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ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission (forerunner to DOE & NRC)
C.F.R.	Code of Federal Regulations
CPE	Ceramic Product Engineering
DOE	U.S. Department of Energy
GE	General Electric
HEPA	high efficiency particulate air
keV	kilovolt-electron, 1,000 electron volts
LANL	Los Alamos National Laboratories
MMSC	Martin Marietta Specialty Components, Inc.
RMMA	radioactive material management area
RTG	radioisotopically-powered thermoelectric generator
SECS	Stack Effluent Control System
SNL	Sandia National Laboratory
TRS	Tritium Recovery System
U.S.C.	United States Code

2.1 INTRODUCTION

Technical Basis Documents and Site Profile Documents are general working documents that provide guidance concerning the preparation of dose reconstructions at particular sites or categories of sites. They will be revised in the event additional relevant information is obtained about the affected site(s). These documents may be used to assist the National Institute for Occupational Safety and Health in the completion of the individual work required for each dose reconstruction.

In this document the word “facility” is used as a general term for an area, building, or group of buildings that served a specific purpose at a site. It does not necessarily connote an “atomic weapons employer facility” or a “Department of Energy (DOE) facility” as defined in the Energy Employees Occupational Illness Compensation Program Act of 2000 [42 U.S.C. Section 7384l (5) and (12)].

Section 2.2 describes site processes and activities including facilities, Section 2.3 describes the site’s products, and Section 2.4 lists the equipment with radioactive components on the site.

The Pinellas Plant is in central Pinellas County, Florida, on 40.4 hectares (99.9 acres) in Section 13, Township 30S, Range 15E, of the Tallahassee Meridian (Figure 2-1). Pinellas County is in the west-central part of peninsular Florida. It is bounded on the north by Pasco County, on the east by Hillsborough County and Tampa Bay, and on the west and south by the Gulf of Mexico.

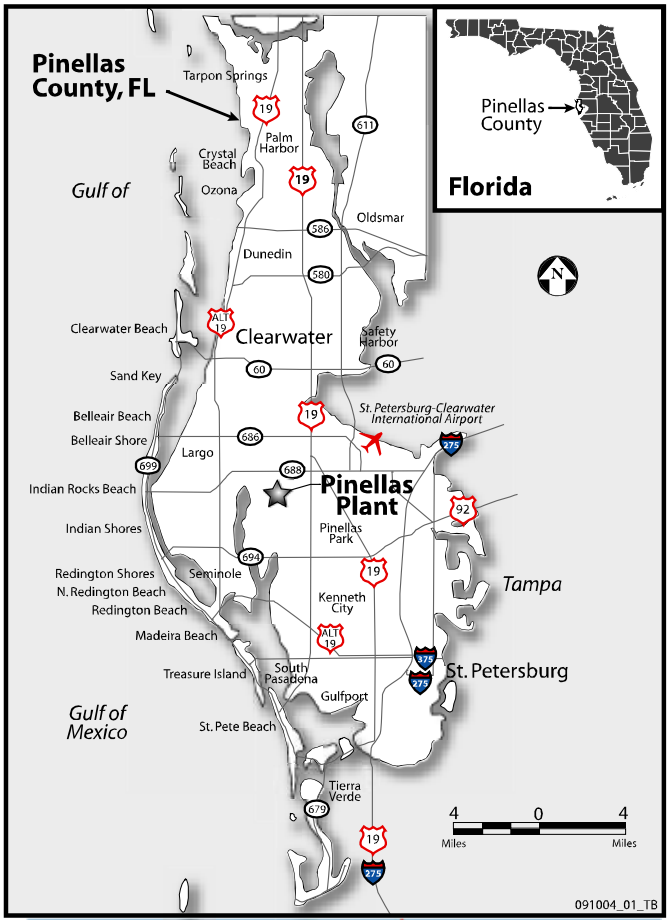

Figure 2-1. Location of Pinellas Plant in Pinellas County, Florida (FDOT 2004).

The site is bordered on the east by Belcher Road (Pinellas County Road 27), on the south by Bryan Dairy Road (Pinellas County Road 135), and on the west by a spur of the Seaboard Coastline Railroad. The area is surrounded by light industry and warehouse operations. The closest residential area is approximately 400 meters (1,300 feet) from the plant.

The area around the Pinellas Plant is characterized as urban land consisting of high-density residential developments, commercial buildings, streets, highways, parking lots, and other types of development (USDA 2004, p. 8). Figure 2-2 is an aerial photograph from 1992 that shows the proximity of residential and commercial development around the Pinellas Site.

Figure 2-2. Aerial photograph of Pinellas Plant (FAS 2004).

2.2 SITE ACTIVITIES AND PROCESSES

The Pinellas Plant (Figure 2-3) has approximately 70,195 square meters (755,584 square feet) under roof on its 40.4 hectares (99.9 acres). The plant was constructed in 1956 by the General Electric Corporation (GE) for the development and production of nuclear generators for the nation's nuclear weapons programs. The Atomic Energy Commission (AEC) (predecessor of the U.S. Department of Energy) purchased the Pinellas Plant from GE in 1957, and contracted them to operate the site from its startup in 1957 until May 31, 1992. In June 1992, Martin Marietta Specialty Components, Inc. (MMSC) took over operation of the facility and served as the managing and operating contractor until the site was shut down in September of 1994 (DHRS 1994, p. 1). As part of the DOE program to promote commercial uses of the site, DOE sold most of the Pinellas Plant to the Pinellas County Industry Council on March 17, 1995 (DOE 1995, p. iii).

DOE has an ongoing environmental restoration program for an 8-hectare (20-acre) plot in the northeast corner of the facility and another 1.8-hectare (4.5-acre) area near the northwest corner of the site. Both of these areas have groundwater contamination caused by previous storage and disposal of drummed waste and construction debris that contained solvents and volatile organic compounds. Remediation of these sites is being addressed under a Federal Resource Conservation

and Recovery Act (RCRA) permit that includes corrective action requirements and cleanup under Florida State Superfund statutes (DOE 1997, p. 1).

