CHAIRMAN Resource

From:	Jerry Cuttler <jerrycuttler@rogers.com>
Sent:	Friday, August 14, 2015 1:26 AM
To:	CHAIRMAN Resource; CMRSVINICKI Resource; CMROSTENDORFF Resource; CMRBARAN Resource
Cc:	'Carol Marcus'
Subject:	[External_Sender] Letter to support petition of Dr. Carol S. Marcus to amend 10 CFR Part 20, Standards for Protection Against Radiation
Attachments:	Cuttler-2015Aug11_Letter to NRC, rad prot policy.pdf; Marcus-2015Feb9_Hormesis-Petition-to-NRC.PDF

Dear Commissioners

My message to you is at the request of Dr. Carol S. Marcus, Professor of Radiation Oncology, of Molecular and Medical Pharmacology (Nuclear Medicine), and of Radiological Sciences; David Geffen School of Medicine at UCLA.

Dr. Marcus examined my August 11th letter to the NRC (attached), in support of her very important petition (attached). She is very pleased with the information my letter contains and asked me to forward this letter to your attention.

Serious harm has been and is being caused by the current standards for protection against radiation. Bringing radiation protection policy into line with the data will result in very important benefits to humanity.

Sincerely

Dr. Jerry M. Cuttler

From: Jerry Cuttler [mailto:jerrycuttler@rogers.com]
Sent: August-11-15 3:09 PM
To: Annette L. Vietti-Cook (NRCExecSec@nrc.gov)
Subject: http://www.regulations.gov Docket ID NRC-2015-0057

U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Attention: Annette L. Vietti-Cook, Secretary

Dear Ms Vietti-Cook

http://www.regulations.gov Docket ID NRC-2015-0057

I am submitting the attached letter in support of the February 9, 2015 petition by Dr. Carol S. Marcus that requests the NRC to amend 10 CFR Part 20, *Standards for Protection Against Radiation* so that radiation and nuclear safety policies and regulations no longer be derived from the LNT model.

Sincerely

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August 11, 2015

Annette L. Vietti-Cook
Secretary, USNRC
Attention: Rulemaking and Adjudications Staff
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852, USA

Dear Ms. Vietti-Cook:

***http://www.regulations.gov* Docket ID NRC-2015-0057**

I submit this letter in support of the February 9, 2015 petition by Dr. Carol S. Marcus that requests the NRC to amend 10 CFR Part 20, *Standards for Protection Against Radiation* so that radiation and nuclear safety policies and regulations no longer be derived from the LNT model.

In June 1956, the National Academy of Sciences (NAS) Biological Effects of Atomic Radiation (BEAR) Genetics Panel recommended that the linear no-threshold (LNT) model be used to assess the risks of radiation-induced mutations and fatal cancers. In this letter, I provide new information to demonstrate that this NAS recommendation was the result of scientific misconduct. Since the NAS recommendation is not based on good science, the NRC should change its present radiation protection policy to comply with the 1934 ICRP recommendation, which is based on 38 years of operating experience of many thousands of radiation practitioners, since 1896, and had been accepted internationally. It limited radiation exposures to a "tolerance dose" rate of 0.2 roentgen per day, a threshold level that amounts to an annual dose of about 500 mGy (Cuttler 2015b).

The tolerance dose method is far simpler and more convenient to use than the LNT model and the policy of ALARA. Compliance with a tolerance dose limit was accepted by the British radiologists in 1920. It provided more than 35 years of satisfactory protection, as determined in subsequent studies demonstrating they had *lower* cancer mortalities and *lower* mortalities from all causes, when compared with unexposed groups. Since many observed responses of organisms, including humans, to low doses and low dose-rates of ionizing radiation contradict the predictions of the LNT model, the scientific method requires that the LNT model be rejected. It is simply wrong (Cuttler 2014, 2015a).

