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PINELLAS PLANT FEASIBILITY STUDY

FINAL REPORT

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MASTER

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EXECUTIVE SUMMARY

The Pinellas Plant was built in 1956 to manufacture neutron generators, a principal component in nuclear weapons. It is owned by the United States Department of Energy (DOE) and was operated by General Electric Neutron Devices (GEND) until May 31, 1992. In June 1992, Martin Marietta Specialty Components, Inc. (MMSC) assumed operation of the plant.

In September 1990, the Department of Health and Rehabilitative Services (HRS) entered into an agreement with DOE to independently examine environmental monitoring data from the plant and health data from Pinellas County to determine if an epidemiological study is technically feasible to measure possible off-site health effects from ionizing radiation. HRS' evaluation is overseen by a steering committee consisting of experts from industry, academia and government as well as representatives from the community.

Through normal plant operations, some radioactive materials have been released to the environment. Eighty percent of the total plant releases of 107,707 curies occurred in the early years of plant operation (1957-1960). The primary materials released were tritium gas, tritium oxide and krypton-85. Environmental monitoring for radioactive releases from the plant has been done regularly since 1975. The United States Public Health Service Centers for Disease Control and Prevention (CDC), in assisting HRS, has determined that sufficient radiological data exist by which a dose reconstruction can be done. A dose reconstruction can provide an estimate of how much radiological exposure someone living in the vicinity of the Pinellas Plant may have suffered from environmental releases.

Health information from Pinellas County, such as death, birth, and fetal death data for selected time periods has been examined for indications of radiologically induced health outcomes. The sources of information include the Office of Vital Statistics, the

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Congenital Defects Surveillance Project and the Florida Cancer Data System (FCDS). The Congenital Defects Surveillance Project was of such limited duration as to be of no benefit to this study. However, health information from the FCDS was very helpful. It must be noted that the analysis of this information must be interpreted cautiously because of the following limitations. A background incidence of cancer for Pinellas County cannot be established for the first twenty-five years of the plant's operation because there are no data. In addition, the demographic structure of the county has changed over time. Gaps in radiation exposure knowledge and an inability to account for other chemical exposures and other personal risk factors also confound the data. Taking into account the above data limitations, for the period 1981-1990, age-adjusted overall cancer incidence for all four race-gender groups appears to be elevated as compared with that of the state. Specifically, primary sites of elevated incidence include colorectal cancers. Based on the information gathered by the feasibility study, further study options would include a step-by-step approach where each step would lead to the next and where any one step might indicate no need for further continuation. Each option would be guided by a panel of agency representatives, scientific experts and public representatives. The following are potential options for future additional studies activities related to the population surrounding the Pinellas Plant:

- 1) Document discovery and radiological dose reconstruction for the Pinellas Plant,
- 2) Historical and prospective cancer surveillance for leukemia, colon and rectal cancers for the Pinellas Plant area, and
- 3) If indicated necessary by the two above phases, a case-control study.

HRS, as the entity which has conducted the feasibility study, is precluded by the contract with DOE from conducting or participating in further studies. DOE will evaluate the need for pursuing the potential options mentioned above and will determine if funding should be made available for them.

1. INTRODUCTION

The Pinellas Plant was built in 1956 to manufacture neutron generators, a principal component in nuclear weapons, and other parts for nuclear weapons [1]. It is owned by the United States Department of Energy (DOE) and was originally operated by General Electric Neutron Devices (GEND), a prime contractor to DOE until May 31, 1992. On June 1, 1992, Martin Marietta Specialty Components, Inc. (MMSC) assumed operation of the Pinellas Plant [2].

The Pinellas site, covering approximately 100 acres, is located near the geographic center of Pinellas County, Florida (Figures 1-1, 1-2 and 1-3). With a land area of 280 square miles and a resident population of 864,953 based on the April 1993 population estimate, Pinellas is the most densely populated county in Florida with about 3,100 people per square mile [3].

Since 1956, the plant has used and processed radioactive materials, including tritium, krypton, carbon-14, plutonium and other radioactive materials, and other hazardous chemicals. Some of these materials were released to the area surrounding the plant through normal operations or accidents [2,4].

In September 1990, a Health Agreement was signed between DOE and the State of Florida [5]. The focus of the Health Agreement is on effects resulting from ionizing radiation. The primary purpose of the agreement is

to provide for an independent assessment to determine whether an epidemiologic study to measure off-site health effects is technically feasible, and, if such a study is deemed feasible, to establish the parameters for the study and arrange for the study to be conducted by a competent, independent entity (Health Agreement between DOE and the State of Florida).

FIGURE 1-1

STATE OF FLORIDA

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FIGURE 1-2

PINELLAS COUNTY

FIGURE 1-3

PINELLAS SITE

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Based on the purpose of the agreement, the feasibility stage summarized by this report will consist of collecting and verifying the following information:

1. Literature review of epidemiologic studies around nuclear facilities.
2. Radioactive material inventory at the plant.
3. Radioactive materials released from the plant.
4. Environmental monitoring data for radioactive materials in Pinellas County.
5. Assessment of the feasibility of a radiological dose reconstruction in the vicinity of Pinellas Plant
6. Geographic information for Pinellas County.
7. Health information for Pinellas County.
8. Potential pathway for exposure from water and agricultural products in Pinellas County.
9. Other environmental concerns.
10. Future study options and power calculations

During the course of the feasibility study, two public meetings have been held in Pinellas County. The first was held on February 28, 1992, and the second on February 10, 1994 at the time of the distribution of the first draft of the final report. Survey questionnaires have also been distributed to elicit information on resident health and environmental concerns. In addition, a steering committee was established to monitor the report progress and to review the findings of the final report. The Steering Committee is composed of representatives of the scientific community, national agencies and the local community.

Public concerns include:

- 1) Preservation of health of workers and citizens,

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- 2) Protection of the environment through prevention of spread in pathways of exposure and waste clean-up, and
- 3) Truth in information and accountability.

The desire for accurate and timely information, as well as personal and environmental health concerns, point to the necessity and usefulness of establishing a dialogue with community residents in the planning, implementation and evaluation stages of any proposed health studies through public meetings, citizen representation on advisory committees and accessibility of agency and scientific representatives to citizens.

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2. Martin Marietta Specialty Components, Inc. Pinellas Plant Annual Site Environmental Reports for Calendar Year 1992. MMSC-ESH-93035, June 1993.
3. Office of the Governor. Office Population Estimates as of April 1, 1993. Dec. 1993
4. General Electric Company Neutron Devices Department. Pinellas Plant Omnibus Environmental Assessment. GEPP-196 Nov. 1975.
5. Health Agreement between the United States Department of Energy and the State of Florida. Sept. 1990.

2. LITERATURE REVIEW OF EPIDEMIOLOGICAL STUDIES AROUND NUCLEAR FACILITIES

More than one hundred study reports, summaries and comments of epidemiological research around nuclear facilities have been collected and reviewed. Since the study is focused on off-site health effects of radioactive emission from the Pinellas Plant, this review is concentrated on literature related to health risks from radioactive emission from nuclear facilities, especially studies around DOE nuclear installations.

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The purpose of this section is to produce a historical review of the literature related to cancer risks from low level radioactive emissions from nuclear installations. There are few epidemiological studies concentrating on the risks of tritium and cancer available, therefore this report will review general risks from radioactive emission from nuclear facilities. Since there have been a lot of prospective reviews and commentaries on the United Kingdoms' studies, this review will focus on the studies in the United States, especially those studies around DOE nuclear installations [18-28].

There has been considerable interest in the possible health risks to the public from low levels of radioactive emission from nuclear installations. Over the past several decades, scientific studies have yielded mixed results. The controversy focuses on sample size of the studies, exposure levels of the study groups, definitions of study boundaries and the control of confounding factors. This is not particularly surprising since the risks from low levels of radiation exposure are thought to be so small that a large number of people would have to be studied before any effect could be reliably distinguished from random fluctuation in background rates.

In the United Kingdom, the possibility that childhood leukemia rates might be elevated near nuclear installations was raised by the Yorkshire Television (YTV)

documentary "Windscale -- the nuclear laundry" on November 1, 1983. Since then, a number of studies on the topic have been undertaken [1-12]. Some studies confirm that a higher incidence rate of leukemia exists in the vicinity of nuclear installations. Other studies have failed to show any difference in the incidence of leukemia between the populations living in the vicinity of nuclear installations and comparison populations.

In France and Canada, similar studies have been carried out in the vicinity of nuclear installations since 1983 [13-16]. There is little evidence to suggest that cancer incidence is raised in these populations. In the United States, the earliest study on the possible cancer risks to the public from nuclear installations is by Moshman and Holland in 1949 [17]. Since then, numerous reports have been published on this topic.

STUDIES OF CANCER RISKS AROUND U.S. NUCLEAR INSTALLATIONS

1. Oak Ridge Site (ORS)

ORS is one of the oldest nuclear installations in the United States. It began operations in 1943 as part of the Manhattan Project to develop atomic bombs. Moshman and Holland examine the possible cancer risks related to ORS in Oak Ridge, Tennessee for the year 1948 [17]. They calculate age-adjusted rates for the Oak Ridge population by sex, based on the 1940 U.S. population and compute the age-standardized cancer incidence rates by organ sites. They have found that the cancer incidence rate for Oak Ridge was 123 per 100,000 compared to the national average for whites of 230 per 100,000. This difference is shown to be equal for males and females. Moshman and Holland believe that the deficit of cancer incidence is due to the healthy, highly selected Oak Ridge population. This phenomenon is called the healthy worker effect, and has been frequently documented in occupational studies. However, a higher proportion of respiratory cancer was found among white males in Oak Ridge than expected. The authors feel that this could be attributed to the general

increase in lung cancer over the decades for the entire U.S. population. Although the study was limited to only one year, 1948, it is the earliest study in the U.S. to examine the potential cancer risks from nuclear installations for the surrounding population.

Patrick has reviewed the vital statistics data for the city of Oak Ridge and for the two counties in which the ORS is located [28]. In this study, age-adjusted cancer mortality rates from the National Cancer Institute for the years 1950 to 1969 have been analyzed. He notes that the overall results suggest that cancer mortality rates are not significantly higher than would be expected in the general population for this period. The author also states that there are problems in his study, particularly that he is unable to collect migration and socioeconomic information.

Goldsmith briefly examines leukemia mortality rates for children of ages less than 10 years in two counties near the ORS for the period 1950 to 1979 [29,30]. The total number of cases for the thirty-year period is 30. He notes excesses of leukemia mortality in the periods 1950 to 1959 ($O/E=16/8.93$) and 1960 to 1969 ($O/E=11/6.92$), but not for 1970 to 1979 ($O/E=3/3.62$). Since this is a preliminary analysis, he cautions that without further study he cannot say if these findings reflect the impact of direct radiation exposure, indirect exposure from parents with occupational exposures, or some other unknown factors.

Jablon et al. have reviewed the cancer mortality rates in two counties around ORS in a study using data from multiple nuclear installations [31]. They have compared the cancer mortality rates with control counties between 1950 and 1984. They have adjusted for age, sex and race for the study counties based on concurrent U.S. experience. Their study finds that, although the relative risks for leukemia are 1.47 in children under 10 years of age, the excess is not statistically significant. In this study, elevation in leukemia rates does not exist in other age groups. The only noteworthy observations are for persons over age 40, where death from cancer of the trachea, bronchus and lung is significantly increased in the study counties; and in

persons over 60, where death from all cancers (except leukemia and trachea, bronchus and lung) are increased by a relative risk of 1.24.

2. Hanford Site

The Hanford site is another early nuclear installation located in southeastern Washington State. It began operation in 1943. Activities at Hanford, which formerly focused on plutonium production, have shifted to environmental restoration, managing the wastes generated by past reactor and processing operations, and research and development for advanced reactors, energy technologies, basic sciences, and waste disposal technologies. Recently released documents show that a large amount of radioactive iodine (about 500,000 curies) was released into the environment from 1945 to 1955 from the Hanford site.

Fadely has studied cancer mortality rates among several counties along the Columbia River that might have been contaminated by the effluent from Hanford [32]. Although the study found some positive relationships between various cancers and the Hanford nuclear installation, there are several serious limitations in the study design. Fadely did not adjust mortality rates for age and sex, several counties in the area were not included, and the actual numbers of deaths were not reported.

Bailar and Young examined cancer mortality in Oregon and Washington states because of the concern over possible cancer risks from the Hanford site [33]. They divided Oregon and Washington state into eight groups based on geography. Cancer mortality rates were computed for all sites as well as leukemia mortality for the years 1934 through 1963. The mortality rates were adjusted for age and sex by the indirect method using the 1950 U.S. population distribution. They found that all cancer rates were consistently lower than in the U.S. as a whole, but that leukemia rates were consistently higher. However, the excess rate of leukemia was present before the Hanford site began operation. They concluded that no evidence can be found that

persons living downstream from the Hanford Site or along the Pacific coast of Oregon have had an excess risk of death from cancer in general or from leukemia in particular.

Goldsmith briefly examined leukemia mortality for children of less than 10 years of age in two counties near Hanford for the period 1950 to 1979 [29,30]. The total number of cases during the thirty-year period was 27. He noted excesses of leukemia mortality from 1950 to 1959 and from 1960 to 1969, but not for 1970 to 1979. Milham noted that the population in the Hanford area fluctuated greatly in the 1950's, reaching a peak in the middle of 1950's [34]. This demographic trend is important to note since the linear interpolation used by Goldsmith to estimate the mid-decade population may have underestimated the population at risk and overestimated the risk of leukemia.

In a study with multiple nuclear installations, Jablon et al. reviewed the cancer mortality rates for Benton County where the Hanford site is located [31]. They adjusted for age, sex and race for the study counties based on concurrent U.S. experience and compared the cancer mortality with control counties from 1950 to 1984. At ages 20-39 and 40-59, the mortality from all cancers except leukemia and from cancer of the trachea, bronchus and lung are significantly lower. For all ages combined, the relative risks for all cancers except leukemia are significantly low (0.96); whereas the relative risks for cancer of the bones and joints is significantly high (1.51). The authors note that the risks might be overestimated since the population was estimated based on linear interpolation between census years (the same reason mentioned above).

3. Rocky Flat Site

The DOE Rocky Flat site began operation in 1953 and is located near Denver, Colorado. Its primary function in support of the U.S. Nuclear Weapons Program is the construction of weapon components from plutonium, uranium, stainless steel, beryllium

and other materials. In the spring of 1969, there was a fire and plutonium was released from the plant to the surrounding area.

Johnson examined the cancer incidence in the Rocky Flat vicinity for the period 1969 to 1971 [35]. He has divided the study area into four groups (three exposed groups and one unexposed group) based on measured soil plutonium concentrations and the distance from the facility. He has found a higher incidence of all cancers in the exposed groups as compared to the unexposed group. He also notes a trend of increased cancer incidence with increasing concentration of plutonium in the soil.

Crump et al. studied cancer incidence in the Rocky Flat vicinity for the period 1969 to 1971 (the same period as Johnson's study) and for 1979 to 1981 [36]. They found no association between disease and proximity to the Rocky Flat facility but did find an association with the proximity to an urban center as measured by the distance from downtown Denver. They noted that the correlation of cancer incidence with proximity to Rocky Flat largely disappears for both periods when analyses are stratified by this urban factor.

Jablon et al. examined cancer mortality rates for Jefferson County where the Rocky Flat nuclear facility is located in a study with multiple nuclear installations [31]. They adjusted for age, sex and race for the study counties based on the concurrent U.S. experience and have compared the cancer mortality with the control counties from 1950 to 1984. They found some evidence for elevation of relative risks of cancer. For those over 60 years of age, female breast cancer is elevated as are all cancers except leukemia. For the 40 to 59 age group, the relative risks for "other" lymphomas and for colorectal cancer are elevated. Overall, for all ages combined, the relative risks for all cancers except leukemia are also elevated. In addition, the researchers have noted that the incidence rates of cancers in the control counties were lower than the average level of the nation.

4. Other DOE Nuclear Installations and Commercial Nuclear Facilities

Although numerous studies on health risks around commercial nuclear installations have been done, only a few have been formally published. Most of the informally published reports have been presented in conference meetings. Only studies which have been formally published are reviewed here.

In addition to the ORS, Hanford and Rocky Flat sites, Jablon et al. have checked the cancer risks for the other seven DOE facilities and fifty-two commercial nuclear installations in their study [31]. This is the largest study of multiple nuclear installations. Over 900,000 cancer deaths from 107 study counties and 1.8 million cancer deaths from 292 control counties have been included in the study. Overall, they have found that nuclear facilities could not be linked to cancer deaths in persons living near them. They conclude that if nuclear facilities pose a risk to neighboring populations, that risk is too small to be detected by a survey such as theirs.

Lambert and Cornell reviewed the mortality rates of leukemia and lymphoma around Big Rock Point nuclear plant for the period of 1950 to 1971 [37]. Five counties within a 25-mile radius of the plant were selected as having been exposed, and five counties outside a 75-mile radius from the plant were selected as a control group. They compared the mortality rates for these two groups, and found no unusual cancer rates. The authors emphasize that there is only a nine-year exposure period and this may be too short a time to induce enough specific cancer cases to increase related cancer rates significantly.

Enstrom examined cancer mortality patterns around the San Onofre nuclear power plant for the period of 1960 to 1978 [38]. Leukemia, lung cancer and overall cancer rates were calculated for three counties near the plant and compared to the rates for California and the United States. In addition, childhood leukemia death rates were also examined in the communities within a 10 and 25-mile radius of San Onofre. The cancer rates near the plant are similar to those for the comparison area. Enstrom feels

that the levels of exposure to radiation are so low that the population which lived around the plant would have to be followed for many years to detect subsequent development of cancers.

Clapp et al. report an increase in leukemia incidence, particularly myelogenous leukemia in adult males, from 1982 to 1984 in five Massachusetts coastal towns near the Pilgrim nuclear power plant [39]. Since the known releases from the Pilgrim plant are too small to account for the increase in leukemia, they postulate the existence of a mechanism by which airborne releases are contained in a coastal pattern near the plant.

Poole et al. examined the cancer incidence rates in the same area as Clapp et al. did for the years from 1985 to 1986 [40]. Only six cases of leukemia have been found compared to 11.8 cases expected for the two-year period. They suggest that a small increase of leukemia, in a restricted age range, in one gender, in a few selected towns, for a short period is better explained as a minor statistical fluctuation than as an effect of radioactive releases into the environment.

DISCUSSION

Although the basic idea that radiation doses cause cancer in humans is generally accepted, the concept of risk of cancer from low levels of radiation is still quite controversial [41,42]. There is not a consensus among researchers as to an interpretation of the results from the epidemiological studies. Disagreements are focused on the definition of study boundaries, dose estimates, sample size and possible confounding factors.

Definition of study boundaries: There is great disparity in study boundaries: age groups, calendar years, geographical boundaries and disease categories. Since the radiation exposure is minor in surrounding populations and the cancer outcome is low, the definition of study boundaries is critical in the interpretation of study results. Using

the U.K. study in Dounreay as an example, it can be shown that the study results change if the study radius is defined at 25km instead of 12.5km and if the study period is increased from 1968 to 1984 instead of 1979 to 1984 [3]. MacMahon concludes that, with the possible exception of the cluster of childhood leukemia in Seascale, none of the reported individual clusters of leukemia, or of leukemia and non-Hodgkin's lymphoma combined, around nuclear facilities in Britain hold up convincingly as a biologically meaningful cluster [43]. Although Taylor and Wilkie note that suspicion has centered on clusters of cases of leukemia near nuclear installations, it all depends on where the boundaries of the study are set [44]. This debate is also meaningful for the U.S. studies. As Poole suggests, if Clapp's study extended the observation period of 1982-1984 to 1982-1986, the results would change dramatically [40, 39]. The standardized mortality ratio would become 0.96 instead of 1.60 for adult leukemia in that area.

Dose estimate: Since the studies are concerned with the risks of cancer due to radioactive exposure from nuclear installations, an actual estimate of the dose level of radiation is critical. Most of the studies reviewed have not based population definitions on exposure levels, but have defined populations based on geographic or political classifications. Shleien et al. point out that the releases of contaminants to the environment do not usually disperse in concentric circles or follow governmental boundaries [45]. In addition, these studies have not considered migration patterns in the study area. As Milham mentioned in his letter on Goldsmith's study, the population demographics in the Hanford area changed dramatically in the 1950's [34, 29, 30]. The doses received by the study participants may be quite different than those estimated. Some people with heavy exposure have moved out of the study area while others without exposure have moved in. This phenomenon is not unusual for

neighborhoods surrounding other DOE facilities, such as Oak Ridge during the 1940's [46].

Sample size: One of the most fundamental concerns of study design in any epidemiological study is whether there is sufficient sample size or power to show the difference of outcome between the study and control groups. Unfortunately, in the studies of low-level radiation exposure and cancer risks reviewed here, the sample size or power is often not large enough (see Lambert's and Enstron's studies [37,38]). Since the cancer risk from low level radiation is so small, a very large sample size is needed to detect the difference in cancer rates and it is usually impractical for a single study to have enough power.

Alternative methods, such as meta-analyses with pooled data and the Jablon et al. study, may overcome the problem of lack of power in a single study. Meta-analyses involves quantitative summaries of the results from similar but independent studies. It is a basic concept of epidemiology that the overall pattern of findings from many studies is generally more convincing than the result of any single study. This is especially important in studies with low power. Some researchers have tried to study cancer risks from low level radiation exposure in the nuclear industry with meta-analyses [47].

Possible confounding factors: The known risk factors for cancer are multiple. There are many other risk factors besides radiation, such as smoking, occupational exposures, diet, viruses (e.g. HSV, EBV, Papovavirus, etc.), and other behavioral and genetic factors. Cigarette smoking is estimated to cause 30% of the cancer mortality in the United States. It is the leading known preventable cause of cancer. As for diet, it has been estimated that 30% to 70% of cancers can be attributed to diet. Although this estimate is highly speculative and chiefly refers to dietary factors which are not yet

reliably identified, most researchers do agree that the importance of diet in preventing cancer is significant [49]. Other risk factors, such as viruses, are related to specific cancers.

A review of the majority of these studies has not been able to elicit much information on the important confounders. Considering this, it is possible that study results have been influenced by multiple factors. Furthermore, doses received by surrounding populations from nuclear installations under normal operations are far lower than the doses received from other sources of radiation. The U.K. National Radiological Protection Board estimates that 98.5% of the total radiation dose received by the population of Thurso, where the Dounreay nuclear installation is located, was from other sources [50]. Only 1.5% of the total radiation dose received was from discharges from nuclear installations.

CONCLUSION

Although there have been a great many efforts to study the relationship between low level radiation exposure and cancer risks since the 1940's, the significance of the relationship is still inconclusive. More studies are necessary to examine whether cancer clusters around some nuclear installations are due to natural statistical fluctuation, radiation exposure or other causes. Our review of studies of cancer around U.S. nuclear facilities indicates that accurate dose estimates, reasonable definitions of study boundaries, and controls for confounding factors are important considerations for further studies. A single study may not have enough power to draw a convincing conclusion. With pooled data and meta-analyses, the difficulty of lack of power in the study of low level radiation and cancer risks can be overcome.

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3. RADIOACTIVE MATERIAL INVENTORY AT THE PINELLAS PLANT

The task of this section is to identify:

1. All types of radioactive materials used in the plant;
2. The quantity of those radioactive materials; and
3. The time periods in which respective radioactive materials were used at the plant.

Based on the available information, the following radioactive materials have been used in the plant [1-23]:

tritium	carbon-14	sodium-22
manganese-54	iron-55	cobalt-57
nickel-59	cobalt-60	nickel-63
krypton-85	strontium-90	cadmium-109
barium-133	cesium-137	promethium-147
gadolinium-148	thallium-204	bismuth-210
polonium-210	lead-210	radium-226
thorium-230	protactinium-234	plutonium-238
uranium-238	plutonium-239	americium-241
curium-244		

These radioactive materials are used at the Pinellas Plant for two basic purposes:

- a) As part of a product, for example tritium used in neutron generators and plutonium used in radioisotopic thermal generators (RTG) formerly manufactured at the plant, or
- b) As sources used for calibration of radiation detectors (commonly used in hospitals and scientific research labs) or tracers for detecting leaks and determining surface cleanliness.

Two sets of inventories of the history of radionuclides used at the plant were

obtained. One inventory is for the radionuclides to be used as part of a product. This includes the type of material and the quantity of the material since 1956. Two kinds of radionuclides, tritium and plutonium, are in this inventory (Appendix 2). The second inventory is for radionuclides to be used in non-product activities. This inventory displays the historical information for twenty-eight types of radionuclides used in the plant, the quantity of these materials, the purpose of using these materials, and the status of these materials for the documentary data (Appendix 3).

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4. RADIOACTIVE MATERIALS RELEASED FROM THE PINELLAS PLANT

The task of this section is to document:

1. The types of radioactive materials released;
2. The quantity of the radioactive materials released;
3. The pathway by which the radioactive materials were released; and
4. The time period when these materials were released.

