PINELLAS PLANT

ENVIRONMENTAL MONITORING REPORT

1983

GEPP-EM--806

DE84 011161

Operating Contractor:

NEUTRON DEVICES DEPARTMENT
GENERAL ELECTRIC COMPANY
POST OFFICE BOX 11508
ST. PETERSBURG, FLORIDA 33733

This report was prepared in accordance with the requirements of U. S. Department of Energy Order 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements.

GEPP-EM-806
8828A-0369A

The Pinellas Plant is owned by the
UNITED STATES DEPARTMENT OF ENERGY

April, 1984

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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 Neutron Devices Department of the General Electric Company. The plant's approximately 1900 employees are engaged in the design, development and manufacture of special electronic and mechanical nuclear weapons components. The Department of Energy maintains a staff of 24 employees at the site.

SITE DESCRIPTION

The Pinellas Plant is located near the center of Pinellas County, Florida (Figure 1-1). The county itself is a peninsula bordered on the west by the Gulf of Mexico and on the east and south by Tampa Bay. Pinellas County has for a number of years been experiencing a rapid population growth and is currently the most densely populated county in the state. The April 1983 population estimate is 766,809. Latest population estimates for the major cities shown in Figure 1-1 are: Dunedin - 31,271; Clearwater - 91,879; Largo - 60,345; Pinellas Park - 35,861; and St. Petersburg - 240,933.[1]

Some light industry and warehousing operations are conducted in the area immediately surrounding the site. The closest residential areas are approximately 0.8 kilometers (1/2 mile) from the plant.

The plant site is shown on Figure 1-2. It 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 Seaboard Coast Line Railroad tracks. The size of the site is approximately 40.1 hectares (99.2 acres).

Approximately thirty-five percent of the site is occupied by structures, paved areas, etc. The remaining sixty-five percent is open space.

