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pinellas plant environmental monitoring report 1978

UNITED STATES
DEPARTMENT OF ENERGY
OPERATED BY
GENERAL ELECTRIC COMPANY
NEUTRON DEVICES DEPARTMENT

MASTER

ENVIRONMENTAL MONITORING REPORT

1978

PINELLAS PLANT

POST OFFICE BOX 11508

ST. PETERSBURG, FLORIDA 33733

Operating Contractor
NEUTRON DEVICES DEPARTMENT
GENERAL ELECTRIC COMPANY

This report was prepared in accordance with the requirements of U.S. Department of Energy Manual, Chapter 0513, "Effluent and Environmental Monitoring and Reporting."

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

April, 1979

INDEX

INDEX

ILLUSTRATIONS

TABLES

Section 1

INTRODUCTION

The Pinellas Plant is operated for the U. S. Department of Energy (DOE) by the Neutron Devices Department of the General Electric Company. The plant's 1300 employees are engaged in the design, development and manufacture of special electronic and mechanical nuclear weapons components.

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 July 1978 population estimate is 708,068. Latest population estimates for the major cities shown in Figure 1-1 are: Dunedin - 28,715; Clearwater - 80,784; Largo - 57,275; Pinellas Park - 31,736; and St. Petersburg - 238,450.[1]

The area immediately surrounding the site contains some light industry, but is primarily undeveloped. The closest residential areas are approximately 0.8 kilometers (½ 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 39.2 hectares (96.9 acres).

Building 100, which has an area of 22,480 square meters (242,000 square feet), is the largest structure on the plant site. Eight other buildings (200 through 900) have a combined area of approximately 5,670 square meters (61,000 square feet).

Two lakes with a combined capacity of approximately 22,150,000 liters (5,850,000 gallons) are located on the site and are utilized, together with a spray irrigation facility, as part of the liquid effluent treatment system.

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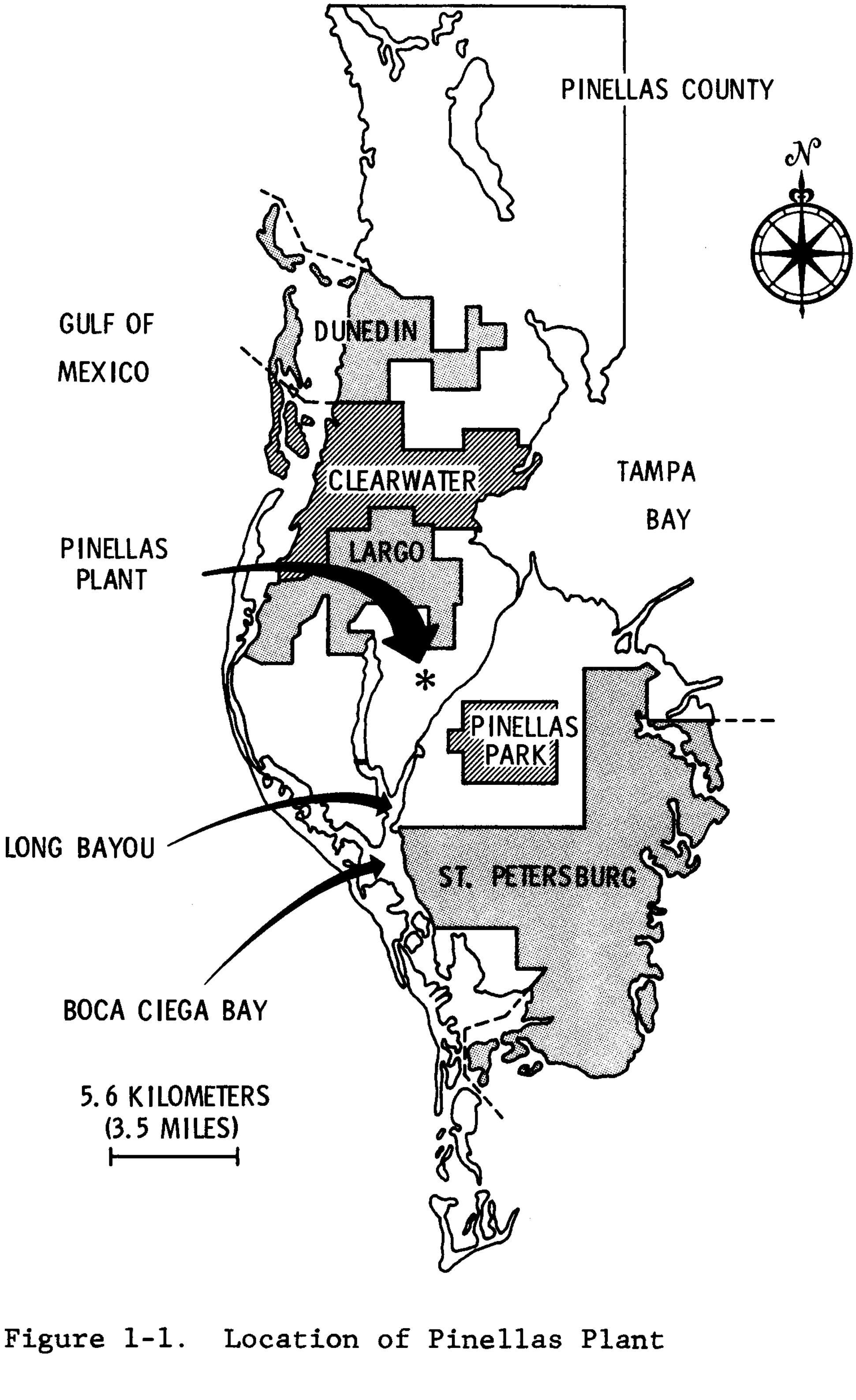
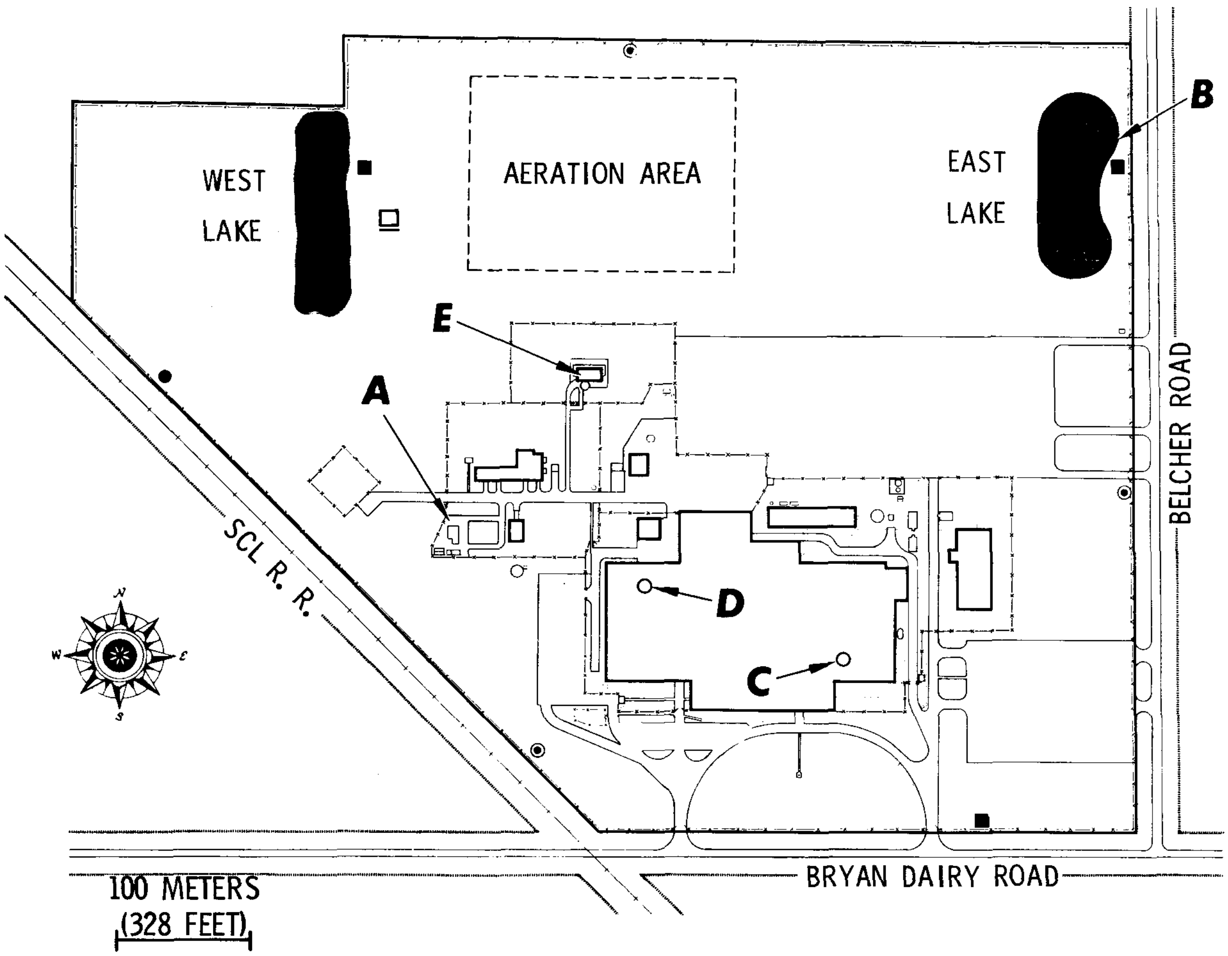