The July 17th article by Calabrese (2015) is substantial, extremely well documented and very troubling. It provides strong evidence that the NAS BEAR Committee, Genetics Panel, as a group, falsified and fabricated the research record, thus committing scientific misconduct at the highest possible societal level and on a topic of continuing profound scientific and public significance. Its unscientific recommendation and very fearful information were communicated worldwide in the journal Science (NAS BEAR 1956).

The 1956 Science paper has a strong, continuing and harmful impact on humanity. This article was the basis for the national and international change from the 1934 threshold dose-response model to the linear no-threshold (LNT) model for assessing the risk of radiation-induced cancer and predicting the number of hypothetical excess deaths. The LNT model still dominates essentially all regulation of carcinogens. This influence is enormous, affecting vast public and private resources, affecting many activities of the international scientific community, personal behavior, education programs and how children are raised. Its fearful influence is pervasive.

Following the discoveries of x-rays and radioactivity in the mid-1890s, many powerful medicinal properties of x-rays and gamma-rays were soon observed, and thousands of physicians began to cure many illnesses using these radiations in imaging and therapies. No significant increases in the incidence of cancer nor any other late adverse effects were apparent following these treatments. Over the past ~120 years, many tens of thousands of medical practitioners and scientists around the world have published the results of their remarkable treatments and studies in peer-reviewed medical and scientific journals (Cuttler 2013 2014 2015a). Since the introduction of the LNT model, nearly all beneficial effects of low radiation have been ignored because radiation protection organizations focus on minimizing exposures and the risk of hypothetical excess cancers, which cannot be observed. As a result, humanity risks losing many very important medical applications of ionizing radiation (Calabrese 2012).

Nuclear energy projects that were affordable in the 1970s are no longer affordable due to the continuously upward ratcheting safety requirements to minimize potential releases of radioactive materials. The experience of such releases, in rare nuclear reactor accidents, indicates that the radiation intensities in residential areas are increased to levels that are comparable to those in natural high background radiation areas where no adverse health effects have been observed. The implementation of extreme, precautionary emergency measures to minimize exposures to such radiation has resulted in many deaths and much hardship and suffering from fear. Had the residents remained in their homes, no increase in the incidence of adverse health effects would have been observed (Cuttler 2015a). The economic consequences of the precautionary measures implemented following the tsunami-induced damage to three of the reactors at the Fukushima-Daiichi power plant are enormous.

Rockwell (1997) pointed out, "The cost of trying to reduce harmless radiation exposures even more is exorbitant, and "predicting" casualties from such exposures generates groundless fear and distorts public policy. It is time to bring radiation protection policy into line with the data. WHEN YOU PRESS them, many regulators will admit there is

really no science to support the notion that any amount of radiation, no matter how small, can be harmful. They say, "We're not really saying it is harmful; just that it might be." But then they ask: "What's wrong with being cautious? We tell people it might hurt them, and perhaps it won't. Can that do any harm?" The answer is: You bet! Plenty of harm. Let me describe ..."

Taylor (1980) stated, "Today we know about all we need to know for adequate protection against ionizing radiation. Therefore, I find myself charged to ask: why is there a radiation problem and where does it lie?" "No one has been identifiably injured by radiation while working within the first numerical standards (0.2 r/day) set by the NCRP and then the ICRP in 1934." "An equally mischievous use of the numbers game is that of calculating the number of people who will die as a result of having been subjected to diagnostic X-ray procedures. An example of such calculations are those based on a literal application of the linear, non-threshold, dose-effect relationship, treating the concept as a fact rather than a theory. ... These are deeply immoral uses of our scientific knowledge."

I urge the NRC to examine the scientific evidence of radiation-induced beneficial health effects, which contradict the predictions of the LNT model. This natural phenomenon is due to low-dose stimulation of the adaptive protection systems that enable every organism to adapt to changing environmental conditions over the range of their capabilities. The dose rates of naturally-occurring ionizing radiation average 2.4 mGy per year, but extend up to hundreds of mGy per year in high natural background areas. When a large, short-term radiation dose is absorbed, the immediately-acting protection systems respond to prevent, repair and remove damage and restore DNA, cellular, tissue and organism health. The adaptive protection systems (more than 150 genes) are stimulated when a significant radiation increase occurs repeatedly or persists for a long time. They activate at different dose thresholds and can persist for days, weeks and even years (Feinendegen et al. 2011, 2012).

