My name is John R. Thornborough. I live at 2623 Stoney Street, Box 637, Shrub Oak, New York.

I hold a B.A and a M.A. Degree in Biological Sciences and a Ph.D. in Human Physiology. My educational background also includes training at Cornell University in radiation and its biological effects. This training program included the use of radioisotopes in biological and medical research. Currently I am a Professor of Physiology at the Sophie Davis School of Biomedical Education of the City College of New York where I am also Associate Dean for Academic Affairs. In addition, I am an Adjunct Professor of Physiology at New York Medical College. The duties of my jobs include administrative functions, teaching of medical students, and laboratory work as a research scientist. In the latter role I regularly use radioisotopes.

My activities relating to environmental matters include: Chairman of the Yorktown Conservation Board;

Chairman of the Westchester County Solid Waste, Recycling and Landfill Committee of the Environmental Management Council, member of the Executive Board of the Westchester County Environmental Management Council; past President, Director and member of the Executive Board of the Federated Conservationists of Westchester County; member of the Biology Advisory Council of Pace University; member of the Environmental Science Advisory Council of the State University of New York, College at Purchase; Director of the New York State Association of Conservation Commissions; Editor of the bi-monthly newspaper, Westchester Environment.

I have been asked to prepare testimony regarding the possible effects on children in Westchester County of the operation of the nuclear generating plants at Indian Point.

My testimony consists of data from the scientific literature supporting statements of fact concerning

radiation and the Indian Point nuclear generating plants. These statements of fact are followed by four logical conclusions.

STATEMENTS OF FACT

1. RADIATION IS DAMAGING TC HUMANS.

2. There is a certain amount of naturally occuring BACKGROUND RADIATION to which all humans are exposed.

3. The damaging effects of radiation exist at all levels of exposure (i.e. no THRESHOLD) and any increase in background radiation will lead to an increase in the extent of damage.

4. CHILDREN ARE MORE SUSCEPTIBLE to the damaging effects of radiation than are adults.

5. The NORMAL OPERATION of the Indian Point nuclear generating plants increases the exposure of Westchester's children to radiation.

6. An ACCIDENT, with an associated release of radiation or radioactive material, is possible at Indian Point and will further expose Westchester's children to hazard.

CONCLUSIONS

1. Nuclear generating plants, such as those at Indian Point, cannot be made completely safe.

2. Nuclear generating plants, therefore, should be sited so as to minimize the chances of radiation exposure to humans (i.e. in areas of low population density).

3. The plants at Indian Point are sited in a highly populated area and, indeed, offer maximum chances for exposure to humans.

4. The plants at Indian Point should be shut down and decommissioned.

SURVEY OF PERTINENT SCIENTIFIC LITERATURE

I. RADIATION IS DAMAGING TO HUMANS

1. Archer, V.E., "Occupational exposure to radiation as a cancer hazard", Cancer, 39: 1802-1896,1977.

> "Whether or not neoplasms result from an exposure is apparently determined largely by probabilistic considerations, although there are differences in susceptibility of individuals."

2. Hempelmann, L., Lisco, H. and Hoffman, J.G. "The acute radiation syndrome: A study of nine cases and a review of the Problem", Annals of Internal Medicine, 36: 279, 1952.

Found increased skin cancer (basal cell and squamous call Ca) in early experimenters and medical and dental practicioners. These subjects were exposed to X-rays at high dose rates.

3. Matanoski, G.M., Seltser, R., Sartwell, P.E., Diamond, E.L. and Elliott, E.A., "The current mortality rates of radiologists and other physician specialists: deaths from all causes and from cancer", American Jour. of Epidemiology, 101(3): 188-198, 1975.

> "The cohort mortality experience of radiologists and other specialists over a 50-year period was examined on the assumption that these groups would differ relative to a presumed decrease in radiation exposure. Radiologists had an excess in all-cause mortality rates compared to the other specialists for all cohorts who entered the Radiological Society of North America before 1940; the excess remained even when the cancer deaths were removed from the rates. These data are consistent with the concept of accelerated aging due to radiation. The cancer mortality rates for radiologists were higher than those of other specialists for an additional decade through 1949. The 1950-1959 cohort had not aged sufficiently to demonstrate the expected peak cancer mortality on the 60-64 year age group. Several hypotheses are presented to suggest reasons for differences in the trends of age-specific cancer mortality by cohorts of entry."

