

**June 15, 2001**

**NCRP REPORT MISREPRESENTS THE SCIENTIFIC EVIDENCE:  
LOW-DOSE RADIATION IS NOT HARMFUL; SHOWS HEALTH BENEFITS**

**SUMMARY**

NCRP Committee 1 has misrepresented the scientific data to support its false premise that low-dose radiation (LDR) *might* be harmful. ***But the data say otherwise.*** The Committee:

1. Produced voluminous irrelevant and misleading data to support the linear no threshold (LNT) premise.
2. Selectively misrepresented and obfuscated data that **do** provide highly statistically significant and consistent evidence of LDR benefits, and null dose-response effects, that contradict the LNT.
3. Failed to consider the voluminous scientific literature, submitted to them by the scientific community, including RSH, that consistently contradicts the unsupported LNT premise.

The NCRP's position leads to extreme radiation protection policies requiring enormous public expenditures for **no** public health benefit. This will be challenged before the Federal agencies that would be misled; before authorities that assess scientific misconduct, and the Office of Scientific Integrity; and before the Congress, and the courts.

**OVERVIEW**

1. The Committee has primarily compiled material that is not relevant to health effects dose-response:
  - Data from irradiated cells, without anti-mutagenic functions, falsely imply effects to living organisms
  - Other high dose, high-dose-rate, data from conditions that overwhelm the body's natural defenses
  - Japanese bomb survivors ('instantaneous' doses; neutrons; poor dosimetry; major confounders)
  - Uranium miners and other extreme conditions (diesel fumes; silica dust; poor dosimetry; smoking)
2. The Committee virtually ignores the vast body of low-dose radiation research data:
  - Human and animal data that show beneficial effects, with no harmful effects where LNT 'predicts' effects
  - Laboratory data and analysis that reveal the many molecular and cellular stimulatory mechanisms
  - Successful treatment of cancer and other diseases in humans and animals
3. Falsely presents data from credible studies that show statistically-significant benefits from LDR:
  - Nuclear Shipyard Workers Study (24% lower overall mortality; 99.9+% confidence level)
  - Canadian fluoroscopy study (statistically-significant reduced breast cancer, called an "anomaly")
  - The many population radon studies (consistent decreases in lung cancer with increasing radon)
4. Inappropriately applies the fact that initial damage to DNA is linearly proportional to dose:
  - *Initial* damage from radiation is trivial compared to that from normal metabolism
  - LDR stimulates anti-mutagenic systems, so *persistent* mutations are reduced overall
5. Misleads about a higher percent of double-strand breaks (DSBs), that are harder to repair, from radiation
  - There are still 1000 times more DSBs produced by metabolism than by background radiation
  - LDR enhances error-free enzymatic repair of **all** DSBs, which are mostly produced by metabolism
6. Misleads about the fact that radiation can linearly increase chromosomal damage
  - Chromosome aberrations do not cause adverse health effects

Relevant data and concerns about such flaws were provided to the Committee. Our data presented to the NRC in 1996 caused Chairman Jackson to formally require the NRC staff to inform the NCRP that such deficiencies must be avoided – and specifically to consider all relevant data. These admonitions were ignored. In the March 1999 NRC review of the October 1998 draft, the Committee again committed to the NRC to consider all of the relevant data. Despite this official warning, the NRC effectively rescinded Chairman Jackson's direction, by indicating that NRC, and its Advisory Committees, would **not** hold the Committee accountable.

### **INITIAL COMMENTS [MORE COMPREHENSIVE COMMENTS BEING DEVELOPED]**

Following doggedly in the path of its predecessors, NCRP Committee 1-6 reported on its six-year evaluation of low-dose radiation health effects as predicted by the linear non-threshold (LNT) premise. The Committee asserts (p.6) **“it is important to note that the rates of cancer in most populations exposed to low-level radiation have not been found to be detectably increased, and that in most cases the rates have appeared to be decreased.”** Despite this proven fact, the Committee concludes that radiation protection policy and regulations should continue on the false “biophysical” premise (NCRP 121, p.45) that any amount of radiation, no matter how small, is hazardous and should therefore be reduced to “as low as reasonably achievable.” The Committee does not claim that this premise is shown to be valid. They merely state that the possibility **“cannot be excluded.”** But this possibility falls if the overwhelming contrary scientific evidence is considered.