Based on the available information, the following radioactive materials have been routinely released from the plant [1-24]:

tritium (since 1957)

krypton-85 (since 1963)

carbon-14 (1979 to 1984)

Among them, tritium is the main element which has been and continues to be released from the plant. It is a radioisotope of hydrogen which has a half-life of approximately 12.35 years. It behaves chemically like normal hydrogen. Most of the tritium was released from plant stacks. From 1957 to 1992, a total of 107,022.8 curies of tritium (98,427.9 curies tritium gas and 8,594.9 curies tritium oxide) was released from the stacks (Table 4-1). Eighty two percent of the total tritium emission from the stacks was released in the first four years (Figure 4-1). A relatively small amount of tritium oxide was released into the plant's waste water stream. From 1982 to 1992, a total of 8.79 curies of tritium oxide (Figure 4-2 and Table 4-2) were released to the county Publicly Owned Treatment Works (POTW). Before 1982, the waste water was released to Cross Bay Canal or used for irrigation within the plant grounds. The amount of tritium released to waste water from 1957 to 1982 has not been established as of this date.

TABLE 4-1
RADIONUCLIDES RELEASED FROM PINELLAS PLANT STACKS
(CURIES)

YEAR	TRITIUM GAS	TRITIUM OXIDE	KRYPTON	CARBON 14
1957	6660	140		
1958	31920	580		
1959	41070	1330		
1960	6265	435		
1961	504	306		
1962	611	249		
1963	179	103	4	
1964	233	57	47	
1965	50	100	153	
1966	325	385	49	
1967	1994	213	70	
1968	1586	215	202	
1969	3275	297	55	
1970	587	465	44	
1971	694	374	12	
1972	111	222	15	
1973	74	318	1	
1974	155	202	4	
1975	154	165	1	
1976	101	176	12	
1977	129	161	28	
1978	132	156	5	
1979	128	206	5	1 E-4
1980	140	209	2	1 E-4
1981	222	195	4	5 E-5
1982	227	257	8	4 E-5
1983	259	152	11	1 E-5
1984	96	206	1.97	
1985	111	149	5.31	
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	91.9	20.3	3.58	
1992	31.7	8	5.3	

Sources: DOE Pinellas Plant stack release records.

FIGURE 4-1 STACKS RELEASE FROM THE PINELLAS PLANT

Sources: DOE Pinellas Plant stack release records

**TABLE 4-2 TRITIUM RELEASED TO
THE PUBLIC OWNED TREATMENT WORKS
(CURIES)**

YEAR	TRITIUM
1982	0.68
1983	1.9
1984	1.25
1985	0.88
1986	0.5
1987	0.56
1988	0.41
1989	0.68
1990	0.56
1991	0.67
1992	0.7

Sources: General Electric Company Neutron Devices Department.
Pinellas Plant Environmental Monitoring Report, 1982 -- 1990.
Martin Marietta Specialty Components, Inc. Pinellas Plant Annual
Site Environmental Reports for Calendar Year 1991 -- 1992.

FIGURE 4-2 TRITIUM RELEASE TO PUBLIC OWNED TREATMENT WORKS

Sources: DOE Pinellas Plant stack release records

Krypton-85 is another radioactive material routinely released by the plant. Krypton-85 is a radioactive gas with a half-life of 10.3 years. From 1963 to 1992, a total of 846 curies of krypton-85 was released from the plant stacks (Table 4-1). No information suggests that krypton-85 has been released into the plant's waste water. A small amount of carbon-14 was released from the plant stacks from 1979 to 1983. The total amount was approximately 0.00034 curies of carbon-14 (Table 4-1). No information indicates that carbon-14 had been released into the plant's waste water.

Although plutonium-238 was used as part of a product between 1975 to 1990, there is no information suggesting that plutonium was released to the outside of the plant. Plutonium-238 is a radioactive material with half-life of 86.4 years. The available monitoring data for plutonium in air, water and soil indicate that the concentration of the plutonium in these samples was under the minimum detection limit on and off-site. Solid radioactive wastes have not been released in the plant vicinity. They have been transported to an off-site DOE waste repository facility [2, 5-17].

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5. ENVIRONMENTAL MONITORING DATA FOR RADIOACTIVE MATERIALS

The purpose of this section is to identify:

1. The kinds of radioactive materials monitored;
2. The time period of the monitoring;
3. The type of samples; and
4. The quality of the monitoring data.

The initial environmental monitoring activities of radioactive materials at the Pinellas Plant were started at the very beginning of the plant's operation. The earliest background monitoring for radiation was performed in April 1957. "Four samples taken from surroundings of the Bryan Dairy Road plant were taken to establish background counts prior to the plant beginning operation [Microfilm #4452A, frame 000026]."

Records for the early years (1957-1971) indicate that air, water, soil, vegetation and milk were sampled. These samples were tested for tritium gas, tritium oxide and krypton. Before the mid-1970's, the monitoring program for radiation was informal and there were no permanent air sample stations off-site. Some monitoring activities were done only on an irregular basis. Up to 1970, this environmental monitoring information existed mainly on microfilm and no formal annual reports are available. Since then, the monitoring activities have been gradually expanded.

Beginning in 1972, a formal, annual environmental report which summarizes the environmental activities of the plant was issued each year[1-21]. During the mid-1970's, six on-site and five off-site permanent air monitoring stations were installed (Figure 5-1 and 5-2). With the installation of these facilities, environmental monitoring has been done on a more regular basis. Starting in 1975, plutonium as well

FIGURE 5-1 ON-SITE AIR SAMPLE LOCATIONS

FIGURE 5-2 OFF-SITE AIR SAMPLE LOCATIONS

as tritium have been monitored but with new technology only recently. Currently, the monitoring program consists of testing water, air and soil both on and off-site.

A meteorological program was absent in the Pinellas Plant before 1991 as the Tiger Team Assessment of the Pinellas Plant pointed out [22]. In 1992, a meteorological station was installed at the plant. From 1956 to 1991, meteorological information from the Tampa International Airport meteorological station is available. Prevailing winds are from the north and northeast during the winter months and predominantly from the east and south during the rest of the year in the Pinellas area [2-20].

Soil samples: The soil samples have been monitored annually for plutonium since 1975 when the plant started to use plutonium for the manufacture of RTGs. Before 1987, the samples were taken on-site and off-site at a distance of five miles from the plant. In 1987, 14 on-site and 16 off-site sample locations were identified (Figure 5-3 and 5-4). Two on-site samples and four off-site samples were tested each year based on a soil sample location schedule (Table 5-1). Table 5-2 displays the summary of the monitoring results of soil samples.

Water samples: Tritium has been monitored in on-site and off-site surface water since the late 1950's. In the early years, the number of locations and samples varied from time to time. A report from the plant in 1963 states: "Surface water samples are normally obtained during the last week of each month. The locations are determined by radioactivity discharges in the exhaust stack effluent and meteorological data [23]."

Before 1971, the tritium monitoring data are stored on microfilm. Summaries of these data are not available. Since there is uncertainty as to the number and exact location of water samples, it is difficult to verify these data without further

ENVIRONMENTAL MONITORING DATA FOR RADIOACTIVE MATERIALS

FIGURE 5-4 OFF-SITE SOIL SAMPLE LOCATIONS

TABLE 5-1
SOIL SAMPLE LOCATION SCHEDULE

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

Sources: Martin Marietta Specialty Components, Inc. Pinellas Plant Annual Site
Environmental Reports for Calendar Year 1992.

**TABLE 5-2 SUMMARY OF SOIL MONITORING FOR PLUTONIUM
(E-9 μ Ci/gm)**

YEAR	Pu-238		Pu-239	
	ON-SITE	OFF-SITE	ON-SITE	OFF-SITE
1976	< 2.1	< 1.9	4.0	6.8
1977	< 3.9	< 7.1	< 9.6	< 12.4
1978	< 12.5	< 14.7	< 17.9	< 31.5
1979		N/A		N/A
1980	4.1	3.8	9.4	9.6
1981	BMDL (1.4 - 6.6)		BMDL (1.8 - 5.4)	
1982	BMDL (0.5 - 1.0)		5.7	4.0
1983	BMDL (0.7 - 2.2)		BMDL (0.7 - 2.2)	
1984	BMDL (1.5 - 41)		BMDL (1.5 - 41)	
1985	BMDL (0.49 - 1.1)		BMDL (0.49 - 1.1)	
1986	BMDL (0.38 - 5.1)		BMDL (0.38 - 5.1)	
1987	BMDL (0.72 - 1.2)		BMDL (0.72 - 1.2)	
1988		N/A		BMDL (0.24 - 2.5)
1989		N/A		BMDL (0.85 - 3.2)
1990		N/A		BMDL (0.48 - 1.9)
1991		N/A		N/A
1992		BMDL (0.675-3.72)		BMDL (0.662-4.72)

Sources: General Electric Company Neutron Devices Department. Pinellas Plant Environmental Monitoring Report, 1976 - 1990.
 Martin Marietta Specialty Components, Inc. Pinellas Plant Annual Site Environmental Reports for Calendar Year 1991 - 1992.

information. Since 1971, the location and the number of water samples have been relatively stable. Water sampling procedures are described below:

The area surrounding the plant has been divided into eight equal pie-shaped segments with the center line of each segment being one of the eight major compass points. The segments were further divided by arcs at distances of two, four and six miles. This procedure results in a total of twenty-four sectors. With the exception of the four-to six-mile northeast sector (mostly in Tampa Bay), samples of surface water from ponds, lakes and ditches are periodically collected from each location and analyzed for tritium content [2].

These locations were sampled four or five times per year and remained unchanged until 1986 when three additional locations were added. Figure 5-5 displays the off-site surface water sample locations. Table 5-3 provides a summary of surface water analyses for tritium content. Plutonium in water was also monitored from 1975 to 1978. The locations and numbers of samples varies from year to year. Table 5-4 provides the summary of surface water analyses for plutonium content.

Air samples: Continuous monitoring of the stack release of tritium started at the beginning of plant operations. Figures provided for annual stack release of tritium gas and oxide are based on these monitoring data. The monitoring of tritium in air was started in the late 1950's. In the early years, air monitoring for tritium varied in location and frequency. There are some lab reports and monthly reports available. Before the permanent air sample stations were installed in the mid-1970's, the capability of the technology available to detect the extremely low concentration of tritium in air is questionable. The situation is described as follows:

Because currently available air sampling instrumentation is not capable of measuring the extremely low concentrations which occur off-site, surface water is used as the sampling media since low tritium concentrations can be measured by laboratory analysis of water samples and surface waters will reflect tritium buildups [2].

FIGURE 5-5 OFF-SITE SURFACE WATER SAMPLE LOCATIONS

TABLE 5-3
SUMMARY OF SURFACE WATER MONITORING FOR TRITIUM
(E-7 uCi/ml)

LOCATION	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
NORTH											
0-3.2	<5.8	2.8	<4.5	<2.6	<1.7	<2.0	<2.0	<1.5	<1.6	<1.9	<0.9
3.2-6.4	<1.8	2.4	<3.9	1.5	<3.0	<1.3	<3.1	<1.5	<1.4	<1.6	<1.0
6.4-9.6	<2.1	<1.1	<2.8	<1.7	<1.4	<1.3	<1.9	<1.6	<1.7	<1.9	<1.1
NORTHEAST											
0-3.2	<2.1	<2.1	<5.3	<1.4	<1.2	<1.2	<1.5	<1.4	<1.8	<1.4	<1.0
3.2-6.4	<2.5	<2.4	<3.1	3.4	<1.5	<1.3	<1.9	<1.5	<1.5	<1.4	<1.2
EAST											
0-3.2	<1.7	<2.9	<2.4	<2.5	<1.8	<1.4	<4.4	<1.4	<1.4	<1.4	<0.9
3.2-6.4	<1.9	<1.6	<5.6	<4.1	<2.5	<2.0	<1.4	<1.8	<10.2	<1.9	<1.7
6.4-9.6	<3.7	<2.4	<3.4	<2.0	<1.5	<2.1	<2.6	<2.1	<1.4	<2.5	<2.4
SOUTHEAST											
0-3.2	<1.8	<1.6	<5.3	<2.0	<2.1	<1.3	<1.9	<1.7	<1.4	<1.5	<1.0
3.2-6.4	<2.8	<2.1	<3.6	<2.2	<2.5	<1.5	<1.4	<2.6	<1.4	<1.8	<1.3
6.4-9.6	<3.3	<1.1	<3.8	<4.6	<1.9	<1.6	<1.4	<1.5	<2.0	<2.0	<1.0
SOUTH											
0-3.2	<3.1	<5.0	<4.1	1.7	<1.7	<1.3	<1.4	<2.1	<3.6	<2.0	<1.0
3.2-6.4	<2.0	<2.2	3.2	<2.0	<2.8	<2.0	<1.8	<1.5	<1.5	<2.9	<1.0
6.4-9.6	<1.8	<1.2	<3.0	<1.3	<1.4	<1.7	<1.4	<1.5	<1.4	<3.4	<1.0
SOUTHWEST											
0-3.2	<1.8	<2.9	<3.9	2.3	<2.2	<1.4	<1.4	<2.0	<1.4	<1.9	<0.9
3.2-6.4	<2.1	<1.3	<6.1	2.3	<1.7	<1.6	<3.0	<1.5	<1.4	<2.9	<1.0
6.4-9.6	<2.1	<1.6	<4.1	<3.0	<1.4	<1.3	<1.8	<1.8	<2.2	<1.8	<1.0
WEST											
0-3.2	<2.3	<2.1	<8.7	<1.6	<2.8	<1.5	<1.4	<1.5	<1.4	<1.8	<1.0
3.2-6.4	<2.1	<1.8	<5.9	<1.9	<1.9	<1.5	<2.1	<1.9	<1.7	<2.7	<1.0
6.4-9.6	<1.9	<2.6	<5.7	<1.7	<2.2	<1.8	<2.6	<1.9	<1.4	<1.7	<1.1
NORTHWEST											
0-3.2	<1.9	<1.7	<4.4	2.5	<1.8	<1.5	<1.4	<1.8	<2.6	<2.0	<1.2
3.2-6.4	<2.1	<2.2	<2.9	<1.5	<1.4	<1.5	<2.2	<1.5	<1.4	<1.7	<1.2
6.4-9.6	<1.9	<1.4	<5.2	<1.7	<3.8	<1.4	<2.6	<2.5	<1.4	<1.6	<1.0

Results for 1972-1974 and 1986-1992 were under minimal detective level.

Sources: General Electric Company Neutron Devices Department. Pinellas Plant Environmental Monitoring Report, 1972 - 1990.

Martin Marietta Specialty Components, Inc. Pinellas Plant Annual Site Environmental Reports for Calendar Year 1991 - 1992.

TABLE 5-4 SUMMARY OF WATER MONITORING FOR PLUTONIUM
(E-11 $\mu\text{Ci/ml}$)

YEAR	Pu-238	Pu-239
1976	ALL BMDL (0.6-9.7)	
1977	BMDL (0.7-1.5)	2.9
1978	BMDL (0.6-0.7)	BMDL(0.49-0.6)

Sources: General Electric Company Neutron Devices Department. Pinellas Plant Environmental Monitoring Report, 1976 - 1978.

TABLE 5-5 SUMMARY OF ON-SITE AIR MONITORING FOR TRITIUM
(E-12 $\mu\text{Ci/ml}$)

YEAR	1		2		3		4		5		6	
	H3 GAS	H3 OXIDE	H3 GAS	H3 OXIDE	H3 GAS	H3 OXIDE	H3 GAS	H3 OXIDE	H3 GAS	H3 OXIDE	H3 GAS	H3 OXIDE
1975	N/A	N/A	< 5.1	< 8.0	N/A	N/A	< 44.2	18.4	< 12.0	< 8.5	15.4	< 11.1
1976	< 4.6	< 6.4	< 6.2	< 3.4	< 18.8	< 4.1	< 5.0	< 3.5	< 87.3	< 5.5	< 4.2	< 5.9
1977	< 7.4	< 7.4	< 5.9	< 6.2	< 8.5	< 6.9	< 26.2	< 8.9	< 12.0	< 11.4	< 9.5	9.8
1978	< 5.2	6.0	4.2	< 5.7	< 1.9	5.3	< 5.0	< 4.4	< 5.8	6.2	< 6.0	9.2
1979	< 3.9	10.2	< 3.6	7.1	< 3.1	6.0	< 2.3	20.9	< 6.0	9.9	< 10.8	15.5
1980	< 4.4	7.1	5.9	7.5	< 4.0	5.2	< 6.2	< 10.2	< 4.2	< 8.5	17.2	9.7
1981	< 5.9	16.5	< 7.2	< 13.1	< 9.3	< 6.9	< 5.4	< 11.2	< 11.4	< 12.4	27.4	19.1
1982	< 10.0	23.7	< 5.0	14.2	< 5.0	< 8.0	< 7.9	19.1	< 5.3	25.4	< 13.2	31.2
1983	< 6.8	9.2	27.1	25.8	< 3.6	< 8.0	< 3.3	6.3	< 22.1	14.6	< 12.2	14.1
1984	< 5.9	14.2	< 11.4	28.2	< 2.1	< 10.0	< 2.5	17.5	3.6	14.9	< 8.5	51.7
1985	< 8.4	9.7	< 5.2	21.5	< 4.1	< 8.4	< 17.7	< 19.3	< 13.6	21.5	< 26.4	29.0
1986	< 7.0	< 17.0	< 6.0	30.0	< 6.0	< 8.0	< 4.0	< 32.0	< 10.0	< 18.0	< 7.0	29.0
1987	N/A											
1988	13.3	4.1	152.0	172.6	48.0	29.6	48.0	8.2	18.6	36.9	5.6	2.9
1989	6.1	11.88	0.68	7.06	3.3	11.45	0.64	6.54	32.56	9.29	36.57	16.46
1990	10.39	5.76	6.37	4.13	11.7	7.34	7.13	4.30	22.65	11.26	27.04	16.11
1991	5.42	1.65	3.84	2.64	2.03	1.54	4.12	2.16	10.69	5.46	15.53	12.66
1992	2.85		1.09		1.45		3.81		8.72		9.47	

Sources: General Electric Company Neutron Devices Department. Pinellas Plant Environmental Monitoring Report, 1976 - 1990.
Martin Marietta Specialty Components, Inc. Pinellas Plant Annual Site Environmental Reports for Calendar Year 1991 - 1992.

ENVIRONMENTAL MONITORING DATA FOR RADIOACTIVE MATERIALS

TABLE 5-6
SUMMARY OF OFF-SITE AIR MONITORING FOR TRITIUM
(E - 12 u Ci/ml)

YEAR	CLEARWATER (North)	CIVIL DEFENSE (Northeast)	PINELLAS (Southeast)	BAY PINES (South)	WALSINGHAM (West)
1976					
Gas	4.9(1.72-2.2)	5.0(1.3-18.2)	3.1(1.0-9.4)	2.3(1.6-3.4)	2.8(1.4-6.5)
Oxide	1.9(1.7-2.4)	2.8(1.8-6.2)	4.8(1.0-2.7)	2.0(1.7-2.6)	1.9(1.3-2.2)
1977					
Gas	2.3(1.9-9.7)	5.9(1.4-32.2)	4.8(1.6-17.8)	3.8(1.5-13.3)	3.2(1.3-7.3)
Oxide	2.0(1.0-4.9)	2.2(1.3-4.5)	2.4(1.0-4.1)	2.1(1.4-3.1)	3.2(1.0-10.6)
1978					
Gas	3.2(0.8-9.5)	3.1(1.0-15.0)	3.5(0.7-7.4)	2.2(1.3-6.4)	2.1(1.9-3.2)
Oxide	3.2(0.9-8.7)	2.5(0.9-6.1)	3.2(0.8-10.0)	2.1(1.2-6.0)	2.3(1.3-3.7)
1979					
Gas	2.1(0.9-5.9)	2.0(0.7-7.4)	3.1(0.7-6.7)	2.0(0.6-3.4)	4.6(0.7-3.1)
Oxide	4.8(0.9-3.5)	4.8(1.1-3.0)	2.7(0.9-6.1)	1.9(1.1-3.0)	2.5(0.9-7.2)
1980					
Gas	2.1(1.1-3.8)	2.0(1.0-5.1)	2.1(1.1-5.5)	2.9(1.5-5.9)	1.7(1.0-3.4)
Oxide	2.1(0.9-3.7)	3.2(1.2-6.8)	2.2(1.1-4.1)	2.5(1.2-6.4)	3.1(1.3-5.1)
1981					
Gas	3.3(2.4-7.6)	2.6(0.7-12.2)	8.4(1.0-27.7)	5.2(1.4-8.7)	2.2(1.0-5.2)
Oxide	3.1(1.1-8.5)	2.9(1.5-5.6)	5.0(0.7-14.1)	2.6(1.0-5.2)	4.2(1.4-17.3)
1982					
Gas	5.8(1.4-16.1)	5.8(1.4-10.0)	8.8(1.7-59.8)	5.5(1.1-8.7)	4.7(1.2-11.9)
Oxide	8.1(4.1-13.5)	5.5(2.0-6.7)	4.7(1.5-18.5)	4.0(1.5-9.8)	6.9(2.1-15.9)
1983					
Gas	18.6(1.3-44.0)	3.9(1.2-26.9)	2.8(1.1-6.7)	3.9(1.1-12.2)	1.6(1.1-1.4)
Oxide	5.6(1.1-27.0)	3.9(1.1-17.3)	2.0(1.2-4.3)	5.7(1.1-25.7)	2.6(1.1-10.0)
1984					
Gas	5.9(1.1-9.5)	3.7(0.9-12.8)	5.0(0.9-18.9)	12.2(1.6-75.4)	2.6(0.9-9.0)
Oxide	4.1(0.9-12.5)	2.7(0.9-8.9)	5.6(0.9-10.5)	8.4(1.4-32.8)	5.9(1.1-17.7)
1985					
Gas	4.74(0.6-17.3)	10.85(0.6-80.5)	2.07(1.0-5.0)	5.30(0.6-25.6)	1.84(0.6-9.7)
Oxide	5.35(1.2-20.5)	2.77(1.1-7.6)	5.32(1.0-29.7)	3.3(0.8-8.7)	5.65(1.0-16.4)
1986					
Gas	24(6-51)	4(2-6)	22(2-58)	4(2-7)	11(1-55)
Oxide	6(2-9)	5(2-9)	30(2-78)	8(3-30)	6(3-8)
1987					
Gas	(3.7-53.8)	(2.9-12.7)	(1.4-9.8)	(3.9-12.8)	(4.2-49.6)
Oxide	(3.5-24.4)	(3.9-62)	(8.2-115.7)	(42-47.2)	(3.2-21.9)
1988					
Gas	1.24(0.24-6.0)	2.85(0.14-3.9)	3.30(0.67-9.5)	2.67(0.09-9.8)	2.87(0.81-10.1)
Oxide	0.84(0.12-3.2)	4.56(0.03-14.2)	1.50(0.52-7.9)	7.12(0.70-30.7)	13.11(0.89-38.2)
1989					
Gas	2.12(0.04-8.36)	2.21(0.43-5.40)	3.01(0.1-4.58)	0.73(0.50-0.96)	0.28(0.17-0.38)
Oxide	7.28(2.91-12.2)	6.22(3.24-11.70)	15.12(2.83-73.53)	20.96(5.71-50.79)	9.54(5.19-14.51)
1990					
Gas	5.35(0.96-15.15)	2.49(0.81-7.30)	3.68(-0.81-7.98)	3.01(-0.37-7.44)	2.73(-1.05-6.18)
Oxide	4.50(0.21-12.58)	5.35(-1.89-6.72)	6.06(-1.31-16.98)	6.30(0.84-17.43)	2.81(-1.35-5.57)

Sources: General Electric Company Neutron Devices Department. Pinellas Plant Environmental Monitoring Report, 1976 - 1990.

TABLE 5-7 SUMMARY OF ON-SITE AIR MONITORING FOR PLUTONIUM
(E-18 $\mu\text{Ci/ml}$)

YEAR	NORTH		EAST		SOUTH		WEST	
	Pu-238	Pu-239	Pu-238	Pu-239	Pu-238	Pu-239	Pu-238	Pu-239
1976	<0.9	4.7	<1.4	3.2	<0.8	4.9	<0.9	3.4
1977	BMDL	17.8	BMDL	15.1	BMDL	14.5	BMDL	22.7
1978	BMDL	25.5	BMDL	31.0	BMDL	18.5	BMDL	26.5
1979	BMDL	BMDL	BMDL	1.9	BMDL	17	0.4	5.0
1980	2.0	2.0	<2.5	<1.4	<1.9	3.1	<2.2	<2.6
1981	BMDL	11.0	BMDL	10.7	BMDL	6.4	BMDL	9.2
1982			ALL BMDL	(0.4 -- 1.6)				
1983			ALL BMDL	(0.5 -- 1.9)				
1984			ALL BMDL	(0.5 -- 2.4)				
1985			ALL BMDL	(0.59-- 2.7)				
1986			ALL BMDL	(0.41-- 3.7)				
1987			ALL BMDL	(0.17-- 5.5)				
1988			ALL BMDL	(3.4 --52)				
1989			ALL BMDL	(1.1 --65)				
1990			ALL BMDL	(1.1 --65)				
1991			N/A					
1992			ALL BMDL	(1.13-- 4.93)				

Sources: General Electric Company Neutron Devices Department. Pinellas Plant Environmental Monitoring Report, 1976 -- 1990.
Martin Marietta Specialty Components, Inc. Pinellas Plant Annual Site Environmental Reports for Calendar Year 1991 -- 1992.

