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From: <Odiejoe@aol.com>
To: <Peach_Bottom_EIS@nrc.gov>
Date: Wed, Nov 21, 2001 1:35 PM
Subject: Comment on Peach Bottom EIS

Dear Sir/Madam:

Please accept the following comment on the application submitted by Exelon Corporation to renew the operating licenses for the Peach Bottom 2 and 3 reactors, and consider it in your upcoming Environmental Impact Statement.

The comment is attached to this email as a Microsoft Word file.

I would greatly appreciate if you would let me know immediately that you have received it, by email or phone (718-857-9825). If I don't hear from you, I will call before the Nov. 26 deadline.

Sincerely yours,

Joseph Mangano, MPH, MBA
National Coordinator
Radiation and Public Health Project

A001

1/22/02

**COMMENT ON ENVIRONMENTAL ISSUES
REGARDING EXELON CORPORATION PROPOSAL
TO THE U.S. NUCLEAR REGULATORY COMMISSION
TO RE-LICENSE THE PEACH BOTTOM 2 AND 3 REACTORS
NOVEMBER 21, 2001**

By the Radiation and Public Health Project
New York, NY

Research Associates

Jay M. Gould, PhD, Director
Ernest J. Sternglass, PhD, Chief Scientist

Jerry Brown, PhD
Joseph Mangano, MPH, MBA
William McDonnell, MA
Marcia Marks, ACSW, LCSW
Janette Sherman, MD
William Reid, MD

EXECUTIVE SUMMARY

A. General

1. Need to protect public from radioactive emissions from nuclear reactors

- Electricity generated from America's nuclear power reactors tripled from 1980-99.
- Electric utilities have requested that the U.S. Nuclear Regulatory Commission (NRC) extend the operating licenses of 43 of 103 aging nuclear reactors for 20 years beyond the existing 40-year license period.
- Electric utilities have declared a goal of building 50 new nuclear reactors in the U.S.

2. Current Health Risk Assessment Policies are Deficient

- The NRC requires that electric utilities measure emissions and environmental levels of radioactive chemicals from nuclear reactors. If levels fall below federal permissible limits, the NRC presumes there is no health risk to local residents.
- The NRC, electric utilities, and public health departments have never measured radioactivity in bodies of persons living near nuclear reactors.
- The NRC, electric utilities, and public health departments have made only one comprehensive study of cancer in persons living near nuclear reactors since 1957, and this made a controversial conclusion that reactors did not affect local cancer rates.
- The NRC has approved the first five applications for 20-year extensions of operating licenses of nuclear reactors without considering local rates of cancer or other disease.

3. Information on In-body Levels of Radiation and Cancer Risk

- The Radiation and Public Health Project's (RPHP) "Tooth Fairy Project" of Strontium-90 (Sr-90) in baby teeth is the first to measure in-body radioactivity levels of persons living near nuclear reactors.
- RPHP has collected over 3000 teeth, and has measured Sr-90 levels in about half of these. Current concentrations of Sr-90 are similar to those in St. Louis children born in 1956, during the period of above-ground atomic bomb testing in Nevada.
- In Suffolk County, NY, RPHP documented a 40.0% rise in average Sr-90 concentrations from the early 1980s to the mid-1990s, and a nearly similar 48.9% rise in the Suffolk rate of cancer in children under 10.
- Tooth study results have been published in three peer-reviewed medical journals.

B. Environmental Radiation and Cancer Near Peach Bottom

1. Environmental Radiation

- The Peach Bottom 2 and 3 nuclear reactors, in a populated area near Baltimore, Philadelphia, and Wilmington, have operated since 1973 and 1974, respectively.
- Peach Bottom 2 and 3 lie within 50 miles of six other operating reactors (Limerick 1/2, Salem 1/2 and Hope Creek, and Three Mile Island 1).
- From 1973-93, Peach Bottom emitted 2.15 trillion picocuries of radioactive chemicals into the air, the 19th highest total of 72 U.S. nuclear plants.
- In the late 1980s, just before the U.S. government ceased publishing data, iodine-131 in Philadelphia and Washington milk was 67% and 28% higher than the U.S. average.
- The average level of Strontium-90 for 33 baby teeth of children born in southeast Pennsylvania or Maryland since 1979 is 60% higher than the U.S. average.

