMENTAL MONITORING

LIQUID EFFLUENTS

Monitoring Procedures

Monthly samples are collected at the Industrial Wastewater pH Neutralization Facility from the industrial and combined (industrial plus sanitary) wastewater streams prior to discharge to the POTW. The samples are collected by automatic instrumentation and are flow proportional, 24-hour composites. All samples are analyzed in accordance with the EPA methods prescribed in 40 Code of Federal Regulations (CFR) Part 136, "Regulations on Test Procedures for the Analysis of Pollutants" [13]. The samples are analyzed to measure discharge effluent compliance with the Pinellas County Sewer Use Ordinance and the Pinellas County Sewer Systems Industrial Wastewater Discharge Permit No. 018-IE. Analyses are performed off-site at an independent State of Florida certified laboratory and on-site in the Pinellas Plant's Environmental Chemistry Laboratory.

Discharges

Results of analyses are tabulated and reported quarterly to the Pinellas County Sewer System Industrial Program Manager. Table 4-1 summarizes the results of the analyses of combined effluents discharged from the site during 1989. The table shows the various parameters for which analyses were performed, the number of analyses, and the Pinellas County Sewer Use Ordinance limits. It also shows the maximum, minimum, and average concentrations detected and the MDL of the analytical technique employed. The less than symbol (<) preceding any value reported (in any table in this document) indicates that no detectable amount(s) was found for the technique in question, and the value is stated as less than the MDL of the analytical technique. When the results of an individual analysis are reported as being less than the MDL, the MDL is used as the value of that analysis in the calculation of the means and standard deviations shown in this report.

Discussion

Sample analyses revealed that all combined (sanitary plus industrial) effluents directed to the POTW were within the limits set forth in the Pinellas County Sewer Use Ordinance and the Industrial Wastewater Discharge Permit. No citation was issued for the incident noted in Table 2-1.

The Pinellas County POTW maintains a locked sampling manhole on the Pinellas Plant site. Samples of the plant's combined effluent obtained from this manhole are analyzed by the county to confirm the effluent results reported by the plant. These samples are collected by county officials on an irregular, unannounced basis. A total of three samples were collected by the county in 1989. In all instances, the results reported by the Pinellas Plant were confirmed by the analyses performed by the POTW.

Table 4-1. Combined Nonradioactive Liquid Effluent Analyses Results

Parameter	No. of Analyses in 1989	Concentration*		Average ($\pm$ 2 std. dev. **)	Minimum Detection Level
		County Effluent Limit	Analysis Result Value Range		
BOD-5	12	250.0	22.0-125.7	55.8 (74.4)	1.0
Cadmium	12	0.2	<0.005-0.01	0.006 (0.007)	0.005
Chromium-Total	12	2.6	<0.03-0.20	0.046 (0.098)	0.03
Copper	10	1.0	0.051-0.29	0.137 (0.136)	0.03
Cyanide	12	1.0	<0.001-0.005	0.046 (0.028)	0.001
Lead	12	0.6	<0.01-0.12	0.057 (0.073)	0.01
Mercury	12	0.1	<0.0001-0.0005	0.0002 (0.0003)	0.0001
Nickel	12	1.0	<0.018-0.12	0.065 (0.055)	0.018
Silver	12	0.4	<0.002-0.10	0.035 (0.123)	0.002
Suspended Solids	12	250.0	10.2-368.4***	92.52 (206.1)	1.0
Zinc	12	1.0	<0.07-0.287	0.168 (0.170)	0.07
pH	361	5.5-9.5	> 5.5- < 9.5	7.00†	Not Applicable

* All concentrations are in mg/l (parts per million) except pH which is measured in pH units.

** Values in parentheses indicate two standard deviations in mg/l.

*** Suspended solids level exceeded the sewer use ordinance limit on one sampling day in April 1989. This was due to flushing the sanitary and chemical drain system in preparation for an inspection of the drains by television cameras. This was reported to the Pinellas County Sewer System; the one-day occurrence was not cited as a violation.

† pH information is recorded continuously on a chart recorder. Periodic individual readings are not recorded separately. The mean value was calculated from the chart recorder.

Summary

The nonradioactive liquid effluent from the Pinellas Plant's Industrial Wastewater pH Neutralization Facility (as combined with the sanitary flow) is monitored for compliance with the constituent effluent discharge limits promulgated in the Pinellas County Sewer Use Ordinance and the Industrial Wastewater Discharge Permit. The analytical results are tabulated monthly and reported quarterly to the Pinellas County Sewer System Industrial Program Manager. During 1989, all analytical results obtained for the monitored effluent constituents were in compliance with the ordinance and permit limits, with the exception of the one-day occurrence (see footnote in Table 4-1). No violations for noncompliance with the ordinance occurred during 1989.

SOLID AND LIQUID WASTE

Storage facilities are provided for the proper management of solid and liquid chemical waste. The facilities include a building and storage tanks which were constructed and equipped to comply with the EPA hazardous waste storage requirements as promulgated in 40 CFR Part 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities" [14]. The construction of the building allows the segregation of

incompatible materials. The storage tank facility consists of five above-ground tanks, four of which are used for segregated storage of the liquids. The fifth tank is reserved for any contingency requirement. All of the tanks are enclosed in a secondary containment system.

On-site treatment facilities provide chemical treatment of reactive materials and thermal treatment of explosive materials. The facilities are maintained and located in compliance with EPA hazardous waste treatment requirements as promulgated in 40 CFR Part 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Facilities" [15], and the Pinellas Plant Hazardous Waste Operating Permit [16].

Chemical treatment is used for water-reacting calcium, calcium bismetal, and material contaminated with lithium silicon. Thermal treatment of materials classified as explosives is accomplished in an open burn facility in accordance with the above-mentioned regulations and the Pinellas Plant Hazardous Waste Operating Permit. Hazardous waste generated at the plant site for which there is no on-site treatment (i.e., all hazardous waste except reactive metals and explosive materials described above) is shipped to commercial disposal facilities. Waste transporters and waste disposal facilities are selected from a corporate GE list of certified transporters and facilities and in accordance with DOE Memorandum, "Policy on the Off-site Treatment, Storage, and Disposal of Non-Radiological Hazardous Waste," dated July 24, 1986 [17]. In addition, the compliance of both the waste transporters and the waste disposal facilities with applicable federal and state hazardous waste regulations is ascertained and evaluated prior to any waste shipment.

