HEALTH RISKS OF ADDING NEW REACTORS TO THE ALVIN VOGTLE NUCLEAR PLANT

Radioactive contamination from Vogtle reactors 1 and 2
and changes in health status within a 40 mile radius

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EXECUTIVE SUMMARY

The Southern Company has proposed adding two nuclear reactors to the two existing ones at the Alvin Vogtle plant, near Waynesboro GA. Such an action would be potentially harmful for local public health. As a basis for predicting such harm, an changes in levels of environmental radioactivity and local cancer rates since Vogtle began operating were analyzed. The major findings are:

1. The two reactors release airborne radioactivity on a routine basis. Releases are much greater from Vogtle unit 1.

2. From 1987-1990 (as Vogtle began operating) to 1991-2003 (during full operation), average radioactivity levels in drinking water, river water, and sediment downriver or at the Vogtle plant rose:

Beta in Raw Drinking Water	+ 37.1%
Beta in Finished Drinking Water	+ 17.8%
Beryllium-7 in Sediment	+ 39.5%
Cesium-137 in Sediment	+ 37.4%
Tritium in River Water	+ 44.6%

3. During the same periods, the cancer death rate for children and adolescents in the 11 counties closest to Vogtle rose 58.5%, compared to a 14.1% decline nationally.

4. During the same periods, the death rate in Burke County GA (where Vogtle is located) rose sharply for all cancers, especially for blacks and for children and young/middle age adults (see below), while U.S. rates declined. In the late 1980s, Burke County cancer mortality rates were below the U.S., but are now considerably higher.

Change in Mortality Rate, All Cancers, 1987-1990 to 1991-2003

Category	Burke County	United States
All Ages, All Races	+25.1%	- 4.2%
All Ages, Whites	+17.5%	- 3.7%
All Ages, Blacks	+30.7%	- 5.7%
Age 0-24, All Races	+55.5%	- 14.1%
Age 25-54, All Races	+55.1%	- 2.9%

The findings suggest that some factor(s) introduced since the late 1980s has raised cancer risk in the area, particularly in Burke County. Because radioactive chemicals are known to cause cancer, the startup of Vogtle 1 and 2 should be considered as one contributing factor. Based on the above observations for 1991-2003, over 500 excess cancer deaths in Burke County can be projected over the entire 40 year license period for the two existing Vogtle reactors. Adding two new reactors could potentially double the total. It would be prudent to examine the correlation between radioactivity from Vogtle and local public health risk further before proceeding with any plan to add new nuclear reactors to the site.

INTRODUCTION

The Alvin W. Vogtle nuclear plant is located on the Savannah River, just east of Waynesboro GA and 26 miles southeast of Augusta GA. It consists of two reactors, each of which has been producing electricity since the late 1980s. It is a subsidiary of the Southern Company, owned jointly by Georgia Power (45.7%), Oglethorpe Power Corporation (30.0%), Municipal Electric Authority of Georgia (22.7%), and the city of Dalton (1.6%).

Originally the Georgia Power Company envisioned four reactors at Vogtle, but two of these were scrapped in the 1970s. The two reactors that were built became operational in 1987 and 1989, respectively (see Table 1):

Table 1
Key Dates in the Startup of Vogtle Reactors

Event	Vogtle 1	Vogtle 2	Vogtle 3	Vogtle 4
Announced	9/ 8/71	9/ 8/71	9/ 8/71	9/ 8/71
NRC application	2/13/73	2/13/73	2/13/73	2/13/73
Construction permit	6/28/74	6/28/74	6/28/74	6/28/74
Initial criticality	3/ 9/87	3/ 1/89	-----	-----
Commercial	6/ 1/89	5/20/89	-----	-----

Source: U.S. Nuclear Regulatory Commission, www.nrc.gov

The Vogtle reactors are relatively new, i.e., the 6th and 13th most recent to achieve initial criticality of the 103 U.S. reactors now operating. They are also among the largest; when they began operating, each Vogtle reactor had a capacity of 1162 megawatts electrical; only the six reactors at the Grand Gulf, Palo Verde, and South Texas Project plants are larger. In 1993 the U.S. Nuclear Regulatory Commission approved an expansion of 4.5% for each reactor, bringing them to 1215 megawatts each.

The Vogtle reactors are licensed by the NRC to operate until the years 2027 and 2029, respectively. In 2003, the Southern Operating Company sent the NRC a letter expressing its intent to request an extension of the two licenses until the years 2047 and 2049. The actual application is expected in June 2007.

Vogtle introduced a new source of electricity for eastern Georgia. The closest nuclear power reactors are the one-reactor Virgil Summer plant in Parr SC (80 miles northeast) and the two-reactor Edwin Hatch plant in Baxley GA (95 miles southwest). The Savannah River Site in Aiken SC is just across the Savannah River from Vogtle, about 15 miles to the northwest. Savannah River's five reactors made fuel for nuclear weapons from 1950 until 1992, when the reactors ceased operations and the major function at the site shifted to decontamination.

The Vogtle reactors are in operation virtually all the time in recent years, a pattern similar for most reactors as utilities find ways to raise productivity. In 2000-2004, Vogtle 1 and 2 operated 94% and 93% of the time, compared to 90% for all American reactors. The primary reason for closing is to refuel, or replace fuel in the reactor's core, which occurs about every 18 months and takes approximately several weeks.

In 2006, the Southern Company announced its intent to build two additional nuclear reactors at the Vogtle complex. This proposal has implications not just locally but nationally; a formal order for a new nuclear reactor would be the first in the U.S. since 1978. Potential effects on local public health will be explored in this report.

RADIOACTIVITY PRODUCED BY VOGTLE

Like all nuclear power reactors, Vogtle 1 and 2 produce electricity through the fission, or atom-splitting process. Uranium-235 atoms are bombarded with neutrons, producing heat which is converted into electricity. Fission also produces over 100 chemicals from the breakup of Uranium-235 atoms. These are not found in nature, but only created when atomic bombs explode or when nuclear reactors operate.

