

July 1, 1987

Carl J. Johnson, M.D., M.P.H.  
(605)773-3361/223-2441

## **Cancer in the Denver Area Related to Rocky Flats: A DOE/Los Alamos Report Versus an Independent Investigation**

The Department of Energy and Los Alamos contracted a \$70,000 study of cancer incidence in the Denver area in 1982. Their report, published in this month's American Journal of Epidemiology, corroborates a 1979-81 study which found a higher cancer incidence in census tracts in areas of soil contaminated with plutonium by the Rocky Flats plant (1,2). My critique of the DOE/Los Alamos study is published in the same issue (pp 153-155), and is attached.

The earlier study (1981) investigated cancer incidence in the Denver area in 1979-1981 to see if there had been a population effect from plumes of radioactive dust and gases released by a fire and explosion in 1957 that blew out all industrial filters in the main stack at Rocky Flats (2). The 620 filters had a four year accumulation of very fine plutonium and uranium and other radionuclides, and a clandestine survey by plant personnel confirmed heavy offsite contamination with plutonium and weapons grade uranium at sites that included two elementary schools. Although this was the principal exposure, occurring 12-14 years before the study period, there were other exposures as well. The earlier study (1981) made the following major findings:

- o A 16% excess incidence of all cancer in the suburban area nearest the Rocky Flats plant, 8.5% higher than in the Denver urban center (Areas II and III).
- o A greater proportion of cancer of more radiosensitive organs, 12.2% more than expected.
- o In addition to cancers of radiosensitive organs, also an excess incidence of cancers of testes, ovary and prostate.

A follow-up study by Johnson and co-workers in 1984 (6) also reported the following:

- o A 10% excess incidence of cancer in suburban Area I near the plant in 1979-1981 and a somewhat higher excess incidence of cancer in the urban core (Areas II and III). However, Area I near the plant is in Jefferson County which had an in-migration of 113,700 people (+48%) between 1970 and 1980. This substantially diluted the population with unexposed people, while in the urban core (Areas II and III) there was an out-migration of 51,700 people (a 10% loss). Thus, any effect from Rocky Flats in Area I in 1979-1981 would be obscured or under-

represented because of the rapid rate of suburban development, and migration would have had much less effect (less dilution) on the more stable population in Denver (Areas II and III).

- o Cancer incidence for the three exposure areas, adjusted for age, race, sex and ethnicity, rose from an excess of 491 cases in 1969–1971 to 1,123 in 1979–1981. Another study found an excess of about 2,000 cases of cancer for the entire Denver metropolitan area, after adjusting for changes in population; an increase of 15% over a ten year period, compared to a national trend of only +9.3% (7–9). That is, the Denver area, once known for its healthy climate, had a rate of increase in cancer incidence 61% greater than the national trend.

- o The infant mortality rate for Jefferson County (including the area around the plant) was below the U.S. rate in 1950, rising above the U.S. rate after Rocky Flats began operations in 1953, and rising still higher after the 1957 explosion and fire.

- o Fetal death rates rose sharply after 1953.

- o Leukemia death rates in children in Jefferson County were below the U.S. rate in the five year period before 1953, but increased to about twice the U.S. rate after the 1957 explosion and fire at Rocky Flats.

- o An increase was also noted for other major childhood cancer deaths. Similar trends were observed in Denver County. Children born after the Rocky Flats explosion in 1957 had a smaller incidence of cancer in 1969–1971. The strong upward trend in cancer incidence for the entire Denver area was not noted by Crump et al. in the DOE/Los Alamos study (1).

Although the DOE report corroborates my findings for the excess cancer incidence in people living in areas with higher concentrations of plutonium in soil (1), other conclusions are based on approaches that rely on arbitrary sectors and distances from the urban center and these are not valid, but are a sort of statistical gerrymandering. For example, their sector and quadrant areas containing the Rocky Flats plant population also include the large unexposed university city population of Boulder, upwind of the plant. There are other major errors and oversights in these other approaches which also invalidate their conclusion that the pattern of excess cancer incidence downwind of Rocky Flats is due only to urban effect.

- o The population of Area I within ten miles of Rocky Flats selected in the DOE study (1,3) increased from 84,080 people in 1970 to 155,696 people in 1980, an increase of 85.2% by in-migration of unexposed people, in contrast to a loss of population in Areas II and III (Denver County).

- o Of the 29 census tracts selected in Area I by the DOE study (1,3), 23 did not exist in 1970 but were created for the 1980 census because of housing development and remarkable population growth in this area by people who were unexposed to Rocky Flats in 1957. That part of Area I 10–13 miles from Rocky Flats was developed earlier and more people there would

have been exposed in 1957 and this could explain the higher cancer incidence in 1979-1981.

Carcinogenicity of plutonium and other transuranics: In contrast to the view expressed in the DOE/Los Alamos report;

- o Cancers caused by plutonium in animal studies include leukemia, mesothelioma, reticulum cell sarcoma, fibrosarcoma, osteosarcoma, liposarcoma, rhabdomyosarcoma, leiomyosarcoma, mammary adenocarcinoma and adenoma of the kidney (12,13).
- o In one study, plutonium induced ten types of tumors after an average latency period of about one year in 114.5% of the animals (many developed two types of cancer) (12).