Figure 1-1. Location of Pinellas Plant



KEY

SEWAGE TREATMENT FACILITY	A	PROPERTY FENCE	x——x——x
EAST LAKE EFFLUENT	B	PROPERTY LINE	———
BUILDING 100 MAIN STACK	C	TRITIUM AIR SAMPLING STATION	■
BUILDING 100 LABORATORY STACK	D	PLUTONIUM AIR SAMPLING STATION	●
BUILDING 400 EXHAUST STACK	E	TRITIUM/PLUTONIUM AIR SAMPLING STATION	⊙

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 majority 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 (29 inches) of the normal annual rainfall of 125 centimeters (49 inches).[2]

Due to the abundance of rainfall in this area, the county maintains an extensive network of drainage ditches. Plant effluents from the east lake enter county piping which travels east on Bryan Dairy Road approximately one-half mile to a drainage ditch. The ditch proceeds in a southerly direction into Cross Bayou Canal which leads to Cross Bayou and finally Boca Ciega Bay. During 1975, a water recycle system was installed which appreciably reduced the volume of these effluents. The system has resulted in an annual savings of approximately 114 million liters (25 million gallons) of water.

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 1886 through 1978, the relative frequency of a hurricane passing within a 40-kilometer (25-mile) radius of the plant site is one in every 14 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. This maximum anticipated high tide would be approximately 4.3 meters (14 feet) above mean sea level. Since this 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 supplied by the National Severe Weather Forecast Center, is 6.4×10^{-4} per year.[5] This probability, as far as the Pinellas Plant is concerned, undoubtedly overestimates the potential. This is due to the fact that 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.

The intensity of the tornadoes which have occurred in the counties within 160 kilometers (100 miles) of Pinellas County was also examined. Of those occurrences, 67 percent had wind speeds less than 44.7 meters/second (100 miles/hour). The remaining 33 percent had wind speeds between 44.7 and 68.8 meters/second (100 to 154 miles/hour). None of higher intensity occurred.

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.

Approximately six 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 published in the 1976 edition of the Uniform Building Code 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, control systems and the surrounding environment can be found in the Environmental Assessment for the Pinellas Plant, November, 1975.