Less than two pages, plus a few scattered phrases, of this 287-page report discuss **hormesis**, the basic biological principle cited by Paracelsus in 1540: **“Nothing is poison, but the dose makes it so.”** This hormetic principle has been demonstrated in hundreds of studies at the level of cells, tissues, and organisms. LDR is shown to prevent and cure cancer, other diseases and adverse health conditions. Biological response mechanisms are stimulated by LDR: Immune cells and functions; genes and adaptive responses that enhance system-wide DNA damage control; and hormones and other physiological responses.

By this principle, radiation, like selenium and other toxic metals and minerals that are nutritional supplements, is harmful at high doses but beneficial, and probably essential, at low doses. The Committee concedes (p.8) that the data they use **“come primarily from observations at moderate-to-high levels of exposure.”** But there is **no** important dispute over moderate-to-high level dose-response data. Far better had the Committee devoted most of the other 285 pages to the abundant LDR human and biological data, showing that populations exposed to LDR show, if and when anything, beneficial, not detrimental, health effects.

The Committee's mutagenesis review (pp.36-49) omits hundreds of significant biological studies of molecular **anti-mutagenic cell functions** and their responses. Also **unmentioned** are **oxidative free radicals and associated reactive oxygen species (ROS)**, the principal cause of DNA damage produced by both ionizing radiation and oxygen metabolism. DNA damage from metabolism exceeds that from 1 mGy per year background radiation by a factor of more than 100 million. The anti-mutagenic system of DNA damage control evolved to cope with this relentless onslaught of **metabolic** damage. There are three effective components of cellular DNA damage control: **prevention** by anti-oxidant scavenging of ROS; enzymatic **repair** of damaged DNA; and **removal** of persistent damage by apoptosis and the immune system.

Double-strand breaks in DNA (DSBs) are a thousand times more likely to have errors in repair than simple single-strand breaks; and they occur in 2% of radiation-induced DNA damage, but only in 0.000001% of metabolism-induced DNA damage. However, DSBs from metabolic damage still exceed those from background radiation by a factor of 1000. But, **LDR stimulates all three components of the anti-mutagenic system.**; (High-dose radiation, on the other hand, suppresses them.) High dose, high dose-rate, radiation mutagenesis is linearly proportional to doses that are sublethal to cells. In contrast, hormetic **LDR decreases mutagenesis**. This effect has been shown to slow aging, and to decrease mortality from cancer and other causes. This generally results in longer mean lifetimes of LDR-exposed populations.

The Committee's primary failure, like its predecessors, is to **ignore most of the vast body of data** that show no harm from low-level radiation, and show stimulatory responses that produce health benefits. E.g., they cite RSH's "Data Document" (but only 1998, though they received the 1999 and 2000 updates), but they do not assess the several hundred science literature data sources there that contradict the LNT. The Committee disingenuously refers to a magazine article that has no references (Muckerheide 1995), while ignoring the actual data sources provided. They cite a one-page editorial comment by Pollycove, but not his comprehensive, data-filled papers; and cite Cohen's 1995 radon health effects paper, but not his many papers that refute the unsubstantiated disparaging comments that they use to simply dismiss, rather than assess, his many studies. They especially fail to assess Cohen's joint paper with Colditz (1994), a renowned Harvard epidemiologist, that finds Cohen's data and analyses epidemiologically valid. Nor do they mention independent confirmatory studies by Bogen (1998) and others.