The plant's Industrial Wastewater pH Neutralization Facility adjusts the pH of all process waters to within the pH range of 6.0 to 8.0 prior to discharge to the county POTW. The effluent from the facility mingles with the plant sanitary water flow to form a combined flow prior to discharge to the POTW.

Solid waste which is not classified as hazardous is disposed of separately. Scrap metal is collected and segregated by type. When sufficient quantities are accumulated, the scrap metal is sold for recycling; scrap cardboard is also sold for recycling. Trash, domestic garbage, paper, wood, and other nonreusable materials are transported to the Pinellas County Resource Recovery Facility. This facility is an incinerator/power generator and landfill.

ATMOSPHERIC EMISSIONS

Volatile organic compounds are exhausted from more than 300 stacks which are evenly distributed over the roof of Building 100. Two-thirds of these stacks serve laboratory fume hoods which are operated intermittently. The remaining exhaust points are associated with various processes and, consequently, provide a nearly continuous source of atmospheric emissions. Additionally, low levels of volatile organic compounds are released from the Chemical Storage Building, Building 600. In December 1989, the Pinellas Plant was inspected by the Pinellas County Air Quality Board. No violations or permitting requirements for the vents or the processes associated with these materials were identified during this audit.

The estimated mass balance of volatile organics release from plant operations is approximately 323 pounds per day. Methylene chloride and trichloroethylene comprise over 50% of the daily emissions. The balance of the volatile organic release is comprised primarily from Freon*. Both atmospheric dispersion modeling and on-site sampling of air quality have been performed.

Results of the atmospheric modeling [18] indicate worst-case average air concentrations on-site below 200 ug/m³ (0.2 ppm). Two on-site air monitoring investigations have been performed. The analyses of samples collected in these investigations were performed on the basis of total volatile organics with no accounting of speciation or local background conditions. As such, these measurements include the influence of off-site sources (i.e., nearby light industry, automobile exhausts). Of these investigations, one detected the presence of volatile organic compounds at concentrations below 2 ppm; the other investigation [19] failed to detect the presence of volatile organic compounds. The permissible exposure limit currently supported by the Occupational Safety and Health Administration is 50 ppm. Both modeled and sampled values fall well below the national standard.

ENVIRONMENTAL PERMITS

The Pinellas Plant received the Pinellas County Sewer System Industrial Wastewater Discharge Permit on August 28, 1989. Effluent limits and parameters monitored are listed in Table 4-1.

The Pinellas Plant applied for a Temporary Hazardous Waste Facility Permit in accordance with the regulations promulgated in 40 CFR Part 265. This permit was granted by the State of Florida Department of Environmental Regulation (FDER) on April 30, 1986. The permit expired on October 30, 1986. The Pinellas Plant submitted an application to the FDER in early October 1986 for a Hazardous Waste Facility permit in accordance with the requirements set forth in 40 CFR Part 264. On August 16, 1988, the FDER issued Permit No. HO52-123377 to the Pinellas Plant for the operation of a hazardous waste treatment and storage facility. In January 1989, the Pinellas Plant requested a modification to this permit to correct minor omissions in the permit text, to request the addition of new waste codes, and to request the activation of a closure plan for an active unit. This modification had not been granted by the FDER as of December 31, 1989.

As of December 31, 1989, the State of Florida had not adopted the Resource Conservation and Recovery Act (RCRA) Hazardous and Solid Waste Amendments (HSWA) of 1984. Therefore, in accordance with 40 CFR 270.10(a) Subpart B, "Regulations for Federally Administered Hazardous Waste Permit Programs [20]," a modified Part B permit application was submitted to EPA Region IV in November 1988 for the operation of HSWA regulated treatment activities.

*Trademark, E.I. du Pont de Nemours & Co., Inc.

SIGNIFICANT ENVIRONMENTAL ACTIVITIES

During 1989, further effort was undertaken to investigate two abandoned hazardous waste contamination sites which were identified by the DOE Albuquerque Operations Office (AL) Environmental Restoration Program. The Pinellas Plant has retained the services of various hazardous waste site engineering firms to investigate, assess, and initiate the cleanup activities.

The first site, discovered in April 1985, is located adjacent to the northwest corner of the plant site on 4.55 acres formerly owned by DOE. The source of contamination, 83 drums of contaminated waste (volatile organic compounds), was removed during 1985. During 1985 and 1986, the extent of contamination was defined and studied; in 1987, a Contamination Assessment Report was completed and approved by the FDER. In addition, a Feasibility Study was undertaken to identify the most appropriate method of cleanup. Table 4-2 summarizes the volatile contaminant levels of concern [21]. This study also was approved by the FDER. In May 1988, an Interim Remedial Action Plan was submitted and approved by FDER. Implementation of the Interim Remedial Action Plan began in October 1988. Construction of the interim remedial action Groundwater Recovery System was completed in December 1988, and cleanup action was initiated to draw the contaminant plume back onto the site (see Figure 4-1). In January 1989, the operation of this groundwater recovery system was terminated with the discovery of contaminant groundwater levels above those permitted to be discharged by the Pinellas County Sewer System. The pumped water was to be released to the POTW as a part of the plant combined waste stream. Monitoring prior to release indicated levels above the POTW effluents and the pumping was discontinued. During 1989, an air stripper treatment system was designed to be integrated with the existing system and was approved by the FDER in August 1989. This system will recover and treat the contaminated groundwater to below the POTW effluent limits prior to discharge. The system is expected to become operational in May 1990.

Table 4-2. Summary of Contaminants of Concern,
4.55-Acre Site ($\mu\text{g/l}$) [21]

<u>Volatile Organic</u>	<u>Range Of Values</u>
Toluene	5-2,700
Vinyl Chloride	37-15,000
Benzene	13-86
1,2-dichloroethane	30-4,200
Trichloroethane	9-370

The second site, the Northeast Site located on the plant property west of the East Pond (Figure 1-4), was identified in July 1986. An assessment of this site was completed in 1987 to determine the constituents and the extent of possible groundwater contamination. No source materials (e.g., drums) were found on the site. The results of this assessment, contained in a Contamination Assessment Report, were approved by the FDER in 1987. In 1989, a Feasibility Study was completed to determine the most appropriate remedial technology. This site has been identified as a SWMU by EPA Region IV in the Pinellas Plant Hazardous and Solid Waste Amendment Permit. In accordance with the HSWA permit, the Northeast site will be remediated as a SWMU. A total of 14 SWMUs are identified in the permit. Assessment of these sites is scheduled to be initiated and completed in FY1990. Until the assessment activities have been completed, potential risks associated with the assumed contamination cannot be assigned. Budget constraints require that remedial activities for those SWMUs which require remediation be scheduled to begin in FY1994 and completed in FY1996 or sooner if possible.

