

**The Alliance For A Clean Environment**

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January 29, 2007 (3:22pm)

OFFICE OF SECRETARY  
RULEMAKINGS AND  
ADJUDICATIONS STAFF

January 26, 2007

**Secretary, U.S. Nuclear Regulatory Commission**

Rulemakings and Adjudications Staff.  
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32

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Phone (301) 415-1966.  
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Submit via website <http://ruleforum.llnl.gov>.

Subject: **More Protective Radiation Standards - PRM-51-11**

Federal Register notice  
<http://www.epa.gov/fedrgstr/EPA-IMPACT/2006/November/Day-20/i19568.htm>

The Alliance For A Clean Environment (ACE) is a grass roots environmental group with members in the tri-county area surrounding the Limerick Nuclear Power Plant. We urge NRC to approve the petition for rulemaking that would provide more protective radiation standards at older reactors.

For twelve years we have been gathering evidence in an attempt to understand why there is a health crisis in communities in our area. We have documented and are attaching information on alarming elevated cancer rates in Montgomery County (home of the Limerick Nuclear Power Plant), elevated infant and neonatal mortality, and learning disabilities.

1. Cancer incidence increased in Montgomery County since Limerick Nuclear Power Plant went on line in the mid 1980s, for many of the kinds of cancers associated with radiation exposure, such as; Thyroid Cancer Increased by 128%, Breast Cancer 61%, and Leukemia 48%. (1985-86 to 1996-97) PA Cancer Registry Data
2. Childhood cancer deaths (ages 1 to 14) increased by 71% in Montgomery County, while going down in surrounding counties, PA and the U.S. Childhood cancer rates are 92.5% higher than the national average in six communities near the nuclear plant, including one in Chester and one in Berks County.
3. Elevated infant and neonatal mortality are far higher than the state average, and even higher than Philadelphia and Reading (according to state data).
4. Learning disabilities are documented to be double state increases at 94% (1990 to 2000) in Montgomery County.

Children in the shadow of Limerick Nuclear Power Plant are documented to be suffering and dying in record numbers. Statistics are alarming. Childhood cancer statistics are significantly higher near Limerick Nuclear Power Plant than across the state, nation, and tri-county.

- More precautionary radiation standards for fetuses and children are imperative. Children in the region of Limerick Nuclear Power Plant need and deserve radiation standards that will protect them, as do all children who are unfortunate enough to live around nuclear power plants or other sources of radiation emissions.
- NRC's radiation standards still ignore the unique vulnerability of children. Radiation regulations used by NRC are still based on the "Standard Man" (an adult healthy male). This is irresponsible, tragic, and unacceptable. NRC radiation regulations also fail to protect women, people already sick, and the elderly. It is long past time for NRC radiation standards to be more reflective of current science and reality.

**Evidence is clear and compelling that children are the ignored victims of outdated and unprotective radiation standards still used by NRC for regulating nuclear power plants.**

For example:

- Since Limerick Nuclear Power Plant first went on line in the mid 1980's, the statistics above show far higher rates of cancer, leukemia, infant and neonatal mortality. Other environmentally related illnesses have also been rising.
- Lessons of Chernobyl show children were the most vulnerable to radiation exposure, even in small doses, and that children exposed to radiation suffer from higher rates of certain childhood cancers, especially leukemia and thyroid cancer, and have a greater likelihood of developing breast cancer as adults.
  - Dramatic increases are well documented in these same cancers (thyroid cancer, leukemia, and breast cancer) since Limerick Nuclear Power Plant first went on line in the mid 1980s.
- Increases in other childhood cancers have been found near nuclear operations in the Navaho Nation, Brookhaven, New York, and nuclear power stations in Oyster Creek, New Jersey and Clinton, Illinois.
- Increases in down syndrome are found near Yankee Rowe power station in Massachusetts.
- Studies show ionizing radiation is also linked to immune system damage, heart defects, and diabetes in children.
- Evidence shows that after closings of nuclear power plants in the U.S., infant death and childhood cancer rates are reduced.

The American Academy of Pediatrics has identified reasons children are most vulnerable. They stated that children have higher minute ventilation or a higher concentration of tiny capillaries in the lungs, leading to greater radioactivity exposure from the same amount of radioactive material. They also said children are extra sensitive to the DNA-damaging effects of radioactive energy.

The cumulative weight of evidence from the three large releases of radiation (Chernobyl, TMI, and Savannah River), confirm that infants and children are most sensitive to damage from low levels of ionizing radiation. (See Attachment)

**A Moral And Ethical Responsibility To Protect Future Generations**

- Evidence of harm to fetuses and children is overwhelming. We urge NRC, the agency with the mission to protect the public from nuclear power plant radiation, to now take crucial precautionary action for more protective radiation standards that will prevent unnecessary harm to all fetuses and children around nuclear plants.

**Costs of Preventable Childhood Cancer, Illness, and Disability: The Price We Pay**

- Costs, both physical and financial, for unnecessary and preventable lifelong disease and disability are obviously astronomical and avoidable. Links between radiation exposure and a broad range of childhood illness, disease, and disability should no longer be disputed by anyone.
- Financial costs to owners of nuclear plants for providing more protective measures regarding nuclear power plant radiation releases would pale by comparison to the costs society pays for preventable childhood cancer, illness, and disability.

**Since Limerick Nuclear Power Plant went on line in the mid 1980s,  
There Are Alarming Cancer Statistics in Montgomery County  
And Even Worse In Communities Near Limerick Nuclear Power Plant. (See Attachments)**

- **Alarming Increases In Many Cancers** after Limerick Nuclear Power Plant went on line in Montgomery County, home of Limerick Nuclear Plant. (PA Cancer Registry Statistics)
  - **Cancer Death Rate (1995 to 2004) FAR Higher** In 13 Townships and Boroughs Near Limerick Nuclear Power Plant, compared to the rest of Montgomery County.
- **Childhood Cancer – Alarming Statistics**
  - **71% Increase in Childhood Cancer Deaths** (Ages 1 to 14)- Montgomery County. 1980's to 90s - Surrounding counties, state, and nation went down
  - **92.5% Above National Average** – (Ages 0 to 19) 1995 to 1999 in communities close to Limerick Nuclear Power Plant – showing an upward trend from 30% higher than the national average in the late 1980s to 60% higher in early 1990s
- **Thyroid Cancer Absolutely Soared** In Montgomery County since Limerick went on line.
  - **About 75% Higher than the U.S. Rate** - 1998,1999, and 2000, Montgomery County's Thyroid Cancer Rate - Thyroid Cancer Incidence is rising across the nation which increases the significance of these shocking increases in Montgomery County.
  - **128% Increase** – Montgomery County 1985-86 to 1996-97 A broad range of thyroid problems have also been reported in alarming numbers.
  - Thyroid Cancer Incidence in PA is highest in counties closest to the concentration of nuclear power plants, and in the predominant wind direction from them.
- **Leukemia Significantly Higher** - Montgomery County and 6 borough/township area near Limerick
  - **40% above other parts of the tri-county area for at least 15 years** - Total of 106 cases from 1985-99
  - **48% Increase in Montgomery County** (1985-86 to 1996-97)
  - **Almost double the state average** (1985 to 1994).
- **Breast Cancer - Significantly Higher In Montgomery County (See Attachments)**
  - **61% Increase** - 1985-86 to 1996-97 - Rising Incidence
  - **39.2% Higher** – (1995-1999) Female Breast Cancer - Compared to the Nation and Tri County 6 Municipalities – 1995 to 1999, in just five years, a total of 263 women were newly diagnosed with Breast Cancer. Among young adult women the most frequently diagnosed cancer, by far, is breast cancer. Considering that breast cancer is a national epidemic, this is cause for precaution.
  - **Female Breast Cancer By Age** (diagnosed 1995-1999) - Compared to the National Average
 

<u>Age</u>	<u>% HIGHER than U.S.</u>
0-29	+ 15.3 %
30-44	+ 51.4 %
45-64	+ 39.3 %
65+	+ 28.6 %
  - Breast cancer is an epidemic across the nation. There is major cause for concern when breast cancer rates in communities near Limerick Nuclear Power Plant are 51.4% higher in young women 30 to 44, and higher in every other age group. Breast cancer links to radiation exposure are well established.
  - Breast Cancer went up in the Philadelphia area after Limerick Nuclear Power Plant started, while going down when a nuclear power plant closed in San Francisco.

- **Brain Cancer**
  - **Almost Doubled** in Montgomery County in a 5 year period - 1995 to 1999
  - **In Pottstown,** (Limerick Nuclear Power Plant mailing address), Brain Cancer Rates Are **Significantly Higher Than State Average** Or Any Municipality Within 12 Miles.
  - **Brain/Central Nervous System Cancer**  
**32.5% HIGHER than Tri-County**  
**38.3% HIGHER than U.S.**
- State data shows that **Malignant Tumors** are **far higher than the state average**, and even far higher than Philadelphia and Reading. **(See graph)**

Whether radiation releases are accidental or allowed is irrelevant. Limerick Nuclear Power Plant's allowable levels of planned radiation releases from routine operations, as well as unplanned radiation releases from leaks and accidents could be a major factor in the alarming cancer and tumor increases in the areas near Limerick Nuclear Power Plant.

- The BEIR VII Report provides a link - "In BEIR VII, the cancer mortality risks for females are 37.5 percent higher. The risks for all solid tumors, like lung, breast, and kidney, liver, and other solid tumors added together are almost 50 percent greater for women than men, though there are a few specific cancers, including leukemia, for which the risk estimates for men are higher." (Summary estimates are in Table ES-1 on page 28 of the BEIR VII Report prepublication copy, on the Web at <http://books.nap.edu/books/030909156X/html/28.html>.)

The broad range of nuclear power's ionizing radiation has been shown to attack many parts of the body - the thyroid, lungs, liver, spleen, kidneys, ovaries, bone, muscle, and skin. **(See Chart)**

- In Montgomery County, home of Limerick Nuclear Power Plant, in addition to alarming increases in thyroid, leukemia, and breast cancers listed above, there are other alarming cancer increases in other organs from the chart above. For example: Montgomery County Increases 1985-86 to 1996-97 - Kidney Cancer increased 96% and Skin Cancer increased 72%.

A long list of studies by independent experts has long provided evidence that there is no safe dose of radiation so low that the risk of a malignancy is zero. **(See Attachment)**

Massive independent research over the past 20 years provides compelling evidence that exposure to radiation at any level can increase the risk of damage to tissues, cells, and DNA, leading to risk of cancer, leukemia, birth defects, genetic mutations, reproductive disorders, cardiovascular disorders, endocrine system disorders, and immune system damage. There is evidence that specific kinds of ionizing radiation from nuclear power plants is linked to damage of specific organs in the body. **(Identified On Attached Chart Above)**

- Many rising cancers in Montgomery County are in parts of the body (listed on the attached chart) shown as impacted by specific kinds of ionizing radiation from nuclear power plants.

### **NRC's Irresponsible Dismissal Of BEIR VII Conclusions Cause Lack of Trust And Harm**

June, 2005, the BEIR VII committee of scientists concluded no level of radiation dose is safe, yet ten months later, at an NRC annual meeting on Limerick Nuclear Power Plant in Limerick, an

It is difficult to understand why NRC employees have made conclusions and statements to us which deny evidence of harm. We have encountered a casual, dismissive attitude about radiation standards and exposure risks from NRC employees. That is both unfortunate and absolutely unacceptable. It is difficult to have confidence in NRC employees who make claims which defy both science and logic.

## **NRC employee used irresponsible deception to discount the BEIR VII report.**

Fetuses and children are far more at risk from radiation levels permitted to be released at Limerick.

Our question concerned elevated cancers, infant mortality, and other childhood disability around Limerick and their relationship to NRC's outdated, unprotective radiation standards based on the average male, not fetuses and children.

- An NRC employee claimed BEIR VII scientists did not recommend more protective standards in their June, 2005 report and therefore, current standards are protective. Video of this inexplicable comment is available upon request. That NRC response was illogical, irresponsible, and deceptive.
  - Why would the National Academy of Science report recommend any level as safe above ZERO, when their report said there is no safe level?
- The NRC employee also stated that Limerick Nuclear Power Plant's radiation emissions were well below "acceptable standards", a statement he cannot prove.
  - This statement ignores the BEIR VII report claiming no level was safe.
  - There is no attempt to account for the additive, cumulative, and synergistic harmful health impacts of all the kinds of radiation released from Limerick.
  - Exelon, the company with a vested interest in the outcome, is doing all the monitoring, testing, and reporting. Considering what has happened at Exelon's nuclear plants in Chicago, it is difficult to have complete trust in radiation emitted into our water, air, and soil here. In addition, it appears Exelon is not required to test, monitor, or report on all the kinds of radiation associated with nuclear power plants.
  - Without site specific independent and comprehensive testing of our, air, water, soil, or the bodies of our children, to know exactly how much of what kinds of radiation exposure people around Limerick are exposed to regularly (not to mention accidental releases), the NRC employee irresponsibly claimed Limerick's radiation releases were not causing a threat to our children based on levels released by Limerick.
  - There are no NRC studies to show levels of radiation in the bodies of our children.
  - The Radiation and Public Health Project collected teeth of children in our area to measure for Strontium-90 radiation, and found high levels of Strontium-90 in the teeth of children around Limerick Nuclear Power Plant. **See Attachments – RPHP Reports and Graphs)**
- BEIR VII Report estimates the differential risk for children. For instance, the same radiation in the first year of life for boys produces three to four times the cancer risk as exposure between the ages of 20 and 50. Female infants have almost double the risk as male infants. (Table 12 D-1 and D-2, on pages 550-551 of the prepublication copy of the report, <http://books.nap.edu/books/030909156X/html/550.html>)." (excerpted from <http://www.ieer.org/comments/beir/beir7pressrel.html>)
- To truly protect children and other vulnerable populations, NRC radiation standards should be ZERO. Exposure at any level above zero should be unacceptable to NRC based on the body of evidence of harm and the BEIR VII Report.
  - **However, it is a start if NRC demands far more precautionary regulations based on recognition of the unique impacts of radiation exposure to vulnerable populations, especially children. Clearly, more protective radiation standards are long overdue and crucial for the future health of our children.**

- Inexplicably, to date, NRC failed to provide more protective radiation standards that would be more precautionary of children, fetuses, and the more vulnerable such as those already sick. Harm from radiation exposure at any level can no longer be disputed and should NOT be denied or ignored by NRC. Ignoring and/or denying the reality continues to unnecessarily jeopardize the public, especially fetuses, children, and those already sick.
- Hopefully, with more protective regulations, NRC employees will start to take radiation exposure more seriously and make more responsible comments and decisions regarding radiation health impacts to the public, especially fetuses and children.

**Protecting The Public From Radiation Emissions  
Into Their Air, Water, Soil, And Bodies  
From Routine Releases and Accidental Radiation Releases At Nuclear Power Plants  
Should Be A Moral And Ethical Obligation For NRC**

**Necessary Actions For Protecting The Most Vulnerable Populations  
In NRC Radiation Standards**

1. Protect the most vulnerable by accounting for more vulnerable populations in NRC standards.
2. Recognize "allowable" levels are not safe. NRC's "allowable" levels of radionuclides are NOT conservative or protective enough for vulnerable fetuses, growing infants and children, the elderly, and those in poor health. They are based only on the obsolete "standard man", a healthy, white male. They also ignore women, who are, according to the BEIR VII Report, 37- 50% more vulnerable than standard man to the harmful effects of ionizing radiation.
3. Consider radiation damage from inhaling or ingesting radionuclides. NRC does not consider the effects of internal radiation from ingested or inhaled alpha and beta emitters. The amount of polonium-210 that recently killed a former Russian intelligence officer was inaccurately considered by IAEA and NRC to be of the lowest possible risk because NRC failed to account for internal radiation damage.
4. Recognize there is no safe dose. Further, regarding low dose radiation, the BEIR VII panel has concluded, "It is unlikely that a threshold exists for the induction of cancers... Further, there are extensive data on radiation-induced transmissible mutations in mice and other organisms. There is therefore no logical reason to believe that humans would be immune to this sort of harm."
5. Recognize that the public is exposed to additive, cumulative, and synergistic radiation doses, far greater than the exposure threat from just one dose of one kind of radiation at a time as evaluated under current standards. Evidence suggests the public can no longer afford to accept radiation standards which are based on illusion. It is long past time to stop ignoring the magnitude of the potential health impacts from additive, cumulative, and synergistic doses of all radiation exposures, especially to those who are unfortunate enough to live around nuclear power plants.
6. NRC should protect all members of the public from all types of excess radiation exposure from nuclear power and its fuel cycle, gamma, alpha, beta, neutron, particulate, fission products, noble gases, etc. and that measurement and monitoring should include all forms and pathways, not just gamma at the fence line.

7. NRC should recognize that low levels of radiation exposure over time can be just as harmful as one high level dose, and make more responsible decisions to immediately warn the public based on any radiation release above normal.
8. Radiation limits should include accidental nuclear power plant releases, as well as the planned everyday radiation emissions from routine operations.
9. Recognize that it is far more costly to the public, than it is for the nuclear industry, if NRC allows nuclear power plants to avoid spending what is necessary to provide all available filtering and monitoring technologies for their radiation emissions into our air, water, soil, and eventually our bodies.
10. Recognize that prevention is key, due to the fact that some radionuclides that are released into the air, water, and soil and their by-products can continue to damage human health for millions of years. Costs for more protective filtering and monitoring technologies pale by comparison to public's costs if NRC fails to require available prevention technologies. NRC should not succumb to the nuclear industry's quest to reduce economic costs, including deferring maintenance which can increase the radiation released – and the risks. For what are the true costs to the public if NRC fails to take more protective action now?

#### **Petitioner's Request**

ACE commends and is thankful that the petitioner is requesting NRC to prepare a rulemaking that will require that the NRC reconcile its generic environmental impact statement for nuclear power plant operating license renewal applications with current scientific understanding of the health risks of low-level radiation, including but not limited to those discussed in the National Academy of Sciences Health Risks From Exposure to Low Levels of Ionizing Radiation: Biological Effects of Ionizing Radiation (BEIR) VII Phase 2 Report.

- However, we urge NRC to require more protective radiation standards for all older nuclear power plants to protect fetuses, children, the elderly, and those already sick around Limerick Nuclear Power Plant and others.

#### **For A Safer Healthier Future ACE URGES NRC To Exercise Precaution**

We appreciate this opportunity to provide NRC with comments. We hope that as NRC Commissioners you will consider each of our comments, as though your children and grandchildren or other family members were living in the shadow of Limerick Nuclear Power Plant.

**Please send a written response to:**

**ACE President, Dr. Lewis Cuthbert  
P.O. Box 3063  
Stowe, PA 19464**

**From:** "AceActivists@Comcast.net" <AceActivists@Comcast.net>  
**To:** "NRC Secretary" <SECY@nrc.gov.>  
**Date:** Mon, Jan 29, 2007 8:28 AM  
**Subject:** ACE COMMENTS - MORE PROTECTIVE RADIATION STANDARDS

To: NRC Secretary

Please review and consider ACE attached comments and requests for more protective radiation standards - PRM-51-11

The attachments that are referred to in our comments will be provided in hard copy by mail.

Thank You,  
Dr. Lewis Cuthbert  
President  
Alliance For A Clean Environment  
(610) 326-6433

**Mail Envelope Properties** (45BDF662.3BD : 11 : 17341)

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# RADIATION-NO SAFE DOSE

WASHINGTON – June 29, 2005

A new report from:

The National  
Academies'  
National  
Research  
Council says:

# NEWS

THE NATIONAL ACADEMIES  
*Advisers to the Nation on Science, Engineering, and Medicine*

NATIONAL ACADEMY OF SCIENCES • NATIONAL ACADEMY OF ENGINEERING • INSTITUTE OF MEDICINE • NATIONAL RESEARCH COUNCIL

**“A preponderance of scientific evidence shows that even low doses of ionizing radiation are likely to pose some risk of adverse health effects.”**

Specifically, the committee's thorough review of available biological and biophysical data supports a "linear, no-threshold" (LNT) risk model, which says that the smallest dose of low-level ionizing radiation has the potential to cause an increase in health risks to humans.

In the past, some researchers have argued that the LNT model exaggerates adverse health effects, while others have said that it underestimates the harm. **The preponderance of evidence supports the LNT model, this new report says.**

**"The scientific research base shows that there is no threshold of exposure below which low levels of ionizing radiation can be demonstrated to be harmless or beneficial,"** said committee chair Richard R. Monson, associate dean for professional education and professor of epidemiology, Harvard School of Public Health, Boston. **The study committee defined low doses as those ranging from nearly zero to about 100 millisievert (mSv)**

**"The health risks – particularly the development of solid cancers in organs – rise proportionally with exposure. At low doses of radiation, the risk of inducing solid cancers is very small. As the overall lifetime exposure increases, so does the risk."**

**The report is the seventh in a series on the biological effects of ionizing radiation.**

The report was sponsored by the U.S. departments of Defense, Energy, and Homeland Security, the U.S. Nuclear Regulatory Commission, and the U.S. Environmental Protection Agency. The National Research Council is the principal operating arm of the National Academy of Sciences and the National Academy of Engineering. It is a private, nonprofit institution that provides science and technology advice under a congressional charter.

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# **RADIATION**

## **NO SAFE DOSE**

“There is no safe level of exposure and there is no dose of radiation so low that the risk of a malignancy is zero”—Dr. Karl Z. Morgan, dubbed the father of Health Physics. 1

“...there is no safe level of exposure to ionising radiation, and the search for quantifying such a safe level is in vain.”—Rosalie Bertell, PhD. 2

In 1940, several members of the US Committee on X-Ray and Radium Protection “proposed that the [radiation exposure] standard be lowered by a factor of five in response to the accumulating evidence that ANY amount of radiation, no matter how small, can cause genetic damage, injuring future generations.” Gioacchino Failla argued against the lowering of the standards saying that “if genetic damage were to be a consideration for standard-setters, then logically no radiation exposure should be allowed.” 3

“...the human epidemiological evidence establishes—by any reasonable standard of proof—that there is no safe dose or dose-rate...the safe-dose hypothesis is not merely implausible—it is disproven.” Dr. J.W. Gofman 4

“One thing we should take from this (1991 study of Oak Ridge weapons workers by Steve Wing, et al.) is that there isn’t any safe level of radiation exposure...”  
Dr. Carl Shy 5.

“The reanalysis (of Hanford worker data) provides no support for the idea that...there is reduced cancer effectiveness of radiation at low dose levels...” Drs. G.W. Kneale and A. Stewart 6.

“There is evidence that single tracks of all types of ionizing radiation can induce a variety of damage including DNA double-strand breaks which are believed to be critical lesions in radiation exposure. There is also a body of experimental evidence that argues against an error-free DNA repair system operating at low doses of ionizing radiation that might result in a dose threshold for the induction of gene and chromosomal mutations.” MP Little and CR Muirhead. 7

“An important feature of alpha irradiation is that, no matter how low the total dose to the whole body, a substantial dose of radiation (approx. .5 Gy) is delivered to an individual cell if it is traversed by a single alpha particle.” E Wright 8.

Works Cited:

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- 2.....*No Immediate Danger? Prognosis for a Radioactive Earth*. Women's Educational Press, Toronto, Ontario. 1985: 45. isbn 0-88961-092-4
- 3 Caufield, Catherine. *Multiple Exposures: Chronicles of the Radiation Age*. Harper and Row, New York. 1989: 48. isbn 0-06-015900-6.
- 4...*Radiation-Induced Cancer from Low-Dose Exposure: An Independent Analysis*. Committee for Nuclear Responsibility, Inc. 1990:18-16, 18-18. Isbn 0-932682-89-8.
- 5 Garloch, Karen. "Repeated low radiation doses hike leukemia risk, UNC study finds." *The Charlotte Observer*. Wednesday, March 20, 1991.
- 6 ..."Reanalysis of Hanford Data: 1944-1986 Deaths." *American Journal of Industrial Medicine*. 23:371-389 (1993).
- 7..."Curvilinearity in the Dose-Response Curve for Cancer in Japanese Atomic Bomb Survivors." *Environmental Health Perspectives*. 105 (6): 1505. (1997)
- 8..."Chromosomal instability in the descendants of unirradiated surviving cells after alpha particle irradiation." *Proc. Natl. Acad. Sci. USA*. 95: 5730 (1998).

**INCREASING  
CANCER  
RATES**

**In Montgomery County  
Home Of**

**LIMERICK  
NUCLEAR  
POWER PLANT**

# **ALARMING Montgomery County CANCER STATISTICS**

Source: Pennsylvania State Cancer Registry - From 1985-86 To 1996-97

Largest Increases In Newly-Diagnosed Cases Occurred For The Following Cancers:

- **Prostate**                      **Increased**      **132%**
- **Thyroid**                      **Increased**      **128%**
- **Kidney**                      **Increased**      **96%**
- **Multiple Myeloma**      **Increased**      **91%**
- **Hodgkin's Disease**      **Increased**      **67%**
- **Non-Hodgkin's Lymphoma**      **61%**
- **Breast**                      **Increased**      **61%**
- **Pancreas**                      **Increased**      **54 %**
- **Leukemia**                      **Increased**      **48%**

Limerick Nuclear Power Plant Is Located In Montgomery County  
It Releases Radioactive Gases And Liquids Into The Air, Water, and Soil  
During Everyday Routine Operations

# Alarming Statistics

Deaths from Neoplasms in Children Ages 1 to 14  
1981-89 vs. 1990-98 CDC Website

## Childhood Cancer

Montgomery County + **71% Increase**

Childhood Cancer Deaths in Montgomery County are UP,  
while DOWN in neighboring counties, PA, and the US

Chester County - **29.0% Decrease**

Berks County - **30.6% Decrease**

Pennsylvania - **17.1% Decrease**

U.S. - **21.2% Decrease**

**Children Are The Barometers Of Our Society**  
**These Facts Should Serve As A WARNING**

Montgomery County is the home of the Limerick Nuclear Power Plant which first went on line in the mid 1980's. Radiation emitted from the Limerick Nuclear Power Plant could be a Major Factor in increased childhood cancer deaths in Montgomery County. The Chernobyl experience confirmed a valuable lesson: Children are by far the most vulnerable to radiation exposure, even in relatively small doses. The American Academy of Pediatrics states that children are extra sensitive to the DNA-damaging effects of radioactive energy.

# CHILDHOOD CANCER

**92.5 % ABOVE NATIONAL AVERAGE**

(Ages 0-19) All Cancers Diagnosed from 1995-1999

Pottstown, West Pottsgrove, Lower Pottsgrove, Upper Pottsgrove, North Coventry, Douglass Berks Township  
 Almost 100% Higher Than State & Tri County Averages  
 Other PENNSYLVANIA - 2.9 % BELOW NATIONAL AVERAGE  
 Other TRI COUNTY (Montgomery, Berks, Chester) - 0.8 % BELOW NATIONAL AVERAGE

Major Types of Cancer in Children - Compared With U.S. Rate 1990-1999

Type of Cancer	Cases 0-19	Rate per 100,000		%AboveU.S.	Significance
		Gr. Pottstown	U.S.		
All Cancers	40	28.33	16.04	+ 76.6	p<.02
Leukemia	13	9.21	3.89	+136.8	p<.055
Brain/Central Nervous Sys.	7	4.96	2.98	+ 66.4	
Kidney/Renal Pelvis	5	3.54	0.73	+384.9	p<.09
Non-Hodgkin's Lymphoma	4	2.83	1.04	+172.1	
All other	11				

(Source: PA Cancer Registry)

Note: Rates calculated using 1990-99 annual Greater Pottstown population 0-19 of 14,120.  
 For example, leukemia rate = 13 cases/10 years/14,120 x 100,000 = 9.21.

Joseph Mangano, MPH, MBA Radiation and Public Health Project New York, NY June 25, 2003

- Rates are MUCH HIGHER for FOUR of the CANCERS most common in children.
- Rates are SIGNIFICANTLY HIGHER for ALL CANCERS and LEUKEMIA
- Rates are BORDERLINE SIGNIFICANT for KIDNEY/RENAL PELVIS.

Half Of Childhood Cancers Above Are Leukemia and Brain/Central Nervous System Cancers  
 Both have been associated with radiation exposure.

## UPWARD TREND

Late 1980's about **30 %** HIGHER than the NATIONAL AVERAGE

Early 1990's about **60 %** HIGHER than the NATIONAL AVERAGE

Late 1990's up to **92.5 %** HIGHER than the NATIONAL AVERAGE

Late 1990's almost **100 %** HIGHER than the STATE and TRI COUNTY

Nationwide, cancer is the #1 disease-related death in children. All children are exposed to similar environmental pollutants, including pesticides and herbicides, cleaning chemicals, mold, second hand smoke, vehicle emissions, and even genetic factors. Logic suggests that when major cancer causing pollution sources are added factors to overall common causes for cancer in children, rates will be far higher.

Limerick Nuclear Power Plant's  
 Routine Radiation Emissions And Accidental Radiation Emissions  
 Into The Air, Water, and Soil Are Logically A Major Factor In Why Childhood Cancer Rates  
 Have Increased So Dramatically In Communities Listed Above

**It's not surprising that childhood cancer rates in this area have skyrocketed above the national, state, and tri county averages.**

1. A CDC report confirmed vast numbers of chemicals in the bodies of people.
2. The Radiation and Public Health Project confirmed that children in this region have high levels of Strontium-90 radiation in their teeth. This study, while only looking for one kind of radiation in our children, Strontium-90, it confirms that the radiation released at Limerick Nuclear Power plant is getting into the bodies of children in the area. Strontium-90 is not a naturally occurring radiation.
3. March, 2003, EPA reported that fetuses and children under two are the most vulnerable to certain cancer causing and mutagenic chemicals (10 times more vulnerable). Children 3 to 15 are 3 times more vulnerable. The youngest in society are most susceptible to the effects of radiation.
4. Developing fetuses, infants, and children are most susceptible to the harmful effects of radiation. Childhood cancer is a key indicator of impacts. Pregnant women in this region and then their newborn babies are exposed to the routine and accidental radiation releases from Limerick Nuclear Power plant.
5. When babies are born with toxic chemicals in their bodies, then exposed daily through their lungs, skin, and eyes to an additive, cumulative, and synergistic combinations of toxic chemicals, including the most damaging, radiation, the harmful impacts we have uncovered should not be surprising.
6. Skyrocketing childhood cancer rates are not the only sign that Limerick Nuclear Power Plant's routine and accidental radiation emissions may have had harmful impacts on our region's fetuses and children, as evidenced by:

**Documented:**

- ✓ Elevated infant and neonatal mortality at rates far higher than the state average, and even higher than Philadelphia and Reading.
- ✓ Learning disability increases at rates twice the state average (1990 to 2000)

**Beyond the unbearable suffering of children and their families as a result of children cancers and lifelong disabilities, there are astronomical financial costs.**

**Those astronomical costs for unnecessary environmentally linked disease and disability in our children can and must be prevented with a political will to require the necessary precautionary measures.**

**Unnecessary toxic exposure can and must be prevented, especially for the radiation releases from routine operations and accidents at nuclear power plants.**

Alliance For A Clean Environment  
(610) 326-6433

Embargoed until 1 p.m., April 14, 2005

Contact Joseph Mangano 484-948-7965

## **CHILD CANCER SOARS IN MONTGOMERY, PHILADELPHIA COUNTIES RISING RADIATION FROM LIMERICK NUCLEAR PLANT MAY BE CAUSE**

Limerick PA, April 14, 2005 - Rates of leukemia and other cancers in Montgomery and Philadelphia County children have soared since 1990, when national rates are either unchanged or declining, according to a new report presented today.

The unusual increase may be due to airborne radioactive emissions from the Limerick nuclear plant entering children's bodies. A study of Strontium-90 (a chemical found only in nuclear weapons and reactors) found local rates rose 26% from the late 1980s to the early/mid 1990s.

"Infants and children suffer most from radiation exposure," says Joseph Mangano, National Coordinator of the Radiation and Public Health Project (RPHP) research group, and author of both the cancer and tooth studies. "Higher local levels of Sr-90 and childhood cancer after Limerick began operations must be taken seriously by plant operators and regulators."