Instead of scientific scrutiny, the Committee **dismisses such studies, using generic comments** with no assessment of their application to the study. In fact, most credible science authors carefully avoid such pitfalls, or analyze their significance. The Committee did not show that results were invalidated by such generic concerns. They only state (p.136) **"Given the intrinsic problems with analyses of ecological data described above, such data cannot be regarded as trustworthy,"** and conclude (p.49): **"Under some experimental conditions the adaptive response can protect cells against the mutagenic effect of ionizing radiation; however... the response seems unlikely to have a significant impact on radiation effects in human populations."** This statement is not compatible with its assertion (p.6 quoted above) that **"cancer in most populations... have not been found to be detectably increased, and that in most cases the rates have appeared to be decreased."**

After dismissing studies on large populations irradiated by radon in homes, or Co-60 at work, or living in high natural radiation areas, or receiving medical treatment with low-to-moderate radiation doses, the Committee states **"in vitro studies have yielded the most reliable dose-response data."** This is true for pounding on cells in a Petri dish, but it has no direct relevance to radiation health effects in whole organisms.

Since *in vitro* tissues and cells do not have capable immune systems, nor enzymatic and hormonal responses, nor apoptotic removal capabilities, etc., they do not indicate how whole organisms respond. Biologists know that cells in culture are laboratory artifacts; that cell experiments help elucidate mechanisms, but they can **not** indicate how an organism will respond. Renato Baserga states in "The Molecular Basis of Cell Cycle and Growth Control," (Ed. Stein, Baserga, et al., Wiley-Liss, 1999): **"If you wish to study the cell cycle of the lining epithelium of the small intestine in mice, there is only one way to study it, and that is in a mouse. But if your concern is about mechanisms, gene expression, growth factors and so on, then yeasts and other cells in culture are the best choice. One only has to be very careful in avoiding extrapolations... the environment of cells in culture resembles the environment of cells in vivo no more than a zoo resembles an African habitat. The Petri dish is a hostile environment, and when cells are asked to grow in that environment, they pull out all the stops and start expressing all kinds of genes they do not express in the adult animal."**

On the page-and-half that "cover" hormesis (pp. 196-197), only two of the studies that clearly show beneficial responses to LDR were "addressed." First: a study by **Miller et al. (1989) of Canadian women TB patients** who were periodically examined by fluoroscopy. Breast cancer incidence vs. radiation dose shows a clear, statistically highly significant, cancer deficit in the 100 to 300 mGy range vs. the lowest-dose controls. Contradicting NCRP member E.W. Webster's analysis of this study in his 1992 Lauriston S. Taylor Lecture at the Annual NCRP meeting, published by NCRP September 1, 1992, the Committee claims that the deficit is not statistically significant, and falsely states that **"a simple linear dose-response curve provided an adequate fit to the data."** A 1996 "update" by Howe and McLaughlin is used instead. But it is well known that this study grouped the 10 to 490 mGy data into a single dose group. It is reasonable to presume that this is to hide this hormetic effect by burying the 53 deaths in the hormetic range (of about 79 "expected") with deaths above and below this range. They then state that **"the most recent report by Howe (2001-to be published)... found that a simple linear model fit the data better than a pure quadratic model... Thus the alleged deficit... should be regarded as a statistical anomaly that has now disappeared."**

Adding to the obvious effort to suppress the actual data, this sleight-of-hand raises other questions: Does the Committee intend that failure to fit a quadratic model automatically proves a linear model? In fact, since entirely different biological processes take place during low-dose irradiation from those occurring at high doses, a single linear fit to both ends of the data is precluded. And is “Howe (2001-to be published)” on which the Committee relies, the same as “Howe (1998-in press)” used in this same context in the October 1998 draft SC 1-6 report (falsely claimed to be “in press”?) still not accepted for publication? The Committee does not even summarize the methods and results of this “new study,” unlike its expositions on other much less significant unpublished studies. The history of the effort to transform this study from clearly demonstrating statistically significant beneficial effects of LDR, into a study “consistent with” linearity, is being documented. The significance of the Committee’s misrepresentation of data is readily apparent in their use of this well-known obfuscated data in Section “9.3.4 Breast Cancer” (p.162), Tables 9.9 and 9.10.