2. Cancer Near Peach Bottom

- Increased cancer deaths in Lancaster and York Counties resulted in over 600 excess cancer deaths in the first 10 years after Peach Bottom began operations, rising most sharply for childhood cancer and adult cancers most sensitive to radiation.
- Breast cancer cases in Chester, Lancaster, and York Counties nearly doubled (609 to 1135) from 1985 to 1998. The 1998 rate is 20% above the U.S. standard.
- Thyroid cancer cases in the three counties soared from 26 to 110 from 1985 to 1998, making the current rate 28% above the nation's.

3. Health Consequences of an Accident

- Radioactive releases from Peach Bottom's reactor core or spent fuel rods after an accident would be catastrophic. A 1982 U.S. government report estimated "peak early deaths" and "peak early injuries" at 72,000 and 45,000, respectively.

C. Recommendations

1. The Radiation and Public Health Project recommends that the NRC take no action on the application to extend the operating license of Peach Bottom 2 and 3 until it
 - Institutes a program of measuring in-body radioactivity levels for persons living near nuclear reactors.
 - Authorizes periodic studies comparing in-body levels of radioactivity with local rates of cancer and other diseases susceptible to radiation exposure.
 - Includes health risks - i.e., local cancer patterns compared to emissions, environmental radiation levels, and in-body levels - as a criterion for extending licenses of existing nuclear reactors, and for granting new licenses.

COMMENT ON ENVIRONMENTAL ISSUES

I. INTRODUCTION

The Radiation and Public Health Project (RPHP) is an independent, non-profit research and educational organization. The focus of RPHP's work is to assess the health effects of exposures to radioactive chemicals released into the environment by nuclear weapons tests and nuclear reactor operations. Founded in 1985, RPHP maintains a staff of professionals from the fields of radiation physics, toxicology, epidemiology, and statistics. Its members have published numerous medical journal articles and books on the radiation health issue (see Appendix).

RPHP has documented substantial evidence linking environmental radioactivity with increased cancer risk. Perhaps the strongest evidence is the correlation of levels of radioactive Strontium-90 in baby teeth with risk of childhood cancer in Long Island. The following comment outlines RPHP findings and considers implications for the environmental impact of extending the operating license of the Peach Bottom 2 and 3 reactors.

II. NUCLEAR REACTOR EMISSIONS AND HEALTH RISK

More Reactors Produce More Power. Currently, 103 nuclear power reactors (at 64 sites) are operating in the U.S., producing about 20% of the nation's electricity. (1) About two-thirds of Americans live within 100 miles of at least one nuclear reactor. Operating utilities have permanently closed a total of 22 reactors. In addition, 128 reactors that were proposed by utilities to federal regulators were later cancelled before commencing operations. (2)

Startup of new reactors and increased use of existing ones have caused the generation of electricity from reactors to nearly triple (248 million to 727 million gigawatthours) from 1980 to 1999. (1) Present trends suggest that use of nuclear power reactors may proliferate in the future. The U.S. Nuclear Regulatory Commission (NRC) has received applications to extend the licenses of 43 reactors from the current life span of 40 years to 60 years. In addition, the Nuclear Energy Institute announced a goal of starting 50 new nuclear reactors at its annual meeting in May 2001.

Problems Presented by Aging Reactors. Increasing use of aging nuclear reactors present environmental health issues that need to be addressed, namely:

1. Do operations of reactors, which routinely emit man-made chemicals into the air that are inhaled and ingested in diet, result in increased disease risk, including cancer?
2. Does the aging of reactors increase the chance of a serious accident?
3. Does the buildup of nuclear waste from reactor operations pose a threat to the health of local residents?

The focus of RPHP's work is primarily issue #1, health effects of routine emissions of radioactive chemicals into the environment.

Government Assessment of Health Risks is Deficient. Because radioactivity can damage human health, an accurate assessment of risk to the public is warranted. **However, current regulatory policies do not include any such risk assessment.** The NRC has approved the first five applications for reactor license extension, with no consideration of disease rates, including cancer, in persons living closest to reactors.

RPHP researchers are investigating health effects of exposures to reactor emissions from the Peach Bottom reactors to local residents.