4. Matanoski, G.M. et al., "The current mortality rates of radiologists and other physician specialists: specific causes of death", American Jour. of Epidemiology, 101 (3): 199-210, 1975.

> "The cohort mortality experience of radiologists over a 50-year period has been compared to that of other specialists with low levels of radiation exposure. The 1920-1929 cohort of radiologists who joined the Radiological Society of North America had the highest mortality for several chronic diseases. After this early period, radiologists ranked highest only for cancer mortality. The excess risk of leukemia which was observed in the 1920-1929 and 1930-1939 cohorts has subsequently decreased. During the same period, lymphoma mortality, especially multiple myeloma, has been increasing with a significant excess of deaths appearing in radiologists who entered the specialty society between 1930-1939 and 1940-1949."

5. Seltser, R. and Sartwell, P.E., "The influence of occupational exposure to radiation in the mortality of American radiologists and other medical specialists", American Jour. of Epidemiology, 81: 2, 1965.

These authors found that American radiologists had a higher age-specific dealth rate than non-radiological medical specialists who had not received occupational radiation exposure.

The mean age at death for the radiologists was five years less than for non-radiologists. This difference has been lessening in recent years with the use of improved machinery and more caution.

6. United Nations Report of the Scientific Committee on the Effects of Atomic Radiation, General Assembly Official Records: 24th Session supp. No. 13, (A/7613), New York, 1969.

This report presents evidence for increased leukemias with X-ray exposure in radiologists, increased lung cancer with Radon daughter exposure and increased thyroid carcinomas in radiotherapy patients.

7. Najarian, T. and Colton, T., "Mortality from leukemia and cancer in shipyard nuclear workers", Lancet, p. 1018-1020, May 13, 1978.

In this study, the next of kin of 592 Portsmouth nuclear shipyard workers were contacted and 146 of these were found to have been exposed to radiation

at work of about 0.2 rem annually. Eighteen deaths were reported where eight were expected. Of the deaths, six were from leukemia where one might be expected in the general population.

> "The incresed numbers of cancer and leukemia deaths among Naval nuclear shipyard workers seem out of proportion to predictions based on prior knowledge of the effects of ionizing radiation in man. Previous data suggest that 50-100 rem doubles leukemia mortality and 300-400 rem doubles the number of total cancer deaths. Radiation records from the shipyard were not available to us, but radiation doses seem to have been well within national occupational safety standards. Information provided by 50 past and present P.N.S. nuclear workers suggested total radiation doses of less than 10 rem lifetime. Withing the Naval Nuclear Propulsion Program the mean radiation exposure for the industrial workers at risk (which includes the shipyard workers) was 0.211 rem annually. The nuclear workers at the P.N.S. had six times the proportional mortality of leukemia and twice the proportional mortality for all cancers expected for U.S. White males of the same age-groups. These increased figures were found with radiation doses that probably averaged less than 10 rem total lifetime exposure as measured by worker's film badges."

8. Archer, V., "Geomagnetic force associations with cancer distribution and weather conditions.", Proceedings 10th Midyear Topical Symposium of the Health Physics Society, Saratoga Springs, Oct. 11-13, 1976.

9. Betell, R., "Measurable health effects of diagnositic X-ray exposure", Testimony before the Subcommittee on Health and the Environment, U.S. House of Representatives, July 11, 1978.

10. Bross, I.D.J., Proceedings of a Congressional Seminar on Low-level Ionizing Radiation; a report submitted by the Subcommittee on Energy and the Environment of the Committee on Interior and Insular Affairs, U.S. House of Rep./ 94th Congress, 2nd Session, 79-767-0, Nov. 1976.

11. Bross, I.D.J., "Major Strategic mistakes in the management of the Conquest of Cancer Program by the NCI", Testimony to the 95th Congress of the United States, House of Representatives, Intergovernmental Relations and Human Resources Subcommittess of the Committee on Government Operations, June 14, 1977.