Secondly: the Committee discusses the **Nuclear Shipyard Worker Study**, clearly the best and strongest epidemiological study of nuclear workers ever conducted. This 10 million dollar, 10-year study (1978-1987) was directed by Congress in response to allegations of adverse health effects in shipyard workers. It was done for the US Department of Energy by the Johns Hopkins Department of Epidemiology. The Technical Advisory Panel was headed by Dr. Arthur Upton, who was concurrently BEIR-V Committee Chairman, now also Chairman of this NCRP Committee. This study population (about 70,000 workers) was taken from more than 700,000 workers that include 108,000 radiation-exposed workers. Thus, the study was able to match unirradiated-worker control groups to exposed-worker groups, by age, under the same health plan, doing the same work under identical working conditions, except for exposure to Co-60 irradiation. In this way, the study, concurred in by its Technical Advisory Panel, was able to eliminate the “healthy worker effect.” All irradiated workers wore film badges, under a rigorous program compared to other early nuclear workers; and since the significant radiation source was external Co-60, they had the most accurate radiation dose data.

As shown in the Figure to the right, there is a highly-significant decrease in mortality from “All Causes,” by 16 standard deviations (SDs). Deaths from “All Malignant Neoplasms,” that is, *All Cancers*, not “just for radiosensitive cancers” (p. 196) were more than 4 SDs below controls (p<0.001). This was apparently not the result expected or desired. These dramatic effects are explained by the Committee as, “This interpretation ignores the likelihood of occupational selection factors that led some to qualify for radiation work while others did not.”

However, this had already been addressed by the study authors. They determined that this selection affected only a handful of nuclear workers out of nearly 30,000, and could not affect the results.

DOE published an abstract in 1993, but neither DOE nor the Principal Investigator has submitted a paper for publication, even though a contract with the Principal Investigator to support this study was continued in 1994. Most egregiously, DOE’s Summary of Findings reported only a few statistically insignificant

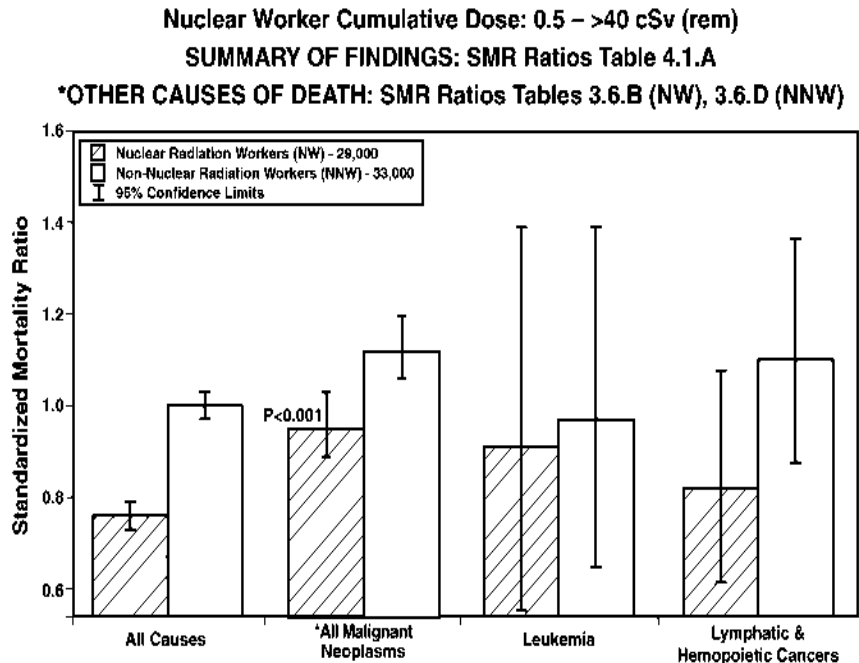


Figure 5. Standardized mortality ratios for selected causes of death among shipyard workers in the U.S. Matanoski GM. (1991)

"radiosensitive cancers", not the most important result - the "All Malignant Neoplasms" category. When DOE finally made the report available with a brief news release in 1991, the large, highly significant decrease in mortality from "All Causes" was explained away as a "healthy worker effect". This duplicitous explanation was recently repeated in DOE's comments on the June 30, 2000 GAO Report on this subject, even though this has been documented and acknowledged many times as a misrepresentation, including by UNSCEAR 1994.

