

Value and ethics of LNT

By James Conca

The nuclear industry certainly values human life. All one has to do is look at Occupational Safety and Health Administration data to see that nuclear workers have the safest work environment, the lowest mortality rates, and the highest average pay of almost any industry.

Most of this is due to strict adherence to procedures and protocols that we have developed over the past 70 years, plus the fact that we understand the behavior of radiation and radioactive materials so well. None of this needs to change.

Society, however, has a skewed idea of the value of human life. We have spent upward of a trillion dollars trying to adhere to the ultra-low radiation limits foisted upon us by the linear no-threshold hypothesis, or LNT. The LNT tries to save a few theoretical lives far in the future, while not saving tens of millions of real lives now for the same amount of money. This is as much an ethical issue as it is a scientific one.

Unjustified fear of low levels of radiation (<10 rem or 0.1 Sv, acute or otherwise) was an important part of the Cold War, purposely pushed by nongovernmental organizations and countries such as the Soviet Union and China as a way to stop aboveground nuclear tests by the United States. No human

cohort has ever been found to be adversely affected by doses below 10 rem/yr, or even 10 rem acute, not even the Japanese bomb survivors. And we have tried very hard to find them.

This fear has led to some unintended consequences, such as people foregoing lifesaving diagnostic procedures and treatments, as well as an intransigence on the part of lawmakers and antinuclear groups to value nuclear energy, the best low-carbon, safest energy source we have to fight global warming.

More immediate, however, is the large amount of money and effort spent by our country, as well as others, to protect against what has never been demonstrated to be at all harmful.

This fear of radiation originated after the dropping of the atomic bombs in 1945 and was codified into regulations around 1959, when the world adopted the singularly unproven LNT hypothesis for the negative biological effects of radiation and its resultant policy, ALARA (as low as reasonably achievable).

The LNT assumes, in contrast to almost all data on living organisms, that any radiation is bad and there is no threshold of radioactivity below which there is no risk, even at Earth background radiation levels (Fig. 1). Following ALARA means that we should protect everyone from

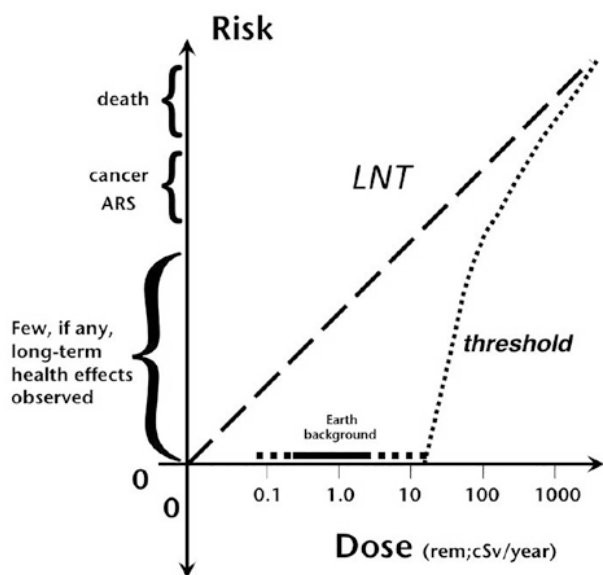


Fig. 1. The assumption of the LNT: any radiation dose, no matter how small, will cause harm. However, small doses of radiation, <10 rem(cSv)/yr, appear to be easily handled by cellular repair mechanisms that evolved as a normal adaptive response with the emergence of the eukaryotic cell 2.3 billion years ago. It would be odd indeed if the upper end of Earth background radiation (1 Sv/yr) was not near the threshold for significant radiation-induced biological effects.

all radiation, making doses as low as we possibly can, even if it costs billions of dollars. The latter point undermines the reasonableness embedded in the term ALARA.

Indeed, we spend billions each year protecting against what were once background levels. It's right out of a *Road Warrior* movie. No wonder the fear of radiation took over the worldview. Science fiction is much more fun to study than real science.

A classic example of this is the "downwinder" cohorts in Utah. It was assumed that fallout during bomb testing in the 1950s and 1960s was harmful and created a cancer epidemic in Utah. But Utah has the lowest cancer rate in the nation, and Washington County, where the fallout was the highest, has the second-lowest cancer rate in the state. These data have been summarized in Antone L. Brooks's book, *Low Dose Radiation: The History of the U.S. Department of Energy Research Program*.