12. Bross, I.D.J., "An action program to protect the public against the mindless use of diagnostic radiation and other technology", Testimony to the United States Senate Commerce Commitee, Oversight Committee for Radiation Health and Safety, June 17, 1977.

13. Brues, A.N., "Radiation as carcinogenic agent", Radiation Research, 3:272-286, 1955.

14. Burrows, H. and Clarkson, J.R., "The role of inflammation in the induction of cancer by X-rays", British Jour. of Radiology, 16:381, 1943.

15. Furth, J. and Tullis, J.L, "Carcinogenesis by radioactive substances", Cancer Research, 16: 5-21, 1956.

16. Furth, J. and Lorenz, E., "Carcinogenesis by ionizing radiation", Radiation Biology, Hollender, A. ed., New York, McGraw Hill, Vol. 1, part 11, p 1145-1201, 1954.

17. Gibson, R., "Leukemia in children exposed to multiple risk factors", New England Jour. of Medicine, 279: 906-909, 1968.

18. Gibson, R., Grahan, S. Et al., "Irradiation in the epidemiology of leukemia among adults", Jour. of National Cancer Institute, 48 (2), 1972.

19. Gofman, J.W. and Tamplin, A.R., A series of 19 reports presented as Testimony before the Joint Committeee on Atomic Energy, 91st Congress, 1-28-1970.

20. Gofman, J.W. and Tamplin A.R., "Epidemiologic studies of carcinogenesis by ionizing radiation", Proceedings of the Sixth Berkeley Symposium of Mathematical Statistics and Probability, Statistical Laboratory, Universtiy of California, U.C. Press, Berkeley, July 20, 1971.

21. Graham, S., Levin, M.L., et at, "Methodological problems and designs of the Tri-State Leukemia Survey", Annals of New York Academy of Science, 107: 557-569, 1963.

22. Hempelmann, L.H., "Epidemiologic studies of leukemia in persons exposed to ionizing radiation", Cancer Research, 20: 18, 1960.

23. Proceedings of the Congressional Seminar on Low-Level Ionizing Radiation. Available from the Environmental Policy Institute, 317 Pennsylvania Avenue S.E., Washington, D.C. 20003, U.S.A.

24. Pochin, E.E., "Carcinogenic effects of radiation in man: The importance of estimates for protection purposes", Proceedings of a Symposium on Radiation Induced Cancer, Athens, Greece, April 28 - May 2, 1969, Vienna, International Atomic Energy Agency, 1969.

25. Sagan, L.A., "Human radiation effect: An overview", Health Physics, 21: 827-833, 1971.

26. Scholte, Van der Wielen and Ruya, "Negligible and non-negligible risks in radio-diagnostic examination of patients", Radiologic Clinics, 45; 314-325, 1976.

27. Symposium on Biological and Environmental Effects of Low-level Radition, Volume I, Vienna, International Atomic Energy Agency, 1976.

28. Upton, A.C., Allen, R.C., et al., "Quantitative experimental study of low-level radiation carcinogenesis", Radiation Induced Cancer, International Atomic Energy Agency, Vienna, page 425-438, 1969.

29. Viadana, E. Bross, I.D.J., "Use of medical history to predict the future occurrence of leukemia in adults", Preventive Medicine, 3: 165-170, 1974.

30. White and Frey, "An estimation of somatic hazards to the United States population from dental radiography", Journal of Oral Surgery, January 1977.

II. BACKGROUND RADIATION

1. Klement, A.W., Miller, C.R., Minx, R.P. and Shleier, B., "Estimates of ionizing radiation doses in the United States, 1960-2000", U.S. Environmental Protection Agency, ORP/CSD 72-1, Rockville, Maryland, Aug. 1972.

Average whole body radiation doses in U.S.A. in 1970:

	millirems/yr.
ENVIRONMENTAL	
natural	130
global fallout	4
all other	< 0.01
MEDICAL	
diagnostic	72
dental radiography	0.3
radiopharmaceuticals	1.0
OCCUPATIONAL	< 1.0
MISCELLANEOUS	
T.V., air transport	< 3.0
TOTAL (approximately)	211

211 mrem/year is about 6.3 rems/30 yrs./person.