Each of the 100-plus isotopes is radioactive. The isotopes decay at varying rates; for example, Iodine-131 has a half life of 8 days, while plutonium-239 has a half life of 24,000 years. Most of this radioactivity is contained within the reactor building, and stored as high level waste in deep pools of constantly-cooled water. Some of the isotopes, with their half lives, are as follows:

Cesium 134 2.06 days
Cesium 137 30.1 years

Iodine 129 15.7 million years
Iodine 131 8.0 days

Strontium 89 50.5 days
Strontium 90 28.7 years

Despite efforts by reactor operators to contain these chemicals within the reactor building, some must be routinely emitted into the air and water, during daily operations and refueling. These metal particles and gases are returned to the earth through precipitation. They enter the human body by breathing and the food chain, where they kill and injure cells by emitting alpha particles, beta particles, or gamma rays. A damaged cell may or may not repair itself; if it fails to do so, it will duplicate into similarly damaged cells, which can lead to mutations and cancer.

While all humans are harmed by fission products, the fetus, infant, and child are most affected. Adult cell division is relatively slow, giving a damaged cell a better chance for repair. But fetal and infant cells divide at a very rapid rate, making repair of the damage less likely. The fetal and infant immune system is also relatively immature, making it less likely to fight off mutations that can become cancer.

The cocktail of over 100 chemicals attacks various parts of the body. Radioactive iodine attaches to the thyroid gland. Strontium seeks out bone and teeth, and penetrates into the bone marrow. Plutonium enters the lung. Cesium disperses throughout the muscles. Thus, exposure to the mix of radioactive elements can raise risk of many diseases, not just bone or thyroid cancer.

ENVIRONMENTAL RELEASES

Actual releases from Vogtle are measured by the plant's operator, in accordance with federal law. Levels vary greatly by year. Table 2 shows Vogtle's annual 1987-1993 emissions of Iodine-131 and particulates, which includes all isotopes with a half life of more than eight days, and thus those that are most likely to enter the body. In three of the years, the annual total was less than 100 microcuries, while in three other years, the total exceeded 1000.

Table 2
Airborne Emissions from Vogtle Nuclear Plant
In Microcuries, by Year, 1987-1993

Year	Microcuries
1987	20
1988	18
1989	1250
1990	85
1991	2080
1992	5870
1993	521

Source: Tichler J, Doty K, Lucadamo K. Radioactive Materials Released from Nuclear Power Plants. NUREG/CR-2907. Upton NY: Brookhaven National Laboratory, prepared for the U.S. Nuclear Regulatory Commission, Annual Report 1993. Represents Iodine-131 and particulates, all airborne releases of particulates with a half life of at least 8 days. (Annual reports that listed all U.S. reactors ceased in 1993).

Levels of various types of radioactive emissions, both airborne and liquid, from 2001 to 2004 are available on the internet. Table 3 displays results for one of these measures, namely gaseous fission and activation products. This is a broad measure including many isotopes that provides a general indication of total emission levels.

Table 3
Gaseous Emissions, Fission and Activation Products
From Vogtle Nuclear Plant, 2001-2004, in Curies

Year	Vogtle 1	Vogtle 2
2001	12.13	0.42
2002	23.89	2.36
2003	1.68	0.64
2004	0.64	1.31
TOTAL	38.34	4.73

Source: U.S. Nuclear Regulatory Commission, www.reirs.com/effluent

The Vogtle 1 reactor emitted about eight times more radioactivity than did reactor 2 (28.34 to 4.73 curies). The majority of these emissions are often clustered into relatively brief time periods. For example, of the 23.89 curies emitted from Vogtle 1 in 2002, 20.40, or about 85%, occurred during the first quarter. During this quarter, relatively high levels of other radioisotopes occurred as well. For example, Vogtle 1 emitted .0191 of a curie of Iodine-131 into the air; making it the 3rd greatest emission of any U.S. reactor during this time, or thousands of times more than typical emissions.

The Vogtle 1 reactor was closed for refueling beginning March 5, 2002, and was restarted beginning on April 8, returning to full power on April 24. Whether these unusually large releases are an outcome of the refueling cannot be ascertained, it is an example of the unpredictable pattern of environmental emissions from the reactors.

On March 20, 1990, there was a loss of offsite power at Vogtle during a shutdown. While official data reflect no unusual environmental releases, a 2006 report "An American Chernobyl" by Greenpeace assessed it as one of 200 "near misses" for a meltdown in the past two decades, rating it as the 7th most serious "near miss."

ENVIRONMENTAL RADIOACTIVITY LEVELS

The NRC requires each nuclear plant operator to measure and report concentrations of radioactivity in the local environment to ensure levels conform to federally-established limits. Results are included in the Annual Radiological Environmental Operating Report prepared by each operator, which the NRC posts on its web site. Samples are taken in water, air, sediment, animals, and food. Some samples are taken at locations within the plant, and at more distant sites, allowing an analysis of how proximity to reactors affects environmental levels. Some measure individual isotopes, while others measure composites, such as all alpha- or beta-emitting radioisotopes.

Vogtle's 2005 report is the latest on file. An examination of the report provides sampling results for a variety of types of radioactive chemicals. Table 4 shows annual results for selected samples in drinking water and in sediment, for the period 1987-1990 (as Vogtle was beginning operations) and 1991-2003 (when the plant was fully operational).