TABLE 5-8 SUMMARY OF OFF-SITE AIR MONITORING FOR PLUTONIUM
(E-18 $\mu\text{Ci/ml}$)

YEAR	NORTH		NORTHEAST		SOUTHEAST		SOUTH		WEST	
	Pu-238	Pu-239	Pu-238	Pu-239	Pu-238	Pu-239	Pu-238	Pu-239	Pu-238	Pu-239
1976			ALL BMDL		(0.5--19.6)					
1977	BMDL	13.8	BMDL	11.2	BMDL	12.5	BMDL	10.9	BMDL	14.2
1978	BMDL	< 18.9	< 2.6	22.2	BMDL	< 19.1	BMDL	16.9	BMDL	19.1
1979		N/A								
1980	< 1.4	< 1.0	< 1.5	0.9	< 0.9	< 1.5	< 1.4	< 1.6	< 0.9	0.7
1981	BMDL	12.1	BMDL	10.0	BMDL	1.2	BMDL	12.6	BMDL	10.4
1982			ALL BMDL		(0.3--1.8)					
1983			ALL BMDL		(0.5--5.0)					
1984			ALL BMDL		(0.31--3.4)					
1985			ALL BMDL		(0.63--3.7)					
1986			ALL BMDL		(0.17--3.0)					
1987			ALL BMDL		(0.17--3.0)					
1988			ALL BMDL		(1.2--2.9)					
1989			ALL BMDL		(0.2--11.0)					
1990			ALL BMDL		(0.2--11.0)					
1991			N/A							
1992			ALL BMDL		(1.13--4.93)					

Sources: General Electric Company Neutron Devices Department. Pinellas Plant Environmental Monitoring Report, 1976 -- 1990.
Martin Marietta Specialty Components, Inc. Pinellas Plant Annual Site Environmental Reports for Calendar Year 1991 -- 1992.

In the mid-1970's, six on-site and five off-site permanent air sampling stations began operation. Tritium in air was continuously monitored by these stations. Tables 5-5 and 5-6 provide a summary of the air tritium monitoring on-site and off-site.

Plutonium in air has also been monitored since the mid-1970's when the plant started to use plutonium for the manufacture of RTGs. Four on-site stations (Figure 5-1) and five off-site stations (Figure 5-2) have continuously monitored plutonium. Table 5-7 and 5-8 display the summary of the monitoring results on and off-site.

Milk samples: Tritium was monitored in dairy farm milk during 1961 to 1972. Milk cows living near the plant could have been exposed to radioactive materials through air, water and food. Monitoring data are available on microfilm and in some plant reports (23-26). Milk samples from four dairy farms were monitored. The exact locations of these farms are difficult to verify, but all these farms are within one to four miles from the plant. There is no information that suggests that tritium in these samples is above a minimum detection limit.

Potential radionuclide dose to the public: The Annual Reports from the Pinellas Plant also estimate the potential radionuclide dose to the public. The potential dose is estimated at three points: the plant boundary, nearest resident and 80 kilometers from the plant boundary. AIRDOS-PC (before 1991) and CAP88-PC (1991) are used for these calculations. Table 5-9 displays the summary of radionuclide dose to the public.

REFERENCES

1. General Electric Company Neutron Devices Department. Environmental Monitoring Report 1972, March 1973.

TABLE 5-9
RADIONUCLIDE DOSE TO PUBLIC FOR THE PINELLAS PLANT
(mrem/yr)

YEAR	PLANT BOUNDARY	NEAREST RESIDENT	EIGHTY KILOMETERS
1973	0.06	0.009	0.0016
1974	0.016	0.005	0.0002
1975	0.0078	0.0008	0.0002
1976	0.0111	0.0042	0.0002
1977	0.0115	0.0038	0.0002
1978	0.0098	0.0027	0.0002
1979	0.0129	0.0034	0.0003
1980	0.0103	0.0041	0.0003
1981	0.0148	0.0058	0.0003
1982	0.0182	0.0089	0.0003
1983	0.0103	0.005	0.0002
1984	0.0172	0.0081	0.0003
1985	0.0071	0.0033	0.0001
1986	0.01	0.004	0.001
1987	0.00004	0.00024	0.003
1988	0.00674	0.0194	0.0041
1989	0.00298	0.00047	0.0014
1990	0.098	0.074	0.029
1991	0.0053	0.0037	

Sources: General Electric Company Neutron Devices Department. Pinellas Plant Environmental Monitoring Report, 1973 -- 1990.
 Martin Marietta Specialty Components, Inc. Pinellas Plant Annual Site Environmental Reports for Calendar Year 1991.

ENVIRONMENTAL MONITORING DATA FOR RADIOACTIVE MATERIALS

2. General Electric Company Neutron Devices Department. Environmental Monitoring Report 1973, April 1974.
3. General Electric Company Neutron Devices Department. Environmental Monitoring Report 1974, April 1975.
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6. ASSESSMENT OF THE FEASIBILITY OF A RADIOLOGICAL DOSE RECONSTRUCTION IN THE VICINITY OF THE PINELLAS PLANT

The object of this section is to evaluate the feasibility of performing a dose reconstruction. It is important to determine whether exposures to the public were sufficient to raise the issue of adverse health outcomes. A radiological dose reconstruction is the process of estimating the exposure dose of radiation received by individuals residing near the Pinellas Plant.

Although study staff applied for security clearance rating of "Q" in January 1992, due to the lengthy security clearance process and study staff turnover, clearance has not yet been granted. Because lack of security clearance rating prevented the study staff from accessing some necessary information, a request to the Radiation Studies Branch at CDC was submitted for assistance on an assessment of the feasibility of a radiological dose reconstruction at the Pinellas Plant. Following is the Executive Summary of the report from the Radiation Studies Branch at CDC:

At the request of the Florida Department of Health and Rehabilitative Services, the Centers for Disease Control and Prevention (CDC), National Center for Environmental Health, Radiation Studies Branch, has helped to assess the feasibility of a radiological dose reconstruction for members of the public from activities at the Department of Energy (DOE)-owned Pinellas Plant (now operated by Martin Marietta Specialty Components). This plant (formally General Electric Aerospace Neutron Devices) was built in 1956 on 99.9 acres of land in central Pinellas County, about 15 miles (across the bay) from Tampa, Florida. The Pinellas Plant was built to manufacture neutron generators (neutron tubes) which are a vital component of nuclear weapons. These generators are designed to assure that the maximum yield is obtained when the weapon is detonated.

Tritium is an essential component of the tubes. It is shipped from the Savannah River Site in gas cylinders and stored at Pinellas in depleted uranium beds (a hydrated powder). It is introduced into the tubes by heating the beds under vacuum conditions.

In 1975 production of Radioisotopic Thermoelectric Generators began and triple-sealed plutonium sources were shipped to the plant from Sandia National Laboratory in New Mexico. Production of these devices and plutonium shipments to the site ended in 1991. According to plant personnel, no plutonium currently remains on site.

Initially, the plant only had one exhaust stack where tritium oxide and tritium gas were released. Over time, three other stacks were added. However, the bulk of the stack releases of tritium apparently occurred in the years 1957, 1958, and 1959, prior to development of more efficient tritium loading procedures and design of a stack effluent control system for this radionuclide.

Typical of many DOE facilities, meticulous environmental monitoring and records keeping did not take place until the early to mid 1970's. Prior to that, the monitoring and records keeping was not very thorough. However, after reviewing plant publications, interviewing key personnel, and checking the existence, accessibility, and quality of documents important to dose reconstruction at the plant, we have concluded that a dose reconstruction is feasible. Nevertheless, we recommend that the Florida Department of Health and Rehabilitative Services analyze the available data and perform a preliminary screening calculation to determine if a more extensive study is required. In addition, an effective public involvement program should be developed in conjunction with the technical work (Appendix 4).

7. PINELLAS COUNTY GEOGRAPHIC INFORMATION

The object of this section is to identify:

1. Demographic information on Pinellas County since the 1950's; and
2. Land development patterns in Pinellas County.

There are several sources of population information available for Pinellas County. The first of these is U.S. Census data which is updated every ten years. The 1950, 1960, 1970, 1980 and 1990 census data for Pinellas County show that the population in Pinellas County has changed greatly in this period. It increased 5.43 times from 1950 to 1990 while that of the State of Florida only increased 4.75 times [1-5]. Based on aerial pictures taken of the Pinellas Plant vicinity, few people lived near the DOE facility in the later 1950's. Age, sex and race information are also available and stored in our office. In addition, census tract information for Pinellas County is also available. A second source of population estimates is the Florida Consensus Estimating Conference [6]. These estimates are routinely used by most researchers and government agencies in the state. They include age, sex and race information beginning in 1981. The third source of population estimates is the California Analytical Consultants, Inc. (CACI) data base. The CACI data base includes population information on zip codes as well as census tracts and counties. Detailed information on age, gender and race are also available beginning in 1990.

The Pinellas County Planning Department provided information on land development (Figure 7-1). The developed area in Pinellas County increased from 37 square miles in 1952 to 155 square miles in 1993, approximately four times in forty years.

REFERENCES

1. U.S. Department of Commerce, Bureau of the Census. Census of Population: 1950, 1952.

FIGURE 7-1

PINELLAS COUNTY LAND DEVELOPMENT
(From Pinellas County Planning Department, 1986)

PINELLAS COUNTY GEOGRAPHIC INFORMATION

2. U.S. Department of Commerce, Bureau of the Census. 1960 Census of Population. 1960.
3. U.S. Department of Commerce, Bureau of the Census. 1970 Census of Population. 1970.
4. U.S. Department of Commerce, Bureau of the Census. 1980 Census of Population. May 1983.
5. U.S. Department of Commerce, Bureau of the Census. 1990 Census of Population. 1990.
6. The State of Florida, Executive Office of the Governor. State of Florida Population & Demographic Forecast, 1992.

8. HEALTH INFORMATION FOR PINELLAS COUNTY

The task of this section is to identify:

1. The type of health information available;
2. The quality of health information; and
3. The relevant time period for this information.

There are several sources of health information for Pinellas County. These include the Florida Cancer Data System (FCDS), the Congenital Defects Surveillance Project (CDSP), and the Florida Vital Statistics Data (FVSD).

I) The Florida Cancer Data System

The FCDS is a complete registry of all cancers diagnosed or treated in Florida hospitals since 1981. It was established by law and funded by the state through an HRS contract with the University of Miami. The data items collected for FCDS are compatible with national standards set by the Surveillance, Epidemiology and End Results (SEER) reporting program, a project of the National Cancer Institute (NCI). Currently, a commercial FCDS data base is accessible from 1981 to 1990. The information in this file includes identification number, race, gender, date of birth, date of diagnosis, the International Classification of Diseases (ICD) codes and morphology codes for cancers, the place of residence (state, county, city, census tract and zip code) and other information. Census tract information is only available for 85% of the FCDS data base.

Analyses of the cancer incidence patterns in Pinellas County have been done based on the FCDS data base for the time period of 1981 to 1990. Two reference groups were chosen for comparison. One was the State of Florida except Pinellas County. The second comparison group was comprised of Broward and Duval counties. Age was adjusted according to the age distribution of the reference groups. Four race-

gender subgroups were compared separately. Standardized Incidence Ratios (SIRs) and their ninety-five percent confidence intervals were calculated. Table 8-1 shows the cancer categories used for the FCDS analyses. Thirty-eight cause-specific cancer incidence rates for Pinellas County as well as overall cancer incidence rates were compared to the corresponding cancer incidence rates of the reference groups.

Table 8-2 and 8-3 display the summaries of the analyses of FCDS. Overall cancer incidence rates show a weak increase for all four subgroups in Pinellas County from 1981 to 1990 except in the non-white male subgroup as compared to Broward and Duval counties. For the various cause-specific cancers, incidence rates of colon, rectum, colorectal, lip, oral cavity & pharynx were elevated, and the incidence of liver was decreased for all subgroups compared to the two reference groups. Testicular cancer in both male subgroups and the cancers of cervix uteri and corpus uteri in both female subgroups were increased compared to both reference groups. These results should be interpreted cautiously because of the limitations of the study, such as unavailable cancer incidence information for the first 25 years of plant operation, the variable population in Pinellas County, lack of radiation exposure data and other chemical exposure information, and other risk factors related to cancers. A detailed analysis report is attached (Appendix 5).

II) The Congenital Defects Surveillance Project

The CDSP is a one-time survey in the state of Florida for the years of 1980, 1981 and 1982. All licensed hospitals with maternity units, neonatal intensive care units and pediatric units from 1980 to 1982 were required to participate in the CDSP. Medical records on birth defects occurring at birth or during the first year of life for the three year period were abstracted. The CDSP data base collects the following data: identification number, date of birth, race, gender, birth weight, classification of birth defect code, mother's place of residence, as well as other information.

TABLE 8-1
CANCER CATEGORIES USED FOR FCDS ANALYSES

Primary site of cancer	ICD-O-2 CODE
All sites	C00.0 - C80.9
Lip, Oral Cavity & Pharynx	C00.0 - C14.8
Esophagus	C15.0 - C15.9
Stomach	C16.0 - C16.9
Colorectal	C18.0 - C20.9, C26.0
Colon	C18.0 - C18.9, C26.0
Rectum	C19.9 - C20.9
Liver	C22.0
Pancreas	C25.0 - C25.9
Nasal Cavities, Sinuses & Ear	C30.0 - C31.9
Larynx	C32.0 - C32.9
Lung & Bronchus	C34.0 - C34.9
Mesothelioma	M9050 - M9053
Melanoma of the Skin	C44.0 - C44.9 & M8720 - M8780
Female Breast	C50.0 - C50.9
Cervix Uteri	C53.0 - C53.9
Corpus Uteri	C54.0 - C54.9
Ovary	C56.9
Vagina	C52.9
Prostate Gland	C61.9
Testes	C62.0 - C62.9
Penis & Other Male Genitals	C60.0 - C60.9, C63.0 - C63.9
Urinary Bladder	C67.0 - C67.9
Kidney & Other Urinary Organs	C64.9 - C66.9, C68.0 - C68.9
Brain & Other Nervous System	C71.0 - C72.9
Thyroid Gland	C73.9
All Lymphomas	M9590 - M9714, M9723
Hodgkin's Disease	M9650 - M9667
Non-Hodgkin's Disease	M9590 - M9595, M9670 -
M9714,	M9723
Multiple Myeloma	M9731 - M9732
All Leukemias	M9800 - M9941
Acute Lymphocytic Leukemia	M9821
Chronic Lymphocytic Leukemia	M9823
Acute Myelocytic Leukemia	M9861, M9867
Chronic Myelocytic Leukemia	M9863, M9868
Other Leukemias	M9800 - M9820, M9822,
	M9824 - M9860, M9862,
	M9864 - M9866, M9870 - M9941
Kaposi's Sarcoma	M9140
Primary Brain Lymphoma	M9590 - M9714 or M9723 &
	C71.0 - C71.9
Other Sites	ELSE

TABLE 8-2
SUMMARY OF STANDARDIZED INCIDENCE RATIOS FOR
CANCER IN PINELLAS COUNTY, 1981-1990
 (Reference group is the State of Florida except Pinellas County)

Primary site of cancer	STANDARDIZED INCIDENCE RATIOS			
	WM	WF	NWM	NWF
All sites	107*	109*	105	112*
Lip, Oral Cavity & Pharynx	113*	117*	96	106
Esophagus	111	107	129	69
Stomach	103	101	93	76
Colorectal	113*	115*	127*	129*
Colon	108*	111*	124	121
Rectum	124*	128*	136	161*
Liver	77*	64*	96	61
Pancreas	100	97	145	107
Nasal Cavities, Sinuses & Ear	126	106	84	63
Larynx	104	105	141	83
Lung & Bronchus	104*	106*	102	118
Mesothelioma	107	67	0*	0
Melanoma of the Skin	125*	130*	149	46
Female Breast	N/A	109*	N/A	108
Cervix Uteri	N/A	121*	N/A	131*
Corpus Uteri	N/A	105	N/A	118
Ovary	N/A	112*	N/A	90
Vagina	N/A	97	N/A	233*
Prostate Gland	111*	N/A	92	N/A
Testes	124*	N/A	231	N/A
Penis & Other Male Genitals	119	N/A	47	N/A
Urinary Bladder	103	118*	112	96
Kidney & Other Urinary Organs	102	110*	139	98
Brain & Other Nervous system	103	116*	139	63
Thyroid Gland	81	77*	0*	113
All Lymphomas	97	100	118	108
Hodgkin's Disease	115	105	56	125
Non-Hodgkin's Disease	95	99	138	104
Multiple Myeloma	96	97	91	82
All Leukemias	102	105	97	119
Acute Lymphocytic Leukemia	131	119	76	154
Chronic Lymphocytic Leukemia	102	101	96	125
Acute Myelocytic Leukemia	91	106	141	125
Chronic Myelocytic Leukemia	70*	106	124	72
Other Leukemias	125*	103	34	119
Kaposi's Sarcoma	55*	123	37*	0*
Primary Brain Lymphoma	88	71	0	0
Other Sites	102	102	97	106

1) The analyses were based on FCDS Commer8190.dat data file.

2) *: statistically significant (P < .05).

TABLE 8-3
SUMMARY OF STANDARDIZED INCIDENCE RATIOS FOR
CANCER IN PINELLAS COUNTY, 1981-1990
(Reference group is Broward and Duval counties)

Primary site of cancer	STANDARDIZED INCIDENCE RATIOS			
	WM	WF	NWM	NWF
All sites	111*	107*	97	103
Lip, Oral Cavity & Pharynx	131*	119*	106	110
Esophagus	120*	103	104	74
Stomach	104	90*	86	75
Colorectal	109*	113*	113	118
Colon	102	108*	106	108
Rectum	128*	127*	134	157*
Liver	74*	68*	97	44
Pancreas	97	95	119	98
Nasal Cavities, Sinuses & Ear	145*	130	71	59
Larynx	104	95	120	104
Lung & Bronchus	110*	98	95	109
Mesothelioma	96	60*	0	.
Melanoma of the Skin	123*	133*	204	40
Female Breast	N/A	107*	N/A	100
Cervix Uteri	N/A	136*	N/A	127*
Corpus Uteri	N/A	106*	N/A	113
Ovary	N/A	108*	N/A	88
Vagina	N/A	133*	N/A	276*
Prostate Gland	131*	N/A	83*	N/A
Testes	125*	N/A	199	N/A
Penis & Other Male Genitals	150*	N/A	65	N/A
Urinary Bladder	101	101	104	75
Kidney & Other Urinary Organs	97	123*	139	95
Brain & Other Nervous system	102	126*	124	60
Thyroid Gland	78*	71*	0*	78
All Lymphomas	92*	96	135	92
Hodgkin's Disease	116	109	66	102
Non-Hodgkin's Disease	89*	94	156	89
Multiple Myeloma	108	94	81	68
All Leukemias	105	104	66*	90
Acute Lymphocytic Leukemia	127	107	44	121
Chronic Lymphocytic Leukemia	100	94	68	103
Acute Myelocytic Leukemia	100	102	115	87
Chronic Myelocytic Leukemia	72*	132*	79	60
Other Leukemias	139*	110	23*	81
Kaposi's Sarcoma	38*	63	57	0*
Primary Brain Lymphoma	93	61	.	0
Other Sites	98	106*	113	92

1) The analyses were based on FCDS Commer8190.dat data file.

2) *: statistically significant ($P < .05$).

A pilot analysis of the birth defects data for Pinellas County has been completed using the same reference groups as above: the State of Florida except Pinellas County, and Broward and Duval counties. Based on a CDC recommendation, birth defects were classified into eight categories: central nervous system, eye, cardiovascular, orofacial, gastrointestinal, genitourinary, musculoskeletal and chromosomal. Table 8-4 lists the classification of birth defects. Table 8-5 displays the incidence rates of congenital defects for Pinellas County, Broward and Duval counties, and the State of Florida except Pinellas county. Table 8-6 and 8-7 show the overall and white incidence ratios of birth defects in Pinellas County compared to Broward and Duval counties. Table 8-8 and 8-9 provide the overall and whites incidence ratios of birth defects in Pinellas County compared to the State of Florida except Pinellas County.

Six out of eight birth defect rates in Pinellas County are lower than both reference groups. Only one, the genitourinary birth defect rate, is higher than both reference groups. The CDSP data base was a one-time survey which covered only a three-year period. Since some important information such as mother's age, socioeconomic status, smoking habits and other risk behaviors was incomplete or not included, this data base does not offer much meaningful information for this study.

III) The Florida Vital Statistics Data

The FVSD is a statewide registry system for birth, fetal death, death, marriage and divorce. It has a long history, beginning in Florida in 1917. Before 1970, microfilms of fetal death information and hard copies of the registry for birth and death are accessible. Since 1970, both the hard copies and computerized files are available. A pilot survey has been done to determine the kinds of information available, and the completeness of the information. Some general information is provided below:

TABLE 8-4
CATEGORIES OF CONGENITAL DEFECTS

CONGENITAL DEFECTS	ICD 9
Central Nervous System	740.000-740.290, 741.000-741.990, 742.300-742.390 742.000-742.090, 742.100
Eye	743.000-743.100, 743.320-743.326, 743.340-743.636 743.420-743.440
Cardiovascular	745.000-745.010, 745.100-745.190, 745.200-745.210 745.400-745.498, 745.500-745.590, 745.600-745.690 746.000-746.090, 746.100-746.105, 746.300-746.490 746.500-746.505, 746.700, 747.000, 747.100-747.190 747.300-747.390, 748.500-748.510,
Orofacial	749.000-749.090, 749.100-749.290
Gastrointestinal	750.300-750.380, 751.200-751.010
Genitourinary	753.000-753.010, 753.500
Musculoskeletal	754.500-754.730, 755.200-755.290, 755.300-755.390, 755.800, 756.700, 756.710
Chromosomal	758.100-758.190, 758.000-758.090, 758.210-758.290

TABLE 8-5
INCIDENCE RATES OF CONGENITAL DEFECTS 1980-1982
(1/10,000)

CONGENITAL DEFECTS	PINELLAS RATES	STATE RATES	BROWARD & DUVAL RATES
Central Nervous System	8.41	19.93	17.77
Eye	2.80	3.56	2.24
Cardiovascular	27.10	64.20	69.87
Orofacial	11.21	15.00	14.93
Gastrointestinal	3.27	5.49	4.48
Genitourinary	2.34	1.55	1.49
Musculoskeletal	20.56	32.94	30.76
Chromosomal	3.27	8.67	9.56

* The analyses were based on CDSP data base at the Florida State Health Office.

TABLE 8-6
INCIDENCE RATIOS OF CONGENITAL DEFECTS
IN PINELLAS COUNTY, ALL RACES, 1980-1982
 (Reference Group is Broward and Duval counties)

Congenital defects	Obs / Exp	IR	%95 CI of IR
Central Nervous System	18 / 38	47	28 - 72
Eye	6 / 4.8	125	45 - 245
Cardiovascular	58 / 149.5	39	29 - 49
Orofacial	24 / 32	75	48 - 108
Gastrointestinal	7 / 9.6	73	29 - 137
Genitourinary	5 / 3.2	156	49 - 324
Musculoskeletal	44 / 65.8	67	49 - 88
Chromosomal	7 / 20.5	34	14 - 64

* The analyses were based on CDSP data base at the Florida State Health Office.

** Obs / Exp: The number of cases observed / the number of cases expected.

*** 95 % CI for IR: 95 percent confidence interval for IR.

TABLE 8-7
INCIDENCE RATIOS OF CONGENITAL DEFECTS
IN PINELLAS COUNTY, WHITE, 1980-1982
 (Reference Group is Broward and Duval counties)

Congenital defects	Obs / Exp	IR	%95 CI of IR
Central Nervous System	13 / 28.6	46	24 - 74
Eye	5 / 3.7	135	43 - 279
Cardiovascular	42 / 96.1	44	31 - 58
Orofacial	21 / 29.3	72	44 - 106
Gastrointestinal	6 / 9.3	65	23 - 127
Genitourinary	5 / 2.2	225	71 - 465
Musculoskeletal	40 / 50.5	79	57 - 106
Chromosomal	6 / 16.7	36	13 - 70

* The analyses were based on CDSP data base at the Florida State Health Office.

** Obs / Exp: The number of cases observed / the number of cases expected.

*** 95 % CI for IR: 95 percent confidence interval for IR.

TABLE 8-8
INCIDENCE RATIOS OF CONGENITAL DEFECTS
IN PINELLAS COUNTY, ALL RACES, 1980-1982
 (Reference Group is State of Florida Except Pinellas County)

Congenital defects	Obs / Exp	IR	%95 CI of IR
Central Nervous System	18 / 42.6	42	25 - 64
Eye	6 / 7.6	79	28 - 154
Cardiovascular	58 / 137.4	42	32 - 54
Orofacial	24 / 32.1	75	48 - 108
Gastrointestinal	7 / 11.8	60	24 - 112
Genitourinary	5 / 3.3	151	48 - 312
Musculoskeletal	44 / 70.5	62	45 - 82
Chromosomal	7 / 18.5	38	15 - 71

* The analyses were based on CDSP data base at the Florida State Health Office.