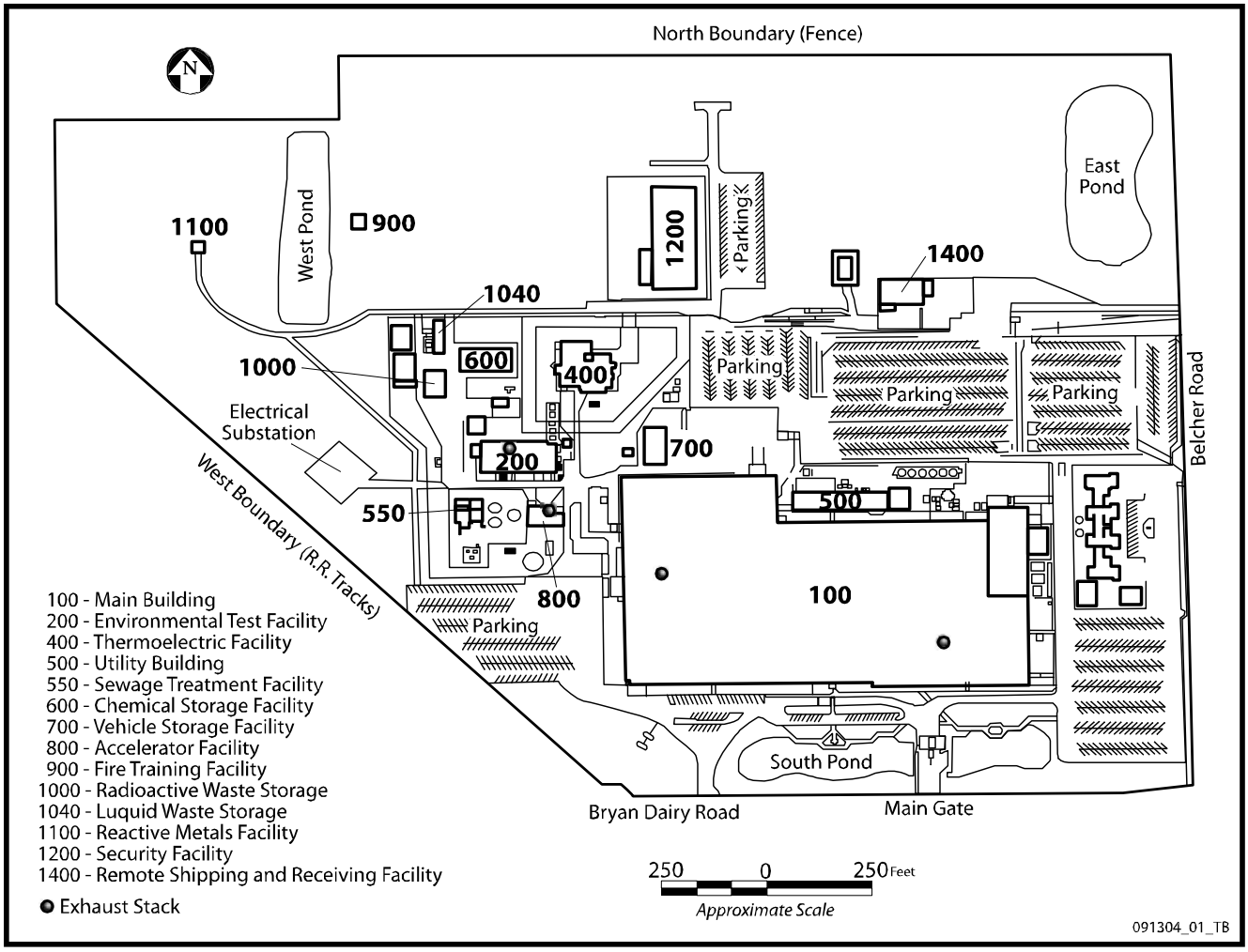

Figure 2-3. Site map (DOE 2002).

The initial mission of the Pinellas Plant was the manufacture of neutron generators and other components for nuclear weapons. The manufacture of neutron generators required equipment, facilities, and expertise that could be applied to a variety of specialty components. As a consequence, DOE expanded the Pinellas Plant mission to produce multiple electronic and support components for other DOE programs. These components included thermal and long-life ambient temperature batteries, specialized shock-absorbing foam supports, ferroelectric- and glass-ceramic encapsulation materials, and Radioisotopically-powered Thermoelectric Generators (RTGs). Part of the expansion included relocation of a similar production facility from Milwaukee, Wisconsin, to Pinellas during the 1966-1967 timeframe.

Pinellas Plant

The Pinellas Plant contains multiple structures and support facilities within the controlled area. Table 2-1 lists the floor space and function of each building, and the following sections discuss each building.

Table 2-1. Functions and sizes of site buildings.

Building	Function	Area	
		Square meters	Square feet
Building 100/300 – 1st Floor	Offices, Production, Laboratory	42,271	455,000
– 2nd Floor	Offices, Utilities	9,625	103,600
– Mezzanines	Offices	6,317	68,000
Total Building 100 Area		*58,213*	*626,600*
Building 200	Product Quality Assurance Testing	1,505	16,200
Building 400	RTG Assembly and Testing	1,375	14,800
Building 500	Utilities, Deionized Water Plant	1,691	18,200
Building 550	Wastewater Neutralization	204	2,200
Building 600	Chemical Storage	669	7,200
Building 700	Maintenance Bldg., Fire Dept.	464	5,000
Building 710	Maintenance Storage Shed	36	384
Building 800	Linear Accelerator Facility	334	3,600
Building 900	Fire Training	65	700
Building 1000 and 1040	Waste Storage & Management	790	8,500
Building 1010	New Container Storage	232	2,500
Building 1100	Special Storage	37	400
Building 1200	Security	2,722	29,300
Building 1400	Remote Receiving	669	7,200
Building 1500 and 1600	School, Child Day Care	1,189	12,800
Site Total		***70,195***	***755,584***

Source: DOE (1995a, p. 3-3).

Building 100

Building 100 was the initial plant building. During DOE ownership of the Pinellas Plant, Building 100 provided space for manufacturing, engineering, and administrative support services. Figure 2-4 shows the layout of Building 100.

Radioactive materials in Building 100 were used in the production, manufacture, storage, and testing of various weapons components. Multiple areas were considered Radioactive Material Management Areas (RMMAs), which indicated the possible presence of unconfined radioactive materials or emissions (DOE 1995a, p. 5-2; DOE 1991, pp. 2, 3, 11, and 13). Table 2-2 lists these areas in Building 100.

Table 2-2. RMMAs in Building 100.

Room/Area	Name	Activity
107	Tube Assembly	Vacuum tube manufacturing & coating
108	Tube Exhaust and Test	Vacuum tube evacuation and testing
109	Product Analysis	Magnetic and radioactive gas leak checking
113 Mezz	Health Physics Laboratory	Instrument calibration & check sources
132 Mezz	Fan Room	Stack effluent control & tritium recovery
157/158	Gas Analysis Laboratory	Hydrogen isotope analysis
176	Radioanalytical Laboratory	Radiological Laboratory, tritium recovery
182-C	Tube Assembly	Vacuum tube development and testing
182-G	Tube Exhaust	Vacuum tube development and testing
191	CPE Hood Room	Ceramic product testing facility

Source: DOE (1995a, p. 5-3).

