

A Critical History of the Regulation of Nuclear Power

1. Establishing the Idea of Standards

In 1865, as Americans returned from the bloody Civil War, they were anxious to try out the emerging array of new industrial technologies, unhampered by the traditions and bureaucracies of “the old country.” A new sense of unlimited possibilities filled the air, as Americans hastened to test out their Constitutionally-guaranteed freedom to pursue happiness and “make an honest dollar” in the process.

On April 27, 1865, the Mississippi River Steamboat *Sultana* showed how far this situation could be pushed. During the 1850s, boiler explosions had been occurring every few days, with increasing loss of life. Insurance companies were beginning to work with boiler manufacturers to ensure that better design and inspection would be available, as larger boilers were made. The two-year old *Sultana* had the latest safety equipment, including a safety relief valve set to open at 150 pounds per square inch.

But there were few limits, and these would be tested. The ship’s stated capacity was 376 passengers, but the captain loaded 2300 soldiers aboard at Vicksburg, a 500% over-load. One boiler was visibly bulging and leaking. The captain was short of funds, so rather than waiting several days for a replacement boiler, he riveted an inadequate patch over the weak spot and took off, top-heavy and over-loaded. When the explosion inevitably came, it cost 1500 to 1900 lives – worse than the *Titanic*.

Other horrendous explosions followed in rapid order, leading to a series of corrective actions:

1866: Hartford Steam Boiler Inspection & Insurance Company founded.

1871: Unified body of marine safety laws developed

1871: Steamboat Inspection Service created

1874: Maritime safety laws revised for vessels driven by steam

1879: Hartford began supervising construction & installation of boilers, and produced “Uniform Steam Boiler Specifications” for all states to adopt

2. A Century of Regulated Technological Development Followed

A dazzling series of unforeseen, and unforeseeable, technological developments followed. Automobiles, airplanes, computers, the pharmaceutical industry, the Internet, cell phones, spy satellites...the list is endless. Altruistic engineers devoted significant volunteer effort to improve safety, to serve on code committees, prepare model state laws, and work in many ways to nurture and support this unprecedented process. All in all, it was quite effective for about a hundred years.

After World War II, the dream of using the atom to generate electricity became a reality. Into this orderly world galloped the nuclear regulators, shooting out the lights, frightening the ladies, and demanding that, from that time on, minimizing our radiation

dose should be our primary concern, eclipsing all others. No justification was presented for making this unprecedented demand.

3. Interacting and Competing Forces in the Nuclear Community

Nuclear power brought with it a complex and troubled background. There were reactor laboratories vs. bomb designers. Scientists vs. engineers. Academic people vs. commercial people. Those who worked only with ideas, vs. those who built hardware. Those who developed questions vs. those interested primarily in answers.

In that nuclear world, the simple, natural process of promoting one's product and urging its widespread use was turned upside down. Fear of The Bomb and mistrust of the Government after Viet Nam led to a turbulent, litigious society. Raucous public participation in the government's decision-making became popular. In this volatile situation, nuclear advocates and regulators gratuitously issued wildly exaggerated stories of the dangers of radiation and nuclear power, and urged the public to fear it.

One of the very first decisions of the new U.S. Atomic Energy Commission in 1947 was that steps should be taken to curb the "unwarranted public enthusiasm for nuclear power." Thirty years later, the U.S. Department of Energy (DOE) was formed, its regulatory responsibilities transferred to the Nuclear Regulatory Commission so that DOE was then empowered to promote nuclear energy relieved of any need to appear neutral. In 1982, the U.S. Nuclear Regulatory Commission hired the Sandia atomic bomb laboratory to prepare a table, listing each of the 130 nuclear plants then built or planned, and calculate deaths, cancer cases and dollars damage for the "maximum accident" (defined for that study as a situation physically impossible to achieve). Each of these cases computed a *hypothetical death toll of up to hundreds of thousands of deaths*. This study and the associated publicity were gratuitous, not in response to any public demand, and timed to hit the Sunday news editions for maximum impact.

See table at: <http://www.ccnr.org/crac.html>

In 2003, when a group of professors associated with the Woodrow Wilson School of Public and International Affairs presented a study that claimed to show that a spent-fuel accident could kill 518,000 people, the nuclear community's response to media queries was, "That is a highly improbable scenario," meaning that we don't expect to kill half-a-million people very often. That is not an effective response.

In trying to understand this behavior, one could argue that being in a position to control such a fearsome force might result in higher pay and prestige than a more pedestrian job. But we don't see aviation controllers telling scary stories about the dangers of flying, and urging people to ride railroads. The problem seems to be unique to nuclear technology. Jane Fonda did not invent the China Syndrome; the nuclear community itself dreamed up the idea. In 1979, when the Three Mile Island plant melted 10 or 20 tons of its reactor core and initiated that dreaded process in the real world, the colder reactor vessel froze the molten core before it could proceed more than a centimeter or so on its trip to China.