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 Manual Chapter 0513, "Effluent and Environmental Monitoring and Reporting."[6]

RADIOACTIVE GASEOUS EFFLUENTS

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

LIQUID EFFLUENTS

Off-site releases of liquid effluents were analyzed for compliance with the NPDES permit issued for this site by the U. S. Environmental Protection Agency. Analyses were performed for biochemical oxygen demand, suspended solids, fecal coliform bacteria, pH, nitrogen, phosphorus, arsenic, chlorides, chromium, copper, cyanides, detergents, fluorides, iron, lead, mercury, oil plus greases, phenols, turbidity and zinc. All results with the exception of suspended solids were well within permit limits.

In addition to the non-radioactive parameters listed above, a small quantity of radioactive tritium oxide was released in the effluent. Analyses showed the average concentration was 0.14 percent of the nonoccupational exposure guide.

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 recommended guide 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.

EVALUATION OF POTENTIAL DOSE TO THE PUBLIC

Calculations were made to determine the radiation doses resulting from releases of tritium oxide and krypton-85 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 recommended 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 210,747 man-rem.

Section 3

MONITORING DATA

RADIOACTIVE GASEOUS EFFLUENTS

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

Areas utilizing radioactive material are connected to special exhaust systems which discharge through one of two, 30.5 meter (100-foot) stacks. Tritium gas, tritium oxide and krypton-85 are discharged from the Building 100 main stack (point C on Figure 1-2), while only tritium gas and tritium oxide are discharged from the Building 100 laboratory stack (point D on Figure 1-2).

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.

Discharges

During the year, 102.76 curies of tritium gas, 87.46 curies of tritium oxide and 5.29 curies of krypton were released from the Building 100 main stack in 7.81×10^{11} liters of air.

Releases from the Building 100 laboratory stack during the year totaled 28.86 curies of tritium gas and 68.38 curies of tritium oxide in 4.53×10^{11} 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 recommended nonoccupational exposure concentration guides listed in DOE Manual Chapter 0524, "Standards 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 162 meters (530 feet) downwind from the stacks, and, depending on wind direction, could be either on or off site (Figure 1-2).

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

Discharge Point	Maximum Ground Level Concentration (μCi/mℓ)	DOEM 0524 Exposure Standard (μCi/mℓ)	Percent of Standard
Building 100 Main Stack			
Tritium Gas	1.1×10^{-10}	2.0×10^{-7}	0.055
Tritium Oxide	9.4×10^{-11}	2.0×10^{-7}	0.047
Krypton-85 Gas	5.7×10^{-12}	3.0×10^{-7}	0.002
Building 100 Lab Stack			
Tritium Gas	3.1×10^{-11}	2.0×10^{-7}	0.016
Tritium Oxide	7.3×10^{-11}	2.0×10^{-7}	0.037

LIQUID EFFLUENTS

Sample analyses revealed all non-radioactive liquid effluents leaving the plant site, with the exception of suspended solids, were well within the limits prescribed by the plant's NPDES permit. Also, the small quantity of tritium in the effluents averaged 0.14 percent of the applicable standard.

Plant sanitary wastes are directed to an on-site extended aeration, activated sludge sewage treatment facility. Its location is shown as point A on Figure 1-2. The effluent joins the industrial waste waters which have previously passed through an acid neutralization facility. The combined effluent flows to an on-site 9.8-million liter (2.6-million gallon) lake (west) containing three, 10-horsepower floating aerators. Water from this lake is pumped to a 4.0-hectare (10-acre) spray irrigation field. A subsurface drain system under the irrigation field collects the liquids and directs them to another on-site lake (east), which has a capacity of 12.3 million liters (3.25 million gallons). A dam and proportional sampling equipment are installed at the exit of the lake from which periodic releases are made (Point B on Figure 1-2). The flow of the effluent stream after it leaves the plant site until it reaches Boca Ciega Bay is shown in Figure 3-1.