III. NEED FOR MORE INFORMATION ON HEALTH

Reactor Operations Release Cancer-Causing Chemicals. Nuclear reactors employ fission of uranium atoms to generate electricity. The fission process creates 100 to 200 radioactive chemicals not found in nature, which may damage the immune, genetic, and hormonal systems. These products include strontium, plutonium, iodine, and other carcinogenic isotopes. The only other source of these man-made chemicals is nuclear weapons explosions. Most fission products generated by reactors are contained as radioactive waste, but a fraction is emitted into air and water.

The NRC requires utilities that operate nuclear power plants to report levels of radioactive emissions into the environment each year, along with levels of radioactivity in local air, food, soil, and water. If levels fall below government-defined "permissible limits," the NRC presumes that the public has not been harmed.

Health Studies Are Lacking. There has been a dearth of scientific, peer-reviewed studies evaluating disease rates near U.S. nuclear power plants since the first reactor began operations in 1957. Only one national study has been done. In 1990, at the insistence of Senator Edward M. Kennedy, the National Cancer Institute published data on cancer near nuclear plants. While the study concluded that there was no connection between radioactive emissions and cancer deaths, rates near many reactors rose after reactor startup. (3) Since 1990, no federal agency, including the Environmental Protection Agency and Nuclear Regulatory Commission, has undertaken any studies of disease rates near nuclear plants.

In-Body Measurements Are Lacking. The lack of health studies near American nuclear reactors is complemented by a lack of measurements of in-body levels of radioactivity for persons living near nuclear reactors. Government-supported programs to measure Strontium-90 in St. Louis baby teeth (4) and in New York City and San Francisco bones (5) were terminated in 1970 and 1982, respectively. Both measured the effects of bomb test fallout rather than nuclear power reactor emissions.

IV. SR-90 IN BABY TEETH AND CANCER RISK

RPHP Tooth Fairy Project. RPHP is addressing the shortage of information on radiation's health effects by documenting radioactivity levels in the human body and comparing them with cancer and other health patterns.

RPHP researchers are conducting **the first-ever study that measures radioactivity in the bodies of persons living near nuclear power reactors.** In 1996, RPHP launched the Tooth Fairy Project, which uses the same methodology of calculating levels of Strontium-90 (Sr-90) in baby teeth employed in St. Louis during the 1950s and 1960s. The chemical enters baby teeth through the mother's diet during pregnancy and through the mother's bones.

Sr-90 is just a marker for the 100-200 radioactive chemicals that are released in nuclear reactor operations, but it is a critical one. Like calcium, Sr-90 attaches to the bone and teeth when it enters the body, where it remains for many years due to its slow rate of decay (half-life of 28.7 years). It kills and impairs bone cells, and penetrates the bone marrow, in which the white blood cells critical to immune function are formed, making it a risk factor for all cancers. Of all man-made radioactive chemicals, Sr-90 was the one that caused the greatest health concern during the atmospheric bomb test years in the 1950s and 1960s. In 1956, Presidential candidate Adlai Stevenson remarked that Sr-90 was "the most dreadful poison in the world." (6)

To date, RPHP has collected over 3000 baby teeth, mostly from areas near reactors in California, Connecticut, Florida, New Jersey, New York, and Pennsylvania. Strontium-90 concentrations have been measured in nearly half (1463) of these teeth by Radiation Environmental Management Systems Inc., an independent laboratory in Waterloo, Canada.

The average current concentration of Sr-90 is similar to that in St. Louis in 1956, in the midst of the period of atmospheric nuclear weapons testing. Results of the Tooth Fairy Project have been published in three peer-reviewed medical journals. (7-9)

Link Between Sr-90 in Teeth and Childhood Cancer - Long Island. The largest number of teeth (563) have been measured for residents of Suffolk County New York, site of the Brookhaven National Lab and surrounded by nearby reactors. Results show that the average level of Sr-90 has steadily increased 40.0% from the early 1980s to the mid-1990s. Because U.S. above-ground bomb testing ceased in the early 1960s, and old bomb fallout is decaying steadily, this trend indicates that **a current source of radioactive emissions is contributing to the buildup of Sr-90 in teeth.** This source can only be nuclear reactors.