Table 4
Trends in Environmental Radioactivity Levels Near Vogtle Nuclear Plant, 1987-2003

Type of Radioactivity	Annual Avg. 1987-1990	Annual Avg. 1991-2003	% Ch
Beta in Raw Drinking Water			
- Indicator (downriver)[1]	2.583	3.540	+ 37.1%
- Control (upriver)[2]	3.535	3.202	- 9.4%
Beta in Finished Drinking Water			
- Indicator (downriver)[1]	2.205	2.597	+ 17.8%
- Control (upriver)[2]	2.113	2.230	+ 5.6%
Beryllium-7 in Sediment			
- Indicator (at Vogtle)[3]	930.5	1297.8	+ 39.5%
- Control (off site)[4]	578.3	1229.8	+112.7%
Cobalt-60 in Sediment			
- Indicator (at Vogtle)[3]	51.33	138.3	+169.5%
Cesium-137 in Sediment			
- Indicator (at Vogtle)[3]	192.3	264.2	+ 37.4%
- Control (off site)[4]	137.8	112.5	- 18.3%
Tritium in River Water, avg. 6 sites	744.9	1077.3	+ 44.6%

[1]Beaufort/Jasper County Water Treatment Plant, Beaufort SC, 112 mi downriver, plus Cherokee Hill Water Treatment Plant, Port Wentworth SC, 122 mi. downriver. [2]Augusta Water Treatment Plant, Augusta GA, 56 mi. upriver. [3]Savannah River, 0.8 mi. ENE of Vogtle plant. [4]Savannah River, 2.5 mi. N of Vogtle plant. Beta and tritium in picocuries per liter, others in picocuries per kilogram dry. Source: Vogtle Electric Generating Plant Annual Radiological Environmental Operating Report for 2005, www.nrc.gov.

A distinct pattern of rising radioactivity concentrations closest to or downriver from the Vogtle plant ("indicator") after the first few years of operation is evident. Perhaps the measure of beta, or the total of all radionuclides emitting beta particles, in water is the closest approximation of the trend in total radioactivity; beta in raw and finished drinking water at the Vogtle plant rose 37.1% and 17.8%, respectively, from 1987-1990 to 1991-2003. Levels of individual radionuclides detected in sediment at Vogtle also increased, by 39.5%, 169.5%, and 37.4%, for Beryllium-7, Cobalt-60, and Cesium-137 respectively.

At more distant locations from Vogtle, trends in radioactivity levels are not as consistent. Of the five measures, two increased and two decreased over time, while no detectable amount of Cobalt-60 was reported. For each type of radioactivity, average levels from 1991-2003 were greater at proximate or downriver sites, varying from 10% greater (gross beta in raw drinking water) to over 100% (Cesium-137 in sediment).

Annual levels of environmental radioactivity (not shown in the table) do not always conform to longer trends. In general, there was a steady rise from the late 1980s until the late 1990s, after which average radioactivity levels, although still higher than the 1987-1990 levels. These findings are important, as they indicate that levels reflect a current source of radioactivity, most likely emissions from Vogtle. Neither emissions from above-ground weapons testing (ended 1963) not emissions from the Savannah River plant (ended 1992) would fit the pattern of consistent rises throughout the 1990s.

RADIOACTIVITY LEVELS IN BODIES

No regulatory body has ever mandated that radioactivity levels in bodies of persons living near U.S. nuclear plants be monitored, even though many such studies have been conducted independently. During the 1960s, as hundreds of atomic bombs were detonated in the atmosphere, scientists from several nations conducted studies of Strontium-90 in baby teeth. Other studies examined Sr-90 buildup in bones. Each came to the same conclusions, i.e. Sr-90 levels in the body rose rapidly as testing went on, and declined sharply after the Partial Test Ban Treaty was enacted. Studies conducted in the 1990s in Greece, Ukraine, and West Germany examined Sr-90 levels in baby teeth after the accident at Chernobyl, and another study studied Sr-90 in baby teeth near the Sellafield nuclear site in the United Kingdom.

Sr-90 is a fission product only found in bomb explosions and reactor operations. It is chemically similar to calcium, and attaches to bone and teeth after entering the body through breathing and the food chain. Its long half life of 28.7 years allows measurements of Sr-90 to be made long after it is ingested. At one time, there were three long-term government-sponsored studies of Sr-90 in the bodies of Americans (baby teeth, children's bone, and adult bone), but these were defunded and terminated in 1970, 1971, and 1982, respectively. Thus, for many years, the U.S. has had no program monitoring body burdens of manmade radioactivity.

The New York-based Radiation and Public Health Project (RPHP) research group became the first to study in-body levels of radioactivity near U.S. nuclear plants. In 1996, it began collecting baby teeth and testing them for Sr-90 concentrations, as prior studies had done. By 2006, RPHP had tested nearly 5,000 teeth (mostly near seven U.S. nuclear plants) and published results in five medical journal articles. The study found that average Sr-90 concentrations rose sharply after the late 1980s, and that levels were consistently higher close to plants.

Only 16 baby teeth were collected from South Carolina and Georgia. This number is insufficient for any meaningful analysis, especially since none were from the area near Vogtle. However, the average concentration of Sr-90 in this small sample (3.46 picocuries of Sr-90 per gram of calcium at birth) was relatively similar to the national average (3.75). Moreover, the average concentration for the 8 teeth from children born in the 1990s was 64% greater than that for the 7 children born in the 1980s, similar to the trend documented near other nuclear plants.

LACK OF PRIOR HEALTH STUDIES NEAR VOGTLE PLANT

Since U.S. nuclear plants began operating in the 1940s, questions have been raised about whether the risk of cancer and other diseases are raised by living near these plants. The only federal study of cancer near nuclear plants was conducted by the National Cancer Institute in 1990, which examined cancer death rates near 62 U.S. nuclear plants. The study concluded that there was no link between proximity to nuclear plants and cancer risk. Because only nuclear plants started before 1982 were examined, Vogtle was not included in the analysis.

Closest to Vogtle, the NCI study documented cancer death rates near the Savannah River plant. The study included three counties closest to the plant (Aiken SC, Barnwell SC, and Burke GA), and compared the local cancer death rate with the U.S. Of the three county area, Aiken accounts for about two-thirds of its population.