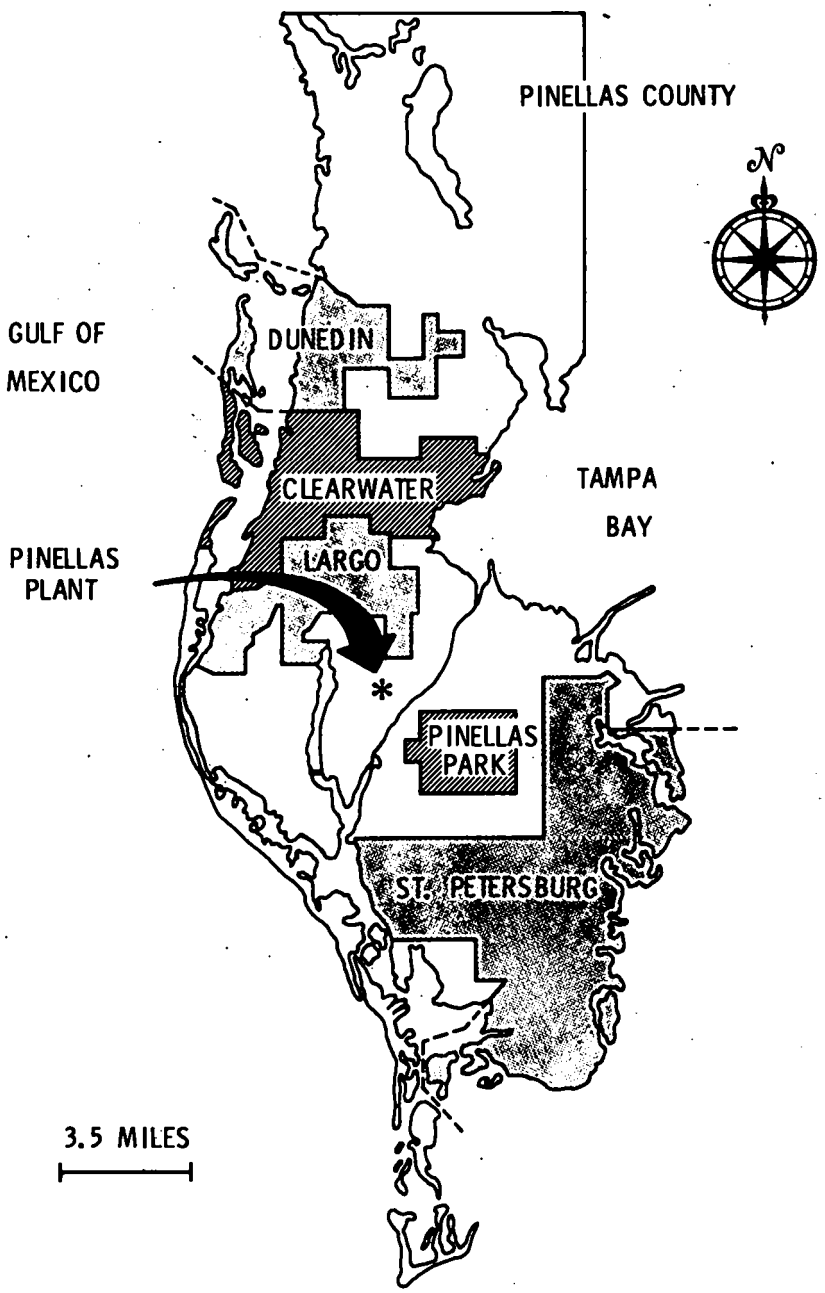

Figure 1-1. Location of Pinellas Plant

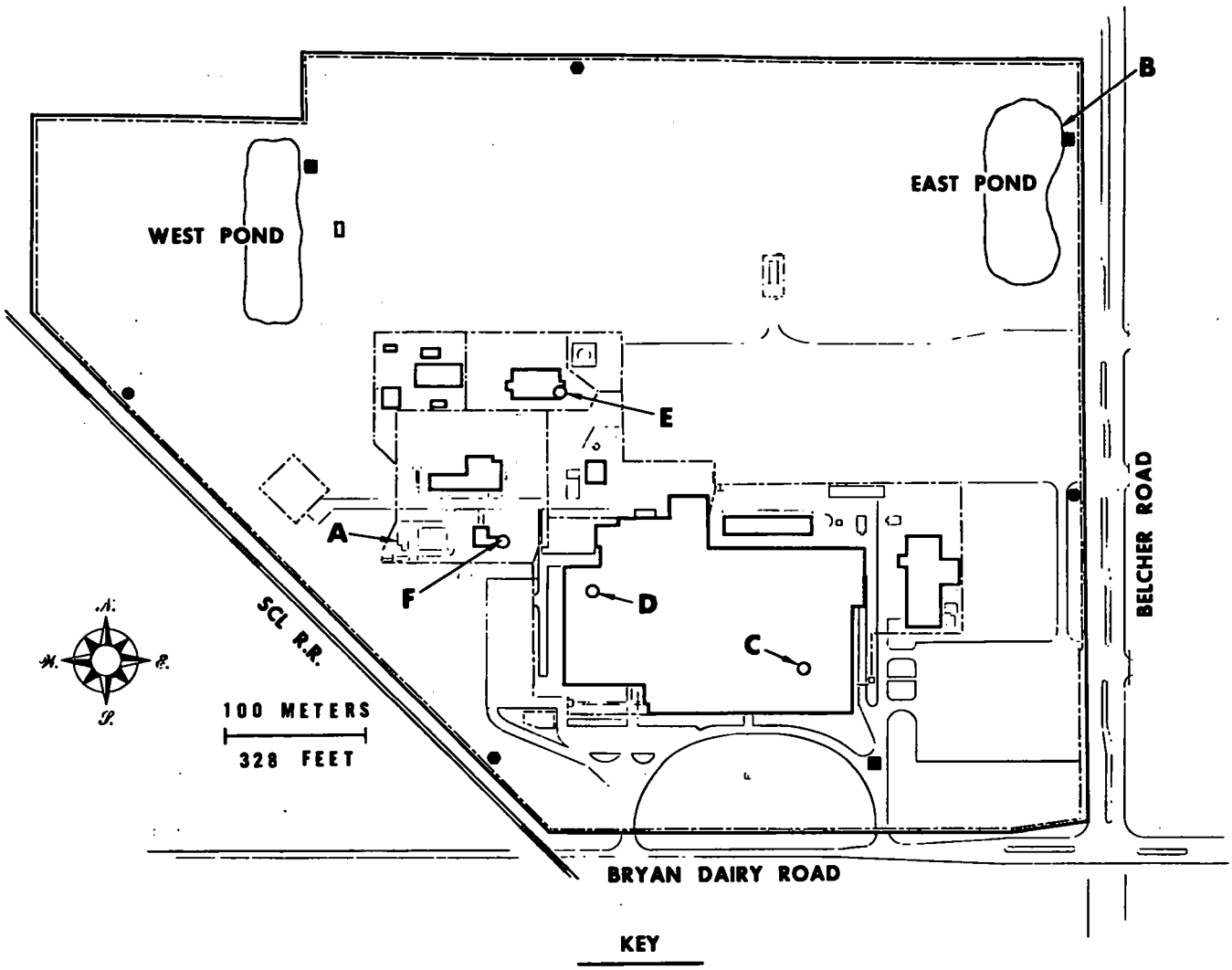

Figure 1-2. Plant Site

GEOLOGY AND HYDROLOGY

The area in which the Pinellas Plant is located 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 are covered by a sandstone and clay layer known as the Hawthorn Formation which is overlain by a surface layer of Myakka and Wabasso shelly sands. The Hawthorn Formation acts as a confining layer between the deeper artesian limestone layers referred to as the Floridan Aquifer and the non-artesian Shallow Aquifer.

The Shallow Aquifer is highly variable in distribution and thickness throughout the region and is generally considered a poor water source. The supply available is relatively small and the quality is commonly objectionable due to high organic color and the concentrations of iron and sulfates.

By far, the greatest amount of water utilized in Pinellas County comes from well fields which tap the Floridan Aquifer and are located in northeastern Pinellas County and in the two adjacent counties (Pasco and Hillsborough), which lie north and east of Pinellas.

THE ENVIRONMENT

The climate in this area is subtropical marine, characterized by long humid summers and mild winters. Average summer temperatures range between the low 20's Celsius (70's Fahrenheit) and the low 30's Celsius (90's Fahrenheit), while average winter temperatures range between the low 10's Celsius (50's Fahrenheit) and the low 20's Celsius (70's Fahrenheit). Freezes may occur once or twice in a season, although many winters have none. The temperatures throughout the year are modified by the waters of the Gulf and bays.[2]

The outstanding feature of the local climate is the summer thundershower season. On the average, thundershowers occur 90 days a year, mostly in the late afternoons during June, July, August, and September. This thundershower season, which is between a dry spring and a dry fall, accounts for about 75 centimeters (30 inches) of the normal annual rainfall of 125 centimeters (49 inches).[2]

The prevailing winds are from the north and northeast during the winter months, while during the rest of the year they are predominantly from the east and south. A westerly sea breeze occurs commonly during the afternoons in the summer months. The conditions result in a fairly uniform overall distribution of wind directions. The most frequent wind is from the east, occurring ten percent of the time. The average wind speed is 3.9 meters/second (8.8 miles/hour).[3]

The potential for hurricanes exists in this area. Based on records from 1866 through 1983, the relative frequency of a hurricane passing within a 80-kilometer (50-mile) radius of the plant site is one in every 8.4 years.[4]

Hurricane tidal flooding causes, by far, the greatest amount of damage. The Corps of Engineers has examined this site in relation to the design hurricane (once in 100+ years) for this area. The maximum anticipated high tide would be approximately 4.3 meters (14 feet) above mean sea level. Since the plant is located several miles inland and has a minimum floor height of 5.6 meters (18.5 feet) above sea level, no damage would occur from tidal flooding.

The probability of a tornado striking any point in Pinellas County, as determined from data covering the period 1950 through 1980 supplied by the National Severe Weather Forecast Center, is 4.3×10^{-4} per year.[5] Waterspouts moving ashore are also classed as tornadoes and were included in the calculation. Waterspouts almost always dissipate soon after reaching land and thus have no potential for reaching the site.

Earthquakes have occurred in Florida. The earliest recorded (and the most severe) earthquake took place on January 12, 1879, near St. Augustine. The tremors lasted for ten minutes and covered an area of 65,000 square kilometers (25,000 square miles) from Savannah, Georgia in the north, to Daytona Beach 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 escaped detection because of the distance to the nearest seismic station and because of the tendency of the residents to identify these with rockets or airplanes.

There is, however, no reasonable expectancy for damaging earthquakes at the Pinellas Plant. The seismic risk map of the United States shows central and southern Florida to be in Zone 0. This is defined as a "no damage" zone.

A more detailed discussion of the plant's operations, the surrounding environment, and the control systems utilized to reduce effluents to levels which are as low as reasonably achievable can be found in the Environmental Assessment for the Pinellas Plant, July, 1983.

Section 2

SUMMARY

The effluent and environmental monitoring programs maintained by the Pinellas Plant are designed to determine the efficiencies of treatment and control mechanisms; to provide measurements of discharge concentrations for comparison with applicable standards; and to assess the concentrations of these discharges in the environment.