During the same time period, the rate of cancer diagnosed in Suffolk County children less than 10 years old steadily rose a nearly identical 48.9%. (10) The data support the theory that exposure to radioactivity increases the risk of cancer, especially in young persons

**Trends in Average Concentration of Sr-90 in Baby Teeth
And Cancer Incidence Age 0-9
Suffolk County, New York, 1981-1996**

<u>Birth Yr</u>	<u>No. Teeth</u>	<u>Avg. Sr-90+</u>	<u>Diag. Yr</u>	<u>Cases</u>	<u>Pop.</u>	<u>Rate#</u>
1981-84	38	1.10	1981-84	92	182,441	12.61
1985-88	157	1.38	1985-88	115	182,463	15.76
1989-92	258	1.41	1989-92	129	185,050	17.43
1993-96	45	1.54	1993-96	146	194,498	18.77

% Ch 81-84

vs. 93-96

+40.0%

+48.9%

+Average picocuries of Strontium-90 per gram of calcium in baby teeth at birth
Cancer cases per 100,000 population

V. PEACH BOTTOM OPERATIONS AND LOCAL HEALTH

Environmental Radioactivity Near Peach Bottom. Units 2 and 3 at Peach Bottom, near the town of Delta PA, have operated since 1973 and 1974, respectively. From 1966 to 1974, Unit 1 operated. This reactor, one of the first to open in the U.S., was beset by frequent mechanical failures and leakage of radioactivity, before it was closed in 1974.

The plant is located close to large population centers, including Baltimore (35 miles southwest), Philadelphia (55 miles east-northeast), and Wilmington (35 miles east). They are also located close to other nuclear reactors, including Limerick 1 and 2 in Pottstown PA (45 miles northeast), Salem 1/2 and Hope Creek in Salem NJ (50 miles east), and Three Mile Island 1 and 2 in Middletown PA (35 miles northwest).

Airborne Releases. From their startup through 1993, the reactors released 2.15 trillion picocuries of radioactivity into the air. This total is more than one-seventh of the 14.20 trillion picocuries emitted during the Three Mile Island accident in March 1979. Peach Bottom releases are the 19th largest of 72 U.S. plants. (11)

Radioactivity in Milk. Peach Bottom is located in an area with a heavy concentration of dairy farms that are a major contributor to the regional supply. The U.S. Environmental Protection Agency has monitored monthly levels of radioactive chemicals in milk in 60 U.S. cities since 1960.

In 1990, the EPA ceased publication of comparative measurements for each city. However, a review of the most recent six years of data (1985-1990) shows that average levels of radioactive iodine-131 were much greater than U.S. averages for Philadelphia (28% higher) and Washington DC (67% higher, see below). The average for Washington may be the highest in the nation. (12)

I-131 is a valid indicator of the current emissions from nuclear power plants, due to its short physical half-life of eight days. Although I-131 in milk in May and June 1986 were mostly fallout from the Chernobyl accident, the remainder of the six-year period

represents reactor emissions, since above-ground bomb tests had ceased, and since medical uses of I-131 are confined to hospitals. It is highly likely that Peach Bottom emissions account for these high levels.

**Average Concentration of Iodine-131 in Pasteurized Milk
Philadelphia and Washington DC, 1985-1990**

<u>Area</u>	<u>Monthly Readings</u>	<u>Average I-131*</u>	<u>% Above/Below U.S.</u>
Philadelphia	67	3.34	+28%
Washington DC	24	4.36	+67%
Average 60 U.S. cities		2.1	

* expressed in picocuries

Strontium-90 in Baby Teeth. While the majority of teeth have been received from California, Florida, New Jersey, and New York, 33 are from children born after 1979 in southeastern Pennsylvania or in Maryland. (After 1979, virtually all strontium-90 in baby teeth was generated from nuclear reactors, rather than atomic bomb test fallout left over from the early 1960s). The average Sr-90 concentration in these teeth is higher than any of the four states with large numbers of teeth (CA, FL, NJ, and NY), and more than 60% greater than the national average. Virtually all of these 33 teeth are from persons living within 55 miles of Peach Bottom.

Many more teeth need to be collected and analyzed to affirm these preliminary results. A press conference in nearby Pottstown PA helped generate an additional 114 teeth since January 2001, and more are anticipated in 2002. When several hundred teeth have been analyzed, RPHP will understand:

- If there is truly a higher-than-average level of Sr-90 in the Peach Bottom area
- If trends in Sr-90 correspond to trends in cancer incidence

Cancer Near Peach Bottom. The only national study undertaken by government public health officials on cancer near nuclear power plants was completed in 1990 by the National Cancer Institute. The study examined death rates for 14 types of cancer near 62 nuclear plants (including Peach Bottom) before and after the plant began operations. These 14 categories represent about two-thirds of all cancer deaths.