From its beginning, nuclear technology has been cursed with a fear-mongering policy of demonization. It started with a need to convince the Japanese immediately after Hiroshima that atomic weaponry was destructive beyond precedent or imagination; that no Army composed of mere mortals could defeat the forces that bind the universe together. That theme was also the threat behind the Cold War policy of Mutually Assured Destruction. When the popular author, John McPhee, wrote *The Curve of Binding Energy* in 1973, he quoted nuclear bomb-makers saying casually, "I think we have to live with the expectation that once every four or five years a nuclear explosion will take place...I can imagine a rash of these things happening. I can imagine—in the worst situation—hundreds of [nuclear] explosions a year."

Looking to bomb-makers as the voice of nuclear reactor safety gives a distorted picture, and the opera, *Dr. Atomic*, carried that bias to the limit. When I and my contemporaries were choosing careers, physics was considered a pure and almost holy world, beholden only to the Platonic laws of the universe. The Bomb changed all that. Physicists were now the creators, and thus the stewards, of this terrible beast, and they could help to harness it, or they could threaten to run off and study butterflies, as some did. But they were no longer free to plead ignorance. And further examination showed glimpses of possible cancer cures, elimination of food poisoning, and whole new worlds of medical research and therapy, in addition to a clean and abundant energy source of virtually limitless availability. Yet we chose to tell people to fear it.

The causes of this fear-mongering are many. The military incentive to describe their weapons in fearful tones is clear and valid. The motivations of civilian atomic scientists are less obvious, but are long-standing and widespread. Many scientists are paid, like doctors and lawyers, to work on problems, not to solve them. When the problem is solved, the money stops. This situation gives such scientists a strong incentive to discover problems, and to characterize the problems as difficult, dangerous and mysterious.

Nuclear pioneer Alvin Weinberg, long-time director of Oak Ridge National Lab, had an additional incentive. Starting in 1973, he repeatedly characterized nuclear technology as a "Faustian Bargain," meaning that it was a gift of great value to humanity, but with the Devil to pay if we slip up. Near the end of his life, I visited Weinberg in Oak Ridge and he urged me to continue using the term, in order to spur nuclear workers to maintain the extraordinary level of technical excellence that has been so important to the field.

I told him I believe the term has done great harm; that excellence should be sold on its own merits; that the Satanic myth implies (intentionally or not) that several hundred years of engineering experience with "ordinary machinery" will never be quite good enough for nuclear work. This would lead to improvising untested solutions, without drawing on the very type of engineering experience most needed. Adding unnecessary "safety features" to protect against hypothesized events that can be shown to be physically unachievable, does not make a plant safer, just more complicated, more expensive, and prone to avoidable accidents.

This safety philosophy is enshrined in the Price-Anderson Act, based on the dubious premise that a nuclear power casualty (not a bomb) could overwhelm the financial resources of the world's insurance companies. This unique law is cited in other kinds of insurance policies—automobile, house, business, etc.—noting that those policies do not cover a nuclear reactor disaster. Ironically, the insurance industry knows from its own statistics, based on nearly three generations of human experience, that the nuclear industry is one of the safest – safer than many clerical jobs..

This progressive tightening of nuclear rules, instead of the normal loosening with increased experience, brought an immediate protest from the most senior radiation specialists. It gave the impression that we were repeatedly discovering that we hadn't been safe enough. (What else were people to think?) The legendary Lauriston S. Taylor, who headed the formation of the first international X-ray protection organization wrote in 1960:

No one has been identifiably injured by radiation while working within the first numerical standards set first by the NCRP and then the ICRP in 1934.... [NCRP chose 0.1 r/day on Mar. 17, 1934; ICRP chose 0.2 r/day in July 1934-- 35 times greater than the present recommendations.] Let us stop arguing about the people who are being injured by exposures to radiation at the levels far below those where any effects can be found. The fact is, the effects are not found despite over 40 years [now nearly 100] of trying to find them. The theories about people being injured have still not led to the demonstration of injury and, if considered as facts by some, must only be looked upon as figments of the imagination. (*Health Physics*, 39 851-874)

Rosalyn Yalow, Nobel Laureate in Medicine, asserted:

No reproducible evidence exists of harmful effects from increases in background radiation three to ten times the usual levels. There is no increase in leukemia or other cancers among American participants in **nuclear testing**, no increase in leukemia or thyroid cancer among **medical patients** receiving I-131 for diagnosis or treatment of hyperthyroidism, and no increase in lung cancer among non-smokers exposed to **increased radon** in the home.