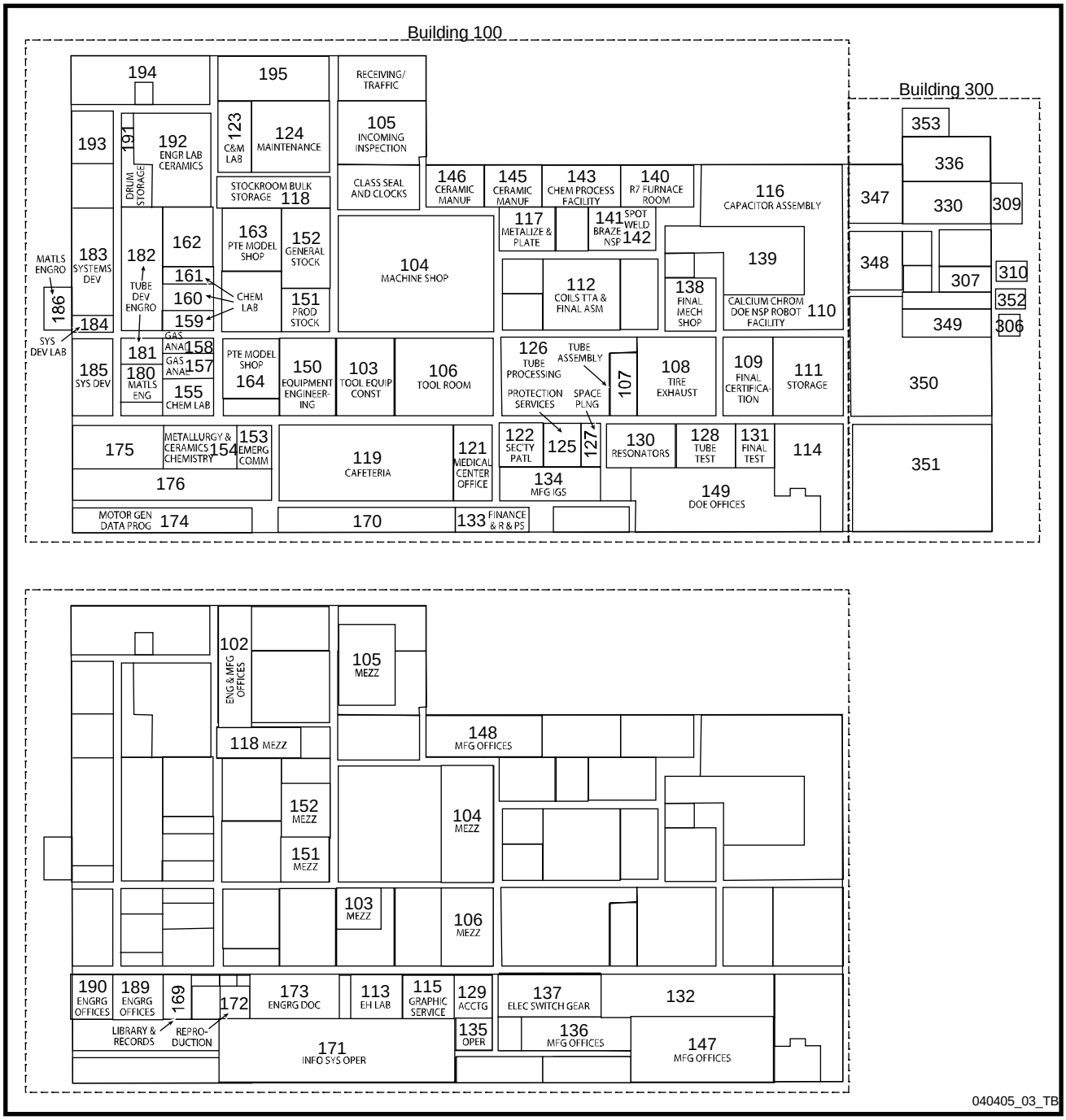

Figure 2-4. Building 100-300 with second floor mezzanines and offices (DOE, 1994).

Area 107 was the assembly area for neutron tubes. A neutron tube is the main subassembly of the neutron generator. The neutron tube is a high vacuum tube similar in operation to a miniature linear ion accelerator (DOE 1990, p. 14). Tube manufacturing required clean-room conditions and used specialized vacuum-sealing technologies and metal spray deposition equipment (PDN 763). Section 2.3.1 of this document provides additional information on the production of neutron tubes.

Area 108 was the primary tritium handling area at Pinellas. Pure tritium gas was received from the DOE Savannah River Site in standard LP50 containers and transferred to depleted uranium beds for

storage. Overall tritium use at Pinellas was generally low with an average yearly inventory of approximately 15 grams (0.53 ounces) (PDN 748, p. 94). Using an activity of 9,640 curies per gram, the average yearly inventory of tritium was approximately 144,600 curies.

The major tritium activity in Area 108 was production loading of neutron tubes and other components with tritium. The assemblies were loaded with tritium through a hydriding process in which the assemblies were evacuated and filled with tritium gas and the tritium was captured by a thin film of metal on the inside of the tube. Initial test firing of the neutron generators occurred in Area 108.

Other activities in Area 108 included mass spectrometer analysis of gas samples and maintenance of the spent uranium storage beds for use and disposal. Most tritium was stored and used in Area 108 (PDN 748, p. 94).

Area 109 contained product testing and product analysis facilities for neutron tubes and completed neutron generators. Manufactured components were tested for operability and vacuum-sealed components were checked for leakage in Area 109. Part of the neutron generator testing included test firing of the devices and leak testing. Initial leak testing used helium and Freon leak-checking systems. In 1963 the Pinellas Plant began using ^{85}Kr in Radiflo® leak test equipment for leak checking of the vacuum tubes (PDN 763).

Area 113M was on the second floor of Building 100 and housed the check sources and calibration laboratory for Health Physics instruments.

Area 132M was on the second floor of Building 100 and housed the central exhaust fan room. It contained the Stack Effluent Control System (SECS) from 1960 until 1982 when that system was replaced by the Tritium Recovery System (TRS) (Weaver 1993, p. 3).

Area 157/158 contained the gas analysis laboratory. This area was used for tritium target sample preparation for the linear accelerator in Building 800 and mass spectrometer analysis of completed components for tritium content. Most of the activities in Area 157/158 were completed inside ventilated laboratory hoods that exhausted through the west exhaust stack.

Area 182 was the vacuum tube development engineering section. It was used to engineer, design, fabricate, and test prototype vacuum tubes for neutron generators and other components. Areas 182-C and 182-G were considered RMMAs due to the small quantities of tritium used in vacuum tube development. Area 182 was exhausted via the west main stack on Building 100.

Area 191/192 was the ceramic product engineering (CPE) section. Minor levels of tritium were used in the production and development of specialty ceramic components.

The Radioanalytical Laboratory was installed in 1966 in Area 176 on the southwest corner of Building 100. It housed the TRS from 1982 until plant shutdown in 1992. The TRS recovered tritium from the plant ventilation stacks and converted it to tritium oxide for dilution and disposal.