Cancer Deaths in the First 10 Years of Operations. NCI researchers defined Lancaster and York Counties as "nuclear" counties, or those most likely to be affected by environmental radioactivity from Peach Bottom. They examined cancer death rates in the period before Units 2 and 3 opened (1950-74) and after the reactors started operations (1975-84). Overall, the local cancer rate jumped from 3% below the U.S. rate to 2%

above. This may appear to be a small increase, but in the 10-year period 1975-84, over 600 additional cancer deaths occurred in Lancaster and York Counties.

Perhaps most telling about the NCI data is that rates for almost all cancers most sensitive to the damaging effects of radiation increased. For example, humans exposed to radiation from nuclear reactors have an increased risk of thyroid cancer, due to the presence of thyroid-damaging iodine in reactor emissions. Thyroid cancer deaths were 14% below the U.S. before 1975, but jumped to 28% above after the reactors opened. The same occurred for bone and joint cancer, and multiple myeloma (bone marrow cancer), sensitive to bone-seeking radioactive chemicals such as strontium and barium (see below). The local breast cancer death rate increased significantly.

A final indicator that Peach Bottom releases contributed to unusually high cancer rates was the rise in cancer deaths among children under age 10 living in Lancaster and York Counties. Children are most susceptible to diseases caused by environmental pollutants such as nuclear power plant emissions.

**Change in Cancer Death Rate
Cancers Most Sensitive to Radiation Exposure
1950-74 vs. 1975-84
Lancaster/York Counties vs. U.S.**

<u>Type of Cancer</u>	<u>% +/- U.S. 1950-74 (deaths)</u>	<u>% +/- U.S. 1975-84 (deaths)</u>	<u>% Change</u>
<u>All Ages</u>			
All Cancers+	- 3% (19653)	+ 2% (12078)	+ 5% *
Leukemia	- 5% (918)	- 1% (495)	+ 4%
Hodgkin's Disease	+ 5% (245)	+10% (72)	+ 5%
Other Lymphoma	+ 8% (624)	+ 5% (412)	- 3%
Multiple Myeloma	- 8% (209)	+14% (213)	+24% *
Female Breast	+ 4% (2028)	+13% (1228)	+ 9% *
Thyroid	-14% (67)	+28% (39)	+49%
Bone and Joint	+ 3% (147)	+14% (47)	+11%
<u>Children Age Under 10</u>			
All Cancers+	-19% (88)	+ 4% (28)	+28%
Leukemia	+ 5% (111)	+11% (21)	+ 6%

+ Excluding leukemia

* statistically significant change

Local Cancer Cases Since the mid-1980s. Chester, Lancaster, and York Counties are located closest to Peach Bottom. Most of the 1.3 million residents of these three counties reside within 35 miles of the plant.

In 1985, the Pennsylvania Health Department began to collect cancer cases (as opposed to deaths) for the first time. Their files are complete through 1998. During that period, the total number of cancer cases rose 48%, from 4280 to 6313. During the same period, the number of new breast cancer cases diagnosed in women nearly doubled, from 609 to 1135. Over half of this increase took place in the most recent four years (1994-98), making the issue a current one (see below).

The number of thyroid cancer cases jumped from 26 to 110 from 1985 to 1998 (see below). Again, the large increase from 1994 to 1998 (72 to 110) makes thyroid cancer a present concern. While thyroid cancer is relatively rare, and is considered one of the more treatable forms of cancer, it is one of the more radiation-sensitive cancers. Radioactive iodine created only in atomic bombs and nuclear reactors enters the body through breathing, drinking, and eating, and seeks out the thyroid gland, where it kills and injures cells. (13)

Current (1998) local rates of all cancers, breast cancer, and thyroid cancer exceed the U.S. average, by 7.3%, 19.9%, and 28.3%, respectively.