Figure 4-1. Contaminant Plume Location

SECTION 5. RADIOACTIVE ENVIRONMENTAL MONITORING

The radioactive environmental monitoring performed at the Pinellas Plant is summarized in Table 5-1. Tritium gas, tritium oxide, and krypton-85 gas are discharged from the Pinellas Plant exhaust stacks. Tritium gas and tritium oxide are discharged from the Building 100 laboratory exhaust stack, Building 200 and Building 800 stacks, while tritium gas, tritium oxide, and krypton-85 gas are discharged from the Building 100 main exhaust stack (Figure 5-1). In addition, tritium oxide is discharged from the plant's Industrial Wastewater pH Neutralization Facility to the county POTW. On- and off-site environmental sampling for plutonium is performed because the material is physically present on the plant site, even though it is completely encapsulated.

GASES AND AIRBORNE PARTICULATES

Tritium gas and tritium oxide discharges are monitored (Building 200 has a sampler only) at the four exhaust stacks. Krypton-85 discharges are monitored at the Building 100 main exhaust stack. Six on-site and five off-site sampling stations monitor the atmospheric levels of tritium gas and tritium oxide resulting from these discharges. The ventilation effluent from the building where the sealed plutonium capsules are handled is monitored for plutonium. Four site perimeter and five off-site plutonium air monitoring stations were operated continuously during the year to monitor the atmosphere for plutonium. The locations of the on- and off-site tritium and plutonium air monitoring stations are shown in Figures 5-1 and 5-2 respectively. Soil samples collected from both on- and off-site were analyzed to provide a set of data for comparison with the pre-operational survey plutonium levels.

Monitoring Procedures

Tritium

Exhaust from the majority of processing and laboratory equipment which utilizes tritium in Building 100 is connected to the Tritium Recovery System. The system converts tritium gas in the exhaust to tritium oxide, which is then collected in moisture-absorbing material. The collected tritium oxide (which represents both the tritium oxide and the tritium gas in the exhaust air) is then measured as a solid radioactive waste prior to disposal off-site. The effluent from the tritium recovery system (from which 95 to 99% + of tritium has been removed) is directed into the Building 100 main stack.

In all tritium gas and tritium oxide exhaust stack monitoring and at on-site perimeter and off-site sampling stations, a continuous air sample is passed through a column of silica gel which collects tritium oxide by absorption. Another continuous air sample is passed through a heated column containing copper oxide which converts tritium gas to tritium oxide. The air then passes through a silica gel column for collection. Thus, the station collects both tritium gas and tritium oxide. Moisture from the exhaust stack sampling columns is removed by water leaching and analyzed by liquid scintillation counting. Moisture is removed from the on-site and off-site air sampling station columns by distillation and is also analyzed by liquid scintillation counting.

Table 5-1. Radioactive Environmental Monitoring Summary

Radionuclide	Matrix	Monitoring Location	No. of Sampling Stations	Analysis Frequency	No. of Samples In 1989	Range of MDA*
Tritium	Air	Exhaust stacks	4	Daily	957**	0.97-4.2E-13
			2	Monthly	104	1.3-3.73E-13
Tritium	Air	On-site perimeter	6	Every four weeks	156	3.0-11.7E-12
Tritium	Air	Off-site	5	Every four weeks	130	2.0-12.4E-12
Tritium	Water	Effluent to POTW	3	Daily	1064	4.2-5.3E-07
Tritium	Water	On-site ponds	3	Weekly	153	3.8-5.1E-07
Tritium	Water	Off-site water sources	26	Quarterly	77	4.2-4.9E-07
Krypton-85	Air	Exhaust stack	1	Continuously	***	6.4E-06 [22] [†]
Plutonium	Air	Exhaust stack	1	Monthly	12	2.6E-18 2.2E-16
Plutonium	Air	On-site perimeter	4	Biweekly	104	1.1-65.4E-18
Plutonium	Air	Off-site	5	Biweekly	130	0.2-11.1E-18
Plutonium	Soil	On-site	††	Annual	4	3.2E-09 8.5E-10
Plutonium	Soil	Off-site	††	Annual	4	1.3-1.6E-09

* Minimum Detectable Activity. Activity is measured in $\mu\text{Ci/ml}$ for water, $\mu\text{Ci/cc}$ for air, and $\mu\text{Ci/g}$ for soil.

** A total of five daily samples are collected per week from four stacks. Weekend samples are composited.

*** Krypton-85 is monitored continuously throughout the year by on-line equipment.

† Estimated.

†† The number of potential soil samples is infinite; however, plutonium soil samples are collected at predetermined areas from a master list.

Figure 5-1. On-Site Exhaust Stack, Effluent Discharge, and Air Monitoring Station Locations

Figure 5-2. Off-Site Tritium and Plutonium Air Monitoring Stations and Tritium Surface Water Sampling Locations

Comparison of the tritium removed from the two columns (one of which collects tritium oxide and the other tritium gas and tritium oxide) is used to determine gas discharge. For the Building 100 main and laboratory exhaust stacks, two sets of columns are operated simultaneously. One set is analyzed daily and the other monthly. The results are compared for accuracy. Curie discharge values, determined either by monthly or daily column analysis, typically differ by less than 10 percent. One set of columns is analyzed monthly from the Buildings 200 and 800 exhaust stacks.

The six on-site air sampling stations (individually numbered 1 through 6) and the five off-site air monitoring stations, which monitor the atmosphere for both tritium gas and tritium oxide, are operated continuously during the year. Samples are analyzed at four-week intervals.

Krypton

The exhaust from all equipment which utilizes krypton-85 is connected to the Building 100 main exhaust stack via a monitored duct. Real-time krypton-85 are determined from a continuous air sample which is drawn through a Kanne-type ionization chamber connected to a picoammeter and recorder. For reporting purposes, releases are calculated regularly based on sampling and analyses of the process gas.