Building 100 has two exhaust stacks. The west main stack exhausted 770 cubic meters per minute (27,200 cubic feet per minute) from the west side of Building 100. The stack is 1.5 meters (5 feet) in diameter and 30.5 meters (100 feet) high (DOE 1983, p. 2-18). The east main stack exhausted 1,140 cubic meters per minute (40,240 cubic feet per minute) from the east side of Building 100. The stack is 2.4 meters (8 feet) in diameter and 21 meters (70 feet) high (DOE 1983, p. 2-18). During plant operation, both stacks exhausted tritium and ^{85}Kr from the vacuum tube exhaust, test, and assembly areas. Both stacks were equipped with continuous samplers to monitor the exhaust stream. An

additional 12 sampling stations were located around the plant perimeter. All measured discharges of tritium and ^{85}Kr were well below DOE and U.S. Environmental Protection Agency standards, and no plutonium release was ever detected during manufacturing or decontamination (MMSC 1995, p. 3-2). Section 2.3.2 provides additional information on the annual tritium and krypton releases.

In 1988 a modernization task force conducted a detailed radiological survey of Building 100 to identify the level and extent of radiological contamination. A June 17, 1988 survey showed smearable tritium contamination in approximately 13 percent of Building 100. The maximum reading was 1×10^{8} disintegrations per minute per 100 square centimeter smear on the interior of an exhaust hood in Area 108. The average reading throughout the building was less than 220 disintegrations per minute per 100 square centimeters (Author unknown 1988a, Bldg. 100/300 survey).

Building 200
Building 200 was built in stages between 1959 and 1978; it covers approximately 1,505 square meters (16,200 square feet). The building was used for destructive testing of neutron generators and other components manufactured at Pinellas (Author unknown 1988a, Bldg. 200 survey). Destructive testing included shock, vibration, and explosive tests.

The modernization task force completed a radiological survey of building 200 in 1988 to identify the general level of radiological contamination and perform an initial decontamination cost estimate. The June 1988 survey showed less than 5 percent of Building 200 contaminated with tritium. The maximum contamination level was 1×10^{4} disintegrations per minute per 100 square centimeter smear inside a testing chamber, and the average contamination was less than 220 disintegrations per minute per 100 square centimeters (Author unknown 1988a, Bldg. 200 survey). The final characterization report in 1997 found that radioactive waste and tritium was present inside the building but did not identify specific contamination levels or types of radioactive waste; the report found that all quantities were less than reportable amounts required by 40 C.F.R. pt. 355 or 40 C.F.R. pt. 302.4 (Author unknown 1996a, p. 3).

During operation the building exhaust system maintained negative pressure on three testing chambers (boom boxes) and a single radiological waste drum. The ventilation system passed through high-efficiency particulate air (HEPA) filters before being exhausted from the building roof (MMSC 1995, p. 5-4). The stack exhausted 36.8 cubic meters per minute (2,300 cubic feet per minute). It stands 17.7 meters (58 feet) tall and is 30.5 centimeters (12 inches) in diameter.

Building 400
Building 400 was first built in 1968 for development and testing activities. It was expanded in 1978 and again in 1986. The facility was used to assemble and test the Radioisotopically-powered Thermoelectric Generator (RTGs) from 1975 until 1992. Operating cells on the north side of the building were used for equipment testing and not involved with the production of RTGs. Figure 2-5 is a layout of building 400.

The first receipt of plutonium heat sources for the RTG assemblies was on November 4, 1975, when seven heat sources totaling approximately 54.4 grams (1.9 ounces) of ^{238}Pu and 13.6 grams (0.48 ounces) of ^{239}Pu were received from Sandia National Laboratories (SNL) (PDN 764). When production of RTG devices ceased in 1990, all unused plutonium heat sources were shipped off the site. During 1994 the building was fully decontaminated and released for use by a commercial tenant. The final decontamination survey found indoor radon levels to be below the action levels of the Indoor Radon Abatement Act. Other radiological surveys of the building showed residual radiation levels below free release limits (MMSC 1995, p. 4-1).

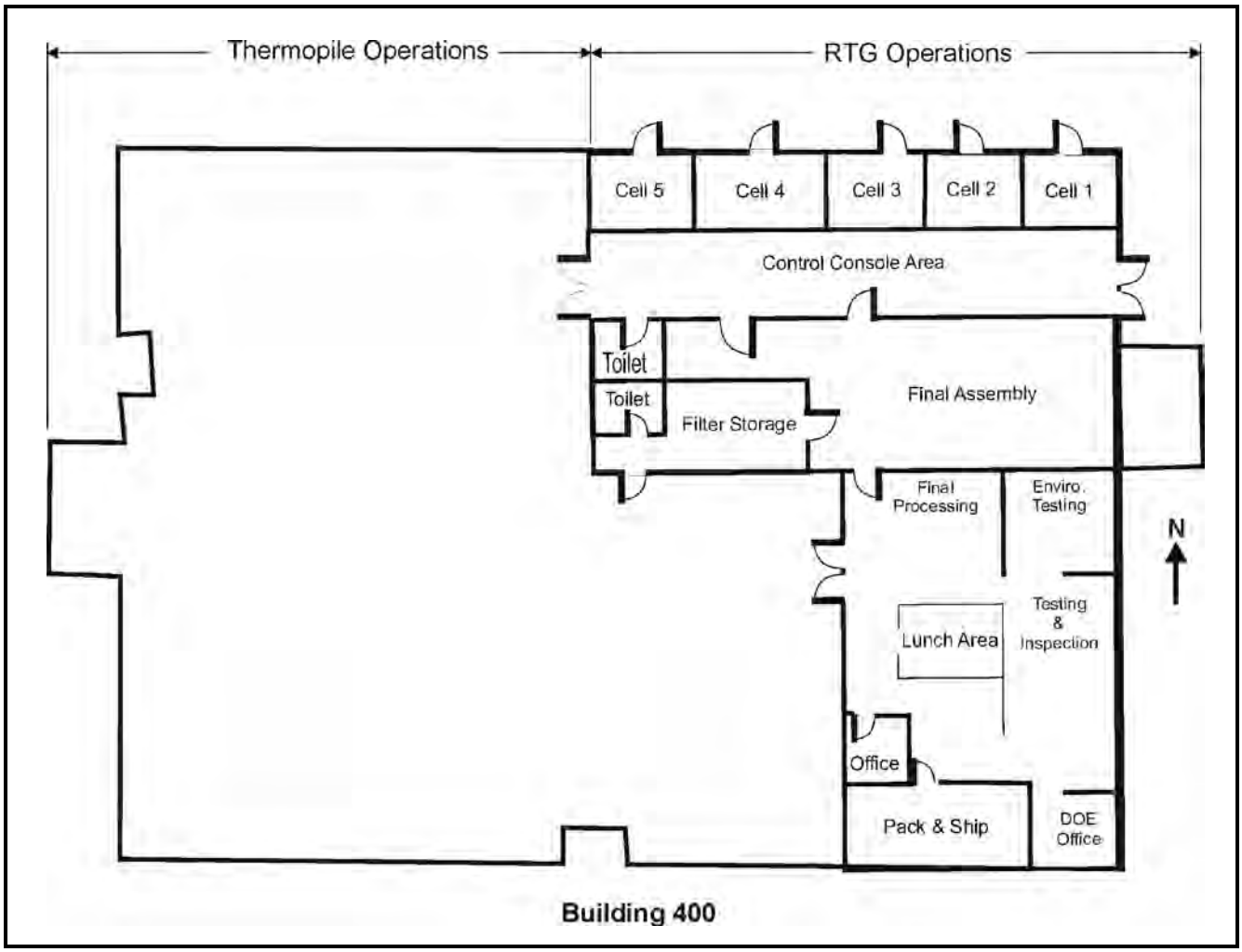

Figure 2-5. Layout of Building 400 (DOE, 1982, pg. 9).