Limerick, a plant with two reactors, began operations in December 1984 and reached full capacity in January 1990. During the early years of operation, cancer and leukemia death rates for children under age 15 in both Montgomery and Philadelphia Counties were well below the national rate. But in the post-startup period (1991-2002), cancer mortality jumped 48.0% and 22.3%, respectively, compared to a national decline of -20.3%. For leukemia deaths, rates rose 16.0% and 46.4%, compared to a national decline of -27.6%. Montgomery and Philadelphia counties lie southeast of Limerick, which is the downwind direction for much of the year.

RPHP collected 150 baby teeth from Pennsylvania children as part of a national study of over 4,000 baby teeth. In medical journal articles, RPHP found that Pennsylvania had the highest average Sr-90 in teeth of any of the six states with significant numbers of teeth, and that the Limerick's average was highest near seven nuclear plants studied, especially in the Pottstown area, where Limerick is located.

Since 1998, Limerick's reactors have operated over 96% of the time, raising concerns whether an aging plant may be releasing more harmful radioactivity into the environment. Data were made available on the day that U.S. Nuclear Regulatory Commission officials held a public meeting with Exelon, which operates the Limerick plant, to assess its 2004 performance.

High local rates of cancer include adults as well as children. Of the 60 most populated U.S. counties, Philadelphia has the highest age-adjusted cancer death rate, both for whites and blacks, from the period 1997-2002. About 4,000 Philadelphia residents die of cancer each year.

## CHERNOBYL: LESSONS LEARNED

Fortunately, scientists have not had much opportunity to study the effects of a nuclear emergency on human beings. Nuclear weapons have been used only twice against people, in Hiroshima and Nagasaki, Japan, near the end of the World War II. There have been only a handful of nuclear reactor meltdowns, and only one that released deadly levels of radioactive energy. It occurred in April 1986, at a nuclear reactor in Chernobyl, Ukraine.

Chernobyl was the first nuclear emergency large enough to threaten the health and well-being of millions of people. During that catastrophe, one of the main reactors of the power plant melted down, releasing an estimated 120 million curies of radioactive material. The surrounding land was heavily contaminated with plutonium and cesium, as well as with dangerous levels of radioactive iodine. Ultimately, more than 21,000 square kilometers of land were contaminated, and about 135,000 people were permanently evacuated. Experts later estimated that 17 million people were exposed to excess radiation,<sup>4</sup> including 2.3 million children living in eastern Russia, southern Belarus, and northern Ukraine.<sup>5</sup>

At first, scientists did not appreciate the threat posed by high levels of radioiodine released during the meltdown. It did not take long, however, to start seeing the effects. Within four years, there was a sharp spike in the incidence of thyroid cancer.<sup>1</sup> This increase occurred in children who had received less than 30 rems of radioiodine to the thyroid.<sup>6</sup> Within 15 years, more than 1,000 cases of thyroid cancer had been reported in the affected areas, a 30- to 60-fold increase.<sup>8</sup> All of the cases,

according to the World Health Organization, were "most probably solely attributable to this single release of radioactivity to the environment."<sup>7</sup> Significantly, none of these areas made potassium iodide widely available.

Following the Chernobyl meltdown, Poland immediately distributed 17 million doses of potassium iodide, including 10 million to children. This was the first time scientists had an opportunity to study the side effects of potassium iodide in a large population. The news was encouraging: side effects were clinically insignificant.<sup>6</sup>

Awful as it was, the Chernobyl experience confirmed a valuable lesson: children are by far the most vulnerable to radiation exposure, even in relatively "small" doses.<sup>7</sup> Children exposed to radiation suffer from higher rates of certain childhood cancers, especially leukemia and thyroid cancer, and have a greater likelihood of developing breast cancer as adults.<sup>7</sup>

Children's greater vulnerability to radiation exposure is attributable to several factors, according to the American Academy of Pediatrics. First, children have higher minute ventilation, or a higher

concentration of tiny capillaries in the lungs. This leads to greater radioactivity exposure from the same amount of radioactive material. Second, children are extra sensitive to the DNA-damaging effects of radioactive energy. Finally, children are more likely than adults to suffer from long-term psychological injury due to a radiation disaster.<sup>1</sup>

## GUIDELINES FOR PROTECTION

Fortunately, adults and children who are given potassium iodide may be completely protected from radioiodine. According to the Federal Register, "potassium iodide should be stockpiled and distributed to emergency workers and institutionalized persons for radiological emergencies at a nuclear power plant and its use should be considered for the general public within the 10-mile emergency planning zone of a nuclear power plant."<sup>8</sup>

Significantly, however, this is only a recommendation. The final decision to stockpile potassium iodide has been left to state and local governments. Although the NRC has made free doses available to local governments, a significant



Shown above: Children suffering from leukemia believed to be the result of exposure to radiation emitted during the 1986 Chernobyl nuclear disaster.

# Thyroid Cancer

1985-86 to 1996-97

Montgomery County's Rising Cancer Incidence Shows A

128% Increase

1998, 1999, and 2000,

Montgomery County's Thyroid Cancer Rate Is About

75% Higher

Than the U.S. Rate (which is also rising).

The Greater Pottstown rate for 1995-1999 is 6.0,  
Just higher than the U.S. rate of 5.9, but lower than the county rate.

**Thyroid Cancer Rates  
Have Absolutely Soared In Montgomery County  
Home Of The Limerick Nuclear Power Plant Since The Mid 1980's.**

***Limerick Nuclear Power Plant Is Likely A MAJOR Factor,  
Specifically Radioactive Iodine Particles Emitted From Limerick.***

**Radiation Emitted From The Limerick Nuclear Power Plant  
Is Breathed In And Can Also Be Ingested In Milk And Water.**

The two Limerick reactors started in 1984 and 1989. It can take years between exposure and diagnosis of cancers. So the rise after 1995 is not a surprise - This was found in other areas such as eastern Connecticut, near the Millstone plant. Within four years of the Chernobyl accident there was a sharp spike in the incidence of thyroid cancer. All of the cases, according the World Health Organization, were "most probably solely attributable to the release of radioactivity to the environment."

**This is evidence in a scientific sense,  
Since thyroid cancer is still relatively rare.**

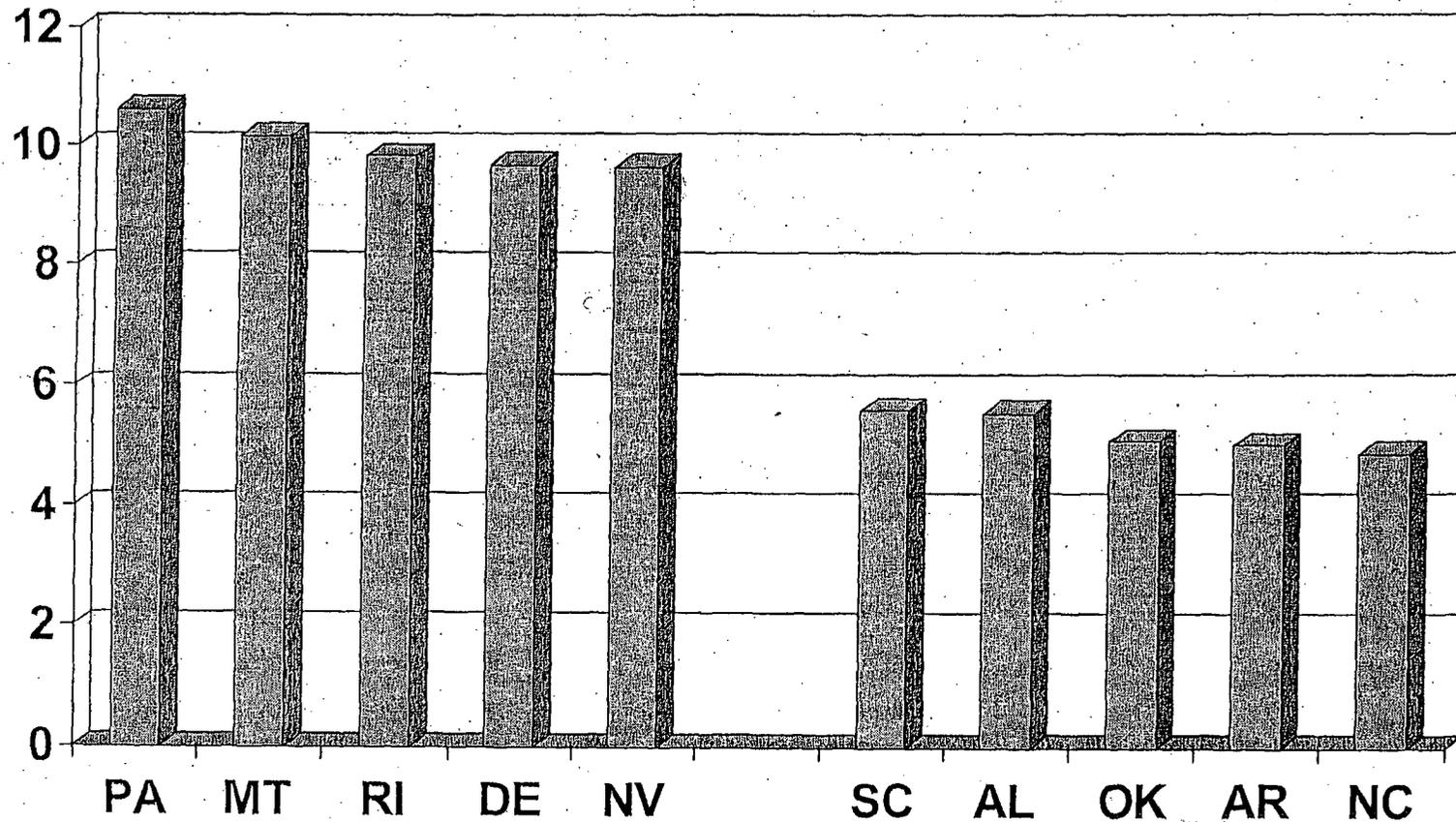
**THYROID CANCER INCIDENCE, MONTGOMERY COUNTY MONT. ADJ RATE CASES US  
RATE**

1985 2.7 19 4.5  
1986 5.1 38 4.6  
1987 5.9 43 4.3  
1988 3.2 27 4.3  
1989 3.6 31 4.6  
1990 3.6 31 4.7  
1991 4.5 37 4.7  
1992 5.7 46 5.1  
1993 5.5 45 4.8  
1994 4.8 41 5.3  
1995 4.9 42 5.5  
1996 7.3 62 5.6  
1997 7.4 68 5.9  
1998 10.4 93 6.0  
1999 12.3 107 6.3  
2000 10.1 89 6.5

# THYROID CANCER INCIDENCE, BY STATE

1999-2002

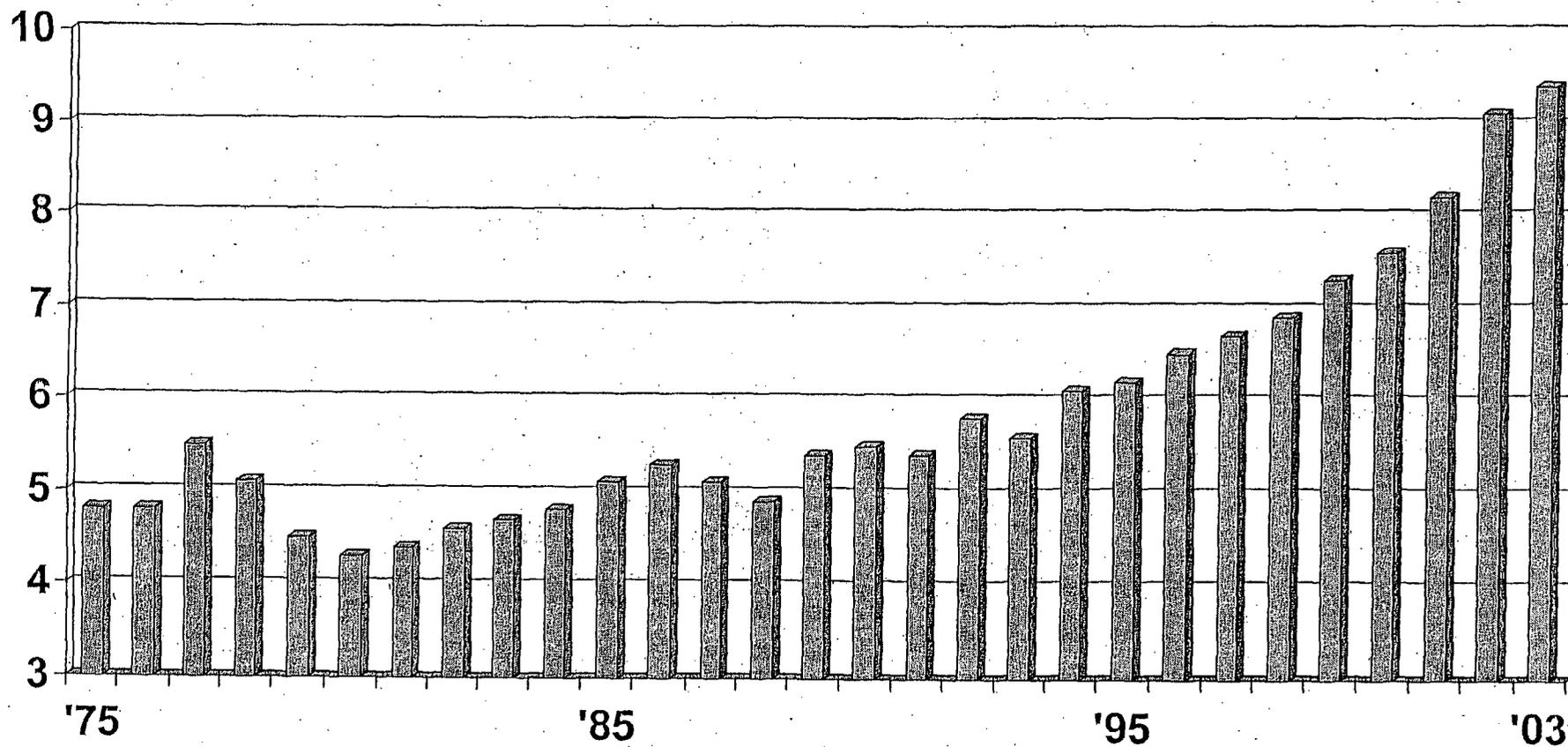
Expressed in Cases per 100,000 population, adjusted to 2000 U.S. Standard  
Includes 38 states plus DC. Source: <http://wonder.cdc.gov>



# THYROID CANCER INCIDENCE, U.S.

1975-2003

Expressed in cases per 100,000 population  
Adjusted to the 2000 U.S. standard population

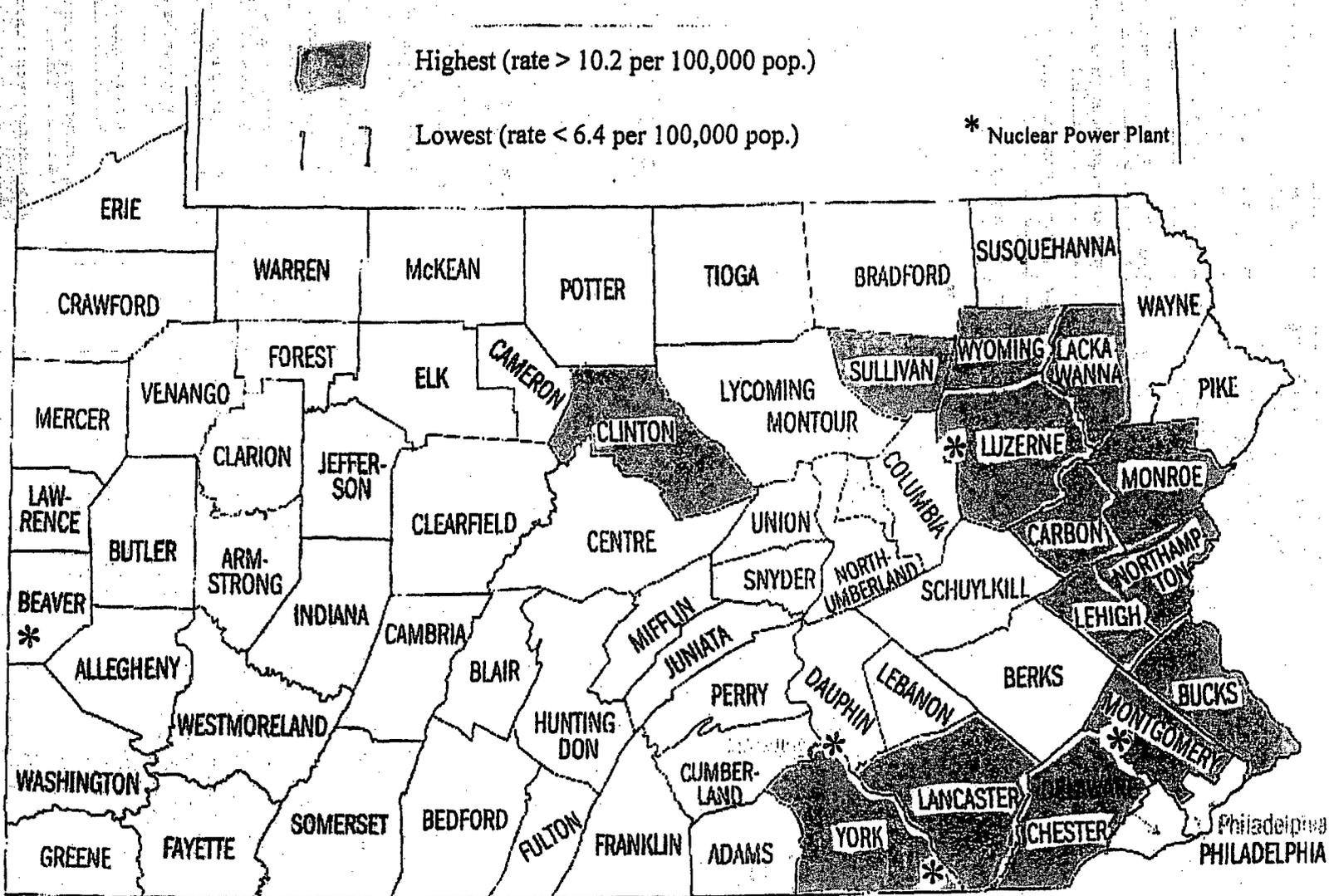


# 1997 - 2003

## THYROID CANCER INCIDENCE RATE

### BY PA COUNTY

(Adjusted to the 2000 U.S. Standard Population)



# **Leukemia**

**Montgomery County**

**1985-86 to 1996-97**

**Up 48%**

Source: PA Cancer Registry Statistics

**From 1985 to 1994**

**West, Upper, Lower Pottsgroves,  
Pottstown, North Coventry, Douglass Berks Township**

**Leukemia was almost DOUBLE**

**The State Average**

Source: PA Cancer Registry Data

**Low-Level Radiation  
Is Linked With Leukemia**

**Since 1985**

**Limerick Nuclear Power Plant  
Released Radiation Into The Air, Water, Soil  
Every Day During Routine Operations**

# Leukemia linked to low-level radiation

■ Studies of children exposed to Chernobyl fallout while in the womb show elevated levels of the cancer.

Associated Press

NEW YORK - For the first time, researchers have detected elevated leukemia rates among children exposed in the womb to fallout from the Chernobyl nuclear disaster, raising disturbing questions about the effects of everyday, low-level radiation on early pregnancy.

Infant leukemia rates more than doubled among Greek children who were exposed to the nuclear power plant's fallout while in the early stages of pregnancy, according to a study released Thursday.

The radiation exposure in Greece was only up to five times higher than what Greeks normally would have received in the year after the accident.

That suggested to the researchers that even the low levels of radiation people are exposed to every day - much of it naturally occurring in food, water and the air - also could contribute to cancer. There are trace amounts of radioactive elements everywhere.

"This is going to create a lot of objections from people who think there is an overanxiety over low levels of exposure," said one of the authors, Dimitrios Trichopoulos of the Harvard Center for Cancer Prevention in Boston.

The study, published in the journal *Nature*, is the first indication leukemia rates might have increased in areas affected by the Chernobyl fallout. Other studies have found elevated rates of thyroid cancer among children.

The researchers collected information on 1.3 million children born in Greece during the 1980s. Among those born in the months after Chernobyl, the researchers found, children in parts of Greece exposed to the fallout were 2.5 times more likely to suffer from leukemia than their unexposed counterparts.

Radiation exposure in Greece was much lower than in regions closer to the accident, which occurred near the Ukrainian city of Kiev.

In Europe overall, about one in 2,000 children develops leukemia by the age of 15. The cancer, which affects the tissues that generate blood cells in the bone marrow and lymph system, is fatal for about three out of four infants who get the disease.

Among epidemiologists, the dangers of low radiation doses from such sources as X-rays and natural radon gas are greatly disputed.

Some researchers point out that there is little direct information about low doses, because the health effects of radiation largely have been studied among populations exposed to high levels, such as survivors of the Hiroshima and Nagasaki atomic bombs.

The study detected additional leukemia cases by looking not just at who was exposed to Chernobyl's radiation, but when. Babies conceived after the fallout had dissipated had no increased incidence of leukemia. Neither did children who were exposed as infants or during the last stages of pregnancy.

Only infants who were exposed during the early stages of fetal development suffered leukemia at increased levels, the study found.

Based on that finding, the researchers suggested the radiation may have caused genetic damage during the critical early stages of pregnancy that led to the leukemia.

# Environmental Health Monthly

Vol. 5 No. 3

December, 1992

## ABSTRACT

### Editorial Review Board

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*Commentary by Steve Wing, PhD and Carl Shy, MD, Dr. PH, University of North Carolina School of Public Health.* It is well known that ionizing radiation can cause cancer, especially leukemia, thyroid, lung and breast cancer, in heavily exposed persons. But in this study, workers at the Oak Ridge National Laboratory were not highly exposed; their average exposures were hardly above usual background levels of ionizing radiation. The death rates of these workers for cancers and for all causes combined was below the national average. However, their leukemia death rate was slightly elevated (63% above average); this finding is significant because leukemia is one of the sentinel cancers caused by ionizing radiation. Of greater significance is that workers who were exposed to slightly greater levels of ionizing radiation showed higher death rates from all cancers combined as well as from leukemia compared to less exposed workers and the risk of cancer increased with the amount of radiation received at the work place. Furthermore, the radiation induced cancers did not appear until 35 years or more after the laboratory was first opened suggesting that there is a long delay between first exposures to low level radiation and the manifestation of excess cancer deaths.

Can these results be directly applied to ionizing radiation from medical x-rays or to workers in the nuclear power industry? The simplest answer is: possibly, but we don't know. Some workers at the Oak Ridge National Laboratory were simultaneously exposed to other cancer risk factors, such as tobacco smoking, alcohol, chemical solvents and reagents, sunlight, and some components of diet. Their life style, living standards and work experiences differ from those of other population groups exposed to ionizing radiation. Although our analysis controlled for some of these variables to the extent that there was information about other cancer risk factors, any epidemiological study of prolonged low level radiation is subject to uncertainties, due to lack of complete information on all relevant factors and to problems in measuring exposure to radiation itself. Until these results are confirmed in other studies of workers exposed to prolonged low level radiation, we cannot answer the question about the direct applicability of these results to other exposed persons. However, this study, along with other evidence, opens to question the existing standards for occupational exposure to ionizing radiation, since out of 88,000 annual dose readings for workers at the Laboratory, only 135 ever exceeded the present occupational standard.

The emergence in this study of a pattern of increasing cancer death rates with increasing low level radiation exposure, the stronger association with radiation received decades ago than with recent doses, the specificity of the association with cancer rather than with other causes of death and the observation of an overall excess of leukemia deaths compared with the general population, all are consistent with a real low dose radiation effect. This raises concern that our results may be applicable to other populations exposed to low level radiation. It is crucial that epidemiological studies of other occupationally exposed populations be conducted to address the ultimate implications of this study.

# **BREAST CANCER**

***Links Between Radiation Exposure And Breast Cancer Are Compelling.  
Limerick Nuclear Power Plant's Routine and Accidental Radiation Emissions  
Are Logically A Major Factor In Breast Cancer Data Documented Below.***

## **Montgomery County**

1985-86 to 1996-97 - Rising Incidence

# **61% Increase**

Source: PA State Cancer Registry

Statistics: Joseph Mangano, MPH MBA National Coordinator RPHP (610) 666-2985

## **Compared to the Nation and Tri County**

6 Municipalities - All Within 5 Miles Of Limerick Nuclear Power Plant  
Lower Pottsgrove, Upper Pottsgrove, West Pottsgrove, Pottstown, North Coventry, Douglass Berks

## **SIGNIFICANTLY HIGHER**

1995-1999 Type of Cancer	Cases	Local Gr. Potts.	Rate per 100,000 U.S.	Oth. 3 Co.	% Above U.S.	% Above Tri County
<b>Breast</b> (female)	263	161.5	116.0	129.8	<b>+39.2 %</b>	<b>+24.5 %</b>

Breast Cancer **By Age** (diagnosed 1995-1999) - Compared to the National Average

<u>Age</u>	<u>% HIGHER than U.S.</u>
<b>0 - 29</b>	<b>+ 15.3 %</b>
<b>30 - 44</b>	<b>+ 51.4 %</b>
<b>45 - 64</b>	<b>+ 39.3 %</b>
<b>65+</b>	<b>+ 28.6 %</b>

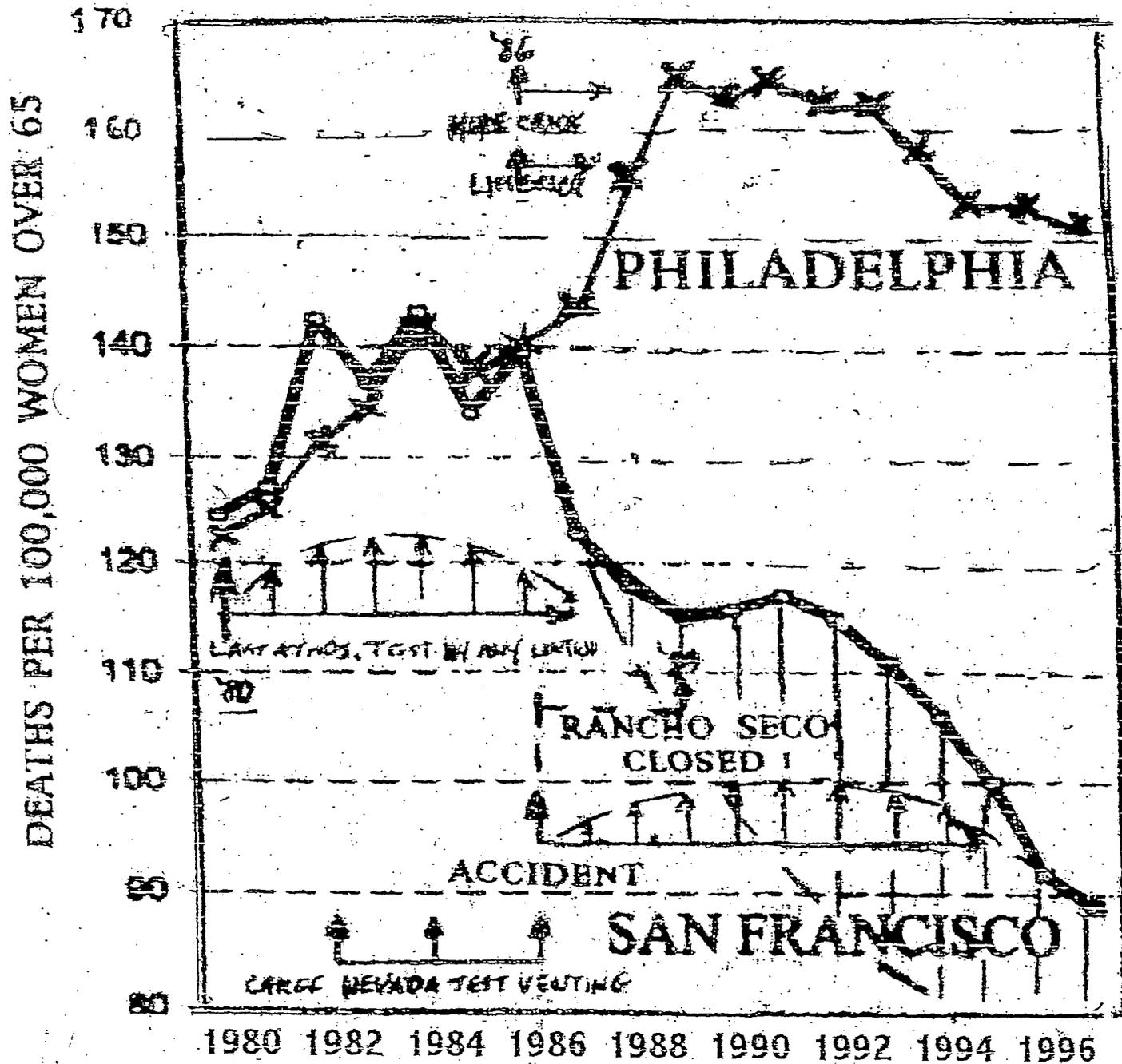
1995 to 1999, in just five years, a total of 263 women were newly diagnosed with Breast Cancer in the communities listed above. Among young adult women the most frequently diagnosed cancer, by far, is breast cancer.

Sources: Pennsylvania State Cancer Registry, National Cancer Institute (cancer cases) 1995 to 1999.  
U.S. Census Bureau (population data)

Statistics: Joseph Mangano, MPH MBA National Coordinator RPHP (610) 666-2985

**Breast Cancer Is An Epidemic Across The Nation. There is major cause for concern when breast cancer rates in women 30-44 in this area are 51.4% higher than the national average and higher in every age group.**

BREAST CANCER DEATHS, WOMEN OVER 65  
 SAN FRANCISCO AND PHILADELPHIA  
 1980-1997  
 THREE YEAR MOVING AVERAGE



## BREAST CANCER CHANGES IN SAN FRANCISCO AND PHILADELPHIA 1980-97

The chart of breast cancer mortality rate per 100,000 women over 65 in the cities of San Francisco and Philadelphia for the period 1980 to 1997 represents the outcome of an enormous unintended human experiment as to the effect of small releases of radioactive nuclear fission products from commercial nuclear plants at presently permitted amounts into the air and water. As shown in this chart, the two cities had the same rising breast cancer mortality rate between 1980 and 1986, the year that the only nuclear reactor, Rancho Seco, was shut down because of an accident in December 1985, while the Limerick Unit I reactor began commercial operation near Philadelphia in February 1986 in Pottstown, Pa. in addition to a number of other reactors already operating within 70 miles of Philadelphia. However, it is seen that within just a few years after 1986 the mortality rates began to diverge sharply, with the deaths in San Francisco declining while those in Philadelphia rose sharply, the gap widening steadily until by 1997 the mortality rate in Philadelphia exceeded that in San Francisco by nearly 70%.

The only possible causal factor for breast cancer that is known to have suddenly changed is that of man-made radiation produced by fission products released into the local air and water. All the ordinary chemical pollutants such as pesticides, herbicides, dioxin, PCB, automobile exhaust, cigarette smoke and fine particulates in the air did not suddenly disappear in San Francisco and increase in Philadelphia in just two to four years. Nor is it likely that medical factors such as the use of mammography changed suddenly in opposite directions in the two cities, or that the availability of medical treatment for breast cancer sharply declined in Philadelphia while it rose suddenly in San Francisco at exactly the same time as the amounts of fission products released from local nuclear plants changed. Clearly, such factors as genetic predisposition for developing breast cancer could not have changed so rapidly, or such known life-style factors as the number of children born to these women and the time they breast-fed their newborns, since all the women represented in the chart were over 65 years of age at death.

On the other hand, a rapid rise in breast cancer mortality took place in Westchester, N.Y. between 1975 and 1979, when the Indian Point Nuclear Plant Units II and III went into operation in that county, while the rate for New York City declined from a peak in 1978 as the city's drinking water supply was increasingly changed from the Croton River watershed in Westchester to the distant headwaters of the Delaware River to the west as described in the International Journal of Health Services, Volume 23, No. 4, pages 783-804, 1993.