This study was excluded by the BEIR V Committee, by the DOE-funded IARC "study of nuclear workers in three countries" (Cardis 1995), and today in the on-going IARC "study of 600,000 nuclear workers."

The Committee makes a few fleeting references on **genetic effects of radiation**. It would have been forthright to confirm, at least, the long-standing conclusion that no heritable genetic effects are observed in several generations of irradiated humans; nor in massive animal studies at doses below 250 mGy. In view of the public fear of the possibility of creating mutant off-spring, exemplified by an estimated 100,000 "preventive" abortions after Chernobyl, the Committee inappropriately leaves such answered questions unanswered.

The Committee misrepresents volumes of data, especially by using high-dose data to project effects to zero dose, and using figures that substantially conceal low dose data. The Committee has figures and tables with multiple data sources that exclude highly significant studies. E.g., for lung cancer, Section 9.3.5 (p.166) does not include the well-known analysis of studies by Harald Rossi and Marco Zaider in their 1997 comprehensive assessment of lung cancer caused by external radiation. (Their "Figure 1" is to the right.)

Rossi and Zaider state: "A critical review of the literature leads to the conclusion that at the radiation doses generally of concern in radiation protection (< 2 Gy), protracted exposure to low linear energy transfer (LET) radiation (x- or gamma-rays) does not appear to cause lung cancer. There is, in fact, indication of a reduction of the natural incidence."

In addition to selective inclusion of data, and misrepresentation of data, the Committee also suppresses voluminous LDR dose-response data from biology and medicine. Animal and human studies consistently show bio-positive responses to LDR, with lower cancer and disease rates, and successful treatment of some established cancers and other diseases. LDR effectiveness in clinical medicine has shown significant results in combating inflammations and infection. The Committee acknowledges these in its statement (p.124-125): "...where the mean survival time of lightly irradiated animals has significantly exceeded that of the controls, the differences have generally been attributable to radiation-induced reduction in the rate of mortality from intercurrent infectious diseases..."

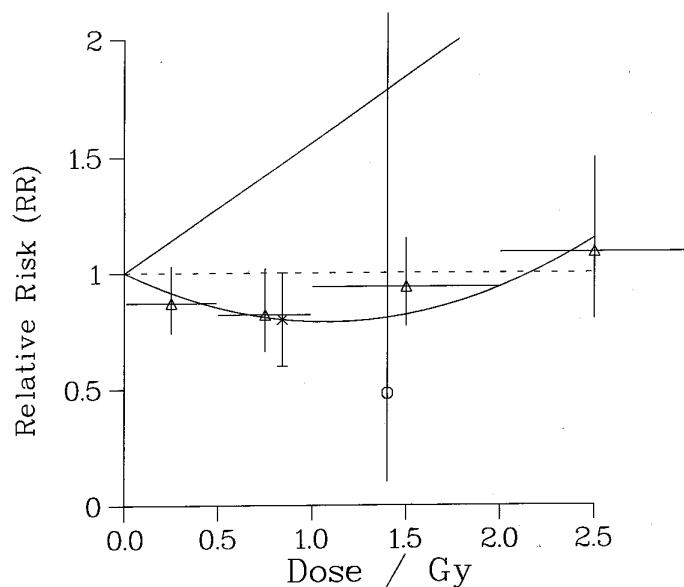
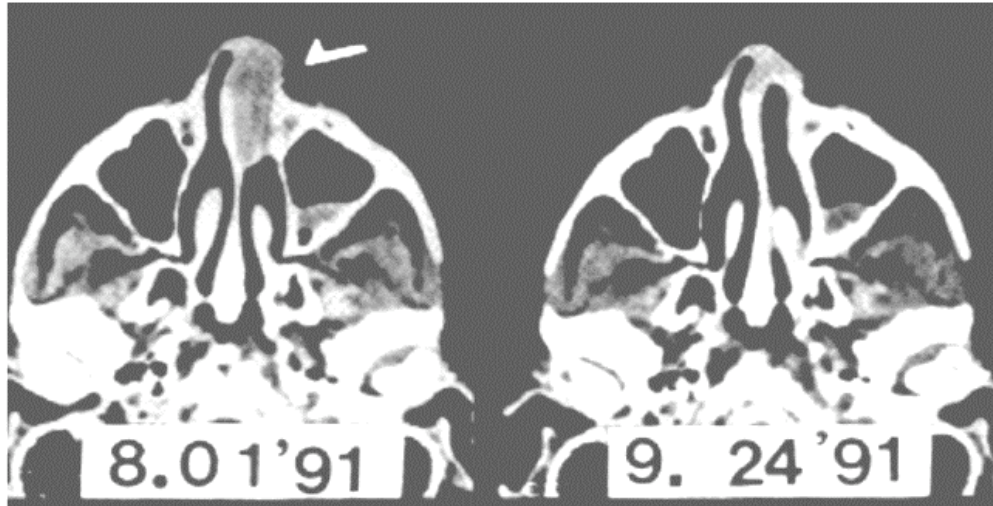