Building 800

Building 800 housed a 200-keV ion accelerator. The accelerator was used to accelerate deuterium ions into various tritium targets to measure neutron output (MMSC 1995, p. 5-5). The building ventilation system exhausted 38 cubic meters per minute (1,350 cubic feet per minute) through a 25- by 33-centimeter (10- by 13-inch) exhaust stack that extends 6.3 meters (20.8 feet) above the ground (DOE 1983, p. 2-18).

A radiological survey in 1988 identified a maximum reading of 1×10^{8} disintegrations per minute on a smear from inside the accelerator, and the average contamination was less than 220 disintegrations per minute per 100 square centimeters. Less than 5 percent of the building area was considered contaminated (Author unknown 1988a, Bldg. 800 survey sheet). Figure 2-6 shows the layout of Building 800.

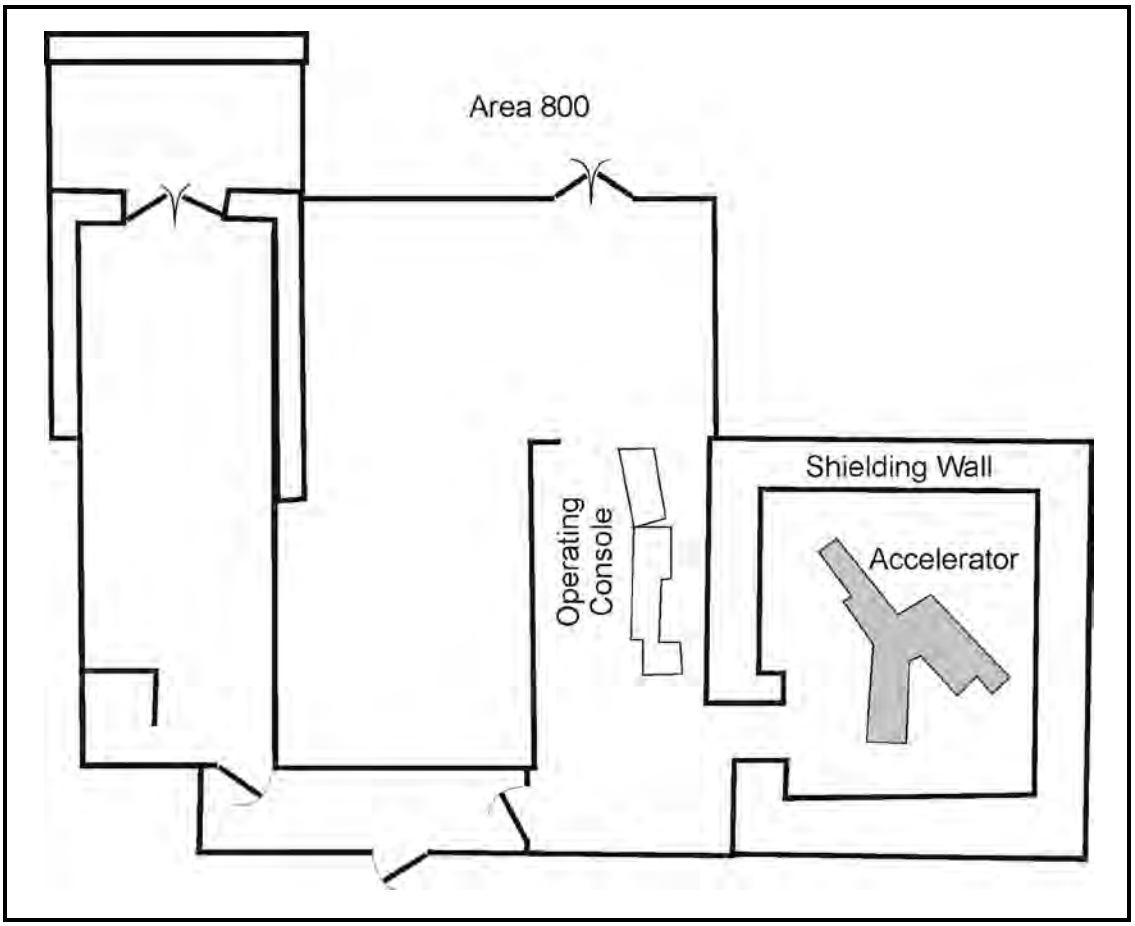

Figure 2-6. Layout of Building 800 (MMSC, 1993, pg. 5).

Building 1000
Building 1000 was used to store low-level solid radioactive waste, solidified waste oil, and used equipment (MMSC 1995, p. 5-5). Waste material was stored in the building until a sufficient quantity was collected either for shipment to a DOE-approved disposal facility or to be sold for scrap.

A radiological survey completed in 1988 identified low levels of contamination in up to 75 percent of the radiological waste storage bay. The maximum measured contamination was less than 220 disintegrations per minute per 100 square centimeters (Author unknown 1988a, Bldg. 800 survey sheet).

2.3 SITE PRODUCTS

2.3.1 Equipment

The Pinellas Plant was built in 1956 and began operation in 1957 to manufacture neutron generators for atomic weapons. Because of the specialty manufacturing techniques required, the plant's mission was expanded to include manufacturing and testing of other special components for nuclear weapons and electronic components for use in extreme environments. Tritium was the primary radioactive isotope used in the Pinellas Plant for the full life of the facility. Thimble-sized plutonium capsules were used as a heat source in the manufacture of RTG assemblies from 1974 to 1990. Krypton-85 was used for leak-testing neutron generators after 1963, and the facility used multiple radioactive sources for instrument calibration and laboratory activities (PDN 748, p. 94). The 200-keV ion accelerator in

Building 800 was another potential source for exposure to ionizing radiation. In addition, manufacturing operations at the Pinellas Plant required the use of 32 radiation emitting devices such as electron beam welders and X-ray inspection equipment. Section 2.4 contains additional information on the radiation emitting equipment used at the Pinellas Plant. The primary products of the Pinellas Plant that required the use of radiological materials included neutron generators, RTGs, and neutron detectors as described in the following sections.

Neutron Generators

Pinellas manufactured neutron generators from 1957 until 1994. The main subassembly of the neutron generator is the neutron tube, which is a high-vacuum tube that operates much like a miniature linear ion accelerator. Initial design and development of the vacuum tubes occurred in Areas 181 and 182 of Building 100. Normal production of the tubes took place in Areas 107, 108, 109, and 126.