**Number of Newly-Diagnosed Cases, by Year
All Cancers, Female Breast Cancer, and Thyroid Cancer
Chester, Lancaster, and York Counties
1985-1998**

<u>Year</u>	<u>All Cancers</u>	<u>Breast Cancer</u>	<u>Thyroid Cancer</u>
1985	4280	609	26
1986	4341	669	39
1987	4359	717	44
1988	4772	772	40
1989	4723	782	52
1990	5174	892	56
1991	5446	891	54
1992	5774	891	58
1993	5825	934	76
1994	5860	863	72
1995	5740	935	85
1996	5855	925	99
1997	5951	1012	102
1998	6313	1135	110

Age-Adjusted Cancer Incidence Rates*, 1998
Chester, Lancaster, and York Counties vs. U.S.
All Cancers, Female Breast Cancer, and Thyroid Cancer

<u>Type of Cancer</u>	<u>Local Rate</u>	<u>U.S. Rate</u>	<u>% Above U.S.</u>
All Cancers	424.2	395.2	+ 7.3%
Female Breast	141.6	118.1	+19.9%
Thyroid	7.7	6.0	+28.3%

* Adjusted for 1970 standard U.S. population; rates expressed per 100,000 population

Health Consequences of an Accident. In recent times, Americans have become much more aware of the possibility of an accident at a nuclear power plant. Such an accident could result from a terrorist attack, a malfunction of equipment, or human error in operating the plant. The containment vessel in which the core is located contains high levels of radioactivity needed to produce electricity. In addition, the storage area containing waste (spent fuel rods) is also highly radioactive.

Accidental releases from either the containment vessel or the waste storage area would be devastating to local health. High levels of radioactivity would quickly enter the atmosphere and be inhaled by local residents. These poisonous chemicals would later be brought to earth by precipitation, and enter the water and food supply for months and years to come, as some chemicals decay more slowly than others.

Estimates of casualties after a nuclear accident were made by Sandia National Laboratories in New Mexico shortly after the partial core meltdown at Three Mile Island in 1979. These estimates were presented as the Calculation of Reactor Accident Consequences (CRAC-2) report presented to Congress on November 1, 1982. CRAC-2 estimates an accident at Peach Bottom would cause 72,000 "peak early deaths" and 45,000 "peak early injuries" soon after it occurs. These figures should be seen as a minimal estimate of the health risk of such an accident.

V. SUMMARY

Since atomic bombs were first manufactured and used during World War II, exposure to man-made fission products has been a critical environmental health issue. The relative novelty of these chemicals in the environment underscores the need for thorough and objective health studies.

When the Cold War ended a decade ago, nuclear weapon manufacture and testing ceased. However, electricity production from American nuclear power reactors has reached an all-time high, and utility companies (supported by the Bush Administration) are considering a large-scale expansion of the industry. These developments indicate that efforts to protect humans from the potentially harmful effects of exposure to radioactive emissions in the environment will be critical.

Relatively high levels of radioactive chemicals emitted from Peach Bottom and found in local milk and baby teeth, along with rising local levels of cancer, are cause for concern. These findings indicate that the federal government should begin a program of measuring in-body levels of radioactivity near nuclear plants. Federal officials should authorize periodic studies comparing in-body levels of radioactivity with local rates of cancer and other diseases susceptible to the harmful effects of radiation. Moreover, the U.S. Nuclear Regulatory Commission should include environmental radioactivity and local disease patterns as a criterion for granting license extensions for nuclear plant operators.

APPENDIX
RECENT PROFESSIONAL PUBLICATIONS
RADIATION AND PUBLIC HEALTH PROJECT

Recent Book Publications

1. Gould JM and members of RPHP. The Enemy Within: The High Cost of Living Near Nuclear Reactors. New York: Four Walls Eight Windows, 1996.
2. Brown J and Brutoco R. Profiles in Power: The Antinuclear Movement and the Dawn of the Solar Age. New York: Twayne Publishers, 1997.
3. Mangano JJ. Low-Level Radiation and Immune System Damage: An Atomic Era Legacy. Boca Raton FL: Lewis Publishers, 1998.
4. Sherman JD. Life's Delicate Balance: Causes and Prevention of Breast Cancer. New York: Taylor and Francis, 2000.

