

Testimony of Dr. Rosalie Bertell before the
Unites States Senate Committee on Veterans' Affairs
10:00 AM, SR-418, Russell Senate Office Building
Tuesday, 21 April 1998

My testimony addresses, in particular, Senate Bill S.1385 (Wellstone), to amend Title 38, United States Code, to expand the number of diseases presumed to be service connected with respect to radiation exposed veterans and Senate Bill S.1822 (Specter et al) which would authorize the Veteran's Administration to provide medical care to veterans who were treated with nasopharyngeal radium irradiation to prevent ear injury caused by severe pressure changes encountered in submarine and flight duty.

By profession, I am a biometrician, which is a specialty in mathematics applied to biomedical problems, and am qualified to design and evaluate epidemiological research. I have worked in the area of the health effects of ionizing radiation, especially at low doses and slow dose rates, for the past 30 years and have produced and published books, and professional papers on the subject.

It seems to me to be very sad that US veterans exposed to the cleanup of Hiroshima and Nagasaki more than fifty years ago, those exposed to radium implants, and those exposed to the nuclear weapon testing in the 1950's and 1960's are still waiting for recognition. The first book on radiation related cancer was published in 1912 - almost 90 years ago. It would seem that the disputes which have surrounded this issue involve much more than straight forward scientific investigation and reporting. I hope to show that the poor design of the research, especially that done on the atomic bomb survivors, together with an arrogance which claimed that this was the definitive study against which all other radiation research was to be judged, has left the Congress without answers to the most fundamental and urgent questions facing the veterans.

Since many of the veterans exposed to nuclear fallout and debris or unwise medical experiments are now dead, I think that government policy with regard to survivors should be as broad as possible. In particular, I support the proposed extension of the list of presumptive diseases which can be radiation induced. The list is eminently reasonable and should have been recognized long ago. I strongly support both of these Bills, and would like to see the guidelines for medical care even broader.

Lung cancer in particular has been a problem for the veterans because of the possible confounding effect of smoking. I was pleased to find this on the extended list. There has been a failure to recognize that radiation is not only able to initiate a cancer, but it is also able to increase susceptibility to and promote a cancer initiated by another carcinogen. Both the smoking and the radiation are responsible for lung disease. The confirmation that the veteran smoked is not a reason to disallow eligibility and responsibility for medical care.

There are two major questions which I would like to address in this testimony:

First, dose reconstruction does nothing to prove or disprove that a veteran's cancer or disease is related to their nuclear radiation exposure. It should be sufficient for a veteran to prove that he or she participated in a "radiation risk activity".

Second, there are non-cancer physical injuries suffered by the veterans and their offspring which have not yet been recognized as indicating eligibility for veteran medical care.

FIRST: The Usefulness of Dose Reconstruction in Determining Causality For Cancer or Other Radiation Related Diseases.

Dose reconstruction has become the practice because the US Government has failed to properly protect the records of veterans either through fire proof repositories or through preparing multiple copies kept in different locations. It is predicated on the argument that there is a cut-off below which cancer and other radiation effects will not be caused.

Normally, failure to retain evidence results in the assumption of maximum wrong doing. I doubt that the IRS would forgive all back taxes if the tax payer lost the records! In effect, hiring the government's radiation protection community to prepare dose reconstructions to replace the records which were lost is like asking the tax payer to guess his or her income which should be the basis of back taxes! In the case of the veteran, the government which has disproportionately more power, is using that power to disinvest the individual who placed his or her life on the line for patriotism.

Furthermore, there is no scientific evidence that a limiting dose of radiation exists below which there is little or no risk of developing a cancer or other health problem. In fact, there is peer reviewed published research which shows that excess cancers have occurred at dose levels which are within the maximum permissible dose levels set for workers and members of the public. Setting such a cut off for a veteran's eligibility for medical care is at best a subjective judgement, and at worst a deliberate ploy to pretend that standards are protective and to save money by denying the veteran health care. Radiation Protection Standards have never claimed to be health based, i.e., levels below which there is no harm. They are clearly the result of cost-benefit trade offs, where the cost is cancer death and the benefits are social and economic. They are inappropriate for use as a criterion for government health care responsibility toward veterans!