Plutonium

Plutonium is not discharged to the environment; however, because of its presence on-site, a plutonium monitoring program is maintained. Sample filters through which a known amount of air has passed are collected from the exhaust ventilation system of the building in which the encapsulated plutonium is housed and from the on- and off-site air monitoring stations. The method of plutonium analysis consists of: 1) aliquoting a known quantity and activity of plutonium-242 tracer onto the air filters, 2) introduction and chemical equilibration of the plutonium-242 tracer for recovery efficiency determination, 3) acid digestion of the combined sample and tracer, 4) plutonium isolation by anion exchange, 5) electrodeposition, and 6) alpha spectrometric analysis.

The exhaust stack on the building where the heat sources are stored and used was continuously sampled during the year. The sampling system collects the exhaust effluent at a rate of approximately 3700 l/hr (2.2 cu ft/min). Whatman Corporation's Brand 934-AH filter material is used for all environmental plutonium air samples. The filters from the building which houses the plutonium are changed monthly and composited for quarterly analysis.

Four on-site and five off-site plutonium air sampling stations were operated continuously during the year. Ambient air was sampled at a rate of approximately 5600 l/hr (3.3 cu ft/min). The filters are changed at two-week intervals and composited for quarterly analysis.

Four on-site and four off-site soil samples were analyzed in 1989 for plutonium. The four off-site soil samples were collected at locations surrounding the plant at distances from 2.5 to 3.7 miles. Each sample consisted of a composite of three 3.5-inch diameter by 2-inch deep plugs. They were dried to constant weight at 110°C prior to analysis. The sample locations are selected annually at random from a master list of sites (Tables 5-2 and 5-3).

Table 5-2. Off-Site Soil Sample Locations

Location Number	Map Coordinates
PC-01	F'-7
PC-02	E-2'
PC-03	C'-8'
PC-04	A-2
PC-05	D-10
PC-06	A'-8'
PC-07	J-2
PC-08	F-6
PC-09	C'-6'
PC-10	F'-7'
PC-11	B-4'
PC-12	G-7'
PC-13	C'-6
PC-14	G'-3'
PC-15	I'-4'
PC-16	I'-2

Table 5-3. Soil Sample Location Schedule

Year	On-site Locations		Off-site Locations			
1987	GE-05	GE-11	PC-03	PC-05	PC-07	PC-16
1988	GE-04	GE-08	PC-02	PC-06	PC-13	PC-14
1989	GE-03	GE-09	PC-04	PC-09	PC-11	PC-15
1990	GE-10	GE-14	PC-01	PC-08	PC-10	PC-12
1991	GE-12	GE-13	PC-03	PC-05	PC-07	PC-16
1992	GE-01	GE-06	PC-02	PC-06	PC-13	PC-14
1993	GE-02	GE-07	PC-04	PC-09	PC-11	PC-15
1994	GE-05	GE-11	PC-01	PC-08	PC-10	PC-12
1995	GE-04	GE-08	PC-03	PC-05	PC-07	PC-16
1996	GE-03	GE-09	PC-02	PC-06	PC-13	PC-14
1997	GE-10	GE-14	PC-04	PC-09	PC-11	PC-15

Discharges

Tritium

Radioactive gaseous effluents are released from four exhaust stacks on the site. Tritium gas, tritium oxide, and krypton-85 gas are discharged from the 70-foot Building 100 main stack (Location C, Figure 5-1); tritium gas and tritium oxide are discharged from the 100-foot Building 100 laboratory stack (Location D, Figure 5-1); from the 58-foot Building 200 exhaust stack (Location I, Figure 5-1); and from the 21-foot Building 800 stack (Location F, Figure 5-1). Discharges from the Building 100 main stack during the year totalled 34.4 Ci of tritium gas and 46.9 Ci of tritium oxide in $4.25E+11$ liters of air. Releases from the Building 100 laboratory stack during the year totalled 9.0 Ci of tritium gas and 13.0 Ci of tritium oxide in $3.72E+11$ liters of air. Calculated maximum ground level concentrations resulting from these discharges using the AIRDOS program, were less than 0.01% of the DOE DCG for tritium and krypton-85 and occurred at a distance of 500 yards from the plant site center.

Discharges from the Building 200 stack totalled 0.017 Ci of tritium gas and 0.09 Ci of tritium oxide in $6.83E+7$ liters of air. Discharges from the Building 800 stack totalled 0.33 Ci of tritium gas and 0.01 Ci of tritium oxide in $2.02E+10$ liters of air.

On-site perimeter tritium samples were analyzed to determine the tritium level resulting from the stack discharges and to monitor conformance with the radionuclide discharge standards set forth in the DOE DCG. The average concentrations detected at the on-site stations were $1.33E-11$ $\mu\text{Ci/cc}$ for tritium gas and $1.04E-11$ $\mu\text{Ci/cc}$ for tritium oxide. This is less than 0.01% of the DOE DCG for tritium oxide in air. The results are shown in Table 5-4. The highest average tritium oxide value obtained from the on-site perimeter stations was 0.016%, or approximately 6000 times less than the DOE DCG for tritium oxide. The highest average was a value taken from on-site monitoring Station No. 6. The maximum single value obtained (tritium oxide) was $1.51E-10$ $\mu\text{Ci/cc}$ (from Station No. 5), and the minimum single value was $0.03E-12$ $\mu\text{Ci/cc}$ (from Station No. 2).

Off-site tritium air samples also were analyzed. The average tritium concentrations detected at the off-site air sampling stations were $1.67E-12$ $\mu\text{Ci/cc}$ for tritium gas and $11.78E-12$ $\mu\text{Ci/cc}$ for tritium oxide. This oxide level is 0.012% of the DOE DCG. The highest average (tritium oxide) obtained from the off-site perimeter stations was 0.021%, or approximately 5000 times less than the DOE DCG. The results are shown in Table 5-5.

Table 5-4. On-Site Tritium Air Sample Results

Location*	Tritium Form	Range of Values** In Air	Average Value** In Air	Percent of DCG***
North, No. 2	Gas	0.03-3.33	0.68	0.007
	Oxide	2.72-11.48	7.06	
Northeast, No. 3	Gas	0.03-11.86	3.3	0.011
	Oxide	5.05-11.00	11.45	
East, No. 4	Gas	0.05-1.95	0.64	0.007
	Oxide	4.90-10.86	6.54	
Southeast, No. 5	Gas	0.07-150.74	32.56	0.009
	Oxide	6.68-16.95	9.29	
Southwest, No. 6	Gas	0.12-150.12	36.57	0.016
	Oxide	6.43-63.90	16.46	
Northwest, No. 1	Gas	0.26-17.76	6.1	0.012
	Oxide	6.93-29.34	11.88	

*See Figure 5-1.