This report was prepared in accordance with the requirements of U. S. Department of Energy Order 5484.1, "Environmental Protection, Safety, and Health Protection Information Reporting Requirements."[6]

RADIOACTIVE GASEOUS EFFLUENTS

Small quantities of tritium gas, tritium oxide, carbon-14 labeled solvent and krypton-85 gas were released from the plant during the year. Average maximum ground level concentrations of these radioisotopes were all less than 3/10 of 1 percent of the standard for continuous nonoccupational exposure.

LIQUID EFFLUENTS

The plant's combined sanitary and industrial liquid effluents are directed to a Pinellas County Publically Owned Treatment Works (POTW) and were analyzed for compliance with the Pinellas County Sewer Use Ordinance. Analyses were performed for arsenic, barium, biochemical oxygen demand, boron, cadmium, total chromium, trivalent chromium, hexavalent chromium, copper, cyanide, iron, lead, manganese, mercury, nickel, phenolics, selenium, silver, sulfides, suspended solids and zinc. All were in compliance with the exception of nickel and zinc. These are discussed in Section 3.

In addition to the non-radioactive parameters listed above, small quantities of radioactive tritium were released to the POTW and from the East Pond. Analyses showed the levels were less than 1/10 of one percent of the applicable standards.

ENVIRONMENTAL MONITORING

Site perimeter and off-site air samples for tritium gas and tritium oxide, as well as off-site surface water samples obtained to distance of 9.6 kilometers (6 miles) from the plant site and analyzed for tritium content, showed levels significantly less than 1/10 of 1 percent of the standard for continuous nonoccupational exposure.

Small sealed plutonium sources containing approximately 80 percent plutonium-238 oxide and 20 percent plutonium-239 oxide and other isotopes, are utilized at this site. No plutonium was released to the environment and monitoring data showed environmental background levels.

EVALUATION OF POTENTIAL DOSE TO THE PUBLIC

Calculations were made to determine the radiation doses resulting from releases of tritium oxide, krypton-85 and carbon-14 to: an individual at the site boundary; individuals in the closest residential area; and the population within 80 kilometers (50 miles) of the plant site. The calculated doses are exceedingly small when compared to the applicable standards. The total dose commitment to the population residing within 80 kilometers (50 miles) was determined to be 0.40 man-rem as compared to the annual dose from natural radiation of 243,117 man-rem.

Section 3

MONITORING DATA

RADIOACTIVE GASEOUS EFFLUENTS

Small quantities of tritium gas, tritium oxide, carbon-14 labeled solvent and krypton-85 gas were released from the plant during the year. Average maximum ground level concentrations of these radioisotopes were all less than 3/10 of 1 percent of the standards for continuous nonoccupational exposure.

Radioactive gaseous effluents are released from three exhaust stacks on the site. Tritium gas, tritium oxide and krypton-85 gas are discharged from the 21.3-meter (70-foot) Building 100 main stack (point C on Figure 1-2). Tritium gas, tritium oxide and carbon-14 are discharged from the 30.5-meter (100-foot) Building 100 laboratory stack (point D on Figure 1-2). Tritium gas and tritium oxide are discharged from the 6.4-meter (21-foot) Building 800 stack (point F on Figure 1-2).

Those pieces of processing equipment in Building 100 which utilize tritium are connected to the Tritium Recovery System. This system removes tritium oxide from gases vented from the equipment by collection in a moisture absorbing material. The system also converts tritium gas to tritium oxide, which is then also collected. The effluent from the system, from which 95 to 99+ percent of tritium has been removed, is directed into the Building 100 main stack.

Monitoring Procedures

A continuous air sample is passed through a column of silica gel which collects the tritium oxide. Another air sample is passed through a heated column containing copper oxide which converts the tritium gas to tritium oxide and then through a silica gel column. This column thus collects both tritium gas and oxide. The moisture is removed from the columns by distillation and analyzed by liquid scintillation counting. Comparison of the tritium removed from the two columns is used to determine gas discharge. The columns are analyzed monthly.

Krypton-85 discharges are determined by a continuous air sample drawn through a Kanne-type ionization chamber connected to a picoammeter and recorder.

Carbon-14 discharges are determined from the volumes of carbon-14 containing solvent used during the year.

Discharges

Discharges from the Building 100 main stack totaled 219.80 curies of tritium gas, 71.61 curies of tritium oxide and 11.33 curies of krypton-85 in 5.96×10^{11} liters of air.

Releases from the Building 100 laboratory stack during the year totaled 39.19 curies of tritium gas, 80.10 curies of tritium oxide and 1.0×10^{-5} curies of carbon-14 in 3.99×10^{11} liters of air.

Discharges from the Building 800 stack totaled 0.48 curies of tritium gas and 0.64 curies of tritium oxide in 6.59×10^{10} liters of air.

Discussion

By applying atmospheric diffusion equations (Sutton's)[7] to the stack discharges, average maximum ground level concentrations may be determined for comparison with the nonoccupational exposure concentration standards listed in USDOE Order 5480.1, Chapter XI, "Requirements for Radiation Protection."[8] Using average daytime weather parameters, these calculations were made for the points of maximum ground level concentration and are shown in Table 3-1. They would occur approximately 110 to 160 meters (360 to 525 feet) downwind from the Building 100 stacks, and, depending on wind direction, could be either on or off site (Figure 1-2). For Building 800 releases, the location would be approximately 25 to 30 meters (80 to 100 feet) downwind and all would occur on site.

Table 3-1. Calculated Ground Level Concentrations of Radioactive Gaseous Effluents

Discharge Point	Maximum Ground Level Concentration (μCi/ml)	Percent of Standard
Building 100 Main Stack		
Tritium Gas	4.7×10^{-10}	2.4×10^{-1}
Tritium Oxide	1.5×10^{-10}	7.7×10^{-2}
Krypton-85 Gas	2.4×10^{-11}	8.1×10^{-3}
Building 100 Lab Stack		
Tritium Gas	4.4×10^{-11}	2.2×10^{-2}
Tritium Oxide	8.9×10^{-11}	4.5×10^{-2}
Carbon-14	1.1×10^{-17}	1.1×10^{-8}
Building 800 Stack		
Tritium Gas	1.2×10^{-11}	5.9×10^{-3}
Tritium Oxide	1.6×10^{-11}	7.9×10^{-3}
USDOE continuous nonoccupational exposure standard		
Tritium Gas	2.0×10^{-7} μCi/ml	
Tritium Oxide	2.0×10^{-7} μCi/ml	
Krypton-85	3.0×10^{-7} μCi/ml	
Carbon-14	1.0×10^{-7} μCi/ml	

SOLID WASTES

Non-Radioactive Solid Wastes

Chemical

Solid chemical wastes, which also include waste solvents, are handled in accordance with Hazardous Waste Management System regulations of the USEPA Resource Conservation and Recovery Act. They are shipped to an off-site permitted disposal facility.