The reason why the deaths changed so rapidly after changes in the exposure to fission products as compared to many years when the exposure is due to X-rays or gamma rays from a nuclear weapon explosion is the following. Research within the last few decades has shown that low dose exposures protracted over long periods of time as compared to brief exposures from a short diagnostic X-ray or a flash of radiation from a nuclear detonation produce much greater cellular damage per unit dose absorbed by factors as large as ten to a thousand times, depending on the degree of protraction. Moreover, releases from nuclear weapons or reactors involve many different radiation emitting elements that concentrate in key organs, while external radiation exposures do not do so. Particularly serious are the bone seeking elements chemically similar to calcium, such as Strontium-90, Barium-140, Plutonium-239, or Lead-210. The short range electrons and alpha particles emitted reach the bone marrow where they damage the white cells of the immune system needed to fight cancer cells, bacteria and viruses. Thus, the most vulnerable individuals who are already suffering from cancer or infectious diseases when the fission products are inhaled or ingested will often die within a short time after exposure, explaining the rapid changes in the mortality rates of the women over 65 seen for the two cities as reported by the Center for Disease Control on its web-site [cdc.gov/wonder](http://cdc.gov/wonder) from which this data was obtained.

# Brain/Central Nervous System Cancer

## Area vs. Tri County and U.S.

Includes Lower Pottsgrove, Upper Pottsgrove, West Pottsgrove, Pottstown, North Coventry, Douglass Berks.  
Other 3 Counties refer to remaining areas of Berks, Chester, and Montgomery Counties

**Incidence Rates - Greater Pottstown Area**  
(adjusted incidence rates per 100,000 pop., from 1995-99):

## **Area EXCEEDS**

Tri-county + **32.5%**

U.S. + **38.3%**

Greater Pottstown (23 cases) = 8.3  
Other tri-county = 6.2  
U.S. (12 states/metro areas) = 6.0

**At one time, the local rate was not high -- but now it is.**

## **Historical Statistics on Brain/Central Nervous System**

Greater Pottstown Area - Around Pottstown Landfill

1985-89 15 cases

1990-94 19 cases

1995-99 23 cases

Childhood Cancer has increased in similar numbers

The number of childhood (0-19) cancer cases are

1985-89 15 cases

1990-94 18 cases

1995-99 22 cases

Almost exactly the same!!!!!!

# Brain Cancer

Source: PENN State - Graduate Student Research

Statistics: PA Department of health, Bureau of Health Statistics (2001, August)

Analysis of cancer incidence in PA counties 1994-1998 <http://www.health.state.pa.us/stats>

Professor - Dr. Steven Couch - (717) 948-6036

## MONTGOMERY COUNTY

### **BRAIN CANCER ALMOST DOUBLED IN ONLY 5 YEARS.**

(1995 to 1999)

#### Montgomery County Brain Cancer

1995 5.80 per 100,000

1999 10.08 per 100,000

### **1999 Brain Cancer Statistics**

(Ages 15 and above) Tri County Area

	Cases	per 100,000
<b>Montgomery County</b>	<b>73</b>	<b>10.08</b>
Berks County	35	9.77
Chester County	22	5.12

**Montgomery County has the HIGHEST RATE of BRAIN CANCER by a large margin compared to: U.S., PA, and Tioga County in PA (a less polluted county for comparison)**

## POTTSTOWN

**BRAIN CANCER IS SIGNIFICANTLY HIGHER than state and national averages and SIGNIFICANTLY HIGHER than any municipality within a 12 mile radius.**

Municipality-level statistics can not account for the high numbers of brain cancers in Pottstown.

1999 Brain Cancer Statistics - Rate per 100,000 in Pottstown 9.25

# **CANCER DEATH RATE**

1995-2004

***13 Townships and Boroughs  
Near Limerick Nuclear Power Plant***

**Limerick**  
**Schwenksville**  
**Trappe**  
**Collegeville**  
**Royersford**  
**Lower Pottsgrove**  
**Upper Pottsgrove**  
**West Pottsgrove**  
**Pottstown**  
**Pennsburg**  
**Perkiomen**

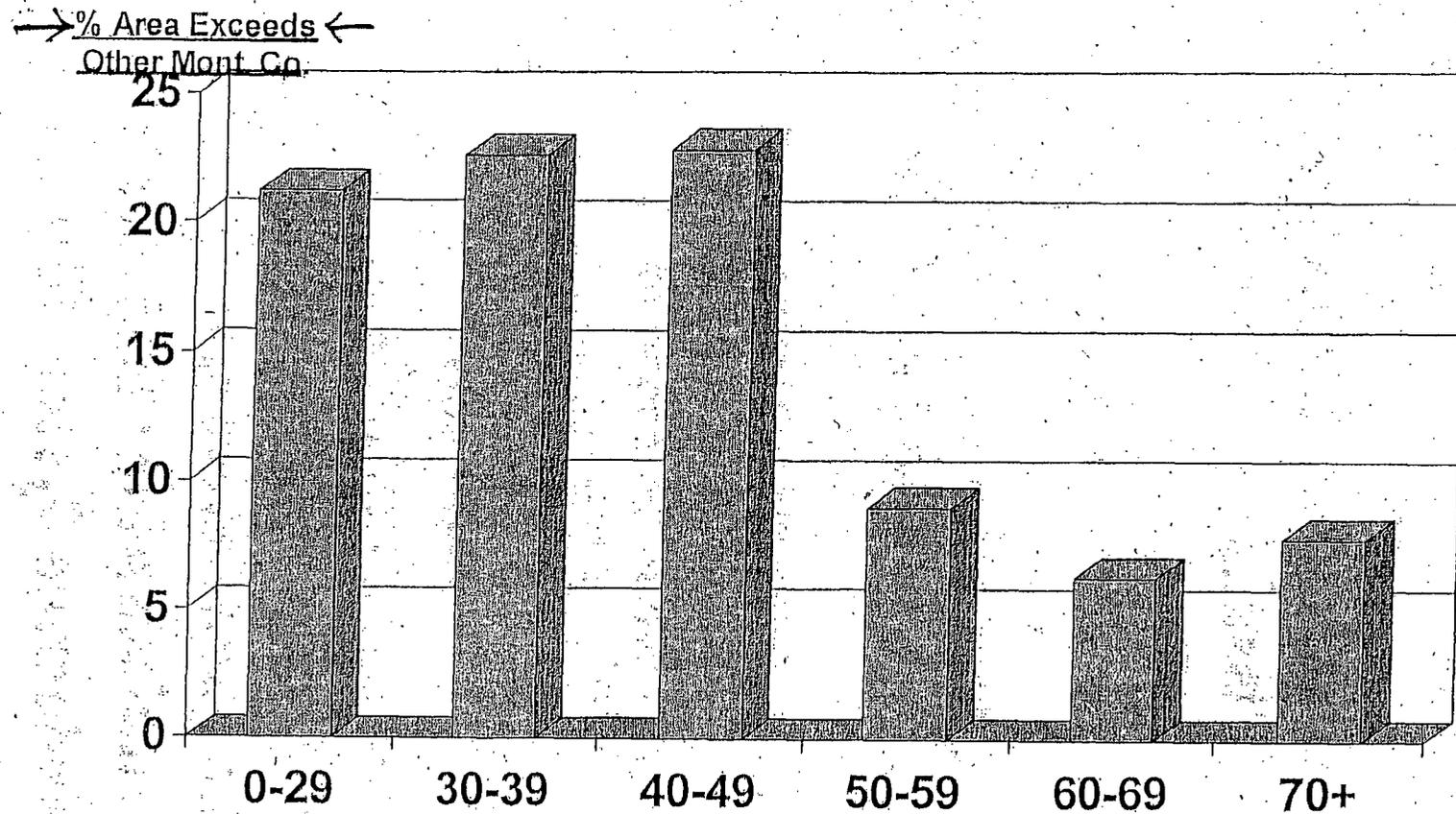
**Compared To Montgomery County**

**BY AGE GROUP**

# CANCER DEATH RATE, 1995-2004

13 Townships and Boroughs Closest to Limerick nuclear plant

% Area Exceeds Other Montgomery County



# **Exposure To Radiation**

**Increases Risk Of Damage To:**

- 1. Tissues**
- 2. Cells**
- 3. DNA**

**Radiation Exposure Potentially Causes:  
Programmed Cell Death (apoptosis)**

**Radiation Exposure Increases Risk Of:**

- 1. Cancer**
- 2. Leukemia**
- 3. Birth Defects**
- 4. Genetic Mutations**
- 5. Reproductive Disorders**
- 6. Immune Disorders**
- 7. Cardiovascular Disorders**
- 8. Endocrine System Disorders**

# NUCLEAR POWER'S IONIZING RADIATION

## THYROID

iodine-131  
beta (gamma), 8 days.

## SKIN

sulfur-35  
beta, 87 days

## LIVER

cobalt-60  
beta (gamma), 5 yrs.

## OVARIES

The Reproductive Organs are attacked by all radioactive isotopes emitting gamma radiation. In addition, the deadly plutonium-239 is known to concentrate in the gonads. The radiation it emits can cause birth defects, mutations and miscarriages in the first and/or successive generations after exposure.

iodine-131  
gamma, 8 days  
cobalt-60  
gamma, 5 yrs.  
krypton-85  
gamma, 10 yrs.  
ruthenium-106  
gamma, 1 yr.  
zinc-65  
gamma, 245 days.  
barium-140  
gamma, 13 days  
potassium-42  
gamma, 12 hrs.  
cesium-137  
gamma, 30 yrs.  
plutonium-239  
alpha, 24,000 yrs.

## MUSCLE

potassium-42  
beta, (gamma), 12 hrs.  
cesium-137 (and gonads)  
beta (gamma), 30 yrs.

## LUNGS

radon-222 (and whole body)  
alpha, 3.8 days  
uranium-233 (and bone)  
alpha, 162,000 yrs.  
plutonium-239 (and bone)  
alpha, 24,000 yrs.  
krypton-85 (and ?)  
beta (gamma), 10 yrs.

## SPLEEN

polonium-210  
alpha, 138 days

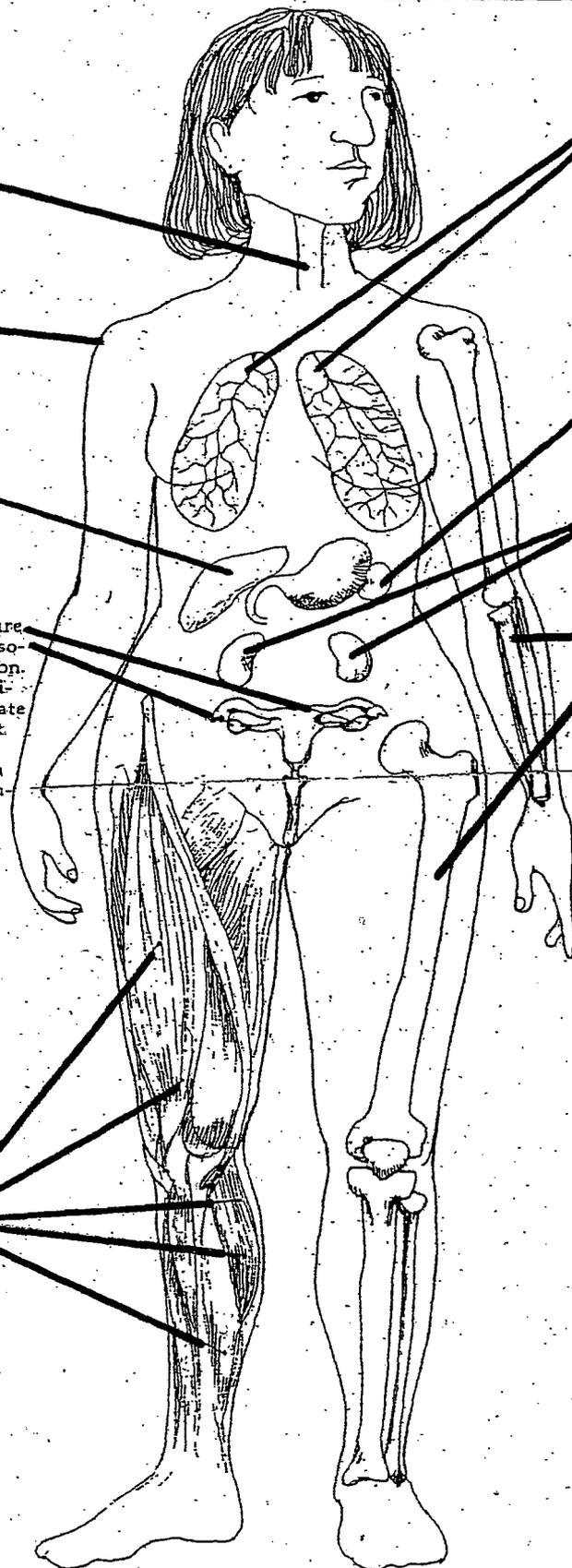
## KIDNEYS

ruthenium-106  
gamma (beta), 1 yr.

## BONE

radium-226  
alpha, 1,620 yrs.  
zinc-65  
beta (gamma), 245 days  
strontium-90  
beta, 28 yrs.  
yttrium-90  
beta, 64 hrs.  
promethium-147  
beta, 2 yrs.  
barium-140  
beta (gamma), 13 days  
thorium-234  
beta, 24.1 days  
phosphorus-32  
beta, 14 days  
carbon-14 (and fat)  
beta, 5,600 yrs.

\*The times listed next to the type of ray emitted are the half-lives: how long it takes for half of the radioactive material to break down.





# The Mercury

## Sunday

APRIL 17, 2008

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A Pulitzer Prize-Winning Newspaper

Pottstown, Pennsylvania

# Is cancer a nuclear plant fallout?



## Researcher asks NRC to study health of people living near sites

It would be irresponsible, Joseph Mangano said, to ignore the fact that the rate for childhood cancers in the area around the Limerick plant was below the national average before the plant was built and is now above the national average.

By Evan Brandt  
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POTTSTOWN — The fact that Philadelphia County has the highest cancer death rate of the 60 most populated counties in the nation as well as the nation's largest concentration of nuclear power plants within 90 miles should not be dismissed as a coincidence, a researcher argued this past week.

Holding a press conference Thursday morning, hours before the Nuclear Regulatory Commission's annual performance assessment of Exelon Nuclear's Limerick Generating Station which followed that evening, Joseph Mangano said he is trying to sound a warning.

Mangano, who heads the controversial Radiation and Public Health Project, came armed with a fistful of sta-

tistics that he said may not prove conclusively that nuclear power plants are causing cancer, but are certainly alarming enough to warrant further study.

Here are a few of those statistics:

- The Environmental Protection Agency's nearest radiation monitoring station is in Wilmington, Del.

From 2000 to 2003 of level of radiation (See NUCLEAR PLANTS on A3)

# Is cancer a fallout of nuclear plants?

## Researcher asks NRC to study health of people living near sites

(NUCLEAR PLANTS from A1)

tion measured in precipitation at the station rose by 15.2 percent over measurements taken in the early 1990s, Mangano said at a Thursday press conference at Montgomery County Community College's West Campus in Pottstown.

The period of increase coincides roughly with the time the Limerick Plant has been running at close to 100 percent capacity, which began around 1998.

• A chemical called strontium-90 does not occur in nature and is produced only by nuclear fission reactions, like those that power nuclear plants. This chemical behaves in the body like calcium and attaches itself to bone.

As a cause of cancer, it damages cells behaving "like a wild bull in a China shop," said Mangano, and tends to create cancer more often in children, whose cells are more vulnerable to damage.

In the 1950s and 1960s, a study by the Washington University School of Medicine in St. Louis measured the level of strontium-90 in 320,000 baby teeth to conclude that radiation from above-ground nuclear tests was slowly poisoning Americans and giving them cancer.

That eventually led to the 1963 treaty banning above-ground nuclear tests and within five years, the level of strontium-90 in baby teeth dropped by half, he said.

It rose again with the advent of nuclear power, said Mangano, whose Tooth Fairy Project has similarly been collecting baby teeth — 4,400 so far — and has found in them a rise in strontium-90.

Of those teeth, 600 were from Long Island, N.Y. where Mangano's first studies were done.

So far, he has received 100 teeth from Pennsylvania residents, and the 37 of them that were from the 19464 and 19465 zip codes had the highest level of strontium-90 of all the Pennsylvania samples, he said.

Mangano acknowledged the criticism — a rather lengthy one is posted on the NRC Web site — that he should not be drawing conclusions from such small samples, saying he is seeking more samples every day.

But Mangano argued that even the small samples show the same strontium-90 trends he found in the larger sample of 600 on Long Island.

He also said the project has received 40 teeth from children who grew up in the Philippines, which has never had a nuclear power plant, and strontium-90 levels in those teeth are one-half those he has studied from the United

In a California community, the project found a 40 percent increase in strontium-90 levels when comparing baby teeth from the time before a nuclear plant was built to after it was put on line, he said.

• Then there are the cancer rates — leukemia in particular.

Nationally, cancer rates are falling, but not in Philadelphia and Montgomery counties, said Mangano.

While rate of leukemia deaths has dropped 27.6 percent nationally, it has jumped by 46.4 percent in Philadelphia and 16 percent in Montgomery County, according to figures from the U.S. Centers for Disease Control supplied by Mangano.

Since the late 1980s, leukemia incidences in children under 15 has "soared" almost 30 percent in Montgomery County and almost 50 percent in Philadelphia, while it has dropped by 0.7 percent nationally.

Of the 60 most populated counties, which represent one third of the entire nation's population, Philadelphia ranks highest in cancer deaths.

"Look, I am not saying we have evidence that there is a direct link here, there are many factors that go into causing cancers — income, health insurance, genetics, behavior," said Mangano.

"What I am saying is we must consider these low doses of radiation exposure as one possible factor."

It would be irresponsible, Mangano said, to ignore the fact that the rate for childhood cancers in the area around the Limerick plant was below the national average before the plant was built and is now above the national average.

The NRC and nuclear industry argue that the low doses of radiation produced by nuclear power plants are not harmful.

But the government has argued this in the past, Mangano said, and subsequently been proven wrong.

He said for years, the government argued that the low level of radiation to which workers who built nuclear weapons were exposed posed no health risk.

But in 2000, the Department of Energy conceded those workers had suffered from cancer in large numbers due to low level exposure.

The nuclear bomb tests in Nevada were called safe by the government until the baby teeth study.

In 1997, the National Cancer Center concluded that 212,000 Americans had contracted thyroid cancer as a result of those bomb tests.

"There is an assumption by the industry and government that low levels of radiation are harmless, but we don't think that assumption is grounded in adequate science," Mangano said.

Rather than criticizing the project's methodology, as it has done in an eight-page critique on its Web site, the NRC should be looking at the results and considering an in-depth study of its own and more stringent regulations on nuclear plants, Mangano said.

This is particularly germane when considering that the EPA just last month issued a new set of guidelines for assessing risk that indicate children are three times more susceptible to the negative effects of harmful chemicals and infants 10 times more susceptible, Mangano said.

"We would hope they would be as concerned about these results as we are and decide to take action and either be partners with us, or start their own studies, rather than just practice denial," he said.

published by WISE News Communique on September 26, 1997

## Exposure to "safe radiation" levels: Six times more cancer

*Low doses of radiation have been proven to kill. A landmark epidemiological study has recently been released on the Rocketdyne facility at Santa Susana near Los Angeles. Employees exposed to radiation below the national standards have a six-to-eight times greater cancer risk than previous studies had found.*

**(478.4747) WISE Amsterdam** - Nearly a third of all the nuclear workers who have died since being exposed to doses of radiation deemed safe by the US government at the rocket engine testing facility died from cancer. The epidemiological study, released on September 12 and funded by the US Department of Energy, found workers exposed to low doses of radiation had a cancer risk of at least six to eight times greater than previous studies had found. Researchers at the University of California, Los Angeles (UCLA), reviewed medical and personnel records for 4,563 employees monitored for radiation between 1950 and 1993. Researchers did not examine the employees.

Rocketdyne officials stressed that employees have never been exposed to radiation levels above the national limit -- which is currently 50 millisieverts a year. The UCLA researchers claimed some of the workers who died of cancer were exposed to radiation far below these standards.

Cancer deaths were more strongly linked to radiation exposure than found in previous studies. The study's Oversight Panel identified:

- Cancer deaths were attributable to doses substantially *below* US standards.
- The risk of "low-dose" radiation was at least six to eight times greater than risks previously assumed.
- Older adults are more at risk from radiation for all cancers.

The Oversight Panel has thus recommended:

- That current limits for radiation exposure be reconsidered by all regulatory and advisory bodies responsible for radiation protection.
- Regulators should take age into consideration when establishing new standards of exposure.

Rocketdyne engineers designed, built and tested early rocket engines for nuclear missiles and went on to produce nearly every rocket engine used in the US space missions, from Mercury to the space shuttle. Rocketdyne also did nuclear research on a contract basis for the Atomic Energy Commission and the Department of Energy between the 1950s and the 1980s. In 1956, a Rocketdyne division called Atomics International began running a series of nuclear test reactors, a fuel-handling facility, and other radiation experiments. The work continued -- through a series of nuclear spills, mishaps and even a partial fuel meltdown in 1959 -- until the firm's "hot lab" for handling fuel was closed in 1989.

At about that time, activists began calling for health studies on workers and people who lived nearby.

# RACHEL'S HAZARDOUS WASTE NEWS #185

Providing news and resources to the Movement for Environmental Justice — June 13, 1990

## Radiation—Part 3 HUMAN HARM FROM LOW-LEVEL EXPOSURE

The federal government is proposing to allow large quantities of "low level" radioactive wastes to be declared non-radioactive ("below regulatory concern," or BRC, is their phrase for it; see *RHWN #183*). These radioactive wastes would then be handled like ordinary household trash; they would be transported, landfilled, incinerated, reused (for example, radioactive tools) or recycled (for example, radioactive metals) along with everything else we discard each day. Such a change would expose Americans randomly to more ionizing radiation than they are exposed to today. Government and industry both argue that this is acceptable. Industry uses one justification, government uses another. Many people in the nuclear industry argue that small increases in ionizing radiation aren't dangerous at all. They argue that there is a threshold dose of radiation, below which no effects occur, and above which people may be harmed (see *RHWN #184*). They say the BRC program will not expose anyone to a dose of radiation greater than the threshold dose, and therefore the BRC program will cause no harm.

Government approaches the matter differently. The U.S. Environmental Protection Agency (EPA) argues that any amount of radiation causes some damage to a large population of exposed individuals; they subscribe to the "linear theory" of radiation damage (see *RHWN #184*). They have set limits for radiation exposure based on the moral premise that it is acceptable to kill one citizen out of every 100,000 citizens by exposing them to radiation. Since the BRC program will not cause exposures that would kill more than one in every 100,000 citizens (and the linear theory tells them that, in reality, the program will kill many fewer people than one in every 100,000), the government argues that the BRC program is acceptable because it will save billions of dollars for the nuclear power industry (which must soon dismantle its aging nuclear reactors and put them "away" somewhere) and for the government itself (which must eventually clean up millions of pounds of radioactive contamination lying around near weapons factories).

Unfortunately, there is now very substantial evidence, from studies of human beings exposed to radiation, that both industry and the government have misunderstood (intentionally or not) the dangers of low levels of ionizing radiation. (By "low levels" we mean within the range 0 to 5 rem [centi-Sievert].)

The most compelling evidence comes from studies of 91,231 people who survived the atomic bombings of Hiroshima and Nagasaki in Japan in 1945. Contrary to popular belief, most of these survivors received only very low exposures to ionizing radiation. Their health has been continuously monitored by international scientific organizations, so they represent the best available information on the effects of low levels of ionizing radiation on humans. The bomb survivor data now shows without doubt that there is no safe dose of radiation and, furthermore, that *the lowest doses have caused the greatest cancer increases per unit of radiation*. (In other words, the shape of the dose-response curve is supra-linear; see *RHWN #184*.) This means that both the industry assumption (threshold theory) and the EPA's assumption (linear theory) seriously underestimate the dangers from exposure to low levels of ionizing radiation. Furthermore, the Japanese data reveal another important fact about low-level radiation: young humans (children and infants) are more sensitive to the effects of low levels of ionizing radiation than are older humans. We will discuss the Japanese data in detail at another time.

Here we will discuss more recent human data provided by accidents that released large amounts of ionizing radiation at Chernobyl (Soviet Union, 1986), Three-Mile Island (Pennsylvania, U.S.A., 1979), and Savannah River (Georgia, U.S.A., 1970). These accidents are the subject of a shocking new book: Jay Gould and Ben Goldman, *Deadly Deceit*, cited in our last paragraph. Page numbers inside parentheses in our text refer to this book. Like the Japanese bomb survivor data, these three accidents indicate that *the lowest doses of ionizing radiation cause the greatest human damage per unit of radiation*. This provides confirmation that the government's estimate of the hazards of low-level radiation is low; that is to say, today's allowable limits for human exposure to ionizing radiation will allow more deaths than our government officially admits. How many more is the question. Bomb survivor data indicate 30 times more, but even this may be low, according to Gould and Goldman.

The three accidental releases of large quantities of radiation also confirm what the bomb survivor data are showing: that infants and children are the most sensitive to damage from low levels of ionizing radiation. Consider these facts:

Consider these facts:

"The Chernobyl nuclear power plant blew up on April 26, 1986; nine days later, radioactivity monitoring stations in Washington state (9,000 miles from Cher-

noby] detected radioactivity in rainfall. By May 16th, 50 EPA monitoring stations detected radioactive iodine-131 in cow's milk all across the U.S. Our government said "no problem." Now government data, analyzed by Gould and Goldman, show that in May, 1986, there was a 5.3% increase in the U.S. death rate, compared to the previous year; the chances are less than one in a thousand that this increase occurred by chance. During June, 1986, the infant mortality rate in the U.S. was 12.3% higher than it had been in June, 1985, and in some parts of the country it was much higher; for example, in the south Atlantic states, the infant mortality rate in June, 1986, was 28% higher than it had been the previous year. Based on this, and on much additional evidence that we haven't space to review, Gould and Goldman suggest that current EPA limits on exposures to low level radiation may need to be tightened by as much as a factor of 1000 (pg. 21).

\*\*In November and again in December, 1970, two nuclear rod meltdowns occurred at the Savannah River nuclear weapons plant in Georgia. The plant was operated for the government by DuPont, who never told the public anything about these accidents until Senator John Glenn grilled Dupont officials in public hearings in late 1988. To this day, DuPont claims that no radiation escaped outside the plant, but official government measurements of radioactivity in rain throughout the southeastern U.S. reveal highly suspicious increases immediately after the accidents. In South Carolina in December, 1970, rain carried six times as much radioactivity as it had carried in December, 1969. Radioactivity was also measurable in local fish; fish in the Savannah river contained radiation levels 100,000 times higher than fish sold in New York City in 1971. A child who ate 1/4 pound of catfish from the Savannah River in 1971 would have received a radiation dose equivalent to 20 chest x-rays. Infant mortality in South Carolina in January, 1971, was 24% higher than it had been a year earlier; in contrast, infant mortality declined that month over

the entire U.S. and over the southeastern states taken as a whole. During the following summer (May through September) infant mortality in South Carolina was 15% higher than it had been the previous year. Again, we are omitting a wealth of detail.

\*\*March 28, 1979, a meltdown at the Three Mile Island (TMI) nuclear power plant spewed more than 10 million Curies of radioactivity into the environment, most of it into the air. Because the radiation dispersed quickly, most people received only low levels of exposure. Government and industry spokespeople have repeatedly assured the public that no one was harmed. However, the government's own health data tell quite a different story. Comparing the period three months prior to the accident against the period four months after the accident, Pennsylvania's infant mortality rate increased 16% and the state of Maryland's increased 41%. All together, Gould and Goldman calculate that perhaps as many as 50,000 deaths occurred during 1980-1982 as a result of the TMI accident (pg. 63).

This is an important book. Any individual fact in the book may be disputed, but the cumulative weight of the evidence is persuasive. And though we generally do not give much credence to conspiracy theories, if you read this book from cover to cover, you will have difficulty believing that your government is telling the full truth about the effects of low-level radiation. We suggest that you act prudently to protect yourself and your family: do whatever it takes to keep BRC wastes out of your community.

Get: Jay M. Gould and Benjamin A. Goldman, *Deadly Deceit: Low-Level Radiation, High-Level Cover-Up* (New York: Four Walls Eight Windows Press [P.O. Box 548, Village Station, New York, NY 10014], 1990). \$19.95

And: Keep in touch with Nuclear Information Resource Service (NIRS), 1616 P Street, NW, Washington, DC 20036; (202) 328-0002; and the Radioactive Waste Campaign, 625 Broadway, 2nd floor, New York, NY 10012; (212) 473-7390.

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## THE BIOLOGICAL HAZARD OF LOW-LEVEL COBALT-60 AND OTHER RADIOACTIVE CHEMICALS RELEASED INTO THE ENVIRONMENT

Recently published studies of the health effects of very low levels of radioactivity far below presently permitted limits discharged into the environment have indicated that the chronic, long-lasting exposures they produce appear to be thousands of times more serious per unit dose than the short exposures to X-rays or gamma rays from nuclear explosions on the basis of which the present standards were set.

This has recently been found for infant mortality in the first month of life by Dr. R. K. Whyte in an article published in *The British Medical Journal* of February 8, 1992, and by Drs. J. M. Gould and E. J. Sternglass in the *International Journal of Health Services* on October 25, 1993 for the case of breast cancer. These latest large-scale studies indicate that inhaled or ingested radioactive materials released by bomb-tests and by nuclear reactors at very low doses of only a few millirads per year, well below the levels of natural background radiation, damage the immune system far more seriously than the naturally occurring radium, cosmic radiation or medical X-rays. The reason is that the man-made radioactive chemicals like Cobalt-60, Iron-59, Strontium-90 and Iodine 129 or 131 emit powerful beta rays that give much larger doses to critical organs in which they concentrate than the cosmic rays or X-rays that irradiate the body uniformly. Moreover, naturally occurring radium produces short-range alpha particles that largely remain trapped in the bone where radium concentrates, while the long-range beta particles are able to reach the bone marrow where the crucial cells of the immune system are formed.

It has now been established that the very low dose-rate radiation produced by radioactive chemicals released into the environment acts predominantly by producing so-called free-radicals that become increasingly efficient in destroying cell-membranes of the immune system that develop in the bone-marrow and the thymus gland as the dose-rate is reduced. As a result, the ability of the body to fight infections and to destroy tumor cells is impaired, and infants are born prematurely and have a much greater risk of dying from all causes or surviving with reduced immune system function and brain damage.

Cobalt-60 is used by the body in place of non-radioactive cobalt to produce vitamin B-12, essential for the proper function of the nervous system. Iron-59 and 60 are taken up by blood cells in place of non-radioactive iron, and strontium-90 which is chemically similar to calcium concentrates in bone, irradiating the marrow and thus damaging the immune defenses of the body.

The data of Dr. Whyte indicate that an extra 320,000 baby deaths in the U.S. and Great Britain were probably caused by the low doses from bomb tests between 1950 and 1980. The study of Gould and Sternglass indicates that the breast cancer mortality across the U.S. in the nine census regions is now highly correlated with the officially published releases of radioactive chemicals from nuclear reactors. Furthermore, the incidence of low birthweight in the most sensitive poor population in New York between 1972 and 1985 rose and declined three times in direct relation to the airborne releases of radioactivity from the Indian Point Nuclear Plant located in Westchester County near

the water reservoirs that store the drinking water for Westchester and New York City, and it showed the same form of the dose- response curve as observed for breast cancer.

An examination of the breast cancer mortality rates for the areas around Syracuse and Rochester, New York, shows the same anomalous pattern of recent changes as for New York City and nearby Westchester. In all these areas, breast cancer rates *declined or remained unchanged in the inner city* during the 1980s, but rose in the nearby county where the nuclear reactors were located. Thus, Onondaga County where Syracuse is located declined 12% from the high of 23.0 per hundred thousand population in 1978-80 to 20.2 in 1986-88, while Oswego County containing the Fitzpatrick and Nine-Mile Point nuclear plants rose 33% from 13.3 to 17.7. In the case of Rochester located in Monroe County there was no change in this time period, but in nearby Wayne County where the Ginna plant operates only 16 miles to the east, the breast cancer death rate rose 58% in just 8 years from a low of 12.0 to a high of 18.9 per hundred thousand. And in all these cases, the average external gamma doses for the population calculated by the NRC within a 50 mile radius was less than one percent of the background gamma ray dose.

Thus, allowing sewage sludge containing low levels of long-lived fission products to be spread over areas where winds can cause radioactive particles to be inhaled or ingested with contaminated food or water can no longer be regarded as an acceptable practice in the light of these findings, even though the doses may be far below those presently permitted.