Most of the fears and questions surrounding radiation have been answered very well over the intervening years, and all studies point to the need to have a reasonable threshold for radiation below which we don't have to worry about health effects, or put differently, below which all other risks far surpass that of radiation. And we don't have to spend billions protecting against a phantom menace.

Unless you are in a boat in the middle of the Pacific Ocean, you're getting a radiation dose between 200 and 1,000 mrem/yr (2 to 10 mSv/yr) in the United States, just from background sources such as rock, dirt, potato chips, and cosmic rays and the radioactive isotopes of uranium, thorium, radon, and potassium that are in them.

Some places in the world have background doses 10 times higher than that of the United States, but there have never been any observable health effects from these doses. Ever. Anywhere.

On the other hand, regulations require nuclear waste disposal systems and cleanup standards to meet release criteria of less than 4 mrem/yr (0.04 mSv/yr) to downgradient drinking water supplies even in the distant future. Moving from Seattle to Spokane will give you an extra 50 mrem/yr (0.5 mSv/yr) or more. Should we make moving to Spokane against the law? Yes, according to these regulations. No, according to common sense.

There are different types of radiation and different biological effects of each, and it doesn't matter whether the radiation is natural or man-made. The measure of dose (rem or Sv) takes all that into account. However, we have made our regulations seem as if they are different, which is not particularly scientific (Fig. 2).

Comparison of 4 mrem/yr Worst-Case Peak Dose from Hanford tanks with Normal Background Radiation

Normal annual exposure from natural radiation

About 300 mrem/yr



- Radon gas
- Human body
- Rocks, soil
- Cosmic rays

200 mrem
40 mrem
28 mrem
27 mrem



Normal annual exposure from man-made radiation

About 70 mrem/yr



- Medical procedures
- Consumer products
- One round-trip coast to coast airplane flight
- Disposal requirements for nuclear waste
- Watching color TV
- Sleeping with another person
- Weapons test fallout
- Nuclear industry

53 mrem
10 mrem
4 mrem
4 mrem
1 mrem
1 mrem
less than 1 mrem
less than 1 mrem



Move to Spokane
50 mrem/yr

Fig. 2. Comparisons of normal doses from various natural and man-made sources of radiation showing the extremely conservative value of the LNT-regulated 4 mrem/yr (0.04 mSv/yr) dose limits to downgradient water sources. By accepting these waste limits, the EPA is suggesting that these other sources should be restricted to as low a level as well, eliminating more than one plane flight per year, as well as most medical procedures. (Figure: State of Connecticut)

Opinion continues

It is not possible to see statistical evidence of public health risks at exposures less than 10,000 mrem/yr (100 mSv/yr) because any risk is well below the noise level of all other risks faced by humans or the environment. That's why we will never see any deaths, or even excess cancers, demonstrably from Fukushima radiation, but 1,600 people died in the days following the accident from the frantic forced evacuations that resulted mainly from fear generated by decades of adherence to the LNT.

As a result of these 1,600 deaths, the U.S. Government Accountability Office (GAO) considers the fear of low radiation levels as a vulnerability in itself because the most dangerous effect of a minor leak or a dirty bomb is the panic fed by these LNT-generated historic fears.

It is useful to note that in the 1950s in the debate surrounding the LNT, it sounded like a good conservative idea, but little did we know the collateral damage that would follow, such as fear of radiological medical diagnostics and treatments that save millions of lives each year.

Health physicists get a little frustrated that although they know there is no real risk from any radiation below background they are required to keep to limits a hundred times lower. The public often asks, "If it's so safe, why are you working so hard to keep it so low?"

Good question. And the answer is, "Because we're told to. It's the rules."

So what are the costs of regulating radiation doses to such absurdly low levels? A better question might be, "How much do we consider the value of a human life to be?" It depends on how you view it, and who is paying:

- \$7 million is the value of a human life, according to the Environmental Protection Agency (EPA).
- \$316,000 is the average paid out by the American health care industry over an average lifetime.
- \$129,000 is the average historic legal value of a human life in the United States as paid out in wrongful death suits.
- \$12,420 is the death benefit to families of deceased soldiers, although circumstances in combat can increase that amount.
- \$45 million is the value of a single healthy human body when chopped up and sold on the black market for body parts.
- \$2.5 billion is the amount we spend to save a single theoretical human life based on the LNT, although it is doubtful that we will save any lives at these levels.
- \$100 is the cost to save a human life by immunizing against measles, diphtheria, and pertussis in sub-Saharan Africa.