In 1950, the year Savannah River began operating, the local cancer death rate was 26% below the national rate, based on 74 cancer deaths. Thereafter, the local rate gradually began approaching the U.S., until by the early 1980s, the 3-county rate was just 1% lower than the nation (Table 5). Thus, the status of the area near the Savannah River plant as a low-cancer region was erased during the first three decades of operation. The NCI study used data on cancer death rates from 1950-1984.

Table 5
Age-Adjusted Cancer Death Rate
Counties Closest to the Savannah River Nuclear Plant
Compared to the U.S. by Five Year Period, 1950-1984

Year(s) of Death	Aiken SC, Barnwell SC, Burke GA Cos. % Local Rate is +/- U.S. Rate (Deaths)
Before Startup	
1950	-26% (74)
After Startup	
1951-1955	-12% (473)
1956-1960	- 9% (548)
1961-1965	-10% (621)
1966-1970	- 9% (724)
1971-1975	-10% (838)
1976-1980	- 6% (1047)
1981-1984	- 1% (1005)
Most Recent	
1999-2003	+11% (2126)

Sources: National Centers for Disease Control and Prevention, http://wonder.cdc.gov, underlying cause of death. Uses cause of death codes C00-D48.9 (1999-2003 data). National Cancer Institute. Cancer in Populations Living Near Nuclear Facilities. NIH Pub. No. 90-874. Washington DC: U.S. Government Printing Office, 1990 (all other data).

More recent data shows that this trend has continued. According to the National Center for Health Statistics, there were 2126 cancer deaths in the three counties in the period 1999-2003. The mortality rate (adjusted to the 2000 U.S. standard population) of 223.2 per 100,000 was 11% greater than the U.S. rate of 200.6. Thus, the below-average cancer death rates in the counties closest to the Savannah River site have been supplanted by above-average rates.

The NCI study also included the nuclear plant in Georgia nearest to Vogtle, namely the Edwin Hatch nuclear plant, which began operating in 1974. Table 6 provides five-year trends in cancer death rates for the two counties (Appling and Toombs) that flank the Hatch plant. Similar to the counties near the Savannah River site, cancer death rates were historically low; in the 1950s, 1960s, and 1970s, they ranged between 17% and 27% less than the U.S. rate. But in the early 1980s, the rate jumped to 3% below the U.S., and by 1999-2003, the rate was 12% greater, (225.1 to 200.6 per 100,000), based on 481 cancer deaths in the two counties.

Table 6
Age-Adjusted Cancer Death Rate
Counties Closest to the Edwin Hatch Nuclear Plant
Compared to the U.S. by Five Year Period, 1950-1984

	Appling GA and Toombs GA Counties
Year(s) of Death	% Local Rate is +/- U.S. Rate (Deaths)
Before Startup	
1950-1954	-27% (114)
1955-1959	-20% (140)
1960-1964	-26% (143)
1965-1969	-17% (184)
1970-1974	-14% (225)
After Startup	
1975-1979	-21% (233)
1980-1984	- 3% (322)
Most Recent	
1999-2003	+12% (481)

Sources: National Centers for Disease Control and Prevention, http://wonder.cdc.gov, underlying cause of death. Uses cause of death codes C00-D48.9 (1999-2003 data). National Cancer Institute. Cancer in Populations Living Near Nuclear Facilities. NIH Pub. No. 90-874. Washington DC: U.S. Government Printing Office, 1990 (all other data).

Each of the counties selected by the NCI closest to the Savannah River and Hatch sites lie completely within a 40 mile radius of the plant. Counties selected for study near all 62 sites near nuclear plants were all within 40 miles as well. Thus, this report will conform with the NCI standard when choosing counties closest to nuclear plants.

COUNTIES CLOSEST TO VOGTLE

A 40 mile radius around the Vogtle plant reveals six counties located completely within 40 miles (Burke GA, Jenkins GA, Richmond GA, Screven GA, Allendale SC, and Barnwell SC), plus a seventh (Aiken SC) nearly all within 40 miles. Less than 50% of four other counties (Columbia GA, Jefferson GA, Bamberg SC, and Edgefield SC) are located within 40 miles of Vogtle. This report will examine health status changes after Vogtle began operating for both the 7-county and 11-county groups.

The demographic characteristics in the local area may be pertinent to this analysis, and are displayed in Table 7. The current population of the region is nearly 600,000, nearly three quarters of which are in the seven closest counties. The largest three counties, with over three-fourths of the 11-county area population, are Richmond GA (Augusta), Aiken SC (Aiken), and Columbia GA (suburban Augusta).

The most significant characteristics of the 11-county/7-county area vs. the U.S. are:

- A higher percentage of poverty in 2003 (15.5/17.2 vs. 12.5). The counties with the highest poverty levels are the more rural counties; Burke, Jefferson, Jenkins, Allandale, and Bamberg all have poverty rates over 20%.

- A much higher percentage of blacks in 2004 (38.2/42.5 vs. 12.8). Burke, Jefferson, Richmond, Allendale, and Bamberg counties each has a population over 50% black.

- A much lower percentage of Hispanics in 2004 (2.5/2/5 vs. 14.1). All counties have a percentage fewer than 4.2%. The Asian population is also very small (1.4/1/1 vs. 4.2).

- A lower percentage of persons age 25 and over with high school diplomas (76.7/75.4 vs. 80.4) and college degrees (19.5/17.5 vs. 24.4). Only Columbia County exceeds the U.S.

Table 7
Demographic Characteristics, 11 Counties Closest to Vogtle vs. U.S.