The neutron tube manufacturing process required spray coating the inside of a glass tube with a thin metal film such as titanium or the rare earth element erbium. The tube was then attached to a glass manifold vacuum system under an exhaust hood. The normal arrangement had two tubes on each system and four systems under each hood. There were 20 hoods in Area 108, but not all of the hoods were used all of the time (GE 1990, p. 2).

As shown in Figure 2-7, the system contained two vacuum pumps and a quartz glass manifold to which deuterium and tritium beds and the metal-coated neutron tubes were attached. A roughing vacuum pump was used for the initial system evacuation. A mercury diffusion pump reduced system pressure to a near perfect vacuum as measured on a mercury U-tube manometer. Once the system reached vacuum, valves isolated the manifold and the tritium and deuterium beds were heated to flood the system with tritium and deuterium gas. After the required exposure time, the beds were allowed to cool, which caused the hydrogen gas to be reabsorbed (GE 1990, p. 1).

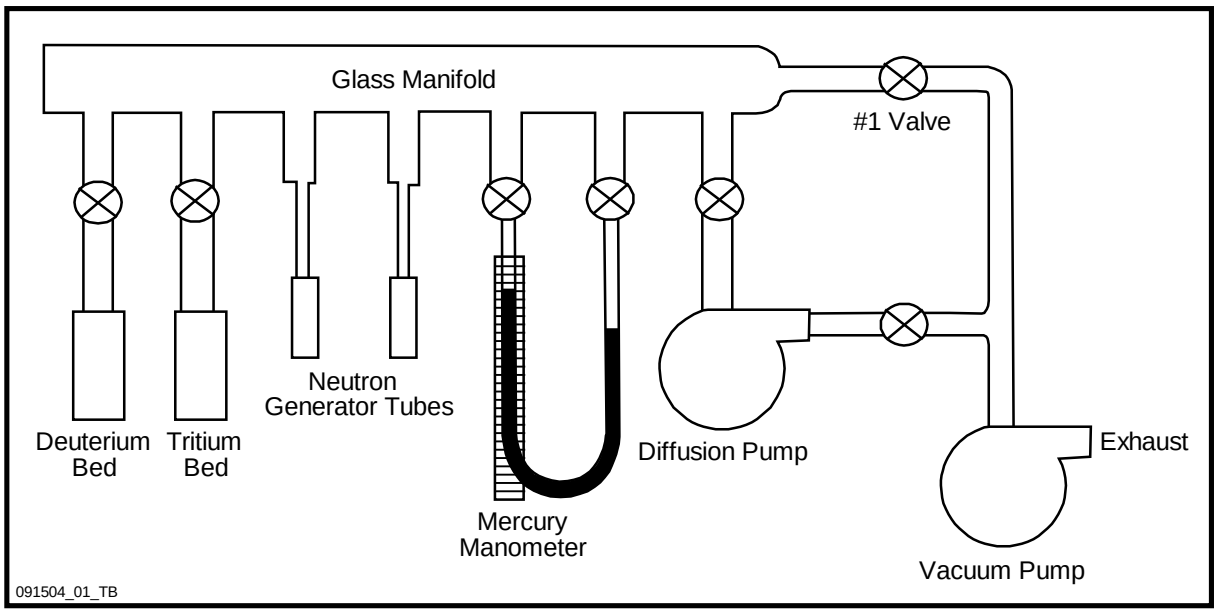

Figure 2-7. Neutron tube tritium loading manifold.

When the manometer showed zero system pressure the operator would use a mobile pulse tank to test the functionality of the neutron tubes still attached to the manifold. The pulse tank would cause the neutron tube to fire a brief burst of neutrons. Tubes that functioned correctly were removed using

a torch to melt the glass manifold connection, seal the neutron tubes, and cut them free of the manifold (GE 1990, p. 1).

Tritium release to the environment occurred during removal of neutron-generating tubes and maintenance of the system. Vacuum pump seal oil would become contaminated with tritium gas, tritium oxide, and mercury vapors. The interior of the glass manifold would become coated with grease containing tritium and deuterium. The pumps and valves were removed periodically to a separate hood area to be cleaned and repaired while the glass manifold was cleaned with solvents to remove accumulated greases. The occasional breakage of a neutron tube would cause floor and hood contamination from the fine metal hydride powder that coated the inside of the tube (GE 1990, p. 2).

Improved management control of the hydride process and replacement of the mercury manometer with vacuum gauges in 1959 and 1960 significantly reduced the amount of tritium released to the environment. Additional reduction resulted after installation of the SECS, which used heated copper wire in the exhaust stream to convert tritium gas to tritium oxide. Chillers and demisters condensed and collected the vapor, and that liquid was routed to underground tanks for dilution and discharge (GE 1990, p. 3).

After manufacture, the neutron generator was leak tested. Initial leak testing used helium or Freon for leak detection. In 1963 the Radiflo leak-testing units were converted to use ^{85}Kr (PDN 748, p. 94).

The neutron tube assembly area was exhausted through a ventilation system that vented a total of 802.5 cubic meters per second (28,340 cubic feet per minute) from two exhaust stacks in the building roof. An exhaust stack alarm was activated when the discharge exceeded 60 microcuries per cubic meter for more than two minutes (Ward, p. 2).

Building 200 was used to test the operability of the neutron generators under extreme conditions. These quality assurance tests included destructive testing of the units inside test chambers known as *boom boxes*. The ventilation system for Building 200 passed through HEPA filters before exhausting out the building roof.

Radioisotopically-powered Thermoelectric Generators

RTGs are batteries that use a silicon-germanium thermopile to convert the thermal energy of decaying plutonium oxide into electricity. Each RTG is capable of generating about 25 milliwatts of electrical power at 2 volts for more than 25 years. They power a multitude of devices from remote airport runway markers to heat sources in satellites.

RTG contain a heat source in the form of a small amount of plutonium oxide encapsulated in a thimble-size, triple-sealed container (DOE 1983, p. 2-7). The capsules were manufactured at Los Alamos National Laboratories (LANL) or Sandia National Laboratory (SNL) and shipped to the Pinellas Plant. No unencapsulated plutonium or plutonium oxide was used at Pinellas, and no record could be found to indicate that the plutonium capsules were breached or opened at Pinellas.

Pinellas manufactured the RTGs in Building 400 from 1975 until 1990. The facility was able to produce approximately 50 units per month and production rarely exceeded 500 units per year (Author unknown 1988b, p. 4). Production was stopped and all plutonium, with the exception of calorimetric sources and small instrument calibration check sources, was removed from the plant in February 1991. No releases of plutonium from Pinellas Plant operations have been detected in the environment (PDN 764).

Neutron Detectors
Neutron detectors were small electronic assemblies used in joint test assemblies to verify the output of a neutron generator during actual tests. The neutron detectors were used to verify operability of the weapon system without initiating a nuclear explosion (DOE 1990, p. 15). These components were manufactured in Building 100 and tested using the linear accelerator in Building 800.