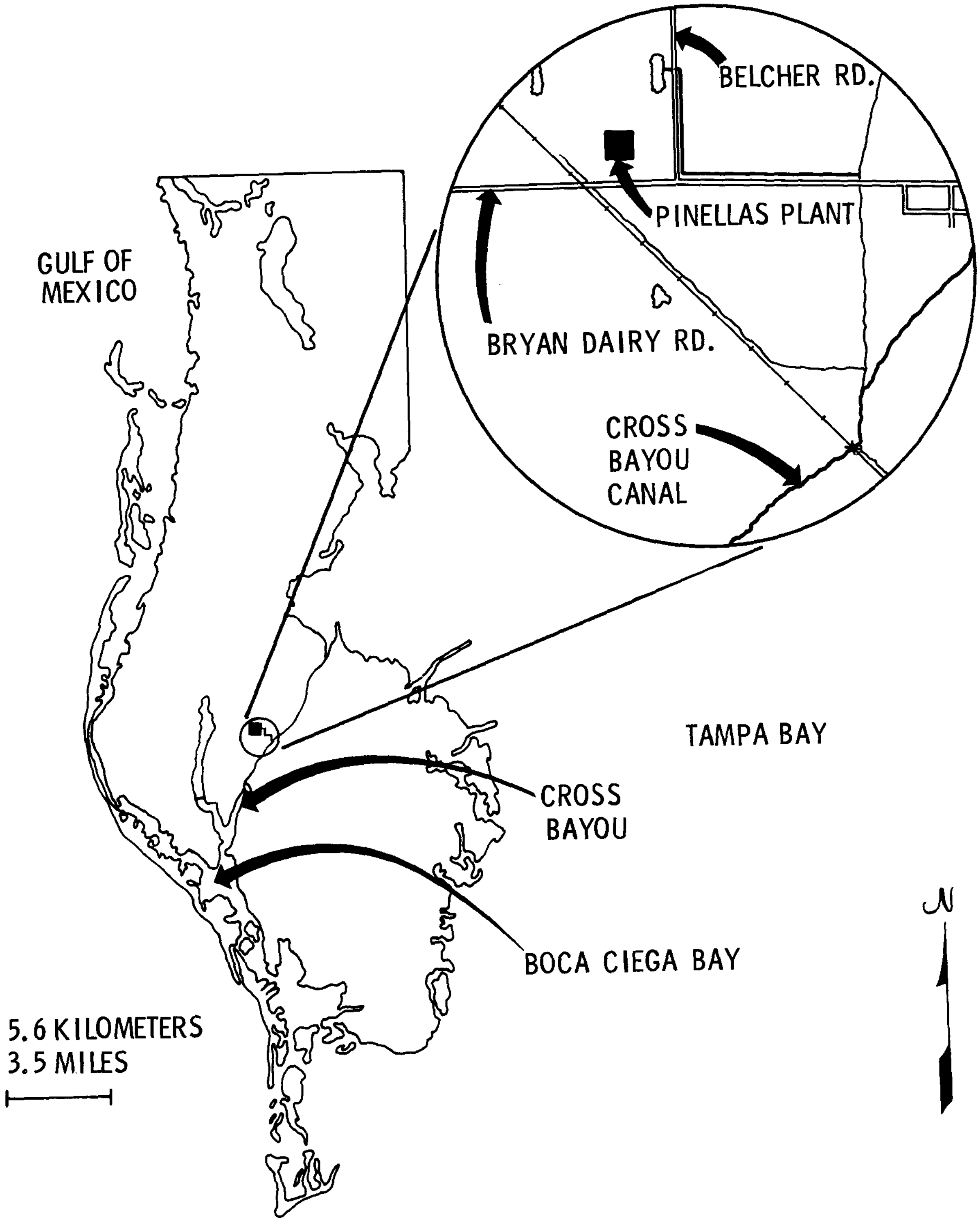


Figure 3-1. Effluent Flow from Plant

Non-Radioactive Liquid Effluents

Monitoring Procedures

Samples were collected and analyzed to determine conformance with the parameters listed in NPDES permit FL000736 issued by the U. S. Environmental Protection Agency for this site. The State of Florida, Department of Environmental Regulation has concurred with requirements set forth in the permit.

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.

The type and frequency of sample collection of effluent discharges were performed as prescribed by the permit. Due primarily to the water recycle system and because of low rainfall, no effluents were discharged from the site during the months of May, October, November and December. Also, only one discharge occurred during the month of September.

Daily grab samples during periods of discharge were analyzed for pH.

Two composite samples were analyzed each month that discharging occurred for biochemical oxygen demand, suspended solids, turbidity, total nitrogen and total phosphorus.

Monthly composite samples of discharges were analyzed for chlorides, total chromium, copper, fluorides, iron, lead, phenols and zinc.

Monthly grab samples of discharges were analyzed for fecal coliform bacteria and oils plus grease.

Quarterly composite samples of discharges were analyzed for arsenic, cyanides, detergents and mercury.

Discharges

Table 3-2 summarizes the analyses of effluents released from the site during 1978. It shows the various parameters for which analyses were performed, the NPDES permit limits and number of analyses. 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	Permit Limits		Number of Analyses	Range	Average (±2 SD)*	Minimum Detection Level
	Weekly Average	Monthly Average				
Biochemical Oxygen Demand (mg/ℓ)	12	8	15	2.4-7.7	4.7(±0.9)	1
Suspended Solids (mg/ℓ)	12	8	15	2.1-12.7	7.4(±1.6)	1
Fecal Coliforms (Coliforms/100 mℓ)	400	200	8	6-130	40(±30)	2
pH (pH Units)	6.0-9.0	6.0-9.0	37	6.8-9.0	N.A.	0.1
Nitrogen, Total (mg/ℓ)	7	5	15	1.3-2.4	1.8(±0.2)	0.1
Phosphorus, Total (mg/ℓ)	3	2	15	0.1-0.7	0.3(±0.1)	0.1
	Daily Average	Daily Maximum				
Arsenic (mg/ℓ)	-	0.05	3	<0.05-<0.05	<0.05	0.05
Chlorides (mg/ℓ)	-	250	8	65-118	79(±12)	5
Chromium, Total (mg/ℓ)	-	1.0	8	<0.05-0.05	<0.05	0.05
Copper (mg/ℓ)	-	0.5	8	0.02-0.08	0.05(±0.02)	0.02
Cyanides (mg/ℓ)	-	None Detectable	3	<0.002-<0.002	<0.002	0.002
Detergents (mg/ℓ)	-	0.5	3	<0.25-<0.25	<0.25	0.25
Fluorides (mg/ℓ)	5	10	8	0.5-1.8	1.1(±0.3)	0.05
Iron (mg/ℓ)	-	0.3	8	0.04-0.23	0.10(±0.05)	0.01
Lead (mg/ℓ)	-	0.05	8	<0.05-0.05	<0.05	0.05
Mercury (mg/ℓ)	-	None Detectable	3	<0.0002-<0.0002	<0.0002	0.0002
Oil and Grease (mg/ℓ)	10	15	8	<5-<5	<5	5
Phenols (mg/ℓ)	-	0.005	8	<0.005-<0.005	<0.005	0.005
Turbidity (Jackson Units)	50	-	15	1.5-6.8	3.8(±0.9)	0.1
Zinc (mg/ℓ)	-	1.0	8	0.03-0.12	0.07(±0.02)	0.002

*Values in parentheses indicate ±2 standard deviations.

Discussion

Although the overall average was satisfactory, results of suspended solids analyses exceeded permit limits on four occasions during the year. One sample in January showed 12.7 mg/ℓ which is in excess of the weekly limit of 12 mg/ℓ. The monthly averages for January and June were 11.7 and 9.8 mg/ℓ, respectively, as compared to the permit requirement of 8 mg/ℓ. During September only one discharge occurred with a suspended solids content of 9.0 mg/ℓ. While within the weekly limit, it exceeded the monthly limit. These excursions are attributed to algae growth in the east lake and to a county road widening project adjacent to the lake.