Category	U.S.	11 Cos.	7 Cos.
2005 est. population	296 M	589816	427670
2000 population	281 M	571015	423208
2003 % below poverty	12.5	15.5	17.5
2004 % black	12.8	38.2	42.5
2004 % Hispanic	14.1	2.5	2.5
2004 % Asian	4.2	1.4	1.1
2000 % High School grad	80.4	76.7	75.4
2000 % College grad	24.4	19.5	17.5

Seven Counties Completely Within 40 Miles of Vogtle

Category	Burke	Jenkins	Richmond	Screven	Aiken	Allendale	Barnwell
2005 est. population	23299	8729	195769	15430	150181	10917	23345
2000 population	22243	8575	199775	15374	142252	11211	23478
2003 % below poverty	21.7	21.9	18.6	18.5	13.5	28.4	17.2
2004 % black	51.1	41.1	52.3	45.4	25.9	72.5	42.8
2004 % Hispanic	1.6	4.2	2.6	1.1	2.8	2.2	1.4
2004 % Asian	0.3	0.3	1.6	0.4	0.8	0.1	0.6
2000 % High School grad	64.9	62.0	78.0	66.9	77.7	60.0	67.5
2000 % College grad	9.5	10.8	18.7	10.2	19.9	9.3	11.6

Four Counties With Less Than Half Its Land Area Within 40 Miles of Vogtle

Category	Columbia	Jefferson	Bamberg	Edgefield
2005 est. population	103812	16926	15880	25528
2000 population	89288	17266	16658	24595
2003 % below poverty	6.8	20.1	21.2	15.8
2004 % black	13.5	55.8	62.1	41.2
2004 % Hispanic	2.8	1.7	0.9	2.2
2004 % Asian	3.5	0.3	0.2	0.3
2000 % High School grad	87.9	58.5	64.7	71.4
2000 % College grad	32.0	9.1	15.4	12.5

Note: Percent high school and college graduates are for adults over age 25. Source: U.S Bureau of the Census, www.census.gov, your gateway to the 2000 census, state and county quick facts.

This report will examine changes in health status before and after the startup of Vogtle, using the U.S. Centers for Disease Control data base on annual deaths in the U.S. from 1979-2003. Analyzing cancer incidence data is not possible, as tumor registries in Georgia and South Carolina were only begun in 1999 and 1996, respectively, after Vogtle startup. Thus, this report will focus on mortality changes.

INFANT MORTALITY

The fetus and infant are most susceptible to harmful effects of radiation. Table 8 displays the change in infant deaths (deaths under one year as a proportion of live births) for U.S. compared to the counties closest to Vogtle, immediately after reactor startup. Because Vogtle 1 went critical in 1987 and only operated at partial power that year, the periods 1985-1987 and 1988-1990 were chosen as the "before" and "after" periods.

Table 8
Change in Infant Death Rate (under 1 year), 1985-1987 to 1988-1990
Counties Closest to Vogtle Plant vs. U.S.

	Rate/100000 (Deaths)		
County	1985-87	1988-90	% Ch. Rate
***Burke GA**	**13.71 (16)**	**23.31 (28)**	**+70.1%**
+Columbia GA	13.68 (41)	10.55 (35)	- 22.9%
Jefferson GA	19.92 (19)	19.98 (19)	+ 0.3%
*Jenkins GA	18.52 (8)	2.21 (1)	- 88.1%
*+Richmond GA	13.77 (145)	14.79 (161)	+ 7.4%
*Screven GA	17.57 (12)	11.77 (9)	- 33.0%
*+Aiken SC	14.75 (81)	9.70 (58)	- 34.3%
*Allendale SC	14.49 (8)	15.51 (9)	+ 7.0%
Bamberg SC	16.35 (12)	16.51 (14)	+ 1.0%
*Barnwell SC	14.23 (14)	8.52 (9)	- 40.1%
Edgefield SC	16.89 (15)	15.92 (15)	- 5.7%
Total 11 Cos.	14.60 (371)	13.27 (358)	- 9.1%
*Total 7 Cos.	14.32 (284)	13.14 (275)	- 8.2%
+3 Largest Cos.	14.04 (267)	12.58 (254)	- 10.4%
8 Smallest Cos.	16.27 (104)	15.30 (104)	- 5.9%
U.S.	10.36 (117329)	9.66 (116916)	- 6.8%

Source: National Center for Health Statistics (http://wonder.cdc.gov, underlying cause of death).

The 9.1% decrease for the 11 counties closest to Vogtle (8.2% decrease for the closest 7 counties) in the first three years of the plant's operation was not markedly different than the U.S. decline of 6.8%. Levels declined 5.9% for the 8 rural counties and 10.4% for the 3 most populated counties (Columbia, Richmond, and Aiken).

The most dramatic change occurred in Burke County, where the number of infant deaths soared from 16 to 28, a 70.1% rate increase (live births rose slightly from 1167 to 1201). This increase is significantly different ($p < .04$) from the national decline. Because Burke is the location of Vogtle, it is likely that the greatest exposures from reactor emissions occurred to county residents.

The question arises whether the increase was a one-time phenomenon or part of a longer-term trend. Table 9 shows the change in Burke's infant death rate over the past quarter century, comparing 9 and 16 years, respectively, before and after the plant opened.

Table 9
Change in Infant Death Rate (under 1 year), by Race
1979-1987 to 1988-2003
Burke County GA vs. U.S.

Race	United States Rate/100,000 (Deaths)	Burke County Rate/100,000 (Deaths)	
All			
1979-1987	1132.9 (374433)	1164.4 (42)	
1988-2003	799.0 (507571)	1382.2 (86)	
% Change	**- 29.5%**	**+18.7%**	p<.002
White			
1979-1987	973.7 (260243)	455.9 (6)	
1988-2003	661.1 (330750)	744.6 (17)	
% Change	**- 32.1%**	**+63.3%**	p<.03
Black			
1979-1987	2017.9 (104439)	1576.9 (36)	
1988-2003	1549.9 (159045)	1755.3 (69)	
% Change	**- 23.2%**	**+11.3%**	p<.04

Source: National Center for Health Statistics (http://wonder.cdc.gov, underlying cause of death).