"The Commission believes that this level (50 mSv or 5 rem radiation exposure over 30 years to the general public, an average of 1.67 mSv or 167 mrem per year, and 50 mSv or 5 rem per year for workers) provides reasonable latitude for the expansion of atomic energy programs in the foreseeable future. It should be emphasized that the limit may not in fact represent a proper balance between possible harm and probable benefit because of the uncertainty in assessing the risks and benefits that would justify exposure." International Commission on Radiological Protection (ICRP) No. 26, 1965.

Atomic Bomb Research:

Research on the survivors of the atomic bombing of Hiroshima and Nagasaki is incapable of providing a scientific support for radiation protection standards. Most people think that the Atomic Bomb survivors offer the ideal epidemiological data base for answering such questions, and indeed the US Government has poured billions of dollars into this research in order to obtain answers. However, a closer look shows why in actual fact this data can never answer the questions with respect to harmful exposures at low doses.

First of all, the hazard being studied by the ABCC (Atomic Bomb Casualty Commission) and its most recent replacement, the RERF (Radiation Effects Research Foundation) is not radiation, but it is the effect of the immediate irradiation from a nuclear bomb blast. In both Hiroshima and Nagasaki, the people were not only exposed to the immediate flash of the bomb, but also to the fallout, which they called Black Rain, the activation products induced by the blast, the resuspended radioactive particles which they breathed, and the contaminated food and water to which they were subsequently exposed. Later on, the Life Span Study involved medical diagnostic X-ray examination of the victims as part of research programs or the routine medical examination. However, the radiation doses assigned to the Hiroshima and Nagasaki survivors as a basis for the research, consists solely of the estimated dose from the original flash of the bomb. No other exposures are included.

First Conclusion: The atomic bomb study radiation risk factors apply directly only to external radiation, high dose and fast dose rate exposure. This research says nothing about the internal contamination with radionuclides experienced by any veteran participating in the Hiroshima and Nagasaki cleanup, in atmospheric weapon testing, or in radium implants. This research says nothing about the incorporation of radionuclides into bone with the subsequent long term chronic irradiation of the surrounding tissue.

Secondly, this definition of "hazard" influenced the researcher's choice of "exposed" and "unexposed" persons for the Life-Span Study. The Life Span cohort, used for the atomic bomb research, consisted of 91,228 people identified in the 1950 Japanese Census as having been within 10 km of the hypocenter of either Hiroshima or Nagasaki at the time of the bombing. Of this number, 26,580 (29.1%) were "not in the city" at the time of bombing, but were residents of the city. Anyone located more than 2 km from the hypocenter in Nagasaki, or more than 1.6 km in Hiroshima, were designated "distally exposed". The ABCC did not routinely collect information on the shielding of these persons for the 1965 tentative (T65) dose estimates, therefore there was no information on this for input into the newer 1986 (DS86) dose estimates. In fact, only 18,517 (20.3%) of the Life Span Study participants had enough information collected for a dose estimate to be made in 1986.

The DS86 team assigned a dose of ZERO to any survivor with a calculated dose less than 10 mGy (1 rad), another 34,043 (37.3%). Therefore, by definition (not science) these low exposed persons were considered to be controls (norms) not exposed. Therefore the research which assumed their experience to be unaffected by radiation cannot be used to "prove" it was not related to radiation.

The Second Conclusion is that the Atomic Bomb Research was not designed to establish a dose below which exposure was "safe". Had this been the case, careful examination of the harm from low dose exposures would have been mandatory.

Moreover, since the Life Span participants were not assigned even tentative doses until 1965, the research could not have backed radiation protection guidelines set in 1952. The dates for determining dosimetry make this use of the data base research impossible. The doses were reassigned and changed in 1986.