Scrap Metal

Scrap metal is collected, segregated by type, and when sufficient quantities are accumulated, sold for recycling.

Other Wastes

These wastes consisting of trash, garbage, paper, wood and other nonreusable materials are transported to the county incinerator/resource recovery installation.

Radioactive Solid Wastes

During the year, 26.2 cubic meters of tritium contaminated solid wastes were shipped from the site. Since the majority of these wastes are classified, they are transported to a DOE controlled storage site by couriered shipment.

The wastes are packed in new Department of Transportation Specification 17H steel drums in the areas of generation. Wastes which can be reduced in volume are compacted in the drums. Small amounts of radioactive liquid wastes, primarily oils, are converted to a non-liquid state by use of an absorbing compound and are included with the solid wastes. The drums are sealed, monitored to insure no external contamination is present and transferred to a locked storage building to await shipment.

LIQUID EFFLUENTS

Sample analyses revealed that, with the exception of results for nickel and zinc, all non-radioactive sanitary and industrial effluents directed to the POTW were within the limits set forth in the Pinellas County Sewer Use Ordinance. Also, the small quantity of tritium in these effluents averaged less than 1/10 of one percent of the applicable standard.

Plant effluents were directed to the POTW beginning in December 1982. Prior to that time, treated effluents were released into a county drainage system from the East Pond. The effluent travels through piping east on Bryan Dairy Road approximately one-half mile where it enters a drainage ditch. The ditch proceeds in a southerly direction into Cross Bayou Canal which leads to Cross Bayou and finally Boca Ciega Bay. Although no plant effluents were directed to the East Pond during 1983, discharges occurred due to rainfall and, since trace quantities of tritium were in the pond, monitoring at this point was continued during 1983. The discharges of tritium during the year averaged less than 1/10 of one percent of the applicable standard.

Non-Radioactive Liquid Effluents

Monitoring Procedures

Monthly samples were collected and analyzed to determine conformance with the parameters listed in the Pinellas County Sewer Use Ordinance.

During the period January through March, samples were analyzed from both the sanitary and industrial waste streams. For sanitary wastes, the monthly sample consisted of a composite of 24 hourly grab samples. For industrial wastes, the monthly sample consisted of a 24-hour sample from a continuous proportional sampler. During April, a continuous proportional sampler was installed to sample the combined sanitary/industrial waste stream. During the remainder of the year, the monthly sample consisted of a 24-hour sample from this location.

All samples were analyzed in accordance with the methods prescribed in Title 40, Code of Federal Regulations, Part 136 - Guidelines Establishing Test Procedures for the Analysis of Pollutants.

Discharges

Table 3-2 summarizes the analyses of effluents released from the site during 1983. It 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 minimum detection level of the analytical technique employed. In Table 3-2, and all subsequent tables in this report, values preceded by a less than (<) symbol indicate no detectable amounts were found and are reported as less than the minimum detection level of the analytical technique. Analyses showing less than the minimum detection level were assigned this value when computing averages.

Table 3-2. Liquid Effluent Analyses

Parameter	Number of Analyses	Concentration (mg/l) County Limit	Range	Average (±2 SD)*	Minimum Detection Level
Arsenic	16	0.1	<0.002-<0.03	<0.03(±0.01)	0.002-0.03
Barium	16	1.0	0.01-0.09	0.03(±0.01)	0.005
BOD-5	15	<~250	14-230	91(±8)	1
Boron	15	1.0	<0.04-0.35	<0.10(±0.04)	0.04
Cadmium	15	0.2	<0.001-0.011	<0.003(±0.002)	0.001
Chromium-Total	15	2.0	<0.01-0.05	<0.02(±0.01)	0.01
Chromium-Trivalent	15	1.0	<0.01-0.05	<0.02(±0.01)	0.01
Chromium-Hexavalent	15	1.0	<0.01-<0.01	<0.01	0.01
Copper	16	1.0	<0.03-0.31	0.13(±0.03)	0.01
Cyanide	15	0.8	0.002-0.220	<0.07(±0.04)	0.002-0.05
Iron	16	5.0	0.32-1.35	0.86(±0.14)	0.01
Lead	16	0.1	0.02-0.06	0.05(±0.01)	0.02
Manganese	16	1.0	0.03-0.32	0.12(±0.05)	0.01
Mercury	15	0.1	<0.0001-0.005	<0.0009(±0.0007)	0.0001
Nickel	16	1.0	0.05-1.10	0.34(±0.14)	0.05
Phenolics	14	0.1	<0.001-0.054	0.015(±0.008)	0.001
Selenium	16	0.05	<0.001-0.001	<0.001	0.001
Silver	16	0.05	0.002-0.030	0.016(±0.004)	0.002
Sulfide	16	50	<1.0-3.9	<1.4(±0.4)	1.0
Suspended Solids	15	<~250	4.8-97.0	33.3(±12.5)	1
Zinc	16	0.08	0.08-0.25	0.16(±0.02)	0.02

*Values in parentheses indicate ±2 standard deviations.

Discussion

Nickel. During June, the nickel analysis showed 1.1 mg/l which exceeded the county standard of 1.0 mg/l. Investigation revealed a laboratory plating operation to be the probable cause. The operation now segregates plating wastes for off-site disposal.

Zinc. Fifteen of the sixteen analyses for zinc performed during the year, exceeded the county standard of 0.08 mg/l. The maximum concentration detected was 0.25 mg/l while the overall average was 0.16 mg/l. Analyses have shown the major source of zinc in the plant effluents results from galvanized piping in the older portions of the plant's potable water distribution system.

Radioactive Liquid Effluents

Tritium oxide is the only radioisotope in the plant's liquid effluents.

Monitoring Procedures

Analyses were performed of composite samples collected by proportional sampling of releases to the POTW. The tritium concentrations were determined by liquid scintillation counting.

Analyses were performed of grab samples collected at the beginning and end of each release from the East Pond. These were also counted using liquid scintillation techniques.

Discharges

During the year, 350 samples of discharges to the POTW were analyzed. The maximum tritium concentration detected was 7.8×10^{-4} µCi/ml while the minimum was 3.6×10^{-7} µCi/ml. The minimum detection level of the counting technique employed ranged from 1.2 to 3.0×10^{-7} µCi/ml. A total of 1.90 curies were released in a volume of 2.1×10^{8} liters of water. The resulting average discharge concentration was 9.0×10^{-6} µCi/ml.