E. J. Sternglass  
Professor Emeritus of Radiology  
January 4, 1994

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**ELEVATED  
INFANT MORTALITY**

**AND**

**“SHOCKING”  
LEARNING DISABILITY  
INCREASES IN  
MONTGOMERY COUNTY**

# Radiation and Children: The Ignored Victims

Hundreds of U.S. industrial sites that generate nuclear electricity and manufacture nuclear weapons regularly release radiation to our air, water and soil via the burial of wastes. These same industries are now lobbying for permission from government to release radioactive materials for re-use in consumer products. **There is no safe radiation dose. Whether the release is accidental or allowed is irrelevant.** This dramatic surge in the release and distribution of radiation, makes it ever more clear that we do not need a nuclear accident to cause disease.

## The Tyranny of "Standard Man"

Unfortunately, even when nuclear activities are performed within legal, "allowable limits," our children are not protected. This is for a simple reason: U.S. radiation protection standards assume that the individual exposed to the harmful radiation released is an adult male. A child exposed to the same release of radiation would often experience a larger dose. The "protection" standards ignore this fact.

## The "Allowable" Poison

Radiation regulations are written by international state and federal agencies. Since no industrial scale nuclear operation is possible without the routine release of radioactive materials, regulators have established "allowable" levels of radiation exposure. All life on Earth is exposed to and impacted by natural sources of ionizing radiation. Radiation exposures are increasing due to planned and accidental releases of man-made radioactivity. Nuclear reactors, central to both nuclear electricity and nuclear weapons production, actually make new radioactivity. Natural uranium is radioactive, but putting uranium fuel in a reactor results in wastes that are millions of times "hotter" after only a few years of use. These materials are much more potent in contaminating human and environmental systems. Every radiation exposure carries with it risk of adverse health effects, so increasing radiation exposure increases risk to our health whether the radiation is natural, more biologically available due to human interference, or human-made.

## Children Are More Susceptible

Radiation--invisible, odorless, tasteless--tears at the very fabric of what makes us human: our genetic material. Children and the unborn are especially susceptible because of their rapid cell

division during physical growth. DNA is most vulnerable to radiation impact while cells divide. In addition to cancer and birth defects, evidence exists that radiation is permanently mutating the gene pool and contributing to its gradual weakening, resulting in "developmental deficiencies in the fetus, hereditary disease, accelerated aging, and such non-specific effects as loss of immune competence" [*The New Scientist*].

The work of Dr. Alice Stewart, a British epidemiologist, established in the 1950's that children born to women who received even one abdominal x-ray during pregnancy were four times more likely to suffer childhood cancer as a "post-birth defect."

Childhood disease clusters have been found in many communities with nuclear facilities. This list includes increases in childhood leukemia near reprocessing facilities in La Hague, France and at Sellafield in the British Isles and the Krummel nuclear reactor in Germany. Childhood leukemia cases near Sellafield are associated with occupational exposure to the father before *conception* of the child. Increases in childhood leukemia also occurred Europe-wide after the passage of the Chernobyl radiation cloud. Increases in other childhood cancers have been found near nuclear operations in the Navaho Nation (uranium mining), Brookhaven, New York (nuclear weapons), and nuclear power stations in Oyster Creek, NJ and Clinton, Illinois. Increases in down syndrome are found near Yankee Rowe power station in Massachusetts. Heart defects of various types have been associated with ionizing radiation exposure as well.

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## Error-ridden Assumptions

The process of setting radiation standards and also determining whether a particular release of radioactive water or other material meets those standards, requires many assumptions. The first of these is about the individual receiving the radiation dose. Most regulators assume that this individual is the "Standard Man:" a fictional individual whose physical characteristics have been defined by officials who set radiation standards. A standard height, weight, age and other parameters are used in equations to project the radiation dose that this hypothetical individual is likely to receive from a given release of radioactivity. Women, fetuses, infants, children, elders and those with compromised immune systems are not Standard Men. Due to many differences including smaller body size, as well as difference in habits (for instance playing outside on the ground), a child may get a radiation dose many times larger than the official dose, based on the Standard Man, as calculated by state and federal radiation "protection" agencies. This larger dose carries with it a greater risk of health consequences. National Council on Radiation Protection (NCRP) states that a child receives 10-50% more of a dose from gamma ground radiation than an adult because their organs are closer to the ground. (NCRP 129 Recommended Screening Limits for Contaminated Surface Soil and Review of Factors Relevant to Site Specific Studies; pg 56 1999). Yet the NRC exposure standards do not account for this difference. This is an external dose scenario. Internal dose scenarios with ingested or inhaled radionuclides often amount to more biological damage to children. For example, Strontium-90 (Sr-90) deposition in the bones can cause bone and blood cancers.

## Radiation Effects on Real People

Exposure to radiation increases the risk of damage to tissues, cells, DNA and other vital molecules--potentially causing programmed cell death (apoptosis), genetic mutations, cancers, leukemias, birth defects, and reproductive, immune, cardiovascular, and endocrine system disorders. The varying impacts on health of each of the hundreds of

different radionuclides to which people may be exposed are, simply not known.

Since scientists do not truly know the specific impacts a given radionuclide may have on the organs and tissues of a specific person, the translation of the amount of radioactivity to which that person has been exposed (in curies or fractions of a curie) into a radiation dose (in rems or millirems) is basically speculation. That is, determining the quality and the quantity of a radiation dose and biological damage to tissue is far from an exact science.

## Unenforceable Standards Are Not Protection

Radiation standards are written in units called "rems" or "millirems" (one one-thousandth of a rem). Like dose calculations, the unit of dose is based on assumptions -- including Standard Man, estimations, averages and computer modeling. As a result, the rem cannot be measured directly; instead it is derived from assumptions and equations, which do not reflect children. No one can say for sure how many rems or millirems any one individual has (or has not) received, therefore standards that use this unit cannot be enforced. An alternative is to prevent the release of radioactivity. When accidents occur it should be assumed that children will be exposed and protective action taken. Most parents support prevention and should seek to avoid any exposure at all. Prevention is the only cure.

--Cindy Folkers & Mary Olson, August 2004

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# **EPA**

**VERIFIES GREATER POTTSTOWN AREA HEALTH CONCERNS**

Reported October 5, 2003 - According to EPA

**Greater Pottstown Area**

**INFANT And NEONATAL MORTALITY  
ARE FAR ABOVE The STATE AVERAGE**

**And EVEN SURPASS CITIES Like  
Philadelphia, Reading And Bethlehem.**

**Greater Pottstown Area State Health Statistics  
Show What EPA Called**

**“DISTURBING NUMBERS”**

**FOR**

**INFANT MORTALITY**

**AND**

**NEONATAL MORTALITY**

## Low-Level Radiation Exposure and Elevated Infant Mortality Is There A Link In Pottstown?

- Hiroshima and Nagasaki data show children and infants are more sensitive to the effects of low levels of ionizing radiation.
  - Data collected from Chernobyl show from monitoring stations as far as 9,000 miles away that infant mortality rates rose after the accident. Researchers suggest that EPA limits on exposures to low level radiation may need to be tightened by as much as a factor of 1000.
  - Infant mortality rates rose after the rod meltdown in Savannah River, Georgia.
  - Infant mortality rates also rose after the Three Mile Island accident where people received only low doses of radiation.
- The cumulative weight of this data collected on affected populations is persuasive enough to call for PRECAUTION!

# The Mercury

<http://www.pottsmorc.com>

FEBRUARY 28, 1999

A PULITZER PRIZE-WINNING NEWSPAPER

POTTSTOWN, PA

# Too many baby deaths in Pottstown

"This is embarrassing. This county is too wealthy and too educated to have this happen. For a county this wealthy we need to do better."

— James W. Maza

By CARL HESSLER JR.  
Mercury Staff Writer

NORRISTOWN — Despite health department efforts to curb infant deaths in Pottstown during the last several years, Pottstown continues to have a higher than average infant mortality rate.

And those babies born to black mothers are dying more often than babies born to white mothers.

"This is embarrassing. This county

is too wealthy and too educated to have this happen. For a county this wealthy we need to do better," Democratic commissioner James W. Maza said when confronted with infant mortality statistics.

According to statistics compiled by the Montgomery County Health Department, the Pottstown area averaged 7.9 infant deaths for every 1,000 live births between 1987 and 1996, the last year for which statistics are avail-

able. The Pottstown area includes Pottstown, Lower Pottsgrove, Upper Pottsgrove and West Pottsgrove.

Overall, the countywide infant mortality rate (deaths of children under age 1) during the same time period was 7.0. The white infant mortality rate countywide was 6.2 and the black infant mortality rate was 15.2.

The statistics indicated that in the Pottstown area, the white infant mortality rate was 6.8 deaths per 1,000

live births between 1987 and while the black infant mortality rate was 15.1 per 1,000 live births.

Robert Gage, director of the health department, said health officials have been working intensely since to try to decrease the infant mortality rates. The department has a program where public health nurses in the Pottstown area pregnant women

(See INFANT MORTALITY on A3)

# In Pottstown, far too many infant deaths

INFANT MORTALITY (from A1)

2/28/99

into prenatal care as soon as possible.

"We have to do more," Gage admitted, adding however, that local statistics mirror trends in the nation and the state. "We are attempting to muster more resources. We have been using on Pottstown and Norristown, on the Census tracks at highest risk."

The commissioners have asked Gage and other health officials to submit a report within two weeks to explain the reasons for the high infant mortality rates in the boroughs of Pottstown and Norristown and to suggest solutions.

"This isn't good enough. We have a long way to go in this county," Maza said. "If it is a problem of money, then I want to discuss what we can do to remedy that. It may not be just money."

Walter Tsou, deputy director of the health department, pointed out that Norristown continues to have the highest infant mortality rate in the county and Norristown ranks fifth in the state in infant mortality. From 1994 to 1996, the infant mortality rate in Norristown was 17.9, with the white infant mortality rate at 18.3 and the black infant mortality rate at 9.9.

Norristown's infant mortality rate is twice the county average.

"There are geographic segments of our county where the rates are higher," Tsou said.

But in Norristown, the mortality rate has increased over the years, despite outreach efforts there. Between 1990 and 1992,

**Average Annual Infant Mortality Rate per 1,000 live births, Pottstown Area, 1987-1996**

Year	All Races	Whites
1987-1990	8.9	7.7
1988-1992	8.9	7.7
1993-1994	7.1	6.7
1995-1996	7.1	6.7
1992-1996	7.5	6.8

Average annual infant mortality rate 1987-1996  
15.1 per 1000 live births - black

Pottstown area - Pottstown, Lower Pottsgrove, Upper Pottsgrove, and West Pottsgrove

Sources: Montgomery County Health Department  
PA Department of Health  
National Center for Health Statistics

Mercury Graphic by C.D. Six

Norristown's overall infant mortality rate was just 12.9 and that climbed to 17.9 during the period 1994-96.

"The numbers are going up substantially instead of going down. We must not be doing something right," Republican commissioner Mario Mele said. "These numbers are very alarming. We need to get more proactive with the community to let people know resources are there to help them."

But Tsou said the news isn't all bad.

"The good news for Montgomery County is that our infant mortality is better than state and national statistics," Tsou said.

Tsou said the county is already below the federal year 2000 objective of 7 infant deaths per 1,000 live births. In 1996, the county's overall infant mortality rate was about 5.7 and Pennsylvania's infant mortality rate was about 7.6.

Infant mortality rates, Tsou said, tend to be closely associated with low birth weight and a mother's access to proper prenatal care.

"Low birth weight is the most important predictor of infant mortality," Tsou said.

The year 2000 goal in the nation is that only 5 percent of all babies born should be of low birth weight. In 1996, about 8.5 percent of all babies born in the county were of low birth weight.

The goal in the year 2000 is to have at least 90 percent of all pregnant women receive prenatal care during the first trimester of pregnancy. In 1996, about 9 percent of all pregnant county women did not initiate prenatal care in the first trimester, including 7.2 percent of white mothers and 28 percent of black mothers.

Even more alarming, Tsou said, is that 30 percent of pregnant Norristown women didn't receive prenatal care during the first trimester in 1996.

"Young people, 45 percent of teen-agers under age 20, did not initiate prenatal care," Tsou said. "As you get older, you get wiser and you get prenatal care."

# Borough's baby death rate fuels 'concern'

By CARL HESSLER JR.  
Mercury Staff Writer

10/13/97

NORRISTOWN — Pottstown has a higher than average infant mortality rate and those babies under 1-year-old born to black mothers are dying more often than their white counterparts, according to Montgomery County health officials.

"It's mostly because of the socio-economic backgrounds and educational levels that (the infant mortality rate) is higher than average in Pottstown," said Anita Crielly, director of clinical services for the health department.

According to a child health needs assessment report released this month by the health department, between 1986 and

1995, Pottstown averaged 9.7 infant deaths for every 1,000 live births.

In comparison, there were 6.1 infant deaths for every 1,000 live births countywide in 1995.

Still, the infant mortality rate in Pottstown was better than that in Norristown, where 15.2 infants died for every 1,000 live births over the 10-year period between 1986 and 1995.

"It's causing us some concern. We have work to do in those areas," said Crielly, referring to the rates in Pottstown and Norristown.

While Pottstown and Norristown continue to have higher than average infant mortality rates, overall, infant mortality rates declined

countywide during the 10-year period — from 7.8 infant deaths per 1,000 live births in 1986 to 6.1 infant deaths per 1,000 live births in 1995.

Crielly said the county is below the federal health goal for infant mortality for the year 2000, which is seven deaths for every 1,000 live births.

"Overall, it looks like we are meeting the year 2000 objectives. But when you break it out by race, we found that the black race has a really high infant mortality rate," Crielly said.

In 1995, 18.4 black infants died for every 1,000 live births in the county. Granted, that

(See INFANTS on A4)

## Borough's baby deaths are fueling 'concern'

(INFANTS from A1)

There is a decrease from the all-time high rate of 25.4 black infant deaths per 1,000 live births in 1986, but still higher than the federal health goal of 11 deaths for every 1,000 live births by the year 2000, Crielly said.

In comparison, 5.1 white infants died for every 1,000 live births during 1995, according to the study.

Crielly said efforts to curb lack infant mortality must intensify in the next few years if the county is going to meet the year 2000 goal.

Crielly said the mortality rates need to be closely tied to low birth weight and a mother's access to proper prenatal care,

"We believe that a woman should be seen at least once by an obstetrician in her first trimester of pregnancy," Crielly said. "One of the most important things a woman can do to ensure good health outcome from a pregnancy is prenatal care."

Health officials said the year 2000 goal is to have at least 90 percent of all pregnant women receive prenatal care in the first three months of pregnancy.

The study found that 90.4 percent of new mothers in 1995 did initiate prenatal care in the first three months of pregnancy.

"But a lot of poorer women are not in contact with a doctor during the first three months," Crielly said.

Only 72 percent of new mothers in Pottstown receive prenatal care in the first three months and only 71 percent of new mothers in Norristown receive prenatal care, according to the study.

Once again, the racial breakdown produces disturbing statistics, Crielly said.

About 30 percent of new black mothers countywide delayed their prenatal care in 1995 while only about 10 percent of white mothers delayed their prenatal care in the first trimester.

Officials said women cite a lack

of transportation and a lack of insurance coverage as the major barriers to receiving timely prenatal care.

To reverse the trends, Crielly said health officials will focus their educational efforts toward minority women in the geographical areas, such as Pottstown and Norristown, where there are high infant mortality rates.

"We are going to have outreach workers going into the communities at welfare and WIC (Women and Infant Care) offices to provide information about prenatal care to pregnant women," Crielly said.

The women will be encouraged to sign up for prenatal care programs or the health department's home visiting program, under which the county's public health nurses visit the homes of low-in-

come women. The outreach workers can help women overcome such barriers as lack of transportation or day care services in order for them to obtain prenatal care.

Crielly said health department officials will also provide prenatal care information to pregnant women they meet while conducting lead poisoning screenings at homes in the county.

Health officials also plan to educate women about the dangers of tobacco and alcohol use during pregnancy. Smoking is closely associated with low birth weight and drug and alcohol abuse among pregnant women can lead to poor pregnancy outcomes, officials said.

# **Infant Death and Childhood Cancer**

## **REDUCTIONS AFTER**

### **Nuclear Plant Closings In The United States.**

Archives of Environmental Health; 1/1/2002

Subsequent to 1987, 8 U.S. nuclear plants located at least 113 km from other reactors ceased operations. Strontium-90 levels in local milk declined sharply after closings, as did deaths among infants who had lived downwind and within 64 km of each plant. These reductions occurred during the first 2 yr that followed closing of the plants, were sustained for at least 6 yr, and were especially pronounced for birth defects. Trends in infant deaths in proximate areas not downwind, and more than 64 km from the closed plants, were not different from the national patterns. In proximate areas for which data were available, cancer incidence in children younger than 5 yr of age fell significantly after the shutdowns. Changes in health following nuclear reactor closings may help elucidate the relationship between low-dose radiation exposure and disease.

THERE IS A RELATIVE PAUCITY of research that documents the beneficial health effects to humans following a reduction in the level of **environmental toxins**. Existing data provide evidence for immediate responses, as well as for responses with longer latencies. Motor vehicle restrictions during the 1996 Summer Olympic Games resulted in a 28% drop in peak ozone concentration and a more than 40% reduction in asthma admissions/emergency room visits among Atlanta children. (1) The decline in smoking for U.S. adult males, from 52% in 1965 to 28% in 1990, (2) was not followed by a reduction in age-adjusted incidence of lung-bronchial cancers until 1984. (3)

Reduction of ionizing radiation in the environment, and hence in the food chain, occurred after enactment of the Partial Test Ban Treaty of 1963 that prohibited atmospheric atomic weapons testing by the United States, the (then) Soviet Union, and Great Britain. In the United States, dietary levels of short-lived isotopes, such as iodine-131 (I-131) and strontium-89 (Sr-89), with respective biological half-lives of 8 and 50 days, fell dramatically. Even concentrations of a long-lived isotope such as strontium-90 (half-life = 28.7 yr) in raw milk declined by one-half in 9 U.S. cities from the peak of April/May 1964 to November/December 1965. This decline, from an average of 30 to 15 picocuries per liter, fell further to 6 by 1970. (4,5)

Diminishing radioactivity levels in the diet were accompanied by immediate and significant morbidity and mortality reductions among infants and young children. U.S. infant deaths per 1,000 births fell from 24.7 to 19.1 from 1965 to 1971, respectively--a rate of decrease more than 4 times greater than for 1951-1965, (6) respectively. (Note: Atmospheric bomb testing in Nevada began in January 1951.) Cancer incidence in children who were younger than 5 yr of age and who lived in Connecticut--the only U.S. state that operated a comprehensive tumor registry--dropped 30% from the 1962-1964 peak of 20.38 cases/100,000 to 14.21 by 1967-1969, following a 40% rise during the time of atmospheric bomb testing. (8)

Although most permanent shutdowns of nuclear power reactors are relatively recent, periods that follow unexpectedly large releases of airborne emissions offer an example of reduced **environmental radioactivity**. In the 1960s, declines in local infant mortality were documented after substantial reductions in gaseous emissions from several nuclear facilities. (9) In downwind areas within 64 km of 5 closed reactors, infant deaths declined at an unexpectedly rapid rate in the first 2 yr that followed closing. (10) We propose to extend that report by presenting data on all reactors for which post-shutdown data are currently available. Mortality 2 yr and 6 yr after reactor closings will be reviewed, the purpose of which will be assessment of whether immediate reductions are sustained over longer periods of time. Proximate areas that are not downwind from closed reactors and 64-129 km downwind will be examined. Finally, childhood cancer incidence trends near closed reactors will also be considered.

#### Method

Subsequent to 1987, 13 nuclear power reactors in the United States have been closed permanently. In addition, 5 other reactors have been nonoperational for at least 2 consecutive calendar years (see Table 1). The 8 regions in which closings left no operating power reactor within a 112-km radius of the closed facility are the focus of this report. Preliminary data have already been presented for 5 of the 8 regions. (10) Of

these 8 regions, 6 have involved permanent shutdowns. The Pilgrim reactor in Massachusetts did not operate from April 1986 until late 1988. During the winter of 1995-1996, all 4 Connecticut reactors--3 at Millstone in Waterford and 1 in Haddam Neck, 29 km to the northwest--were closed. Millstone units 2 and 3 resumed operations in July 1999 and July 1998, respectively.

Demographic characteristics of the 8 areas are presented in Table 2. Population density varied greatly; some regions were urban settings, and some were sparsely populated areas. Poverty rates and percentages of Blacks and Hispanics in the population were less than the U.S. standard in each area.

An approximation of change in environmental radioactivity before and after a reactor shutdown may be observed with annual measures of Sr-90 in pasteurized milk, reported each July by the U.S. Environmental Protection Agency in 60 U.S. cities. (11) Readings for cities located within 64 km of closed reactors are also provided. The analysis of levels of long-lived Sr-90 has likely underestimated the reduction in environmental radioactivity inasmuch as short-lived isotopes emitted by reactors would no longer be present after a shutdown.

Short-lived airborne radioactive particulates often decay before entering the food chain. However, they can enter the body through inhalation. Persons with the greatest uptake from this vector are those who live downwind from the source, inasmuch as prevailing winds carry the majority of particles in the downwind direction. Longer-lived isotopes can also be inhaled, but they are also returned to earth by precipitation, after which they are again consumed in the diet. Again, levels are most likely highest in downwind, rainy areas. This principle is illustrated in the patterns of fallout from atmospheric atomic bomb tests in Nevada. For example, after the large "Smoky" test on August 31, 1957, U.S. government officials documented elevated levels of radioisotopes in raw milk. The typical concentration of Sr-89 (< 5 picocuries/l) was exceeded in Cincinnati, Ohio (i.e., 150 picocuries/l); in New York (160 picocuries/l); in Sacramento, California (30 picocuries/l); in Saint Louis, Missouri (290 picocuries/l); and in Salt Lake City, Utah (120 picocuries/l). (12) The only upwind city--Sacramento--had the lowest concentration of Sr-89. In addition, the total in Salt Lake City (i.e., city closest to Nevada) was exceeded by the much rainier Cincinnati (Ohio), New York, and Saint Louis (Missouri) areas.

Given that airborne radioactive particulates are propelled by prevailing winds, in this analysis we focused on counties located downwind and mostly or totally within 64 km of the closed reactors. Prevailing wind directions for the large city or cities nearest to each closed reactor were used. (13) Winds in Portland, Oregon--near the closed Trojan reactor--emanate from the east-southeast and northwest during 6 individual months; therefore, "downwind" counties are situated in both directions.

Infant deaths that occurred during the first year of life were obtained from the National Center for Health Statistics. County-specific deaths and population information were available on the world wide web (<http://www.cdc.gov/data and statistics/CDC Wonder>). The accuracy of the count of infant deaths is likely very high; all U.S. states have reported death data to the federal government, subject to reliability tests since 1933. Coding the reason for death should also be consistent over time; the 9th revision of the International Classification of Diseases (ICD) coding system was used for the classification of all deaths from 1979 to 1998. The county of residence for an infant death (i.e., mother's residence) has been a standard data element collected in the hospital medical record for many years.

Infant mortality rates before and after reactors ceased operations were compared. The period before a reactor is closed is defined as the last 2 yr of operation, including the year of closing. For example, the LaCrosse reactor ceased operations on April 30, 1987; therefore, the "before" period of operation is 1986-1987. Given that cellular damage from radioactive exposures is most pronounced in the fetal period, many births that followed the closing of a reactor (but in the same year) were subject to exposures from reactor operations prior to birth. Rates for the 2 yr before closing are contrasted with rates for the subsequent 2- and 6-yr periods.

The report also reviewed infant mortality from congenital anomalies (ICD codes 740.0-759.9) known to be sensitive to the effects of radiation. Approximately 1 of every 4 deaths in the first year of life results from a birth defect. Approximately one-half of the infant congenital anomaly deaths involves heart defects. Chromosomal defects (including Down's, Edwards', and Patau's syndromes), and nervous system defects (including anencephalus and spina bifida) account for another quarter of deaths. (6)

Childhood cancer data were also analyzed because of the increased sensitivity of the developing fetus to the carcinogenic effects of ionizing radiation. Cancer incidence data were available only from state registries of California, Colorado, and Wisconsin. These states operated comprehensive tumor registries before and after closings (i.e., reporting of cancer cases was mandated by state law, reporting originated from several sources, and the reporting system was complete and accurate). Cases diagnosed before an individual's 5th birthday, which likely represented a fetal origin, were analyzed.

Trends in infant mortality near closed nuclear facilities were compared with U.S. patterns. Aggregated data (i.e., 1988-1996) from states and cities that made up approximately 47% of the U.S. population were used for cancer incidence because no national registry exists. (Areas include the states of California, Connecticut, Florida, Hawaii, Iowa, Massachusetts, New Jersey, New Mexico, New York, Pennsylvania, Utah, and Wisconsin; and the Standard Metropolitan Statistical Areas of Atlanta, Denver, and Seattle.) Infant mortality and childhood cancer trends in counties near nuclear plants were also compared with all other counties in the state. For Millstone, "other state" represents Connecticut and Rhode Island combined, whereas for Trojan, "other state" represents Oregon and Washington combined.

## Results

**Change in environmental radioactivity.** Sr-90 concentrations in pasteurized milk over a 12-yr period before and after shutdown were available for 3 cities within 64 km of closed nuclear plants. These were compared with trends in 23 U.S. cities for which an annual reading was reported each year from 1983-1994 (Table 3). In each area near a closed reactor, the average Sr-90 concentration fell by more than the U.S. decline (67.1%, 48.0%, and 47.1%, compared with 34.0%). This comparison was hampered by the availability of only 1 annual measurement, thus raising the chance of random fluctuation.

**Infant mortality---all causes.** Infant mortality in each of the 8 downwind areas decreased during the first 2 yr following closing (Table 4). Each decline exceeded the U.S. average 2-yr reduction of 6.4%, and the total decline of 17.4% was significant ( $p < .01$ ). Each decline also exceeded the trend for other counties in the state; the total reduction in other counties of 6.7% was significantly different from the "nuclear" counties ( $p < .01$ ).

Infant mortality data for 6 yr post-shutdown were available for counties near 4 of the 8 plants; the other plants closed too recently or they were re-started (Table 5). In each of the 4 areas, reductions continued to exceed the U.S. standard, and the total decline of 26.9% was significantly greater than the national trend ( $p < .0001$ ). Reductions near the Rancho Seco and Trojan plants were also significant. Rates also fell faster than in other counties in respective states.

**Infant mortality--congenital anomalies.** During the first 2 yr following reactor shutdown, infant deaths from congenital anomalies declined 22.4%, compared with an average 2-yr decline in the U.S. of 5.5% ( $p < .05$ ) and a total decline of 5.6% combined for other counties in the state where reactors were located. Declines in 7 of the 8 areas exceeded that of the U.S.; declines in 6 of the 8 areas exceeded those of other counties in the state (Table 6). During the first 6 yr following the closing of the reactor (for the 4 areas for which data were available), declines near each reactor continued. The change near the Trojan reactor in Oregon is significant, compared with both the U.S. and other counties in Oregon and Washington (Table 7).

**Infant mortality--downwind 64-129 km from the plant.** Infant mortality in downwind counties located 64-129 km from the closed reactors rose near 5 of the 7 plants (the area downwind from the Pilgrim reactor is the Atlantic Ocean). The overall increase of 5.4% was not significantly different from the 6.4% average national decrease. The 39.3% rise near the Rancho Seco reactor was significant at  $p < .01$  (Table 8).

**Infant mortality--counties not downwind.** In 6 of 8 regions, reductions in infant mortality rates occurred in the first 2 yr following shutdown in non-downwind counties located less than 64 km from closed facilities. However, none of the reductions were significant, and the combined change of 7.1% was equivalent to the average U.S. 2-yr decline (Table 9).

**Incidence--childhood cancer.** In the states that operated comprehensive cancer registries at the time of reactor shutdown, incidence of newly diagnosed cancers in children under age 5 yr declined in downwind counties within 64 km. The decline measures the 2 yr prior to closing with 7 yr post-shutdown. The total reduction of 25.0% was significantly different from the stable U.S. trend ( $p < .005$ ) and from the trend in

other counties in the state ( $p < .006$ ) (Table 10). The reduction near the Rancho Seco plant in California was significant, compared with the reduction in the United States ( $p < .02$ ) and in the remainder of the state ( $p < .004$ ).

## Discussion

Research on changes in health in populations exposed to reduced levels of radioactivity has been scant. However, falling infant mortality and a decrease in childhood cancer immediately after atmospheric nuclear weapons testing was halted in 1963 suggest that "smaller" exposures may result in measurable improvements in health, especially in infants and young children.

In each of 8 areas downwind and proximate to closed nuclear power plants, infant deaths declined in excess of national trends during the first 2 yr following shutdown. Declines in mortality from congenital anomalies among local infants were particularly sharp. These trends were consistent for 2-yr and 6-yr periods after plant closings. Although declines near each reactor have fallen short of statistical significance, the possibility that similar trends should occur in each area by random chance is low.

The unexpectedly large decline in infant mortality occurred only in downwind counties that were located less than 64 km from closed nuclear facilities. Nondownwind counties located less than 64 km from reactors have nonsignificant declines in infant deaths. In downwind counties located 64-129 km from the plants, infant death rates increased, but the increases were not significant. Therefore, any beneficial effect of reactor shutdowns may apply only to the closest downwind counties. This finding illustrates the importance of analyzing the health of populations that live near nuclear facilities by direction, rather than as a whole. It also suggests that inhalation of airborne radioactive gases and particles, by which process the fetus absorbs radioactivity through the placenta, (14) may be a significant vector of exposure, along with dietary intake.

Cancer diagnosed in children under the age of 5 yr was also reduced in proximate downwind counties with available data. This trend is meaningful because it takes into account disease incidence, which cannot be affected by life-saving technological innovations, and may, therefore, be a more sensitive indicator of radiation effects than mortality.

No demographic characteristic predisposes these areas to health improvements. Reduced infant mortality rates occurred in both rural and urban regions. The relatively small proportions of minorities and poor individuals should not affect short-term changes inasmuch as it is unlikely that the racial distribution of studied counties changed appreciably in 2 yr. In addition, during the 20th century, improvements in infant health have yielded relatively equal benefits for all races and socioeconomic classes (i.e., similar reductions in infant mortality have occurred for all races).

The data support prior research that has shown that in utero exposures to radioactivity are most deleterious given the heightened sensitivity of the developing fetus and newborn infant. In the United States, infant deaths have been linked to exposure to fission products from atmospheric weapons tests. (15) In both Germany (16) and the United States, (17) increases in infant mortality have been attributed to fallout from the 1986 Chernobyl accident. Increased incidences of various congenital malformations have been documented in several European nations after Chernobyl (18-21) Elevated rates of childhood cancer near U.S. nuclear reactors have also been reported. (22-24)

In addition to reduced exposures to fission products, there may be other explanations for the decline. One such possibility is a demographic shift (i.e., closing of a nuclear power facility results in loss of employment for plant workers, who leave the area in search of work). Although some nuclear workers remain after reactors are closed to assist in deactivating the plant, many, in fact, lose their jobs. The processes of operating a reactor and deactivating it are distinctly different.

Some evidence, however, suggests that this population shift may not account for the unexpectedly large infant death and childhood cancer decreases in their entirety.

1. Nuclear plant workers are generally healthier than other workers of childbearing age. They are sufficiently healthy to hold full-time jobs, and their employer-based health insurance allows them access to medical care (including prenatal care--an important determinant of infant mortality risk). Thus, any departure of these

workers from a downwind county after reactor closing would leave a higher-risk population than existed prior to closing of the reactor.

2. In urban areas, such as Sacramento, California, and Portland, Oregon, workers at the nuclear plant likely represent a small percentage of the overall workforce, and they have little impact on the postclosing infant death and cancer rates. Even in rural areas, numbers of live births did not decline rapidly following the closure of the reactor.
3. Workers are as likely to live upwind as they are to live downwind from the plant; however, consistent improvements in infant health occurred only in downwind areas.
4. Two of the plants were closed only temporarily. They did not lay off large numbers of workers, yet disease and death trends were similar to those obtained for the permanently closed reactors.