2. Spiers, G.W. "Background radiation and estimated risks from low-dose irradiation." Helath Physics. 37 (6): 784-789, 1979.

III. QUESTION OF THRESHOLD

1. Archer, V.E., "Occupational exposure to radiation as a cancer hazard", Cancer, 39: 1802-1896,1977.

"It appears to be impossible to establish a threshold level for ionizing radiation in the production of neoplasms in experimental animals."

The linear hypothesis"....is a conservative approach for x-rays and other low-LET (Linear Energy Transfer) radiations but is probably not conservative when dealing with alpna particles or other radiations having high-LET."

"It appears to be impossible to establish a threshold level for ionizing radiation in the production of neoplasms in experimental animals."

2. Bair, W.J., and Thompson, R.C., "Plutonium: Biomedical Research", Science, 183: 715-722, 1974.

100% of dogs with small amouns of Plutonium-239 put in the lung died of lung cancer.

3. Baum, J.W., "Population heterogeneity Hypothesis on radiation induced cancer", Health Physics, 25: 97, August 1973.

At lower doses of radiation the linear hypothesis underestimates the risk of cancer.

4. Brown, J.M., "Linearity vs. non-linearity for dose response for radiation carcinogenesis", Health Physics, 31: 231, September 1976.

At lower doses of radiation the lenear hypothesis underestimates the risk of cancer.

5. Morgan, K.Z., Cancer and low level ionizing radiation", Bulletin of the Atomic Scientists, 300-41, September 1978.

[Morgan: Director of Health Physics Division of Oak Ridge National Laboratory (1943-1972)]

"There is no safe level of exposure and there is no dose of radiation so low that the risk of a malignancy is zero."

6. Morgan, K Z., "The linear hypothesis of radiation damage appears to be non-conservative in many cases", Proceedings of 4th International Congress of International Radiation Protection Association, Paris, France, paper #451, August 1976.

7. Morgan, K.Z., "Suggested reduction of permissible exposure to plutonium and other transuranium elements", American Industrial Hygiene Association Journal, August 1975.

> "Dr. Morgan has suggested that existing radiation standards could underestimate the effects of exposure for many different reasons:
>
> 1. Extrapolations are made on data with observation periods of no longer than twenty years. Many conclusions are based on studies of animals with life spans of less than ten years. Because many health effects may not be apparent until twenty to thirty years after the initial exposures, or even longer, and because human beings live more than seventy years, on the average, known health effect rates can only increase as more human data are gathered.
>
> 2. The linear model assumes an average exposure. The elderly and the very young may be more susceptible to radiation effects than the middle-aged.
>
> 3. Adequate data on the effects of very low exposures have not been developed. Instead, the standards are based on extrapolations from high or intermediate doses down to zero. But at a higher dose a larger fraction of the exposed cells may be directly killed from radiation, instead of showing signs of genetic damage or cancer. At lower doses fewer cells may be killed and more could be likely to suffer latent radiation damage, such as cancer, as a consequence."
>
> (This summary taken from Nader et al, Menace of Atomic Energy.)

8. Muller, J., and Wheeler, W.C., "Causes of death in Ontario uranium mines (second report)", May 1974.

> "There is now no longer any real question of recommending a level of exposure to ionizing radiation that in the light of present knowledge can be considered absolutely safe."

"In the absence of evidence of a threshold below which it may be presumed that there is no risk, it is prudent to assume that the risk of excess lung cancer increases with ioninizing radiation from zero exposure.

IV. CHILDREN ARE MORE SUSCEPTIBLE

1. Bithell and Stewart, "Prenatal irradiation and childhnod malignancy: A review of British data from the Oxford Survey", British Journal of Cancer, pages 31-71, 1975.

2. Bross, I.D.J., and Natarjan, N., "Leukemia from low-level radiation", New England Journal of Medicine, 287: 107-110, 1972.

These authors report that children with hives or asthma are 8 times more susceptible to leukemia from the same radiation exposure than other children.