The "unexposed" population, 34,043 (59.5%) of the Hiroshima and Nagasaki survivors in the Life Span study, consisted of those whose calculated direct dose of radiation from the flash of the bomb was less than 10 mSv (1 rem). They were assigned a dose of ZERO and called unexposed or "out of the city at the time of bombing". I know of one such woman in the control group who lived within 1 km of the hypocenter but was at work, just 3 km away from the hypocenter when the bomb exploded. She went to her home as soon as it was possible after the explosion, and found her Mother, Father and Brother dead. Not knowing where to go, she stayed in what was left of her home for three days, burying the dead and trying to retrieve what she could of personal belongings. Later she had many of the expected radiation exposure symptoms but she is considered an "unexposed control" in the Atomic Bomb study. Contrast this with the current definition by the Senate of veterans who engaged in "radiation risk activity", namely those who were assigned to Hiroshima or Nagasaki anytime between the occupation of Japan (around the 19th of September 1945) and 1 July 1946. How can a veteran considered "exposed" at Hiroshima or Nagasaki, discover the health consequences of that exposure when the Japanese in the study with the same exposure were considered "unexposed"?

Third Conclusion: The atomic bomb researchers assumed (but did not demonstrate or prove) that below 1 rem exposure from the original bomb blast no radiation related cancers deaths would occur. Therefore this data base can tell us nothing about such low dose exposures because the researchers assumed their exposure was "safe" and did not test for an effect. In philosophy we call this "begging the question" and it results in an invalid "proof".

Moreover, these "unexposed" persons in the study would likely have had internal contamination due to fallout, resuspension of fallout particles, water and food contamination, leading to internal radiation doses also not calculated and assumed to be zero. Therefore the control population, the so called "normal" comparison group would contain most of the internally contaminated low dose exposed people - exactly the group needed to understand what happened to the majority of veterans who would have had internal contamination! Any Japanese with comparable exposures to the veterans, and some with more exposure because they went into the contaminated area to help survivors as soon as they could after the fires subsided, were considered to be the model for normal cancer occurrence in those not exposed to the atomic bomb.

The Senate is being asked to accept the assumptions of researchers as if these were scientific facts proven through the use of a scientific method of investigation. Based on this faulty study, veterans who suffered radiation injuries at low dose levels are being denied the medical assistance for their injuries. The assumption of injury should go to the veteran when the research has been designed so as not to include their situation in the study. They were deliberately excluded and there is no scientific basis for the claim that the research did not "show" any excess. By design, the research could not even address their situation.

Fourth Conclusion: There is no scientific basis in the atomic bomb research for denying medical care for radiation related injury to veterans whose calculated doses of radiation are below some arbitrary cut off.

Other Research which supports including Low Dose Exposure Cancers in eligibility for medical programs:

TABLE 1.

STUDY	CANCERS SIGNIFICANTLY INCREASED (P <5%)	CANCERS INCREASED, BUT NOT SIGNIFICANTLY
Wing 1991 (Oak Ridge) 26 years follow-up. 1524 deaths; 1.4 mSv; median dose (140 mrem)	Leukemia	Prostate, Lymphoma, Reticulosarcoma, Hodgkins, Pancreatic and Brain Cancer, Lung Cancer among workers not monitored for radiation.
Checkoway 1985 (Oak Ridge) up to 21 years follow-up; 966 deaths; median dose below 20 mSv (2 rem)	None	Leukemia, Prostate, Hodgkins and Stomach (relative to State of Tennessee)
Smith and Douglas 1986 (Sellafield, UK) 9 year av. Follow-up; 2,270 deaths; median dose 2 to 20 mSv (0.2 to 2 rem)	Bladder, Lymphatic and Hemopoietic Neoplasms, including Myeloma.	Ill defined cancers and secondary sites; Prostate.
Beral 1985; 16 year follow-up; 5,378 deaths; median dose 10 mSv (1 rem)	Prostate	Testicular Cancer; Leukemia; Thyroid Cancer; non-Hodgkins's Lymphoma, Uterine and Ovarian Cancer.
Mancuso, Stewart and Kneale (Hanford) 1984; 3,520 deaths; median dose 2 mSv (0.2 rem)	Myeloma, Pancreas and Lung	
Gilbert 1989 (Hanford); 21 years follow-up; 4234 deaths; median dose 2.5 mSv (0.25 rem)	Myeloma, Female Genital Cancers	All Female Cancers; Lung Cancer in Males with more than 2 rem exposure.
Cragle 1988 (Savannah River) 1022 deaths; 20 year follow-up; median dose 4 mSv (0.4 rem)	Leukemia, Aleukemia among a subset of workers with 5 to 15 years of employment. Lymphopoietic Cancers among all workers with 5 to 15 years of employment.	Among hourly employees: Pancreas, Leukemia and Aleukemia, and other Lymphatic Cancers. Among salaried workers: Pancreas
Among all workers: All cancers combined, Lung Cancer and Respiratory Cancers.	Wilkinson 1987 (Rocky Flats) 14 years follow-up; 406 deaths, median dose 10 mSv (1 rem)	None