Fig.1 The relative risk of lung cancer following exposure to low-linear energy transfer (LET) radiation:  $\Delta$  (Howe 1995);  $\times$  (Davis et al 1989);  $\circ$  (Neuguit et al. 1993). Howe data horizontal bars indicate the dose bins he used. Neuguit et al data are the relative risk in the contralateral lung 10 years or more after diagnosis of breast cancer; it is shown at the average of the two doses reported for this tissue. The 95% confidence intervals, indicated by vertical bars, were taken from the original publications; for the data point from Neuguit et al., the confidence interval was estimated by us. The straight line of positive slope is:  $RR=1+0.56D/Gy$  recommended by ICRP [1991]. The curve represents the expression, Eq(1). [Not shown. From Rossi and Zaider 1997.]

This same immune system also controls cancer. This is shown by hundreds of studies, and current anti-cancer research.

ONEEXAMPLE, from a study of 24 patients with non-Hodgkin's lymphoma, is shown in the Figure to the right (from Takai, 1992).

LDR stimulation of the immune system by "half-body" X-ray (by 2 or 3 exposures / week, of 150 or 100 mGy, for 5 weeks, for 1.5 Gy total exposure) was sufficient to eliminate this nasal tumor at the base of the skull. These CT images were



CT scan of upper nasal cavity before and after half-body radiation (HBI). Nasal tumor, though completely outside the HBI field, disappeared after HBI

obtained one week before and one week after the LDR series. Blood tests and tumor tissue examinations confirmed the role of the enhanced immune system in destroying the tumor. These studies, and much more data on immune system stimulation by LDR, was provided to the Committee. They chose to ignore, and thereby misrepresent, the data.

The suppression of the relevant data by this Committee, and its predecessors, on behalf of extreme radiation protection standards, regulatory agencies, and funding, inhibits serious research and applications that could have prevented millions of unnecessary early deaths from cancer and other diseases. The Committee stated the significance of its conclusions as follows (p.205): "Although it is widely acknowledged that adaptive responses may underlie some of the observed [data]...there is no firm evidence thus far that such responses can be expected to operate effectively enough to protect completely against the mutagenic and carcinogenic effects of low-level radiation. Thus, in spite of some suggestions to the contrary... the data are generally interpreted not to exclude the linear non-threshold model and thus to provide insufficient grounds for rejecting the linear non-threshold dose-response model as a basis for assessing the risks of low-level ionizing radiation in radiation protection (ACRP, 1996; NRPB, 1995; UNSCEAR, 1994)."

To achieve even this weak conclusion, the Committee had to select biased data, and cite for support their kindred policy bodies whose reports are similarly biased, rather than substantial scientific sources.

This report, constructed by NCRP, a full member of the tight-knit North America-Europe radiation protection 'family,' evokes the words of Army prosecutor Joseph N. Welsh at a hearing of Senator Joseph McCarthy's Committee for the Investigation of Un-American Activities:

**"Have you no sense of decency, Sir, at long last? Have you no sense of decency?"**