**Value E-12 $\mu\text{Ci/cc}$

***DCG standard for tritium oxide in air: $1\text{E-}07 \mu\text{Ci/cc}$

Arithmetic mean:
(of all on-site stations) Gas - $1.33\text{E-}11 \mu\text{Ci/cc}$
 Oxide - $1.04\text{E-}11 \mu\text{Ci/cc}$

Minimum detection levels: Gas - $1.9\text{-}14.6\text{E-}12 \mu\text{Ci/cc}$
 Oxide - $2.3\text{-}13.7\text{E-}12 \mu\text{Ci/cc}$

Note: When the value reported was less than the MDL of the analysis method, the MDL was used as a value in arithmetic calculations.

Table 5-5. Off-Site Tritium Air Sample Results

Location*	Tritium Form	Range of Values** In Air	Average Value** In Air	Percent of DCG***
Clearwater (North)	Gas	0.04-8.36	2.12	0.007
	Oxide	2.91-12.12	7.28	
Civil Defense (Northeast)	Gas	0.43-5.40	2.21	0.006
	Oxide	3.24-11.70	6.22	
Pinellas Park (Southeast)	Gas	0.10-4.58	3.01	0.015
	Oxide	2.83-73.53	15.12	
Bay Pines (South)	Gas	0.50-0.96	0.73	0.021
	Oxide	5.71-50.79	20.96	
Walsingham (West)	Gas	0.17-0.38	0.28	0.009
	Oxide	5.19-14.51	9.34	

*See Figure 5-2.

**Value E-12 $\mu\text{Ci}/\text{ml}$

***DCG standard for tritium oxide in air: $1\text{E}-07 \mu\text{Ci}/\text{cc}$

Arithmetic mean:
(of all off-site stations) Gas - $1.67\text{E}-12 \mu\text{Ci}/\text{cc}$
 Oxide - $11.78\text{E}-12 \mu\text{Ci}/\text{cc}$

Minimum detection levels: Gas - $2.6-10.8\text{E}-12 \mu\text{Ci}/\text{cc}$
 Oxide - $2.7-11.7\text{E}-12 \mu\text{Ci}/\text{cc}$

Note: When the value reported was less than the minimum detection level of the analysis method, the MDL was used as a value in arithmetic calculations.

Krypton

All exhaust effluents containing krypton-85 are directed to the Building 100 main exhaust stack. Analysis of an air stream from this stack was performed continuously during 1989. The stream from the exhaust stack passes through a Kanne chamber which is connected to a picoammeter and a recorder. Discharges are calculated by the direct measurement of the radionuclide releases at the exhaust stack and by the inventory balance method. A total of 12.9 Ci of krypton-85 was discharged from the main stack in a total of $4.29\text{E} + 11$ liters of air. The average concentration at the point of release was, therefore, $3.1\text{E}-08$ $\mu\text{Ci}/\text{ml}$ or about 1% of the DCG.

Plutonium

Plutonium filter samples from the Building 400 exhaust ventilation system and the four on-site and five off-site monitoring stations were analyzed for plutonium-238 and plutonium-239 content throughout the year. All samples were reported as less than the minimum detection levels. The minimum detection level for the Building 400 samples ranged from $2.8\text{E}-12$ to $2.2\text{E}-10$ $\mu\text{Ci}/\text{cc}$. No plutonium releases occurred during 1989. All on-site perimeter air samples were reported as less than the minimum detection levels. The minimum detection level for these samples ranged from $1.1\text{E}-18$ to $6.5\text{E}-17$ $\mu\text{Ci}/\text{cc}$. The DOE DCG for plutonium-239 is $2\text{E}-14$ $\mu\text{Ci}/\text{cc}$. All off-site air samples were reported as less than the minimum detection levels. The minimum detection level for these samples ranged from $0.2\text{E}-18$ to $1.1\text{E}-17$ $\mu\text{Ci}/\text{cc}$.

Four on-site and four off-site soil samples were analyzed for plutonium during the past year. The four off-site soil samples were collected at locations surrounding the plant at distances from 2.5 to 3.7 miles. The minimum detection levels for both on-site and off-site plutonium-239 samples ranged from $8.5\text{E}-10$ to $3.2\text{E}-09$ $\mu\text{Ci}/\text{g}$ of soil. The results of the analysis of all eight samples were less than the respective minimum detection levels.

Discussion

A computer code [23] was used to calculate the environmental concentrations of tritium and krypton-85 in airborne releases. The closest plant site boundary is approximately 110 yards from the center of the plant site in a southwest direction. The maximum air concentration at this boundary was calculated to be $5.7\text{E}-11$ $\mu\text{Ci}/\text{cc}$ for tritium and $2.9\text{E}-13$ $\mu\text{Ci}/\text{cc}$ for krypton-85. The maximum ground level air concentrations may be determined for comparison with the nonoccupational exposure concentration standards listed in the DOE DCG for tritium and krypton-85 (see Table 2-1). The calculations were made to determine the distance and direction at which the maximum ground level air concentration would occur. These results are shown in Table 5-6. In the case of both tritium and krypton, the maximum concentration in any direction would occur at a distance 500 yards from the center of the plant site. The maximum concentrations of tritium and krypton obtained were found 500 yards west of the plant site and were 0.044% and 0.0002% of the respective DOE DCG values.