Recent Medical Journal Articles

1. Gould JM et al. Strontium-90 in deciduous teeth as a factor in early childhood cancer. International Journal of Health Services 2000;30(3):515-39.
2. Mangano JJ et al. Strontium-90 in newborns and childhood disease. Archives of Environmental Health 2000;55(4):240-4.
3. Gould JM et al. The Strontium 90 baby teeth study and childhood cancer. European Journal of Oncology 2000;5(suppl. 2):119-25.
4. Mangano JJ. Improvements in local infant health after nuclear power reactor closing. Environmental Epidemiology and Toxicology 2000;2:32-6.
5. Mangano JJ et al. Infant death and childhood cancer reductions after nuclear plant closing in the U.S. Archives of Environmental Health (article accepted, publication in mid-2002).

RISK FROM LOW-DOSE RADIOACTIVE NUCLIDES

The often held notion that reactions to chemicals and ionizing radiation follow a linear dose-response curve is not supported by fact. While a reaction may be proportional at high doses that impair or kill, a straight-line dose-response is not borne out at low-dose exposures, (14) nor when an insult occurs at the critical periods of fetal development, and during cell division and repair. (15)

Internal exposures to toxic chemicals and radionuclides below the level that kills a cell is critical: such sub-lethal exposures that alter cellular function or structure and are not repaired become expressed as cancer or functional alteration. The DES daughters and sons are prime examples. Diethylstilbestrol (DES) was administered to pregnant women in the misguided idea that it would protect against fetal loss during pregnancy. Children and now grandchildren were born with anatomic and functional genital abnormalities and developed genital cancers when they reached adulthood. (16) Cells undergoing replication are hundreds of times more susceptible to radiation and magnetic effects. (17) (18)

Internal radiation may involve exposure to nuclides such as plutonium-239 and strontium-90, which stay within a body essentially for life because of long half-lives. It also involves exposure to nuclides with a short half-life such as barium-140, cobalt-57, chromium-51, cesium-134, iodine-131, and others, which release significant amounts of radiation over a period of hours to days.

Many nuclides undergo sequential decay, an ideal condition for sub-lethal damage to promote the induction of genomic instability. (19) Thus, internal decay of such isotopes as plutonium-239 and carbon-14 deliver a biological effect of infinite duration and the potential to induce genetically transmitted defects. (20) In addition, very low levels of radiation exposure demonstrate an enhanced, supra-linear effect due to the release of free radicals, resulting in functional and physiological effects, separate from genetic or mutational alteration. (21) (22)

RADIOACTIVE STRONTIUM-90 (SR-90) IN BABY TEETH

Sr-90 is a reliably measured surrogate to determine radiological fallout because of its stability in the body and a long half-life of 28.7 years. With a half-life of 28 years, Sr-90 is persistent in the environment and in the bodies of humans. The uptake of radioactive Sr-90 follows that of calcium and becomes deposited in bones and teeth. The newborn's calcium and Sr-90 are derived from the mother's dietary intake and from her bone stores during pregnancy. (23) But Sr-90 was understood before the first atomic bomb was detonated when it was proposed by Enrico Fermi to use the bone-seeking isotope to poison the food supply of Germany during World War II. (24)

Measurements of Sr-90 deposited in human bones and teeth began after the onset of above-ground nuclear bomb tests in Nevada and were carried out by various governments, including the U.S. (25) (26) (27) An independent, comprehensive study by the Committee for Nuclear Information measured Sr-90 levels in about 300,000 baby teeth collected from children in St. Louis. (23) (28) Comparing 1949-50 births with those in 1964, Sr-90 levels increased in concentration from 0.20 to 11.03 picocuries per gram of calcium. The risk to health from this contamination and concern for the health of children worldwide led to a ban on above ground nuclear testing by the U.S. and U.S.S.R., a treaty signed by President Kennedy and Premier Khrushchev.

More recent testing followed Chernobyl releases, when the Otto Hug Institute in Germany documented a ten-fold increase in Sr-90 levels in baby teeth for children born in 1987, compared with those born in 1983-85. (29) These elevated levels are comparable to those documented in the St. Louis children at the height of above-ground nuclear bomb testing. In 1990, for unknown reasons, the U.S. Environmental Protection Agency program of reporting monthly levels of barium-140, cesium-137, and iodine-131 in pasteurized milk in 60 U.S. cities was discontinued after 33 years. (30)

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5. Klusek CS. Strontium-90 in Human Bone in the U.S., 1982. EML-435. New York: U.S. Department of Energy, 1984.
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11. Brookhaven National Laboratory. Radioactive Materials Released from Nuclear Power Plants. NUREG/CR-2907, annual reports.
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