External Radiation: Brain Tumors, Liver Cancer, Lymphosarcoma, Reticulosarcoma, Myeloid Leukemia
Workers with >2nCi Plutonium: All causes of death, Leukemia, Multiple Myeloma, All Lymphopoietic

Neoplasms (Leukemia and Multiple Myelomas) Digestive Cancers Whole Cohort: Benign and unspecified Neoplasms; Intracranial Tumors.

These research findings were all peer reviewed and published in professional journals. All findings of significance were measured against the rate in the general public, although it is known that the "healthy worker effect" generally results in mortality ratios 20% below that of the public. Veterans, who were screened at the time of their enlistment would also be expected to show the "health worker effect".

One can only conclude that it is direct fault of the Atomic Bomb research itself which is being used to deny medical care to the veterans in their legitimate claims resulting from low dose exposures. Therefore it is a foolish and inhumane policy to prepare dose reconstructions, at considerable cost, in order to deny those claims.

Fifth Conclusion: It would be better to give that money currently wasted on dose reconstruction to the direct medical care and needs of veterans who were participants in the radiation risk activities.

SECOND: The Need to Recognize Non-Cancer Illnesses as Radiation Related for Veterans Who Have Participated in Radiation-Risk Activity, and Congenital Diseases or Deformities in their Offspring.

Again, we find a fundamental flaw in the design of the Atomic Bomb studies, which have been relied upon by the Congress as identifying radiation related diseases and disabilities. Due to another research decision, these studies have focused on cancer death as the biological end point used to compare "exposed" with the "unexposed" population. Cancer death rates are also the basis for tissue weighting and calculation of effective doses used to judge the detriment of the reconstructed dose. For teratogenic effects in offspring, they recognize only severe mental retardation, i.e., inability to return a greeting or take care of basic life functions. Virtually all of those in utero at the time of the bombing and who survived, had some degree of mental retardation. Only severe genetic damage is counted by the ABCC and RERF, excluding multifactorial diseases.

The probability of damage occurring when someone is exposed to ionizing radiation is 100%. You can see, by the enclosed picture of the living cell, its complexity. The electron micrograph of a plutonium particle exploding in lung tissue gives you some idea of the destruction wrought by one "nuclear event" in living tissue. The energy needed to break the molecular bonds in the DNA is roughly 6 to 10 eV (electron volts), whereas the energy release in just one atomic transformation of a plutonium atom is about 5 MeV (million electron volts). The energy from one transformation of one radium atom is about the same, and the energy of cesium 137 and strontium 90 is about 0.5 MeV (five hundred thousand eV). There can be no question of the ability of the smallest particle of one of the radionuclides to disrupt the chemical bonds of the DNA. The probability that this damage will cause genomic instability in the cells affected is still high, just slightly less than 100% (since some cells die). This renders the surviving cells more susceptible to cancer initiation at a later time.

In one nuclear transformation striking living tissue, we expect some cells to be killed, some to be damaged and then repaired or misrepaired, and some to be permanently damaged yet able to reproduce. The misrepaired cells, which then malfunction, and the damaged cells able to reproduce their mutated DNA, can later result in ill health or cancer.

Atomic Bomb research generally assumes that the only damage one should care about (clearly a self-serving judgement not a scientific fact) is direct damage to DNA which results in a cancer which is fatal. More recently, they have included some non-fatal cancers (slighting breast and skin), genetic damage to offspring and severe mental retardation with in utero exposure. The Hiroshima and Nagasaki research on cancer incidence rates was not published until 1994. A comprehensive report on other chronic disease prevalence has never been forthcoming.