Table 5-6. Calculated Maximum Ground Level Concentrations of Radioactive Gaseous Effluents at 500 Yards* from the Pinellas Plant Site

Direction from Plant	Nuclide	Maximum Ground Level Concentration ($\mu\text{Ci/cc}$)	Percent of Standard**
N	H-3	7.0E-12	0.007
N	Kr-85	9.7E-13	<0.0001
NNW	H-3	6.2E-12	0.006
NNW	Kr-85	1.2E-12	<0.0001
NW	H-3	8.7E-12	0.009
NW	Kr-85	1.4E-12	<0.0001
WNW	H-3	1.1E-11	0.011
WNW	Kr-85	2.0E-12	<0.0001
W	H-3	1.7E-11	0.017
W	Kr-85	2.3E-12	<0.0001
WSW	H-3	7.3E-12	0.007
WSW	Kr-85	2.4E-12	<0.0001
SW	H-3	1.2E-11	0.012
SW	Kr-85	1.8E-12	<0.0001
SSW	H-3	7.4E-12	0.007
SSW	Kr-85	1.4E-12	<0.0001
S	H-3	7.5E-12	0.008
S	Kr-85	9.7E-13	<0.0001
SSE	H-3	5.2E-12	0.005
SSE	Kr-85	8.7E-13	<0.0001
SE	H-3	5.4E-12	0.005
SE	Kr-85	7.4E-13	<0.0001
ESE	H-3	6.1E-12	0.006
ESE	Kr-85	9.8E-13	<0.0001
E	H-3	8.5E-12	0.009
E	Kr-85	1.0E-12	<0.0001
ENE	H-3	6.0E-12	0.006
ENE	Kr-85	1.0E-12	<0.0001
NE	H-3	5.1E-12	0.005
NE	Kr-85	8.4E-13	<0.0001
NNE	H-3	5.5E-12	0.006
NNE	Kr-85	9.1E-13	<0.0001

* The maximum ground level concentrations occurred at a distance of 500 yards from the plant site center in all directions.

** DOE DCG or continuous nonoccupational exposure standard [10]:
tritium - 1.0E-07 $\mu\text{Ci/cc}$; krypton-85 - 3.0E-06 $\mu\text{Ci/cc}$

All of the monitoring results obtained at both the on- and off-site air monitoring stations were extremely small when compared to the DOE DCG of $1\text{E}-07 \mu\text{Ci/cc}$ for tritium oxide in air. On-site tritium oxide levels were 0.010% of the standard. Off-site tritium oxide levels were 0.012% of the same standard. These results support the conclusion that the contribution of the tritium discharges from the Pinellas Plant to the local environment is insignificant.

Sealed, encapsulated plutonium oxide sources are used on-site. The effluent from the industrial exhaust ventilation system from the building in which the sealed capsules are handled and stored is monitored for plutonium. The effluent passes through high efficiency particulate air (HEPA) filters prior to being released to the environment. These filters, along with those from on-site perimeter and off-site air monitoring stations, are analyzed for plutonium. All of the results obtained were below the analytical method minimum detection level. This result was not unexpected and supports the fact that no plutonium was released to the environment.

A total of eight soil samples were analyzed for plutonium during 1989, four on-site soil samples and four off-site soil samples. The on-site and off-site soil sample locations are shown in Figures 5-3 and 5-4, respectively. Off-site sample location descriptions are listed in Table 5-2. A soil sampling location schedule is given in Table 5-3. The results were less than the analytical method minimum detection level in all cases and are comparable to those found during the survey conducted prior to the introduction of plutonium sources at this site. These results also support the conclusion that no plutonium has been released from the site.

LIQUID EFFLUENTS

The effluent from the Pinellas Plant is directed to the Pinellas County POTW from the plant's Industrial Wastewater pH Neutralization Facility. This effluent is monitored daily for tritium. Effluents were directed to the POTW beginning in December 1982. Prior to that time, treated effluents were released in compliance with local regulations into the county drainage system from the East storm water retention pond. Although no plant effluents were directed to the East Pond during the period January 1983 to December 1989, overflow water discharges from the pond have occurred due to rainfall; and, since trace quantities of residual tritium were found in the pond, monitoring at this point was continued on a weekly basis. Water samples are obtained on a weekly basis from the West and South Ponds for tritium analysis. Both of these ponds are storm water retention ponds. Water samples are also collected during the year from several off-site water areas to judge the effect of the plant's operation on the local environment. The water areas sampled are selected on a random basis from a list of available sites (illustrated in Figure 5-4).

Figure 5-3. On-Site Soil Sample Locations (numbers represent approximate locations)

Figure 5-4. Off-Site Soil Sample Locations

Monitoring Procedures

Daily tritium analyses are performed on 24-hour composite samples from the Industrial Wastewater pH Neutralization Facility. Samples are collected by flow proportional sampling of releases to the POTW from the combined (industrial plus sanitary) effluent flume. Tritium concentrations are determined by liquid scintillation counting. Weekly grab samples for tritium analysis are collected at the overflow to the county storm water drainage system from the East and South storm water retention ponds. Weekly samples are collected at the bank of the West Pond. These are also analyzed using liquid scintillation techniques.

Discharges

A total of 362 combined samples discharged to the POTW were analyzed during the year. The maximum tritium concentration detected was $8.1\text{E-}05$ $\mu\text{Ci/ml}$. The minimum detection level ranged from $4.2\text{E-}07$ to $5.3\text{E-}07$ $\mu\text{Ci/ml}$. A total of 0.682 Ci of tritium were released in a volume of 1,482,176 liters of water from the radioactive wastewater holding tanks to the Industrial Wastewater pH Neutralization System. Releases from the Industrial Wastewater pH Neutralization System to the county POTW (as combined with the sanitary flow) totaled 228,029,970 liters in 1989. The resulting average tritium concentration in the effluents discharged to the POTW (as detected in the combined samples) was $5.7\text{E-}06$ $\mu\text{Ci/ml}$. The maximum allowable concentration for tritium in water released to public sanitary sewage systems is $1.0\text{E-}02$ $\mu\text{Ci/ml}$ [10] (see Table 2-1). The average concentration of the discharges from the Pinellas Plant to the county POTW during the year was 0.06%, or 1700 times lower than the standard. Based upon the average combined effluent $\mu\text{Ci/ml}$ value, it is calculated that a total of 1.15 Ci of tritium oxide was discharged from the Industrial Wastewater pH Neutralization Facility to the POTW in 1989.

A total of 51 samples from the East Pond were analyzed during the year. The maximum tritium concentration detected was $2.8\text{E-}06$ $\mu\text{Ci/ml}$, while the minimum was $3.8\text{E-}07$ $\mu\text{Ci/ml}$. The minimum detection level of the counting technique employed ranged from $3.8\text{E-}07$ to $5.1\text{E-}07$ $\mu\text{Ci/ml}$. The resulting average release concentration was $4.9\text{E-}07$ $\mu\text{Ci/ml}$. Releases from the East Pond during 1989 were 0.025%, or 4500 times lower than the standard for tritium in drinking water as set forth in the DOE DCG. A total of 102 weekly grab samples were analyzed from the West and South Ponds in 1989. The average values from the West and South Ponds were $4.9\text{E-}07$ and $5.5\text{E-}07$ $\mu\text{Ci/ml}$, respectively. The highest of these values is 3600 times lower than the standard set in the DCG.