The standard for tritium in water released to public sanitary sewage systems as set forth in DOE Order 5480.1 is 1×10^{-1} µCi/ml. The discharges from the Pinellas Plant during 1983 averaged 0.009 percent of that standard.

During the year, 102 samples of releases from the East Pond were analyzed. The maximum tritium concentration detected was 5.0×10^{-6} µCi/ml while the minimum was 6.0×10^{-7} µC/ml. The minimum detection level of the counting technique employed ranged from 1.2 to 3.0×10^{-7} µCi/ml. A total of 0.37 curie was released in a volume of 2.74×10^{8} liters of water. The resulting average release concentration was 1.4×10^{-6} µCi/ml.

The standard for tritium in water released to surface waters as set forth in DOE Order 5480.1 is 3.0×10^{-3} µCi/ml. The releases from the Pinellas Plant during 1983 averaged 0.05 percent of that standard.

ENVIRONMENTAL MONITORING

Site perimeter and off-site air samples for tritium gas and tritium oxide, as well as off-site surface water samples obtained to distances of 9.6 kilometers (6 miles) from the plant site and analyzed for tritium content, showed levels significantly less than 1/10 of 1 percent of the standard for continuous nonoccupational exposure.

Small sealed plutonium sources are utilized at this site. No plutonium was released to the environment and monitoring data showed environmental background levels only.

Tritium

On-Site Air Monitoring

Monitoring Procedures. Six on-site air sampling stations which monitor the atmosphere for both tritium gas and tritium oxide operated continuously during the year. The stations are located around the perimeter of the plant site and are shown in Figure 1-2. The samples were analyzed at four-week intervals by the same method as that used to monitor exhaust stack effluents (see Radioactive Gaseous Effluents - Monitoring Procedures, page 3-1).

Results. Samples were analyzed to determine conformance with the nonoccupational exposure standards set forth in DOE Order 5480.1. The average concentrations detected were less than 12.5×10^{-12} µCi/ml for tritium gas and less than 13.0×10^{-12} µCi/ml for tritium oxide. These results are less than 0.006 and 0.007 percent respectively of the standard. The results are shown in Table 3-3.

Table 3-3. Perimeter/Tritium Air Samples

Location*	Tritium Form	Concentration in Air x 10^{-12} µCi/ml Range	Average (±2 SD)**	Percent of Standard
North	Gas	3.8-75.6	27.1(±9.6)	0.014
	Oxide	8.7-59.9	25.8(±8.0)	0.013
Northeast	Gas	<1.2-14.0	<3.6(±1.9)	<0.002
	Oxide	<1.1-28.4	<8.0(±4.5)	<0.004
East	Gas	<1.1-9.8	<3.3(±1.7)	<0.002
	Oxide	2.2-17.3	6.3(±2.9)	0.003
Southeast	Gas	<1.1-229.0	<22.1(±33.3)	<0.011
	Oxide	4.6-60.1	14.6(±7.7)	0.007
Southwest	Gas	<1.0-64.8	<12.2(±10.4)	<0.006
	Oxide	2.9-26.8	14.1(±4.6)	0.007
Northwest	Gas	<1.9-40.6	<6.8(±5.6)	<0.003
	Oxide	1.8-22.8	9.2(±3.4)	0.005
Arith Mean:	Gas		<12.5	<0.006
	Oxide		<13.0	<0.007

*See Figure 1-2.

**Values in parentheses indicate ±2 standard deviations.

Minimum detection levels: Gas 1.0-2.5 x 10^{-12} µCi/ml
Oxide 1.0-2.5 x 10^{-12} µCi/ml

Results showing less than the minimum detection level were assigned this value when computing averages.

Standard: Tritium gas and tritium oxide 2 x 10^{-7} µCi/ml.

Off-Site Air Monitoring

Monitoring Procedures. Five off-site air monitoring stations which monitor the atmosphere for both tritium gas and tritium oxide operated continuously during the year. Their locations are shown on Figure 3-1. The monitoring technique is the same as that used for the on-site stations described above.

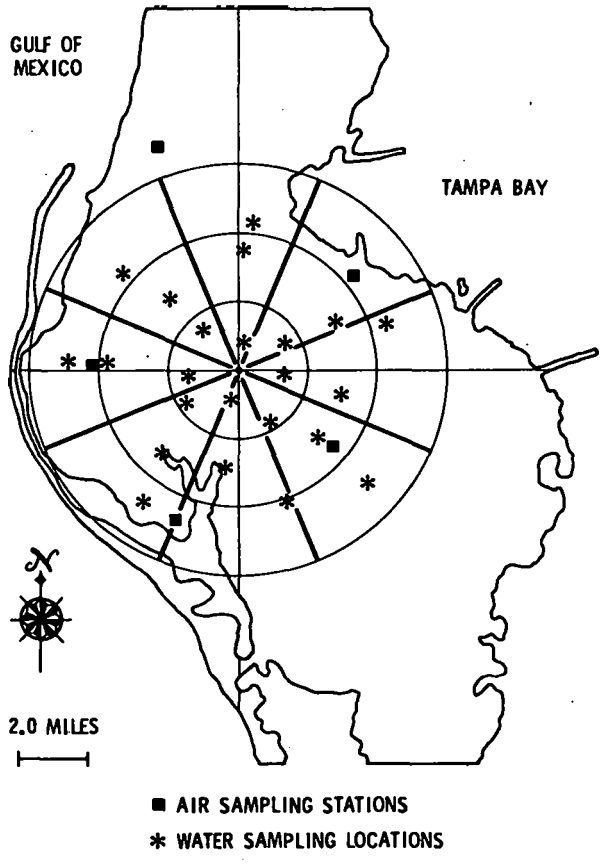

Figure 3-1. Off-Site Sampling Locations

Results. Samples were analyzed to determine conformance with the nonoccupational exposure standards set forth in DOE Order 5480.1. The average concentrations detected were less than 6.2×10^{-12} µCi/ml for tritium gas and less than 4.0×10^{-12} µCi/ml for tritium oxide. These results are less than 0.003 and 0.002 percent respectively of the concentration guide. The results are shown in Table 3-4.