Whereas a substantial lag period between exposure and disease manifestation may be observed for adult cancers exposed to external x-rays, a much shorter lag period has been documented for very young individuals. Pelvic x-rays administered in utero are linked with increased cancer deaths before an individual's 10th birthday, (25) and 2/3 of these malignancies are diagnosed before the age of 5 yr. Thyroid cancer among children under 15 yr of age who lived near the Chernobyl facility began a sustained increase just 4 yr after the April 26, 1986, accident. (26-28) In 3 Pennsylvania counties located closest to the Three Mile Island facility, cancer deaths in persons under the age of 10 yr jumped from 28 to 36 in the 5 yr following the March 28, 1979, accident. (29)

A relatively short latency period that followed the addition of radioactivity raises the question of whether a similarly short lag exists between reduced exposures and declining disease rates. Short-lived airborne radioisotopes emitted from reactors are completely removed from the environment/diet within several months of the plant shutdown. Long-lived isotopes decay slowly, but existing data on dietary levels of Sr-90 suggest that these may be reduced substantially within several years after plant closing.

The data indicate that improvements in health occur after relatively slight reductions in dietary radioactivity. Sr-90 concentrations measured in milk samples in 9 U.S. cities fell from 30 to 15 picocuries per liter over an 18mo period following cessation of large-scale atmospheric nuclear weapons tests in the mid-1960s. In contrast, Sr-90 reductions in milk near closed nuclear reactors fell from approximately 1.0 to 0.5 picocuries after shutdown. Changes in health status after a relatively small reduction support the effects of low-dose exposures on laboratory animals. (30) In light of these data, the current understanding of the relationship between low-dose radiation exposure and disease should be reconsidered.

Several factors limit this study from being more meaningful. There is a dearth of research on health effects of reduced exposures to ionizing radiation and other toxic substances with which to compare results. Small population sizes in several of the areas near closed facilities make significant findings elusive. The 60 cities with federally reported dietary levels of radioactivity are often not proximate to nuclear sites. Moreover, routine reports of particular isotopes (e.g., barium-140, cesium-137, iodine-131, strontium-89) are no longer available. Reliance on annual strontium-90 levels in milk is a relatively basic measure of radiation burden on local residents. The use of weekly or monthly levels of a variety of isotopes (i.e., both short- and long-lived) would make dose estimates more meaningful. Moreover, given that locally consumed milk is often not produced locally, radioisotope concentrations in air and water would be useful.

The current report was based on aggregate data. In this report, we did not measure levels of radioactivity in the bodies of individual decedents or of infants who survived the first year of life. More dose information--not just in **environmental/dietary** levels--but in vivo, is needed. U.S. government programs that measure Sr-90 in deciduous teeth, children's vertebrae, and adult vertebrae were discontinued in the 1970s and early 1980s. (31) A recent project in which Sr-90 concentrations were measured in deciduous teeth of persons living near nuclear reactors indicated a link between Sr-90 levels and childhood cancer incidence. (32)

More research on how intrauterine exposure to radiation affects health in later life is critical in understanding effects of nuclear reactors. With more than 400 such facilities operating worldwide, such data can play a vital role in any program of disease prevention and health promotion.

Table 1.--U.S. Nuclear Reactors Closed Subsequent to 1987

Reactor name (location)	Started/ closed	Prevailing wind direction *
LaCrosse (Genoa, WI)	07/11/67 04/30/87	South (LaCrosse)
Rancho Seco (Clay Station, CA)	09/16/74 06/07/89 CA)	Southwest (Sacramento,
Fort St. Vrain (Platteville, CO)	01/31/74 08/18/89	South Denver, CO)
Trojan (Prescott, OR)	12/15/75 11/09/92	East-southeast/ northwest (Portland, OR)
Maine Yankee (Wiscasset, ME)	10/23/72 08/05/97	South (Portland, ME)
Big Rock Point (Charlevoix, MI)	09/27/62 08/29/97	West-northwest (Sault Ste. Marie, IL) Southwest (Alpena, MI)

Temporary shutdowns

Haddam Neck (Haddam Neck, CT)	07/24/67 --	South (Hartford, CT)
Millstone 1,2,3 (Waterford, CT)	10/26/70 --	Southwest (Providence, RI)
Pilgrim (Plymouth, MA)	06/16/72 04/30/86	Southwest (Boston, MA)

Comparison of reactors closed subsequent to 1987  
with physical locations of additional operating reactors located < 113  
km from closed reactor specified

Reactor name (location)	Date closed
Handford-N (Richmond, WA)	02/01/88
Yankee Rowe (Rowe, MA)	10/01/91
San Onofre (San Clemente, CA)	11/30/92
Clinton (Clinton, IL)	Autumn of 1996
LaSalle County 2 (Seneca, IL)	Autumn of 1996
Zion 1,2 (Zion, IL)	01/16/98

Reactor name (location)	Cities located downwind (< 64 km from closed reactor)	1990 Population (n)
LaCrosse (Genoa, WI)	LaCrosse, WI Vernon, WI	97,904 25,617

Rancho Seco	Amador, CA	30,039
(Clay Station, CA)	El Dorado, CA	125,995
	Placer, CA	172,796
	Sacramento, CA	1,041,219
Fort St. Vrain	Larimer, CO	186,136
(Platteville, CO)	Weld, CO	131,821
Trojan	Columbia, OR	37,557
(Prescott, OR)	Clark, WA	238,053
	Cowlitz, WA	82,119
	Multnomah, OR	583,887
	Wakhiakum, WA	3,832
Maine Yankee	Kennebec, ME	115,904
(Wiscasset, ME)	Knox, ME	36,310
	Lincoln, ME	30,357
Big Rock Point	Antrim, MI	18,185
(Charlevoix, MI)	Charlevoix, MI	21,468
	Cheboygan, MI	23,800
	Emmet, MI	25,040
	Otsego, MI	17,957

#### Temporary shutdowns

Haddam Neck	Middlesex, CT	143,196
(Haddam Neck, CT)	New London, CT	254,957
Millstone 1,2,3	Tolland, CT	128,699
(Waterford, CT)	Windham, CT	102,525
	Kent, RI	161,135
	Washington, RI	110,006
Pilgrim	Plymouth, MA	435,276
(Plymouth, MA)		

Comparison of reactors closed subsequent to 1987  
with physical locations of additional operating reactors located < 113  
km from closed reactor specified

Reactor name (location)	Reactor name and distance/direction from closed reactor
Handford-N (Richmond, WA)	Washington Nuclear 2; same site as closed reactor
Yankee Rowe (Rowe, MA)	Vermont Yankee; 24 km northeast
San Onofre (San Clemente, CA)	San Onofre 2 and 3; all 3 reactors located at same site
Clinton (Clinton, IL)	LaSalle 1; 113 km north
LaSalle County 2 (Seneca, IL)	LaSalle 2; same site as closed reactor
Zion 1,2 (Zion, IL)	Byron 1; 104 km west

Notes: WI = Wisconsin, CA = California, CO = Colorado, OR = Oregon,  
WA = Washington, ME = Maine, MI = Michigan, CT = Connecticut,

MA = Massachusetts, IL = Illinois, and RI = Rhode Island.

\* In this column, specific cities that appear within parentheses are located downwind in the wind direction cited.

Table 2.--Demographic Data and Downwind Counties Located < 64 km from Nuclear Reactors that Had Closed

Reactor name	Percentage			
	Population per km <sup>2</sup> in 1997	Black (1995) (%)	Hispanic (1995) (%)	Low SES person
U.S.	29.2	12.7	11.0	13.8
LaCrosse	40.1	0.5	0.8	10.2
Rancho Seco	127.0	7.4	13.6	13.6
Fort St. Vrain	22.3	6.6	14.4	10.8
Trojan	133.5	4.5	4.2	12.0
Maine Yankee	42.3	0.2	0.5	11.7
Big Rock Point	17.6	0.3	1.4	10.5
Haddam Neck/Millstone	144.3	3.0	2.3	6.5
Pilgrim	270.1	5.1	2.8	7.8
Areas with higher concentrations than U.S.	6	0	2	0
Areas with lower concentrations than U.S.	2	8	6	8

Notes: SES = socioeconomic status; low SES refers to those individuals whose incomes were below the poverty line.

Table 3.--Change in Average Strontium-90 Concentrations in Pasteurized Milk in Cities Located < 64 km from Nuclear Plants that Had Closed

City/state	Closest reactor	Years included	
		BC	AC
Sacramento, CA	Rancho Seco, CA	1983-1988	1989-1994
Denver, CO	Fort St. Vrain, CO	1983-1988	1989-1994
Portland, OR	Trojan, OR	1987-1992	1993-1994
U.S. (23 cities)		1983-1988	1989-1994

Average strontium-90 concentration \*

City/state	BC	n	AC	n	Change (%)
Sacramento, CA	0.92	6	0.48	6	-47.1
Denver, CO	1.52	6	0.50	2	-67.1
Portland, OR	1.25	6	0.65	2	-48.0
U.S. (23 cities)	1.97		1.30		-34.0

Notes: BC: before closing reactor, AC = after closing reactor,

CA = California, CO = Colorado, and OR = Oregon.

\* Concentrations of strontium-90 are expressed in picocuries of Sr-90 per liter of milk.

Table 4.--Change in "All-Causes" Death Rates of Infants during

Their First Year of Life and Who Were Located < 64 km Downwind of Reactors, 2 Years before vs. 2 Years after Nuclear Plant Closings

Reactor	Year Closed	Infant deaths		Live births	
		BC	AC	BC	AC
LaCrosse, WI	1987	36	30	3,507	3,452
Rancho Seco, CA	1989	418	390	44,500	49,414
Ft. St. Vrain, CO	1989	83	72	9,725	9,977
Trojan, OR	1992	253	204	30,320	29,799
Big Rock Point, MI	1997	25	15	2,922	3,040
Maine Yankee, ME	1997	19	18	38,841	4,013
Pilgrim, MA	1986	97	76	12,956	13,412
Millstone, CT	1995	166	130	22,261	21,093
Total for 8 areas		1,097	935	130,032	134,200
U.S. average for 2-yr change		1986-1998			

Reactor	Deaths/1,000		Change (%)		
	BC	AC	Local	Other state	
LaCrosse, WI	10.27	8.69	-15.4	-1.9	
Rancho Seco, CA	9.39	7.89	-16.0	-9.2	
Ft. St. Vrain, CO	8.53	7.22	-15.4	-5.2	
Trojan, OR	8.34	6.85	-17.9	-5.9	
Big Rock Point, MI	8.56	4.93	-42.4	+2.0	
Main Yankee, ME	4.95	4.49	-9.3	+22.8	
Pilgrim, MA	7.49	5.67	-24.3	-13.1	
Millstone, CT	7.46	6.16	-17.4	-5.4	
Totals for 8 areas		8.44	7.00	-17.4 *	-6.7
U.S. average for 2-yr change		-6.4			

Notes: BC = 2 yr before closing reactor, AC = 2 yr after closing reactor, WI = Wisconsin, CA = California, CO = Colorado, OR = Oregon, MI = Michigan, ME = Maine, MA = Massachusetts, and CT = Connecticut.

\* p < .01 (nuclear counties vs. both U.S. and other state totals).

Table 5.-- Change in "All-Causes" Death Rates of infants during Their First Year of Life and Who Were Located < 64 km Downwind of Reactors, 2 Years before vs. 6 Years after Nuclear Plant Closings

Reactor	Year Closed	Infant deaths		Live births	
		BC	AC	BC	AC
LaCrosse, WI	1987	36	69	3,507	10,302
Rancho Seco, CA	1989	418	1,038	44,500	144,770
Ft. St. Vrain, CO	1989	83	192	9,725	30,129
Trojan, OR	1992	253	523	30,320	92,649
Totals for 4 areas		790	1,822	88,052	277,880
U.S. average for 6-yr change		1986-1998			

Reactor	Deaths/1,000		Change (%)	
	BC	AC	Local	Other state
LaCrosse, WI	10.27	6.70	-34.8	-7.7
Rancho Seco, CA	9.39	7.17	-23.6	-16.5
Ft. St. Vrain, CO	8.53	6.37	-25.3	-15.2

Trojan, OR	8.34	5.64	-32.4	-12.7
Totals for 4 areas	8.97	6.56	-26.9*	-15.1
U.S. average for 6-yr change			-11.9	

Notes: BC = 2 yr before closing reactor, AC = 6 yr after closing reactor, WI = Wisconsin, CA = California, CO = Colorado, and OR = Oregon.

\* p < .0001 (nuclear counties vs. both U.S. and other state totals). Rancho Seco difference (p < .05) and Trojan difference (p < .0001) were significant.

Table 6.--Change in "Congenital Anomalies" Death Rates of Infants during Their First Year of Life and Who Were Located < 64 km downwind of Reactors, 2 Years before vs. 2 Years after Nuclear Plant Closings

Reactor	Year Closed	Infant deaths		Live births	
		BC	AC	BC	AC
LaCrosse, WI	1987	7	4	3,507	3,452
Rancho Seco, CA	1989	90	79	44,500	49,414
Ft. St. Vrain, CO	1989	20	24	9,725	9,977
Trojan, OR	1992	61	41	30,320	29,799
Big Rock Pt., MI	1997	10	4	2,922	3,040
Maine Yankee, ME	1997	6	5	3,841	4,013
Pilgrim, Ma	1986	26	23	12,956	13,412
Millstone, CT	1995	51	37	22,093	21,093
Totals for 8 areas		271	217	130,032	134,200
U.S. average for 2-yr change	1986-1998				

Reactor	Deaths/1,000		Change (%)	
	BC	AC	Local	Other state
LaCrosse, WI	2.00	1.16	-42.0	+1.3
Rancho Seco, CA	2.02	1.60	-20.8	-10.1
Ft. St. Vrain, CO	2.06	2.41	+17.0	-6.6
Trojan, OR	2.01	1.38	-31.3	-1.0
Big Rock Pt., MI	3.42	1.32	-61.5	+1.0
Maine Yankee, ME	1.36	1.25	20.2	+5.4
Pilgrim, Ma	2.01	1.71	-14.9	-32.5
Millstone, CT	2.29	1.75	-23.6	-7.7
Totals for 8 areas	2.08	1.62	-22.4*	-5.6
U.S. average for 2-yr change			-5.5	

Notes: BC = 2 yr before closing reactor, AC = 2 yr after closing reactor, WI = Wisconsin, CA = California, CO = Colorado, OR = Oregon, MI = Michigan, ME = Maine, MA = Massachusetts, and CT = Connecticut.

\* p < .05 (nuclear counties vs. both U.S. and other state totals).

Table 7.--Change in "Congenital Anomalies" Death Rates of Infants during Their First Year of Life and Who Were Located < 64 km Downwind of Reactors, 2 Years before vs. 6 Years after Nuclear Plant Closings

Reactor	Year Closed	Infant deaths		Live births	
		BC	AC	BC	AC
LaCrosse, WI	1987	7	17	3,507	10,302

Rancho Seco, CA	1989	90	228	44,500	144,770
Ft. St. Vrain, CO	1989	20	52	9,725	30,129
Trojan, OR	1992	61	123	30,320	92,649

Totals for 4 areas            178   420   88,052   277,850  
 U.S. average for  
 6-yr change 1986-1998

Reactor	Deaths/1,000		Change (%)	
	BC	AC	Local	Other state
LaCrosse, WI	2.00	1.65	-17.5	-7.7
Rancho Seco, CA	2.02	1.57	-22.3	-17.4
Ft. St. Vrain, CO	2.06	1.73	-16.0	-14.3
Trojan, OR	2.01	1.33	-34.0	-4.9

Totals for 4 areas    2.02   1.51   -25.2\*   -14.8  
 U.S. average for  
 6-yr change                            -10.9

Notes: BC: 2 yr before closing reactor, AC = 6 yr after closing reactor, WI = Wisconsin, CA = California, CO = Colorado, and OR = Oregon.

\*  $p < .02$  (nuclear counties vs. U.S.), and  $p < .08$  (nuclear counties vs. other state totals). The Trojan trend was significantly different from those for U.S. ( $p < .03$ ) and for other state ( $p < .006$ ).  
 Table 8.--Change in "All Causes" Death Rates of Infants during Their First Year of Life and Who Were Located 64-129 km Downwind of Reactors, 2 Years before vs. 2 Years after Nuclear Plant Closings

Reactor	Year Closed	Infant deaths		Live births	
		BC	AC	BC	AC
LaCrosse, WI	1987	13	14	1,570	1,467
Rancho Seco, CA	1989	67	101	9,637	10,426
Ft. St. Vrain, CO	1989	33	28	3,347	3,229
Trojan, OR	1992	9	11	1,605	1,608
Big Rock Pt., MI	1997	5	16	1,131	1,180
Maine Yankee, ME	1997	7	7	1,778	1,762
Pilgrim, MA	1986	No data: Atlantic Ocean is downwind			
Millstone, CT	1995	312	285	53,078	51,247
Totals for 8 areas		446	462	72,146	70,890

Reactor	Deaths/1,000		Change (%)
	BC	AC	
LaCrosse, WI	8.28	9.54	+15.3
Rancho Seco, CA	6.95	9.68	+39.3 ( $p < .01$ )
Ft. St. Vrain, CO	9.86	8.67	-21.1
Trojan, OR	5.61	6.84	+22.0
Big Rock Pt., MI	4.42	13.56	+206.8
Maine Yankee, ME	3.94	3.97	+0.8
Pilgrim, MA	area		
Millstone, CT	5.88	5.56	-5.4
Totals for 8 areas	6.18	6.52	+5.4

Notes: BC = 2 yr before closing reactor, AC: 2 yr after closing reactor, WI = Wisconsin, CA: California, CO = Colorado, OR = Oregon, MI = Michigan, ME = Maine, MA = Massachusetts, and CT = Connecticut.

Counties included Buffalo (Wisconsin), Jackson (Michigan), Trempealeau (Wisconsin)--LaCrosse reactor; Douglas (Nevada), Lyon (Nevada), Storey (Nevada), Washoe (Nevada)--Rancho Seco reactor; Albany (Wyoming), Laramie (Wyoming)--Fort St. Vrain reactor; Hood River (Oregon), Wasco (Oregon), Pacific (Washington)--Trojan reactor; Alpena (Michigan), Montmorency (Michigan), Presque Isle (Michigan)--Big Rock Point reactor; Franklin (Maine), Somerset (Maine)--Maine Yankee reactor; Norfolk (Massachusetts), Worcester (Maine), Providence (Rhode Island)--Millstone reactor.

Table 9.--Change in "All Causes": Death Rates of infants during Their First Year of Life and Who Were Located < 64 km--and Not Downwind--from Reactors, 2 Years before vs. 2 Years after Nuclear Plant Closings

Reactor	Year Closed	Infant deaths		Live births	
		BC	AC	BC	AC
LaCrosse, WI	1987	57	63	7,431	7,176
Rancho Seco, CA	1989	310	324	36,944	40,073
Ft. St. Vrain, CO	1989	537	530	58,790	59,923
Trojan, OR	1992	66	73	11,826	12,296
Big Rock Pt., MI	1997	13	12	2,184	2,288
Maine Yankee, ME	1997	45	37	9,254	8,990
Pilgrim, MA	1986	579	528	57,466	60,619
Millstone, CT	1995	637	555	86,642	83,920
Totals for 8 areas		2,244	2,122	270,537	275,285

Reactor	Deaths/1,000		Change (%)
	BC	AC	
LaCrosse, WI	7.67	8.78	+14.4
Rancho Seco, CA	8.39	8.09	-3.6
Ft. St. Vrain, CO	9.13	8.84	-3.2
Trojan, OR	5.58	5.94	+ 6.4
Big Rock Pt., MI	5.95	5.24	-11.9
Maine Yankee, ME	4.86	4.12	-15.4
Pilgrim, MA	10.08	8.71	-13.6
Millstone, CT	7.35	6.61	-10.0
Totals for 8 areas	8.29	7.71	-7.1

Notes: BC = 2 yr before closing reactor, AC = 2 yr after closing reactor, WI = Wisconsin, CA = California, CO = Colorado, OR = Oregon, MI = Michigan, ME = Maine, MA = Massachusetts, and CT = Connecticut. Counties included Allamakee (Iowa), Clayton (Iowa), Winnishiek (Iowa), Fillmore (Minnesota), Houston (Minnesota), Winona (Minnesota), Crawford (Wisconsin), Grant (Wisconsin), Monroe (Wisconsin), Richland (Wisconsin)--LaCrosse reactor; San Joaquin (California), Solano (California), Sutter (California), Yolo (California)--Rancho Seco reactor; Adams (Colorado), Arapahoe (Colorado), Boulder (Colorado), Gilpin (Colorado), Grand (Colorado), Jefferson (Colorado)--Fort St. Vrain reactor; Clatsop (Oregon), Washington (Oregon)--Trojan reactor; Grand Traverse (Michigan), Leelanau (Michigan)--Big Rock Point reactor; Androscoggin (Maine), Cumberland (Maine), Sagadahoc (Maine)--Maine Yankee reactor; Barnstable (Massachusetts), Bristol (Massachusetts), Dukes (Massachusetts), Norfolk (Massachusetts), Suffolk (Massachusetts), Bristol (Rhode Island), Newport (Rhode Island)--Pilgrim reactor; and Hartford (Connecticut), New Haven (Connecticut), and Suffolk (New York)--Millstone reactor.

Table 10.--Changes in the Incidence Rates of All Cancers during the

First 5 Yr of Life of Children Who Lived in Counties that Were Downwind 64 km from Closed Nuclear Plants at 2 Years before vs. 7 Years after Closure of Reactors

Reactor	Year closed permanently	Cancer cases (n)	
		BC	AC
LaCrosse, WI	1987	7	15
Rancho Seco, CA	1989	50	153
Ft. St. Vrain, CO	1989	10	32
Total for 3 areas		67	200
U.S. change	1988-1989 to 1990-1996		

Reactor	Population 0-4 yr of age		Cases/100,000	
	BC	AC	BC	AC
LaCrosse, WI	17,492	61,053	40.02	24.57
Rancho Seco, CA	208,302	854,118	24.00	17.91
Ft. St. Vrain, CO	49,156	178,742	20.34	17.90
Total for 3 areas	274,950	1,093,913	24.36	18.28
U.S. change				

Reactor	Change (%)	
	Local	Other state *
LaCrosse, WI	-38.6	-5.1
Rancho Seco, CA	-25.4	-1.0
Ft. St. Vrain, CO	-12.0	+32.9
Total for 3 areas	-25.0 ([dagger])	-0.5
U.S. change	+0.3	

Notes: BC: 2 yr before the reactor was closed, AC = 7 yr after the reactor was closed, WI = Wisconsin, CA = California, and CO = Colorado.

\* "Other" category for Colorado includes Denver area (i.e., Adams, Arapahoe, Boulder, Denver, Douglas, and Jefferson counties), approximately 55% of the state's population 0-4 yr of age.

([dagger])  $p < .005$  (nuclear counties vs. U.S.), and  $p < .006$  (nuclear counties vs. other state total). Rancho Seco trend differed significantly from trends from U.S. ( $p < .02$ ) and other state ( $p < .004$ ).

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# Learning Disabilities

Statistics by Penn State Graduate Students – 2002

Source: Montgomery County Intermediate Unit (IU 23) was compared to (IU 17)

Statewide Statistics: Pennsylvania Department of Education

<http://ed.hbg.psu.edu/documments/PennDataBooks/SpecialEducation>

Census Figures: 1990 and 2000 <http://www.census.gov/prod/cen1990/dpl/2kh42>

Autism: Several websites including: [naar.org](http://naar.org), [exploringautism.org](http://exploringautism.org), [nich.nih.gib/autism](http://nich.nih.gib/autism) and Naar

## 1990 to 2000

Montgomery County + **94 % Increase**

Montgomery County Increase Is **DOUBLE** the **State Increase**

**Pennsylvania** + **46.6 % Increase**

## Limerick Nuclear Power Plant Is Located In Montgomery County

*Could Limerick Nuclear Power Plant's Daily Routine Radiation Emissions, Plus Accidental Releases, Into The Air, Water, and Soil, Be One Major Factor For Shocking Montgomery County Learning Disability Increases, Double The State Average?*

## 1990 to 2000

**Learning Disabilities have RISEN THREEFOLD in Montgomery County in Comparison To Population (1990 to 2000)**

## 1990 to 2000

Total Enrollment in Montgomery County Schools Down	- 10.9 %
Montgomery County Intermediate Unit Total Enrollment	+ 32.7 %
Montgomery County - Learning Impairment Services	+ 32.7 %
Least Polluted Counties - Learning Impairment Services	+ 1 %

## 1990 to 2000 - ADD/ADHD and Autism

Montgomery County <b>ADD/ADHD</b>	+ 32.7 %
Montgomery County <b>Autism</b>	+ 310 %

# **CHILDREN In Harm's Way**

***"In Harm's Way:  
Toxic Threats To Child Development"***

Published by Greater Boston

**Physicians for Social Responsibility**

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**This Report Links  
Toxic Exposures During Early Childhood  
To Lifelong Disabilities**

Including:

**LEARNING DISABILITIES**

**ADD/ADHD, Reduced IQ, Poorly-Controlled Aggression**

**RADIATION**

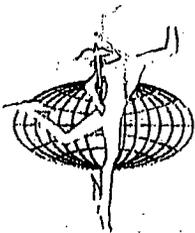
**One of the most harmful chemicals to fetuses and children**

**Since 1985, From Routine Operations,**

**Limerick Nuclear Power Plant**

**Has Released Radiation**

**Into Our Air, Water, and Soil**



# The Mercury

TUESDAY  
September 24, 2002

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Pottstown, Pennsylvania

## Is area's child cancer rate too high?

ACE: 'We were shocked when we saw the results'

By Evan Brandt  
ebrandt@pottsmmerc.com

POTTSTOWN — Child cancer rates in the Pottstown area are nearly 100 percent higher than rates for the nation, the state and the remainder of the tri-county area, according to an analysis of cancer statistics released Monday.

A statistical analysis of data from the Pennsylvania Cancer Registry by Joseph J. Mangano shows that among area residents 19 and younger, the incidence of cancer from 1995 to 1999 was 92.5 percent higher than the national rate for the same age group.

Mangano, who is affiliated with the Radiation and Public Health Project in New York, looked at the state's statistics for residents of Pottstown borough, West Pottsgrove, Upper Pottsgrove, Lower Pottsgrove, North Coventry and Douglass (Berks) townships.

He conducted the study at the request of the Alliance for a Clean Environment, better known as ACE, which released the results at a press conference at Pottstown Middle School

"We were shocked when we saw those figures," said ACE activist Donna Cuthbert.

Her husband, ACE President Lewis Cuthbert, added, "We were most upset when we realized how much the statistics realized our children are being exposed and poisoned. Our children depend on us to protect them, and we have to do a better job."

The percentages of children's cancer in the past five years boil down to 22 cases, 13 of which were leukemia and seven of which were cancers of the brain or the central nervous system.

That works out to a rate of 30.88 cancer cases per 100,000 people in that age group. The U.S. rate for cancers of the same age group is 16.04 cases per 100,000.

The rates in the "remainder of the tri-county area and the state are actually below the national level, meaning the problem in the area is probably a localized one," Mangano wrote in the report.

Interestingly, as the age groups into which the study clustered people rose — and the actual number of cancer cases went up as well — the percentages actually fell.

(See CHILD CANCER RATES on A3)

(CHILD CANCER RATE from A1)

For example, the cancer rate per 100,000 people in the same six-town area dropped to 17.4 percent above the national rate when you look at adults age 20 to 44. From age 45 to 54, the six-town rate is 18 percent above the national rate.

And by the time you get to residents over 55, the statistics in this six-town area are actually 6.8 percent below the U.S. rate according to Mangano's analysis.

That's because more than 80 percent of cancer cases are diagnosed after age 55. So while the number of cases skyrocketed among the older age groups — all the way up to 1,050 new cases in five years for people over 55 — that's actually about average in the United States for a similar population.

And this may account for the fact that an often-criticized cancer study of the same six towns, conducted in 1998 by the Montgomery County Health Department, showed only a 6 percent cancer rate for the area above the rest

of Berks, Chester and Montgomery counties.

But that conclusion was based on spreading the statistics across all age groups and did not look at all cancers, but several selected types of cancer.

That study, which looked at the period from 1990 to 1994, found a children's cancer rate 51 percent higher than that of the surrounding counties, but it was based on too few cases to be judged statistically significant by the county.

Further, Mangano's study added, age-adjusted rates like in the county cancer study "can be informative," but "the large proportion of cancer cases among the elderly may mask unusual patterns among younger groups."

Unusual patterns were also evident in terms of breast cancer, which was not included in the Montgomery County health study.

According to Mangano's analysis the rate for women age 30 to 44 being diagnosed with breast cancer in the six municipality area is 51.4 percent higher



# Local

Tuesday, September 24, 2002

## Is area's child cancer rate too high

than the national rate. That rate was generated by 31 cases out of 6,013 people in that age group.

In total, 263 women in the six-town region were diagnosed with breast cancer in five years.

ACE also released other statistics as the result of work done by another group — graduate students from Penn State University who analyzed statistics under the direction of Steven Couch, Ph.D.

Couch is a professor of sociology who runs a small master's program on community psychology and social change at Penn State's Capital College in Harrisburg.

That analysis showed that while the rates of brain cancer in Pennsylvania and Tioga County, chosen as a comparison county, have remained relatively stable, Montgomery County's rate is increasing.

Montgomery ranks second in Pennsylvania for brain cancer cases per 100,000 in counties with more than 60,000 people. The Penn State analysis

shows an increase of one case per 100,000 each year, meaning 7.5 people in Montgomery County will develop brain cancer this year.

And the rate has almost doubled in five years from 5.8 per 100,000 in 1995 to 10.08 per 100,000 in 1999.

Couch's students also looked at learning disabilities and found that while total enrollment in Montgomery County schools was down 10.9 percent from 1990 to 2000, the Montgomery County Intermediate Unit has seen a 94-percent increase in the number of students with learning disabilities.

Statewide, the increase in learning disabilities is 46.6 percent.

Rates of attention deficit disorder and attention deficit and hyperactivity disorder have risen 32.7 percent in that period, and the rate of autism, in Montgomery County has jumped by 310 percent, the Penn State study concluded.

The statistics indicate, according to ACE and the authors of the studies, that pollution is the most likely cause

for the unnerving health statistics, particularly among children.

"All children in the nation are exposed to the same kinds of pollution — cars, pesticides, household chemicals, smoking in the home, heredity," said Donna Cuthbert.

"What's different about our children here is the chemical plague they are exposed to in this toxic triangle, where we are put in danger from the Occidental Chemical plant, the nuclear power plant and the landfill," she said.

Contending that "children are the barometers of our society's health," ACE said that the fact that childhood cancer rates are high is an indicator of how bad pollution is in the area.

"Because the developing fetus, infant and child are most susceptible to the harmful effects of pollutants, childhood cancer is often a key indicator of any potential hazards," said a release handed out at the press conference.

"Enough excuses, enough blaming the victim," said Lewis Cuthbert. "We cannot lifestyle ourselves out of this crisis."



# EPA moves to protect kids from chemicals

By H. Josef Hebert  
Associated Press Writer

WASHINGTON — The government proposed tougher guidelines Monday for evaluating cancer risks to children on grounds the very young may be 10 times more vulnerable than adults to certain chemicals.

The guidelines, when made final after a review by the Environmental Protection Agency's science advisory board, would dramatically alter current agency policy, which assumes cancer risks to a fetus or an infant are no greater than for a similarly exposed adult.

For the time being, the increased scrutiny would be limited to assessing a group of chemicals that damage a person's genes by causing them to mutate so that cancer may form more easily later in life. Among these are some pesticides as well as a number of chemicals released in combustion or used in the making of plastics.

The agency said that as more information is developed, other cancer-causing pollutants, not those that cause gene mutations, may also be brought under the new guidelines if they are found to pose heightened risk to children.

How to assess cancer risk to the very young from environ-

mental pollution has been an question vexing the EPA for years. This would be the first time the EPA has proposed formally taking into account the differences between exposure to an adult and a baby or toddler in assessing cancer risks.

The final guidelines are to be reviewed by the EPA science advisory board in May, with a final document to be issued by summer, said Bill Farland, the EPA's acting deputy assistant administrator for science.

The EPA also revealed broader guidance Monday that attempts to refine and make more precise how EPA scientists evaluate cancer risks when deciding how to regulate a chemical. The new guidance would recommend that scientists give greater weight to the latest science and try to develop a more complete picture, said Farland.