When the unrepaired or misrepaired damage due to radiation occurs in the germ cells, sperm (and stem cells which produce sperm) or ovum, that damage will be incorporated into every cell of the offspring made from that damaged DNA. It may show up as a miscarriage, still birth, teen age cancer or mid-life heart disease, but these are not considered to be "detriments" - another value judgement and not a scientific fact. Elimination of regulatory concern for diseases in offspring which are multifactorial reduced the number of genetic effects which would be counted. Even cancer and heart disease in offspring were eliminated. Guidelines today include only dominant and sex linked chromosomal damage, and polyploidy, obvious from birth.

"The Committee's estimates of total genetic damage are highly uncertain, however, as they include no allowance for diseases of complex genetic origin, which are thought to comprise the largest category of genetically related diseases".

The probability that the misrepaired or permanently damaged cell line will begin to proliferate is rare, and that it will survive the body's defenses and go on to become a diagnosable cancer still more rare. Then, to require that the person die of the cancer reduces this probability still further. The radiation risk factors currently in use are based on this rare event occurring, and it is these estimates of cancer death which are being used to estimate the probability of cancer incidence in the veterans. Death is too late for medical assistance and compensation!

Sixth Conclusion: Atomic Bomb research on cancer death in atomic bomb survivors is inappropriate for judging the veterans claim to recognition as radiation related those cancers and other health problems which they or their offspring have suffered.

What sort of damage generally occurs when a person is exposed to ionizing radiation? This is rather well covered in BEIR V (quoted above):

"The initiating event more likely [than a specific single-locus mutation] appears to be an event that increases genomic instability of the cells in subsequent rounds of cell division....The hypothesized high-frequency initiating event could conceivably be a change in gene expression of a type that might occur in a large portion of irradiated cells; in *Escherichia coli*, for example, radiation induces an error prone DNA repair system which leads to mutations which would otherwise occur only rarely."

The human genome consists of the cellular DNA plus that in the mitochondria (derived from the mother). Radiation induced cancers are premised on specific single-locus mutations which result in a malignant cell line eventually resulting in a cancer. What else might we expect from genome instability?

Anyone who has seriously studied the health effects of low doses of radiation would tell you that it is unwise to try to extrapolate from the findings at high doses. The mechanisms are different at low dose, and direct damage to the DNA is of less importance because more rare. It is equally unscientific to try to extend the findings from low dose radiation studies to predict effects at high doses. Among some of the more important mechanisms which cause clinical effects on health after exposure to low doses of radiation are: effects on the functioning of the B Lymphocytes by inducing pathologic processes disrupting humoral immunity; free radical effects causing rupture of cell membranes at very low doses of radiation; damage at very low doses of radiation, below the level which triggers the cellular repair system; the inflammatory process at micro Gray doses; and the effect of internal radionuclides stored in bone on the stem cells in the bone marrow.

In a 1965 study conducted by Selser and Sartwell: "Occupational Exposure of Radiologists and Mortality", the cause of death for 16,808 physicians between the ages of 65 and 69 were studied. When these were normalized as death rates per 100,000, they found the following:

TABLE 2.

Death Rates per 100,000 Physicians by Specialty

Cause of Death	Radiologists	Internists	Ophthalmologists
Cardio-vascular renal	4,000	3,100	2,900
Cancer	1,000	800	700
All other causes	850	700	400
Overall death rate	6,800	4,500	3,900

What most people recall from this study is that leukemia cancer carried the highest relative risk for radiologists. However, a close look at the data shows that there was a large excess of cardiovascular disease, all cancers and other causes. It should be noted that because this study compared three medical specialties rather than compare the radiologists with the general public, there is no "healthy worker effect" in this data.

In another study of 1,233 Atomic Bomb survivors of average age 59.5 years undertaken in 1986 by the Investigative Committee of Atomic Bomb Victims of Hannan Chuo Hospital, Osaka, Japan, comparison was made to the expected level of disease reported for the same age group by the Japanese Ministry of Health 1986 Report.

TABLE 3.

Ratio Between Illness in Atomic Bomb Survivors
and that in the General Japanese Public of the same Age Group

Disease Incidence	Relative Morbidity in A-bomb Survivors
Leukopenia	3.4
Liver Disease	6.4
Ocular Disease	5.0
Neuralgia and Myalgia	4.7
Ischemic Heart Disease	4.7
Gastro-duodenal Ulcer	4.7
Gastritis	4.5
Lumbago	3.6
Diabetes	2.7
Hypertension	1.7

It should be very clear that the Radiation Research which has been done by the ABCC and RERF has never clearly addressed the problems of non-cancer effects of exposure. Instead, they have relied on their earlier judgement that these other biological endpoints were "not of concern" and should not be studied. Cancer incidence rates were not even reported until 1994. Incidence rates for other chronic diseases has not yet even been collected in the data base, which is concerned with first cause of death. A disease like neuralgia is not likely to be a first cause of death!