** Obs / Exp: The number of cases observed / the number of cases expected.

*** 95 % CI for IR: 95 percent confidence interval for IR.

TABLE 8-9
INCIDENCE RATIOS OF CONGENITAL DEFECTS
PINELLAS COUNTY, WHITE, 1980-1982
 (Reference Group is State of Florida Except Pinellas County)

Congenital defects	Obs / Exp	IR	%95 CI of IR
Central Nervous System	13 / 28.7	45	24 - 73
Eye	5 / 5.4	93	29 - 192
Cardiovascular	42 / 84.3	50	36 - 66
Orofacial	21 / 27.8	76	47 - 111
Gastrointestinal	6 / 9.7	62	22 - 122
Genitourinary	5 / 2.4	208	66 - 431
Musculoskeletal	40 / 51.4	78	56 - 104
Chromosomal	6 / 12.4	48	17 - 95

* The analyses were based on CDSP data base at the Florida State Health Office.

** Obs / Exp: The number of cases observed / the number of cases expected.

*** 95 % CI for IR: 95 percent confidence interval for IR.

a) BIRTH DATA: The information on FVSD birth data includes identification number, name, race, gender, date of birth, place of birth, birth weight, plurality, parents' age, place of residence and some other information. A test abstract of the birth data for the early years (1955, 1960) shows that less than 5% of the above information is incomplete or missing except place of residence (in which 8% of the number and street names were missed). A computerized file of birth data was obtained from the HRS Office of Vital Statistics for the years 1970, 1975, 1980, 1985 and 1990. The computerized file has relatively little missing information (<2%).

A pilot analysis of birth weight in Pinellas County has been done based on the computerized file for the years of 1970, 1975, 1980, 1985, 1990. Again Broward and Duval counties were chosen for comparison. Mother's age was adjusted according to the age distribution of the comparison group. White and nonwhite were compared separately. SIRs and their 95% confidence intervals were calculated. Low birth weight is defined as less than 2500 grams.

Tables 8-10 to 8-12 show the total, white and non-white observed and expected number of low birth weight babies, and SIRs and their 95% confidence intervals in Pinellas County for the years of 1970, 1975, 1980, 1985, 1990. Overall, the incidence of low birth weight in Pinellas County was similar to that of the comparison group. There were slightly elevated incidence rates of low birth weight among the non-white group for the years 1975, 1980, 1985 and 1990. Since this is only a pilot analysis, more detailed analyses with complete data would be necessary to provide a complete picture of birth data comparisons for this period.

b) FETAL DEATH DATA: The information on FVSD fetal death data includes identification number, race, gender, date of delivery, weight at birth, plurality, parents' age, place of residence along with other information. Before 1970,

TABLE 8-10
STANDARDIZED INCIDENCE RATIOS OF LOW BIRTH WEIGHT
IN PINELLAS COUNTY, ALL RACES
 (Reference Group is Broward and Duval Counties)

Year of Birth	Obs / Exp	SIR	%95 CI of SIR
1970	516 / 549	94	86 - 102
1975	460 / 432	106	97 - 116
1980	507 / 530	96	88 - 104
1985	659 / 669	98	91 - 106
1990	765 / 798	96	89 - 103

* The analyses were based on information obtained from a computerized data base at the Florida Office of Vital Statistics.

** Low birth weight: < 2500g.

*** Obs / Exp: The number of cases observed / the number of cases expected.

**** 95 % CI for SIR: 95 percent confidence interval for SIR.

TABLE 8-11
STANDARDIZED INCIDENCE RATIOS OF LOW BIRTH WEIGHT
IN PINELLAS COUNTY, WHITE
 (Reference Group is Broward and Duval Counties)

Year of Birth	Obs / Exp	SIR	%95 CI of SIR
1970	348 / 351	99	89 - 110
1975	299 / 262	114	101 - 127
1980	317 / 343	92	82 - 103
1985	435 / 420	104	94 - 114
1990	511 / 495	103	95 - 112

* The analyses were based on information obtained from a computerized data base at the Florida Office of Vital Statistics.

** Low birth weight: < 2500g.

*** Obs / Exp: The number of cases observed / the number of cases expected.

**** 95 % CI for SIR: 95 percent confidence interval for SIR.

TABLE 8-12
STANDARDIZED INCIDENCE RATIOS OF LOW BIRTH WEIGHT
IN PINELLAS COUNTY, NONWHITE
 (Reference Group is Broward and Duval Counties)

Year of Birth	Obs / Exp	SIR	%95 CI of SIR
1970	168 / 179	94	80 - 109
1975	161 / 149	108	92 - 125
1980	190 / 152	125	108 - 143
1985	224 / 183	122	107 - 139
1990	254 / 230	110	97 - 124

* The analyses were based on information obtained from a computerized data base at the Florida Office of Vital Statistics.

** Low birth weight: < 2500g.

*** Obs / Exp: The number of cases observed / the number of cases expected.

**** 95 % CI for SIR: 95 percent confidence interval for SIR.

fetal death information is available only on microfilm. Since 1970, both hard copies and computerized data are accessible. A computerized file of fetal death data was obtained from the HRS Office of Vital Statistics for the years 1970, 1975, 1980, 1985 and 1990. The computerized file had relatively less missing information (<2%).

A pilot analysis of fetal death in Pinellas County has been done based on the computerized file for the years of 1970, 1975, 1980, 1985, 1990. Broward and Duval counties were the comparison group. Mother's age was adjusted according to the age distribution of the comparison group. White and nonwhite rates were compared separately. SIRs and their 95% confidence intervals were calculated.

Tables 8-13 to 8-15 show the total, white and non-white observed number of fetal deaths, the expected number of fetal deaths, and the SIRs and their 95% confidence intervals in Pinellas County for the years 1970, 1975, 1980, 1985, 1990. Overall, the incidence of fetal death is similar to the comparison. Since this is only a pilot analysis, more detailed analyses with complete data are necessary to provide a full picture of fetal death in Pinellas County.

c) DEATH DATA: The information on FVSD death data includes identification number, name, race, gender, date of birth, date of death, cause of death, place of residence along with other information. A test abstract of the cancer death data for the early years (1955, 1965) shows that less than 3% of the above information is incomplete or missing except place of residence (in which 5% of the number and street name were missed). A computerized file of death data was obtained from the HRS Office of Vital Statistics for the years 1970, 1975, 1980, 1985 and 1990. The computerized file had relatively less missing information (<2%) than the earlier data.

A pilot analysis of cancer deaths in Pinellas County has been done based on the computerized file for the years of 1970, 1975, 1980, 1985, 1990. Broward and Duval

TABLE 8-13
STANDARDIZED INCIDENCE RATIOS OF FETAL DEATH
IN PINELLAS COUNTY, ALL RACES
 (Reference Group is Broward and Duval Counties)

Year of Delivery	Obs / Exp	SIR	%95 CI of SIR
1970	83 / 102	82	65 - 100
1975	59 / 71	83	63 - 106
1980	64 / 66	97	75 - 122
1985	75 / 82	92	72 - 114
1990	92 / 84	109	88 - 133

* The analyses were based on information obtained from a computerized data base at the Florida Office of Vital Statistics.

** Obs / Exp: The number of cases observed / the number of cases expected.

*** 95 % CI for SIR: 95 percent confidence interval for SIR.

TABLE 8-14
STANDARDIZED INCIDENCE RATIOS OF FETAL DEATH
IN PINELLAS COUNTY, WHITE
 (Reference Group is Broward and Duval Counties)

Year of Delivery	Obs / Exp	SIR	%95 CI of SIR
1970	61 / 63	96	73 - 122
1975	37 / 47	79	55 - 106
1980	46 / 47	98	71 - 128
1985	60 / 56	107	82 - 136
1990	59 / 45	131	100 - 166

* The analyses were based on information obtained from a computerized data base at the Florida Office of Vital Statistics.

** Obs / Exp: The number of cases observed / the number of cases expected.

*** 95 % CI for SIR: 95 percent confidence interval for SIR.

TABLE 8-15
STANDARDIZED INCIDENCE RATIOS OF FETAL DEATH
IN PINELLAS COUNTY, NONWHITE
 (Reference Group is Broward and Duval Counties)

Year of Delivery	Obs / Exp	SIR	%95 CI of SIR
1970	22 / 33	66	41 - 97
1975	20 / 21	96	58 - 142
1980	17 / 17	102	59 - 157
1985	15 / 20	74	41 - 117
1990	33 / 27	120	83 - 165

* The analyses were based on information obtained from a computerized data base at the Florida Office of Vital Statistics.

** Obs / Exp: The number of cases observed / the number of cases expected.

*** 95 % CI for SIR: 95 percent confidence interval for SIR.

counties are the comparison group. Age was adjusted according to the age distribution of the comparison group. White male and white female rates were compared separately. Standardized Mortality Ratios (SMRs) and their 95% confidence intervals were calculated. Twenty-nine cause-specific cancer mortality rates for Pinellas County as well as overall cancer mortality rates were compared to the corresponding cancer mortality rates of the reference group. Table 8-16 displays the cancer categories used in the analysis.

Tables 8-17 and Table 8-18 show the summaries of cancer SMRs among white males and white females in Pinellas County for the years 1970, 1975, 1980, 1985 and 1990. Among white males, the overall cancer mortality rate is around 100. This may reflect a natural fluctuation. For the cause-specific cancers, only colorectal cancer is slightly elevated. Stomach and pancreas cancers are slightly low for all five years. Among white females, the overall cancer mortality rate is lower than the comparison for all five years. For the cause-specific cancers, only Hodgkin's disease is slightly high. Pancreas, lung & bronchus, non-Hodgkin's disease and other site-specific cancers are slightly low for all five years. Appendix 6 gives the detailed information on the observed number of cancer cases, the SMRs and their 95% confidence intervals.

TABLE 8-16
CANCER CATEGORIES USED FOR FVSD ANALYSES

Primary site of cancer	ICD-9
All sites	140.0-208.9
Lip, Oral Cavity & Pharynx	140.0-149.9
Esophagus	150.0-150.9
Stomach	151.0-151.9
Colorectal	153.0-154.1 AND 159.0
Colon	153.0-153.9 AND 159.0
Rectum	154.0-154.1
Liver	155.0
Pancreas	157.0-157.9
Nasal Cavities, Sinuses & Ear	160.0-160.9
Larynx	161.0-161.9
Lung & Bronchus	162.2-162.9
Female Breast	174.0-174.9
Cervix Uteri	180.0-180.9
Corpus Uteri	182.0-182.8
Ovary	183.0
Vagina	184.0
Prostate Gland	185
Testes	186.0-186.9
Penis & Other Male Genitals	187.1-187.9
Urinary Bladder	188.0-188.9
Kidney & Other Urinary Organs	189.0-189.9
Brain & Other Nervous system	191.0-192.9
Thyroid Gland	193
All Lymphomas	200.0-202.9
Hodgkin's Disease	201.0-201.9
Non-Hodgkin's Disease	200.0-200.8 AND 202.0-202.9
Multiple Myeloma	203.0-203.8
All Leukemias	204.0-208.9
Other Sites	ELSE

TABLE 8-17
SUMMARY OF STANDARDIZED MORTALITY RATIOS
FOR CANCER IN PINELLAS COUNTY, WHITE MALE
 (Reference group is Broward and Duval counties)

Primary site of cancer	WHITE MALE				
	1970	1975	1980	1985	1990
All sites	102	95	94*	96	99
Lip, Oral Cavity & Pharynx	92	130	97	142*	79
Esophagus	111	73	83	68*	152*
Stomach	98	89	73*	97	75
Colorectal	107	119*	101	102	114
Colon	115	109	96	98	118*
Rectum	76	169*	134	127	89
Liver	65	80	111	106	86
Pancreas	90	92	89	70*	96
Nasal Cavities, Sinuses & Ear	140	0*	0*	156	134
Larynx	96	83	77	87	111
Lung & Bronchus	102	92	95	105	101
Prostate Gland	106	79	95	90	94
Testes	0	398*	33	0*	118
Penis & Other Male Genitals	55	.	0*	113	0*
Urinary Bladder	122	69	82	66*	92
Kidney & Other Urinary Organs	88	111	128	93	119
Brain & Other Nervous system	150	125	61*	82	102
Thyroid Gland	136	153	41	39	67
All Lymphomas	136	80	83	108	68*
Hodgkin's Disease	366*	93	33*	167	28
Non-Hodgkin's Disease	120	78	91	105	70*
Multiple Myeloma	122	82	112	91	86
All Leukemias	171*	104	103	83	132
Other Sites	69*	107	106	92	87

* Statistically significant ($P < .05$)

** The analyses were based on computerized data base from the Office of Vital Statistics, Florida

TABLE 8-18
SUMMARY OF STANDARDIZED MORTALITY RATIOS
FOR CANCER IN PINELLAS COUNTY, WHITE FEMALE
 (Reference group is Broward and Duval counties)

Primary site of cancer	WHITE FEMALE				
	1970	1975	1980	1985	1990
All sites	86*	87*	95	88*	92*
Lip, Oral Cavity & Pharynx	115	159	238*	61*	84
Esophagus	55	151	82	72	112
Stomach	52*	46*	100	61*	78
Colorectal	103	84*	119*	100	104
Colon	102	83*	120*	98	103
Rectum	112	92	114	118	113
Liver	42	65	41	36*	74
Pancreas	114	73*	86	120	96
Nasal Cavities, Sinuses & Ear	0*	.	232	155	0*
Larynx	129	20*	87	0*	70
Lung & Bronchus	96	81*	93	71*	90
Female Breast	70*	104	85*	90	89
Cervix Uteri	101	104	104	140	85
Corpus Uteri	62	101	72	87	71
Ovary	122	91	117	120	99
Vagina	196	81	58	189	114
Urinary Bladder	60*	131	92	94	72
Kidney & Other Urinary Organs	98	78	83	95	102
Brain & Other Nervous system	52*	76	160*	111	117
Thyroid Gland	166	81	144	121	43
All Lymphomas	83	82	103	73*	83
Hodgkin's Disease	147	170	263*	145	103
Non-Hodgkin's Disease	71	77	82	70*	81
Multiple Myeloma	116	156	55*	173*	101
All Leukemias	77	100	97	104	100
Other Sites	80*	76*	74*	81*	86

* Statistically significant ($P < .05$)

** The analyses were based on computerized data base from the Office of Vital Statistics, Florida

9. POTENTIAL PATHWAYS FROM WATER AND AGRICULTURAL PRODUCTS IN PINELLAS COUNTY

The object of this section is to verify:

1. The historical information on water systems in Pinellas County, and
2. The historical information on agricultural products in Pinellas County.

Water and agriculture products are two potential exposure pathways which can transfer environmental contaminants to an individual. In this section, the development of the Pinellas County water system and agricultural products are discussed.

I) Pinellas County water system

The first stages of the Pinellas County water system were built in 1937. Currently, there are four well fields which supply water for the system [1]. They are the East Lake well field, Eldridge-Wilde well field, Cypress Creek well field and the Cross Bar well field. Two of them are in northeast Pinellas County and the others are in Pasco County (Figure 9-1). The closest well fields are about fifteen miles away from the DOE plant. The monitoring data from the Pinellas County water system show that tritium in the water system is not more than 500 pCi/L since 1979 (Appendix 7). The standard for drinking water is less than 20,000 pCi/L [2]. There are no monitoring data for radiation available before 1976 for the Pinellas County water system.

II) Pinellas County agricultural products

Historically, agriculture has been the main industry in Pinellas County. However, acres of crop production and the number of livestock in Pinellas County are now much less than in previous years. Tables 9-1 and 9-2 display the general information on agriculture in Pinellas County from the Census of Agriculture from

FIGURE 9-1 WELL FIELDS OF THE PINELLAS COUNTY WATER SYSTEM
(From Historical report of Pinellas County Water System, 1989)

TABLE 9-1
LIVESTOCK PRODUCTION IN PINELLAS COUNTY

	1954	1959	1964	1969	1974	1978	1982	1987
BEEF COWS	1930	2902	1979	1636	1570	NA		
MILK COWS	5778	3496	2452	2500	1280	NA		
HOG & PIGS	1288	657	1864	283	126	997	617	NA
SHEEP & LAMB	----	----	----	4	9	NA	NA	NA
CHICKEN	116402	164147	174971	125635	959	668	3077	NA

* Data from United States Department of Commerce, Bureau of the Census. 1954 to 1987 Census of Agriculture.

TABLE 9-2
CROP PRODUCTION IN PINELLAS COUNTY
(ACRES)

	1954	1959	1964	1969	1974	1978	1982	1987
CORN	4	----	4	50	158	NA	NA	38
HAY	624	834	1204	585	1224	1781	349	189
ORCHARD	12749	10516	7523	5180	4123	3361	3033	615
VEGITABLE	52	29	24	2	33	NA	NA	NA

* Data from United States Department of Commerce, Bureau of the Census. 1954 to 1987 Census of Agriculture.

1954 to 1987 [3-10]. As Table 9-1 and 9-2 indicate, virtually all agricultural operations in Pinellas County have decreased.

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10. OTHER ENVIRONMENTAL CONCERNS

Although this study is focused by definition on the risks from radioactive emission from the plant, we note that some chemical wastes have been released from the Pinellas Plant [1-23]. In April, 1985, groundwater contamination was confirmed at a 4.55-acre site adjacent to the plant [24]. Chemical wastes identified include organic and inorganic materials, such as methylene chloride, trichloroethylene, lead, copper, mercury, arsenic, zinc, etc. It is possible that these chemical wastes may also affect the health of those near the plant. Cleanup of these wastes is being monitored by the Florida Department of Environmental Protection and the Environmental Protection Agency.

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11. FUTURE STUDY OPTIONS AND POWER CALCULATIONS

A review of the literature on the relationship between low level radiation exposure and cancer risks has shown that the significance of this relationship remains inconclusive. Previous studies also indicate the importance of accurate dose estimates, reasonable definitions of study boundaries and controls for confounding factors in future studies.

A radioactive material inventory of the plant identified a number of radioactive materials used for two basic purposes: 1) to be part of a product and 2) as sources used for calibration or tracer activities. The types of radioactive materials routinely released from the plant were documented including krypton-85, carbon-14 and tritium, the last of which is the main element which has been and continues to be released from the plant as a function of normal operations. Environmental monitoring data include soil, water, air and milk samples monitored for tritium gas, tritium oxide and krypton-85, and since 1975, plutonium. Geographic information collected for the feasibility study shows a dramatic increase in both population and land development in the last 40 years. In addition, the development of the Pinellas County water system relative to the Pinellas Plant was examined along with a brief history of the agricultural industry in the area.

An assessment of the feasibility of a radiological dose reconstruction in the vicinity of the plant by the Radiation Studies Branch of CDC has shown that it is feasible. The CDC report recommends a preliminary screening calculation to determine if a more extensive study is required. Sources of health information for Pinellas County have also been examined for type, quality and relevant time period. The major sources of health information include the Florida Cancer Data System

(FCDS), the Congenital Defects Surveillance Project (CDSP) and Florida Vital Statistics Data (FVSD).

The public living near the Pinellas Plant are concerned about their health as affected by radiation emission from the plant. Public participation in all aspects of future activities or studies is vital. Public participation should be structured to ensure the public is involved in the decision-making process including the planning, conduct and communication of activities and studies. Any further studies or activities should include resources for public participation, community education and training.

Based on the information gathered by the feasibility study, the following are potential options for future additional studies and activities related to the population surrounding the Pinellas Plant. The parameters of each option should be guided by a panel of experts composed, at a minimum, of representatives from HRS, DOE, epidemiologists from the scientific community and public representatives. These options embody a careful, step-by-step approach whereby each step leads to the next and where any one step may indicate that there is no need for further continuation.

1) Dose assessment and reconstruction

Based on the report from the CDC Radiation Studies Branch, a radiological dose reconstruction is feasible. However, a comprehensive dose reconstruction should not be done at this time, but rather a comprehensive document review process should be undertaken. This is a critical, initial step in any assessment/reconstruction effort. Following the document review, environmental screening calculations should be done to determine the nature and extent of a comprehensive dose reconstruction. This screening phase should be used to guide the need

for further surveillance activities, especially the need for maintaining a birth defects registry.

2) Cancer surveillance and historical health outcome analysis

In tandem with the above, a historical prospective cancer surveillance for leukemia, colon, and rectal cancers in the Pinellas Plant area should be done to discover preliminary specifics about their occurrences. An active health outcome surveillance of this type can discover community health problems as well as provide a data base for any future epidemiological studies. In addition, it would be useful to articulate case reports of potential sentinel health events observed by physicians in the community. This would help examine the mobility of persons potentially exposed by having physicians collect information on residence histories.

3) Case control study

If the results of the radiological dose reconstruction and cancer surveillance/health outcome analysis indicate that there are potentially plausible correlations, a case control study should be performed. This would involve identifying all cases of interest during a specific study period by contacting individuals and their families. A great deal of information would need to be collected including occupation, smoking and alcohol behaviors, residence history, medical history and other behavioral data. A control group would also need to be chosen and similar information would be gathered for this group as well. The purpose of these comparisons would be to determine if the cases in the study group are more likely to have been exposed to plant activities than

the members in the control group. Guided by experts, a case control study could be completed in one to three years and is particularly efficient for rare diseases such as cancers.

Figures 11-1, 11-2, 11-3, and 11-4 display the relationship of power level and sample size for case-control studies. Table 11-1 shows the relationship of power and sample size in case-control studies under 0.05 alpha level, 20% exposure rate and odds ratio from 1.5 to 3.0. Table 11-2 displays the relationship of power and sample size in case-control studies under 0.05 alpha level, 40% exposure rate and odds ratio from 1.5 to 3.0. Table 11-3 shows the relationship of power and sample size in case-control studies under 0.10 alpha level, 20% exposure rate and odds ratio from 1.5 to 3.0. Table 11-4 shows the relationship of power and sample size in case-control studies under 0.10 alpha level, 40% exposure rate and odds ratio from 1.5 to 3.0.

FIGURE 11-1 POWER AND SAMPLE SIZE FOR CASE-CONTROL STUDY

(Alpha is 0.05 and exposure rate among control is 0.20)

FIGURE 11-2 POWER AND SAMPLE SIZE FOR CASE-CONTROL STUDY
(Alpha is 0.05 and exposure rate among control is 0.40)

FIGURE 11-3 POWER AND SAMPLE SIZE FOR CASE-CONTROL STUDY
(Alpha is 0.10 and exposure rate among control is 0.20)

FIGURE 11-4 POWER AND SAMPLE SIZE FOR CASE-CONTROL STUDY

(Alpha is 0.10 and exposure rate among control is 0.40)

APPENDIX 1a

LETTER OF RECOMMENDATION FROM HRS

STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES

August 4, 1994

David S. Ingle
Environmental Compliance Manager
U.S. Department of Energy
Pinellas Area Office
P.O. Box 2900
Largo, FL 34649

Dear Mr. Ingle:

I am enclosing a final copy of the HRS Pinellas Plant Feasibility Study report which was performed by this department under contract with DOE. This report recommends that two options be initiated: 1) a document discovery/dose reconstruction study and 2) historic and prospective cancer surveillance of leukemia, colon and rectal cancers for the Pinellas area. The report also recommends a third option, a case-control study, be performed if the findings of options 1 and 2 show it to be desirable. We assume that DOE will evaluate the need for these studies and determine if funding should be made available.

HRS, as the entity which has conducted the feasibility study is precluded by our contract with DOE from conducting or participating in the recommended further studies. However, HRS would be happy to serve in an oversight capacity in this endeavor should DOE choose to pursue any of the options outlined in the study.

Please call me at 904-488-6811 if you have any questions or comments.

Sincerely,

Richard G. Hunter, Ph.D.
State Health Officer for Environmental Health
and Statewide Services

Enclosure

APPENDIX 1b

**LETTER OF RECOMMENDATION FROM
THE FEASIBILITY STUDY STEERING COMMITTEE**

Department of Epidemiology and Biostatistics
College of Public Health
University of South Florida
13201 Bruce B. Downs Boulevard
Tampa, Florida 33612-3805
(813) 974-4860
SUNCOM 574-4860
FAX (813) 974-4718

August 29, 1994

David S. Ingle
Environmental Compliance Manager
U.S. Department of Energy
Pinellas Area Office
P.O. Box 290-0
Largo, FL 34649

Dear Mr. Ingle:

This letter concerns the recently completed HRS Pinellas Plant Feasibility Study. As chairperson for the feasibility study Steering Committee, I am forwarding our recommendations regarding the study directly to you.

By majority vote of those present, on March 23, 1994, the Steering Committee for the HRS Pineallas Plant Feasibility Study passed the following resolution:

Be it considered that, based on the HRS Pinellas Plant Feasibility Study report and study options, HRS and DOE implement the study options outlined in the report. In addition, be it resolved that any future health study activities and document discovery include hazardous chemicals.