Health effects in workers: The DOE/Los Alamos report understates risks;

- o The DOE report implies that plutonium has an affinity only for lung, liver and bone. Yet an autopsy study of DOE workers found plutonium deposits in every organ measured, including brain, omentum and skin. Further, the rate of excretion is so slow that these are life-long deposits (the rate of excretion from bone is only about one-half in 200 years).
- o Organs of workers whose widows are suing Rocky Flats for injury also had important concentrations of americium and other radionuclides, in addition to plutonium.
- o Plutonium induces chromosome injury in man in extremely small doses; i.e., 0.4 to 4 billionths of a curie caused a 30% increase in chromosome damage in Rocky Flats workers.
- o The DOE study asserts that plutonium has not caused cancer in man. Yet, a 1980 study of Rocky Flats plutonium workers found an eight-fold excess of brain tumors, a three-fold excess of malignant melanoma, and an excess of respiratory cancer (10,11). That study has now been confirmed by another Los Alamos study published in February in the American Journal of Epidemiology.

The DOE study found an excess of prostate cancer near the plant in both time periods but deny the prostate is radiosensitive or would be exposed to plutonium (1). In my report of 1969-1971 there was a 9% excess incidence of cancer of prostate and other organs not considered radiosensitive near the plant(2). In exposed areas there were 42 cases of cancer of testes where only 18 cases were expected. This cancer was also in excess in 1979-1981 (6). Both prostate and testes had greater concentrations of plutonium in the autopsy study of DOE workers than in muscle, fat and kidney (15).

The DOE study fails to note that plutonium isopleths used for the 1969-1971 studies have less relevance for the 1979-1981 study, in view of strong winds in the area and contamination of Denver area water supplies with plutonium, uranium and other radionuclides (2,20,21). The

concentration of Rocky Flats plutonium in Denver area treated drinking water ranged from 7,000 to 40,000 times that of background from nuclear fallout concentrations in New York City water as recently as 1972 (20). This contamination is also reflected in air concentrations. A DOE station near Rocky Flats recorded the highest air concentrations of plutonium reported in the world for every month measured, ranging from 68 times higher than in New York City in 1970 (average for the year) to 745 times higher for the month of November in 1976 (2,22). Air concentrations were much higher in earlier years.

The DOE study without qualification cites a conclusion of a joint study by EPA, University of Colorado and the Department of Defense (EPA/UC/DOD) of plutonium in autopsy specimens of persons who lived around Rocky Flats (19). That study actually concluded "We cannot rule out the possible conclusion that people who lived southeast of the Rocky Flats and lived near the plant for the last five years of life may have a larger proportion of weapons-grade plutonium in their lungs than people who lived farther away" and "it should be borne in mind that the reported results are to some extent selected from among a great many analyses performed and this could have an effect on the true probabilities associated with putatively significant relationships"(19). That the DOE relies on a study with "selected results" is illustrated by a scattergram (19) of lung plutonium by distance from Rocky Flats which shows no analyses within 11 kilometers of Rocky Flats, although elsewhere stating that there were three persons within 10 kilometers in the study.

- o There are only five persons indicated within 10 miles of Rocky Flats and these five had more than 12 times as much plutonium in the lung than found in people in Finland exposed to fallout from Russian bomb tests (Mussalo et al., Health Physics 39:244-255).

- o The EPA/UC/DOD project failed to report the amount of plutonium in lungs for 56% of the men in the study and for 65% of women.

- o Two percent of the men had 35 to 53 times more plutonium in the lung than in Finland and four percent had 10-13 nuclear disintegrations per minute in the liver.

- o Appreciable amounts of plutonium 236 and 238 from Rocky Flats were found in lung and liver samples without internal controls. The finding of these isotopes invalidates this study because these same isotopes had been selected as internal controls.

- o The plutonium tissue study included only lung and liver, although plutonium clears these organs in less time than in bone (1/2 in 200 years). The organ specimens were collected some 20 years after the major exposure in 1957. Yet bone samples from the small number of people in the study who lived near Rocky Flats in 1957 were not analysed by the Department of Defense Laboratory contracted for this work (the chemist now works for the Los Alamos National Laboratory).

o In view of many legal actions against this DOE plant and its contractors (Dow and Rockwell) by downwind landowners and widows of workers, an independent laboratory should have been retained and bone specimens analyzed.

o Further, this study addressed only plutonium 239 and 240, when in fact plutonium 238 and americium 241 are similar in importance as risks around nuclear installations.

o There are an additional eight plutonium isotopes among the 80 transuranics of potential importance around nuclear plants. Isotopes of curium, for example, may be important. This is supported by a surveys that found curium, cesium 137 and strontium 90 contamination to be much higher near the plant. Yet, none of these were addressed in the tissue study (19).