The association of radiation with the atomic bomb and with excessive regulatory and health physics ALARA practices [As Low As Reasonably Achievable] has created a climate of fear about the dangers of radiation at any level. However there is **no evidence that radiation exposures at the levels equivalent to medical usage are harmful.** (*Mayo Clinic Proc* 69:436-440, 1994)

Hugh F. Henry at Oak Ridge summarized the low dose data in the *Journal of the American Medical Association*:

A significant and growing amount of experimental information indicates that the overall effects of chronic exposure (at low levels) are not harmful...The preponderance of data better supports the hypothesis that low chronic exposures result in an increased longevity... Increased vitality at low exposures to materials that are markedly toxic at high exposures is a well-recognized phenomenon. (*JAMA*176, 27 May 1961)

The fact that low-dose radiation is harmless and often beneficial is not a new or minority opinion. The proto-scientist Paracelsus said in 1540, “Nothing is poison but the dose makes it so.” Within a few months after Roentgen’s discovery of x-rays, reports began appearing in scientific journals on the use of x-rays to cure infection. It was recognized even then that the radiation was not strong enough to kill the bacteria directly, and that its effectiveness must result from stimulation of the immune system. This phenomenon—toxicity at high levels and stimulation of healing at low levels—is a nearly-universal biological process, called *hormesis*. Low dose radiation consistently shows that it acts to reduce subsequent cancer incidence. Calabrese and Baldwin report (*Nature* 421, 691, 2003) “thousands of studies demonstrating hormesis...we see it across the whole plant and animal kingdom... and at essentially every endpoint...*the hormetic model is not an exception to the rule—it is the rule.*”

Even after the unprecedented series of blunders at Fukushima, it remains an uncontested fact that no person, not a single one, received a lasting injury from radiation there. This includes the heroic operators who brought the plants under control, in the dark, and sometimes in contaminated water, while being told they were a “suicide squad,” doomed to die painfully from cancer. The fact is, that irradiation, in the applicable dose range, *decreases* the probability of subsequent cancer. But the media were all too willing to spread fear, and many officials, scientists and others who knew better also irresponsibly added to the panic.

On January 11, 2001, U.S. Energy Secretary Bill Richardson announced proposed changes to legislation to enable “compensating thousands of current and former workers in nuclear weapons-related activities...whose service to the country left them sick or dying.” He said a recent study, based on previously discredited reports, showed that that death toll was large, and that previous government officials were aware of this situation but had covered it up. A preliminary list of locations where workers might have been affected named 317 sites in 37 states, DC, Puerto Rico and the Marshall Islands. The Energy Department sent out personnel to these sites, visiting retirement homes to ask residents if they were suffering any illnesses that might have been caused by radiation exposure decades earlier. I knew there was no scientific basis for any charge that nuclear workers were being harmed by their occupational exposure. I wrote the Secretary’s office and asked for a copy of this “new report.” There was no such report. I received copies of the various “discredited reports.” I was familiar with them. They are scientifically indefensible. The Assistant Secretary assured me this was only the beginning of the study, and “robust public discussion” would follow. It did not. With the change of administration, Richardson was replaced and immediately made a trustee of the anti-nuclear Natural Resources Defense Council.

In response to repeated news stories, the U.S. Congress held hearings and issued a statement:

“It is the Sense of Congress that—

(1) Since World War II Federal nuclear activities have been explicitly recognized by the U.S. Government as an ultra-hazardous activity...involved unique dangers, including potential

catastrophic nuclear accidents that private insurance carriers would not cover...

(2)...large numbers of nuclear weapons workers...were put at risk without their knowledge or consent...

(5) Over the past 20 years more than two dozen scientific findings have emerged that certain Department of Energy workers are experiencing increased risk of dying from cancer and non-malignant diseases at numerous facilities...

(6) ...Furthermore, studies indicate that 98% of radiation induced cancers within the Department of Energy complex occur at dose levels below existing maximum safe thresholds.

Each of these alleged facts is either demonstrably false or inherently unsupportable.

Radiation protection policy and procedures declare that “human made” radiation is ten or one hundred times more harmful than “natural,” though neither instruments nor the human body can detect any difference.¹ This curious policy creates situations like lawsuits against oil companies for contaminating the ground with dirt by bringing up more naturally-radioactive dirt in drilling for oil. Yucca Mountain carries this curse to the extreme, ending up with radiation requirements that can’t possibly be demonstrated (or justified), leading to a multi-billion-dollar hole in the ground that must be guaranteed flawless for a million years—for material that will reach background radiation level in a few centuries.

Through all of this, the National Academies, professional societies, and various regulatory groups issued vague and contradictory statements and then refused to clarify their positions.

On 10 December 2012, World Nuclear News (WNN) issued the following News Bulletin:

The United Nations is to adopt advice on radiation that clarifies what can be said about its health effects on individuals and large populations. A preliminary report has also found no observable health effects from last year’s nuclear accident in Fukushima... Having been officially approved by the UN General Assembly, the reports, as well as a resolution welcoming them, will be endorsed in coming weeks. They will then serve to inform all countries of the world when setting their own national radiation safety policies.... This is in line with studies already published by the World Health Organization and Tokyo University that showed people near the damaged power plant received such low doses of radiation that no discernible health effect could be expected.

¹ The complexity of carrying out such a distinction was discussed in a four-day Health Physics Society Professional Development School, whose content is published in a 550-page book, *Naturally Occurring Radioactive Materials (NORM) and Technologically Enhanced NORM (TENORM)* by PA Karam and BJ Vetter (Eds.), Available through Medical Physics Publishing Co. (2009) at www.medicalphysics.org

A WNN News Bulletin dated 28 August 2012, quoted Malcolm Grimston, an honorary senior research fellow at Imperial College, saying

If we took a 'do more good than harm' approach, I suspect we would abandon forced evacuation altogether.