Sincerely yours,

Paul E. Leaverton, Ph.D.
Chairperson, Steering Committee
HRS Pinellas Plant Feasibility Study

PEL:Blf

cc: Dr. Richard G. Hunter

PEL:Blf

TAMPA

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APPENDIX 2

INVENTORY OF RADIONUCLIDES IN THE PINELLAS PLANT (for production activities)

Tritium - grams

<u>Month</u>	<u>1956</u>	<u>1957</u>	<u>1958</u>	<u>1959</u>	<u>1960</u>	<u>1961</u>
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	3.51
4	0.0	0.0	13.57	14.73	0.0	7.04
5	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	7.24	0.0	0.0	0.0	0.0
7	0.0	7.88	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	13.89	0.0	0.0	0.0	0.0
12	5.95	0.0	15.15	0.0	0.0	0.0

<u>Month</u>	<u>1962</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>
1	0.0	0.72	0.0	5.81	2.91	3.01
2	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	3.00	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	2.96	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0
8	3.93	5.77	0.0	0.0	0.0	0.0
9	0.0	0.0	6.14	0.0	0.0	0.0
10	0.0	2.81	0.0	0.0	0.0	0.0
11	6.55	0.0	0.0	2.78	0.0	3.34
12	0.0	0.0	0.0	0.0	0.0	0.0

1-56 Thru 4-71 are grams of material received each month.

5-71 Thru 5-75 are grams in inventory at beginning of each month.

Tritium - grams

<u>Month</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
1	0.0	0.0	0.0	0.0	20.29	20.57
2	0.0	0.0	3.27	0.0	20.18	19.89
3	0.0	0.0	0.0	0.0	19.96	19.64
4	3.33	0.0	0.0	3.03	19.41	19.43
5	0.0	0.0	0.0	16.94	22.29	18.62
6	0.0	0.0	0.0	16.23	22.03	18.16
7	0.0	3.45	0.0	15.48	21.97	20.42
8	0.0	0.0	0.0	22.16	21.86	19.58
9	0.0	0.0	3.07	21.78	21.94	19.40
10	0.0	0.0	0.0	21.08	21.76	18.93
11	0.0	0.0	0.0	21.08	21.30	18.54
12	0.0	0.0	0.0	20.29	21.07	18.42

<u>Month</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>
1	18.33	19.68	0.0	0.0	0.0	0.0
2	20.24	19.48	0.0	0.0	0.0	0.0
3	20.04	18.84	0.0	2.90	0.0	0.0
4	19.29	18.84	0.0	0.0	3.01	0.0
5	18.78	18.93	0.42	0.0	0.0	0.0
6	18.41	0.0	0.02	0.0	0.0	0.0
7	18.07	0.0	2.92	0.0	0.0	0.09
8	17.94	3.05	0.0	0.0	0.0	0.0
9	17.73	0.0	0.0	0.0	0.0	0.0
10	20.22	0.0	0.0	0.0	0.0	0.0
11	20.15	0.12	0.0	0.0	0.0	0.0
12	19.77	3.07	0.0	0.0	2.99	0.0

6-75 Thru 4-88 are grams of material received each month.

5-88 Thru 7-91 are grams of material in inventory at beginning of each month.

(for production activities)

Tritium - grams

<u>Month</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>
1	0.0	0.0	0.0	3.01	0.0	0.0
2	2.9	0.0	3.0	3.98	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0
5	2.97	0.03	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	3.74	2.93
7	0.0	2.93	0.0	0.0	0.0	0.0
8	0.41	0.0	2.95	0.0	0.0	0.0
9	0.08	0.0	0.0	0.0	0.09	0.0
10	0.0	0.42	0.0	2.88	0.0	0.0
11	0.88	0.0	0.65	0.0	0.0	0.0
12	0.0	0.0	0.0	0.21	0.0	0.0

<u>Month</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>
1	0.0	0.0	0.0	21.95	22.06	16.25
2	0.0	0.0	0.0	21.95	22.06	16.25
3	0.0	0.0	0.0	21.98	22.06	16.25
4	0.0	0.0	0.0	21.98	17.00	15.26
5	0.0	0.0	18.94	21.98	17.00	15.26
6	0.0	0.0	18.94	21.98	17.00	15.26
7	0.0	0.0	18.94	21.98	17.00	15.26
8	0.0	0.0	18.94	22.06	17.00	
9	0.0	0.0	18.94	22.06	17.00	
10	0.0	0.0	18.94	22.06	16.25	
11	2.96	3.0	18.94	22.06	16.25	
12	0.0	0.06	18.94	22.06	16.25	

FU-238 - grams

<u>Month</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>
1	0.0	31.2	251.7	222.1	1239.8	1729.8	1914.9
2	0.0	147.7	224.2	319.5	1239.8	1923.8	1872.5
3	0.0	147.7	224.2	266.1	1124.6	1924.5	1871.9
4	0.0	147.7	221.1	301.3	1310.7	1961.7	1889.6
5	0.0	108.5	203.3	522.6	1274.7	1961.7	1319.4
6	0.0	108.5	241.4	496.1	1919.3	1925.6	1619.5
7	0.0	194.4	241.4	496.1	1706.1	1711.0	1637.0
8	0.0	302.1	308.6	496.1	1627.0	1489.0	1751.3
9	0.0	302.1	308.6	389.4	1917.8	1755.3	2027.2
10	54.4	224.2	257.7	699.4	1952.8	1862.4	2239.4
11	54.4	239.2	222.1	1010.3	1713.8	1900.6	2215.3
12	54.4	290.2	222.1	1239.8	1968.2	1936.2	2260.0

<u>Month</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>
1	2296.4	3520.2	3137.3	2818.6	2286.7	1832.0	2262.9
2	2296.4	3260.4	3554.8	3420.4	2286.7	1719.7	2178.0
3	2104.6	3696.3	3524.2	3127.9	2527.6	1718.6	2082.5
4	2104.6	3552.3	3839.6	2940.4	2244.8	1737.8	1779.4
5	2104.6	3297.1	3660.5	2585.1	2786.9	1931.4	1871.5
6	2104.6	3663.9	4046.7	2370.0	2591.6	2168.0	2204.0
7	2104.6	4397.5	3434.7	3233.9	2686.5	1934.6	2426.6
8	2299.7	4191.6	3444.2	2908.4	2686.5	2223.4	2446.2
9	2832.8	3928.3	3741.9	2915.5	3005.3	2131.8	2555.7
10	2894.2	3972.7	2988.7	2695.1	2900.9	2175.5	2581.8
11	2803.1	3972.7	3618.7	2815.6	2782.5	2267.1	2266.3
12	3625.4	3777.2	2818.6	2285.7	1832.0	2158.2	2391.3

PU-238 - grams

<u>Month</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>
1	2100.1	2039.9	618.5
2	2513.6	2054.3	0.8
3	2379.3	2232.6	0.8
4	2167.8	1961.9	0.8
5	2148.0	2089.7	0.8
6	1840.6	1860.2	0.8
7	2384.8	1504.3	0.8
8	2131.9	1849.5	
9	2252.4	1603.5	
10	2626.4	1484.5	
11	2456.8	797.0	
12	2049.2	618.5	

0.8 gram Calibration source for calorimeter calibration remains onsite.

PU-239 - grams

	* <u>1970</u> <u>1971</u> <u>1972</u> <u>1973</u> <u>1974</u> <u>1975</u> <u>1976</u> <u>1977</u>							
<u>Month</u>								
1	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
3	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
4	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
6	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
7	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
8	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
9	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
10	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
11	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
12	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0

	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>
<u>Month</u>								
1	7.0	7.0	32.0	32.0	32.0	32.0	32.0	32.0
2	7.0	7.0	32.0	32.0	32.0	32.0	32.0	32.0
3	7.0	7.0	32.0	32.0	32.0	32.0	32.0	32.0
4	7.0	0.0	32.0	32.0	32.0	32.0	32.0	32.0
5	7.0	0.0	32.0	32.0	32.0	32.0	32.0	32.0
6	7.0	0.0	32.0	32.0	32.0	32.0	32.0	32.0
7	7.0	0.0	32.0	32.0	32.0	32.0	32.0	32.0
8	7.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0
9	7.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0
10	7.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0
11	7.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0
12	7.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0

* 7 gram source was purchased 1-57.

PU-239 - grams

<u>Month</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>
1	32.0	32.0	32.0	32.0	32.0	0.0
2	32.0	32.0	32.0	32.0	32.0	0.0
3	32.0	32.0	32.0	32.0	32.0	0.0
4	32.0	32.0	32.0	32.0	32.0	0.0
5	32.0	32.0	32.0	32.0	32.0	0.0
6	32.0	32.0	32.0	32.0	32.0	0.0
7	32.0	32.0	32.0	32.0	32.0	0.0
8	32.0	32.0	32.0	32.0	32.0	
9	32.0	32.0	32.0	32.0	32.0	
10	32.0	32.0	32.0	32.0	0.0	
11	32.0	32.0	32.0	32.0	0.0	
12	32.0	32.0	32.0	32.0	0.0	

APPENDIX 3

INVENTORY OF RADIONUCLIDES IN THE PINELLAS PLANT **(for nonproduction activities)**

APPENDIX 3: INVENTORY OF RADIONUCLIDES IN THE PINELLAS PLANT
(for nonproduction activities)

PINELLAS PLANT RADIOACTIVE SOURCE HISTORICAL INVENTORY/STATUS

<u>Radionuclide</u>	<u>Initial Activity/Date</u>	<u>Seal/ Unsealed</u>	<u>Used</u>	<u>Status/Date</u>
H-3	200 uCi/08/16/82	U	Static meter	Inactive awaiting disposal/ 10/91
H-3	1 Ci/03/27/86	U	Calibration source on gas analyzer	Sold as excess/ 02/90
H-3	150 uCi/11/15/83	U	Explosive meter	Inactive awaiting disposal/ 10/91
H-3	150 uCi/11/15/83	U	Explosive meter	Inactive awaiting disposal/ 10/91
H-3	2000 Ci/10/63	U	Heat source	Disposed as void waste in drum 3713/ 05/83
H-3	2000 Ci/10/63	U	Heat source	Disposed as rad waste in drum 3711/ 05/83
H-3	0.8 Ci/11/10/87	U	Calibration gas	Active/ 10/91
H-3	200 dpm/06/16/88	U	Calibration plates	Active/ 10/91
H-3	200 mCi/12/01/88	U	Gas chromatograph	Active/ 10/91
C-14	0.16 uCi/10/02/79	U	Calibration source	Inactive/ 10/91
C-14	100 dpm/1968	U	Calibration source	Inactive/ 10/91
-14	700 uCi/1966	U	LSC source	Disposed as rad waste/ 12/13/89
C-14	245 uCi/1966	U	LSC source	Disposed as rad waste/ 12/13/89
C-14	245 uCi/1966	U	LSC source	Disposed as rad waste/ 12/13/89
Na-22	1.25 uCi/03/21/75	S	Check source	Active/ 10/91
Mn-54	1.34 uCi/03/27/75	S	Check source	Active/ 10/91
Fe-55	100 uCi/03/75	U	Thickness gauge	Disposed as rad waste/ 1983
Fe-55	30 mCi/11/86	U	Thickness gauge	Inactive-storage/ 10/91
Fe-55	20 mCi/12/89	U	Thickness gauge	Inactive-storage/ 10/91

Legend:

(u) - micro, 10^{-6}
(m) - milli, 10^{-3}
(dpm) - disintegrations per minute

APPENDIX 3: INVENTORY OF RADIONUCLIDES IN THE PINELLAS PLANT
(for nonproduction activities)

PINELLAS PLANT RADIOACTIVE SOURCE HISTORICAL INVENTORY/STATUS

<u>Radionuclide</u>	<u>Initial Activity/Data</u>	<u>Seal/Unsealed</u>	<u>Uses</u>	<u>Status/Data</u>
Fe-55	18.5 mCi/01/81	U	Thickness gauge	Active/ 10/91
Fe-55	30 mCi/12/81	U	Thickness gauge	Active/ 10/91
Fe-55	50 mCi/12/83	U	Thickness gauge	Active/ 10/91
Fe-55	15 mCi/01/82	U	Thickness gauge	Active/ 10/91
Co-57	1.38 uCi/07/75	S	Check source	Active/ 10/91
Ni-59	0.1 uCi/03/69	U	Check source	Active/ 10/91
Co-60	1.14 uCi/04/75	S	Check source	Active/ 10/91
Co-60	1.1 uCi/1968	S	Check source	Inactive-storage/ 10/91
Co-60	0.8 uCi/1964	S	Check source	Inactive-storage/ 10/91
Co-60	60 uCi/02/61	S	Check source	Inactive-storage/ 10/91
Co-60	39 uCi/05/77	S	Check source	Inactive-storage/ 10/91
Co-60	80 uCi/1961	S	Gamma source	Shipped to Gamma Industries for disposal 11/86
Co-60	495 mCi/1961	S	Gamma source	Shipped to Gamma Industries for disposal/ 11/86
Ni-63	15 mCi/09/84	U	Gas chromatograph source	Active/ 09/91
Ni-63	8 mCi/02/84	U	Gas chromatograph source	Active/ 09/91
Ni-63	15 mCi/08/85	U	Gas chromatograph	Active/ 09/91
Kr-85	4.72 uCi/09/74	U	Gas sample in glass vial	Active/ 10/91
Kr-85	5 uCi/1962	U	Gas sample in glass vial	Inactive-storage/ 10/91
Kr-85	4.52 uCi/1972	U	Gas sample in glass vial	Active/ 10/91
Legend: (u) - micro, 10^{-6} (m) - milli, 10^{-3} (dpm) - disintegrations per minute				

APPENDIX 3: INVENTORY OF RADIONUCLIDES IN THE PINELLAS PLANT
(for nonproduction activities)

PINELLAS PLANT RADIOACTIVE SOURCE HISTORICAL INVENTORY/STATUS

<u>Radionuclide</u>	<u>Initial Activity/Data</u>	<u>Seal/Unsealed</u>	<u>Uses</u>	<u>Status/Data</u>
Sr 90	5 uCi/11/68	S	Check source	Inactive-storage/ 10/91
Sr 90	25 uCi/1985	S	Check source	Inactive-storage/ 10/91
Sr 90	0.013 uCi/1989	U	Beta check source	Active/ 10/91
Sr 90	0.25 uCi/1985	U	Beta check source	Inactive-storage/ 10/91
Cd 109	13.8 uCi/1975	S	Check source	Active 10/91
Cd 109	10 uCi/12/71	S	Check source	Active 10/91
Ba 133	10 uCi/1986	S	Ba bolts for lead probes	Active/ 1091
<We have approximately 40 on-site>				
Ba 133	1.1 uCi/1968	S	Check source	Inactive-storage/ 10/91
Cs 137	30 uCi/1984	S	Check source in LSC	Active/ 10/91
Cs 137	0.02 uCi/1969	S	Check source	Inactive/ 10/91
Cs 137	0.1 uCi/1985	S	Check source	Inactive/ 10/91
Cs 137	1.0 uCi/1985	S	Check source	Inactive/ 10/91
Cs 137	.012 uCi/1977	S	Check source	Inactive/ 10/91
Cs 137	.05 uCi/1957	S	Check source	Inactive/ 10/91
Cs 137	.492 uCi/1960	S	Check source	Inactive/ 10/91
Cs 137	30 uCi/1969	U	Liquid check source	Active 10/91
Cs 137	20 uCi/1962	S	Check source	Inactive 10/91
Cs 137	.95 uCi/1975	S	Check source	Active 10/91
Cs 137	108 uCi/1988	S	Check source	Active 10/91
Cs 137	110 uCi/1988	S	Check source	Active 10/91
Cs 137	.001 uCi/1988	S	Check source	Active 10/91

Legend:

(u) - micro, 10^{-6}
(m) - milli, 10^{-3}
(dpm) - disintegrations per minute

APPENDIX 3: INVENTORY OF RADIONUCLIDES IN THE PINELLAS PLANT
(for nonproduction activities)

PINELLAS PLANT RADIOACTIVE SOURCE HISTORICAL INVENTORY/STATUS

<u>Radionuclide</u>	<u>Initial Activity/Data</u>	<u>Seal/ Unsealed</u>	<u>Uses</u>	<u>Status/Data</u>
Cs 137	1.5 uCi/1989	S	Check source	Inactive-storage/ 10/91
Cs 137	1.5 uCi/1989	S	Check source	Inactive-storage/ 10/91
Cs 137	5.71 mCi/1990	S	Calibrator source	Active/ 10/91
Cs 137	41 uCi/03/15/87	S	Old check sources from LSC	Inactive-storage/ 10/91
Cs 137	200 uCi/1962	S	Check source	Inactive-storage/ 10/91
Cs 137	120 Ci/07/73	S	Calibration source	Active/ 10/91
Cs 137	200 uCi/1962	S	Check source	Inactive-storage/ 10/91
Cs 137	200 uCi/1962	S	Check source	Active/ 10/91
Cs 137	200 uCi/1962	S	Check source	Inactive-storage/ 10/91
Cs 137	200 uCi/1962	S	Check source	Inactive-storage/ 10/91
Cs 137	41 uCi/1987	S	Check source	Inactive-storage/ 10/91
Pm 147	600 uCi/06/69	S	Check source	Inactive-storage/ 10/91
m 147	3 uCi/1985	S	Check source	Inactive-storage/ 10/91
Gd 148	0.14 uCi/09/85	U	Check source	Active/ 10/91
Ti 204	300 uCi/1971	S	Thickness source	Dispose as rad waste/ 05/09/7
Ti 204	30 uCi/02/04/78	S	Check source for thickness gauge	Inactive-storage/ 10/91
Ti 204	50 uCi/05/01/70	S	Check source for thickness gauge	Inactive-storage/ 10/91
Ti 204	50 uCi/02/25/74	S	Check source for thickness gauge	Inactive-storage/ 10/91
Ti 204	50 uCi/01/06/70	S	Check source for thickness gauge	Inactive-storage/ 10/91
Bi 210	0.1 uCi/1969	S	Check source	Inactive-storage/ 10/91

Legend:
 (u) - micro, 10^{-6}
 (m) - mill, 10^{-3}
 (dpm) - disintegrations per minute

APPENDIX 3: INVENTORY OF RADIONUCLIDES IN THE PINELLAS PLANT
(for nonproduction activities)

PINELLAS PLANT RADIOACTIVE SOURCE HISTORICAL INVENTORY/STATUS

<u>Radionuclide</u>	<u>Initial Activity/Data</u>	<u>Seal/Unsealed</u>	<u>Uses</u>	<u>Status/Data</u>
Po 210	24 mCi/03/1982	U	Static eliminator	Returned to 3M 03/19/82
Po 210	0.016 uCi/1989	U	Check source	Active/ 10/91
Po 210	500 uCi/11/1983	U	Static eliminator	Inactive-storage/ 10/91
Po 210	500 uCi/11/1983	U	Static eliminator	Inactive-storage/ 10/91
Po 210	500 uCi/11/1983	U	Static eliminator	Inactive-storage/ 10/91
Pb 210	20 uCi/03/1969	S	Check source	Inactive-storage/ 10/91
Pb 210	0.2 uCi/1969	S	Check source	Inactive-storage/ 10/91
Ra 226	7uCi/03/07/83	S	Dew pointer	Active/ 10/91
Ra 226	7uCi/03/07/86	S	Dew pointer	Active/ 10/91
Th 230	0.005 uCi/1986	U	Plated source	Active/ 10/91
Th 230	4000 dpm/1989	U	Plated source	Active/ 10/91
Pa 234	0.01 uCi/1986	S	Check source	Inactive-storage/ 10/91
U 238	0.01 uCi/1986	U	Alpha source	Inactive-storage/ 10/91
J 238	0.01 uCi/1961	U	DU Slab	Active/ 10/91
U 238	0.03 uCi/1989	U	Old DU Billets	Inactive-storage/ 10/91
Pu 238	0.01 uCi/1990	U	Alpha source	Active/ 10/91
Pu 238	800 dpm/1980	U	Alpha source	Inactive-storage/ 10/91
Pu 238	15 Ci/1986	S	Heat sources	Returned to another DOE site/ 1989
Pu 238	820 dpm/10/15/75	U	Alpha check source	Active/ 10/91
Pu 238	395 dpm/03/18/74	U	Alpha check source	Active/ 10/91
Pu 238	748 dpm/11/16/76	U	Alpha check source	Active/ 10/91
Pu 239	362 dpm/07/19/82	U	Alpha check source	Active/ 10/91

Legend:

(u) - micro, 10^{-6}
(m) - milli, 10^{-3}
(dpm) - disintegrations per minute

APPENDIX 3: INVENTORY OF RADIONUCLIDES IN THE PINELLAS PLANT
(for nonproduction activities)

PINELLAS PLANT RADIOACTIVE SOURCE HISTORICAL INVENTORY/STATUS

<u>Radionuclide</u>	<u>Initial Activity/Data</u>	<u>Seal/ Unsealed</u>	<u>Uses</u>	<u>Status/Date</u>
Pu 238	1810 dpm/10/16/75	U	Alpha check source	Active/ 10/91
Pu 238	10.26 Ci/08/17/89	S	Sealed heat source standard	Active/ 10/91
Pu 238	3.42 Ci/08/17/89	S	Sealed heat source standard	Active/ 10/91
Pu 239	1.7 Ci/08/14/62	S	Neutron source	Moved to another DOE site/ 1990
Pu 239	0.43 Ci/11/76	S	Neutron source	Moved to another DOE site/ 02/79
Am 241	.11 uCi/07/11/77	U	Alpha source	Active/ 10/91
Am 241	500 uCi/06/11/68	U	Alpha source	Active/ 10/91
Am 241	10 Ci/1988	S	AmBe	Inactive/being excessed 10/91
Am 241	50 mCi/11/71	U	Alpha source	Active/ 10/91
Cm 244	4 mCi/02/13/80	S	Check source	Active/ 10/91

Legend:

(u) - micro, 10^{-6}
(m) - milli, 10^{-3}
(dpm) - disintegrations per minute

APPENDIX 4

**ASSESSMENT OF THE FEASIBILITY
OF A RADIOLOGICAL DOSE RECONSTRUCTION
AT THE PINELLAS PLANT**

**Radiation Studies Branch
National Center for Environmental Health
Centers for Disease Control and Prevention
December, 1993**

Executive Summary

At the request of the Florida Department of Health and Rehabilitative Services, the Centers for Disease Control and Prevention (CDC), National Center for Environmental Health, Radiation Studies Branch, has helped to assess the feasibility of a radiological dose reconstruction for members of the public from activities at the Department of Energy (DOE) X-owned Pinellas Plant (now operated by Martin Marietta Specialty Components). This plant (formally [sic] General Electric Aerospace Neutron Devices) was built in 1956 on 99.9 acres of land in central Pinellas County, about 15 miles (across the bay) from Tampa, Florida. The Pinellas Plant was built to manufacture neutron generators (neutron tubes) which are a vital component of nuclear weapons. These generators are designed to assure that the maximum yield is obtained when the weapon is detonated.

Tritium is an essential component of the tubes. It is shipped from the Savannah River Site in gas cylinders and stored at Pinellas in depleted uranium beds (a hydrated powder). It is introduced into the tubes by heating the beds under vacuum conditions.

In 1975 production of Radioisotopic Thermoelectric Generators began and triple-sealed plutonium sources were shipped to the plant from Sandia National Laboratory in New Mexico. Production of these devices and plutonium shipments to the site ended in 1991. According to plant personnel, no plutonium currently remains on site.

Initially, the plant only had one exhaust stack where tritium oxide and tritium gas were released. Over time, three other stacks were added. However, the bulk of the stack releases of tritium apparently occurred in the years 1957, 1958, and 1959, prior to development of more efficient tritium loading procedures and design of a stack effluent control system for this radionuclide.

Typical of many DOE facilities, meticulous environmental monitoring and records keeping did not take place until the early to mid 1970's. Prior to that, monitoring and records keeping was not very thorough. However, after reviewing plant publications, interviewing key personnel, and checking the existence, accessibility, and quality of documents important to dose reconstruction at the plant, we have concluded that a dose reconstruction is feasible. Nevertheless, we recommend that the Florida Department of Health and Rehabilitative Services analyze the available data and perform a preliminary screening calculation to determine if a more extensive study is required. In addition, an effective public involvement program should be developed in conjunction with the technical work.

I. Introduction

Under agreement with the Department of Energy (DOE), the Florida Department of Health and Rehabilitative Services started a project to assess the feasibility of conducting a health study to determine if the health of members of the public have [sic] been adversely affected by radioactive releases from the DOE-owned Pinellas Plant. In order to conduct a health study linking potential health effects to radiation exposure, the Florida Department of Health and Rehabilitative Services first must determine if it can assess the radiation exposure that members of the public received from the plant over the plant's operating history.

In the summer of 1993, the Florida Department of Health and Rehabilitative Services requested assistance from the Centers for Disease Control and

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Prevention (CDC), National Center for Environmental Health, Radiation Studies Branch, in assessing the feasibility of a radiological dose reconstruction of exposure to the public from activities at the DOE-owned Pinellas Plant. CDC personnel attended several meetings with the Florida Department of Health and Rehabilitative Services and other interested parties concerning this issue; documents already supplied to the Florida Department of Rehabilitative Services from the Pinellas Plant were reviewed; and four CDC staff members accompanied a Florida Department of Rehabilitative Services staff member on a plant visit to interview key plant personnel and check the existence, accessibility, and quality of important documents at the plant relating to dose reconstruction.