But the EPA viewed the question of exposure to children so significant that it decided to develop a separate guidance paper on risks of cancer to the very young, assuming for the first time that fetuses, infants and toddlers are substantially more vulnerable.

Limiting its analysis, for the time being, to mutagenic chemicals, or those that cause gene mutations, the EPA said exposure to these chemicals is signif-

icantly more dangerous to young children.

They cause a 10 times greater risk of a future cancer in children under 2 years old and in

fetuses when the mother is exposed, the EPA guidance concluded. It said children from 3 to 15 may face a risk at least three times greater than adults.

## **EPA Admits:**

**Fetuses and Children under 2  
Can be 10 Times  
More Vulnerable Than Adults,  
To Mutagenic Toxic Chemicals**

**Children 3 to 15  
Can be 3 Times More Vulnerable**

# **TOOTH FAIRY**

**PRESS CONFERENCE**

**Nov. 19, 2003**

Held By:

Pottstown Mayor Jones

Alliance For A Clean Environment

**JOSEPH MANGANO, RADIATION AND PUBLIC HEALTH PROJECT DIRECTOR**

## **ANNOUNCEMENT OF RPHP RESEARCH RESULTS**

### **RADIATION IN THE BABY TEETH OF CHILDREN AROUND LIMERICK NUCLEAR POWER PLANT**

**AND**

### **HOW THAT COMPARES WITH OTHER NUCLEAR FACILITIES.**

Montgomery County Community College

**RPHP has been studying levels of radioactive Strontium-90 in baby teeth for several years.**

- Sr-90 is a chemical only produced by atomic bomb explosions and nuclear reactor operations.
- It is chemically similar to calcium; thus, when it is ingested by breathing or the food chain, it attaches to bone and teeth, where it remains for a lifetime.
- Sr-90 presents a risk factor for all cancers and immune diseases, as it can penetrate into the bone marrow, where the white blood cells crucial to the immune system are formed.

**The RPHP presentation will cover the following regional baby tooth results:**

- The average level of Sr-90 in about 100 baby teeth from the region around the Limerick nuclear reactors will be compared with other areas near reactors.
- The trend in Sr-90 in baby teeth over the past 20 years will be analyzed.
- A comparison of trends in Sr-90 in baby teeth and childhood cancer rates will be made.

The above information will be published in the medical journal, The Science of the Total Environment, in January 2004.

**RPHP will also announce its latest effort in its study of baby teeth.**

RPHP is making an appeal for donations of baby teeth from children with cancer, and is comparing Sr-90 averages in teeth of children with and without cancer. RPHP will appeal for baby tooth donations from local children who have been diagnosed with cancer.

Date: 11-17-03

To:

From: Alliance For A Clean Environment (ACE) Pottstown, PA  
Contact: Dr. Lewis or Donna Cuthbert (610) 326-6433 or (610) 326-2387

# **Tooth Fairy**

**Research Results Reported**

**November 19 1:30 P.M.**

Montgomery County Community College, College Drive, Pottstown

**FIND OUT HOW MUCH**

**STRONTIUM-90 RADIATION**

**IS IN THE BABY TEETH OF CHILDREN WHO LIVE  
AROUND THE LIMERICK NUCLEAR POWER PLANT**

## Agenda

1. Dr. Lewis Cuthbert, ACE President  
Overview - Regional Involvement In Tooth Fairy Project  
The Toxic Triangle – Third Exposure Route Confirmed
2. Joseph Mangano – National Director, Radiation and Public Health Project  
Reporting Results of Strontium 90 Radiation Levels In Baby Teeth Collected  
Around the Limerick Nuclear Power Plant and compared to Strontium 90 levels in  
baby teeth around other nuclear power plants.
3. Pottstown Mayor Anne Jones  
Greater Pottstown Area Children – Support for this kind of research and call for  
prevention and solutions - relationship to Pottstown Landfill expansion.  
Appeal for Baby Teeth, especially for children with cancer and in areas closest to, and in the  
predominant wind patterns from, the Limerick Nuclear Plant, including Limerick, Linfield,  
Schwenksville, Spring City, East Coventry Phoenixville, Trappe, Collegeville, Royersford.
4. Aaron Holden – Owen J. Roberts student who lives near the Limerick Nuclear Plant  
A personal view of his battle with cancer - Need to prevent unnecessary exposure  
risks which can cause cancer - Support for the Tooth Fairy Research Project.
5. Dr. Lewis Cuthbert – ACE Plan For Prevention and Solutions



# The Mercury

Wednesday, November 19, 2003

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A Pulitzer Prize-Winning Newspaper

Pottstown, Pennsylvania

## Grim results expected from Tooth Fairy Project

By Evan Brandt  
[ebrandt@pottsmmerc.com](mailto:ebrandt@pottsmmerc.com)

POTTSTOWN — When the Tooth Fairy comes to town this afternoon, he won't be bringing good news.

Joseph Mangano, national director of the Radiation and Public Health Project, will be in town to announce the results of a study that looked for a radioactive isotope in baby teeth of local children.

The report will be explained in detail at a 1:30 p.m. press conference at the

Montgomery County Community College campus in Pottstown. It is open to the public.

A copy of the report was obtained Tuesday by The Mercury and a review suggests the results of the study are grim.

The level of the isotope in the 95 baby teeth from Montgomery, Berks and Chester counties for children born after 1979 is 34 percent higher than the rest of Pennsylvania, the report says.

Even worse, the average in teeth from Pottstown children is 62 percent

higher, according to the report.

The study says the age of the teeth is significant because the first unit of what is now Exelon Nuclear's Limerick Generating Station began operations in 1984 and the second unit in 1989.

Further, there are 11 other operating nuclear reactors within 80 miles of Pottstown.

The substance being studied is called strontium-90 and, according to the report, is one of 100 different radioactive isotopes produced only by atom

(See TOOTH FAIRY PROJECT on A4)

## LOCAL

## Grim results expected from Tooth Fairy Project

(TOOTH FAIRY PROJECT from A1)

bombs, nuclear submarines and nuclear reactors.

Each of these substances is carcinogenic and decays at different rates. What makes strontium-90 a good substance to study is its long half-life, 28.7 years, and the fact that it behaves in a manner similar to calcium and adheres to bone.

So the aptly named Tooth Fairy Project collects baby teeth saved by parents and tests them for strontium-90.

Nationally, the project has collected more than 4,000 baby teeth, mostly from children born since the mid-1980s living close to one or more nuclear reactors, according to the report.

Levels of the isotope, which were high during the 1950s when above-ground nuclear bomb testing was common, are on the rise again in the 1990s, according to the report.

And results from the 100 baby teeth submitted from Berks, Chester and Montgomery counties show local levels of strontium-90 to be above both the state and national average, the highest level being in Pottstown itself, according to the study.

The study takes things a step further.

Because strontium-90 is a known carcinogen, Mangano's study also looks at cancer rates in the area.

Preliminary results of Mangano's examination of cancer statistics were released earlier by the Alliance for a Clean Environment, which is sponsoring today's press conference.

They showed a cancer rate among children to be 94 percent higher in the tri-county area than national, state and regional rates.

Childhood cancer mortality in Montgomery County rose 30 percent from the 1980s through the 1990s, compared to a 22 percent reduction in the state and nation, according to the report.

Some of Mangano's figures had come under fire, but last week the Pennsylvania Health Department released its own comparison of the same statistics and confirmed many of Mangano's findings, such as higher rates of breast cancer, brain cancer and leukemia.

However, state officials intoned the same cautions as others who have disputed Mangano's statistics, arguing that the overall number of local cases being compared is too small a sample from which to draw a reliable statistical conclusion.

A previous study conducted by Mangano's group in Suffolk County, Long Island, near the Brookhaven Nuclear Plant, showed a "nearly identical" increase in incidences of childhood cancer and increases in the strontium-90 found in baby teeth.

Nationally, the center has collected 95 teeth from children with cancer and has tested 61 of them. Results show the average level of strontium-90 in the teeth of children with cancer is 50 percent higher than in teeth taken from children without cancer.

An analysis of baby teeth from the Pottstown area, compared to cancer statistics for the same area, "suggests a link between radiation and cancer in Berks, Chester and Montgomery county children," according to the study.

"Teeth from children with cancer living in the Limerick area will be sought in the near future," the report notes.

Although there appears to be a four-year lag between high levels of strontium-90 and high rates of childhood cancer, the study notes "when Sr-90 increased, there was an increase in cancer incidence four years later."

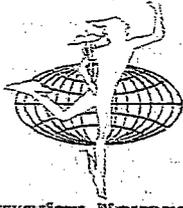
Officials at the Exelon Nuclear's Limerick Generating Station, as well as government officials at the Nuclear Regulatory Commission, have long argued that the low levels of radiation emitted by properly operating nuclear power plants are too low to be a cause for alarm.

But Mangano's group argues that's what doctors used to say about things like exposure to X-rays and other low doses of radiation.

That was until studies proved otherwise.

"The above results suggest that current reactor emissions — not old fall-out from Nevada bomb tests in the 1950s and 1960s — account for a substantial proportion of radioactivity in bodies of local children," the report concludes.

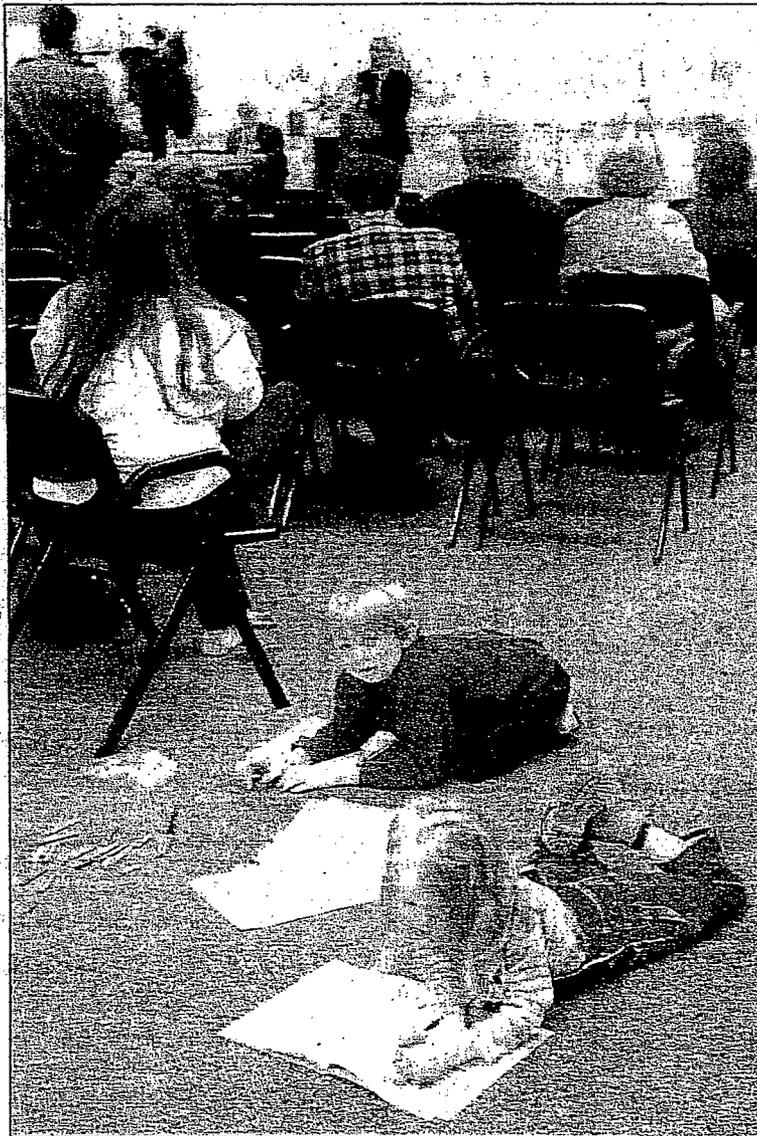
# The Mercury



Thursday, November 20, 2003

www.pottsmmerc.com

Pottstown, Pennsylvania



Daniel P. Creighton/The Mercury  
Jared Grater, 7, and his sister, Brooke Grater, 4, entertain themselves with coloring books as Joe Mangano, national director for the Radiation and Public Health Project, announces the results of a baby tooth study for the Pottstown area.

## ACE: Study shows 'potential link' to radiation, cancer

By John Gentzel  
jgentzel@pottsmmerc.com

POTTSTOWN — Aaron Holden knows what it's like to be young and have cancer.

The Owen J. Roberts High School student was diagnosed with cancer several years ago, and missed lots of school. And in the process, Holden said he lost many friends. Those classmates who would talk to him "were afraid of catching cancer," he said.

Many in the community, including the members of the Alliance for a Clean Environment, believe that Holden is an unfortunate casualty of living inside what it calls the toxic triangle surrounding Pottstown.

The triangle is comprised of the toxic emissions coming from Occidental Chemical in Lower Pottsgrove and the Pottstown Landfill in West Pottsgrove, and the radiation from Exelon Nuclear's Limerick Generating Station. And this combination of pollutants is why ACE and other environmental activists believe the Pottstown area has significantly higher cases of certain types of cancer, including those affecting children.

On Wednesday, Joseph Mangano, national director of the Radiation and Public Health Project, discussed the results of a study that local activists believe reaffirm existence of the toxic triangle.

The aptly titled Tooth Fairy Project looks at the levels of a radioactive isotope in the baby  
(See TOOTH FAIRY PROJECT on A3)

# ACE: Study shows 'potential link' in toxic triangle to radiation, cancer

(TOOTH FAIRY PROJECT from A1)

teeth of children across the country. So far, Mangano said, nearly 4,000 teeth have been studied nationally, including many in the Pottstown area.

The level of the isotope in question, strontium-90, in the 95 baby teeth collected in communities in the Pottstown area from children born after 1979 is 34 percent higher than the rest of Pennsylvania, the study says. Even worse, the average in teeth from Pottstown children is 62 percent higher, according to the report.

Because strontium-90 is a known carcinogen, Mangano's study also looked at cancer rates in the area. The results show the cancer rate in Pottstown area children to be 94 percent higher than the national, state and regional rates.

The information represents a "potential link" between radiation and cancer, and ACE President Lewis Cuthbert said they were advocating the closing of the landfill and the opposition of renewing Limerick Generating Station's operating permit.

"It has now been confirmed that they are also at risk from Limerick's radiation," Pottstown Mayor Anne Jones said at the press conference. "We now know, that radiation gets into the bodies of our children. That our children are far more vulnerable. That there is no safe exposure. And that on

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**The results show the cancer rate in Pottstown area children to be 94 percent higher than the national, state and regional rates.**

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average more children have cancer here than anywhere else."

Strontium-90 is not a naturally occurring product. It's one of 100 radioactive isotopes released by atomic bombs, nuclear submarines and nuclear reactors.

Since nuclear weapons haven't been tested above ground since the 1960s, and the level of strontium-90 has increased, Mangano said the likely cause of the increase is the nation's nuclear power plants.

Lisa Washak, spokeswoman for Exelon Nuclear's Limerick Generating Station, said officials were familiar with the study. She argued that the information has "never been substantiated by scientific evidence" and is often used to "support an anti-nuclear agenda."

Washak said a comprehensive environmental study was conducted before construction of the Limerick Generating Station in the 1970s to determine what elements were in the air, ground and water. Since both reactors started operating in the late 1980s, the facility constantly monitors its releases and conducts thorough envi-

ronmental testing to make sure all emissions are consistent or lower than pre-operational background levels and compliant with all state and federal regulations. The information is available to the public and is reviewed by the Nuclear Regulatory Commission.

"There's nothing here that wasn't here before we built the plant," Washak said.

Other skeptics of the Tooth Fairy Project point out that it's impossible to make any reasonable determination from such a small sample of the population, only 95 of the millions of people in Pennsylvania.

Additionally, the study seems to have no control group, or tests results from areas away from nuclear facilities. This is particularly prevalent in the results presented Wednesday, as all 95 teeth sampled were collected from communities surrounding nuclear plants, including 34 in Pottstown alone. And, opponents argue, while the levels may seem high, they might be comparable to levels of strontium-90 found in the baby teeth of children in other areas.

Still, the results are staggering enough for many to want further explanations provided and studies conducted.

"We need to work together starting today," Cuthbert said. "We don't have any expendable children that we're willing to give over to those polluters and have them wind up as victims."

The Philadelphia Inquirer

# City & Region

SATURDAY, JANUARY 13, 2001

B2 B

THE PHILADELPHIA INQUIRER

## A request for baby teeth, to check radiation levels

Montgomery County families are asked to join a study detecting a substance emitted by nuclear power plants.

By Kathryn Masterson  
INQUIRER SUBURBAN STAFF

A private research group appealed to Montgomery County residents yesterday to donate family members' baby teeth for a study of radiation in people who live near nuclear power plants.

At a news conference in Pottstown, the New York-based Radiation and Public Health Project asked the residents to submit teeth to its Tooth Fairy Project to be analyzed for a radioactive chemical released from nuclear fallout, stron-

tium-90, which attaches to bone in a way similar to that of calcium.

The group has looked for evidence of the chemical in teeth from Toms River, N.J., and Long Island, N.Y., Joseph Mangano, project coordinator, said. The Tooth Fairy Project is a replication of a study done in the 1950s and 1960s, before nuclear testing was banned above ground, Mangano said.

The intent is to try to correlate higher rates of childhood cancer with higher exposure to strontium-90, Mangano said. A study in

Suffolk County, N.Y., showed such a relationship, he said, and the group now hopes to prove it in a national study.

"Our goal is to do research and develop information to be used in nuclear policy," Mangano said.

Sponsoring the local effort is Alliance for a Clean Environment, a Stowe group that several years ago successfully pressed for a cancer-cluster study in towns in Montgomery, Chester and Berks Counties near the Pottstown Landfill. (The 10-month study, results of which were released in January 1998, showed that cases of leukemia, lung and cervical cancer were higher among adults living in the area than

they were in three neighboring counties, but that the incidence of cancer was not centered on the landfill.)

"What we really want to know now is what's coming into our bodies," said Donna Cuthbert, the alliance's vice president. Peco Energy Co.'s Limerick Nuclear Generating Station is in western Montgomery County, about a mile from Pottstown.

Pottstown Mayor Anne Jones said at the news conference that she was working with local parent-teacher groups to distribute envelopes in which parents can send teeth to the Tooth Fairy Project.

The teeth will be tested for radioactivity at a lab in Canada, said Jay

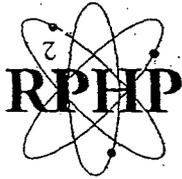
Gould, project director. So far, he said, 1,500 teeth have been tested, out of 2,300 donated from New York, New Jersey, Connecticut and Florida. Each test costs about \$100.

When 5,000 teeth are analyzed, the group plans to do a survey to try to correlate levels of radioactivity by location.

Kathryn Masterson's e-mail address is [kamasterson@phillynews.com](mailto:kamasterson@phillynews.com)

### For More Information

To contact the Tooth Fairy Project, call 1-800-882-3716.



## Radiation and Public Health Project

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November 19, 2003; contact: Joseph Mangano (917-903-5847)  
Dr. Lewis Cuthbert or Donna Cuthbert (ACE) (610-326-2387) (610) 326-6433

### **RADIATION IN TEETH RISING, HIGHEST NEAR LIMERICK POTENTIAL LINK TO CHILDHOOD CANCER SEEN**

Pottstown PA, November 19 - Radioactivity levels in Pennsylvania baby teeth rose during the 1990s, and are highest in Pottstown PA, closest to the Limerick nuclear power reactors, according to results of a study released today.

The study also found that the trends in average radioactivity levels and childhood cancer are similar, suggesting a link between the two. The study was presented in Pottstown by the Radiation and Public Health Project (RPHP), a New York City-based research group.

"We tested 95 baby teeth from children living in Berks, Chester, and Montgomery Counties, and found that average Strontium-90 levels rose 21% in the 1990s, and are 34% higher than in the rest of Pennsylvania," says Joseph Mangano, RPHP National Coordinator and study author. "In 34 teeth from Pottstown children, the excess is 62%." RPHP enlisted a laboratory to test teeth for Strontium-90 (Sr-90), a yellowish metal found only in atomic bomb explosions and nuclear reactor emissions. Sr-90 is radioactive and causes cancer.

Mangano explained that in the three-county area, increases in average Sr-90 levels were followed four years later by rises in cancer in children under age ten. High local rates of childhood cancer rates have recently been discussed in the Pottstown area; in the late 1990s, cancer incidence under age 20 in six local townships and boroughs was 94% above the state and national rate.

"It's important to collect this kind of clinical data in order to work toward prevention and solutions," says Dr. Lewis Cuthbert, President of The Alliance For A Clean Environment, who also spoke at the press conference. "By testing amounts of a specific toxic chemical in the body, the tooth study is producing useful information on one potential factor." Pottstown Mayor Anne Jones also spoke in support of the tooth project, saying that "this kind of research provides documented evidence of harm, which can and should be used to demand use of the Precautionary Principle in all government decisions. We must put an end to the alarming rates of childhood cancer plaguing our community."

RPHP is asking for donations of baby teeth from local children who have been diagnosed with cancer, so that comparisons could be made of Sr-90 averages in children with and without the disease. Based on 61 U.S. teeth, children with cancer have about a 50% higher average Sr-90 level, and more teeth would make this preliminary comparison more significant.

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## EXECUTIVE SUMMARY

Since 1996, the **Radiation and Public Health Project (RPHP)** has conducted the only known study of radiation levels in the bodies of persons living near nuclear reactors. Specifically, it has measured Strontium-90 (Sr-90) concentrations in baby teeth. Strontium is chemically similar to calcium; after it enters the body by breathing, food, or water, it attaches to bone and teeth. Sr-90 has a slow decay rate, and remains in the body for many years.

One area that the study focused on is the Pottstown PA region, near the Limerick nuclear plant. Health and safety concerns about Limerick are reflected in the following data:

### Major Meltdowns

- Limerick's two reactors began operations in 1984 and 1989, respectively. In recent years, the **Exelon Generation Company LLC** has operated the reactors a high percentage of the time (**96.7% in 2002 and 2003**). The issue of whether aging parts are being pushed past their safe limits, raising the risk of a catastrophic mechanical failure and meltdown, is a serious consideration.
- The reactor lies about 30 miles northwest of downtown Philadelphia. The Al Qaeda terrorist network has considered an attack against U.S. reactors, raising the concern that reactors in heavily populated areas might be primary targets. **The federal estimate of 610,000 local cases of radiation poisoning if either Limerick reactor suffered a major meltdown is the highest in the U.S.**

### Radioactivity Routinely Emitted

- Radioactivity from the Limerick reactors is routinely released into the environment. There are variations over time when reactors accidentally emit radioactivity or release it as part of routine maintenance.
- Including Limerick, there are 13 nuclear reactors, 11 of which are still operating, situated within 80 miles of Pottstown, the heaviest concentration in the U.S. (along with northern Illinois). Each reactor releases radioactivity into the environment on an ongoing basis.

### High Cancer Rates Near Limerick

- **From 1995-1999, cancer incidence in children under age 20 living in Greater Pottstown was 94% higher than the national, state, and regional rates.** For the entire 1990s, the rate was 77% higher (total of 40 children diagnosed with cancer).
- Childhood cancer mortality in Montgomery County rose 30% from the 1980s to the 1990s, compared to a 22% reduction in the state and nation.
- From 1995-1999, cancer incidence for young adults (age 20-54) in Greater Pottstown was 18% above the national average. A total of 287 local residents in this age group were diagnosed with cancer during these five years.

- Local incidence of breast cancer in 1995-1999 exceeded the U.S. rate by 51% (age 30-44); by 39% (age 45-64); and by 29% (age 65 and over). In the five year period, 263 local women were diagnosed with breast cancer.

#### Tooth Study Results

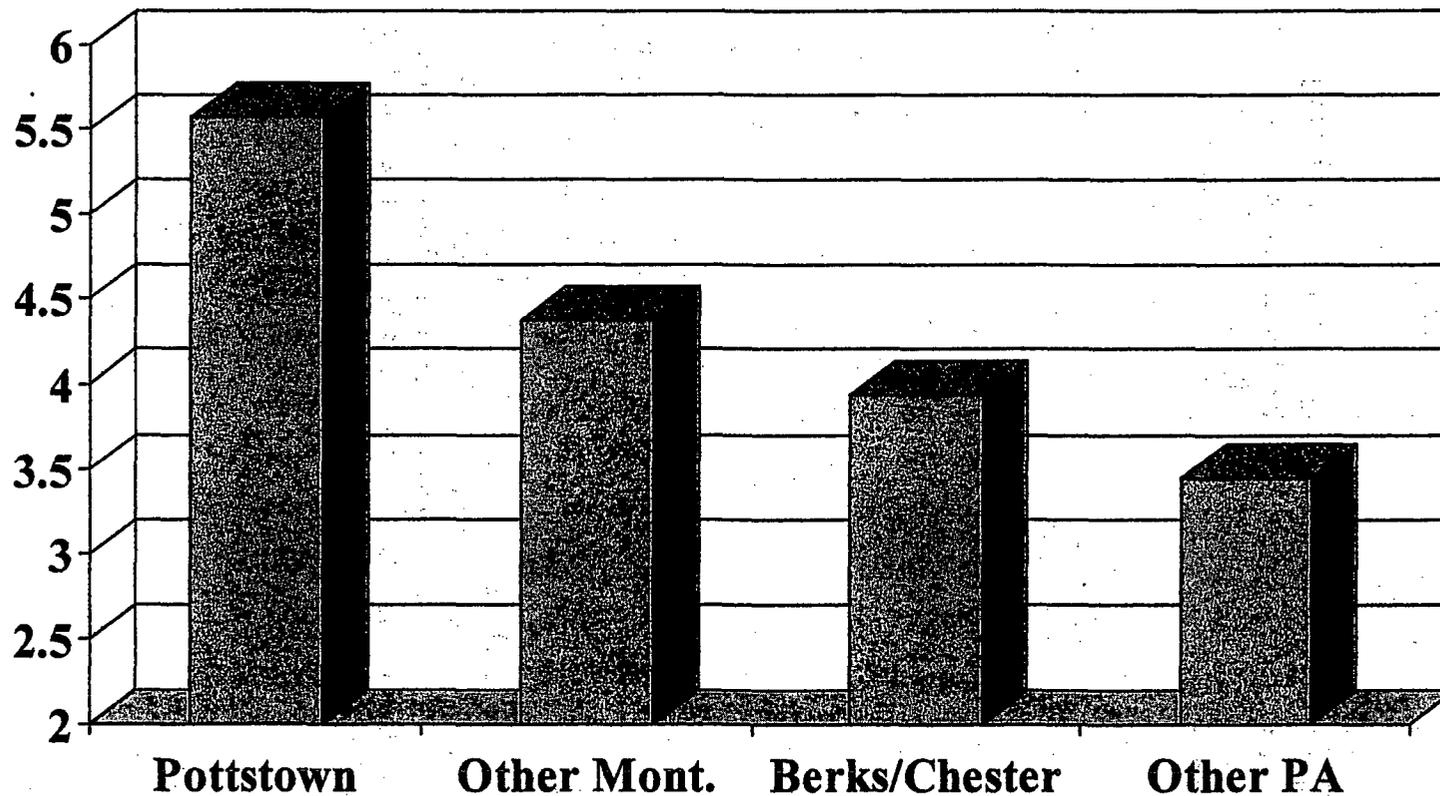
The combination of personal appearances in Pottstown by RPHP's Janette Sherman and Joseph Mangano, plus interest from local residents, resulted in 146 baby teeth being donated to RPHP. These teeth were all tested for Sr-90, and principal results of the analysis are as follows:

1. The average concentration of Sr-90 in <sup>95</sup>100 baby teeth from Montgomery, Berks, and Chester county children born after 1979 is 34% above the rest of Pennsylvania, while the average in Pottstown is 62% higher.
2. From 1986-89 to 1994-97, average Sr-90 levels in the tri-county area steadily rose 21%, reversing a decline that began in the early 1960s. This pattern is similar to that in five other states where the majority of teeth have been collected.
3. In the tri-county area, trends in Sr-90 are similar to trends in cancer deaths among children under age ten

The above results suggest that current reactor emissions - not old fallout from Nevada bomb tests in the 1950s and 1960s - account for a substantial proportion of radioactivity in the bodies of local children. More importantly, there is a statistical link between Sr-90 and childhood cancer in Montgomery, Berks, and Chester counties.

Further studies, such as comparing Sr-90 in teeth of healthy children with teeth of children with cancer, are warranted. (RPHP has recently begun such a study). Moreover, **any policy discussions concerning Limerick should take into account the actual excess diseases and deaths caused by routinely-emitted low-dose radioactivity, along with a (hypothetical) catastrophic accident.**

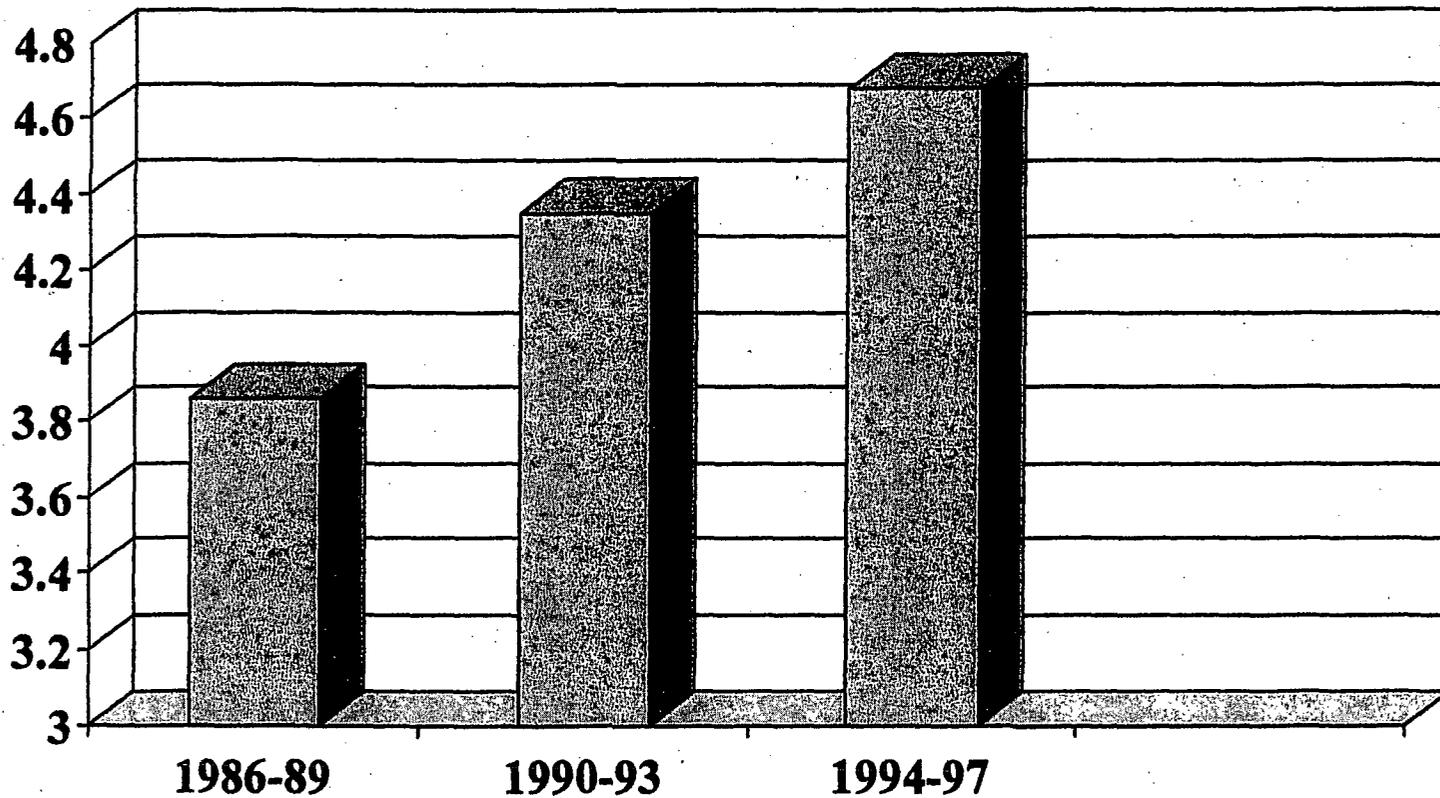
Figure 1  
**AVERAGE SR-90 IN BABY TEETH  
BY AREA OF PENNSYLVANIA**



Scale represents average picocuries Sr-90 per gram calcium at birth in baby teeth. Only births after 1979 included. Number of teeth include Pottstown (34), Other Montgomery (18), Berks/Chester (43), Other PA (34).