After all the shilly-shallying around on this subject, we should make the most of this authoritative proclamation by the international regulators. Americans are still paying people hard cash to reduce their collective dose, a quantity with no physical meaning whatsoever. This practice has no demonstrable health benefits.

The BP Gulf of Mexico oil spill in 2011, following the 2006 Prudhoe Bay oil spill in Alaska, contrasted dramatically with the virtually flawless operation of hundreds of nuclear submarines for nearly half a century. Investigators of the oil spill asked Dr. Zack Pate, Director-Emeritus of the nuclear industry's Institute of Nuclear Power Operators (INPO) and the World Association of Nuclear Operators (WANO), what they might learn from the nuclear industry. Although many people had developed mathematical formulas for defining quality control criteria, Pate testified that what was needed was not a magic formula but simply the determination to ensure that facts, rather than hopes or wishes, were tirelessly tracked down and used to determine actions. It was not complicated, just a lot more work than most people are willing to devote to the task, year in and year out. The nuclear industry has shown that such diligence pays off in unprecedented reliability and safety.

So, where does this bring us? Now that we are assured that radiation from nuclear power presents no public hazard, we have some mail to answer. The New York Academy of Sciences (NYAS), one of the oldest and most prestigious scientific organizations in the world, issued a report in 2009 on the reactor that destroyed itself in 1986 in Chernobyl in the Soviet Ukraine. The consequences of that event have been studied more than any other industrial accident. The reactor was a special design, inherently unstable, built to produce plutonium for Soviet weapons, no longer being produced. There is nearly unanimous scientific consensus that the health consequences of the accident on the public were small.

The authors of the NYAS report decided that the health consequences of the accident *must be* devastating, and that the procedures and criteria of traditional science were simply inadequate to evaluate such an unprecedented event. So, aided by Greenpeace International, they collected anecdotes, gossip and rumors, building up to the conclusion that nearly a million people had already died from the radiation by 2004, and that the death and injury toll would continue to increase throughout the Northern Hemisphere for centuries to come. *The report, in fact, stands as an exemplar for why an industrial society has to replace folk medicine with modern science.*

The authors acknowledge that the international scientific community disagrees with them, and they attribute this disagreement to an unsupported premise that the scientific community has sold out to an allegedly corrupt nuclear industry. So we are left with an unanswered charge that we are covering up a dangerous radiation situation. For nearly three years I have worked privately with NYAS, of which I am a member, trying to

protect the reputation of that organization and its distinguished members. In a feeling of misguided fellowship, no scientific organization has challenged NYAS. They say, “we don’t tell others how to run their organization.” So, recently I mailed a copy of the report to the ANS, asking for a comment on its grave charge. I assumed ANS had to answer its mail. Failing to respond to a question of scientific opinion would seem to me to be failing to “do science,” a case of malfeasance of duty. We’ll see what happens.

As a minimum, ANS could reply to NYAS that it agrees with NYAS that the scientific method does not support the conclusion that a large number of casualties resulted from the Chernobyl meltdown. Therefore, ANS concludes that the NYAS report is, on its own terms, not a scientific report, and suggests that NYAS say that, after careful study, it has decided to withdraw its imprimatur.

4. The Meaning of “Conservative” or “Prudent”

A common source of argument between scientists and engineers finds the scientist complaining “I’m just trying to be conservative,” and the engineer replying “when you pile up too many safety factors, you’re no longer conservative, you’re just plain wrong.” Heisenberg, Weinberg, Teller were famously guilty of that practice. Dr. Nils J. Diaz, who was Nuclear Regulatory Chairman during many of the critical early days of the Rickover era, saw this problem clearly, and urged that safety factors be withheld during the calculation of safety problems and be used only at the end, clearly identified as such.

The history of radiation protection is replete with examples where the ostensibly conservative practice of assuming that radiation might be a bit more dangerous than we expect turns out to be harmful in practice, rather than protective. For example, a new well was recently discovered in Arabia, springing from deep underground. It was clean and plentiful, but (gasp!) radioactive. So it was immediately decided that it must be diluted with water that is less radioactive, but unfortunately suspect bacteriologically.

I can picture a Mighty Voice proclaiming from the Heavens, “Who dares to call unclean that which the Lord God hath provided?”

Apparently some radiation protectors feel they’ve done their job if they can assure that we die of something else. Anything other than radiation. Why is that considered a desirable goal? Particularly since we know that within the applicable radiation dose range, further irradiation is most likely to be beneficial rather than harmful, *decreasing* the probability of subsequent cancer.

There are now a number of well-documented studies showing that unnecessary evacuations actually killed people in large numbers in both Chernobyl and Fukushima.