The DOE/Los Alamos study concludes that future studies must be based on more specific measures of plutonium exposure. This is an unsupportable conclusion. Further, it has been extremely difficult to get accurate information concerning releases of radionuclides from nuclear installations. Public health authorities must rely on empirical studies such as my study of cancer incidence in census tracts within radionuclide soil concentration isopleths around the nuclear point source. However, for Denver, the next study should be a follow-up study of cancer incidence in a cohort of families who lived near the plant in 1957, similar to my study of cancer related to fallout in southwestern Utah. This would address the mobility of populations in the Denver area over a period of 30 years.

#### REFERENCES

- Crump KS, Ng T-H, Cuddihy RG. Cancer incidence patterns in the Denver metropolitan area in relation to the Rocky Flats plant. *Am J Epidemiol* 1987;125:000-000.
- Johnson CJ. Cancer incidence in an area contaminated with radionuclides near a nuclear installation. *Royal Swedish Academy of Sciences: Ambio* 1981;10:176-82.
- Crump KS, Ng TH, Cuddihy RG. Statistical analyses of cancer incidence patterns in the Denver metropolitan area in relation to the Rocky Flats plant. Typescript version LMF-110, VC-48. Report of research conducted under Department of Energy contract #De AC04-76EV01013, subcontract 8115006 from the Lovelace Inhalation Toxicology Research Institute, Albuquerque, New Mexico, August 20, 1984.
- Johnson CJ. Before Chernobyl: Hanford, Savannah River and Rocky Flats. (Letter.) *JAMA* 1987;257:187.
- Third National Cancer Survey: incidence data. National Cancer Institute Monograph. Bethesda, MD: National Institutes of Health, 1975.
- Johnson CJ, Ellis B, Lehman J, Kheel I. Cancer incidence and mortality, 1947-1981, in the Denver Standard Metropolitan Statistical Area downwind from the Rocky Flats Nuclear Plant. Presented at the annual meeting of the American Public Health Association, Dallas, November 1983.
- Berg J. Cancer in Colorado: a new high. Incidence data. Denver: AMC Cancer Research Center, 1982.
- Young JL, Percy CL, Asire AJ, eds. Surveillance, epidemiology and end results: incidence and mortality data 1973-1977. National Cancer Inst Monogr 57, NIH publication no. 81-2330. Washington, DC: US GPO, 1981.
- Horn J, Asire AJ, Young J, et al. 1986 annual cancer statistics review. National Cancer Institute, publication no. 85-1837. Washington, DC: US GPO, 1981.
- Johnson CJ. An investigation of brain cancer, melanoma and other neoplasms in employees of the Rocky Flats Nuclear Weapons Plant in Jefferson County, Colorado. Presented at the annual meeting of the American Public Health Association, Los Angeles, November 1981.
- Johnson CJ. Glioblastoma, other brain tumors and melanoma in plutonium workers. *Royal Swedish Academy of Sciences, Ambio* 1983;12:280-1.
- Sanders CL, Jackson TA: Induction of mesothelioma and sarcoma from "hot spots" of plutonium-239 dioxide activity. *Health Phys* 1972;22:755-9.
- Svovoda V, Sedlak A, Bubenikov AD, et al. Biological effects of bone-seeking alpha emitters with respect to the risk of internal contamination in man. *Czech Med* 1982;5:80-9.
- Brandon WV, Saccomanno G, Archer PG, et al. Somatic cell chromosome and sputum cell cytology changes in humans exposed to 222 radon and 239 plutonium. Progress Report, Department of Energy Contract E 2902-3649, Rockwell International, Rocky Flats Division, Health Sciences Group (with University of Colorado Medical School and University of Denver), 1976.
- Norwood WD, Newton CE. U.S. Transuranium Registry: study of 30 autopsies. *Health Phys* 1975;28:669-75.
- Krey PN. (1976). Remote plutonium contamination a total inventories from Rocky Flats. *Health Ph* 1976;30:209-12.
- Poet SE, Martell EA. (1972). "Plutonium 239 and americium 241 contamination in the Denver area". *Health Ph* 1972;23:537-48.
- Johnson CJ, Tidball RR, Severson RC. Plutonium hazard in respirable dust on the surface of soil. *Scien* 1976;193:488-90.
- Cobb JC, Eversole C, Archer PG, et al. Plutonium burden in people living around the Rocky Flats plant. Contract #68-03-2217 for the Environmental Monitoring and Support Laboratory, US Environmental Protection Agency National Technical Information Services, 1982.
- Johnson CJ. Contamination of municipal water supply in the Denver metropolitan area by the Rocky Flats plutonium plant. Presented at the annual meeting of the American Association for the Advancement of Science, San Francisco, January 1980.
- Johnson CJ. Public health standards limiting the concentration of uranium in drinking water. (Letter.) *Health Phys* 1986;50:164-5.
- Toonkel LE, Feely HE, Larsen RJ. Radionuclides and trace metals in surface air. In: *Environmental Quarter* of the Environmental Measurements Laboratory (US Department of Energy, New York, NY 10014), 1979:C/160.
- McInroy JF. Reports on the radiochemical analyses of tissues of Rocky Flats plant workers. 1981-1984. University of California/Los Alamos National Laboratory, P Box 1663, Los Alamos, NM 87545.