The protection systems act, not only against the damage that was, or is being induced by the radiation increase, but *also* against the much more extensive damage or damage rate that is occurring due to natural endogenous processes (Billen 1990) and the damages induced by exogenous causes, such as injuries, infections, and ingestion of chemicals. The overall response to a *low* radiation increase is a beneficial effect, an improvement in health that may include a *reduction* in the risk of cancer. When a *high* radiation increase occurs, protection systems are inhibited or damaged, resulting in overall harmful effects that may include an *increase* in the risk of cancer. Figure 1 is the dose-response model that corresponds to this biological behavior, low dose stimulation of protection and high dose inhibition. It shows the *no observed adverse effects level* (NOAEL), which is the threshold for adverse health effects, such as a reduction of expected lifetime or an excess cancer mortality, compared to the control group.

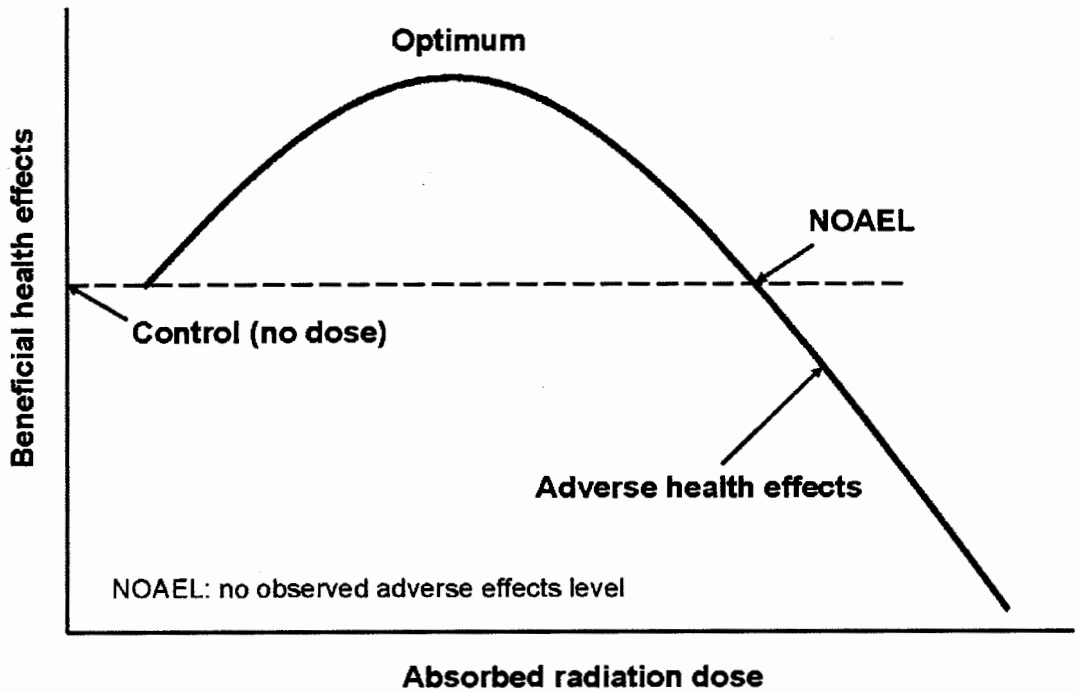

Figure 1. Radiation hormesis dose-response model showing the no observed adverse effects level (NOAEL), which is the threshold for adverse effects, such as reduction of expected lifetime or excess cancer mortality.

Changing NRC radiation protection policy, to discard the unscientific LNT model and recognize the reality of beneficial health effects of low radiation exposures, will likely be opposed by a consensus of many international organizations that favor its ongoing use. To overcome this resistance, it will be necessary to assess the serious harm that has been and is being caused by retaining ALARA and emphasize the very important benefits to humanity of bringing radiation protection policy into line with the biological data. A public education program will be needed to dispel the widespread fear of low radiation.