Marianna Hasegawa posted the following about Chernobyl's self-settlers, the babushkas-grandmothers:

"Those who left are worse off now. They are all dying of sadness...According to reports by the United Nations Development Programme and the United Nations Children’s Fund, many of those who were relocated after the accident now suffer from

anxiety, depression and disrupted social networks, the traumas of displaced people everywhere. And these conditions seem to have health effects as real as those caused by radiation. The journalist Alexander Anisimov, who spent his career studying the self-settler community, claimed that the women who returned to their ancestral homes in the zone *outlived those who left by a decade.*"

<http://www.telegraph.co.uk/earth/environment/9646437/The-women-living-in-Chernobyls-toxic-wasteland.html>

Orders to minimize collective dose led to leaving the reactor vessel of the Davis-Besse power plant unexamined while boric acid was corroding through the head. Incentives that lead to such situations are not protective or conservative.

5. Nuclear Weapons as Threat to, or Protector of, World Peace

Many people ask: Isn't the very existence of nuclear weapons a threat to world peace? Wouldn't we all breathe easier if they were eliminated? We can speculate philosophically on that question, but there is a historical record that is relevant. The Pulitzer-winning historian, Richard Rhodes, wrote me (private correspondence):

No question that the advent of nuclear weapons basically eliminated major war by making it suicidal. If you graph manmade deaths from war from the 18th century through the 20th, they increase almost exponentially to 1943, when they peak at 15 million (including the deaths of the Holocaust). In 1945 they drop to about 1-2 million/year, and stay there forward. A physicist would call that change a singularity. And though the role of nuclear weapons in the change has been disputed, I think they're pretty obviously the main cause.

In the Fall 2012 issue of *The Submarine Review*, Vice Admiral Michael Connor, USN, Commander of Submarine Forces, wrote the following about the role of nuclear weapons in deterring major power warfare:

So let's talk about the good old days – before those nasty nuclear weapons came on the scene. On average – during the 400 or so years prior to nuclear weapons, major power war killed about 1% of the population –the world population – every year! In a bad year, that number approached about 3%....In a typical year, about 70 MILLION people might die in wars that could no longer be effectively deterred. In a bad year, that number would push 200 MILLION.

VADM Connor was not debating, he was describing U.S. defense policy.

6. The Strange Story of Radon

In the environmental movement of the early 1970s, the Environmental Protection Agency was formed to stop Technological Man from bulldozing the Garden of Eden. As the 1980s dawned, some scientists began to point out that in its zeal to eliminate all traces of radioactivity, EPA was now requiring nuclear power plants, nuclear medical facilities and industries using radiation, to monitor, control, and reduce radiation levels

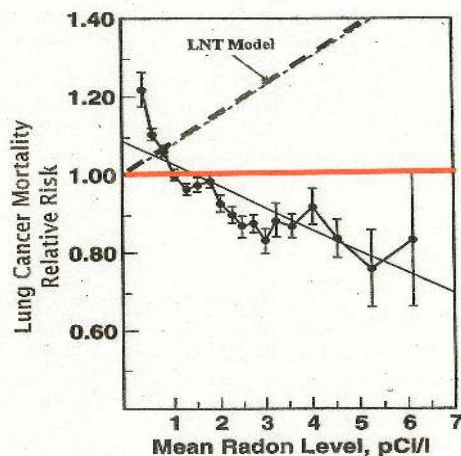
below the natural background radiation people were exposed to in their own homes from radon, a natural decay product of uranium. EPA managed to ignore this inconsistency for over a decade, but when forced to face it, it performed a remarkable turnabout: *Instead of admitting that its radiation protection standards were unrealistic, it announced it would regulate Nature.* The environment, so poignantly portrayed as the innocent victim, was now to be seen as a merciless, silent killer.

The first impact of this change in strategy was to extend EPA's empire from control over a handful of corporations to the entire world. *Thousands of radon detectors were issued to school-children, who were told to measure the extent of the threat and to pressure their parents to do something about it.* EPA contracted the National Research Council to set up a committee. On February 19, 1998, the committee announced in report BEIR-VI that radon in homes causes 15,400 to 21,800 deaths each year in America. Scientists with impressive credentials spoke convincingly of their confidence in this conclusion, despite the fact that no evidence has ever directly demonstrated that radon in homes is harmful. The report noted that about 90% of the deaths attributed to radon occurred in smokers, and *"most of the radon-related deaths among smokers would not have occurred if the victims had not smoked."*

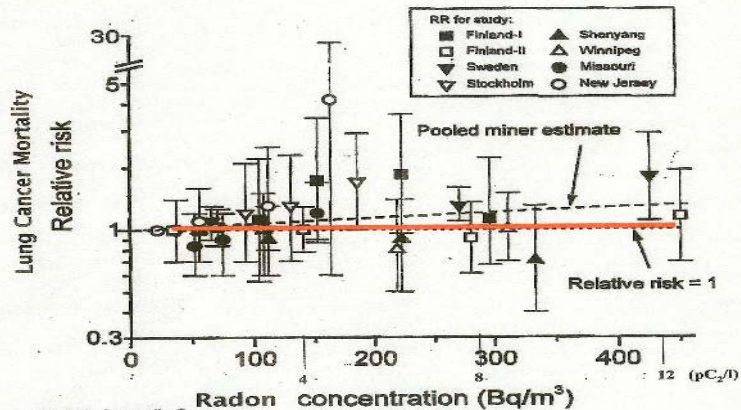
In the mid 1980s EPA began issuing pamphlets warning against the "colorless, odorless killer" and running TV ads showing a typical American family sitting happily in their living-room while a dire warning is intoned against funereal background music. The skit ends as the parents, then the children, and finally the dog turn to skeletons. *The predicted annual death rate from radon was said to equal the death rate from automobile accidents.*