Table 3-4. Off-Site/Tritium Air Samples

Location*	Tritium Form	Concentration in Air x 10^{-12} µCi/ml Range	Average (±2 SD)**	Percent of Standard
North	Gas	1.3-44.0	18.6(±8.3)	0.009
	Oxide	<1.1-27.0	<5.6(±4.3)	<0.003
Northeast	Gas	<1.2-26.9	<3.9(±4.0)	<0.002
	Oxide	<1.1-17.3	<3.9(±2.8)	<0.002
Southeast	Gas	<1.1-6.7	<2.8(±1.1)	<0.001
	Oxide	<1.2-4.3	<2.0(±0.5)	<0.001
South	Gas	<1.1-12.2	<3.9(±2.0)	<0.002
	Oxide	<1.1-23.7	<5.7(±3.8)	<0.003
West	Gas	<1.1-1.4	<1.6(±0.2)	<0.001
	Oxide	<1.1-10.0	<2.6(±1.3)	<0.001
Arith Mean:	Gas		<6.2	<0.003
	Oxide		<4.0	<0.002

*See Figure 3-1.

**Values in parentheses indicate ±2 standard deviations.

Minimum detection levels: Gas 1.0-2.5 x 10^{-12} µCi/ml
Oxide 1.1-2.5 x 10^{-12} µCi/ml

Results showing less than the minimum detection level were assigned this value when computing averages.

Standard: Tritium gas and tritium oxide 2 x 10^{-7} µCi/ml.

Off-Site Surface Water Monitoring

Monitoring Procedures. The area surrounding the plant has been divided into eight equal, pie-shaped segments with the center line of each being one of the major compass points. These segments were further divided by arcs at distances of 3.2, 6.4, and 9.6 kilometers (2, 4, and 6 miles). This procedure results in a total of 24 sectors. With the exception of the 6.4- to 9.6-kilometer (four- to six-mile) northeast sector (mostly in Tampa Bay), samples of surface water from ponds, lakes and ditches were collected quarterly during the year from each location and analyzed by liquid scintillation counting for tritium content. During 1983, 92 samples were analyzed. The location of these samplings is shown on Figure 3-1.

Results. The results are shown in Table 3-5, together with a comparison with standards set forth in DOE Order 5480.1. The average concentration detected was less than 2.1 x 10^{-7} µCi/ml which is less than 0.007 percent of the standard.

Table 3-5. Tritium in Surface Water

Location*		Concentration x 10^{-7} µCi/ml		
Direction	Distance (km)	Range	Average (±2 SD)**	Percent of Standard
North	0-3.2	<1.4-2.2	<1.6(±0.3)	<0.005
North	3.2-6.4	<1.3-<1.4	<1.4(±0.1)	<0.005
North	6.4-9.6	<1.3-2.7	<1.7(±0.6)	<0.006
Northeast	0-3.2	<1.3-3.1	<1.8(±0.8)	<0.006
Northeast	3.2-6.4	<1.4-1.9	<1.5(±0.2)	<0.005
East	0-3.2	1.3-<1.5	<1.4(±0.1)	<0.005
East	3.2-6.4	<1.4-37.0	<10.2(±15.4)	<0.034
East	6.4-9.6	<1.3-<1.4	<1.4(±0.1)	<0.005
Southeast	0-3.2	<1.3-<1.5	<1.4(±0.1)	<0.005
Southeast	3.2-6.4	<1.0-1.6	<1.4(±0.2)	<0.005
Southeast	6.4-9.6	<1.4-3.4	<2.0(±0.8)	<0.007
South	0-3.2	<1.0-10.0	<3.6(±3.7)	<0.012
South	3.2-6.4	<1.0-1.9	<1.5(±0.3)	<0.005
South	6.4-9.6	<1.0-1.5	<1.4(±0.2)	<0.005
Southwest	0-3.2	<1.0-1.4	<1.4(±0.2)	<0.005
Southwest	3.2-6.4	<1.0-<1.5	<1.4(±0.2)	<0.005
Southwest	5.9-9.6	<1.0-5.0	<2.2(±1.6)	<0.007
West	0-3.2	<1.0-<1.5	<1.4(±0.2)	<0.005
West	3.2-6.4	<1.4-2.5	<1.7(±0.5)	<0.006
West	6.4-9.6	<1.4-<1.5	<1.4(±0.1)	<0.005
Northwest	0-3.2	<1.5-5.6	<2.6(±1.7)	<0.009
Northwest	3.2-6.4	<1.4-<1.5	<1.4(±0.1)	<0.005
Northwest	6.4-9.6	<1.4-<1.5	<1.4(±0.1)	<0.005
		Arith Mean	<2.1	<0.007

*See Figure 3-1.

**Value in parentheses indicate ±2 standard deviations.

Minimum detection level: 1.0-1.6 x 10^{-7} µCi/ml.

Results showing less than the minimum detection level were assigned this value when computing averages.

Standard: 3.0 x 10^{-3} µCi/ml.

Plutonium

Small sealed plutonium capsules are used as heat sources in the manufacture of radioisotopic thermoelectric generators at the Pinellas Plant. The heat sources, which are triply encapsulated in metal, are produced at another DOE site. These encapsulations are designed to ensure complete containment of the plutonium under the most extreme potential accident conditions.

Even though the plutonium is completely contained by the encapsulations, an environmental sampling program is maintained because of the presence of the material on the plant site.

The method of analyses of all the samples described below consisted of: (1) aliquoting, (2) introduction and chemical equilibration of a plutonium-242 tracer for recovery efficiency determination, (3) acid digestion of the sample, (4) plutonium isolation by anion exchange, (5) electrodeposition and (6) alpha spectrometric analysis.

On-Site Stack Monitoring

Monitoring Procedures. The exhaust stack of Building 400 (see Figure 1-2), where the heat sources are stored and used, was continuously monitored during the year. The monitoring system sampled the exhaust effluent at a rate of 3700 l/h (2.2 ft^3/min). Microsorban* filter material was used for these and all other environmental plutonium air samples. The filters were changed weekly and composited for quarterly analysis.

Results. Samples were analyzed for plutonium-238 and plutonium-239 content. The results are shown in Table 3-6 together with comparisons to the nonoccupational exposure standards set forth in DOE Order 5480.1, Chapter XI, "Requirements for Radiation Protection."

*Trademark, Delbag-Luftfilter, Halensee, Germany

Table 3-6. Plutonium Stack Monitoring

Isotope	Concentration in Air x 10^{-18} µCi/ml Range	Average (±2 SD)*	Percent of Standard
Plutonium-238	1.0-<2.8	<1.8(±0.7)	<0.003
Plutonium-239	<1.0-<2.8	<1.8(±0.7)	<0.003

*Values in parentheses indicate ±2 standard deviations.

Results showing less than the minimum detection level were assigned this value when computing averages.