Sincerely,

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February 9, 2015

Annette L. Vietti-Cook
Secretary, USNRC
Attention: Rulemakings and Adjudications Staff
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Dear Ms. Vietti-Cook:

I am submitting this petition for rulemaking pursuant to 10 CFR Part 2.802. The petitioner requests that the NRC amend 10 CFR Part 20, *Standards for Protection Against Radiation*, based on new science and evidence that contradicts the Linear No-Threshold (LNT) hypothesis, a model that has served as the basis for radiation protection regulations. I will present scientific data as reported in study after study to justify that safety regulations and policies should no longer be derived from the LNT model in order to ensure these requirements are more risk-informed. This ultra-simplistic concept assumes that all radiation absorbed doses, no matter how small, have a finite probability of causing a fatal cancer. The lower the quantity of radiation absorbed dose, the lower the probability of cancer induction, but the probability is never zero, let alone negative (i.e. beneficial or hormetic). The rate of radiation delivery is irrelevant, and all absorbed doses are additive; this is demonstrably false as evidenced by the practices of radiation oncology and of radionuclide therapy. Use of the LNT assumption enables regulators to feel justified in ratcheting down permissible worker and public radiation levels, either through actual dose limits or use of the "as low as reasonably achievable" (ALARA) principle, giving the illusion that they are making everyone safer (and creating ever-increasing workload for themselves and their licensees). There has never been scientifically valid support for this LNT hypothesis since its use was recommended by the U.S. National Academy of Sciences Committee on Biological Effects of Atomic Radiation (BEAR I)/Genetics Panel in 1956. The costs of complying with these LNT-based regulations are enormous. Prof. Dr. Gunnar Walinder has summed it up: "The LNT is the greatest scientific scandal of the 20th century (1)."

On the other hand, there is a vast literature demonstrating **no effects** or **protective effects** at relatively low doses of radiation. The literature showing no effects supports a **threshold** concept, in which radiation below a certain level is of no concern because it causes no deleterious effects. The literature showing **protective effects** supports the

concept of **hormesis**, in which low levels of potentially stressful agents, such as toxins, other chemicals, ionizing radiation, etc., **protect** against the deleterious effects that high levels of these stressors produce and result in **beneficial effects** (e.g. lower cancer rates). To properly characterize risk at low radiation doses, a range of health outcomes, including beneficial or zero health effects, must be acknowledged.

Biological organisms are exceedingly complex, and have evolved in a world full of stressors, particularly oxygen, and also the bombardment by low dose background radiation from above, below, and within our own bodies. **More than 150 genes** have been recognized so far that are involved in defense of the organism and the production of defensive systems to protect against noxious agents. Although low level radiation absorbed dose may cause cellular damage, this radiation also up-regulates a system of protective mechanisms in cells, tissues, animals, and humans that counteract the damage and then protect far more than they were damaged in the first place. As the levels of radiation absorbed dose rise, the damage and benefits equalize, and at higher doses the overall effect is harm (2).

The fortunes of the United States have been founded upon advances in science and technology. Agriculture, medicine, energy production, communication, and materials science, to name only a few areas, have revolutionized the way we live. Americans in general have embraced progress. Why then have regulators chosen to use the LNT model to put a choke hold on radiation-related activities? Why is valid science being denied, while the LNT ideology based on erroneous evidence is embraced? It is important to answer this question to fully understand how such a myth perpetrated on society could have survived for so long.