There is a great deal of good data on radium and radon in homes. The most extensive and the most thoroughly analyzed is a series of measurements and calculations by the late Dr. Bernard L. Cohen, Professor Emeritus of Physics, University of Pittsburgh. Prof. Cohen supervised the measurement of radon levels in about 350,000 American homes and compared the radon levels, county by county, with the lung cancer mortality in each county (since lung cancer is the only potential health effect that radon might cause). Cohen surveyed nearly 2000 counties housing more than 90% of the U.S. population and therefore has excellent statistical precision. *He found exactly the opposite of what he and the EPA expected.* He found that the counties with the highest radon levels had the *lowest* lung cancer mortality and those with the lowest radon had the *highest* lung cancer. He then turned off his radon-removal system.

Cohen's Data on radon in homes.
Higher radon levels tied to lower
cancer incidence.



BEIR-6 data, which is claimed to show an LNT relationship.



Since he was dealing with *average* radon levels and *average* cancer mortality figures, rather than with individuals, Cohen was well aware that other confounding factors might be causing this relationship. “It’s legitimate to raise generic questions about ecological studies. But when those question have been answered for this particular set of data, then it is no longer legitimate to keep dismissing this evidence solely on the basis of the generic questions. You can always question how precisely we can correct for various factors, but *the discrepancy between these data and the LNT is so large that I cannot imagine how one could explain it away.*”

At that point, EPA commissioned from the National Research Council, a report on radon, BEIR-VI. *The body of this one-inch-thick report contains virtually no discussion of Cohen’s and others’ work with people living above ground in the kinds of situations to which EPA’s regulations apply.* Appendix G, the last in the book, dismisses the matter as follows:

“Because of the inability to control for confounding...the Committee believes that ecological studies of indoor radon exposure and lung cancer are essentially non-informative and shed little light on the association of indoor radon-progeny exposure and lung cancer...There was a strong negative association between 1970-1979 lung-cancer mortality and the county-average radon concentrations; *this association could not be explained by confounding. In interpreting this finding, Cohen proposes that the negative association implies failure of the linear non-threshold theory for carcinogenesis from inhaled radon products.*”

With this simple statement, the report gives no further consideration of Cohen’s conclusion, or of this vast body of data and ten years of analysis.

Cohen’s work has been replicated by others. For example, Dr. Gary Sandquist and others (1997) took EPA’s radon data and cancer data from the American Cancer Society and showed the same relationship that Cohen’s work shows. They found that average radon doses vary from state to state by an order of magnitude, and that the *cancer rate in the lowest radon states was nearly four times that “predicted” by the LNT model, whereas the cancer rate in the high-radon states was only one-seventh of the LNT prediction.*

An interesting *contrast to the hypothetical speculations of the EPA* and its contractors is given by the data on **radioactive health spas** that people have visited since ancient times. Radium and radon levels in the air and in the “healing waters” are monitored and proudly advertised by many of these facilities. At some healing spas in central Europe *people drink and bathe in water with radon concentrations one million times higher than EPA’s recommended upper limit*. Visitors spend hours a day on repeated visits under the care of in-house physicians, and workers at the facilities are exposed to it for years. Austrian and German government health insurance recognizes these spas as legitimate health treatment, and pay 90% of all costs incurred by patients visiting such spas. Austrian spas cannot officially qualify as healthfully radioactive waters unless they maintain at least 30 times the EPA limit. EPA claims its radon limit poses one chance in 10,000 of getting lung cancer, which means that the Hungarian spa poses a 100% risk of lung cancer (one million divided by ten thousand). **Many of these facilities keep detailed records** of the names and health conditions of each person using the springs, along with radium and radon concentrations..

Some sources of data on health benefits from radon exposure are discussed at: www.radscihealth.org/rsh/docs/Radon/RnTherapiesIndex.htm

Cohen’s radon papers, criticisms, rebuttals are available at: www.phyast.pitt.edu/~blc/

The latest, and probably definitive, work on the subject is the 181-page report *Human Lung Cancer Risks from Radon* by Bobby Leonard. In this report, Dr. Leonard documents and summarizes a great deal of work that he and others have done on every aspect of the radon/lung cancer connection over the decades. In colored charts and graphs, he shows the many variables that can affect the risk of cancer from exposure to radon and its co-products. What is so remarkable is that he shows that an extremely small amount of energy per traversal is sufficient to trigger the protective mechanism.

After studying almost every variable and combination of variables, Dr. Leonard reached some important conclusions:

In no case can the LNT premise, or any other linear expression, properly describe the dose-response relationship.

The application of data from miners is generally not capable of properly describing the situation of people in houses or other above-ground buildings.

The role of smoking has generally been underestimated.