This last point is the most important of all. We could save 25 million lives in Africa in a year for the cost of saving one theoretical life from low levels of radioactivity by keeping to the LNT in our nuclear waste disposal programs.

This is nuts, and it creates an ethical dilemma we have not faced up to yet because of the stovepiping caused by regulations that the public and their elected officials do not understand.

The best way to illustrate this dilemma is to look at the Department of Energy's environmental management programs. In 2019, the GAO reported that the fiscal liability for cleaning up DOE sites such as Hanford will probably exceed \$600 billion.

What will this amount of money accomplish? How does the LNT drive this? How does it compare to using more reasonable cleanup limits?

The LNT has resulted in the DOE and the EPA using a 15 mrem/yr (0.15 mSv/yr) threshold for the cleanup of radiologically contaminated sites, declaring with no real data that this level has a cancer risk of about 1 in 10,000. But this is about 25 times lower than natural background in most places on Earth, and a hundred times lower than natural background in many places, including Brazil, Iran, and China, where these radiation levels have not shown any increased cancer risk.

If we just raised this limit to 100 mrem/yr (1 mSv/yr), still well below background, then the LNT-based cancer risk would be about 1 in 2,000, although, again, we have never seen any excess cancers at these levels.

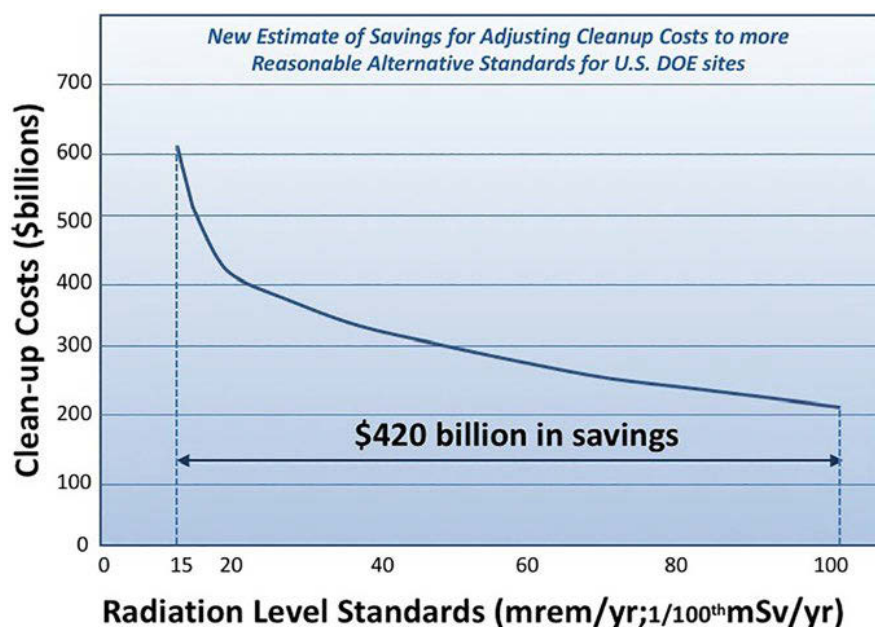


Fig. 3. The DOE could save billions—and clean up more sites—if society adopted a more reasonable limit for radiation, still well below background levels, where no harm has ever been observed. (Chart: DOE)

But the DOE would save over \$400 billion (Fig. 3), which, if put toward immunization in Africa against the three largest scourges, would save up to a billion lives over the next 20 years. If spent in the United States on health care and medical research, it would save millions of lives. Compared to saving a few virtual lives in the distant future, this is an easy, and correct, ethical decision to make.

The presence or absence of a threshold dose for radiation is a societal decision that society has been left out of. That needs to change. We have real problems that need to be solved. Yes, we need to deal with radiation doses above, say, 5 rem, 7 rem, or whatever level is decided upon as the threshold. But epidemiologically, there is always a threshold. No different than mercury, cadmium, or lead. Everything is in the environment at some level, but the old adage that dose makes the poison is still true.

James Conca is a scientist in the field of the earth and environmental sciences, specializing in geologic disposal of nuclear waste, energy-related research, planetary surface processes, radiobiology and shielding for space colonies, and subsurface transport and environmental cleanup of heavy metals. Conca also writes about nuclear, the environment, and energy for Forbes; you can view his stories online at forbes.com/sites/jamesconca.



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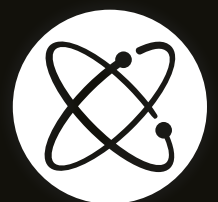
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