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 all releases from the east lake. The tritium concentrations were determined by liquid scintillation counting. The minimum detection level of the counting technique employed ranged from 1.2 to 1.4×10^{-7} µCi/mℓ.

Discharges

During the year, 24 samples were analyzed for tritium oxide content. The maximum result was 5.2×10^{-6} µCi/mℓ, while the minimum was 2.9×10^{-6} µCi/mℓ. A total of 0.54 curie was released in a total of 1.27×10^{8} liters of water. The resulting average discharge concentration was $4.1\ (\pm 0.3) \times 10^{-6}$ µCi/mℓ.

The concentration guide for tritium in water released from the plant site as set forth in DOE Manual Chapter 0524 is 3.0×10^{-3} µCi/mℓ. The discharges from the Pinellas Plant during 1978 averaged 0.14 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 recommended guide 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 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).

Results. Samples were analyzed to determine conformance with the nonoccupational exposure concentration guides set forth in DOE Manual Chapter 0524. The average concentrations detected were <4.7 x 10^{-12} µCi/mℓ for tritium gas and <6.1 x 10^{-12} µCi/mℓ for tritium oxide. These results are <0.002 percent and <0.003 percent respectively of the concentration guide. 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	Concentration in Air x 10^{-12} µCi/mℓ: Average (±2 SD)**	Percent of Standard
North	Gas	1.8 - 9.3	4.2 (±1.4)	0.002
	Oxide	<1.9 - 16.9	<5.7 (±2.3)	<0.003
Northeast	Gas	<0.8 - 3.0	<1.9 (±0.4)	<0.001
	Oxide	2.0 - 10.9	5.3 (±1.6)	0.003
East	Gas	<1.4 - 16.8	<5.0 (±2.3)	<0.003
	Oxide	<1.3 - 10.1	<4.4 (±1.5)	<0.002
Southeast	Gas	<1.2 - 17.8	<5.8 (±2.7)	<0.003
	Oxide	1.6 - 12.9	6.2 (±2.1)	0.003
Southwest	Gas	<1.8 - 25.9	<6.0 (±3.5)	<0.003
	Oxide	2.1 - 20.8	9.2 (±3.2)	0.005
Northwest	Gas	<1.4 - 13.3	<5.2 (±2.1)	<0.003
	Oxide	2.3 - 11.8	6.0 (±1.7)	0.003
		Arith Mean: Gas	<4.7	<0.002
		Oxide	<6.1	<0.003

*See Figure 1-2.

**Values in parentheses indicate ±2 standard deviations.

Minimum detection levels: Gas 0.8 - 2.1 x 10^{-12} µCi/mℓ
Oxide 0.8 - 2.0 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 3-2. The monitoring technique is the same as that used for the on-site stations described above.

Results. Samples were analyzed to determine conformance with the nonoccupational exposure concentration guides set forth in DOE Manual Chapter 0524. The average concentrations detected were $<2.8 \times 10^{-12}$ μCi/mℓ for tritium gas and $<2.7 \times 10^{-12}$ μCi/mℓ for tritium oxide. These results are <0.001 percent 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		Percent of Standard
		Range	Average (±2 SD)**	
North	Gas	<0.8 - 9.5	<3.2 (±1.4)	<0.002
	Oxide	<0.9 - 8.7	<3.2 (±1.3)	<0.002
Northeast	Gas	<1.0 - 15.0	<3.1 (±2.1)	<0.002
	Oxide	<0.9 - 6.1	<2.5 (±0.9)	<0.001
Southeast	Gas	<0.7 - 7.4	<3.5 (±1.0)	<0.002
	Oxide	<0.8 - 10.0	<3.2 (±1.4)	<0.002
South	Gas	<1.3 - 6.4	<2.2 (±0.9)	<0.001
	Oxide	<1.2 - 6.0	<2.1 (±0.8)	<0.001
West	Gas	<1.9 - 3.2	<2.1 (±0.3)	<0.001
	Oxide	<1.3 - 3.7	<2.3 (±0.5)	<0.001
Arith Mean:	Gas		<2.8	<0.001
	Oxide		<2.7	<0.001

*See Figure 3-2.

**Values in parentheses indicate ±2 standard deviations.

Minimum detection levels: Gas 0.7 - 2.0 x 10^{-12} μCi/mℓ
Oxide 0.8 - 2.1 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