Regulators use the LNT assumption because nationally and internationally respected bodies recommend and advocate it. NCRP, ICRP, IAEA, and NAS-NRC's BEIR Committee come to mind. However, they appear to have lost their sheen of expertise and appear mostly committed to maintaining the *status quo*. An army of regulators at NRC, EPA, FDA, as well as DOE, would be unbudgeted if the LNT disappeared. In addition, there are politicians whose anti-nuclear stand gets them votes. Most regulators are fearful of political anger at their actions because they don't know how to successfully defend themselves and because they rely on Congress for their budgets. Those people who are against nuclear weapons are against nuclear everything, in general, and this thinking affects mass media such as the press, movies, and television. Children are taught lies about radiation, and we therefore have a badly misinformed citizenry. Lawyers make money on bogus radiation damage lawsuits. One of the most shameful groups are scientists themselves, established professors in fine universities whose grants, graduate programs, consulting jobs, and membership in prestigious supposedly scientific groups require toeing the LNT line. It is going to take a good deal of courage to stand up and state that "The Emperor has no clothes." But, it must happen.

In 2001 the NCRP published Report no. 136 entitled "Evaluation of the Linear-Nonthreshold Dose-Response Model for Ionizing Radiation" (3), in which the LNT was upheld. In 2003 Zbigniew Jaworoski of the United Nations Scientific Committee on the

Effects of Atomic Radiation (UNSCEAR) and Michael Waligorski destroyed that Report with an astonishing exposé of scientific misconduct (4). What they did not include in their scathing rebuttal is that the group that paid for the NCRP study was none other than the NRC, which created the appearance of a conflict of interest. Every radiation regulator should read this paper. It is not highly technical, and requires no advanced mathematical ability. It is a scathing indictment of the NCRP Report.

Prof. Edward J. Calabrese of the Univ. of Massachusetts has traced amazing misconduct by the nation's leading geneticists in mid-twentieth century (5, 6, 7). He states, "This paper extends a series of historical papers which demonstrated that the linear-no-threshold model for cancer risk assessment was founded on ideological-based scientific deceptions by key radiation genetics leaders. Based on an assessment of recently uncovered personal correspondence, it is shown that some members of the United States (US) National Academy of Sciences (NAS) Biological Effects of Atomic Radiation I (BEAR I) Genetics Panel were motivated by self-interest to exaggerate risks to promote their science and personal/professional agenda. Such activities have profound implications for public policy and may have had a significant impact on the adoption of the LNT model for cancer risk assessment." In addition, the antinuclear movement of the Cold War era promoted the lie that harm at any level of radiation would occur as part of their antinuclear everything agenda. There was no science here. The LNT is based on hogwash.

I am not talking about a few scientific papers that show that the LNT model is in error. **We are talking about thousands.** There are a couple of textbooks in this field, and journals that publish scientific findings that refute the LNT model. This is a whole field of science that regulators pretend does not exist. The attitude of today's regulators is reminiscent of the Catholic Church at the time of Galileo. The Church taught that the earth was flat, and Galileo insisted that it was round, and instead of looking at the evidence, the Church threatened to torture Galileo to death unless he rescinded his point of view. Galileo retracted his statements but was kept under house arrest for the remainder of his life. And while today's regulators do not have the tools of torture available that the Catholic Church used, today's regulators will certainly destroy careers for regulatory violations of questionable importance. The LNT model is more like a religion than anything else. It certainly isn't science. Imposing it upon the citizens of the United States must stop.

There are numerous human situations in which we have good data that support radiation hormesis. Sadly, there are scientists who look at these data and ignore the apparent beneficial effect of low doses of radiation. When they make graphs of relative cancer risk vs. radiation absorbed dose, they simply draw a straight line **that misses the low dose points** and then proclaim that their data support the LNT model. The most commonly referenced study is the Life Span Study of the Radiation Effects Research Foundation (RERF) which studies the **Japanese atomic bomb survivors**. Recent data (8) show a hormetic effect for all solid cancers in the 0.3-0.7 Gy (30-70 rad) dose range, and the study of leukemia rates in the 96,000 survivors (9) showed hormesis at low doses with a threshold at about 500 mSv (50 rem).