There has been a substantial (18.7%) increase in the Burke County infant death rate since Vogtle began operating, in contrast to the 23.2% decrease nationwide. This pattern is consistent for all both whites and blacks, and is statistically significant ($p<.05$) for all races, whites, and blacks. Despite the socioeconomic problems in Burke County, infant mortality for both whites and blacks were well below the national rates for 1979-1987, before Vogtle began operations. Subsequently, however, the county rate far exceeds the nation, after Vogtle startup.

CANCER IN CHILDREN AND ADOLESCENTS

In studies of radiation health risk, childhood cancer is perhaps the most-studied disease, due to the increased risk from radiation exposures to the fetus, infant, and child. The CDC maintains annual information on cancer deaths by age for each year from 1979-2003, making it possible to study changes in local childhood cancer rates before and after Vogtle began operating. For this analysis (and for all mortality analyses hereafter) the "before" period selected was 1987-1990, when environmental radioactivity levels were still relatively low (see section 4 of this report). Moreover, in this period the two Vogtle reactors had just began operating, and any exposure would not likely result in a cancer death for at least several years.

Table 10 reveals the changes in cancer mortality under age 25 near the Vogtle plant before and after startup.

Table 10
Change in Cancer Death Rate Age 0-24, 1987-1990 to 1991-2003
Counties Closest to Vogtle Plant vs. U.S.

	Cancer Deaths		Population 0-24		Deaths/100000		
County	'87-90	'91-03	'87-90	'91-03	'87-90	'91-03	% Ch
***Burke GA**	**1**	**5**	**36207**	**116431**	**2.8**	**4.3**	**+55.5**
+Columbia GA	4	16	99333	314050	4.0	5.1	+
Jefferson GA	0	4	29350	86979	0.0	4.6	+
*Jenkins GA	0	2	13283	42225	0.0	4.7	+
*+Richmond GA	7	31	310380	1015605	2.3	3.1	+
*Screven GA	1	3	22145	71597	4.5	4.2	-
*+Aiken SC	7	36	179246	641639	3.9	5.6	+
*Allendale SC	0	5	19536	57571	0.0	8.7	+
Bamberg SC	0	1	30389	87493	0.0	1.1	+
*Barnwell SC	1	4	32783	111774	3.1	3.6	+
Edgefield SC	0	3	28504	103016	0.0	2.9	+
11 Counties	21	110	801156	2648380	2.62	4.15	+ 58.5%
*7 Counties	17	86	613580	2056842	2.77	4.18	+ 50.9%
+3 Largest Cos.	18	83	588959	1971294	3.06	4.21	+ 37.8%
8 Smallest Cos.	3	27	212197	677086	1.41	3.99	+182.8%
United States					4.33	3.72	- 14.1%

Source: National Center for Health Statistics, http://wonder.cdc.gov, underlying cause of death. Uses codes for all cancers; ICD-9 codes 140.0-239.9 (until 1998), and ICD-10 codes C00-D48.9 (after 1998).

The death rate in the 11 counties closest to Vogtle increased 58.5% (50.9% for the 7 closest counties), compared to a 14.1% decrease nationally. This difference is highly significant ($p<.001$); county-specific changes are not significant due to the small number of deaths. The rate increased for 10 of the 11 counties, with the exception of Screven.

In the early years of Vogtle operation, the local death rate of 2.62 deaths per 100,000 was 39.5% below the U.S. rate of 4.33 per 100,000. Since 1990, the local rate has increased to 4.15 deaths per 100,000, which exceeds the national rate of 3.72 by 16.3%. This change is significant, not just because of the large local rise in child/adolescent cancer mortality, but because of the large number of deaths involved (110 in the 13-year period 1991-2003).

The increase for the 8 smallest counties was 182.8%, far greater than that for Columbia, Richmond, and Aiken Counties (37.8%). The rate in the rural areas, which was well below the large three counties in the late 1980s, has virtually caught up (3.99 vs. 4.21 deaths per 100,000 in 1991-2003). It is possible that prior to Vogtle startup, the environmental pollution levels were quite low in the virtually pristine rural areas near the plant. The population under age 25 in the eight counties has been stagnant in the past two decades; thus, a new form of pollution must be considered as a factor in this unexpected cancer rise.

CANCER IN YOUNG/MIDDLE AGE ADULTS

Trends in cancer death rates near Vogtle were also analyzed for young adults, defined here as age 25-54. Table 11 displays these trends for the same periods (1987-1990 and 1991-2003) for the 11 counties closest to the plant vs. the U.S.

Table 11
Change in Cancer Death Rate Age 25-54, 1987-1990 to 1991-2003
Counties Closest to Vogtle Plant vs. U.S.

	Cancer Deaths		Population 25-54		Deaths/100000		
County	'87-90	'91-03	'87-90	'91-03	'87-90	'91-03	% Ch
***Burke GA**	**15**	**84**	**30919**	**111666**	**48.5**	**75.2**	**+55.1%**
+Columbia GA	50	274	119024	516742	42.0	53.0	+26.2%
Jefferson GA	16	74	25398	87829	63.0	84.3	+33.7%
*Jenkins GA	9	41	12382	43908	72.7	93.4	+28.5%
*+Richmond GA	255	886	312503	1101989	81.6	80.4	- 1.5%
*Screven GA	17	57	21555	76239	78.9	74.8	- 5.2%
*+Aiken SC	131	481	197093	765473	66.5	62.8	- 5.5%
*Allendale SC	10	60	17486	61453	57.2	97.2	+70.7%
Bamberg SC	18	56	23941	81303	75.2	68.9	- 8.4%
*Barnwell SC	26	88	31200	120831	83.3	72.8	- 12.6%
Edgefield SC	14	101	29492	130980	47.5	77.1	+62.4%
11 Counties	561	2202	820993	3098413	68.3	71.1	+ 4.0%
*7 Counties	463	1697	623138	2281559	74.3	74.4	+ 0.1%
+3 Largest Cos.	436	1641	628620	2384204	69.4	68.8	- 0.7%
8 Smallest Cos.	125	561	192373	714209	65.0	78.5	+20.9%
United States					59.0	57.3	- 2.9%

Source: National Center for Health Statistics, http://wonder.cdc.gov, underlying cause of death. Uses codes for all cancers; ICD-9 codes 140.0-239.9 (until 1998), and ICD-10 codes C00-D48.9 (after 1998).