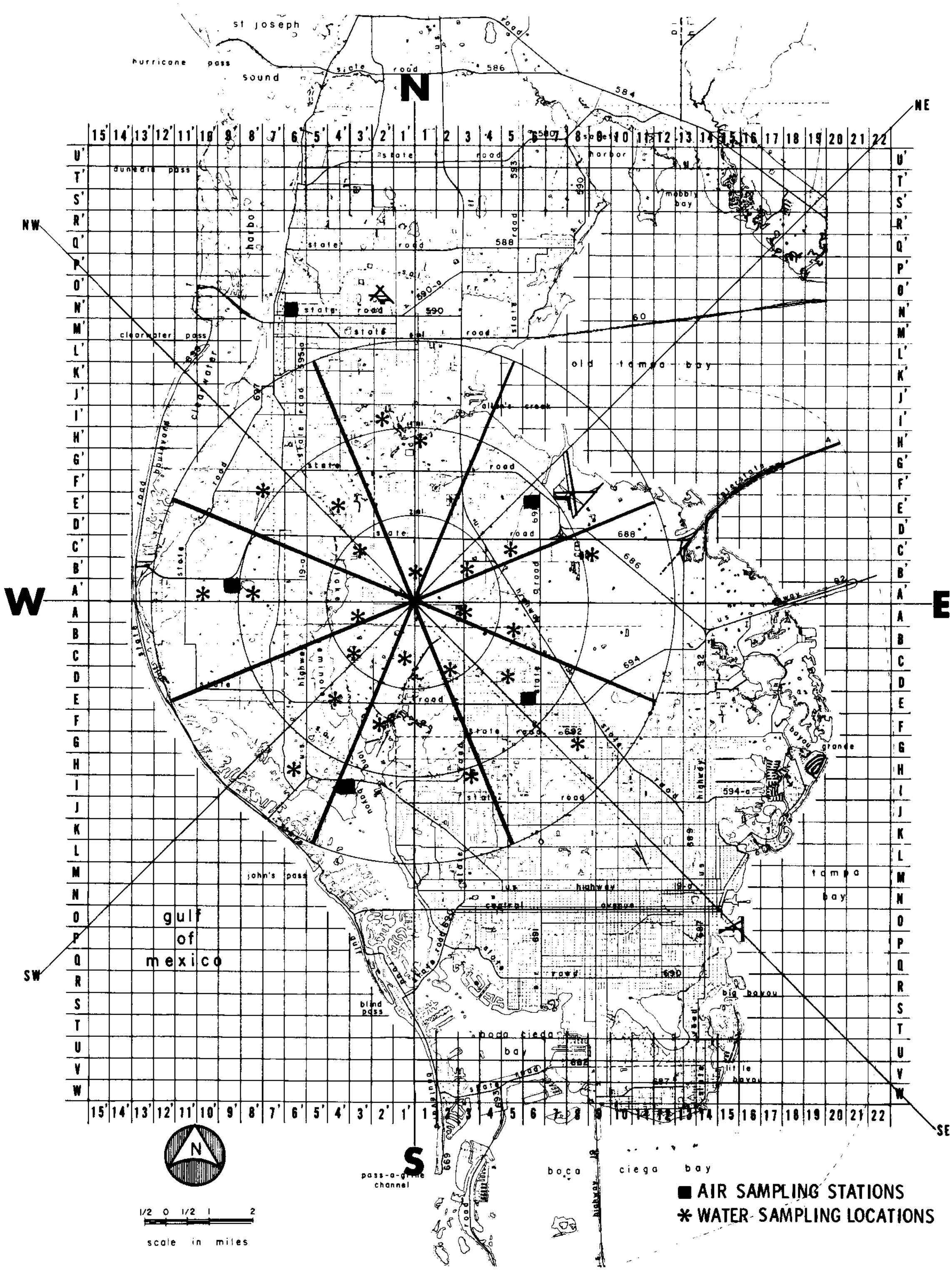


Figure 3-2. Off-Site Sampling Locations

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 on four occasions during the year from each location and analyzed by liquid scintillation counting for tritium content. During 1978, 92 samples were analyzed. The location of these samplings is shown on Figure 3-2.

Results. The results are shown in Table 3-5, together with a comparison with standards set forth in DOE Manual Chapter 0524. The average concentration detected was <2.2 x 10^{-7} μCi/mℓ which is <0.008 percent of the concentration guide.

Table 3-5. Tritium in Surface Water

Location*	Concentration x 10^{-7} μCi/mℓ		Percent of Standard
	Range	Average (±2 SD)**	
B'-1	<1.3 - 4.1	<2.6 (±1.4)	<0.009
A-3	<1.5 - 4.1	<2.5 (±1.2)	<0.009
D-2	<1.3 - 2.6	<2.0 (±0.7)	<0.007
B'-3	<1.3 - 1.4	<1.4 (±0.1)	<0.005
C'-5	1.9 - 6.0	3.4 (±1.8)	0.011
C'-9	<1.5 - 5.9	<4.1 (±1.9)	<0.014
I'-2'	1.4 - 1.6	1.5 (±0.1)	0.005
H'-1	<1.3 - 2.5	<1.7 (±0.6)	<0.006
E'-4'	<1.3 - 2.0	<1.5 (±0.3)	<0.005
E'-7'	<1.2 - 2.8	<1.7 (±0.8)	<0.006
A'-10'	<1.3 - 2.0	<1.7 (±0.5)	<0.006
A'-8'	<1.3 - 3.3	<1.9 (±0.9)	<0.006
I-6'	<1.2 - 7.4	<3.0 (±3.0)	<0.010
E-4'	1.5 - 2.6	2.3 (±0.5)	0.008
F-2'	<1.3 - 2.8	<2.0 (±0.7)	<0.007
H-3	<1.2 - <1.4	<1.3 (±0.1)	<0.004
G-8	<1.3 - 11.2	<4.6 (±4.5)	<0.015
D-5	<1.3 - 2.8	<2.2 (±0.7)	<0.007
B-5	<1.3 - 3.0	<2.0 (±0.7)	<0.007
C-1'	1.3 - 2.3	1.7 (±0.5)	0.006
C-4'	1.7 - 2.8	2.3 (±0.6)	0.008
A-3'	<1.3 - 2.5	<1.6 (±0.6)	<0.005
C'-3'	1.5 - 4.0	2.5 (±1.1)	0.009
	Arith Mean	<2.2	<0.008

*See Figure 3-2.

**Values in parentheses indicate ±2 standard deviations.

Minimum detection level: 1.2 - 1.5 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 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 5600 ℓ/h (3.3 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 concentration guides set forth in DOE Manual Chapter 0524, "Standards for Radiation Protection."

Table 3-6. Plutonium Stack Monitoring

Isotope	Concentration in Air x 10^{-18} µCi/mℓ		Minimum Detection Level	Percent of Standard
	Range	Average (±2 SD)*		
Plutonium-238	<1.0 - <2.0	<1.5 (±0.4)	1.0 - 2.6	<0.002
Plutonium-239	1.5 - 8.4	4.2 (±3.0)	1.0 - 1.5	0.007

*Values in parentheses indicate ± 2 standard deviations.