Workers exposed in the **nuclear power industry** comprise the largest group of occupationally exposed workers studied. They generally receive low radiation doses. Over 400,000 workers were studied from 154 facilities in 15 countries (10, 11) and the study showed a decrease in the risk of all cancers including leukemia. The BEIR VII report from the National Academy of Sciences points out that in most of the nuclear industry worker studies, mortality from all cancer and all causes is substantially lower than the reference population. While they have no explanation for this phenomenon, which could be caused by radiation hormesis, the National Academy Committee suggested the possibility of a "healthy worker effect". This mysterious effect is often cited to explain lower cancer rates in workers receiving low doses of radiation, but a little thought will show that the "healthy worker effect" is actually backwards (12). Most radiation workers get into that industry in their twenties and thirties, when most people are healthy. Cancer is largely a disease of older people, with more than half of all cancers occurring in people over 65 years old (13). You have to be healthy to get old enough to die of cancer. Sickly people don't live long lives and generally don't die of cancer. People with hyperlipidemia die early of myocardial infarctions, people with cystic fibrosis often die early of infections, and people with juvenile onset diabetes often die early from infections, myocardial infarctions, renal failure, or complications from dialysis or kidney transplants. The "healthy worker effect" idea needs to quietly die. Hormesis is a perfectly good alternative explanation.

Thirty-one thousand, seven hundred and ten female patients with tuberculosis in Canadian sanatoriums from 1930-1952 were subjected to multiple fluoroscopies to monitor their disease status. Of these patients, 26.4 % received radiation doses to the affected side of 10 cGy (10 rads) or more, and therefore most received lower doses. The relative risk of eventual breast cancer was studied in all these patients. **Patients who received a total radiation absorbed dose in the range from 5 – 30 cGy (5-30 rads) had a breast cancer incidence up to one third less than the background incidence.** Only at radiation absorbed doses above 50 cGy (50 rads) did the cancer incidence begin to increase above baseline (14, 15).

The radium dial watch painters comprise another group of radiation exposed workers. In some 900 young women who sharpened paint brushes with their tongues, there were 54 bone sarcomas and 25 carcinomas of the mastoids and paranasal sinuses. Radium is a bone seeker. **None of these malignancies occurred at a radiation absorbed dose to bone less than 10 Gy (1000 rads) (16).** While these studies were not designed to demonstrate hormesis, they do show a threshold, and a very high one, for the induction of bone cancer.

Following World War II, after the invention of nuclear reactors and the expansion of peaceful uses of atomic energy, patients with hyperthyroidism were treated with radioactive iodine-131 (I-131); this is still the treatment of choice today. While the I-131 cured the hyperthyroidism, there was a concern about late affects from the radiation. The Cooperative Thyrotoxicosis Therapy Follow-Up Study of over 36,000 treated hyperthyroid patients looked at eventual leukemia rates in these patients, as leukemia is

considered the most radiosensitive of cancers and occurs faster than other radiogenic cancers. The total body radiation doses to these patients were 130-140 mSv (13-14 rem). **The age-adjusted leukemia incidence rate was 11/100,000 patient years in the I-131 treated patients and 14/100,000 patient years in patients treated by surgical removal of the thyroid gland (the standard procedure before I-131 became the therapy of choice).** While the authors concluded that there was no increased incidence of leukemia at this low whole body radiation dose (17), **the 22% decrease in the I-131 treated patients suggests a possible hormetic effect.**

The explosion of radioactive waste from a nuclear fuel reprocessing facility called "Mayak" in 1957 resulted in a stream of radioactive waste affecting an area in the East Urals of Russia. Research was performed on data collected from 1957-1987 on occupants of the 22 villages evacuated from the radioactive waste zone (18). Radiation absorbed dose groups were made for those receiving 40 mSv (4 rem), 120 mSv (12 rem), and 500mSv (50 rem). **Although all three groups had less cancer than the baseline expected in the area, the 50 rem and 12 rem groups were statistically significantly lower than the baseline cancer rate expected, suggesting hormesis.** The cancer death rate in the 50 rem group was 29% lower than the controls, and in the 12 rem group was 39% lower than the controls.