3. Bross, I.D.J., and Natarajan, N., "Risk of Leukemia in susceptible children exposed to preconception, in utero, and postnatal radiation", Preventive Medicine, 3: 361-369, 1974.

4. Court-Brown, W.M. and Doll, R., "Leukemia in childhood and young adult life", British Medical Journal, 1: 981, 1961.

These authors demonstrate an increased cancer rate with in utero, low-dose x-rays.

5. Court-Brown, W.M. and Doll, R., "Mortality from cancer and other causes after radiotherapy for ankylosing spondylitis", British Medical Journal, 1327-1332, 1965.

> "Exposure to moderate amounts of radiation in childhood has produced cancer of the thyroid, and it seems probable that exposure to small amounts of the order of 1-10 rads in utero produces all the principal types of childhood cancer. Mortality rates from all cancers other than leukemia were raised in American radiologists compared with those in specialist physicians and ophthalmologists and otorhinolaryngologists (Selster and Sartwell, 1965)...".

6. Ford, D.D., Patterson, J.C.S., and Treuting, W.L. "Fetal exposure to diagnostic x-rays and leukemia and other malignant diseases in childhood", Journal of the National Cancer Institute, 22: 1093-1104, 1959.

This is a retrospective study of 152 cases and 306 controls dead from other causes. They found a relative risk of 1.7 after intrauterine x-ray exposure.

7. Graham, S., "Preconception, intrauterine, and postnatal irradiation as related to leukemia", National Cancer Institute Monograph, 19: 347-371, 1966.

8. Hempelmann, L.H., "Neuoplasms in youthful populations following x-ray treatment in infancy", Environmental Research, 1: 338, 1967.

Conclude that radiation induced thyroid carcinoma presents a higher risk in children than in adult populations. Furthermore, risk increases linearly as the dose increases.

9. Holford, R.M., "The relation between juvenile cancer and obstetric radiogrpahy", Health Physics, 28: 153, February 1975.

10. Keith, Brown and Ames, "Possible obstetric factors affecting leukemia in twins", Comparative Leukemia Research, (1975), Bibl. Haemat, No. 43, pages 221-223.

11. Landau, E., "Health effects of low-dose radiation: Problems of assessment", International Journal of Environmental Studies, 6: 51, 1974.

12. McMahon, B., "Prenatal x-ray exposure and childhood cancer", Journal of National Cancer Institute, 28: 1173, 1962.

13. MacMahon, B., "X-ray exposure and malignancy", Journal of the American Medical Association, 183: 721, 1963.

This paper reports that children have a higher risk of dying of radiation induced leukemia than do middle-aged persons.

14. McMahon, B. and Hutchinson, G.B., "Prenatal x-ray and childhood cancer: A review", Acta Unio Int. Contra Cancrum, 20: 1172, 1964.

"A study of the association between prenatal x-ray and childhood cancer is described. Review of all published studies of this question reveals both positive and negative results. However, many studies are based on small numbers and the results have large sampling errors. All published studies, taken either individually or as a group, are compatible with the cancer risk in children x-rayed *in utero* being 40 per cent higher than in children not x-rayed *in utero*. Several individual studies and all studies taken as a group are, on the other hand, incompatible with the hypothesis of no difference in cancer risk between the two groups."

15. MacMahon, B., and Newill, V.A., "Birth characteristics of children dying of malignant neoplasms", Journal of the National Cancer Institute, 28: 231-244, 1962.

This is a retrospective cohort study in which 556 cancer deaths were referred to a cohort of 734,243 with number exposed based on a 1% sample (intrauterine x-ray: 770 exposed, 6,472 unexposed) and a relative risk of 1.44 was found.

16. Modan, B., et al, "Radiation induced head and neck tumors", Lancet, 277-279, February 23, 1974.

Radiation for ringworm of the scalp resulted in an increasing risk of brain, parotid and thyroid tumor. The dose causing thyroid carcinoma, 6.5 rads, is the lowest reported.

17. Mole, R.H., "Ante-natal irradiation and childhood cancer: Causation or coincidence?," British Journal of Cancer, 30: 199, 1974.