Obviously non-study does not "prove" that such diseases have not been increased as part of the experience of the radiation exposed veterans. However, veterans will never be able to obtain medical benefits under the current inadequate Atomic Bomb research base. Some of these Japanese findings for atomic bomb survivors, researched outside of the official RERF supervision, have been confirmed in the survivors of the Chernobyl disaster. However, instead of documenting these Chernobyl findings in order to estimate dose-response relationships we find the radiation protection community (namely the International Atomic Energy Agency, assisted by the US radiation protection community) taking the lead in denying their existence! The term radiophobia was invented to belittle the suffering of the Chernobyl people. While I would strongly oppose assigning radiation as the cause of all ill health, I am forced to speak out against the pseudo-science which builds on ignorance and non-studies, while claiming to be the holder of the bench mark "classical" studies.

Recommendations:

I would strongly encourage the Senate Committee on Veterans' Affairs in consideration of the US research failure to study biological endpoints of concern to the veterans, to extend radiation related medical care for all cancers and for the above list of other potentially radiogenic illnesses to all veterans without regard to dose reconstruction estimates. It is reasonable to presume that the genomic instability induced by radiation exposure left the individual survivor fragile in the face of normal environmental and

life style insults, resulting in the observed premature chronic diseases and reduced quality of life. This is the least the government can do for the few survivors after years of denial of their injuries.

Redirect research money in order to provide relevant health information for veterans exposed to military technology. This would be more appropriate than trying to use the research into military effectiveness of specific weaponry, in this case, the atomic bomb technology, for evaluating the veterans health problems. The research goals and designs are different, and the information gathered by the military to evaluate weapon effectiveness is not appropriate for decision making with respect to the medical care of veterans.

This Committee, or a relevant Congressional oversight Committee of RERF, should strongly recommend that RERF make available to the Japanese researchers who are studying chronic diseases in the atomic bomb the survivors the DS86 dose estimates for those survivors. This would enable them to test whether or not disease prevalence increases with dose.

Require that administrative decisions of the radiation protection community, namely that only cancer deaths are "of concern" and that this cancer must be caused (not just promoted) by radiation, through direct damage to the DNA, be broadened to include the newest research on low dose radiation mechanisms and indirect or promotional causes of cancer. These are not scientific questions, they are discretional judgements.

I would hope also that the Committee would revisit the question of genetic damage to the offspring of radiation exposed veterans. This is especially appropriate since the US Government has recently recognized such damage for the offspring of Viet-Nam Veterans exposed to Agent Orange.

Dr. Rosalie Bertell
International Institute of Concern for Public Health
710-264 Queens Quay West
Toronto ON M5J 1B5 CANADA
Tel: 1-416-260-0575
Fax: 1-416-260-3404
E-mail: IICPH@compuserve.com

REFERENCES:

1. R. Bertell. Handbook for Estimating the Health Effects of Ionizing Radiation, 2nd Edition. October 1986, Institute of Concern for Public Health, Toronto, Ontario, Canada; Ministry of Concern for Public Health, Buffalo, New York, USA; International Radiation Research and Training Institute, Birmingham, England, UK.
2. R. Bertell. No Immediate Danger: Prognosis of a Radioactive Earth. The Women's Press Ltd. London, England, UK 1985.
3. R. Bertell, "X-ray Exposure and Premature Aging", Journal of Surgical Oncology, Vol.9, Issue 4, 1977.