In 1982 several orphan cobalt-60 (Co-60) sources were recycled accidentally in the steel scrap industry in northern Taiwan. This resulted in the Co-60 contamination of more than 20,000 tons of steel used in the construction of over 200 residential, industrial and school buildings in Taiwan. In 1992 this contamination was identified, and the exposed population was studied for cancer incidence (19). The population of 7271 people representing 101,560 person-years at risk was exposed to chronic radiation amounting to an average of about 5 cGy (5 rads) from 1983-2002. The range of radiation exposure was <1-2363 mSv (<0.1-236 rem). **The standardized incidence ratios (SIR) and the 95% confidence intervals calculated for all cancers was 0.8 (0.7, 1.0), for all cancers except leukemia was 0.8 (0.6, 0.9), and for solid cancers was 0.7 (0.6, 0.9).** (A SIR of 1.0 means the same as that of unirradiated controls.) The lowered cancer incidence rate was significant at the 95% confidence interval for all cancers except leukemia and for solid cancers. The lowered cancer incidence rate for all cancers was significant at the 90% confidence interval. The lowered cancer incidence rates in these people exposed to chronic, low levels of radiation suggest radiation hormesis.

The situation with residential radon exposure and lung cancer is most interesting. The seminal research of Bernard Cohen (20, 21, 22, 23) in the United States showed that **increasing levels of residential radon were associated with decreasing levels of lung cancer**. His data were carefully corrected for 54 socioeconomic variables, including smoking, but the inverse correlation of radon levels with lung cancer did not change. Bobby Scott (24) has analyzed the situation and has shown that low level radon and its radioactive daughters cause activated natural protection against lung cancer, including smoking-related lung cancer, at levels up to the Environmental Protection Agency's (EPA's) action level of 4 picocuries/L (about 150 Bq m^{-3}). Somewhat above this level, the activated natural protection effect progressively goes to zero and it is here that we see

an increase in lung cancer. **Low levels of radon are hormetic.** Klaus Becker (25) has shown similar correlations in data from Central Europe.

In 1986, the Chernobyl reactor accident riveted much of the world, prompting huge hysteria (26). In the former Soviet Union, 336,000 people were forcibly evacuated, some from areas with five times lower radiation levels than are present in Grand Central Station in New York City, which is constructed with natural granite. There were large numbers of unnecessary abortions in Western Europe due to fears of mutant babies. Huge amounts of food were wasted because of miniscule levels of contamination which would hurt no one. The LNT was responsible for much of the hysteria, multiplying very small radiation doses times hundreds of millions of people to estimate huge numbers of cancer deaths. The affected population in the former Soviet Union was followed for increased cancer incidence. According to UNSCEAR 2000b (27) and the United Nations Chernobyl Forum in 2006, except for thyroid cancers in the highly contaminated areas, there was no increased incidence of leukemias or solid tumors, and no evidence of increased genetic diseases. The increase in thyroid cancers was found in children under 15 years of age in 1987, the year after the accident. However, the radiation doses were too low to have caused this, and there was no dose-response relationship. In addition, the timing was off---the mean latent period for radiation induced thyroid cancer is about 28 years (27). However, the increase was highly likely due to a mass screening effect (22). Occult thyroid cancer is actually extremely common, with an autopsy prevalence in various countries of 4.5% to 36% (28, 29). These are small cancers that never caused problems and were unknown during the person's lifetime. The development of sensitive ultrasound techniques have made the diagnosis of these occult cancers, or "incidentalomas", much more common. In the United States, a screening program uncovered a 2100% increase in thyroid nodules (30), and mandatory yearly screening in children in the contaminated areas around Chernobyl resulted in a similar phenomenon. **According to Jaworowski (26), the natural incidence of occult thyroid cancers is approximately 1000 times higher than the highest incidence of reported thyroid cancers in the countries with the greatest fallout from the Chernobyl accident. The supposed increased finding of thyroid cancer due to radiation from the Chernobyl accident is instead due to intense screening (31).** The Chernobyl accident resulted in 28 radiation deaths among rescue workers and employees of the power station who received 2.9-16 Gy (290-1600 rads). Three others died of different causes. The surviving workers show a 15-30% lower mortality from solid cancers than the general Russian population and the residents of the Bryansk district, which received the highest contamination, had a 5% lower solid tumor incidence than expected (26).