Other Products
In addition to the products discussed, the Pinellas Plant produced other special mechanical and electronic devices and test equipment for a variety of DOE and General Electric applications. These components included long-life batteries, high-speed switching circuits, and specially designed capacitors. These products did not require direct use of radioactive isotopes for their manufacture, and this document does not cover them further.

2.3.2 Radioactive Materials

Tritium
Tritium gas was stored in beds of depleted uranium metal at the Pinellas Plant. The uranium and tritium join to form uranium tritide, which allowed large quantities of ultra-pure tritium to be stored in a small volume at normal temperature and pressure. A search of plant records indicated that, from the start of plant operation in 1957 until November 1993, the total amount of tritium received by Pinellas was 234.1 grams (8.3 ounces), which, at 9,640 curries per gram, is 2.26×10^{6} curies. The total amount of tritium shipped, as product, waste, or material returned to the DOE, was 164.6 grams (5.8 ounces) or 1.6×10^{6} curies. The amount calculated to have decayed away was 58.4 grams (2 ounces; 562,976 curies), and the amount released into wastewater or air was 11.1 grams (0.4 ounces; 107,000 curies) (PDN 765, p. 1).

Exposure to tritium oxide is the prime consideration when assessing tritium dose because the body does not retain gaseous tritium very well, whereas tritium oxide is readily absorbed, which causes a continuous radiation exposure until eliminated by normal water excretion (DOE 1983, p. 2-10).

Krypton-85
Very small quantities of Krypton-85 were used in two of the Radiflo leak detection units at Pinellas from 1963 until 1994. The Radiflo leak detection units were housed in separate rooms and surrounded by ventilation shrouds. Each shroud was connected to ductwork that exhausted 93.4 cubic meters per minute (3,300 cubic feet per minute) to the east main exhaust stack (DOE 1990, p. 3).

Carbon-14
Between 1979 and 1983 a very small quantity of ^{14}C was discharged to the atmosphere through the Pinellas Plant stacks. The total amount discharged between 1979 and 1983 was approximately $3x10^{-4}$ curries. The annual discharges of ^{14}C are shown in Table 2-3. No specific information was available to identify the plant activities that resulted in the release of the ^{14}C.

Atmospheric Discharges of Tritium, Krypton-85, and Carbon-14
The majority of the atmospheric releases of tritium, ^{85}Kr, and ^{14}C were through the four exhaust stacks on Buildings 100, 200, and 800. Table 2-3 lists the releases of these radionuclides between 1956 and 1992

.

Table 2-3. Annual radionuclides released from Pinellas Plant stacks in curies.

Year	Tritium gas	Tritium oxide	Krypton-85	Carbon-14	Comments
1956					Plant under construction
1957	6,660	140			First tritium operations in June 1957
1958	31,920	580			
1959	41,070	1330			
1960	6,265	435			Process changed to reduce tritium loss. SECS installed.
1961	504	306			
1962	611	249			
1963	179	103	4		Kr-85 first used in Radiflo leak test units
1964	233	57	47		
1965	50	100	153		
1966	325	385	49		
1967	1,994	213	70		Milwaukee group moved to Pinellas Plant
1968	1,586	215	202		
1969	3,275	297	55		
1970	587	465	44		
1971	694	374	12		
1972	111	222	16		Gas laboratory connected to SECS
1973	74	318	1		
1974	155	202	4		
1975	154	165	1		
1976	101	176	12		
1977	129	161	18		
1978	132	156	5		
1979	128	206	5	1.0 E-4	
1980	140	209	2	1.0 E-4	Tritium stack air monitoring installed in Building 800
1981	222	195	4	5.0 E-5	Pinellas County sewer system began sampling for tritium
1982	227	257	8	4.0 E-5	TRS replaced SECS in September
1983	259	152	11	1.0 E-5	
1984	96	206	2		
1985	111	149	5.3		
1986	33	161	4.6		
1987	68	138	38		
1988	132.2	124.1	30		
1989	43.7	60	12.9		
1990	35.5	60.5	12.1		
1991	23	88	3.58		
1992	8	31.7	10		

Source: DOE, 1994, pg. 27.

Releases Due to Unusual Events

Other releases of radionuclides during operation of the Pinellas Plant have been identified. These were caused by accidents, operator errors, or similar unplanned events. Table 2-4 lists a chronology of some of the unusual events and the resultant radiological releases (if known) at the Pinellas Plant from startup through 1982.

Table 2-4. Chronology of unusual events.

Date	Description	Curies released
11-1957	Neutron generator output measured at 10 millirem/pulse at 2.5 cm (1 inch).	
12-1957	Raytheon X-ray units found to contain 10 nanocuries of Co-60	
12-10-57	Operator error in reading manometer in Room 18	458
2-11-58	Error estimating amount of tritium remaining in charging system in Room 18	1,253
7-8-58	Glass system breakage in Room 22	280
3-7-58	Glass system breakage in Room 18	567

8-16-58	Operator error with tritium loader valve position – Room 21	780
8-18-58	Glass manifold breakage – Room 21	1,180
2-10-59	Operator error in valve positioning – Room 8	286
6-4-59	Personnel error working on SECS test system – Room 21	753
6-18-59	Excess air released from tritium loading system	423
1-1960	Operator error – stopcock left open on tritium loading system	40
2-5-60	Glass manifold broke from strain	72
2-11-60	Operator error – stopcock left open on tritium loading system	308
7-8-60	Broken sample bulb	6.8
9-1963	Krypton-85 first used in Radiflo leak testing units	
2-1964	E-beam welder found reading 250 millirem/hr at startup – shielded to 4 millirem/hr.	
2-4-65	Explosion during cold trapping of krypton	38
12-1965	X-ray diffraction unit found leaking – new shielding installed	
5-1966	SECS cold water removal problems	252
1-27-67	Glove box vacuum pump oil degassed	32
4-1967	HP surveying new X-ray machine received 1.6-rad exposure. Shielding installed.	
1-17-68	Faulty relay in Radiflo unit No. 1 – vented krypton-85 when placed in manual	129
2-1969	Leaking flange at absorption pump in Area 108	8
2-3-69	Equipment failure – Radiflo valve did not seat properly – Kr-85 vented	20
9-1969	X-ray unit in Area 155 found leaking to 1.6 rad/hr	
12-28-70	SECS column saturated due to air leak in Area 108	117
3-12-71	Copper gasket uncovered in Room 18 hood – high internal dose	7.3
10-9-71	Radiflo Unit No. 1 – Krypton-85 storage tank leak	6.1
10-21-71	Tritium release from improperly baked evaporator system in Area 182D	129
4-1972	Area contaminated from liquid discharge in Area 182D	1.5
5-1972	Hand exposure from XRE X-ray emission unit No. 7R during cleaning	
8-3-72	Leaking absorption pump	12
1-31-75	Improper valve closure on uranium bed	150
2-10-75	Absorption pump leak – Area 182D	42

Source: GE (1990, pp. A-1 to B-8).