A. Description of Key Plant Operations

The Martin Marietta Specialty Components Pinellas Plant (formally [sic] General Electric Aerospace Neutron Devices) was built in 1956 on 99.0 acres of land in central Pinellas County, about 15 miles (across the bay) from Tampa, Florida. At the time it was built, this area was fairly remote with dairy and beef cattle and some warehousing operations, surrounded by pine flatwoods. Eventually light industry moved in and now there are residential areas only 1/4 mile from the plant boundary. The nearest population areas are Largo and Clearwater to the north, and Pinellas Park and St. Petersburg to the south.

The area has a subtropical marine climate, characterized by long humid summers and mild winters. Rainfall is abundant and there is a potential for hurricanes and tornadoes. The Florida peninsula is underlain [sic] to significant depths by a number of layers of limestone (known as the Floridan Aquifer) which is the source of water for the population.

The Pinellas Plant was built to manufacture neutron generators (neutron tubes) which are a principle component of the nuclear weapons. These generators were designed by Sandia National Laboratories in order to assure that the maximum yield is obtained upon weapon detonation. Production began in 1957 with neutron tubes being the only Pinellas Plant product for the first 10 years.

Neutron Tubes

Neutron tubes provide a pulsed source of neutrons through ionization of the tritium in the tube and acceleration of the ions to the end of the tube where they fuse with a layer of deuterium producing the following reaction:

The tubes consist of a miniaturized linear ion accelerator assembled with the pulsed electrical power supplies required for its operation. Creation of these devices required development of several areas of specialty including high vacuum technology, hermetic seals between glass, ceramic, and metal materials and high voltage generation and measurement. This eventually lead [sic] to many other products (mostly those that use ceramics and electronics), including a commercially

available neutron generator called the zetatron (or zetatube) which is a continuous neutron source instead of a pulsed source.

The tritium for the tubes is shipped from the Savannah River Site in gas cylinders. The tritium is stored at Pinellas in depleted uranium beds (a hydrated powder). It is introduced into the tubes by heating the beds under vacuum conditions. The depleted uranium powder is used over and over. The amount of tritium required for each tube has been greatly reduced over the years in order to extend the shelf life of the tubes.

Radioisotopic Thermoelectric Generators

In 1975, production of Radioisotopic Thermoelectric Generators began and triple-sealed plutonium sources were shipped to the plant from Sandia National Laboratory in New Mexico. These devices evolved from a need for batteries with extremely long operating lives (25 milliwatts of power at 2 volts for 25 years). Plutonium-238 (oxide) was used as a heat source in the semi-conductor material. Production of these devices and plutonium shipments to the site ended in 1991. According to plant personnel, no plutonium currently remains on site.

Other Potential Sources of Radiological Releases

Since 1963, the use of krypton-85 gas has been employed at the plant to check the efficiency of seals. From 1979 to 1983 a carbon-14 tracer was used to check cleaning efficiency of solvents. Another method, not involving radioactive materials, is now employed for the latter process.

Radionuclides of Interest

The radionuclides of interest in a dose reconstruction, therefore, appear to be tritium, krypton-85, carbon-14, depleted uranium, plutonium-238 and plutonium-239.

Potential Chemical Contaminants

Potential chemical contaminants include chlorinated solvents from degreasing (such as freon) and toxic organics (such as chloroform). Metals such as copper, zinc, mercury, nickel, lead, cadmium and chromium are also of potential concern. There were 15 solid waste management units within the site boundary which have been cleaned up. One area, known as the 4.5 Acre Site, was used in past years for chemical storage and has been found to contain methylene chloride, toluene and vinyl chloride in addition to small amounts of benzene and acetone. The 4.5 Acre Site is currently in the process of being cleaned up. The Pinellas Plant is not a Superfund site.

B. History of Plant Releases and Monitoring Efforts

Plant Releases

Initially, the plant only had one exhaust stack (the building 100 Main Stack) where tritium oxide and tritium gas were released. Over time, three other stacks were added for releases from laboratory development

activities, environmental testing activities and accelerator experiments, in addition to production activities.

Treated industrial wastewater was initially discharged into ditches flowing to the Cross Bayou Canal, then to Boca Ciega Bay and to the Gulf of Mexico. In 1972 the wastewater was discharged into onsite holding ponds where it was spray irrigated, the percolate was collected and then it was discharged to the Cross Bayou Canal. Then in 1982, after the Tritium Recovery System became operational, the wastewater was discharged to Pinellas County Publicly Owned Treatment Works.

In 1960 a newly designed Stack Effluent Control System became operational. This system consists of a refrigeration coil to condense the tritiated water from the effluent stream. At the same time, changes in tube loading procedures and equipment were put in place. Data published in GEPP-EV-1126, "Environmental Health and Safety, Historical Report on Radiation Protection at GE Neutron Devices," indicated a 98% reduction in tritium stack releases from 1959 to 1961. In the mid 1960's changes in operations came in to use and the effluents were not connected to the Stack Effluent Control System until 1972. Still, the bulk of the stack releases of tritium apparently occurred in the years 1957, 1958, and 1959.

Monitoring

The release stacks were monitored from the start of operations by Kanne Chambers (which are simple flow through ion chambers). Some rain water and surface water was sampled in the 1950's, but formal annual environmental reporting was not required by DOE until 1960. In the early days these reports contained the results of daily off-site sewer effluent samples in addition to surface water and vegetation samples. Occasional off-site air monitoring was also done, as was milk sampling at the local dairy farm. In 1964 an Emergency Monitoring Team was formed and a truck with a Kanne Air Monitoring System was purchased. With this truck, informal environmental air monitoring was performed for a few years. However, a more formal environmental monitoring program was not put in place until the mid-1970's (at about the time the first plutonium heat sources were to be shipped). Currently the plant has an environmental monitoring program involving air, water, and soil which includes daily and monthly stack monitoring, 24 hour composite samples collected daily from the industrial wastestream, the sanitary sewage wastestream and the combined wastestream, seven on-site air sampling stations, six off-site air sampling stations, three on-site stormwater retention ponds (sampled weekly), and twenty-six off-site water locations (sampled monthly). An on-site meteorological station has been operating for about one year (previously the data from the meteorological station at the Tampa airport was used).

II. Results

Appendix A lists the documents collected by the Florida Department of Health and Rehabilitative Services and CDC personnel. Appendix B lists the documents not collected, but viewed on site. Appendix C lists

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records and data which may be of special interest for a dose reconstruction.

"Work for Others" (i.e., work that was done for non-DOE entities such as other nations) was monitored along with normal plant releases and is part of the total releases reported. According to plant personnel, they are phasing out all Q-classified work (the highest classification level), and will be only doing L-classified or non-classified work. Also, there is a declassification process underway which should allow non-Q cleared persons to view most of the previously classified documents.

Typical of many DOE facilities, meticulous environmental monitoring and records keeping did not take place until the early to mid 1970's. Prior to that, the monitoring and records keeping was not very thorough. However, the information required to conduct a radiological dose reconstruction appears to be available. The information reviewed was readable and of good quality and raw data was [sic] obtainable. Nevertheless, the completeness of this information has yet to be confirmed.

Plant management and key personnel were cooperative, including those who were already retired. No obstacles to a dose reconstruction effort were apparent.

III. Conclusions and Recommendations

A radiological dose reconstruction at the Pinellas Plant appears to be feasible, based on the limited information we have. However, available data should be analyzed to determine if the potential amount of radionuclide(s) released to the environment would demonstrate the potential to result in adverse health outcomes.

Note: A very rough set of screening calculations, i.e., initial very conservative estimates, can be done with the information already available (see Appendix C). These calculations could be done based on determining how much of each radionuclide arrived on site, subtracting how much was sent off site, and conservatively assuming that all of the remainder was released to the environment. Using Tampa airport meteorological data (not enough data has yet been collected from the on site meteorological tower), conservatively assuming that the current population has existed around the site since 1957, and following instructions given in references 1 through 5, the maximal dose to the population can be calculated.

In addition, an effective public involvement program should be developed in conjunction with the technical work.

References

1. NCRP Commentary No. 3, *Screening Techniques for Determining Compliance with Environmental Standards, Releases of Radionuclides to the Atmosphere*, Revision of January, 1989, National Council on Radiation Protection and Measurements, Bethesda, MD.
2. NCRP Commentary No. 8, *Uncertainty in NCRP Screening Models Relating to Atmospheric Transport, Deposition and Uptake by Humans*, September, 1993, National Council on Radiation Protection and Measurements, Bethesda, MD.
3. NCRP Report No. 76, *Radiological Assessments, Predicting the Transport, Bioaccumulation and Uptake by Man of Radionuclides Releases to the Environment*, 1984, National Council on Radiation Protection and Measurements, Bethesda, MD.
4. IAEA Safety Series No. 57, *Generic Models and Parameters for Assessing the Environmental Transfer of Radionuclides from Routine Releases: Exposures of Critical Groups*, 1982, International Atomic Energy Agency, Vienna.
5. EPA 520/1-89-003, *User's Guide for the Comply Code*, October, 1989, United States Environmental Protection Agency, Washington, DC.

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**Appendix A
Documents Collected as of November, 1993**

Annual Environmental Monitoring Reports, 1974 - 1992

Pinellas Plant Facts (Oct 89)

Pinellas Plant Omnibus Environmental Assessment (Nov 75)

**Environmental Health & Safety-Safety Assessment (Pinellas Plant Child
Development Center/Partnership School, June 21, 1990)**

Environmental Monitoring (Procedures, calculations, standards etc., 1970)

Pinellas Plant Radioactive Source Historical Inventory/Status

**Pinellas Plant Radiological Monitoring Data by Year of Operation (list of
samples took [sic], no results, 1974 1990)**

**General Electric Neutron Devices Environmental Data by Type of Sample
(microfilm film and frame numbers)**

**General Electric Neutron Devices Environmental Monitoring Data by Year
(microfilm film and frame numbers, 1957 - 1986)**

**Environmental Health & Safety-Historical Report on Radiation Protection at GE
Neutron Devices**

Radioactive Materials at Pinellas Plant (H^3 , Pu^{238} , and Pu^{239})

Environmental Monitoring Procedures (Current as of 8/21/91)

Stack Release Inventory

Microfilm List

Summary of Pinellas Plant Data

**4.55 Acre Site Volatile Organic Compound Treatment System (prepared by
CH2M Hill)**

**Country [sic] Raw Data (Compost, incinerator, sewage treatment discharge
information into Publicly Owned Treatment Works)**

Martin Marietta Specialty Components Telephone/Mail Direcorry (July 1993)

List of Acronyms

General Ledger containing an inventory of Plutonium

Calendar Year 1973 Offsite Effluent Release Report (raw data from each stack)

DOE/EA-0209, 1983 Environmental Assessment of Pinellas Plant Site

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**1960 Environmental Monitoring Report (containing information on vegetation
and milk sampling in addition to air and water)**

Environmental Monitoring Program Overview (presented by Donn Brown)

Records Search Findings To-Date (presented by Donn Brown)

**APPENDIX B
DOCUMENTS VIEWED ON SITE**

**Appendix B
Documents Viewed on Site**

Microfilm Cartridges 4451A, 4452A, 4455A, 5821A, 7101A, 7378A. The information contained in these microfilms includes: water sample sheets, exhaust stack monitor results (daily, monthly and annual), smear and contamination survey sheets, soil beta activity counter, log checks, oxide work sheets, Radioactive receipts (waste shipments sent off-site), HP monthly reports from 1957 through 1969, then quarterly reports through 1974, then they become annual reports), instrument and monitor calibration sheets, process hold tank concentrations, bioassay work sheets, personnel exposures, and various procedures.

Environmental Monitoring Log Book From 1973 (three ring binder). It contained various data and calculation sheets from air, surface water, effluent and vegetation sampling. There were Beckman Counter Log sheets (raw data), Environmental Oxide Sample sheets, Liquid Sample sheets (raw data from effluent, surface water, vegetation, etc.), pollution control water sample sheets and various service request forms for special samples that were taken.

Active Environmental Monitoring records (located in building 100 on the 2nd floor in Area 190).

One file cabinet contained environmental monitoring data from 1976-80 and 82-93 including data sheets and purchase orders for the 1980's, storage permits from the 70s through 80s, a 1980 waste management study and Publicly Owned Treatment Works data for 1983 through 1989.

Another file cabinet contained environmental monitoring reports from 1971-74, lists of deficiencies such as leaking drums and valves and inadequate safety guards, meteorological information from 1950-74, descriptions of specific projects, water resource studies, and memos dated in the 50's.

A file cabinet and book shelves in the conference room contained Publicly Owned Treatment Works discharge for 1988-90; self monitoring data from 1991-93; Lab analysis data from 1991-93; tritium analysis for 92, discharge to ponds for 1990, and surface water data for 1990-91; current monitoring manuals and ground water monitoring for 1991 and 92.

Classified documents, including radionuclide inventory logs.

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**APPENDIX C
DOCUMENTS OF SPECIAL INTEREST**

Appendix C
Documents of Special Interest

For Screening Calculations¹

Inventory records of plutonium, tritium, uranium, krypton and carbon-14
Meteorological Data from the Tampa airport
Current Demographic data from the U.S. Census Bureau

For Source Term Evaluation

Exhaust Stack Emission Plots
Exhaust Stack Discharge Data Sheets
Health Physics Monthly Reports
Inventory Records
Gel column analyses
Incident Reports
Beta Counter Log Sheets
Instrument and monitor calibration sheets
Environmental Monitoring Logs
Publicly Owned Treatment Works Monitoring Data
Rad Waste Records

For Model Validation

Environmental Monitoring Logs

¹ The Florida Department of Health and Rehabilitative Services should be able to do a very rough set of screening calculations based on determining how much of each radionuclide arrived on site, subtracting how much was sent off site, and conservatively assuming that all of the remainder was released to the environment. Using Tampa airport meteorological data (not enough has yet been collected from the on site meteorological tower) and conservatively assuming that the current population has existed around the site since 1957, the Florida Department of Health and Rehabilitative Services can then calculate the maximal dose to the population. See Reference 1 through 5 for instructions on screening calculations.

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For Historical Outlook on Demography

**Demographic Data from the U.S. Census Bureau
Demographic Data from the Bureau of Economic and Business Research of the
University of Florida
United States Geographical Survey Maps from 1950
United States Geographical Survey Maps from 1980**

Other

Onsite Meteorological data.

APPENDIX 5

CANCER INCIDENCE PATTERNS IN PINELLAS COUNTY:

1981-1990

ABSTRACT

The cancer incidence patterns among the Pinellas County population where a DOE facility is located were examined for the period 1981 to 1990 using the Florida Cancer Data System. During this period, there were a total of 60,522 cases of cancer diagnosed in Pinellas County. Two groups were chosen for comparison. One group was the State of Florida excluding Pinellas County (the state reference). The other group was Broward and Duval counties (the county reference). The Standardized Incidence Ratio (SIR) was computed for the comparison. As compared to the state reference, the overall cancer incidence was slightly elevated for all four race-gender groups (white male: SIR=107 95% CI=105-108, white female: SIR=109 95% CI=108-110, non-white male: SIR=105 95% CI=98-112, and non-white female: SIR=112 95% CI=105-119). As compared to the county reference, the overall cancer incidence was also weakly increased except in the non-white groups (white male: SIR=111 95% CI=110-112, white female: SIR=107 95% CI=106-108, non-white male: SIR=97 95% CI=91-104, non-white female: SIR=103 95% CI=97-110).

Thirty-eight cause-specific cancers were also examined. Consistently high incidence rates among all four race-gender groups were found for colorectal cancer including colon cancer and rectal cancer separately. Consistently low incidence rates among all four race-gender groups were found for liver cancer. Some reproductive organ cancers (female breast, cervix uteri, testes) were high in their gender groups. These results should be interpreted with caution because of the limitations of this type of study. Limitations include the unavailability of cancer incidence information for the first 25 years of plant operations, a dramatically changing demographic structure in

Pinellas County during this period, lack of radiation exposure data and other chemical exposure information, and lack of knowledge concerning other risk factors related to cancers. Further studies are necessary to distinguish the relationship between radiation exposure and cancer incidence in this community.

INTRODUCTION

There has been great concern about the possible human health effects of low level radiation related to radioactive releases from nuclear facilities. It is generally thought that the likelihood of adverse health risks resulting from low level radiation from nuclear facilities is negligible or too small to be detected. However, epidemiological studies of populations living near nuclear facilities have yielded mixed results and questions continue to be raised about the adverse health risks. The goal of this study is to examine the cancer incidence patterns for Pinellas County, where a U.S. Department of Energy (DOE) nuclear facility is located, and to compare the cancer incidence rates of Pinellas County to two comparable counties and to the State of Florida.

The Pinellas Plant, which is owned by DOE and currently operated by Martin Marietta Specialty Components, began operation in 1957. It is located in central Pinellas County where over 800,000 individuals live within a 20-mile radius as of 1990. The plant employs about 1,100 workers and produces neutron generators and other application products for nuclear weapons (1). It released at least a cumulative total of 107,707 curies of radioactive materials from the plant stacks and a relatively small amount from waste water between 1957 and 1990 (2). Eighty-two percent of the stack releases occurred between 1957 and 1960. According to existing records, the main radioactive materials released were tritium gas and oxide, and krypton gas (3).

For a number of reasons, there has not been a systematic examination of the cancer incidence patterns since the facility began operation. Ideally, an analysis of complete cancer registry data before and after the facility began to operate would reflect any change of cancer incidence patterns in Pinellas County. Unfortunately, the cancer incidence data is not available before 1981, as Florida began its cancer registry effort in that year. Nevertheless, using the available incident cancer information and comparing this with data for the similar counties and for the entire state still can yield meaningful results.

SUBJECTS AND METHOD

The Florida Cancer Data System (FCDS) was used to identify both the study and comparison groups between 1981 and 1990. The FCDS is a complete registry of all cancers diagnosed or treated in Florida hospitals since 1981. It was established by law and funded by the state through an HRS contract with the University of Miami. The data items collected for the FCDS are compatible with national standards set by the Surveillance, Epidemiology and End Results reporting program (SEER), a project of the National Cancer Institute (NCI).

All unique incidence cancer cases from Pinellas County were included in the study group except cases with unknown race, gender, year of birth or with invalid year of birth. Two groups were selected as comparisons. One comparison group included incidence cancer cases from Broward and Duval counties (county reference). The two counties were similar to Pinellas County in population size, percentage change in population in age groups between 1980 and 1990, and coastline geographic position. The second comparison group included all cases from the State of Florida excluding Pinellas County (state reference). A total of 60,522 cases from Pinellas County were identified in the FCDS between 1981 and 1990.

Population data were obtained from the Governor's Office for both the study group and comparison groups (4). These data were estimated by the Florida Consensus Estimating Conference and their estimates are routinely used by most researchers and agencies in Florida. The total person-years for age-groups were obtained by summing the number of cases between 1981 and 1990 by race-gender groups.

Overall and thirty-eight cause-specific incidence rates for Pinellas County based on race and gender were compared to the corresponding incidence rates of the county reference and the state reference. For these comparisons, the Standardized Incidence Ratio (SIR) served as the measure of association. The SIR was calculated as the ratio of the observed number of cause-specific cases in Pinellas County to the expected number, multiplied by 100. The expected number was based on the cause-specific incidence rate in the comparison group, stratified by race (white or non-white), gender (male or female) and age (five-year group). The expected number was computed by multiplying the rates for each race-gender grouping and age-specific categories in the comparison group by the corresponding population categories in Pinellas County. The resulting quantities were summed over the stratifying factors to obtain the expected number. Ninety-five percent confidence interval (95% CI) for SIR was calculated under the assumption that the observed cancer incidence followed a Poisson distribution (5). A SIR is designated as statistically significant if the 95% CI does not include the null value of 100.

RESULTS

The population data, number of cases and crude cancer incidence rates for four race/gender groups in Pinellas County between 1981 and 1990 are listed in Table 1. The race/gender distribution was 42.2% white male and 49.3% white female. The

TABLE 1
PINELLAS COUNTY POPULATION AND CANCER INCIDENCE
1981-1990

Race and gender	Population (person/year)	Cancer cases	Crude incidence rate (1/100,000)
White male	3,408,034	29,277	859.05
White female	3,985,445	29,434	757.54
Nonwhite male	314,440	858	272.86
Nonwhite female	368,415	953	258.67
Total	8,076,334	60,522	749.37

Sources: Population information is from the Governor's Office of the state of Florida..
 Cancer incidence data is based on FCDS Commer8190.dat data file.

non-white group made up only 8.5% of the entire county population and had relatively low crude incidence rates.

Table 2 displays the overall and cause-specific number of cases, SIRs and their 95% CI among white males in Pinellas County compared with the state reference. The overall SIR was 107 (95% CI: 105-108), based on 29,277 observed cases. This indicates a 7% excess of overall cancer incidence among white males in Pinellas County between 1981 and 1990. Significantly increased SIRs were found for the following sites of cancer: lip, oral cavity and pharynx; colorectal; colon; rectum; lung and bronchus; melanoma of the skin; prostate; testes; and other leukemias. Significantly low SIRs were found for the following sites of cancer: liver; chronic myelocytic leukemia; and Kaposi's sarcoma. No other SIRs were significantly high or low.

Table 3 shows overall and cause-specific number of cases, SIRs and their 95% CI among white females in Pinellas County compared with the state reference. The overall SIR was 109 (95% CI: 108-110), based on 29,434 observed cases. This indicates a 9% excess of overall cancer incidence among white females in Pinellas County between 1981 and 1990. Significantly increased SIRs were found for the following sites of cancer: lip, oral cavity and pharynx; colorectal; colon; rectum; lung and bronchus; melanoma of the skin; female breast; cervix; ovary; urinary bladder; kidney and other urinary organs; and brain and other nervous system. Significantly low SIRs were found for liver and thyroid cancers. No other SIRs were significantly high or low.

Table 4 presents overall and cause-specific number of cases, SIRs and their 95% CI among non-white males in Pinellas County compared with the state reference.

TABLE 2
WHITE MALE STANDARDIZED INCIDENCE RATIOS FOR
CANCER IN PINELLAS COUNTY, 1981-1990
 (Reference group is the State of Florida except Pinellas County)

Primary site of cancer	Obs	SIR	95 % CI of SIR
All sites	29277	107	105 - 108
Lip, Oral Cavity & Pharynx	1031	113	106 - 120
Esophagus	354	111	100 - 123
Stomach	652	103	95 - 111
Colorectal	5081	113	109 - 116
Colon	3597	108	105 - 112
Rectum	1484	124	118 - 130
Liver	113	77	64 - 92
Pancreas	600	100	92 - 108
Nasal Cavities, Sinuses & Ear	72	126	99 - 157
Larynx	646	104	96 - 112
Lung & Bronchus	5593	104	101 - 106
Mesothelioma	99	107	87 - 129
Melanoma of the Skin	764	125	116 - 134
Prostate Gland	6984	111	108 - 113
Testes	164	124	106 - 144
Penis & Other Male Genitals	74	119	93 - 148
Urinary Bladder	2508	103	99 - 107
Kidney & Other Urinary Organs	782	102	95 - 109
Brain & Other Nervous System	348	103	92 - 114
Thyroid Gland	70	81	63 - 101
All Lymphomas	865	97	91 - 104
Hodgkin's Disease	122	115	96 - 137
Non-Hodgkin's Disease	743	95	88 - 101
Multiple Myeloma	258	96	85 - 109
All Leukemias	607	102	94 - 110
Acute Lymphocytic Leukemia	57	131	99 - 168
Chronic Lymphocytic Leukemia	212	102	89 - 117
Acute Myelocytic Leukemia	140	91	76 - 106
Chronic Myelocytic Leukemia	53	70	52 - 90
Other Leukemias	145	125	106 - 147
Kaposi's Sarcoma	65	55	43 - 69
Primary Brain Lymphoma	12	88	45 - 145
Other Sites	1547	102	97 - 107

* The analyses were based on FCDS Commer8190.dat data file.