Figure 2

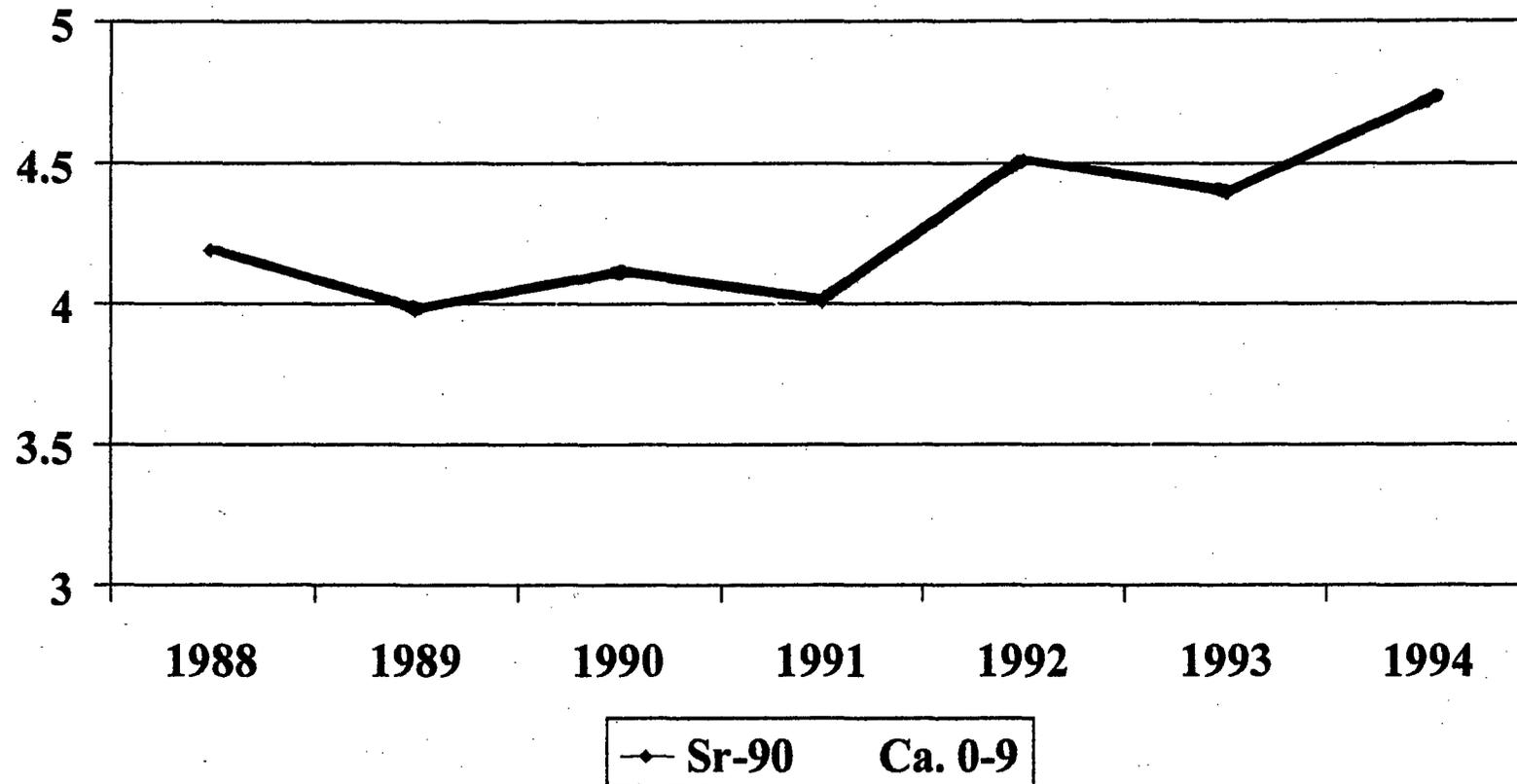
# AVERAGE SR-90 IN BABY TEETH TREND IN TRI-COUNTY AREA



Scale represents average picocuries Sr-90 per gram calcium at birth in baby teeth. Number of teeth include 17 in 1986-1989, 42 in 1990-1993, and 29 in 1994-1997. Years represent birth years.

Figure 3

# TRENDS IN SR-90 AND CANCER AGE 0-9 BERKS, CHESTER, MONTGOMERY (PA) COUNTIES



Scale represents cancer cases 0-9 per 25,000 population, average picocuries Sr-90 per gram of calcium at birth in baby teeth. Points represent middle year of three-year groups, e.g., 1988 = 1987-1989. Four year lag between points, e.g., first Sr-90 point is 1987-1989, first ca 0-9 point is 1991-1993. Sources: Radiation and Public Health Project (Sr-90 data), Pennsylvania Cancer Registry (ca 0-9 data).

**RADIOACTIVE STRONTIUM-90 IN BABY TEETH  
OF SOUTHEAST PENNSYLVANIA CHILDREN  
AND THE LINK WITH CANCER: A SPECIAL REPORT**

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## EXECUTIVE SUMMARY

Since 1996, the **Radiation and Public Health Project (RPHP)** has conducted the only **known study of radiation levels in the bodies of persons living near nuclear reactors**. Specifically, it has measured Strontium-90 (Sr-90) concentrations in baby teeth. Strontium is chemically similar to calcium; after it enters the body by breathing, food, or water, it attaches to bone and teeth. Sr-90 has a slow decay rate, and remains in the body for many years.

One area that the study focused on is the Pottstown PA region, near the Limerick nuclear plant. Health and safety concerns about Limerick are reflected in the following data:

### Major Meltdowns

- Limerick's two reactors began operations in 1984 and 1989, respectively. In recent years, the **Exelon Generation Company LLC has operated the reactors a high percentage of the time (96.7% in 2002 and 2003)**. The issue of whether aging parts are being pushed past their safe limits, raising the risk of a catastrophic mechanical failure and meltdown, is a serious consideration.
- The reactor lies about 30 miles northwest of downtown Philadelphia. The Al Qaeda terrorist network has considered an attack against U.S. reactors, raising the concern that reactors in heavily populated areas might be primary targets. **The federal estimate of 610,000 local cases of radiation poisoning if either Limerick reactor suffered a major meltdown is the highest in the U.S.**

### Radioactivity Routinely Emitted

- Radioactivity from the Limerick reactors is routinely released into the environment. There are variations over time when reactors accidentally emit radioactivity or release it as part of routine maintenance.
- Including Limerick, there are 13 nuclear reactors, 11 of which are still operating, situated within 80 miles of Pottstown, the heaviest concentration in the U.S. (along with northern Illinois). Each reactor releases radioactivity into the environment on an ongoing basis.

### High Cancer Rates Near Limerick

- **From 1995-1999, cancer incidence in children under age 20 living in Greater Pottstown was 94% higher than the national, state, and regional rates.** For the entire 1990s, the rate was 77% higher (total of 40 children diagnosed with cancer).
- Childhood cancer mortality in Montgomery County rose 30% from the 1980s to the 1990s, compared to a 22% reduction in the state and nation.
- From 1995-1999, cancer incidence for young adults (age 20-54) in Greater Pottstown was 18% above the national average. A total of 287 local residents in this age group were diagnosed with cancer during these five years.

- Local incidence of breast cancer in 1995-1999 exceeded the U.S. rate by 51% (age 30-44); by 39% (age 45-64); and by 29% (age 65 and over). In the five year period, 263 local women were diagnosed with breast cancer.

#### Tooth Study Results

The combination of personal appearances in Pottstown by RPHP's Janette Sherman and Joseph Mangano, plus interest from local residents, resulted in 146 baby teeth being donated to RPHP. These teeth were all tested for Sr-90, and principal results of the analysis are as follows:

1. **The average concentration of Sr-90 in 95 baby teeth from Montgomery, Berks, and Chester county children born after 1979 is 34% above the rest of Pennsylvania, while the average in Pottstown is 62% higher.**
2. **From 1986-89 to 1994-97, average Sr-90 levels in the tri-county area steadily rose 21%, reversing a decline that began in the early 1960s. This pattern is similar to that in five other states where the majority of teeth have been collected.**
3. **In the tri-county area, trends in Sr-90 are similar to trends in cancer deaths among children under age ten**

The above results suggest that current reactor emissions - not old fallout from Nevada bomb tests in the 1950s and 1960s - account for a substantial proportion of radioactivity in the bodies of local children. More importantly, there is a statistical link between Sr-90 and childhood cancer in Montgomery, Berks, and Chester counties.

Further studies, such as comparing Sr-90 in teeth of healthy children with teeth of children with cancer, are warranted. (RPHP has recently begun such a study). Moreover, **any policy discussions concerning Limerick should take into account the actual excess diseases and deaths caused by routinely-emitted low-dose radioactivity, along with a (hypothetical) catastrophic accident.**

## BACKGROUND - HEALTH EFFECTS OF RADIOACTIVE EMISSIONS

### A. General History of Reactors.

After the discovery of fission that led to the Hiroshima and Nagasaki bombs in August 1945, scientists and government officials looked for alternative uses of man-made radioactive chemicals. President Eisenhower made his "Atoms for Peace" speech to the United Nations on December 8, 1953, suggesting that (among other uses), atomic power could generate electricity. (1) Congress passed the Atomic Energy Act in 1954, which allowed private companies to build nuclear power plants and ordered the federal Atomic Energy Commission to provide technical assistance. (2)

The Shippingport reactor near Pittsburgh became the first nuclear power reactor to begin operations, in December 1957. Currently, 103 reactors are now licensed by the federal government to produce electricity (including two at the Limerick site). Since the late 1980s, nuclear power has generated about 20% of the electricity consumed in the U.S. (3)

### B. Health Effects of Radioactivity.

Much consideration has been given to health effects of a large-scale meltdown of a reactor's core (where electricity is produced) and/or its spent fuel pools (where radioactive waste is stored). The discussion has been particularly serious since the terrorist attacks of September 11, 2001. Such a major meltdown at a reactor near a large city would constitute the worst environmental catastrophe in U.S. history, comparable to the 1986 Chernobyl accident.

However, nuclear reactors pose health concerns other than major meltdowns. To produce electricity, each reactor must emit relatively low-dose amounts of airborne and liquid radioactivity into the environment. This radioactivity represents over 100 different isotopes only produced in reactors and atomic bombs, including Strontium-89, Strontium-90, Cesium-137, and Iodine-131. Humans ingest them either by inhaling or through the food chain (after precipitation returns these airborne chemicals to earth).

Each of these 100-plus chemicals has a special biochemical action; iodine seeks out the thyroid gland, strontium clumps to the bone and teeth (like calcium), and cesium is distributed throughout the soft tissues. All are carcinogenic. Each decays at varying rates; for example, Iodine-131 has a half-life of eight days, and remains in the body only a few weeks. Strontium-90 (Sr-90) has a half-life of 28.7 years, and thus remains in bone and teeth for many years.

These chemicals are different from "background" radiation found in nature in cosmic rays and in the earth's surface. Background radiation, while still harmful, contains few chemicals that specifically attack the thyroid gland, bones, or other organs.

Because no nuclear reactor in the U.S. has been ordered since 1978, the current crop of 103 reactors is aging, which presents additional health concerns. As reactors age, their parts are more likely to wear down and malfunction, raising the possibility of higher emissions and increased levels of environmental radioactivity. For example, in March

2002 officials noticed that corrosion from boric acid in the Davis-Besse reactor in Ohio had worn down a steel lid from six inches to three-eighths of an inch; that reactor has been closed for nearly two years to make needed repairs.

C. Lack of Studies Comparing Low-Level Radioactivity with Disease Rates.

Currently, federal regulators require annual reports from plant operators to submit annual reports of emissions and environmental (air, water, milk, soil) levels of radioactivity. If these levels fall below federally-defined "permissible limits" they are judged to be harmless, and the plant operator retains its license. **The Nuclear Regulatory Commission, utilities that operate plants, and state health departments perform no studies evaluating any health risks of plant emissions or environmental radiation levels.**

For decades, scientists have documented harm from relatively low-dose exposures of radioactivity otherwise presumed to be safe. In the 1950s, British physician Alice Stewart found that pelvic X-rays to pregnant women nearly doubled the risk that the child would die from cancer by age ten. (4) In 1997, the National Cancer Institute estimated that up to 212,000 Americans developed thyroid cancer after ingesting fallout from above-ground nuclear weapons tests in Nevada. (5) In 2000, the U.S. Department of Energy acknowledged independent studies showed that thousands of workers in atomic weapons plants developed cancer and other diseases in excessively high numbers. (6)

Elevated disease rates in persons living near nuclear power reactors have been reported in dozens of medical journal articles. For example, at least 12 studies have demonstrated high rates of childhood cancer near separate nuclear plants in the United Kingdom. (7-18) In the U.S., very few studies have been done on childhood cancer near nuclear plants; and these examined patterns from decades ago, were small in scale, and yielded mixed results. (19-22) **Moreover, no study has ever been done comparing in-body radioactivity of persons living near U.S. nuclear plants with cancer risk.** Thus, much remains to be learned on the health effects of nuclear reactor emissions.

D. RPHP Baby Tooth Study - A Pioneering Effort.

In 1996, the **Radiation and Public Health Project (RPHP)** initiated the first-ever study of in-body radioactivity near U.S. nuclear plants. Known as the "Tooth Fairy Project," the study involved collecting discarded baby teeth and performing laboratory testing for levels of radioactive Sr-90. RPHP is a New York-based non-profit group of scientists and health professionals dedicated to researching the link between low-dose radiation exposures and disease. Since 1994, group members have written five books and published 19 articles in professional medical/scientific journals on this topic.

The Tooth Fairy Project is not unprecedented. A 1958-70 effort in St. Louis collected over 300,000 baby teeth and measured many of them for Sr-90 levels. The St. Louis project showed that because of fallout from atomic bomb testing in Nevada, children born in 1964 had about 50 times greater concentrations of Sr-90 than did children born in 1950. It also found that in-body levels of Sr-90 decreased by about 50% from 1964 to

1969, after the Partial Test Ban Treaty signed by President Kennedy and Premier Khrushchev relegated all testing to underground sites. (23)

In recent years, there have been at least four studies of Sr-90 from nuclear reactor emissions in baby teeth outside of the U.S. Three of these addressed fallout from the Chernobyl accident in Germany, Greece, and the Ukraine (24-26), while the other examined releases from the Sellafield plant in western England (27). However, none of these compared releases to disease patterns.

To bridge the knowledge gap due to lack of prior research, the RPHP baby tooth study set the following goals:

1. To measure patterns of Sr-90 concentrations in baby teeth near U.S. nuclear reactors.
2. To compare Sr-90 patterns with those of cancer and other diseases.

To date, RPHP has collected over 4000 baby teeth, of which laboratory results of Sr-90 levels are available for about 3500. Most of these teeth are from children born since the mid-1980s living close to one or more nuclear reactors.

RPHP researchers have already published three medical journal articles on preliminary results. (28-30) A fourth will be published in January 2004. The principal findings are:

1. Current Sr-90 levels in children are similar to St. Louis children born in the late 1950s, during the time of above-ground bomb testing.
2. Levels have risen during the 1990s, suggesting that a current source of radioactive emissions is contributing to the burden on the body. Because Sr-90 is only produced in atomic bombs and nuclear reactors, the logical conclusion is that current rises likely represent reactor emissions.
3. In Suffolk County, NY (near the Brookhaven reactors), and in Ocean/Monmouth county NJ (near the Oyster Creek reactor) where hundreds of teeth have been tested, the recent trend in Sr-90 is nearly identical to the trend in childhood cancer, suggesting a cause-and-effect relationship.

## EVOLUTION OF PENNSYLVANIA STUDY/SUPPORTING DATA

Concerned local citizens involved in the Alliance for a Clean Environment (ACE) invited RPHP's Janette Sherman, MD, to make a presentation in November 2000. Dr. Sherman, a toxicologist, discussed the harmful effects of a variety of chemicals, and mentioned RPHP's research on one category of these chemicals, i.e., radioactive emissions from nuclear reactors. Because the two Limerick reactors operated by Exelon Generation Company LLC were located in Pottstown, ACE became interested in RPHP activities, especially its Tooth Fairy Project. In January 2001, National Coordinator Joseph Mangano held a press conference in Pottstown describing the tooth project and appealing for contributions of baby teeth. The event was widely covered by local media, and 146 baby teeth were submitted to RPHP and tested in its laboratory.

### A. Types of Reactor Emissions Posing Health Threats

The Limerick nuclear power plant is located in Pottstown, and consists of two reactors. Unit 1 "went critical" (began producing radioactive chemicals from operations) on December 22, 1984, while Unit 2 followed on August 1, 1989. (31)

Pottstown is situated in an area with the greatest concentration of nuclear reactors in the U.S., along with northern Illinois. Other nearby reactors include:

<u>Reactor</u>	<u>Location</u>	<u>From Pottstown</u>	<u>Startup</u>
1. Limerick 1	Pottstown PA	--	12/22/84
2. Limerick 2	Pottstown PA	--	8/ 1/89
3. Salem 1	Salem, NJ	45 mi. SE	12/11/76
4. Salem 2	Salem, NJ	45 mi. SE	8/ 8/80
5. Hope Creek	Salem, NJ	45 mi. SE	6/28/86
6. Oyster Creek	Forked River, NJ	80 mi. E	5/ 3/69
7. Peach Bottom 1	Delta, PA	50 mi. SW	3/ 3/66 (closed 10/31/74)
8. Peach Bottom 2	Delta, PA	50 mi. SW	9/16/73
9. Peach Bottom 3	Delta, PA	50 mi. SW	8/ 7/74
10. Three Mile Is. 1	Middletown, PA	60 mi. W	6/ 5/74
11. Three Mile Is. 2	Middletown, PA	60 mi. W	3/27/78 (closed 3/28/79)
12. Susquehanna 1	Berwick, PA	70 mi. NW	9/10/82
13. Susquehanna 2	Berwick, PA	70 mi. NW	5/ 8/84

### Number of operating reactors

#### Within 80 miles of Pottstown

1965 - 0  
 1970 - 2  
 1975 - 3  
 1980 - 5  
 1985 - 9  
 1990 - 11

There are four types of public health risk posed by reactors like Limerick:

1. Meltdown After Terrorist Attack.

Health concerns about Limerick and all nuclear reactors rose after September 11, 2001. There has been a prolonged debate about the vulnerability of reactors to a terrorist strike against a reactor's core and/or waste pools, and the health consequences of a subsequent meltdown. In 1982, the Nuclear Regulatory Commission estimated the casualties after a reactor core meltdown. The estimates for each of the two Limerick reactors were 74,000 rapid deaths from and 610,000 rapid cases of radiation poisoning (**easily the highest of all U.S. nuclear plants**), along with 34,000 eventual cancer deaths. (32) These figures should be seen as conservative because they only consider

- a core meltdown, not one in the waste pools where the majority of radioactivity exists
- persons only living within 30 miles of the reactor
- 1980 population figures, which have risen since

Because Limerick lies just 30 miles northwest of Philadelphia, one of the most densely populated areas in the U.S., particular concern should be raised about the threat of a terrorist attack against this plant.

2. Meltdown After Mechanical Failure.

A terrorist attack is not the only way in which a reactor meltdown can occur; mechanical failure is the other. The Chernobyl plant suffered a full meltdown of its core in 1986, while Three Mile Island Unit 2 in Pennsylvania experienced a partial meltdown in 1979, closing the reactor permanently.

Because the Limerick (and other) reactors are aging, there is greater concern about parts being more likely to wear out, leak, or corrode. This concern was illustrated in March 2002 at the Davis-Besse plant near Toledo, Ohio (see page 6).

Adding to the concerns of the mechanical failure is the recent tendency of plant operators to run aging reactors more of the time. Between 1986 and 2001, the percent of the time that U.S. reactors were in operation rose from 63 to 91 percent. (3) **In 2002 and 2003, each of the Limerick reactors operated 96.7% of the time.** (33)

3. Waste Buildup.

Each nuclear plant accumulates high-level radioactive waste, known as "spent fuel rods." These resemble 10-foot long steel rods about the diameter of a pencil, containing high levels of radioactivity, and must be placed in 40 feet deep pools of constantly-cooled water. Some nuclear facilities have begun converting waste to "dry cask" storage, or thick concrete containers, but Exelon does not yet have a license to do this. The U.S. government is planning to eventually store all waste at Yucca Mountain, Nevada, but this plan is being contested in the courts, and the earliest possible date that waste transfers would begin is 2010. Whether the waste remains on site, or is transferred to Nevada, there is a chance that a terrorist attack or mechanical failure disrupting the cooling water in the fuel pools could cause a large-scale meltdown.

#### 4. Routine Emissions.

While most radioactivity produced in reactors is contained in the building and stored as waste, a small proportion of this mix of 100-plus carcinogenic chemicals escapes through the stacks of the reactor. These tiny particles and gases present a concern for public health, since they enter the human body by breathing or through the food chain, after precipitation brings it to reservoirs, dairies, and other sources of food and water.

**RPHP's work is largely confined to health effects from routine emissions.** To date, there have been no Chernobyl-type major accidents at U.S. reactors, and the hazardous waste is not actively involved in the food chain. Thus, the only **ACTUAL** exposure to radioactivity that reactors have posed to the public is from routine emissions.

#### B. Health Data Suggesting Harm to Residents Near Limerick

Various forms of evidence suggest that Limerick emissions may be linked with cancer.

##### 1. Childhood Cancer Incidence in Greater Pottstown.

The Pennsylvania Cancer Registry makes cancer incidence data available for each township and borough in the state, for the periods 1985-89, 1990-94, and 1995-99. The reports include the number of newly-diagnosed cancer cases for each five-year age group (0-4 to over 85), for all cancers combined plus 23 types of cancer. Dividing the number of cancer cases by the population yields an incidence rate.

In 1998, the Montgomery County Health Department issued a report on local cancer patterns. The Department defined the Greater Pottstown area to include six townships or boroughs: Douglass (Berks County), North Coventry (Chester County), and Lower Pottsgrove, Upper Pottsgrove, West Pottsgrove, and Pottstown (all in Montgomery County). The area had a 1990 population of 48,859, which grew to 51,697 in 2000. (34)

The Department's report analyzed the rate of cancer in children (defined as under age 20) from 1985 to 1994. There were 33 cases in this period, and the rate of 24.4 cases per 100,000 children exceeded the rest of Berks, Chester, and Montgomery Counties (16.2) by 50%. The difference fell just short of statistical significance, and the Department concluded "the cancer experience of children living in the Greater Pottstown analysis area is not different from children living elsewhere in the three county area." (35)

Children are most susceptible to the biochemical damage caused by radiation exposure. The immune system of the fetus, infant, and young child is not well developed, and the rate of cell division is very rapid compared to that in adults. Thus, it is less likely that the young body is able to repair a cell that is damaged by radioactivity. And because the local cancer rate in children was 50% above the local rate, further analysis is warranted.

Table 1 updates the Montgomery County Health Department report. It shows that in the period 1995-1999, there were 22 cases of cancer diagnosed in Greater Pottstown children. This number represents an increase from 18 in the early 1990s and 15 in the late 1980s. The 22 cases mean that **the local rate of childhood cancer is 94% above the U.S. rate** (significant at  $p < .05$ , confidence interval 17.75 - 44.05). Rates for the rest of the tri-

county area and state are roughly equal to the U.S. rate. If the 1990s are considered as a whole, the rate for Greater Pottstown is 77% above the U.S., also significant ( $p < .05$ , CI = 19.37-37.29). Of the 40 cases diagnosed in the 1990s, half are either leukemia (13) or brain cancer (7).

Table 1  
 CANCER INCIDENCE AGE 0-19  
 GREATER POTTSTOWN vs. PA and U.S.  
 1995-1999 and 1990-99

<u>Area</u>	<u>Cases</u>	<u>Ann. Population</u>	<u>Cases/100,000</u>	<u>% +/- U.S.</u>
<u>1995-1999</u>				
Greater Pottstown	22	14251	30.88	+94%
Other Tri-County	312	391979	15.92	- 0%
Other Pennsylvania	2509	3222791	15.57	- 2%
U.S.			15.94	
<u>1990-1999</u>				
Greater Pottstown	40	14120	28.33	+77%
Other Tri-County	581	384360	15.12	- 5%
Other Pennsylvania	5025	3208862	15.66	- 2%
U.S.			15.97	

Sources: Pennsylvania Cancer Registry, Harrisburg-PA (PA data). Cancer registries for Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco, Seattle, and Utah (U.S. data).

## 2. Childhood Cancer Mortality in Montgomery County.

In addition to cancer incidence, cancer mortality in children may be another indicator suggesting that radiation exposure and other environmental toxins may be harming local residents. No mortality data are available at the township/borough level, so data from Montgomery County are used instead. Because prevailing winds blow from the northwest much of the year, Montgomery County can be considered downwind from Pottstown.

During the 1990s, 88 Montgomery County children under age 20 died of cancer (Table 2). The county rate of 4.82 deaths per 100,000 children was 43% and 41% higher than the state (3.28) and U.S. (3.41), respectively ( $p < .05$ , CI = 3.79 - 5.85).

Moreover, **Montgomery County's childhood cancer death rate rose 30% from the 1980s to the 1990s, jumping from 65 to 88 deaths.** This trend differs from the reductions in childhood cancer deaths across the nation. The state and national rate each fell 22% during this time ( $p < .01$ ).

Table 2  
**CANCER MORTALITY AGE 0-19**  
**MONTGOMERY COUNTY vs. PA and U.S.**  
 1980s vs. 1990s

<u>Area</u>	<u>Cancer Deaths</u>		<u>Annual Pop.</u>		<u>Deaths/100,000</u>		<u>% Ch.</u>
	<u>1980-9</u>	<u>1990-9</u>	<u>1980-9</u>	<u>1990-9</u>	<u>1980-9</u>	<u>1990-9</u>	
Montgomery County	65	88	175056	182521	3.71	4.82	+30%
Other Penn.	1327	1003	3.14M	3.05M	4.22	3.28	- 22%
United States	31226	25975	71.3M	76.1M	4.38	3.41	- 22%

Sources: National Center for Health Statistics (available from <http://www.cdc.gov>, data and statistics, CDC Wonder). Uses ICD-9 codes 140.0-239.9 (neoplasms). Bair FE. Weather of U.S. Cities, 4<sup>th</sup> Edition. Detroit: Gale Research Company Inc., 1992 (prevailing wind direction).

### 3. Cancer Incidence in Young and Middle Age Adults in Greater Pottstown.

Aside from children, younger adults are perhaps the next most sensitive group to radiation exposure, as exposures early in life may take years to manifest as cancer. Table 3 shows that **the 1995-1999 cancer incidence rate in Greater Pottstown is 18% higher than the U.S. for persons age 20-54** (significant at  $p < .05$ , CI = 203.85 - 257.15). With 287 local residents age 20-54 diagnosed with cancer during these five years, these elevated rates should be seriously considered.

Table 3  
**CANCER INCIDENCE AGE 20-54**  
**GREATER POTTSTOWN vs. PA and U.S.**  
 1995-1999

<u>Area</u>	<u>Cases</u>	<u>Ann. Population</u>	<u>Cases/100,000</u>	<u>% +/- U.S.</u>
Greater Pottstown	287	24956	230.0	+18%
Other Tri-County	7262	696876	208.4	+ 7%
Other Pennsylvania	58015	5819072	199.4	+ 2%
U.S.			195.3	

Sources: Pennsylvania Cancer Registry, Harrisburg PA (PA data). Cancer registries for Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco, Seattle, and Utah (U.S. data).

### 4. Cancer Incidence in Elderly Adults in Greater Pottstown

Table 4 shows that 1995-1999 cancer incidence in Greater Pottstown for persons 55 and over is roughly the same as that of the tri-county area, state, and nation. Despite this, the fact that persons under age 55 (77% of the local population) have high cancer rates suggests that more investigation into potential environmental causes is warranted.

Table 4  
**CANCER INCIDENCE**  
**GREATER POTTSTOWN vs. PA and U.S.**  
 1995-1999, Age 55-64 and 65+

<u>Area</u>	<u>Cases</u>	<u>Ann. Population</u>	<u>Cases/100,000</u>	<u>% +/- U.S.</u>
<u>Age 55-64</u>				
Greater Pottstown	230	4464	1030.5	- 7%
Other Tri-County	7039	131018	1074.5	- 3%
Other Pennsylvania	59708	1135609	1051.6	- 5%
U.S.			1106.1	
<u>Age 65+</u>				
Greater Pottstown	820	7175	2285.9	+ 1%
Other Tri-County	22675	195272	2322.4	+ 3%
Other Pennsylvania	211849	1884973	2247.8	- 1%
U.S.			2262.2	

Sources: Pennsylvania Cancer Registry, Harrisburg PA (PA data). Cancer registries for Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco, Seattle, and Utah (U.S. data).

**5. Breast Cancer Incidence in Greater Pottstown**

Female breast cancer is the second most commonly diagnosed cancer in the U.S., just behind prostate cancer. Approximately 211,300 women will receive this diagnosis in the year 2003. (36) Prior research has shown elevated breast cancer rates in persons exposed to radiation.

Table 5 shows the 1995-1999 breast cancer incidence rate in Greater Pottstown. The local rate, based on 263 cases, exceeded the U.S. rate for young, middle aged, and elderly women (by 51%, 39%, and 29%, respectively). Excesses are significant for age 45-64 (p<.02, CI = 331.5 - 484.9), and age 65 and over (p<.05, CI = 482.6 - 691.8).

Table 5  
**FEMALE BREAST CANCER INCIDENCE**  
**GREATER POTTSTOWN vs. U.S.**  
 BY AGE GROUP, 1995-1999

<u>Age</u>	<u>Cases</u>	<u>Ann. Population</u>	<u>Cases/100,000</u>		<u>% +/- U.S.</u>
			<u>Local</u>	<u>U.S.</u>	
0-29	1	10205	2.0	1.7	+15%
30-44	31	6013	103.1	68.1	+51%
45-64	105	5145	408.2	293.1	+39%
65+	126	4292	587.2	456.6	+29%
TOTAL	263				

Sources: Pennsylvania Cancer Registry, Harrisburg PA (PA data). Cancer registries for Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco, Seattle, and Utah (U.S. data).

6. Incidence of Most Common Cancers in Greater Pottstown.

Data from the Pennsylvania Cancer Registry makes an analysis of individual forms of cancer possible. Table 6 documents Greater Pottstown's 1995-1999 incidence rate of the 11 most common (nationally) cancer types, compared to rates for the U.S. and other parts of the tri-county area. These 11 cancer types make up 78.3% of the cancer cases diagnosed in Greater Pottstown residents in the late 1990s.

The Greater Pottstown rate exceeds the local and national rate for 8 of the 11 most common cancer types. Because of the large number of cases, many of the elevated rates are significantly higher.

Table 6  
**CANCER INCIDENCE, 11 MOST COMMON CANCER TYPES  
 GREATER POTTSTOWN vs. OTHER TRI-COUNTY and U.S.  
 1995-1999, ALL AGES COMBINED**

<u>Type of Cancer</u>	<u>Local Cases</u>	<u>Rate per 100,000</u>			<u>% Local Above</u>	
		<u>Gr. Potts.</u>	<u>U.S.</u>	<u>Oth. 3 Co.</u>	<u>U.S.</u>	<u>Oth. 3 Co.</u>
All Cancers	1432	449.9	402.0	430.4	+11.9*	+ 4.5
Prostate (male)	174	127.4	143.1	139.4	- 11.0	- 8.6
Breast (female)	263	161.5	116.0	129.8	+39.2*	+24.5*
Lung	197	62.3	55.7	52.6	+11.8	+18.4**
Colon	129	37.9	31.3	36.7	+21.1	+ 3.3
Urinary Bladder	79	22.9	16.9	19.4	+35.5**	+17.9
Skin Melanoma	46	14.0	14.5	15.5	- 3.4	- 10.0
Non-Hodgkins Lymphoma	43	14.1	16.1	16.2	- 12.4	- 12.8
Rectum	61	18.2	12.6	16.0	+44.4*	+13.5
Uterine (female)	51	31.7	22.0	22.8	+44.1**	+38.7
Kidney/Renal Pelvis	45	15.2	9.5	10.7	+60.0*	+42.7
Leukemia	35	11.6	10.4	10.1	+11.5	+14.9

U.S. includes Alaska Territories, Atlanta area, Connecticut, Detroit area, Hawaii, Iowa, Los Angeles area, New Mexico, San Francisco area, San Jose-Monterrey, Seattle area, Utah (about 14% of U.S. population)

Most common cancer types are those with the most cases expected nationally in 2003 (prostate = 220,900; female breast = 211,300; lung = 171,900; colon = 105,500; urinary bladder = 57,400; skin melanoma = 54,200; non-Hodgkin's lymphoma = 53,400; rectum = 42,000; uterine (corpus uteri) = 40,100; kidney/renal pelvis = 31,900; leukemia = 30,600). Source: National Cancer Institute (www.seer.cancer.gov)

Rates adjusted for 1970 U.S. standard population

\* = significant at p<.05; \*\* borderline significant at p<.10

Sources: Pennsylvania State Cancer Registry, National Cancer Institute (cancer cases). U.S. Census Bureau (population data)

## METHODOLOGY

### A. Collecting Teeth.

As described above, most of the teeth donated to the Tooth Fairy Project in the Pottstown area resulted from Joseph Mangano's appearance in January 2001, and subsequent efforts by ACE to solicit tooth donations from community members.