18. Natarajan, N. and Bross, I.D.J., "Preconception radiation and leukemia", Journal of Medicine, 4: 2765-281, 1973.

19. Pochin, E.E., "Malignancies following low radiation exposures in man", British Journal or Radiology, 49: 577, July 1976.

20. Refetoff, S., Harrison J., et al, "Continuing occurrence of thyroid carcinoma after irradiation to the neck in infancy and childhood", New England Journal of Medicine, 292: 171-175, 1975.

21. Silvernman, C., and Hoffman, D.A., "Thyroid tumor risk from radiation during childhood", Preventive Medicine, 4: 100, 1975.

Review of 7 epidemiological studies and of radiation doses from diagnostic x-rays, scans and uptakes. The low dose, 6 rads, associated with thyroid cancer in 2 studies, raises questions about the long-term effect of dignostic procedures in childhood.

A study from the University of Chicago of 100 persons who received childhood irradiation showing a 7% increase of carcinoma. As 71,000 persons in the Chicago area received childhood irradiation, the public health implications are overwhelming.

22. Sternglass, E.J. "Radiation Risks", Bulletin of the Atomic Scientists, page 4-5, June 1972.

"...It is the dose to the early developing embryo and fetus during the first few months of pregnancy

that produces the greatest impact, both for a given family and for society as a whole."

"....The dose required to double the incidence of serious defects in the genetic control mechanism of the human cell...is of the order of 100 millirads in the first trimester, compared to 10.0 to 100. 0 rads...in the reproductive cells of the mature adult."

"A typical chest x-ray....results in an average dose of about 50 millirads to the upper part of the body. However, the dose to the gonads from scattered radiation is only about 2 millirads."

23. Stewart, A., "Low dose radiation cancers in man", Advances in Cancer Research, 14: 359, 1971.

Found increase of other cancers than leukemia in irradiated in utero children.

24. Stewart, A., and Kneale, G.W., "Radiation dose effects in relation to obstetric x-rays and childhood cancers", Lancet, June 6: 1185-1187, 1970.

Epidemiological data from the Oxford Survey of Childhood Cancers was analyzed in respect to in utero exposure to x-rays during obstetrical investigations. The risk of cancer was greatest when exposure occurred during the first trimester and excess cancer was directly related to fetal dose.

25. Stewart, A., Webb, J., and Hewitt, D., "A survey of childhood malignancies", British Medical Journal, 1: 1495-1508, 1958.

This is a retrospecitve study that matched 1,638 cancer cases with 1,638 live controls and found a relative risk of 1.92 after intrauterine x-ray exposure.

26. Wick, G.L., "Is there a safe radiationlimit", New Scientist, page 276-278, August 6, 1979.

"If the claims of some radiologists, that no 'safe' limit exists, are true, the setting of radiation standards should be a public issue."

"Damage caused by it (radiation) has been studied much more extensively than that of any form of pollution.

V. NORMAL OPERATION

1. Ichikawa, and Nagata, "Nuclear power plants suspected to increase mutations", from the Laboratory of Genetics, Faculty of Agriculture, Kyoto University, Kyoto, Japan 606.

An intereting article based on the use of bioassay with susceptible plants (the spider-wort) to determine possible health effects of very low-level radiation around a nuclear power plant.

2. Neyman, J., "Public health hazards from electricity producing plants", Science, 195 (4280): 754-758, 25 February 1977.

Author concludes that one cannot extrapolate well from A-bomb studies and mice studies, but must take into account multipollutant and multilocality considerations.

In addition to the above, there is a considerable amount of evidence presented at the current hearing and at others that the normal operation of nuclear generating plants lead to an increase in the radiation exposure suffered by the neighboring population.

VI. ACCIDENT

Especially since the accident at Three Mile Island, the literature abounds with evidence of radiation beyond from both real and postulated reactor accidents. Further citations are not need here.

SOURCES OF RADIOACTIVE RELEASE FROM REACTORS & REACTOR WASTE

1. "routine radioactive releases."
2. "accidental" releases at the reactor
3. accidental releses during transport of spent fuel rods from reactors
4. planned and accidental releases from nuclear fuel reprocessing plants
5. environmental contamination from storage or disposal of high-level wastes
6. accidental releases through sabotage".