All off-site water samples obtained to a distance of 8 miles from the plant site showed levels below the analysis method minimum detection level, ranging from $4.2\text{E-}07$ to $4.9\text{E-}07$ $\mu\text{Ci/ml}$.

Discussion

Tritium oxide is the only radioisotope in the plant's liquid effluents. Effluent discharges containing low levels of tritium oxide, following analysis, are directed to the POTW. Although no radioactive discharges are directed to the East, West, or South storm water retention ponds, these ponds are monitored on a weekly basis for tritium. The South Pond receives runoff from the plant's eastern and western parking lots and is interconnected with the East Pond. This connection is normally valved closed. The East Pond receives runoff from the

plant's northern parking lots and from the undeveloped areas of the plant site. The West Pond receives runoff primarily from the undeveloped area of the plant site. Storm water discharge from the East Pond travels through force main piping under Bryan Dairy Road for approximately one-half mile where it then enters a county drainage ditch. The ditch proceeds in a southerly direction into Cross Bayou Canal which leads to Cross Bayou and finally Boca Ciega Bay. Storm water discharge from the South Pond travels in a southwest direction in a drainage ditch. The ditch discharges into Cross Bayou Canal and ultimately Boca Ciega Bay. The West Pond does not discharge off-site.

Tritium activity was analyzed in 26 off-site water sources up to 8 miles from the plant in order to ascertain the effect of Pinellas Plant operations on the local environment. The tritium levels obtained were below the analysis method average minimum detection level of tritium in water of $4.5\text{E}-07 \mu\text{Ci/ml}$. This result is directly comparable to the average tritium levels obtained for the on-site ponds (East Pond, $4.9\text{E}-07$; West Pond, $4.9\text{E}-07$; and South Pond, $5.2\text{E}-07 \mu\text{Ci/ml}$) and is insignificant in comparison to the DCG of tritium in drinking water of $2\text{E}-03 \mu\text{Ci/ml}$. In all instances, the results of tritium analyses from the East, West, and South storm water retention ponds were well below this standard. The highest of these annual averages (the South Pond) was 3600 times lower than the standard. If one assumes that the tritium level obtained from the off-site water sources represents a natural environmental background, then (as the on-site ponds contain comparable levels of tritium activity) it follows that insignificant amounts of tritium have been contributed (either directly due to effluent discharge or indirectly due to exhaust stack discharge) to the on-site ponds by the continuous operation of the Pinellas Plant.

Discharges from the Pinellas Plant to the Pinellas County POTW during 1989 were, in all the samples analyzed, below the standard maximum allowable concentration for tritium in water released to public sanitary sewage systems as set forth in the DOE DCG. The annual average of the combined (industrial plus sanitary) discharges to the POTW was $5.07\text{E}-06 \mu\text{Ci/ml}$, or 0.05% of this standard. The contribution of the plant's effluent tritium to the POTW in 1989 was negligible when compared to this standard.

SECTION 6. EVALUATION OF POTENTIAL DOSE TO THE PUBLIC

The EPA computer code (AIRDOS-EPA) was used for calculating the environmental concentrations of and resultant doses from the Pinellas Plant airborne releases of tritium and krypton-85. These calculations showed the potential radiation doses to the public at the site perimeter, at the nearest residential area, and within 50 miles of the plant site. All of these values were exceedingly small. The average exposure for individuals within the 50-mile area surrounding the plant was $1.4\text{E}-03$ mrem. This value is 0.043% of the EPA standard of 10 mrem per year to the whole body [24] and is 0.004% of the DOE standard of 100 mrem to the whole body [10]. The total dose to the whole body of an individual with the maximum exposure to both tritium and krypton-85 (calculated using AIRDOS-EPA) was $2.8\text{E}-03$ mrem, or 0.028% of the EPA standard. The total dose commitment to the population residing within 50 miles of the site was determined to be 3.57 man-rem. This value is approximately 250,000 times lower than the annual background dosage of 902,000 man-rem received by the surrounding population from natural radiation [25].

TRITIUM

Calculations were made to estimate the radiation exposure to the public for the year 1989 as a result of airborne discharges of tritium gas and oxide from the Pinellas Plant. Three sets of calculations were performed to determine the radiation dose: to an individual at the site boundary, to an individual in the nearest residential area, and to the population residing within 50 miles of the plant site. The results and the methodology used in these determinations are summarized below.

Dose to an Individual at the Site Boundary

Through the use of atmospheric diffusion equations [26, 27] and historical wind data [5, 28], the determination of the location at the site boundary with the maximum exposure to tritium was made. The assumption was made that an individual remained at this location continuously throughout the entire year. The average continuous concentration of tritium to which this individual would be exposed was $3.29\text{E}-09$ $\mu\text{Ci/cc}$ of air. The total dose for this individual at the site boundary for an entire year was determined to be $2.84\text{E}-02$ mrem.

Dose to Individuals in the Nearest Residential Area

The nearest residential area is approximately 0.4 miles southwest of the plant site. Calculations similar to those described above were made for this location and, as before, it was assumed the residents remained continuously in the area for a whole year. The average concentration of tritium to which these individuals were exposed was $7.46\text{E}-09$ $\mu\text{Ci/cc}$, resulting in an annual dose of $4.12\text{E}-04$ mrem.

Dose to the Population Within 50 Miles of the Plant Site

Calculations were performed to determine the radiation exposure to all individuals residing within 50 miles of the plant site. This dose is expressed in units of man-rem; for example, if 1000 people resided in the area, and each received a radiation dose of 1 rem, the population dose would be 1000 man-rem. Figures published by the Bureau of Economic and Business Research at the University of Florida showed the 1988 estimated population within 50 miles of the plant site to be 2,504,296 [2]. Calculations were made to determine exposure concentrations based on population location. The resulting total radiation exposure to these individuals due to releases of radioactive material from the Pinellas Plant during the year was 10.52 man-rem. This results in a calculated average dose to each individual of approximately $4.2\text{E}-03$ mrem.

KRYPTON-85

During 1989, releases of krypton-85 totalled 12.9 Ci. Calculations were made (similar to those for tritium) to determine the dose to an individual at the site boundary. The average exposure concentration at the boundary was calculated to be $1.69\text{E}-10$ $\mu\text{Ci/cc}$ of air.