Minimum Detection Levels: Plutonium-238 1.0-2.8 x 10^{-18} µCi/ml
Plutonium-239 1.0-2.8 x 10^{-18} µCi/ml

Standard: Plutonium-238 7 x 10^{-14} µCi/ml
Plutonium-239 6 x 10^{-14} µCi/ml

On-Site Air Monitoring

Monitoring Procedures. Four site perimeter air sampling stations were operated continuously during the year. Their locations are shown in Figure 1-2. Ambient air was sampled at a rate of 5600 l/h (3.3 ft^3/min). The filters were changed at two-week intervals and composited for quarterly analysis.

Results. Table 3-7 shows the results from each of the perimeter samplers.

Table 3-7. Perimeter/Plutonium Air Samples

Sample* Station	Isotope	Concentration in Air x 10^{-18} µCi/ml Range	Average (±2 SD)**	Percent of Standard
North	Pu-238	<0.5-<1.9	<1.3(±0.6)	<0.002
	Pu-239	<0.5-<1.9	<1.3(±0.6)	<0.002
East	Pu-238	<1.0-<1.8	<1.4(±0.3)	<0.002
	Pu-239	<1.0-<1.8	<1.4(±0.3)	<0.002
South	Pu-238	<0.5-<1.7	<1.2(±0.5)	<0.002
	Pu-239	<0.5-<1.7	<1.2(±0.5)	<0.002
West	Pu-238	0.5-<1.3	<0.8(±0.3)	<0.001
	Pu-239	<0.5-<1.3	<0.8(±0.3)	<0.001
Arith Mean:	Pu-238		<1.2	<0.002
	Pu-239		<1.2	<0.002

*See Figure 1-2.
**Values in parentheses indicate ± 2 standard deviations.

Results showing less than the minimum detection level were assigned this value when computing averages.

Minimum Detection Levels: Plutonium-238 0.5-1.9 x 10^{-18} µCi/ml
Plutonium-239 0.5-1.9 x 10^{-18} µCi/ml

Standard: Plutonium-238 7 x 10^{-14} µCi/ml
Plutonium-239 6 x 10^{-14} µCi/ml

Off-Site Air Monitoring

Monitoring Procedures. Five off-site air sampling stations were operated continuously during the year. Their locations are shown on Figure 3-1. The sampling rate was 5600 l/h (3.3 ft^3/min). The filters were changed at two-week intervals and composited for quarterly analysis.

Results. Table 3-8 shows the results of the samples analyzed from each of the off-site sampling stations.

Table 3-8. Off-Site/Plutonium Air Samples

Sample* Station	Isotope	Concentration in Air x 10^{-18} µCi/ml Range	Average (±2 SD)**	Percent of Standard
North	Pu-238	<0.5-<1.0	<0.8(±0.2)	<0.001
	Pu-239	<0.5-<1.0	<0.8(±0.2)	<0.001
Northeast	Pu-238	<0.6-<3.7	<1.4(±1.3)	<0.002
	Pu-239	<0.6-<3.7	<1.4(±1.3)	<0.002
Southeast	Pu-238	<0.5-<4.2	<1.7(±1.5)	<0.002
	Pu-239	<0.5-<4.2	<1.7(±1.5)	<0.003
South	Pu-238	<0.7-<4.2	<1.6(±1.5)	<0.002
	Pu-239	<0.7-<4.2	<1.6(±1.5)	<0.003
West	Pu-238	<1.0-<5.0	<2.1(±1.7)	<0.003
	Pu-239	<1.0-<5.0	<2.1(±1.7)	<0.004
Arith Mean:	Pu-238		<1.5	<0.002
	Pu-239		<1.5	<0.003

*See Figure 3-1.
**Values in parentheses indicate ±2 standard deviation.

Results showing less than the minimum detection level were assigned this value when computing averages.

Minimum Detection Levels: Plutonium-238 0.5-5.0 x 10^{-18} µCi/ml
Plutonium-239 0.5-5.0 x 10^{-18} µCi/ml

Standard: Plutonium-238 7 x 10^{-14} µCi/ml
Plutonium-239 6 x 10^{-14} µCi/ml

Soil Monitoring

Monitoring Procedures. Two on-site soil samples were analyzed for plutonium content during the year. In addition, four off-site soil samples collected at locations surrounding the plant at distances from 4 to 6 kilometers (2.5 to 3.7 miles) were also analyzed. Each sample consisted of a composite of three 9 cm (3.5 in) diameter by 5 cm (2 in) deep plugs. They were dried to constant weight at 110°C prior to analysis. The results are shown in Table 3-9.

Table 3-9. Plutonium Soil Samples

Location	Concentration in Soil x 10^{-9} µCi/gm Isotope	Range	Average (±2 SD)*
On-Site	Pu-238	<0.7-<1.9	<1.3(±0.8)
	Pu-239	<0.7-<1.9	<1.3(±0.8)
Off-Site	Pu-238	<0.8-<2.2	<1.4(±0.6)
	Pu-239	<0.8-<2.2	<1.4(±0.6)

*Values in parentheses indicate ±2 standard deviation.

Minimum Detection Levels: Plutonium-238 0.7-2.2 x 10^{-9} µCi/gm
Plutonium-239 0.7-2.2 x 10^{-9} µCi/gm

Discussion

The results of all the various types of samples described above are comparable to those found during the preoperational survey conducted prior to the introduction of the plutonium sources at this site. The results are also in agreement with environmental levels detected at other locations and attributed to global fallout.

ANALYTICAL QUALITY CONTROL PROGRAMS

Assuring the quality of analytical results is a continuing activity at the Pinellas Plant. This is accomplished by such programs as periodic scheduled instrument calibrations, the analyses of known positive and blank samples, the preparation of statistical quality control charts and duplicate and triplicate analyses of the same sample.

The plant also participates in laboratory quality assurance programs in which analyses were performed on unknown samples from the USEPA Environmental Monitoring Support Laboratory, the USDOE Environmental Measurements Laboratory and a commercial supplier of quality control samples.

The analyses of quality assurance 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 methodologies.

For each analysis an R value is determined by dividing the reported value by the known value. Thus, an R value greater than unity indicates a positive bias, while one less than unity indicates a negative bias.

Mean R values were calculated for each type of quality assurance analysis in each type of matrix. The standard deviation of each mean R value was also determined assuring normal (Gaussian) distribution. These are shown in Table 3-10 together with the number of analyses performed.