The death rate in the 11 counties closest to Vogtle increased 4.0% (0.1% for the 7 closest counties), compared to a 2.9% decrease nationally. This difference is significant ($p<.03$). The rate increased for 6 of the 11 counties; the largest rises took place in Allendale (70.7%), Edgefield (62.4%), and Burke (55.1%). The rate in the 8 smallest counties increased 20.9%, but decreased 0.7% in the other 3 counties.

Thus, increases in cancer mortality for young and middle age adults are similar to the findings for children and adolescents. There was a statistically significant rise after the late 1980s, with the largest increases occurring in the most rural counties. Even though the local-national rate increase gap (+4.0% vs. -2.9%) is not as large as that for children and adolescents (+58.5% vs. -14.1%), the large number of local cancer deaths for young and middle age adults (2202 from 1991-2003) makes this increase meaningful.

CANCER – ALL AGES COMBINED

Trends in cancer death rates near Vogtle were also analyzed for persons of all ages, adjusted to the 2000 U.S. standard. Table 12 displays these trends for the same periods (1987-1990 and 1991-2003) for the 11 closest counties vs. the U.S.

Table 12
Change in Cancer Death Rate, All Ages, 1987-1990 to 1991-2003
Counties Closest to Vogtle Plant vs. U.S.

	Cancer Deaths		Total Population		Deaths/100000		
County	'87-90	'91-03	'87-90	'91-03	'87-90	'91-03	% Ch
***Burke GA**	**135**	**570**	**83210**	**281609**	**185.0**	**231.5**	**+25.1%**
+Columbia GA	271	1532	248674	1092278	194.6	212.7	+ 9.3%
Jefferson GA	144	574	70743	225283	200.2	242.8	+21.3%
*Jenkins GA	102	255	33367	111334	294.1	222.0	- 24.5%
*+Richmond GA	1521	5156	756868	2592214	256.8	236.8	- 7.8%
*Screven GA	116	494	56890	192601	198.0	237.2	+19.8%
*+Aiken SC	908	3814	472613	1794144	218.1	220.3	+ 1.0%
*Allendale SC	91	351	46355	149762	220.9	245.0	+10.9%
Bamberg SC	155	473	68642	217718	244.4	213.2	- 12.8%
*Barnwell SC	157	612	80348	294679	219.0	215.4	- 1.6%
Edgefield SC	154	586	73004	292769	234.7	217.2	- 7.5%
11 Counties	3754	14417	1990714	7244391	230.2	226.6	- 1.6%
*7 Counties	3030	11252	1529651	5416343	236.5	229.8	- 2.8%
+3 Largest Cos.	2700	10502	1478155	5478636	234.0	226.6	- 3.2%
8 Smallest Cos.	1054	3915	512559	1765755	229.2	226.6	- 1.1%
United States					216.6	207.6	- 4.2%

Source: National Center for Health Statistics, http://wonder.cdc.gov, underlying cause of death. Uses codes for all cancers; ICD-9 codes 140.0-239.9 (until 1998), and ICD-10 codes C00-D48.9 (after 1998).

The death rate in the 11 counties closest to Vogtle decreased only 1.6% (2.8% for the 7 closest counties), compared to a 4.2% decrease nationally. This difference is significant ($p<.03$). The rate increased for 6 of the 11 counties; the largest rises took place in Burke (25.1%), Jefferson (21.3%), and Screven (19.8%), all rural counties in Georgia. The rate in the 8 smallest counties declined only 1.1%, compared to a 3.2% decrease in the other 3 counties – a pattern similar to those of children and young adults.

A 1.6% decline in the local rate compared to a 4.2% decline nationwide may not appear large, but it is statistically significant due to the large number of deaths (14417 from 1991-2003). Perhaps another way of expressing this difference is that in 1987-1990, only 6 of the 11 counties had a cancer death rate above the U.S. average. But in 1991-2003, the rate in all 11 counties exceeded the U.S. This trend illustrates the local area's shift to a high-cancer area.

CANCER MORTALITY TRENDS IN BURKE COUNTY

The consistently large increases in Burke County infant mortality and cancer mortality rates merit further investigation, as Vogtle is located in Burke and all county residents live within 25 miles of the plant. Table 13 shows the trends in Burke County mortality, for all cancers and all other causes of death, for whites, blacks, and all races combined.

Table 13
Change in Death Rate, All Ages Combined, by Race
Cancer and All Other Causes of Death, 1987-1990 to 1991-2003
Burke County GA vs. U.S.

	Burke Deaths		Burke Rate/1000		US Rate/100000		% Ch Rate	
Area	'87-90	'91-03	'87-90	'91-03	'87-90	'91-03	Burke	U.S.
Cancer –All	135	570	185.0	231.5	216.6	207.6	**+25.1**	**- 4.2**
Cancer - White	73	310	190.3	223.5	212.4	204.5	**+17.5**	**- 3.7**
Cancer – Black	62	260	185.0	241.7	277.3	261.6	**+30.7**	**- 5.7**
Other Causes – All	701	2317	971.6	929.1	741.5	675.8	- 4.4	- 8.9
Other Causes – White	319	1130	894.3	863.0	717.3	655.7	- 3.5	- 8.6
Other Causes – Black	382	1186	1083.3	1042.1	988.9	894.2	- 3.8	- 9.6

Source: National Center for Health Statistics, http://wonder.cdc.gov, underlying cause of death. Uses codes for all cancers; ICD-9 codes 140.0-239.9 (until 1998), and ICD-10 codes C00-D48.9 (after 1998).