Informative reviews on **molecular mechanisms of hormesis** and related phenomena may be found in the papers by Tang and Loke (32) and Brooks and Dauer (33).

It is important to compare a joint report of the French Academy of Sciences and of the French Academy of Medicine (34) on low radiation dose carcinogenic effects, published in 2005, shortly before a comparable report of BEIR VII/Phase 2 of the National Academy of Sciences-National Research Council (35) was published. Covering the same questions, the two groups of experts came to different conclusions (36). The French

report finds that as epidemiological studies have been unable to detect any significant increases in cancer after radiation doses of up to about 100 mSv (10 rem), that there are no convincing data showing any increase in cancer in adults, children, or infants receiving doses under about 100 mSv (10 rem). The LNT therefore greatly overestimates the risk of these low doses, and its use is unjustified and should be discouraged for doses below 20 mSv (2 rem). In contrast, the BEIR VII report concludes that "The committee judges that the balance of evidence from epidemiologic, animal and mechanistic studies tends to favor a simple proportionate relationship at low doses between radiation dose and cancer risk. Uncertainties on this judgment are recognized and noted." The BEIR VII report recommends the continued use of LNT at low or very low doses. The BEIR VII report does not consider the cancer threshold data of the radium dial watch painters or that of patients in whom Thorotrast was used as an x-ray contrast agent (liver dose of 2 Gy [200 rads] required for hepatomas). The French report does. The two groups differ in their interpretation of the results of the Hiroshima/Nagasaki Life Span Study. The French report finds no significant increase in cancer after doses below 100 mSv (10 rem), while the BEIR VII report tends to lump the low dose data with higher dose data to find cancer increases. Animal studies have not shown increased cancer at doses below 100 mSv (10 rem); many show thresholds and about 40% show hormesis. The French report points out the high efficacy of DNA repair mechanisms and apoptosis (death of damaged cells), while the BEIR VII report minimizes this research because all the mechanisms have not yet been worked out. An important difference between the two reports concerns *in utero* radiation. While the BEIR VII report concludes that fetal doses of 10-20 mSv (1-2 rem) caused increased levels of leukemias and solid cancers, the French report doubts a causal relationship because this represents a biased sample of fetuses in which only pregnant women with problems were subjected to x-ray studies. The randomly irradiated fetuses in the Hiroshima/Nagasaki Life Span Study showed no such cancer increase, nor have *post partum* twin studies where one was irradiated and the other was not. More detailed comparisons are in (36). It is interesting to note that the BEIR VII report was funded by the EPA, the NRC, and the NIST. As the present radiation programs of the EPA and the NRC are based upon the LNT, one wonders about the appearance of a conflict of interest.

RECOMMENDED CHANGES FOR 10 CFR PART 20

It is therefore requested that the NRC greatly simplify and change Part 20 to take radiation hormesis into account. The following recommendations are made:

1) Worker doses should remain at present levels, with allowance of up to 100 mSv (10 rem) effective dose per year if the doses are chronic.
2) ALARA should be removed entirely from the regulations, as it makes no sense to decrease radiation doses that are not only harmless but may be hormetic.
3) Public doses should be raised to worker doses, as these low doses may be hormetic. Why deprive the public of the benefits of low dose radiation?
4) End differential doses to pregnant women, embryos and fetuses, and children under 18 years of age.

Obviously there will have to be many other changes to NRC regulations when 10 CFR Part 20 is brought up to present scientific standards. Examples include the medical regulations and low level radioactive waste regulations. But it all needs to start with ending reliance on the LNT model.

Thank you for your attention and consideration.

Sincerely,

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