Table 3-10. Quality Assurance Sample Analyses

Analysis	Matrix	Number of Samples	Mean R Value (±1 SD)
Arsenic	Water	1	0.61
Barium	Water	1	1.10
BOD-5	Water	1	1.30
Boron	Water	1	1.19
Cadmium	Water	1	1.00
Chromium	Water	1	1.09
Copper	Water	1	1.01
Cyanide	Water	1	0.68
Dissolved Solids	Water	1	0.94
Gross Alpha	Air	3	1.01(±0.05)
Iron	Water	1	0.93
Lead	Water	1	1.17
Manganese	Water	1	1.03
Nickel	Water	1	0.89
Pu-238	Air	1	0.88
Pu-238	Soil	2	1.82(±0.72)
Pu-238	Water	1	1.14
Pu-239	Air	3	1.01(±0.06)
Pu-239	Soil	2	1.13(±0.26)
Pu-239	Water	2	1.04(±0.03)
pH	Water	1	0.99
Sulfate	Water	1	0.88
Total Solids	Water	1	1.01
Tritium	Water	5	0.98(±0.04)
Zinc	Water	1	1.02

Section 4

EVAUATION OF POTENTIAL DOSE TO THE PUBLIC

Evaluations showed the potential radiation doses to the public at the site perimeter, the nearest residential area and within 80 kilometers (50 miles) of the plant site were exceedingly small with the maximum being less than 3/1000 of 1 percent of the standard. The total dose commitment to the population residing within 80 kilometers of the site was determined to be 0.40 man-rem as compared to the annual dose from natural radiation of 243,117 man-rem.

PLUTONIUM

There was no radiation dose to the public from the utilization of plutonium at the Pinellas Plant since none was released to the environment.

TRITIUM

Calculations were made estimating the radiation exposure to the public for the year 1983 as a result of airborne discharges of tritium oxide from the Pinellas Plant. While both tritium gas and tritium oxide were discharged, only the releases of tritium oxide were used in the calculations. Tritium gas can be slowly converted to tritium oxide. However, in the time required for any significant quantity to be converted to oxide, the releases were greatly diluted in the atmosphere and dispersed over a wide area. This dilution, coupled with the minimal body retention of tritium gas, negates its possibility for radiological impact on the public in the environs of the Pinellas Plant.

Three sets of calculations were performed to determine the radiation dose at the site boundary, the radiation dose at the nearest residential area, and the radiation dose to the population residing within 80 kilometers (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[7] and historical wind data[3], the determination was made of the location at the site boundary with the maximum exposure to tritium oxide. The assumption was then made that an individual remained at this location throughout the entire year. The average continuous concentration of tritium oxide to which this individual would be exposed was 6.0×10^{-12} µCi/ml of air.

Using the dose conversion formula $D = 1.6 \times 10^{9}\ C$ where D = the annual dose to the individual in mrem and C = the average continuous exposure concentration of tritium oxide in µCi/ml of air,[9] the dose to an individual at the site boundary was determined to be 0.0097 mrem.

Dose to Individuals in the Closest Residential Area

The nearest residential area is approximately 0.8 kilometers (1/2 mile) south-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. The average concentration of tritium oxide to which these individuals were exposed was 3.0×10^{-12} µCi/ml, which results in an annual dose of 0.0048 mrem.

Dose to the Population Within 80 Kilometers of the Plant Site

Calculations were performed to determine the radiation exposure to all individuals residing within 80 kilometers (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 of the University of Florida[1] show the 1983 estimated population within 80 kilometers of the plant site to be 2,025,976. 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 1983 was 0.40 man-rem. This results in a calculated average dose to each individual of approximately 0.0002 mrem.

KRYPTON-85

Releases of krypton-85 during 1983 totaled 11.33 curies. Calculations were made similar to those for tritium oxide to determine the dose to an individual at the site boundary. The average exposure concentration was calculated to be 9.5×10^{-13} µCi/ml of air. The dose conversion formula for krypton-85 is $D = 5 \times 10^{8} C$ where D = the annual dose in mrem and C = the average continuous exposure concentration in µCi/ml of air.[8] The dose to this individual would thus be 0.0005 mrem.

Individuals remaining in the nearest residential area during the year would be exposed to an average continuous concentration of 3.1×10^{-13} µCi/ml of air. This results in an annual dose of 0.0002 mrem.

The doses to the population groups farther from the plant site would be significantly lower. These were not calculated since they would be less than 1/10000 of one percent of the standard.

CARBON-14

Releases of carbon-14 during the year totaled 1.0×10^{-5} curies. Calculations were made similar to those for tritium oxide to determine the maximum dose to an individual at the site boundary. The average exposure concentration was calculated to be 5.0×10^{-19} μCi/ml of air. The dose conversion formula for carbon-14 is $D = 1.3 \times 10^{9}$ C where D = the annual dose in mrem and C = the average continuous exposure concentration in μCi/ml of air[8]. The dose to this individual would thus be 6.5×10^{-10} mrem.

The doses to the population groups farther from the plant site would be significantly lower. These were not calculated since, as shown in Table 4-1, the site boundary dose is less than 1/10000 of one percent of the standard.

DISCUSSION

Radiation protection standards for individuals and population groups are specified in DOE Order 5480.1. As a means of evaluating the significance of the radiation exposures due to the radioactivity releases from the Pinellas Plant, Table 4-1 was prepared.

Table 4-1. Area Radiation Dose Compared to DOE Standards

Location	DOE Standard (mrem/yr)	Annual Radiation Dose From Plant Operations (mrem)	Percent of DOE Standards
Individual at Site Boundary	500	0.0097 (Tritium)	0.0019
	500	0.0005 (Krypton-85)	0.0001
	1500	<0.0001 (Carbon-14)	<0.0001
Nearest Residential Area	170	0.0048 (Tritium)	0.0028
	170	0.0002 (Krypton-85)	0.0001
80 km Radius	170	0.0002 (Tritium)	0.0001

Another interesting comparison can be made between the radiation dose due to plant activities and the radiation dose the population receives from naturally occurring radiation.[10] This dose results from three sources:

Cosmic Radiation from Outer Space. The cosmic radiation dose varies significantly with altitude and less strongly with latitude. In Florida, the estimated annual dose is 35 mrem.

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. The average annual dose over the United States is 60 mrem.

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, which is inhaled. The average dose from these sources is 25 mrem/year.

An individual in Florida, therefore, receives a dose of approximately 120 mrem/year from naturally occurring radiation. Applying this figure to the estimated population residing within 80 kilometers of the plant site, the comparison shown in Table 4-2 demonstrates the negligible impact on man of the radioactivity releases from the Pinellas Plant.

Table 4-2. Man-Rem Dose Comparison

Source of Exposure	80-km (50-mile) Man-Rem Dose
Pinellas Plant Releases	0.40
Natural Radiation	243,117

Section 5

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Section 6

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