4. R. Bertell. "Radiation Exposure and Human Species Survival" *Environmental Health Review*. Vol. 25, No.2, 1981.
5. R. Bertell. "Chernobyl - April 1991" *Environmental Health Review*, Vol 35, No. 3, 1991.
6. R. Bertell. "Epidemiology in Radioactive Contaminated Areas" in *Biomedical and Psychosocial Consequences of Radiation from Manmade Radionuclides*. Editor: Gunnar Sundnes. Proceedings of the International Symposium, Royal Norwegian Society of Sciences and Letters Foundation, Kongsvoll, Norway, 5-10 June 1994, Tropolheim, Norway 1994 (pp 303-324).
7. R. Bertell. "Low Level Radiation Exposure Effects in the Tri-State Leukemia Survey" in *One Hundred Years after Roentgen*. Editor: Inge Schmitz-Feuerhake and Edmund Lengfelder. Proceeds of the International Congress, Berlin, 1995. Published 1997 (pp 48-59).
8. US National Academy of Science Committee on the Biological Effects of Ionizing Radiation (BEIR V) 1990, p 139.
9. Ibid, p 138.
10. D.L. Preston and D.A. Pierce. "The Effect of Changes in Dosimetry on Cancer Mortality Risk Estimates in the Atomic Bomb Survivors: Technical Report PERF TR 9-87. Radiation Effects Research Foundation 1987.
11. Ibid. p 8.
12. Ms. Kasuko Yamashina, of Nagasaki. Her Testimony before the Permanent Peoples Tribunal is published in: *Chernobyl: Environmental, Health and Human Rights Implications*", International Peace Bureau, Geneva, Switzerland. 1997.
13. S. Wing et al. *Journal of the American Medical Association* Vol 265, No. 11, March 1991.
14. Checkoway et al. *British Medical Journal* Vol 42. 1985 (pp 525-533).
15. P.G. Smith and A. J. Douglas. *British Medical Journal*, Vol. 298, 1986.
16. Beral et al. *British Medical Journal* Vol 291, 1985.
17. G. Kneale, F. T. Mancuso, and A.M. Stewart. *British Journal of Industrial Medicine* Vol 41, (pp 6-8, and 9-14).
18. E. Gilbert et al. *Radiation Research* Vol. 120, 1989 (pp 19-35).
19. Cragle et al. *American Journal of Industrial Medicine* Vol.14, 1988 (pp 379-401).
20. G. Wilkinson et al. *American Journal of Epidemiology* Vol. 125, 1987 (pp 231-250).

21. Lang's Handbook of Chemistry, Fourteenth Edition. Editor: John A. Dean. McGraw Hill, New York, 1992.
22. A Series of four articles on Cancer Incidence in Atomic Bomb Survivors can be found in Radiation Research Vol. 137, 1994.
23. US National Academy of Science Committee on the Biological Effects of Ionizing Radiation BEIR V, 1990.
24. Ibid p. 138.
25. L.P. Titov et al, "Effects of Radiation on the Production of Immunoglobulins in Children Subsequent to the Chernobyl Disaster." Allergy Proceedings Vol. 16, No 4, 1995.
26. A Petkau. "Protection and Repair of Irradiated Membranes" in Free Radicals, Aging and Regenerative Diseases, Alan Liss Inc. 1985 (pp 481-506).
27. E. B. Burlakova et al. "Mechanisms of Biological Action of Low Dose Irradiation" in Consequences of Chernobyl Catastrophe: Human Health. Scientific Council on Radiobiology; Emanuel Institute of Biochemical Physics, Institute of Biophysics; and Institute of General Genetics, Russian Academy of Science 1997.
28. M.G. Vicker. "Radiosensitivity Mechanisms at Low Dose: Inflammatory Responses to micro-Gray Radiation Levels in Human Blood" International Perspectives in Public Health, Vol.9, 1993 (pp 4-20).
29. R. Bertell, "Internal Bone Seeking Radionuclides and Monocyte Counts." International Perspectives in Public Health. Vol 9, 1993 (pp 21-26).
30. R. Selzer and P.E. Sartwell. American Journal of Epidemiology Vol 81, 1965 (pp 2-22).
31. K. Furitsu. "The Japanese Experience at Hiroshima and Nagasaki," in Chernobyl: Environmental, Health and Human Rights Implications" International Peace Bureau, Geneva, Switzerland 1997 (pp 155-158, and accompanying written testimony).
32. The International Chernobyl Project: Assessment of the Radiological Consequences and Evaluation of Protective Measures. Report by an International Advisory Committee, International Atomic Energy Agency, Vienna 1991.