Plutonium

The first recorded receipt of plutonium at the Pinellas Plant was on January 18, 1957, when a single 7-gram (0.25-ounce) ^{238}Pu calibration source was received to calibrate Health Physics monitoring equipment. Plutonium for RTG production did not arrive on site until November 4, 1975 when seven sealed sources totaling 54.4 grams of ^{238}Pu arrived from SNL. The RTG production operation at Pinellas Plant used small sealed sources of plutonium produced by LANL or SNL. Each sealed source contained about 9 grams (0.3 ounce) of a four-to-one mixture of ^{238}Pu and ^{239}Pu. The last plutonium, with the exception of calibration check sources, was removed from Pinellas Plant in February 1991 (PDN 764, Item 7).

The plutonium sources at Pinellas were enclosed in a triple metal encapsulation. These units were never opened. The sealed capsules were used as heat sources for the RTGs manufactured in Building 400 (DOE 1983, p. 2-11).

Plutonium-238 has a half-life of 87.74 years, and ^{239}Pu has a half-life of 24,110 years. Both emit alpha particles, gamma photons, and neutrons. The principal hazard from these isotopes is from alpha particle emission from quantities retained in the body. Plutonium oxide is relatively insoluble and, if ingested, is not readily retained in the body. The primary source of body deposition is by inhalation of respirable particles.

Depleted Uranium
Tritium was stored in one of several uranium hydride flasks, each storage flask containing 50 grams (1.8 ounces) of depleted ^{238}U powder in a stainless-steel cylinder 25 millimeters (1 inch) in diameter by 152 millimeters (6 inches) long. The tritium bonds with the depleted uranium metal to form uranium tritide, which is stable at room temperature but can be decomposed by heating to release ultra-pure tritium. The uranium beds can be hydrided and dehydrided many times under appropriate conditions without loss of efficiency. The depleted uranium metal was fully contained inside the storage flask, and no information could be found to indicate that depleted uranium metal was released during plant operations (Ward, p. 12).

Calibration Sources
Pinellas used multiple calibration sources for checking and calibrating plant instrumentation. These items were maintained in the Health Physics Laboratory in Area 113 of Building 100. While the exact inventory of radioactive sources varied, most sources were sealed microcurie (1×10^{-6}) check sources of radioactive isotopes such as ^{137}Ce, $^{238,239}Pu$, ^{60}Co, ^{14}C, and ^{90}Sr (PDN 765, pp. 1–6).

2.3.3 Waste Disposal

Liquid Radioactive Waste
Four types of liquid waste were generated during plant operation: Sanitary, industrial, chemical and, potentially, tritium-contaminated waste. Before 1982, sanitary wastes were processed by an onsite sewage treatment facility and mixed with neutralized industrial waste in the west pond. Chemical drain lines from inside the plant routed industrial waste to an onsite treatment facility where it was chemically neutralized and pumped to the west pond. Water from the west pond was sprayed on a 10-acre irrigation field. A subsurface drain system under the 10-acre field collected liquids and routed them to the east pond. Liquid in the east pond was sampled and periodically discharged to a Pinellas County drainage pipe and roadside ditch that drained into Cross Bayou Canal and Tampa Bay (DOE 1983, p. 2-14).

It is possible that tritium-contaminated liquid waste generated during operations and tritium oxide from the TRS was piped to a group of three underground holding tanks in the health physics area outside the southwest corner of Building 100. The liquid was sampled and discharged if the radioactive content was below the limits specified in Chapter XI of DOE Order 5480.1. Liquids with higher concentrations of tritium were incorporated into a solid for offsite burial. Effluent discharge from the holding tanks was pumped to the west pond where it mixed with the sanitary and industrial wastes discussed earlier (DOE 1983, p. 2-13).

Solid Radioactive Waste
The majority of radioactive waste from the site consisted of tritium-contaminated classified components. These components were packaged and shipped to a DOE-controlled site for disposal. Small quantities of radioactive liquids were solidified with absorbing compounds and included with the solid radioactive waste (DOE 1983, p. 2-21).

Gaseous Radioactive Waste
Gaseous radioactive effluents were produced and released during the operation of the Pinellas Plant. Gaseous tritium, tritium oxide, ^{85}K, and a very a small quantity of ^{14}C were the only identified releases. The four main discharge points were the two exhaust stacks on Building 100 and the single exhaust stacks on Buildings 200 and 800. During the initial years of plant operation tritium releases were as high as 42,400 curies per year. Installation of the SECS in 1960 reduced tritium emissions to less than 1,000 curies per year, and installation of the TRS in 1982 further reduced tritium emissions to less than 500 curies per year.

2.4 SITE EQUIPMENT

Exposure to radioactive isotopes was not the only source of ionizing radiation at the Pinellas Plant. Many pieces of production equipment used at the Pinellas Plant were capable of producing radiation. Table 2-5 lists the locations of radiation generating equipment on the Pinellas Plant site.

Table 2-5. Radiation-producing equipment.[a]

Location	Quantity	Type	ID Number
107	2	X-Ray Emission (XRE) Units	CCN87103, CCN99591
114	2	Industrial X-Ray Units	MN87904, MN87851
114	1	Faxitron X-Ray Corp	MN87243
114	1	TFI X-Ray Television	None found
127	1	Inspector Unit	None found
138	1	Electron Beam Welder	MN62183
161B	2	X-Ray Diffraction (XRD) Units	MN86640, MN86641
161B	1	Micro X-Ray Diffraction (XRD) Unit	MN86747
161B	1	Electron Microprobe	MN86607
161B	1	Energy Dispersive Analyzer (EDA)	MN86475A
162	2	Scanning Electron Microscope (SEM)	MN94109, MN94225
162	1	Transmission Electron Microscope (TEM)	MN94168
163	1	X-Ray Thickness Gage	MN550042
164	1	Cabinet X-Ray Unit	CCN91407
175	1	X-Ray Diffraction (XRD) Unit	CN87952
176	1	X-Ray Emission (XRE) Unit	None found
192B	1	Sedigraph	MN94285
193N	1	Scanning Electron Microscope (SEM)	MN91992
194E	1	Picker (Cabinet X-Ray Unit)	MN87042
300	2	Electron Beam Welder	MN61660, MN76803
300	1	Phillips (Cabinet X-Ray Unit)	MN87810
300	2	Faxitron X-Ray Corp	MN088001, MN099915
400	2	Electron Beam Welder	MN61346, None found
400	1	Cabinet X-Ray Unit	MN63294
899	1	Ion Accelerator	
Warehouse	1	X-Ray Television	None found

Source: PDN (1022); Author unknown (1986, p. 1).

a. Neutron generators produced for use in nuclear weapons are not listed in this table and may have been found throughout the plant.

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