The role of previous irradiation from medical, natural or other sources has been underestimated.

The BEIR-VI claim that the number of deaths from radon in homes and offices is comparable to the number of traffic deaths is grossly overstated.

It is interesting that Leonard shows that *the beta rays* from the radon progeny deposited in the lungs should produce the low-LET charged particle lung cell traversals, and activate the adaptive response (AR). Hence, as shown by Cohen, increased radon exposure increases protection, and radon in homes and offices causes few if any cancers.

This informative report is published by International Academy of Hi-Tech Services, Inc, 1007 Rosslare Ct., Arnold, MD 21012 and can be ordered from the publisher or though amazon.com or other services

8. The Great LNT Folly (“Linear, No Threshold”)

Those who wanted to ensure that there was always an unsolved radiation problem to work on had one last gambit: one could never prove that the tiniest amount of radiation was completely harmless. If radiation’s harm were proportional to the dose, then there was always that last little bit to worry about. This is the LNT Doctrine: that the damage from radiation is linearly proportional to the radiation dose, all the way down to zero dose, i.e., without a threshold.

There has never been any convincing evidence for such a relationship. In fact, as James Muckerheide’s report documents, “There Has Never Been a Time When the Benefits of Low Dose Ionizing Radiation Were Not Known.” It might seem to be conservative to assume that radiation could be more harmful than we believe, but as we have seen, in practice such a premise proves to be harmful rather than protective.

The latest scientific evidence for the beneficial effects of radiation was presented at the June 2012 Annual Conference of the American Nuclear Society in Chicago at the President’s Special Plenary: http://www.new.ans.org/store/i_690089

This is arguably the best scientific report the ANS has published in years. Of course, it doesn’t represent the official position of the Society; such reports seldom do. But it contains the latest and best data, and readers can judge it for themselves.

9. The Relevance of Studies on A-Bomb Survivors

The Japanese-American Radiation Effects Research Foundation (RERF) at: http://www.rerf.jp/index_e.html has been studying the effects of radiation from the Hiroshima and Nagasaki A-Bomb explosions on survivors since 1950. RERF offers its analyses of the A-bomb survivors as “The Gold Standard” by which all other irradiated populations will be judged, from nuclear submarine crews, to nuclear power plant operators, to families in homes with radon. With all the radiation data available on those populations just named, why should one rely on data from a wholly different exposure experience (“instantaneous” bomb exposure vs. slow or chronic, exposure; neutrons vs. no neutrons, etc.) and on a demographically different population (Japanese at war, vs western peace-time populations, etc.) and a war-torn, unmonitored population vs. peaceful civilians with carefully controlled individual radiation monitors.

Radiation pioneer, Myron Pollycove, MD, did an analysis of the RERF report on Mortality of Atomic Bomb Survivors, 1950-1990. He notes (unpublished report):

The authors did not present the usual statistical analysis of this data even though, “the question of ‘the lowest dose at which there is a statistically significant excess risk’ is of interest to some”. This analysis of the data was omitted “Because of the tendency for the failure to find a significant effect to be equated to ‘no effect,’ this does not reflect a very cogent approach to inference about low-dose risks.”

Most readers, however, are interested in knowing the lowest dose at which there is a statistically significant excess risk... The authors’ “very cogent approach” *does*

not use the observed excess solid cancer deaths, but substitutes estimated excess deaths derived from a model fit that assumes linearity.”

The RERF work also raises some other serious questions. Its “control group,” which it considers unirradiated, shows clear evidence for hormesis in the 50 and 150 mSv groups. And the report bases its conclusions not on the data itself, but on what the data would show if it had to demonstrate linearity. Even then, it does not give straightforward answers the basic question at issue: what minimum levels of radiation showed evidence of radiation damage?

But why should we depend on the RERF studies? Excellent radiation monitoring is generally done wherever humans are deliberately exposed to significant radiation doses – in medical, industrial, research, power generation, and even in natural, high-radiation situations such as aircraft crews and workers and users of radon health spas. In view of this, radiation from Hiroshima and Nagasaki has little relevance to understanding the effects of radiation in current and future peace-time civilian situations.

Of course, there is the question of exposure from a nuclear bomb attack, but that information is a separate area of study, much of it classified, that is not apt to be very helpful in understanding the radiation effects of our various current and future radiation uses.

10. Phobic Thinking About Nuclear Power

*Nothing in this life is to be feared,
it is only to be understood.
Now is the time to understand more,
so that we may fear less.
Marie Curie, radiation pioneer*

*Right from the start, this new idea of atomic weapons
was linked with a more impressive idea: the end of the world.
This was an entirely new idea: that it might be technically possible
for someone to destroy the world deliberately.
Yet the idea slipped into the public mind with suspicious ease...
The imagery of bombs and reactors did not spread by itself;
it was promoted by particular people for their own purposes
[and] came to represent what everyone “knows” – or feels – about nuclear devices.
Spencer Weart, historian of physics*

*We nuclear people have made a Faustian bargain with society...
the price we demand of society for this magical source
is both a vigilance from and longevity of our social institutions
that we are quite unaccustomed to.
Alvin M Weinberg, nuclear pioneer*

In 1980, The Media Institute published a 29-page, red-covered booklet titled “Nuclear Phobia: Phobic Thinking About Nuclear Power” now out of print. The first 24 pages contain a discussion between the Media representative and Robert L. DuPont, M.D., an expert on phobias. This is followed by an Appendix with excerpts from Mental Health Aspects of the Peaceful Uses of Atomic Energy (WHO Tech Report 151, Geneva (1957)).