Minimum Detection Levels: 0.8 - 1.9 x 10^{-18} µCi/mℓ

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

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

*Trademark, Delbag-Luftfilter, Halensee, Germany

On-Site Air Monitoring

Monitoring Procedures. Four site perimeter air sampling stations were operated continuously during the year. Their locations are shown on Figure 1-2. Ambient air was sampled at a rate of 6800 ℓ/h (4 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

		Concentration in Air x 10^{-18} μCi/mℓ			
Sample Station	Isotope	Range	Average (±2 SD)*	Minimum Detection Level	Percent of Standard
North	Pu-238	<0.8 - <1.9	<1.3 (±0.6)	0.8 - 1.9	<0.002
	Pu-239	5.3 - 48.6	25.5 (±23.4)	0.6 - 2.0	0.043
East	Pu-238	<1.4 - <4.2	<2.4 (±1.3)	1.4 - 4.2	<0.003
	Pu-239	4.5 - 77.1	31.0 (±34.0)	1.0 - 4.2	0.052
South	Pu-238	<0.5 - <2.6	<1.7 (±1.0)	0.5 - 2.6	<0.002
	Pu-239	5.5 - 29.3	18.5 (±12.3)	0.5 - 1.8	0.031
West	Pu-238	<0.7 - <2.0	<1.3 (±0.5)	0.7 - 2.0	<0.002
	Pu-239	7.2 - 48.7	26.5 (±20.1)	0.7 - 2.0	0.044
Arith Mean:		Pu-238	<1.7		<0.002
		Pu-239	25.4		0.043

*Values in parentheses indicate ±2 standard deviations.

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

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

On-Site Soil, Vegetation, Water and Sediment Monitoring

Monitoring Procedures. One set of four each soil and vegetation samples were collected from on-site locations north, south, east and west of Building 400. The soil samples consisted of a composite of three, 9 cm (3.5-in.) diameter by 5 cm (2-in.) deep plugs while the vegetation samples consisted of approximately 50 grams of grasses and other ground vegetation. One water and one pond sediment sample was also collected from each of the two on-site lakes.

Results. The results are shown in Table 3-8.

Table 3-8. On-Site/Plutonium Soil, Vegetation, Water and Sediment Samples

Type of Sample	Isotope	Concentration		Minimum Detection Level
		Range	Average (±2 SD)*	
Soil (µCi/g)**	Pu-238	<1.0 - <37.5 x 10^{-9}	<12.5 (±17.1) x 10^{-9}	1.0 - 37.5 x 10^{-9}
	Pu-239	<9.9 - <37.5 x 10^{-9}	<17.9 (±13.5) x 10^{-9}	1.0 - 37.5 x 10^{-9}
Vegetation (µCi/g)**	Pu-238	<4.9 - <26.5 x 10^{-9}	<11.1 (±10.3) x 10^{-9}	4.9 - 26.5 x 10^{-9}
	Pu-239	<4.9 - <26.5 x 10^{-9}	<10.6 (±10.6) x 10^{-9}	4.9 - 26.5 x 10^{-9}
Water (µCi/mℓ)	Pu-238	<6.0 - <7.0 x 10^{-12}	<6.5 (±1.0) x 10^{-12}	6.0 - 7.0 x 10^{-12}
	Pu-239	<4.9 - 6.0 x 10^{-12}	<5.5 (±1.0) x 10^{-12}	4.9 - 6.0 x 10^{-12}
Sediment (µCi/g)**	Pu-238	<0.5 - <15.6 x 10^{-9}	<8.1 (±15.1) x 10^{-9}	0.5 - 15.6 x 10^{-9}
	Pu-239	<0.5 - <11.0 x 10^{-9}	<5.8 (±10.5) x 10^{-9}	0.5 - 11.0 x 10^{-9}

*Values in parentheses indicate ±2 standard deviations.

**Dry weight after drying to constant weight at 110°C.

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

Off-Site Air Monitoring

Monitoring Procedures. Five off-site air sampling stations were operated continuously during the year. Their locations are shown on Figure 3-2. The sampling rate was 6800 ℓ/h (4 ft^3/min). The filters were changed at two-week intervals and composited for quarterly analysis.

Results. Table 3-9 shows the results of the samples analyzed from each of the off-site sampling stations.

Table 3-9. Off-Site/Plutonium Air Samples

Sampling Station	Isotope	Concentration in Air x 10^{-18} μCi/mℓ Range	Average (±2 SD)*	Minimum Detection Level	Percent of Standard
North	Pu-238	<0.7 - <10.3	<3.4(±4.6)	0.7 - 10.3	<0.005
	Pu-239	<10.3 - 50.0	<18.9(±20.8)	0.7 - 10.3	<0.032
Northeast	Pu-238	<0.7 - 7.6	<2.6(±3.4)	0.7 - 3.8	<0.004
	Pu-239	3.8 - 39.5	22.2(±19.2)	0.7 - 3.8	0.037
Southeast	Pu-238	<0.6 - <5.9	<2.0(±2.6)	0.6 - 5.9	<0.003
	Pu-239	<5.9 - 36.4	<19.1(±15.8)	0.6 - 5.9	<0.032
South	Pu-238	<0.6 - <1.2	<0.9(±0.3)	0.6 - 1.2	<0.001
	Pu-239	6.5 - 30.8	16.9(±11.7)	0.6 - 1.2	0.028
West	Pu-238	<0.8 - <4.7	<1.9(±1.9)	0.8 - 4.7	<0.003
	Pu-239	3.3 - 34.4	19.1(±15.9)	0.8 - 3.3	0.032
		Arith Mean: Pu-238	<2.2		<0.003
		Pu-239	<19.2		<0.032

*Values in parentheses indicate ±2 standard deviations.

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

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

Off-Site Soil, Vegetation, Water and Sediment Monitoring

Monitoring Procedures. One set of eight each soil and vegetation samples were collected from locations surrounding the site to a distance of 8 kilometers (5 miles). The collection procedure was the same as that used for the on-site samples. One set of four each pond water and pond sediment samples were also collected at surrounding off-site locations. Approximately one liter samples of water and two kilogram samples of sediment were collected.

Results. Table 3-10 contains the results of these samples.