Individuals remaining in the nearest residential area during the year would be exposed to an average continuous concentration of $9.74\text{E}-10$ $\mu\text{Ci/ml}$ of air. Krypton-85 contribution to the whole body dose is 0.15%. The doses to population groups further from the plant site would be significantly lower. These were not calculated since they would be less than $1.0\text{E}-04$ percent of the DOE standard [29].

PLUTONIUM

There was no radiation dose to the public as a result of the use of plutonium at the Pinellas Plant because, as was verified by environmental monitoring (Section 5), none was released to the environment.

DISCUSSION

For the maximally exposed individual, the total dose to the whole body from both tritium and krypton-85, calculated using AIRDOS-EPA, was 0.028 mrem. Radiation protection standards for individuals and population groups are specified in DOE Draft Order 5480.11, "Radiation Protection (Occupational)" [29]. The standards promulgated by the EPA are specified in 40 CFR Part 61 Subpart H [24]. Table 6-1 was prepared as a means of evaluating the significance of the radiation exposures due to the radioactivity emissions from the Pinellas Plant.

Table 6-1. Pinellas Plant Area Radiation Dose Compared to Federal Standards [24, 29]

Dose Location	Total Effective Dose Equivalent		Annual Radiation Dose from Plant Operations		Total Dose (H3 + Kr)
	DOE	EPA	(mrem/yr)		(mrem/yr)
Site Boundary	100	25	0.00284 (Tritium)	0.00014 (Krypton-85)	0.00298
Nearest Residential Area	100	25	0.00041 (Tritium)	0.00006 (Krypton-85)	0.00047
Within 50-mile Radius	100	25	0.00140 (Tritium)	< 0.00010 (Krypton-85)	0.00141

Naturally Occurring Radiation

Another interesting comparison can be made between the radiation dose from plant activities and the radiation dose the population receives from naturally occurring radiation [12, 25]. Naturally occurring radiation results from three sources:

- Cosmic Radiation from Outer Space: The cosmic radiation dose varies significantly with altitude and longitude, less strongly with latitude.
- External Gamma Radiation: Naturally occurring radionuclides produce external gamma exposures. The major contributors are radon and its isotopes, which arise from uranium and thorium deposited in rocks, and potassium-40.
- Internal Radiation: The primary contributors to the internal radiation dose are potassium-40, polonium-210, radium-226, and carbon-14, which are ingested in foodstuffs, and radon-222 (and its daughter), which are inhaled.

An individual in the United States receives a dose of approximately 360 mrem/year from naturally occurring radiation [12]. When this figure is applied to the estimated population residing within 50 miles of the plant site, the comparison demonstrates the negligible impact on the population of the radionuclide releases from the Pinellas Plant. A comparison is given in Table 6-2.

Table 6-2. Comparison of the Annual Radiation Dose Received by the Surrounding Population* from Pinellas Plant Operations and from Natural Radiation Sources

Source of Exposure	Dose man-rem	Average mrem
Pinellas Plant Releases	3.57	0.0014
Natural Radiation	902,000	360

*The surrounding population within a 50-mile radius of the Pinellas Plant site is estimated at 2,504,296.

The dose to the surrounding population resulting from the release of radioactivity from the Pinellas Plant is exceedingly small when compared to the dose received from natural radiation sources. The effects of radiation released from the Pinellas Plant on the surrounding environment are negligible.

SECTION 7. ANALYTICAL QUALITY CONTROL PROGRAMS

Ensuring the quality of analytical results is an ongoing activity at the Pinellas Plant. This is accomplished in part by periodically scheduled instrument calibrations and analyses of known positive, blank, and replicate samples.

The Pinellas Plant also participates in external laboratory quality assurance programs in which analyses are performed on unknown samples from the EPA's Environmental Monitoring Support Laboratory, the DOE's Environmental Measurements Laboratory, and from the Environmental Resource Associates Laboratory, a commercial supplier of quality control samples. Analyses of quality assurance (QA) samples provide information regarding the capabilities of the analytical methods employed. The results are used to evaluate both accuracy and precision and are also helpful in solving any problems in laboratory techniques.

A mean "R" value is determined by dividing the reported value by the known value for each analysis. Thus, an R value greater than unity indicates a positive bias, while an R value less than unity indicates a negative bias. These results are used to identify and correct problems in the analytical techniques or equipment used for environmental monitoring.

A total of 5124 environmentally related analyses were completed by the Pinellas Plant's Environmental Chemistry Laboratory in 1989. Of this number, there were 3841 environmental monitoring samples, 176 replicates, 474 background, 558 standard, and 75 QA samples. The total number of QA samples represents 2.0% of the 3841 environmental monitoring samples analyzed by the laboratory in 1989. The QA results are shown in Table 7-1. The R values obtained for all of the analytical techniques were close to unity and well within accepted practices. Table 7-2 demonstrates the breakdown of quality control percentages by analysis category.

Table 7-1. GEND Environmental Chemistry Laboratory External Quality Assurance Program

Analysis	Matrix	Number of Samples	Mean R Value ($\pm$ 2 std. dev.)
BOD-5	Water	4	0.95 (0.24)
Cadmium	Water	4	0.96 (0.12)
Chromium-Total	Water	4	0.92 (0.12)
Copper	Water	3	1.03 (0.05)
Cyanide	Water	1	0.86 (0.00)
Lead	Water	4	1.26 (0.78)
Nickel	Water	4	1.01 (0.06)
Gross Alpha	Air	6	0.89 (0.12)
Pu-239	Air	4	1.01 (0.21)
Pu-239	Soil	2	1.02 (0.03)
Pu-239	Water	2	0.97 (0.11)
pH	Water	4	1.00 (0.03)
Suspended Solids	Water	3	1.09 (1.08)
Tritium	Water	8	0.99 (0.09)
Zinc	Water	4	0.92 (0.25)

Table 7-2. External Quality Assurance Analyses by Category

Analysis	Number of Environmental Monitoring Samples	Number of Quality Assurance Samples	Quality Assurance Percentage
Tritium	2741*	12	0.4
Gross Alpha	108	6	5.6
Plutonium	46	8	37.0
Water Ions	946	41	4.2
Total	3841	75	2.0**

*Includes all tritium samples in air and water.

**Represents the overall QA percentage.

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