** Obs: Observed cases.

*** SIR: Standardized Incidence Rate.

**** CI: Confidence Interval.

TABLE 3
WHITE FEMALE STANDARDIZED INCIDENCE RATIOS FOR
CANCER IN PINELLAS COUNTY, 1981-1990
 (Reference group is the State of Florida except Pinellas County)

Primary site of cancer	Obs	SIR	95 % CI of SIR
All sites	29434	109	108 - 110
Lip, Oral Cavity & Pharynx	640	117	108 - 126
Esophagus	164	107	91 - 124
Stomach	413	101	91 - 111
Colorectal	5074	115	112 - 118
Colon	3769	111	107 - 115
Rectum	1305	128	121 - 135
Liver	57	64	49 - 82
Pancreas	633	97	90 - 105
Nasal Cavities, Sinuses & Ear	45	106	77 - 139
Larynx	158	105	89 - 121
Lung & Bronchus	3482	106	103 - 110
Mesothelioma	17	67	39 - 103
Melanoma of the Skin	618	130	120 - 141
Female Breast	8183	109	107 - 112
Cervix Uteri	1579	121	115 - 127
Corpus Uteri	1571	105	100 - 110
Ovary	1180	112	106 - 119
Vagina	73	97	76 - 120
Urinary Bladder	942	118	110 - 126
Kidney & Other Urinary Organs	534	110	101 - 120
Brain & Other Nervous System	333	116	104 - 129
Thyroid Gland	160	77	65 - 89
All Lymphomas	888	100	93 - 107
Hodgkin's Disease	102	105	86 - 127
Non-Hodgkin's Disease	786	99	92 - 106
Multiple Myeloma	243	97	85 - 110
All Leukemias	488	105	95 - 114
Acute Lymphocytic Leukemia	40	119	85 - 159
Chronic Lymphocytic Leukemia	163	101	86 - 117
Acute Myelocytic Leukemia	133	106	89 - 125
Chronic Myelocytic Leukemia	63	106	81 - 133
Other Leukemias	89	103	83 - 125
Kaposi's Sarcoma	13	123	65 - 198
Primary Brain Lymphoma	7	71	28 - 134
Other Sites	1946	102	98 - 107

* The analyses were based on FCDS Commer8190.dat data file.

** Obs: Observed cases.

*** SIR: Standardized Incidence Rate.

**** CI: Confidence Interval.

TABLE 4
NON-WHITE MALE STANDARDIZED INCIDENCE RATIOS FOR
CANCER IN PINELLAS COUNTY, 1981-1990
 (Reference group is the State of Florida except Pinellas County)

Primary site of cancer	Obs	SIR	95% CI of SIR
All sites	858	105	98 - 112
Lip, Oral Cavity & Pharynx	44	96	70 - 126
Esophagus	40	129	92 - 172
Stomach	31	93	63 - 128
Colorectal	101	127	104 - 153
Colon	73	124	97 - 154
Rectum	28	136	90 - 191
Liver	9	96	44 - 170
Pancreas	30	145	98 - 202
Nasal Cavities, Sinuses & Ear	2	84	8 - 240
Larynx	31	141	95 - 195
Lung & Bronchus	202	102	88 - 116
Mesothelioma	0	0	0 - 98
Melanoma of the Skin	3	149	28 - 366
Prostate Gland	181	92	79 - 105
Testes	4	231	60 - 514
Penis & Other Male Genitals	2	47	4 - 135
Urinary Bladder	25	112	72 - 160
Kidney & Other Urinary Organs	24	139	89 - 200
Brain & Other Nervous System	14	139	76 - 221
Thyroid Gland	0	0	0 - 46
All Lymphomas	26	118	77 - 168
Hodgkin's Disease	3	56	11 - 137
Non-Hodgkin's Disease	23	138	87 - 200
Multiple Myeloma	14	91	50 - 145
All Leukemias	19	97	58 - 146
Acute Lymphocytic Leukemia	3	76	14 - 186
Chronic Lymphocytic Leukemia	5	96	30 - 198
Acute Myelocytic Leukemia	6	141	51 - 275
Chronic Myelocytic Leukemia	4	124	32 - 276
Other Leukemias	1	34	0 - 135
Kaposi's Sarcoma	3	37	7 - 92
Primary Brain Lymphoma	0	0	0 - 240
Other Sites	53	97	73 - 125

* The analyses were based on FCDS Commer8190.dat data file.

** Obs: Observed cases.

*** SIR: Standardized Incidence Rate.

**** CI: Confidence Interval.

The overall SIR was 105 (95% CI: 98-112), based on 858 observed cases.

Significantly increased SIRs were found for colorectal cancer. Significantly low SIRs were found for mesothelioma, thyroid cancer and Kaposi's sarcoma. No other SIRs were significantly high or low.

Table 5 provides overall and cause-specific number of cases, SIRs and their 95% CI among non-white females in Pinellas County compared with the state reference. The overall SIR was 112 (95% CI: 105-119), based on 953 observed cases. This indicates a 12% excess of overall cancer incidence among non-white females in Pinellas County between 1981 and 1990. Significantly increased SIRs were found for the following sites of cancer: colorectal, rectum, cervix, and vagina. A significantly low SIR was found for Kaposi's sarcoma. No other SIRs were significantly high or low.

Table 6 displays overall and cause-specific number of cases, SIRs and their 95% CI among white males in Pinellas County compared with the county reference. The overall SIR was 111 (95% CI: 110-112), based on 29,277 observed cases. This indicates an 11% excess of overall cancer incidence among white males in Pinellas County between 1981 and 1990. Significantly increased SIRs were found for the following sites of cancer: lip, oral cavity and pharynx; esophagus; colorectal; rectum; nasal cavities, sinuses and ear; lung and bronchus; melanoma of the skin; prostate; testes; penis and other male genitals; and other leukemias. Significantly low SIRs were found for the following sites of cancer: liver; thyroid; all lymphomas; non-Hodgkin's disease; chronic myelocytic leukemia; and Kaposi's sarcoma. No other SIRs were significantly high or low.

Table 7 shows overall and cause-specific number of cases, SIRs and their 95% CI among white females in Pinellas County compared with the county reference.

TABLE 5
NON-WHITE FEMALE STANDARDIZED INCIDENCE RATIOS FOR
CANCER IN PINELLAS COUNTY, 1981-1990
 (Reference group is the State of Florida except Pinellas County)

Primary site of cancer	Obs	SIR	95% CI of SIR
All sites	953	112	105 - 119
Lip, Oral Cavity & Pharynx	19	106	64 - 160
Esophagus	9	69	31 - 121
Stomach	17	76	44 - 116
Colorectal	132	129	108 - 152
Colon	98	121	98 - 146
Rectum	34	161	112 - 220
Liver	3	61	12 - 151
Pancreas	25	107	69 - 153
Nasal Cavities, Sinuses & Ear	1	63	0 - 248
Larynx	4	83	22 - 185
Lung & Bronchus	83	118	94 - 145
Mesothelioma	0	0	0 - 370
Melanoma of the Skin	1	46	0 - 180
Female Breast	228	108	95 - 123
Cervix Uteri	177	131	113 - 152
Corpus Uteri	45	118	86 - 155
Ovary	27	90	60 - 128
Vagina	12	233	120 - 383
Urinary Bladder	14	96	53 - 153
Kidney & Other Urinary Organs	15	98	55 - 154
Brain & Other Nervous System	6	83	23 - 124
Thyroid Gland	9	113	51 - 199
All Lymphomas	21	108	67 - 159
Hodgkin's Disease	5	125	39 - 258
Non-Hodgkin's Disease	16	104	59 - 161
Multiple Myeloma	14	82	45 - 131
All Leukemias	19	119	72 - 179
Acute Lymphocytic Leukemia	4	154	40 - 342
Chronic Lymphocytic Leukemia	4	125	32 - 276
Acute Myelocytic Leukemia	6	125	45 - 245
Chronic Myelocytic Leukemia	2	72	7 - 207
Other Leukemias	3	119	22 - 292
Kaposi's Sarcoma	0	0	0 - 27
Primary Brain Lymphoma	0	0	0 - 560
Other Sites	72	106	83 - 132

* The analyses were based on FCDS Commer8190.dat data file.

** Obs: Observed cases.

*** SIR: Standardized Incidence Rate.

**** CI: Confidence Interval.

TABLE 6
WHITE MALE STANDARDIZED INCIDENCE RATIOS FOR
CANCER IN PINELLAS COUNTY, 1981-1990
 (Reference group is Broward and Duval counties)

Primary site of cancer	Obs	SIR	95% CI of SIR
All sites	29277	111	110 - 112
Lip, Oral Cavity & Pharynx	1031	131	123 - 139
Esophagus	354	120	108 - 133
Stomach	652	104	96 - 112
Colorectal	5081	109	106 - 112
Colon	3597	102	99 - 106
Rectum	1484	128	122 - 135
Liver	113	74	61 - 88
Pancreas	600	97	89 - 105
Nasal Cavities, Sinuses & Ear	72	145	114 - 181
Larynx	646	104	96 - 112
Lung & Bronchus	5593	110	107 - 113
Mesothelioma	99	96	78 - 116
Melanoma of the Skin	764	123	114 - 132
Prostate Gland	6984	131	128 - 134
Testes	164	125	107 - 145
Penis & Other Male Genitals	74	150	118 - 187
Urinary Bladder	2508	101	97 - 105
Kidney & Other Urinary Organs	782	97	90 - 104
Brain & Other Nervous System	348	102	92 - 113
Thyroid Gland	70	78	61 - 98
All Lymphomas	865	92	86 - 98
Hodgkin's Disease	122	116	96 - 137
Non-Hodgkin's Disease	743	89	83 - 96
Multiple Myeloma	258	108	95 - 122
All Leukemias	607	105	97 - 114
Acute Lymphocytic Leukemia	57	127	97 - 162
Chronic Lymphocytic Leukemia	212	100	87 - 114
Acute Myelocytic Leukemia	140	100	84 - 117
Chronic Myelocytic Leukemia	53	72	54 - 93
Other Leukemias	145	139	117 - 162
Kaposi's Sarcoma	65	38	29 - 48
Primary Brain Lymphoma	12	93	48 - 152
Other Sites	1547	98	94 - 103

- The analyses were based on FCDS Commer8190.dat data file.
- ** Obs: Observed cases.
- *** SIR: Standardized Incidence Rate.
- **** CI: Confidence Interval.

TABLE 7
WHITE FEMALE STANDARDIZED INCIDENCE RATIOS FOR
CANCER IN PINELLAS COUNTY, 1981-1990
 (Reference group is Broward and Duval counties)

Primary site of cancer	Obs	SIR	95% CI of SIR
All sites	29434	107	106 - 108
Lip, Oral Cavity & Pharynx	640	119	110 - 128
Esophagus	164	103	88 - 120
Stomach	413	90	81 - 99
Colorectal	5074	113	110 - 116
Colon	3769	108	105 - 112
Rectum	1305	127	121 - 134
Liver	57	68	52 - 87
Pancreas	633	95	88 - 102
Nasal Cavities, Sinuses & Ear	45	130	95 - 170
Larynx	158	95	81 - 110
Lung & Bronchus	3482	98	95 - 101
Mesothelioma	17	60	35 - 93
Melanoma of the Skin	618	133	123 - 144
Female Breast	8183	107	105 - 110
Cervix Uteri	1579	136	129 - 142
Corpus Uteri	1571	106	101 - 111
Ovary	1180	108	102 - 114
Vagina	73	133	104 - 165
Urinary Bladder	942	101	95 - 108
Kidney & Other Urinary Organs	534	123	113 - 134
Brain & Other Nervous System	333	126	113 - 140
Thyroid Gland	160	71	61 - 83
All Lymphomas	888	96	90 - 102
Hodgkin's Disease	102	109	89 - 131
Non-Hodgkin's Disease	786	94	88 - 101
Multiple Myeloma	243	94	83 - 106
All Leukemias	488	104	95 - 113
Acute Lymphocytic Leukemia	40	107	76 - 143
Chronic Lymphocytic Leukemia	163	94	80 - 109
Acute Myelocytic Leukemia	133	102	86 - 120
Chronic Myelocytic Leukemia	63	132	101 - 167
Other Leukemias	89	110	88 - 134
Kaposi's Sarcoma	13	63	34 - 103
Primary Brain Lymphoma	7	61	24 - 115
Other Sites	1946	106	101 - 111

* The analyses were based on FCDS Commer8190.dat data file.

** Obs: Observed cases.

*** SIR: Standardized Incidence Rate.

**** CI: Confidence Interval.

The overall SIR was 107 (95% CI: 106-108), based on 29,434 observed cases. This indicates a 7% excess of overall cancer incidence among white females in Pinellas County between 1981 and 1990. Significantly increased SIRs were found for the following sites of cancer: lip, oral cavity and pharynx; colorectal; colon; rectum; melanoma of the skin; breast; cervix; corpus uteri; ovary; vagina; kidney and other urinary organs; brain and other nervous system; and chronic myelocytic leukemia. Significantly low SIRs were found for stomach, liver, mesothelioma and thyroid cancers. No other SIRs were significantly high or low.

Table 8 presents overall and cause-specific number of cases, SIRs and their 95% CI among non-white males in Pinellas County compared with the county reference. The overall SIR was 97 (95% CI: 91-104), based on 858 observed cases. This suggests that non-white men in Pinellas County had an overall cancer incidence rate that was identical to that of non-white men in Broward and Duval counties. Statistically low SIRs were found for the following sites of cancer: prostate; thyroid; all leukemia; and other leukemia. No other SIRs were significantly high or low.

Table 9 provides overall and cause-specific number of cases, SIRs and their 95% CI among non-white females in Pinellas County compared with the county reference. The overall SIR was 103 (95% CI: 97-110), based on 953 observed cases. This suggested that non-white women in Pinellas County had an overall cancer incidence rate that was identical to that of non-white women in Broward and Duval counties. Significantly increased SIRs were found for cancers of the rectum, cervix, and vagina. A significantly low SIR was found for Kaposi's sarcoma. No other SIRs were significantly high or low.

The summary of SIRs for four race/gender groups compared with the state reference is shown in Table 10. The overall cancer SIRs for all four groups were

TABLE 8
NON-WHITE MALE STANDARDIZED INCIDENCE RATIOS FOR
CANCER IN PINELLAS COUNTY, 1981-1990
 (Reference group is Broward and Duval counties)

Primary site of cancer	Obs	SIR	95% CI of SIR
All sites	858	97	91 - 104
Lip, Oral Cavity & Pharynx	44	106	77 - 140
Esophagus	40	104	74 - 139
Stomach	31	86	58 - 118
Colorectal	101	113	92 - 136
Colon	73	106	83 - 132
Rectum	28	134	89 - 188
Liver	9	97	44 - 171
Pancreas	30	119	81 - 166
Nasal Cavities, Sinuses & Ear	2	71	7 - 205
Larynx	31	120	82 - 166
Lung & Bronchus	202	95	82 - 108
Mesothelioma	0	0	0 - 108
Melanoma of the Skin	3	204	38 - 499
Prostate Gland	181	83	71 - 95
Testes	4	199	52 - 442
Penis & Other Male Genitals	2	65	6 - 186
Urinary Bladder	25	104	67 - 148
Kidney & Other Urinary Organs	24	139	89 - 200
Brain & Other Nervous System	14	124	68 - 198
Thyroid Gland	0	0	0 - 38
All Lymphomas	26	135	88 - 192
Hodgkin's Disease	3	66	13 - 163
Non-Hodgkin's Disease	23	156	98 - 226
Multiple Myeloma	14	81	44 - 128
All Leukemias	19	66	40 - 99
Acute Lymphocytic Leukemia	3	44	8 - 109
Chronic Lymphocytic Leukemia	5	68	22 - 141
Acute Myelocytic Leukemia	6	115	42 - 226
Chronic Myelocytic Leukemia	4	79	21 - 176
Other Leukemias	1	23	0 - 92
Kaposi's Sarcoma	3	57	11 - 140
Primary Brain Lymphoma	0	.	-
Other Sites	53	113	85 - 146

* The analyses were based on FCDS Commer8190.dat data file.

** Obs: Observed cases.

*** SIR: Standardized Incidence Rate.

**** CI: Confidence Interval.

TABLE 9
NON-WHITE FEMALE STANDARDIZED INCIDENCE RATIOS FOR
CANCER IN PINELLAS COUNTY, 1981-1990
 (Reference group is Broward and Duval counties)

Primary site of cancer	Obs	SIR	95% CI of SIR
All sites	953	103	97 - 110
Lip, Oral Cavity & Pharynx	19	110	66 - 165
Esophagus	9	74	34 - 130
Stomach	17	75	43 - 114
Colorectal	132	118	99 - 139
Colon	98	108	88 - 131
Rectum	34	157	109 - 215
Liver	3	44	8 - 108
Pancreas	25	98	63 - 140
Nasal Cavities, Sinuses & Ear	1	59	0 - 230
Larynx	4	104	27 - 231
Lung & Bronchus	83	109	87 - 134
Mesothelioma	0	.	.
Melanoma of the Skin	1	40	0 - 157
Female Breast	228	100	87 - 113
Cervix Uteri	177	127	109 - 147
Corpus Uteri	45	113	82 - 148
Ovary	27	88	58 - 124
Vagina	12	276	142 - 454
Urinary Bladder	14	75	41 - 120
Kidney & Other Urinary Organs	15	95	53 - 149
Brain & Other Nervous System	6	60	21 - 117
Thyroid Gland	9	78	36 - 138
All Lymphomas	21	92	57 - 135
Hodgkin's Disease	5	102	32 - 210
Non-Hodgkin's Disease	16	89	51 - 138
Multiple Myeloma	14	68	37 - 108
All Leukemias	19	90	54 - 135
Acute Lymphocytic Leukemia	4	151	31 - 269
Chronic Lymphocytic Leukemia	4	103	27 - 228
Acute Myelocytic Leukemia	6	87	31 - 171
Chronic Myelocytic Leukemia	2	60	6 - 172
Other Leukemias	3	81	15 - 198
Kaposi's Sarcoma	0	0	0 - 64
Primary Brain Lymphoma	0	0	0 - 397
Other Sites	72	92	72 - 115

* The analyses were based on FCDS Commer8190.dat data file.

** Obs: Observed cases.

*** SIR: Standardized Incidence Rate.

**** CI: Confidence Interval.

TABLE 10
SUMMARY OF STANDARDIZED INCIDENCE RATIOS FOR
CANCER IN PINELLAS COUNTY, 1981-1990
(Reference group is the State of Florida except Pinellas County)

Primary site of cancer	STANDARDIZED INCIDENCE RATIOS			
	WM	WF	NWM	NWF
All sites	107*	109*	105	112*
Lip, Oral Cavity & Pharynx	113*	117*	96	106
Esophagus	111	107	129	69
Stomach	103	101	93	76
Colorectal	113*	115*	127*	129*
Colon	108*	111*	124	121
Rectum	124*	128*	136	161*
Liver	77*	64*	96	61
Pancreas	100	97	145	107
Nasal Cavities, Sinuses & Ear	126	106	84	63
Larynx	104	105	141	83
Lung & Bronchus	104*	106*	102	118
Mesothelioma	107	67	0*	0
Melanoma of the Skin	125*	130*	149	46
Female Breast	N/A	109*	N/A	108
Cervix Uteri	N/A	121*	N/A	131*
Corpus Uteri	N/A	105	N/A	118
Ovary	N/A	112*	N/A	90
Vagina	N/A	97	N/A	233*
Prostate Gland	111*	N/A	92	N/A
Testes	124*	N/A	231	N/A
Penis & Other Male Genitals	119	N/A	47	N/A
Urinary Bladder	103	118*	112	96
Kidney & Other Urinary Organs	102	110*	139	98
Brain & Other Nervous system	103	116*	139	63
Thyroid Gland	81	77*	0*	113
All Lymphomas	97	100	118	108
Hodgkin's Disease	115	105	56	125
Non-Hodgkin's Disease	95	99	138	104
Multiple Myeloma	96	97	91	82
All Leukemias	102	105	97	119
Acute Lymphocytic Leukemia	131	119	76	154
Chronic Lymphocytic Leukemia	102	101	96	125
Acute Myelocytic Leukemia	91	106	141	125
Chronic Myelocytic Leukemia	70*	106	124	72
Other Leukemias	125*	103	34	119
Kaposi's Sarcoma	55*	123	37*	0*
Primary Brain Lymphoma	88	71	0	0
Other Sites	102	102	97	106

1) The analyses were based on FCDS Commer8190.dat data file.

2) *: statistically significant ($P < .05$).

elevated, ranging from 105 to 112, with statistical significance found for non-white females, white males and white females. This suggests that a general increase of cancer incidence existed in the Pinellas County general population from 1981 to 1990. Among the various cause-specific cancers, colorectal, colon, rectum, lung and bronchus cancers were elevated. Liver, multiple myeloma, and primary brain lymphoma were decreased among all four groups. Within genders, the cancers of the female breast, cervix and corpus uteri were elevated for women, and testicular cancer was elevated for men.

The summary of SIRs for four race-gender groups compared with the county reference group is listed in Table 11. Total cancer SIRs for white male and white female groups were statistically elevated, ranging from 107 to 111. These increases were not found in the non-white groups. Statistically significant elevations were found for various cause-specific cancers: lip, oral cavity and pharynx; colorectal; colon; and rectal cancer. Cancers of the liver, mesothelioma, thyroid and Kaposi's sarcoma were decreased for all four groups. Among women, elevations were found for cancers of the cervix, corpus uteri and vagina. Testicular cancer was raised for men.

DISCUSSION

In this study, we found a slight increase of overall cancer incidence in the general population in Pinellas County compared with the entire state from 1981 to 1990. This increase was also found among white male and white female groups compared with the reference counties. The results were somewhat unusual since very few similar studies have yielded positive results of overall cancer increase at the county level. Jablon et al. (6) examined cancer mortality data and some incidence rates for twelve DOE facilities and fifty-two commercial nuclear installations in 1990. Overall, they have found that nuclear facilities have not caused any cancer deaths in

TABLE 11
SUMMARY OF STANDARDIZED INCIDENCE RATIOS FOR
CANCER IN PINELLAS COUNTY, 1981-1990
(Reference group is Broward and Duval counties)

Primary site of cancer	STANDARDIZED INCIDENCE RATIOS			
	WM	WF	NWM	NWF
All sites	111*	107*	97	103
Lip, Oral Cavity & Pharynx	131*	119*	106	110
Esophagus	120*	103	104	74
Stomach	104	90*	86	75
Colorectal	109*	113*	113	118
Colon	102	108*	106	108
Rectum	128*	127*	134	157*
Liver	74*	68*	97	44
Pancreas	97	95	119	98
Nasal Cavities, Sinuses & Ear	145*	130	71	59
Larynx	104	95	120	104
Lung & Bronchus	110*	98	95	109
Mesothelioma	96	60*	0	.
Melanoma of the Skin	123*	133*	204	40
Female Breast	N/A	107*	N/A	100
Cervix Uteri	N/A	136*	N/A	127*
Corpus Uteri	N/A	106*	N/A	113
Ovary	N/A	108*	N/A	88
Vagina	N/A	133*	N/A	276*
Prostate Gland	131*	N/A	83*	N/A
Testes	125*	N/A	199	N/A
Penis & Other Male Genitals	150*	N/A	65	N/A
Urinary Bladder	101	101	104	75
Kidney & Other Urinary Organs	97	123*	139	95
Brain & Other Nervous system	102	126*	124	60
Thyroid Gland	78*	71*	0*	78
All Lymphomas	92*	96	135	92
Hodgkin's Disease	116	109	66	102
Non-Hodgkin's Disease	89*	94	156	89
Multiple Myeloma	108	94	81	68
All Leukemias	105	104	66*	90
Acute Lymphocytic Leukemia	127	107	44	121
Chronic Lymphocytic Leukemia	100	94	68	103
Acute Myelocytic Leukemia	100	102	115	87
Chronic Myelocytic Leukemia	72*	132*	79	60
Other Leukemias	139*	110	23*	81
Kaposi's Sarcoma	38*	63	57	0*
Primary Brain Lymphoma	93	61	.	0
Other Sites	98	106*	113	92

1) The analyses were based on FCDS Commer8190.dat data file.

2) *: statistically significant ($P < .05$).

persons living near them. They conclude that if nuclear facilities pose a risk to neighboring populations, that risk is too small to be detected.

It is of interest to examine the cause-specific cancer incidence patterns. For most of the hormonally dependent cancers (female breast, cervix, corpus uteri, vagina, prostate, testes, penis and other male genitals), the incidence rates were elevated. These results were particularly reliable in the white groups due to their large population. These excesses have been observed in other studies (7-9).

For the bone marrow cancers, the most frequently mentioned cancers in epidemiological studies on radiation exposure, the incidence rates were close to that of reference groups. This is reasonable because studies suggest that this group of cancers has a relatively short latent period. The atomic bomb study states that an increased risk was apparent 1 to 3 years after August 1945, reached a peak about 6 to 7 years after the bombing, and has since declined steadily (10). In our study, the earliest cancer incidence information was more than 20 years after 82% of the radionuclide waste was released from the plant stacks. In other words, most of the release occurred in the late 1950's and our earliest incidence of cancer in the FCDS was in 1981, a latency of 20 years.

The most unexpected result is the deficit of thyroid cancer among the general population in Pinellas County. Many epidemiological studies have shown a positive relation between radioactive exposure and thyroid cancer (9,11). In our study, the SIRs of thyroid cancer were generally lower except for non-white females (113, 95% CI: 51-199) compared with the state reference. The reason for the deficit is unknown, but this phenomenon is quite unlikely to be a benefit of radioactive exposure. Research also suggests that thyroid cancer is specifically related to radioactive iodine exposure (9). According to our study, radioactive iodine has not been used in the Pinellas Plant.