Several observations may be made for these data, namely:

- Burke County cancer death rates are rising for all races, compared to a decline nationwide. The increases for all races, whites, and blacks are 25.1%, 17.5%, and 30.7%, respectively, and are statistically significant ($p < .00001$, $p < .02$, and $p < .0002$).

- In the late 1980s, the Burke County cancer death rate for all races and for whites was less than the U.S., but since then the rate is higher.

- Burke County death rates for all causes other than cancer are declining, but not as rapidly as the U.S. trend. The local decreases are just 4.4%, 3.5%, and 3.8% for all races, whites, and blacks, respectively, less than half of the national decline. These differences are not statistically significant.

- Burke County death rates for causes other than cancer exceeded the U.S. rate for each racial group in the late 1980s, and still exceed the nation, albeit by a larger percentage.

Examining death rates for specific cancers can provide information on which cancers are elevated in Burke County. Table 14 compares age-adjusted mortality rates between Burke County and the United States for the six types of cancer with the largest number of deaths nationally for 1999-2003, accounting for over 60% of all cancer deaths. (There

was no other type of cancer with more than eight deaths in Burke County during this time, which makes meaningful comparisons difficult to make).

Table 14
Mortality Rate, for Most Common Cancers, 1999-2003
Burke County GA vs. U.S.

Type of Cancer	United States Rate/100,000 (No.)	Burke County Rate/100,000 (No.)	%/- U.S.
Lung and Bronchus	55.12 (779,089)	62.89 (62)	+ 14.1%
Colon and Rectum	19.92 (281,659)	22.69 (22)	+ 13.9%
Female Breast	26.04 (207,544)	10.71 (6)	- 58.9%
Male Prostate	28.97 (153,526)	62.98 (19)	+117.4%
Pancreas	10.56 (149,258)	14.44 (14)	+ 36.7%
Other/Unspecified	9.52 (134,654)	22.82 (22)	+139.7%
All	200.6 (2,838,181)	227.7 (222)	+ 13.5%

Source: National Center for Health Statistics (http://wonder.cdc.gov, underlying cause of death).

The mortality rate in Burke County was higher for five of the six most common cancers, with breast cancer being the exception. Rates for prostate cancer and cancers classified as "other or unspecified" were more than double the national rate. Without the benefit of data for a larger number of cancer types, it appears that the excess cancer rates include many types of the disease, not just a limited number.

CORRELATING RADIOACTIVITY AND CANCER NEAR VOGTLE

This report has presented trend data on radioactive emissions from the Vogtle nuclear plant, and environmental levels of radioactivity near the plant. In addition, it has examined changes in death rates from cancer near the plant. A comparison of the two data sets is important when addressing the question of whether emissions from the plant have harmed the health of local residents.

The highest levels of environmental radioactivity are those taken at the plant; thus, even though the report examined 11 counties within 40 miles of Vogtle, it may be most appropriate to restrict the comparison to the population living closest to the plant, i.e. Burke County residents (Table 15).

Table 15
Change in Environmental Radioactivity near Vogtle Plant, Cancer in Burke County
1987-1990 to 1991-2003

ENVIRONMENTAL RADIOACTIVITY	
Beta in Raw Drinking Water	+ 37.1%
Beta in Finished Drinking Water	+ 17.8%
Beryllium-7 in Sediment	+ 39.5%
Cobalt-60 in Sediment	+169.5%
Cesium-137 in Sediment	+ 37.4%
Tritium in River Water	+ 44.6%
CANCER MORTALITY, BURKE COUNTY	
All Cancers, Age 0-24	+55.5%
All Cancers, Age 25-54	+55.1%
All Cancers, Age Adjusted, All Races	+25.1%
All Cancers, Age Adjusted, White	+17.5%
All Cancers, Age Adjusted, Black	+30.7%

With the exception of Cobalt-60 in Sediment, the percent change for each indicator of environmental radioactivity ranges from 17.5% to 44.6%. Cancer mortality rose 25.1%, slightly less for whites and slightly more for blacks, during the same period, with a 55% increase for children and young/middle age adults. The large number of samples of radioactivity measurements and the large number of cancer deaths make the trends statistically significant, suggesting that these parallel increases may not be due to random chance, but rather a cause-and-effect relationship.

There are many factors that can influence cancer rates, such as genetics, life styles, and various environmental factors. Such large increases in cancer in Burke County have no apparent explanation, and thus should be taken seriously. More detailed studies of various potential factors, including radioactive emissions from Vogtle, should be conducted to understand these trends, and to prevent their continuation in the future.

PUBLIC HEALTH RISK OF NEW VOGTLE REACTORS

The data presented in this report detail the increases in environmental radioactivity and local rises in cancer rates since the Vogtle reactors began operating. The parallel between these two trends is to be taken seriously, as radioactive fission products are carcinogenic, and are especially toxic to the young.

The addition of two new reactors at Vogtle would double the capacity of the plant and presumable double the radioactive emissions. Assuming there is no major reduction in health risk to the local population – such as an influx of new medical services or a large reduction in poverty – the local population will be at increased risk of cancer, based on the findings in this report. It is possible that harm may be even greater than in the past two decades, because

- The emissions from the new reactors will combine with those from Vogtle 1 and 2, perhaps raising the local body burden of radioactivity

- A growing proportion of local citizens will have been exposed to Vogtle emissions for their entire life, especially in the critical fetal, infant, and childhood periods

Using the national trend in cancer mortality as the expected, the excess cancer deaths in Burke County from 1991 to 2003 was 167. (If a 4.2% decline had occurred rather than a 25.1% increase, the total of 570 deaths would have been 403). Two additional reactors operating for 40 years would be expected to produce about 500 additional cancer deaths in Burke County, along with 500 more from the two existing reactors. A greater excess could occur in neighboring counties. These projections should be monitored and followed with more detailed analyses, and be considered in any decision to license new reactors.