Table 3-10. Off-Site/Plutonium Soil, Vegetation, Water and Sediment Samples

Type of Sample	Isotope	Concentration		Minimum Detection Level
		Range	Average (±2 SD)*	
Soil (μCi/g)**	Pu-238	<0.6 - <94.9 x 10^{-9}	<14.7 (±23.2) x 10^{-9}	0.6 - 94.9 x 10^{-9}
	Pu-239	<1.6 - 120.9 x 10^{-9}	<31.5 (±33.9) x 10^{-9}	0.5 - 94.9 x 10^{-9}
Vegetation (μCi/g)**	Pu-238	<1.0 - <28.3 x 10^{-9}	<8.3 (±6.3) x 10^{-9}	1.0 - 28.3 x 10^{-9}
	Pu-239	<2.6 - <20.0 x 10^{-9}	<8.6 (±4.3) x 10^{-9}	1.0 - 20.0 x 10^{-9}
Water (μCi/mℓ)	Pu-238	<5.8 - <10.8 x 10^{-12}	<7.6 (±2.3) x 10^{-12}	5.8 - 10.8 x 10^{-12}
	Pu-239	<5.7 - <7.8 x 10^{-12}	<6.8 (±1.0) x 10^{-12}	5.7 - 7.8 x 10^{-12}
Sediment (μCi/g)**	Pu-238	<0.7 - <3.8 x 10^{-9}	<1.5 (±1.5) x 10^{-9}	0.7 - 3.8 x 10^{-9}
	Pu-239	<0.7 - <3.8 x 10^{-9}	<1.8 (±1.5) x 10^{-9}	0.7 - 3.8 x 10^{-9}

*Values in parentheses indicate ±2 standard deviations.

**Dry weight after drying to constant weight at 110°C.

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

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 negative samples, the preparation of statistical quality control charts and duplicate and triplicate analyses of the same sample.

The plant also participates in three laboratory quality assurance programs in which analyses are performed throughout the year on unknown samples submitted by outside agencies. Samples are received from the USDOE Environmental Measurements Laboratory, the USEPA National Environmental Research Center and the USEPA Environmental Monitoring Support Laboratory.

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 assuming normal (Gaussian) distribution. These are shown in Table 3-11 together with the number of analyses performed.

Table 3-11. Quality Assurance Sample Analyses

Analysis	Matrix	Number of Samples	Mean R Value (±1 SD)
Ammonia-N	Water	8	1.02 (±0.02)
Arsenic	Water	9	0.91 (±0.17)
BOD-5	Water	6	0.97 (±0.16)
Chlorides	Water	7	1.04 (±0.03)
Chromium	Water	10	0.99 (±0.03)
Copper	Water	10	0.98 (±0.07)
Detergents	Water	5	1.04 (±0.11)
Fluorides	Water	7	1.07 (±0.06)
Gross Alpha	Air	12	0.93 (±0.01)
Iron	Water	10	0.94 (±0.14)
Kjeldahl-N	Water	8	0.98 (±0.09)
Lead	Water	10	0.95 (±0.06)
Nitrate-N	Water	8	0.96 (±0.03)
pH	Water	7	0.98 (±0.01)
Phosphorus	Water	8	1.02 (±0.04)
Pu-238	Air	6	0.99 (±0.23)
Pu-238	Soil	8	0.50 (±0.06)
Pu-238	Vegetation	4	1.34 (±0.52)
Pu-239	Air	8	0.99 (±0.02)
Pu-239	Soil	8	0.84 (±0.03)
Pu-239	Water	8	1.24 (±0.28)
Pu-239	Vegetation	4	1.61 (±0.38)
Tritium	Water	15	0.95 (±0.01)
Turbidity	Water	4	1.65 (±0.20)
Zinc	Water	10	1.26 (±0.16)

Section 4

EVALUATION OF POTENTIAL DOSE TO THE PUBLIC

Evaluations of 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 2/1000 of 1 percent of the recommended 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 210,747 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 1978 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

Analyses of ten years of hourly observations show the prevailing wind to be from an easterly direction.[3] This condition occurs ten percent of the time with an average wind speed of 3.9 meters/second (8.8 miles/hour). A point at the site boundary directly west of the exhaust stacks was, therefore, selected as the point of maximum probable exposure. The assumption was then made that an individual remained at this location during the entire year. By the use of stack diffusion equations,[7] the average concentration of tritium oxide at this location was determined to be 6.0×10^{-12} μCi/mℓ. This calculated result agrees quite well with the measured results at the perimeter sampling stations shown in Table 3-3. Using the dose conversion formula $D = 1.6 \times 10^9 \bar{C}$ where D = the annual dose to the individual in mrem and $\bar{C}$ = 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 0.0096 mrem.

Dose to Individuals in the Closest Residential Area

The nearest residential area is approximately 0.8 kilometers (½ mile) south-southeast 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 1.7×10^{-12} μCi/mℓ, which results in an annual dose of 0.0027 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 that the estimated population within 50 miles of the plant site is 1,756,222. Calculations were made to determine exposure concentrations based on population locations. The resulting total radiation exposure to these individuals due to releases of radioactive material from the Pinellas Plant during 1978 was 0.40 man-rem. This results in a calculated average dose to each individual of approximately 0.0002 mrem.

KRYPTON

Releases of krypton-85 during 1978 totaled 5.29 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 1.5×10^{-13} μCi/mℓ of air. The dose conversion formula for krypton-85 is $D = 1.7 \times 10^9 \bar{C}$ where D = the annual dose in mrem and $\bar{C}$ = the average continuous exposure concentration in μCi/mℓ of air.[8] The dose to this individual would thus be 0.0002 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 Manual Chapter 0524. 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	0.0002 (krypton) 0.0096 (tritium)	<0.0001 0.0019
Nearest Residential Area	170	0.0027 (tritium)	0.0016
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 these 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	210,747

Section 5

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Section 6

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DOE Pinellas Area Office	10
General Electric Company Neutron Devices Department	45