### B. Testing Teeth.

RPHP measures the amount of Strontium-90 in each baby tooth by contracting with REMS, Inc., a laboratory in Waterloo, Ontario, Canada under the direction of Hari Sharma, PhD, a radiochemist. RPHP sends teeth to the laboratory in batches, and teeth are tested individually using a scintillation counter. **All lab personnel are "blinded" about all information concerning each tooth, that is, they know nothing about what state it is from, how old the child is, etc.** This "blinding" helps assure objective, non-biased results.

The laboratory measures the concentration of Sr-90; specifically, it calculates the picocuries of Sr-90 per gram of calcium in each tooth. (See Appendix 1 for more specific technical procedures). The strontium-to-calcium ratio was used in the St. Louis study in the 1960s, and all other recent baby tooth studies mentioned earlier. Effects of harmful strontium can be negated by health-promoting calcium.

The laboratory returns results to RPHP, where staff converts the ratio to that at birth, using the Sr-90 half-life of 28.7 years. For example, if the lab determines the tooth had 3.00 picocuries of Sr-90 per gram of calcium, and the person was 28.7 years old, the ratio at birth would be 6.00 (half of the Sr-90 would have decayed in 28.7 years). RPHP computerizes the results, and produces summary reports.

The Sr-90/Ca ratio for a single tooth is not a precise number because a typical baby tooth is small in mass and subject to some error. In fact, only the most modern machines can test individual teeth with any precision; the St. Louis study only tested batches of teeth. The standard error for each tooth is conservatively estimated as plus or minus 0.7 picocuries. Thus, there is a 95% chance that the "actual" amount of Sr-90 in a tooth with a ratio of 6.00 is between 4.60 and 7.40 (plus or minus twice the standard error). Obviously, when using large numbers of teeth, the error for the average level becomes much smaller.

Ratios for some teeth are less reliable than for others. Generally, the ones with the lowest reliability are the smallest and/or most decayed, leaving little healthy enamel to be tested. RPHP assigns each tooth a reliability (quench) factor, and excludes those teeth deemed most unreliable (i.e. a quench factor of over 1.24) from analyses of aggregate data.

### C. Change in Counter, Technique.

After June 2000, when RPHP had Sr-90 results for 1303 teeth, it made two upgrades to its testing procedures. First, it leased and began using a new machine, the 1220-003 Quantulus Ultra Low-Level Liquid Scintillation Spectrometer. Made by the Perkin-

Elmer Company of Massachusetts, this new model is considered to be one of the most sophisticated counters in the field. Introduced in 1995, only about 15 to 20 are in use in the United States. (37)

The new counter is located on the premises of REMS, Inc., and not in the basement of the University of Waterloo's science building, thus changing the nature of the radiation background. Also, the method of removing organic material from the teeth was changed by treating them with hydrogen peroxide prior to grinding them into powder. This proved to be more effective in allowing light produced in the liquid scintillation fluid by the beta particles emitted by the Sr-90 and its daughter product, Yttrium-90, to reach the photomultipliers, partly by shifting the spectrum of the light emitted by the scintillation fluid to some degree. As a result of these changes in the counter, its location, the nature of the background, and the method of cleaning the teeth, the efficiency of detecting the very low radioactivity in single teeth was more than doubled, improving the quality of the data.

Because the results from the two counters are each internally consistent but differ, the data from teeth measured before and after June 2000 cannot be merged. This report only covers those "newer" teeth, numbering 2263 at this writing.

#### D. Comparisons for Consistency of Data.

RPHP set up a method to test the same teeth for Sr-90 in different laboratories, to assure that results produced by the REMS lab were consistent and accurate. The Perkin-Elmer Company staff recommended several users of the same model scintillation counter that RPHP was employing. RPHP selected Michael P. Neary, PhD, of the University of Georgia Center for Applied Isotope Studies for this test. Dr. Neary, an experienced radiochemist, operates three of the 15-20 units in the U.S., and was perhaps the first American to use them when he purchased them in the mid-1990s.

RPHP sent Dr. Sharma two batches of teeth to test. They contained 10 teeth each from persons born in St. Louis (from the original 1958-70 study mentioned earlier). One batch were 1954 births, and the other were 1959 births. Again, Drs. Sharma and Neary were blinded and had no information other than that they were baby teeth.

1. Interlaboratory Consistency. Dr. Sharma dried teeth in the two batches, removed any decay and fillings, and ground them into a powder. He tested Sr-90 levels for the 10 teeth from 1954 on the counter used in the RPHP tooth study. When he completed work, he sent the entire batch to Dr. Neary. Dr. Neary could only test the Sr-90 level of the dissolved solution of teeth, not the crushed powder, but this will not alter the results. The findings from each test of the 1954 teeth are as follows:

Table 7  
INTER-LAB COMPARISON, ST. LOUIS TEETH, 1954 BIRTHS

<u>Tester</u>	<u>Sr-90</u>		<u>Confidence</u>
	<u>Level*</u>	<u>Std. Error</u>	<u>Interval+</u>
Sharma	1.77	+/- 0.31	1.15 - 2.39
Neary	2.13	+/- 0.31	1.51 - 2.75

\* Average picocuries of Strontium-90 per gram of calcium at birth

+ Average Sr-90 level plus or minus two times the standard error, i.e. there is a 95% certainty that the actual value falls between these two values

While there is some variation between each set of readings, there is substantial overlap between each confidence interval, therefore indicating that measurements are largely consistent between labs. It is clear that with a small sample (10 teeth), results will vary somewhat, which is why RPHP collected hundreds of teeth before presenting data as anything more than preliminary.

2. Intralaboratory Comparison. A second reliability test was performed by Dr. Sharma. Prior results from the St. Louis study indicated that average 1959 Sr-90 levels were considerably higher than those for 1954. Dr. Sharma split his two samples of 10 teeth each into two "sub-batches," and calculated Sr-90 levels separately. The following results were obtained:

<u>Batch</u>	<u>Avg. Sr-90*</u>	<u>% 1959 Over 1954</u>	<u>Std. Error</u>	<u>Confidence Interval</u>
#1 - 1954	1.66		+/- 0.27	1.12 - 2.20
- 1959	3.28	+98%	+/- 0.36	2.56 - 4.00
#2 - 1954	1.77		+/- 0.31	1.15 - 2.39
- 1959	3.36	+90%	+/- 0.37	2.64 - 4.10

\* Average picocuries of Strontium-90 per gram of calcium at birth

In the two tests, the excess of 1959 averages are slightly less than double that of 1954 (98% and 90%). Confidence levels do not overlap, meaning it is very likely the "true" values of the 1959 results exceed those for 1954. Thus, the RPHP results are also internally consistent, and are largely consistent with those found in the St. Louis study in the 1960s.

#### E. Do Sr-90 Levels Represent Current or Past Emissions?

Some have suggested that the Sr-90 detected in the RPHP study may not represent new emissions from nuclear reactors, but leftover fallout from atmospheric atomic bomb tests in Nevada from 1951-62. Large-scale atmospheric testing ended in 1963, and the last above-ground test worldwide took place in China in 1980. U.S. underground tests ended in 1992. There are no other sources of Sr-90 other than bomb tests or reactor emissions.

There are numerous reasons why the large majority of Sr-90 detected in baby teeth of today's children represents emissions from nuclear reactors, not old bomb test fallout.

1. Physical/Biological Half-Life. A fetus takes up Sr-90 in its tooth buds from the mother's bone stores and from the mother's diet (delivered to the fetus through the placenta) during pregnancy. During early infancy, Sr-90 is taken up from the diet, whether the baby is bottle-fed or breast-fed.

The biological half-life of Sr-90 in the body is about two years for children and 5-10 years for adults, before transforming into its daughter product Yttrium-90. Thus, the bones of the mothers of tooth donors (many of whom were at least 25 at delivery) should have little Sr-90 remaining in their bone stores by now.

The physical half-life of Sr-90 is about 28.7 years. But Sr-90 that rained into reservoirs (drinking water) 40-50 years ago has long sunk into the sediment, because strontium is heavier than water. Similarly, Sr-90 that rained onto grass where cows graze has long ago penetrated into the soil, or run off with excess water.

Thus, it is logical that little Sr-90 from 1950s and 1960s bomb tests remains in mother's bodies or in the environment, and most of the current Sr-90 represents emissions from nuclear reactors.

2. Sr-90 in Bone, Teeth Leveling or Rising. There is a precedent for reactor emissions causing rises in Sr-90. In southern Germany, 280 baby teeth from children born before and after the Chernobyl accident were analyzed. The change from an average of 0.81 to 7.56 picocuries of Sr-90 per gram calcium, nearly a ten-fold increase, was observed for children born 1983-85 and 1987. (24)

The St. Louis baby tooth study also examined Sr-90 levels in the mandibles (jaw bone) of stillborn fetuses. Similar to baby teeth, a large increase was observed in the early 1960s, during the height of atmospheric bomb testing. However, after large-scale testing ended following the Test Ban Treaty, average Sr-90 levels fell by about half from 1964-69. No further data are available because federal government support for the study ceased in 1970. (23)

In the late 1960s, only a half-dozen small nuclear power reactors were in operation, and underground bomb tests emitted considerably less radiation into the atmosphere than did above-ground tests. If the 1964-69 trend had continued, about 97-99% less Sr-90 should now be present in the body at birth, or less than 0.5 picocuries. But RPHP found otherwise. In the first 1303 teeth (using the "old" counter and technique), the average Sr-90 level fell by more than half from 1974-1977 (average 2.83 picocuries) to 1985-1988 (1.38), then stopped declining in 1989-1992 (1.36). Using the new technique/counter, **the rapid Sr-90 decline stopped at the same time, and has actually increased 60% from 1986-89 to 1994-97 (Table 8).**

**There can be no explanation for this reversal other than an increase in a current source of radioactivity, and this source almost certainly is must be emissions from nuclear reactors.** Since the early 1980s, the number of operating reactors has risen from about 70 to just over 100. Moreover, plants are closed less frequently for inspections, maintenance, and repairs, and the number of gigawatt-hours of electricity produced by these reactors tripled during this time. (3)

Table 8  
AVERAGE SR-90 CONCENTRATION, BY BIRTH YEAR, U.S.  
TEETH TESTED AFTER JUNE 2000

<u>Birth Yr</u>	<u>No. Teeth</u>	<u>Avg. Sr-90*</u>
1962-65	8	9.48
1966-69	16	7.01
1970-73	38	5.98
1974-77	46	6.84
1978-81	85	4.34
1982-85	179	3.96
1986-89	552	3.16
1990-93	880	3.70
1994-97	411	5.06

% Change, 1986-89 to 1994-97 +60%

Note: Most teeth are from areas near reactors in CA, CT, FL, NJ, NY, and PA

\* Average picocuries of Strontium-90 per gram of calcium at birth

3. Philippino Sr-90 Teeth Considerably Lower. RPHP collected several dozen teeth from persons born in the Philippine Islands. No nuclear reactor (for weapons, power, or research) has ever operated in this nation. It may have received fallout from Chinese atmospheric bomb tests, but there were many fewer of these tests than in the U.S., and Chinese testing ended in 1980. Thus, if emissions from reactors are contributing to current Sr-90 levels, Philippino teeth should contain less of this chemical than American teeth.

Thirteen (13) teeth of children born in 1991 and 1992 (9 and 4, respectively), were tested. The average Sr-90 concentration at birth was 2.04 (using the new technique/counter). The average for teeth of American children born those years was 3.44, making Philippino teeth about 41% lower than U.S. teeth. Again, reactors appear to be a major source of current Sr-90 levels (note that some Sr-90 may exist in Philippino teeth due to imported food products from affected areas), and that there is an error factor when using only 13 teeth.

4. California Sr-90 Teeth Rise After Reactor Opening. RPHP collected 34 teeth from San Luis Obispo County CA, the location of the Diablo Canyon 1 and 2 reactors, which started operations in 1984 and 1985. The average Sr-90 concentration for

children born after the reactors opened was 49.6% greater than those born before (average of 2.02 vs. 1.35), suggesting that emissions from the new reactors accounted for this rise. The comparison used the "old" technique and machine.

5. Other Reports Indicate Current Rates Should Be Near Zero. One of the recent Sr-90 tooth studies mentioned earlier by Greek researchers contained a chart summarizing trends in Sr-90 in deciduous (baby) teeth from various European nations and the Soviet Union. The chart shows that, from a level of about 0.27 picocuries of Sr-90 per gram of calcium in 1951, a peak of 6.75 was reached in 1964, similar to the U.S. trend. By 1975, the average level had slumped to about 0.81 (three times the 1951 average) and was still declining. (25)

At three times the 1951 average, the 1975 U.S. Sr-90 level should have been about 0.6 (0.2 times three) picocuries Sr-90 per gram calcium. But the actual levels found by RPHP were 3.03 and 4.96 (8 and 12 teeth, respectively, using the old and new technique/method).

6. Short-Lived Radioactive Chemicals Found In Local Eggshells. In 2001, a high school student from Rockland County NY presented an innovative idea for the Tooth Fairy Project. RPHP could not measure levels of short-lived radioactive chemicals in baby teeth, which now can only come from reactors. These include Strontium-89, with a physical half-life of 50 days and Barium-140, with a half-life of 13 days. By the time the child lost a baby tooth, at least five years after birth, the short-lived particles had disappeared.

The student's idea was to test chicken eggshells for short-lived radioactivity. She collected several local specimens soon after they were hatched, and rushed them to the REMS laboratory, which tested for Barium-140. These preliminary tests found several picocuries of Ba-140, which because of its rapid half-life could only have come from a nuclear reactor, probably the nearby Indian Point facility.

## STUDY RESULTS

### A. Results by Area of State.

A total of 146 "Pennsylvania" teeth (defined as the mother of the tooth donor lived in Pennsylvania during pregnancy) were tested under the "new" method and technique. Of these, 17 are excluded (six born before 1980, when fallout from Nevada tests was still relatively high and eleven with insufficient enamel to produce an accurate result). The average concentration of Sr-90 for the remaining 129 Pennsylvania teeth was 4.30 picocuries of Sr-90 per gram calcium at birth. This figure exceeds the 3.84 mark for 2071 teeth from all areas studied.

Table 9 reveals that **the 95 teeth analyzed from the tri-county area had an average of 4.61, or 20% above the U.S., and 34% higher than the rest of Pennsylvania** (34 teeth, average 3.45). The 34 Pennsylvania teeth from outside the three counties are from the Philadelphia area (15), south central Pennsylvania (10 teeth), western Pennsylvania (7 teeth), and two others.

Montgomery County has the highest average in the tri-county region, at 5.15 (52 teeth), while the 34 teeth from zip code 19464 in Pottstown had an average of 5.57, or 45% higher than the national standard and 62% higher than the state outside the tri-county region (5.57 vs. 3.45). **The average in-body concentration of Sr-90 appears to be highest in the area closest to the Limerick plant.** Figure 1 illustrates the variation of Sr-90 levels around the state.

Table 9  
 AVERAGE SR-90 CONCENTRATION\* BY REGION  
 PENNSYLVANIA RESIDENTS BORN AFTER 1979

<u>Region</u>	<u>Teeth</u>	<u>Avg pCi Sr90*</u>
Tri-County	95	4.61
- Montgomery Co.	52	5.15
(Pottstown, zip 19464)	34	5.57)
(Other Montgomery)	18	4.37)
- Berks	33	4.30
- Chester	10	2.76
All other Pennsylvania	34	3.45
Philadelphia area	15	3.19
(Bucks, Delaware, Philadelphia Cos.)		
South Central area	10	4.15
(Dauphin, Lancaster, Lebanon, York Cos.)		
Western Pennsylvania	7	3.11
(Allegheny, Erie, Fayette, Washington Cos.)		
All Other Pennsylvania	2	3.00
Total Pennsylvania	129	4.30
All Areas Studied	2071	3.84

\* Average picocuries of Strontium-90 per gram of calcium at birth

**B. Results Over Time.**

This report noted earlier that since the mid-1960s, average Sr-90 levels had steadily fallen nationwide, but rose about 50% from the late 1980s to the late 1990s. This reversal occurred in Pennsylvania as well. Table 10 and Figure 2 show the trend ending for persons born 1986-89, then rising until the latest period, 1994-97. **The rise in average Sr-90 between the two periods was 21% in the tri-county area, below the U.S. figure of 60%.**

Table 10  
TRENDS IN AVERAGE STRONTIUM-90\* LEVELS  
SINCE 1980, BERKS, CHESTER, AND MONTGOMERY COUNTIES

<u>Birth Yr.</u>	<u>Teeth</u>	<u>Avg. Sr-90*</u>
1980-85	7	7.66
1986-89	17	3.86
1990-93	42	4.35
1994-97	29	4.68

% Ch, 1986-89 to 1994-97    +21%

\* Average picocuries of Strontium-90 per gram of calcium at birth

C. Gross Beta in Precipitation. A program measuring environmental radioactivity other than Sr-90 in teeth is maintained by the U.S. Environmental Protection Agency. (38) Each month, the EPA maintains levels of "gross beta" radioactivity in precipitation in several dozen U.S. cities. Gross beta represents the sum of all radioactive chemicals emitting beta particles (the others emit alpha particles and gamma rays). Sr-90 is a beta emitter.

One of the cities included in the EPA report is Harrisburg PA, 60 miles west of Pottstown. Table 11 shows the average gross beta levels for the same four-year periods given in earlier Sr-90 data. Following a large drop, from the mid-1980s to the late 1990s, the average rose from 1.71 to 2.48 picocuries of gross beta per liter of water, or 45%. This trend is another independent means of confirming the accuracy of the increase found in Sr-90 in local baby teeth.

Table 11  
AVERAGE GROSS BETA IN PRECIPITATION  
HARRISBURG PA, 1978-1997

<u>Year</u>	<u>Measurements</u>	<u>Avg. Gross Beta*</u>
1978-81	36	4.63
1982-85	42	1.71
1986-89	46	2.22
1990-93	48	2.03
1994-97	48	2.48

% Ch, 1982-85 to 1994-97    +45%

D. Birthweight.

RPHP asked parents donating teeth to provide the child's birth weight to assess if high- or low-weight babies have unusual levels of Sr-90. Elevated Sr-90 (and other radioactivity) levels may impair fetal development, possibly leading to underweight births (at or under 5 pounds 8 ounces); and many medical journal articles have tied unusually high birth weight (at or over 8 pounds 12 ounces) to a high risk of childhood cancer.

Average Sr-90 in the tri-county area was relatively high for low-weight babies, but this finding is not significant since it only includes three subjects. Average Sr-90 for high-weight babies is actually considerably lower than the tri-county average (Table 12). Thus, there is no association yet detected between birth weight and Sr-90 level.

Table 12  
 AVERAGE STRONTIUM-90\* LEVELS BY BIRTHWEIGHT  
 BERKS, CHESTER, AND MONTGOMERY COUNTIES

<u>Birth Weight</u>	<u>Teeth</u>	<u>Avg. Sr-90*</u>
Low (under 5 lb. 9 oz.)	3	5.76
Normal (5 lb. 9 oz. - 8 lb. 11 oz.)	79	4.84
High (8 lb. 12 oz. and over)	13	2.95

\* Average picocuries of Strontium-90 per gram of calcium at birth

E. Strontium-90 and Childhood Cancer Trends.

This report has already discussed rising Sr-90 rates and cancer risk, especially in children. The logical question is whether there is a statistical linkage between the two. In a previous report, RPHP showed that trends in average Sr-90 levels and childhood cancer incidence (rate of new cases) in Suffolk County, Long Island, where the Brookhaven nuclear plant is located, were nearly identical over a 10-year period, covering hundreds of baby teeth and cancer cases. (28) Since then, a similar match was found in Ocean and Monmouth Counties in New Jersey, where the Oyster Creek plant was located, over a 14-year period.

The trends in Sr-90 average and childhood cancer incidence in the tri-county area were compared using three-year groups (1987-89, 1988-90, etc.) instead of single years to enlarge the number of cases/teeth, making the comparison more meaningful. In addition, a "lag period" between exposure and diagnosis was tested. If Sr-90 increases in a given year, one would investigate any increase in childhood cancer not necessarily the same year, but more likely several years in the future. For example, the Chernobyl accident took place in 1986, but the large rise in childhood thyroid cancer did not take place until 1990. In the tooth study near Limerick, a four-year latency proved to be the best match.

Table 12 and Figure 3 show that the trends in Sr-90 and cancer incidence in tri-county children under age 10 look alike over a seven-year period. In other words, when Sr-90 increased, there was an increase in cancer incidence 0-9 four years later; decreases were followed by subsequent decreases. This finding is very similar to that in Suffolk County, Long Island; and since it involves 85 baby teeth and 261 cancer cases, **it suggests a link between radiation and cancer in Berks, Chester, and Montgomery County children.** More baby teeth would make future analyses of this relationship more meaningful.

Table 12  
 TRENDS IN SR-90 AND CANCER INCIDENCE 0-9  
 BERKS, CHESTER, AND MONTGOMERY (PA) COUNTIES  
 FOUR-YEAR LATENCY PERIOD

<u>Birth Year at Birth (No. Teeth)</u>	<u>Avg. pCi Sr-90/g Ca</u>	<u>Diag. Year</u>	<u>Cancer Incidence Rate/100,000 (Cases)</u>
1987-89	4.19 (14)	1991-93	14.74 (85)
1988-90	3.98 (21)	1992-94	14.29 (83)
1989-91	4.11 (28)	1993-95	16.75 (98)
1990-92	4.01 (27)	1994-96	15.78 (93)
1991-93	4.51 (35)	1995-97	15.84 (94)
1992-94	4.39 (44)	1996-98	12.88 (77)
1993-95	4.72 (43)	1997-99	13.79 (83)

Sources: Radiation and Public Health Project (Sr-90) and Pennsylvania State Cancer Registry (cancer).

## DISCUSSION/IMPLICATIONS

The RPHP study of Sr-90 concentrations in baby teeth of children near nuclear reactors is a landmark scientific effort, the first program of testing in-body levels of humans living near reactors. Southeast Pennsylvania is one of two parts of the nation (the other is northern Illinois) with the highest concentration of nuclear reactors. High local rates of cancer in children and young/middle aged adults near the Limerick nuclear plant - especially in Greater Pottstown - made the area a logical one to examine current trends and patterns of Sr-90.

The study tested 146 teeth from Pennsylvania, focusing on 129 born after 1979 (whose in-body Sr-90 is mostly from a current source, not old Nevada bomb test fallout) for which there are accurate results. Of these, 95 were from Berks, Chester, and Montgomery Counties. The state average Sr-90 of 4.30 exceeded the national mark of 3.84, with the highest levels in the tri-county area (4.61), Montgomery County (5.15) and Pottstown (5.57). Thus, **proximity to a nuclear reactor may be one factor in elevated Sr-90, with a downwind location being another** (the prevailing wind near Limerick blows from the northwest, towards Montgomery County).

After a long period of declining Sr-90 after the 1963 treaty ending large-scale above-ground bomb tests, averages rose in the Limerick area and other states after the late 1980s. **In the tri-county region, children born in 1994-97 had an average of 21% more Sr-90 than those born 1986-89.** This steady and consistent increase, documented in over 2000 teeth, must reflect a current source of radioactivity. The last underground atomic bomb test in Nevada occurred in September 1992. The only current sources of Sr-90 besides power reactors are waste (which is stored and not active in the food chain), nuclear-powered submarines (again, not in the food chain), and research reactors (there are only a few, they are small, and their number is declining). Thus, it is logical to conclude that **nuclear power reactors are likely to be the principal source of the most recent Sr-90 rise**, especially as reactors age and are in operation a greater percentage of the time.

Perhaps the most important finding in the study is **that local trends in Sr-90 are followed four years later by similar trends in childhood cancer.** This suggests a linkage between radioactive emissions from nuclear plants and cancer. Testing more baby teeth and adding them to this analysis would increase the significance of this finding.

Another means of assessing the cancer-strontium link is to perform a "case-control" study, i.e., compare levels of Sr-90 in children with and without cancer. RPHP has collected 95 teeth from children with cancer, and has tested 61 of these. The average Sr-90 in these teeth is roughly 50% above those for children without cancer. While these results are preliminary, they indicate that more teeth from children with cancer need to be collected to further assess this relationship. Teeth from children with cancer living in the Limerick area will be sought in the near future.

## APPENDIX 1

### DETERMINATION OF STRONTIUM-90 TO CALCIUM RATIO

Strontium-90 in deciduous teeth was determined under the direction of Hari D. Sharma, Professor Emeritus of Radiochemistry and president of REMS, Inc., Waterloo, Ontario, Canada. Employing a 1220-003 Quantulus Ultra Low-Level Liquid Scintillation Spectrometer manufactured by the Perkin Elmer Company in Massachusetts, Dr. Sharma followed the following procedure.

Water-washed teeth were treated with 30 per cent hydrogen peroxide for a period of 24 hours to ensure that organic material adhering to teeth was oxidized. Teeth were then scrubbed with a hard brush for removing oxidized organic material and the fillings. Teeth are then dried at 110 degrees celsius (centigrade) and then ground to a fine powder (ball mill). It is very important to remove any filling because if left behind inside a tooth, it tends to give colored solution or dissolution in a mineral acid. The presence of colored solution reduces the efficiency of counting.

Approximately 0.1 gram of the powder is weighed in a vial, then digested for a few hours with 0.5 milliliter of concentrated nitric acid along with solutions containing 5 milligrams of  $\text{Sr}^{2+}$  and 2 milligrams of  $\text{Y}^{3+}$  carriers at about 110 degrees C on a sand bath. The solution is not evaporated to dryness. The digested powder is transferred to a centrifuge tube by rinsing with tritium-free water. Carbonates of Sr, Y, and Ca are precipitated by addition of a saturated solution of sodium carbonate, then centrifuged. The carbonates are repeatedly washed with a dilute solution of sodium carbonate to remove any coloration from the precipitate. The precipitate is dissolved in hydrochloric acid, and the pH is adjusted to 1.5 to 2 to make a volume of 2 milliliters, of which 0.1 milliliter is set aside for the determination of calcium. The remaining 1.9 milliliters are mixed with 9.1 milliliters of scintillation cocktail Ultima Gold AB, supplied by Packard Bioscience BV in a special vial for counting. A blank with appropriate amounts of  $\text{Ca}^{2+}$ ,  $\text{Sr}^{2+}$ , and  $\text{Y}^{3+}$  is prepared for recording the background.

The activity in the vial with the dissolved tooth is counted four times, 100 minutes each time, for a total of 400 minutes, with the scintillation spectrometer. The machine has special features so that the background count-rate in the 400 to 1,000 channels is  $2.25 \pm 0.02$  counts per minute. The background has been counted for over 5,000 minutes so that the error associated with the background measurement is about 1 percent. The overall uncertainty or one sigma associated with the measurement of Sr-90 per gram of calcium is  $\pm 0.7$  picocuries per gram of calcium.

The efficiency of counting was established using a calibrated solution of Sr-90/Y-90 obtained from the National Institute of Standards and Technology, using the following procedure. The calibrated solution is diluted in water containing a few milligrams of  $\text{Sr}^{2+}$  solution, and the count-rate from an aliquot of the solution is recorded in channel numbers ranging from 400 to 1,000 in order to determine the counting efficiency for the beta particles emitted by Sr-90 and Y-90. It is ensured that the Y-90 is in secular equilibrium with its parent Sr-90 in the solution. The counting efficiency was found to be 1.67 counts per decay of Sr-90 with 1.9 milliliters of Sr-90/Y-90 solution with 25 milligrams of  $\text{Ca}^{2+}$ , 5 milligrams of  $\text{Sr}^{2+}$ , 2 milligrams of  $\text{Y}^{3+}$ , and 9.1 milliliters of the scintillation cocktail.

The calcium content was determined by using an Inductively Coupled Plasma instrument. The analysis is provided by the University of Waterloo laboratories.

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**RESIDENTS EXPRESS CONCERN**

**ABOUT LIMERICK NUCLEAR POWER PLANT'S**  
**RADIOACTIVE RELEASES INTO OUR AIR AND WATER**

**AND**

**ABOUT NRC'S FAILURE TO REQUIRE**  
**MORE PROTECTIVE RADIATION STANDARDS**

July, 2006  
Letter to the Editor

Residents have expressed deep concern to members of the Alliance For A Clean Environment about the potential harmful health impacts of Limerick Nuclear Power Plant's toxic brew of routine radiation emissions into our air and the Schuylkill River.

The Nuclear Regulatory Commission (NRC) determines what levels of radiation Limerick can release into our air and discharge into the river, but allows Exelon to do most of its own monitoring, testing, and reporting, with little independent verification.

A video of the July 13, 2006 Limerick meeting, deepened concern more than ever, for many families living in this region, especially for their children. NRC appears to fail to take radiation's health threats seriously.

July 13, NRC stated they may wait hours or even days to alert the public to evacuate after an accidental release of radiation at Limerick Nuclear Power Plant. Have they learned nothing from the consequences of waiting for 3 days to alert the public after the Three Mile Island accident? Or from the BEIR VII report?

The National Academy of Science report, the Biological Effects of Ionizing Radiation (BEIR VII) report, issued June 2005, states there is no safe level of radiation. Still, instead of working to further minimize our region's risk from Limerick's radiation emissions, NRC appears to be attempting to simply minimize concern.

NRC's denial of serious health threats from radiation exposure unnecessarily jeopardizes public health. NRC needs to start to value public health more than the interests of the nuclear industry. It doesn't serve the public's interest if NRC fails to immediately inform the region's families of unplanned radiation releases from the Limerick Nuclear Power Plant, whether it is from an accident or terrorist attack.

The public needs and deserves more protective standards and immediate notification of any accidental radiation release from Limerick.

I also encourage everyone in this region to contact federal officials and request an investigation into NRC's policies and procedures on permissible radiation limits, and their failure to revise outdated, unprotective standards.

Donna Cuthbert  
ACE Vice President

## A Radiologist's Comments On Radiation Health Impacts

Beth Rapczynski's statement that nuclear plants like Limerick have been proven harmless (Forum, April 29) is not supported by medical evidence.

As a retired radiologist, I understand that any exposure to radiation carries a risk of disease. The radiation physicians use to diagnose and treat illness carry a risk. Companies continue to produce new X-ray machines that yield less radiation and reduce doses, so that fewer people will develop cancer after exposure. We try especially hard not to expose young children to radiation. Dental X-rays aren't taken until the child is of school age. Doctors are now cautious about giving CAT scans to children, unless they are absolutely necessary.

Radiation exposures damage cells and cause them to mutate, sometimes leading to cancer. The radiation produced in nuclear plants like Limerick includes over 100 harmful chemicals that damage various organs of the body. Strontium-90 attaches to the bone and enters the bone marrow. Plutonium-239 seeks out the lung. Iodine-131 enters the thyroid gland. Cesium-137 disperses itself in all the soft tissues.

Even at low doses, these chemicals are toxic to human health, especially to children. We should learn from the experience of atomic bomb test fallout, which is the same radiation produced in nuclear plants, and find out the true cancer risk from Limerick. We have a serious cancer problem in this area. Professional research efforts like the Tooth Fairy Project should be supported.

Fred Winter, MD