Dr. DuPont was shown an aggregate of 13 hours of videotaped news broadcasts on nuclear power, from which he concluded that “the major TV networks have injected, intentionally or otherwise, further fear – irrational, phobic fear – into an already fear-inspiring subject: nuclear energy.”

What follows below are excerpts from that discussion, that explain and discuss what he means by saying that public fear of nuclear is phobic, rather than rational thinking. Although that discussion took place not long after Three Mile Island, subsequent events, including Chernobyl and Fukushima, have kept the fear alive. All the words below are excerpts from that discussion, so I will not use quotation marks.

Fear was the motif of the entire series of nuclear stories...voices of reassurance are constantly being undermined by the fear process itself...What this implies is that almost anybody who knows anything about nuclear energy has an investment in it, and therefore cannot be believed, unless, of course, he is one of that minority that says that nuclear power is as bad as you think, or worse. Only then is the expert credible. It is amazing...The debate is hinged on fear of a particular kind. I would call it nuclear phobia, or more precisely, phobic thinking about nuclear power. A phobia is fear based on an exaggerated, unrealistic danger...phobic people are generally mentally healthy people who have been sensitized to particular experiences or situations which trigger terror or panic reactions...

A phobia is a malignant disease of *what ifs*...Phobic thinking always travels down the worst possible branchings of *what ifs*, until the person is absolutely overwhelmed with the potentials for disaster...Consider for a moment the *China Syndrome*, a Hollywood film...The actual feared thing itself did not happen, yet the frightened person will come back and say “But it almost did.” That is characteristic of phobic thinking...Phobic fear, at root, is fear of fear. Fear of the panicky feeling.

The presumption on the tapes is, you either will not have cancer if you do not have radiation exposure, or you will get it if you do. This is incorrect...Finally, the tapes suggest that nuclear power is a primary source of radiation exposure. This also is incorrect.

There are two parts to the transmission process. You see people in various roles on camera who are afraid. Then you are told by some experts who are critical of nuclear power, authority figures, that *they* are afraid...And that is the key. You see authority figures who say I fear it...This authority figure says the right way to behave is to be afraid...That is not common in journalism. You just do not see a lot of stories of planes that might have crashed...Why is this news? The answer is: Fear is news because fear is interesting...The adrenalin gets flowing, our minds become more alert. It is like taking

amphetamines. Fear is an upper...The longest lines at amusement parks are always for the scariest rides...there is no question but that one gets attention with fear; there is nothing to parallel it.

If you reassure people and say there is no problem, that's like saying, "There is no news. I have nothing to say"...nobody wants to be in the position of having said the danger is exaggerated only to have disaster strike...the pessimist is never disappointed. "After all," he can always say, "disaster almost did happen..."

It is magical thinking. "They," by their expertise, have become alien from you and me...it is almost as if anybody who understands the issue of nuclear power cannot be like you and me. He cannot be credible right from the beginning...On the other hand, there is the person who says, "There is a cover-up"...That person has instant credibility...

Even the logos that the networks used for nuclear stories were often negative...the sign of the danger of radioactivity...and the hexagonal sign with an atom symbolized inside. While it lacks two sides of being the common octagonal "stop sign," it is so close in form that it is highly suggestive of the real thing. It implies that what we should do about nuclear energy now is to "STOP" it. Using that logo is like doing a show about medicine and constantly using the skull and cross bones as a logo...

I believe there is a lot more fearlessness out there than the media...leads a viewer to believe. The people who covered the news during the crisis at Three Mile Island often seemed surprised by that...I remember one woman who said, in effect, "I'm not going to leave my home when they still have people on the Island. They have workers on that island; they're letting them go there. Then why am I going to leave my home a few miles away? It doesn't make sense."

My own expectation of how the nuclear phobia will play out is that we will, as a nation, reach a point of boredom. Most phobic people get over their phobia by becoming bored stiff...We really do not solve these issues of risk; we just get bored with them...I think we will, one day, get bored with nuclear fear too.

8. Conclusion: It's still true that radiation from commercial nuclear power plants has never killed anyone. Most of us are radiation-deprived; we'd be healthier with more radiation. There is no health benefit in reducing harmless radiation doses. In the dose range of interest, radiation is essential to life and beneficial; it *decreases* the chance of subsequent cancer. The world is radioactive. Accept and enjoy it!

Personal Note:

I described these events as I experienced them. Other persons I respect experienced the same events quite differently. I have opinions as to why that difference might exist, but I will not speculate on the motivations of others. I will just say that I can only honestly report on what I saw and how I reacted to it. I fully accept and appreciate that other views exist.