The main strength of this study derives from its large size, especially among the white male and female groups. Because of this, we were able to detect small differences in cancer incidence. Furthermore, we could conduct detailed analyses of incidence patterns for many cause-specific cancers as well as for overall cancer. Another strength of this study is the use of incidence information instead of mortality information. This is very important since a reduction in mortality rate may not necessarily reflect the environmental exposure but may, instead, reflect improvements in medical technology. In addition, the earliest time that incidence data were used in this study was 24 years after the plant began to operate. This has the benefit of observing cancers with a long latent period. The atomic bomb study demonstrated that for all cancers except leukemia, a significant excess risk was apparent until after 1961. Shimizu et al. postulate that radiation only induces the first mutational step in transformation of a normal cell to a malignant one. It does not shorten the latent period for cancer incidence (10).

This study also has some potentially important limitations. First, the incidence data were incomplete. The first 25 years of cancer incidence data were not available. For some cancers with a short latent period, it is possible that the peak incidence years were missed. For example, the latent period for leukemia is about 5 to 7 years. If the early years' release from the plant elevated the incidence of leukemia, the peak incidence would have been in the 1960's. This study is not able to reflect incidence patterns of cancer in those early years. Also, as the incidence data before the plant started were not available, we could not compare the incidence rates before and after the plant started.

Secondly, the population of Pinellas County has changed dramatically since 1956. In 1956, the population of Pinellas County was about 264,602. In 1990, the population of the county was 864,428, an increase of 3.3 times. It is possible that the

risks of radiation exposure were underestimated because of these unstable population changes.

Another limitation of the study is the lack of environmental monitoring information. Because of this, we cannot analyze the data by dose exposure categories. It is also possible that by including the entire county we have mixed a heavily exposed population with a low or nonexposed population. Thus, the result may represent the mixture of underestimating the risks of a heavily exposed population and overestimating the risks of a low or nonexposed population. There is the additional possibility that other industrial contamination might effect the cancer incidence patterns in Pinellas County. Due to the scope of this study, it was not possible to collect these data. It was also not possible to get the information on socioeconomic status, smoking habits and resident history. All these variables could affect the results of our study.

Because of the nature of statistical tests, some of the above results may be due to chance. Those SIRs which were consistently elevated for both comparison groups and among all races and genders (where appropriate) are the least likely to be chance associations. These consistently elevated cancers are colorectal cancer including colon cancer and rectal cancer separately, female breast cancer, cervix uteri cancer, and testicular cancer in their gender groups.

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APPENDIX 6

STANDARDIZED MORTALITY RATIO TABLES

**STANDARDIZED MORTALITY RATIOS FOR CANCERS
IN PINELLAS COUNTY WHITE MALE, 1990**
(Reference group is Broward and Duval counties)

Primary site of cancer	Obs	SMR	95% CI of SMR
All sites	1480	99	94 - 104
Lip, Oral Cavity & Pharynx	29	79	53 - 111
Esophagus	44	152	111 - 201
Stomach	40	75	53 - 100
Colorectal	187	114	98 - 131
Colon	165	118	101 - 137
Rectum	22	89	56 - 131
Liver	10	86	41 - 147
Pancreas	77	96	76 - 118
Nasal Cavities, Sinuses & Ear	2	134	13 - 384
Larynx	19	111	67 - 167
Lung & Bronchus	503	101	93 - 110
Prostate Gland	208	94	82 - 107
Testes	1	118	0 - 462
Penis & Other Male Genitals	0	0	0 - 62
Urinary Bladder	44	92	67 - 121
Kidney & Other Urinary Organs	36	119	83 - 161
Brain & Other Nervous system	38	102	72 - 137
Thyroid Gland	2	67	6 - 192
All Lymphomas	42	68	49 - 90
Hodgkin's Disease	1	28	0 - 111
Non-Hodgkin's Disease	41	70	50 - 93
Multiple Myeloma	16	86	49 - 134
All Leukemias	52	132	99 - 170
Other Sites	130	87	73 - 103

* The analyses were based on computerized data base from the Office of Vital Statistics, Florida.

** Obs: Observed cases.

*** SMR: Standardized Mortality Rate.

**** CI: Confidence Interval.

**STANDARDIZED MORTALITY RATIOS FOR CANCERS
IN PINELLAS COUNTY WHITE MALE, 1985**
(Reference group is Broward and Duval counties)

Primary site of cancer	Obs	SMR	95% CI of SMR
All sites	1380	96	91 - 101
Lip, Oral Cavity & Pharynx	41	142	102 - 188
Esophagus	24	68	43 - 98
Stomach	45	97	71 - 128
Colorectal	191	102	88 - 117
Colon	156	98	83 - 114
Rectum	35	127	88 - 172
Liver	9	106	48 - 186
Pancreas	52	70	52 - 90
Nasal Cavities, Sinuses & Ear	1	156	0 - 613
Larynx	16	87	49 - 134
Lung & Bronchus	500	105	96 - 115
Prostate Gland	149	90	76 - 106
Testes	0	0	0 - 63
Penis & Other Male Genitals	3	113	21 - 277
Urinary Bladder	33	66	46 - 91
Kidney & Other Urinary Organs	32	93	63 - 127
Brain & Other Nervous system	23	82	52 - 119
Thyroid Gland	1	39	0 - 152
All Lymphomas	54	108	81 - 139
Hodgkin's Disease	5	167	53 - 345
Non-Hodgkin's Disease	49	105	77 - 136
Multiple Myeloma	18	91	54 - 138
All Leukemias	42	83	60 - 110
Other Sites	146	92	78 - 108

- * The analyses were based on computerized data base from the Office of Vital Statistics, Florida.
 ** Obs: Observed cases.
 *** SMR: Standardized Mortality Rate.
 **** CI: Confidence Interval.

**STANDARDIZED MORTALITY RATIOS FOR CANCERS
IN PINELLAS COUNTY WHITE MALE, 1980**
(Reference group is Broward and Duval counties)

Primary site of cancer	Obs	SMR	95% CI of SMR
All sites	1320	94	89 - 99
Lip, Oral Cavity & Pharynx	29	97	65 - 136
Esophagus	24	83	53 - 119
Stomach	44	73	53 - 96
Colorectal	187	101	87 - 116
Colon	156	96	82 - 112
Rectum	31	134	91 - 185
Liver	9	111	50 - 195
Pancreas	65	89	69 - 112
Nasal Cavities, Sinuses & Ear	0	0	0 - 65
Larynx	15	77	43 - 120
Lung & Bronchus	433	95	86 - 104
Prostate Gland	152	95	81 - 111
Testes	1	33	0 - 130
Penis & Other Male Genitals	0	0	0 - 90
Urinary Bladder	48	82	60 - 107
Kidney & Other Urinary Organs	32	128	88 - 177
Brain & Other Nervous system	23	61	39 - 88
Thyroid Gland	1	41	0 - 162
All Lymphomas	34	83	57 - 113
Hodgkin's Disease	2	33	3 - 95
Non-Hodgkin's Disease	32	91	62 - 126
Multiple Myeloma	23	112	71 - 162
All Leukemias	48	103	76 - 134
Other Sites	152	106	89 - 123

* The analyses were based on computerized data base from the Office of Vital Statistics, Florida.

** Obs: Observed cases.

*** SMR: Standardized Mortality Rate.

**** CI: Confidence Interval.

**STANDARDIZED MORTALITY RATIOS FOR CANCERS
IN PINELLAS COUNTY WHITE MALE, 1975**
(Reference group is Broward and Duval counties)

Primary site of cancer	Obs	SMR	95% CI of SMR
All sites	1163	95	90 - 101
Lip, Oral Cavity & Pharynx	34	130	90 - 178
Esophagus	20	73	44 - 108
Stomach	51	89	66 - 115
Colorectal	178	119	102 - 137
Colon	134	109	91 - 128
Rectum	44	169	123 - 222
Liver	10	80	38 - 137
Pancreas	65	92	71 - 116
Nasal Cavities, Sinuses & Ear	0	0	0 - 28
Larynx	14	83	45 - 132
Lung & Bronchus	361	92	83 - 102
Prostate Gland	112	79	65 - 95
Testes	8	398	170 - 721
Penis & Other Male Genitals	1	--	-- --
Urinary Bladder	40	69	49 - 92
Kidney & Other Urinary Organs	29	111	75 - 156
Brain & Other Nervous system	25	125	81 - 179
Thyroid Gland	2	153	14 - 438
All Lymphomas	33	80	55 - 110
Hodgkin's Disease	5	93	29 - 191
Non-Hodgkin's Disease	28	78	52 - 110
Multiple Myeloma	14	82	45 - 131
All Leukemias	50	104	77 - 135
Other Sites	116	107	88 - 127

* The analyses were based on computerized data base from the Office of Vital Statistics, Florida.

** Obs: Observed cases.

*** SMR: Standardized Mortality Rate.

**** CI: Confidence Interval.

**STANDARDIZED MORTALITY RATIOS FOR CANCERS
IN PINELLAS COUNTY WHITE MALE, 1970**
(Reference group is Broward and Duval counties)

Primary site of cancer	Obs	SMR	95% CI of SMR
All sites	1019	102	96 - 108
Lip, Oral Cavity & Pharynx	24	92	59 - 133
Esophagus	17	111	65 - 170
Stomach	44	98	71 - 129
Colorectal	138	107	89 - 125
Colon	117	115	95 - 136
Rectum	21	76	47 - 112
Liver	6	65	24 - 128
Pancreas	58	90	68 - 114
Nasal Cavities, Sinuses & Ear	3	140	26 - 344
Larynx	16	96	55 - 149
Lung & Bronchus	329	102	92 - 114
Prostate Gland	102	106	87 - 128
Testes	0	0	0 - 296
Penis & Other Male Genitals	1	55	0 - 215
Urinary Bladder	48	122	90 - 159
Kidney & Other Urinary Organs	21	88	55 - 130
Brain & Other Nervous system	29	150	100 - 210
Thyroid Gland	2	136	13 - 391
All Lymphomas	35	136	94 - 184
Hodgkin's Disease	6	366	132 - 717
Non-Hodgkin's Disease	29	120	80 - 167
Multiple Myeloma	15	122	68 - 192
All Leukemias	49	171	127 - 222
Other Sites	82	69	55 - 85

* The analyses were based on computerized data base from the Office of Vital Statistics, Florida.

** Obs: Observed cases.

*** SMR: Standardized Mortality Rate.

**** CI: Confidence Interval.

**STANDARDIZED MORTALITY RATIOS FOR CANCERS
IN PINELLAS COUNTY WHITE FEMALE, 1990**
(Reference group is Broward and Duval counties)

Primary site of cancer	Obs	SMR	95% CI of SMR
All sites	1262	92	87 - 97
Lip, Oral Cavity & Pharynx	16	84	48 - 130
Esophagus	16	112	64 - 173
Stomach	31	78	53 - 108
Colorectal	164	104	89 - 121
Colon	145	103	87 - 121
Rectum	19	113	68 - 170
Liver	4	74	19 - 164
Pancreas	69	96	75 - 120
Nasal Cavities, Sinuses & Ear	0	0	0 - 28
Larynx	5	70	22 - 145
Lung & Bronchus	324	90	81 - 101
Female Breast	202	89	77 - 102
Cervix Uteri	16	85	48 - 132
Corpus Uteri	11	71	35 - 119
Ovary	75	99	78 - 123
Vagina	2	114	11 - 326
Urinary Bladder	18	72	42 - 108
Kidney & Other Urinary Organs	23	102	64 - 147
Brain & Other Nervous system	32	117	80 - 162
Thyroid Gland	2	43	4 - 122
All Lymphomas	54	83	62 - 107
Hodgkin's Disease	5	103	33 - 214
Non-Hodgkin's Disease	49	81	60 - 106
Multiple Myeloma	21	101	63 - 149
All Leukemias	44	100	72 - 131
Other Sites	133	86	72 - 101

* The analyses were based on computerized data base from the Office of Vital Statistics, Florida.

** Obs: Observed cases.

*** SMR: Standardized Mortality Rate.

**** CI: Confidence Interval.

**STANDARDIZED MORTALITY RATIOS FOR CANCERS
IN PINELLAS COUNTY WHITE FEMALE, 1985**
(Reference group is Broward and Duval counties)

Primary site of cancer	Obs	SMR	95% CI of SMR
All sites	1132	88	83 - 93
Lip, Oral Cavity & Pharynx	14	61	33 - 97
Esophagus	9	72	33 - 127
Stomach	23	61	39 - 89
Colorectal	175	100	86 - 116
Colon	148	98	83 - 114
Rectum	27	118	78 - 167
Liver	3	36	7 - 88
Pancreas	72	120	94 - 149
Nasal Cavities, Sinuses & Ear	1	155	0 - 607
Larynx	0	0	0 - 29
Lung & Bronchus	220	71	62 - 81
Female Breast	196	90	78 - 103
Cervix Uteri	19	140	84 - 210
Corpus Uteri	14	87	47 - 139
Ovary	82	120	96 - 148
Vagina	3	189	36 - 464
Urinary Bladder	22	94	59 - 138
Kidney & Other Urinary Organs	18	95	56 - 145
Brain & Other Nervous system	29	111	74 - 155
Thyroid Gland	4	121	32 - 269
All Lymphomas	41	73	53 - 98
Hodgkin's Disease	4	145	38 - 322
Non-Hodgkin's Disease	37	70	49 - 94
Multiple Myeloma	17	173	101 - 265
All Leukemias	38	104	74 - 140
Other Sites	132	81	67 - 95

* The analyses were based on computerized data base from the Office of Vital Statistics, Florida.

** Obs: Observed cases.

*** SMR: Standardized Mortality Rate.

**** CI: Confidence Interval.

**STANDARDIZED MORTALITY RATIOS FOR CANCERS
IN PINELLAS COUNTY WHITE FEMALE, 1980**
(Reference group is Broward and Duval counties)

Primary site of cancer	Obs	SMR	95% CI of SMR
All sites	1093	95	90 - 101
Lip, Oral Cavity & Pharynx	20	238	145 - 354
Esophagus	11	82	41 - 137
Stomach	35	100	69 - 135
Colorectal	203	119	103 - 136
Colon	175	120	103 - 139
Rectum	28	114	76 - 160
Liver	3	41	8 - 101
Pancreas	60	86	65 - 109
Nasal Cavities, Sinuses & Ear	2	232	22 - 665
Larynx	4	87	23 - 192
Lung & Bronchus	190	93	80 - 106
Female Breast	174	85	73 - 98
Cervix Uteri	18	104	61 - 158
Corpus Uteri	12	72	37 - 119
Ovary	70	117	91 - 145
Vagina	1	58	0 - 228
Urinary Bladder	22	92	58 - 135
Kidney & Other Urinary Organs	17	83	48 - 126
Brain & Other Nervous system	35	160	112 - 218
Thyroid Gland	4	144	37 - 319
All Lymphomas	37	103	72 - 139
Hodgkin's Disease	11	263	131 - 441
Non-Hodgkin's Disease	26	82	53 - 116
Multiple Myeloma	12	55	28 - 91
All Leukemias	42	97	70 - 128
Other Sites	121	74	62 - 88

* The analyses were based on computerized data base from the Office of Vital Statistics, Florida.

** Obs: Observed cases.

*** SMR: Standardized Mortality Rate.

**** CI: Confidence Interval.

**STANDARDIZED MORTALITY RATIOS FOR CANCERS
IN PINELLAS COUNTY WHITE FEMALE, 1975**
(Reference group is Broward and Duval counties)

Primary site of cancer	Obs	SMR	95% CI of SMR
All sites	846	87	81 - 93
Lip, Oral Cavity & Pharynx	21	159	98 - 234
Esophagus	15	151	85 - 238
Stomach	20	46	28 - 69
Colorectal	136	84	71 - 99
Colon	114	83	69 - 99
Rectum	22	92	58 - 135
Liver	3	65	12 - 159
Pancreas	48	73	54 - 95
Nasal Cavities, Sinuses & Ear	1	—	— —
Larynx	1	20	0 - 78
Lung & Bronchus	109	81	66 - 96
Female Breast	158	104	88 - 121
Cervix Uteri	19	104	63 - 156
Corpus Uteri	12	101	52 - 167
Ovary	63	91	70 - 114
Vagina	1	81	0 - 316
Urinary Bladder	22	131	82 - 192
Kidney & Other Urinary Organs	10	78	37 - 134
Brain & Other Nervous system	19	76	45 - 113
Thyroid Gland	5	81	25 - 167
All Lymphomas	25	82	53 - 118
Hodgkin's Disease	3	170	32 - 416
Non-Hodgkin's Disease	22	77	48 - 112
Multiple Myeloma	14	156	85 - 249
All Leukemias	36	100	70 - 136
Other Sites	108	76	62 - 91

* The analyses were based on computerized data base from the Office of Vital Statistics, Florida.

** Obs: Observed cases.

*** SMR: Standardized Mortality Rate.

**** CI: Confidence Interval.

**STANDARDIZED MORTALITY RATIOS FOR CANCERS
IN PINELLAS COUNTY WHITE FEMALE, 1970**
(Reference group is Broward and Duval counties)

Primary site of cancer	Obs	SMR	95% CI of SMR
All sites	673	86	80 - 93
Lip, Oral Cavity & Pharynx	19	115	69 - 172
Esophagus	4	55	14 - 121
Stomach	21	52	32 - 76
Colorectal	125	103	86 - 122
Colon	107	102	84 - 122
Rectum	18	112	66 - 169
Liver	2	42	4 - 121
Pancreas	49	114	84 - 148
Nasal Cavities, Sinuses & Ear	0	0	0 - 24
Larynx	6	129	47 - 254
Lung & Bronchus	66	96	74 - 120
Female Breast	108	70	58 - 84
Cervix Uteri	25	101	65 - 144
Corpus Uteri	8	62	27 - 113
Ovary	49	122	90 - 159
Vagina	4	196	51 - 435
Urinary Bladder	13	60	32 - 97
Kidney & Other Urinary Organs	15	98	55 - 153
Brain & Other Nervous system	7	52	21 - 98
Thyroid Gland	4	166	43 - 369
All Lymphomas	31	83	56 - 115
Hodgkin's Disease	9	147	67 - 258
Non-Hodgkin's Disease	22	71	44 - 103
Multiple Myeloma	8	116	49 - 210
All Leukemias	25	77	50 - 110
Other Sites	84	80	64 - 99

* The analyses were based on computerized data base from the Office of Vital Statistics, Florida.

** Obs: Observed cases.

*** SMR: Standardized Mortality Rate.

**** CI: Confidence Interval.

APPENDIX 7

**RADIOACTIVE MEASUREMENTS OF PINELLAS COUNTY
WATER SOURCES**

Pinellas County Water System
October, 1993

PINELLAS COUNTY WATER SOURCES RADIOACTIVITY MEASUREMENTS								
Units = pCi/L		Radium		Total		Radon		
	Date	226	228	Alpha	Beta	222	Tritium	Strontium
Keller 1	04-07-76			<2				
	06-05-79			1.1	<0.1		<100	<0.5
	02-05-82			3.0	0.2		0	<2.0
Composite	03-10-83			2.7	0.6		<100	<2.0
Composite	06-05-84			0.2	0.3		0	<0.3
	05-04-88			1.9	<0.5			
	08-17-88					120		
	09-15-88					230		
	11-16-88			<0.5	14			
	02-08-89			5.1	25			
	04-06-89			<0.5	14			
	11-27-90			0.5	1.4			
	02-25-91			0.9	0.6			
	05-14-91			1.0	3.9			
	08-20-91			3.4	1.3			
	11-05-91			1.8	3.5			
	02-17-92			2.4	3.2			
	11-06-92			<1.0	<1.2			

PINELLAS COUNTY WATER SOURCES RADIOACTIVITY MEASUREMENTS								
Units = pCi/L		Radium		Total		Radon		
	Date	226	228	Alpha	Beta	222	Tritium	Strontium
Keller 2	04-07-76			<2				
	06-05-79			0.5	1.0		500	<0.5
	02-05-82			0.8	0.1		0	<2.0
Composite	03-10-83			1.1	0.2		<100	<2.0
Composite	06-05-84			0.3	4.7		0	0.5
	05-04-88			<0.5	<0.5			
	08-17-88					91		
	09-15-88					82		
	11-16-88			<0.5	10			
	02-08-89			1.2	22			
	04-06-89			<0.5	10			
	11-27-90			<0.5	<0.5			
	02-25-91			0.5	<0.5			
	05-14-91			3.7	3.2			
	08-20-91			1.6	2.1			
	11-05-91			3.2	<0.5			
	02-17-92			<0.5	2.6			
	11-06-92			<0.8	2.6			
	05-27-93			3.8	4.1			
	07-13-93	0.8	0.0	1.1				

PINELLAS COUNTY WATER SOURCES RADIOACTIVITY MEASUREMENTS								
Units = pCi/L		Radium		Total		Radon		
	Date	226	228	Alpha	Beta	222	Tritium	Strontium
Cypress Composite Composite	02-05-82			0.8	4.4		0	<2.0
	03-10-83			1.1	2.6		<100	<2.0
	06-05-84			0.6	1.6		0	<0.3
	05-04-88			0.7	<0.5			
	09-15-88					140		
	11-16-88			<0.5	<0.5			
	02-08-89			<0.5	3.1			
	04-06-89			<0.5	<0.5			
	11-27-90			1.5	3.0			
	03-12-91			1.6	1.4			
	05-14-91			1.0	<0.5			
	08-20-91			1.7	1.1			
	11-05-91			2.8	2.6			
	02-17-92			1.9	1.6			
	11-06-92			2.8	2.8			
	05-27-93			0.6	1.9			
	07-13-93	0.9	0.0	0.5				
	07-13-93	1.1	0.0	1.1				
East Lake	04-07-76			<2				
	05-04-88			1.2	<0.5			
	11-16-88			<0.5	7.9			
	02-08-89			2.8	6.3			
	04-06-89			<0.5	7.9			
	03-21-91			0.9	2.2			
EWPW Composite Composite								
	02-12-79	0.5	<0.5	1.6	<0.1	<100	<1.0	
	06-27-80			0.8	3.6	<200	<0.5	

PINELLAS COUNTY WATER SOURCES RADIOACTIVITY MEASUREMENTS

Site	Radon 222 (pCi/L)	Date
Kel 1 Influent	430	08-17-88
•	400	09-15-88
Kel 2 Influent	250	08-17-88
•	150	09-15-88
TS-M/Camelia	130	09-15-88
Dunedin-M/Evans	170	09-15-88
Clw-M/Bellair	85	09-15-88
SP-M/Carillion	58	09-15-88
PP-M/Park	110	09-15-88
Capri Influent	170	09-15-88
Ft. DeSoto	31	09-15-88
EWPW 1	620	03-15-88
EWPW 101	190	12-14-88
EWPW 102	210	12-14-88
EWPW 103	220	06-05-88
EWPW 103	110	12-14-88
EWPW 104	270	06-15-88
EWPW 105	<73	06-15-88
EWPW 106	<74	06-15-88
EWPW 107	260	08-17-88
EWPW 109	100	08-17-88
EWPW 10A	160	06-15-88
EWPW 10A	210	12-14-88
EWPW 10A QC2	210	12-14-88
EWPW 110	62	12-14-88
EWPW 111	150	08-17-88
EWPW 112	370	08-17-88
EWPW 113	40	03-15-88
EWPW 114	<94	03-15-88
EWPW 115	430	06-05-88
EWPW 115	400	12-14-88
EWPW 116	230	03-15-88
EWPW 117	160	03-15-88
EWPW 117	210	08-17-88
EWPW 118	310	12-14-88
EWPW 119	420	03-15-88
EWPW 11A	62	12-12-88
EWPW 12	530	12-12-88
EWPW 120	<74	06-15-88
EWPW 120	110	12-14-88
EWPW 121	92	03-15-88
EWPW 122	<73	06-15-88
EWPW 122	56	12-14-88
EWPW 122 QC1	42	12-14-88

PINELLAS COUNTY WATER SOURCES RADIOACTIVITY MEASUREMENTS

Site	Radon 222 (pCi/L)	Date
EWPW 13	210	12-12-88
EWPW 131	110	08-17-88
EWPW 134	180	12-14-88
EWPW 135	170	08-17-88
EWPW 136	260	12-14-88
EWPW 137	<66	08-17-88
EWPW 138	880	08-17-88
EWPW 139	280	12-14-88
EWPW 140	170	08-17-88
EWPW 142	220	12-14-88
EWPW 1S	1200	12-14-88
EWPW 2	310	12-14-88
EWPW 2A	33	03-15-88
EWPW 3B	590	08-17-88
EWPW 3S	550	03-15-88
EWPW 4	410	12-12-88
EWPW 4A	470	03-15-88
EWPW 4N	410	12-14-88
EWPW 4S	1100	12-12-88
EWPW 5	820	12-12-88
EWPW 5A	270	03-15-88
EWPW 5A	500	06-15-88
EWPW 5B	680	12-12-88
EWPW 5N	<91	03-15-88
EWPW 5S	1900	08-17-88
EWPW 6	990	12-12-88
EWPW 6	610	12-12-88
EWPW 6N	180	12-14-88
EWPW 6S	710	06-15-88
EWPW 6S	790	12-14-88
EWPW 7	970	12-12-88
EWPW 7S	1200	12-12-88
EWPW 8	240	12-12-88
EWPW 8S	400	12-12-88
EWPW 9	270	12-12-88