Rulemaking1CEm Resource

From: RulemakingComments Resource
Sent: Tuesday, November 10, 2015 1:40 PM
To: Rulemaking1CEm Resource
Subject: Comment on PRM-20-28, 20-29 & 20-30
Attachments: NRC-2015-0057-DRAFT-0456.pdf

DOCKETED BY USNRC—OFFICE OF THE SECRETARY

SECY-067
PR#: PRM-20-28, PRM-20-29, and PRM-20-30
FRN#: 80FR35870
NRC DOCKET#: NRC-2015-0057
SECY DOCKET DATE: 10/27/2015
TITLE: Linear No-Threshold Model and Standards for Protection Against Radiation
COMMENT#: 435

Hearing Identifier: Secy_RuleMaking_comments_Public
Email Number: 1246

Mail Envelope Properties (d15093e9e8914f82a99848de6ae3a90c)

Subject: Comment on PRM-20-28, 20-29 & 20-30
Sent Date: 11/10/2015 1:39:36 PM
Received Date: 11/10/2015 1:39:40 PM
From: RulemakingComments Resource

Created By: RulemakingComments.Resource@nrc.gov

Recipients:
"Rulemaking1CEm Resource" <Rulemaking1CEm.Resource@nrc.gov>
Tracking Status: None

Post Office: HQPWMSMRS03.nrc.gov

Files	**Size**	**Date & Time**
MESSAGE	300	11/10/2015 1:39:40 PM
NRC-2015-0057-DRAFT-0456.pdf	281313	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

PUBLIC SUBMISSION

As of: 10/30/15 3:49 PM
Received: October 27, 2015
Status: Pending_Post
Tracking No. 1jz-8lx3-dfoc
Comments Due: November 19, 2015
Submission Type: Web

Docket: NRC-2015-0057
Linear No-Threshold Model and Standards for Protection Against Radiation

Comment On: NRC-2015-0057-0086
Linear No-Threshold Model and Standards for Protection Against Radiation; Extension of Comment Period

Document: NRC-2015-0057-DRAFT-0456
Comment on FR Doc # 2015-20722

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General Comment

Please see the attached document = the dangers of low-dose radiation less than 100 mSv

Attachments

important4

"We have to be careful when calling hormesis beneficial. You might end up stimulating a disease through hormesis—it might be 'good' for the cancer cells or invaders—more than you stimulate the body's defenses..."

--quoting Edward Calabrese, Hormesis advocate, regarding naturally-high-radon water health-type-treatments

http://discovermagazine.com/2002/dec/featradiation

==> Low-level radiation researcher Dr. David Brenner supports the Linear No Threshold model: http://www.ncbi.nlm.nih.gov/pubmed/16470411

==> And he is not alone.

"Until more results concerning the effects of low-dose exposure are available, a reasonable radiation protection approach is to consider the risk proportional to the dose."

http://www.ncbi.nlm.nih.gov/pubmed/25802468

==> "Dr. David Brenner, director of the Center for Radiological Research at Columbia University, is among those who believe there is no threshold. Radiation damages DNA, he says, and just one damaged cell can become the seed of a cancer, though it takes decades to develop. He is studying the possibility that in terms of causing cancer, low doses of radiation might be more dangerous than calculations based on high doses would predict."http://www.nytimes.com/2011/04/05/health/05radiation.html?_r=0

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Dear NRC, Please do not forget these important points:

*** Even low doses of radiation are cumulative, and those low doses can easily add up to high doses in time**

*** External radiation exposure is not the same as Internal radiation exposure which occurs when ingesting and inhaling radionuclides**

*** The radionuclides created by uranium fission at nuclear power plants are NEW to the world, and humans have not developed an adaptive response to the deleterious health effects of these radionuclides.**

*** There is ample research proving the deleterious health and environmental effects of radionuclides.**

*** Not all radiation is alike. For example, neutrons and alpha particles can produce more damage per-rad-dose than x-rays, gamma and beta rays.**

*** Hormesis can never serve as a legitimate once-size-fits-all radiation exposure model because:**

(a) radiation affects cells and genes and DNA, etc. differently

(b) different types of radiation cause different types of damage

(c) radiation effects different people differently. There is no homogeneity. There is no "NORM."

(d) many studies on radiation-hormesis were based on very SHORT-term medical x-ray exposures; not life-long exposures, and not exposures to man-made radionuclides

(e) one radiation-hormesis study was based on only a SINGLE x-ray exposure

(f) research on radiation-hormesis was performed using a CONTROLLED amount of radiation, thereby distribution of the dose was controlled

It is impossible to have CONTROLLED radiation releases from nuclear power plants, because:

(a) the amounts of Gaseous or Liquid effluents released from nuclear power plants can vary greatly due to problems at a nuclear power plant such as unplanned outages, refueling, mother nature, human error, the wind, the weather, pipe leaks, etc.

b) it is simply impossible to control a Gaseous or Liquid Effluent in the same way that a beam of a medical x-ray can be controlled

"The problem here lies again in impossibility to define norms. What for one person is 'normal' i.e. it is a small dose that have positive effect on this person, for another person may be already very large dose, a cause of illness or even of death."

www.wseas.us/e-library/conferences/2011/Prague/MEDIC/MEDIC-30.pdf

II. The studies below show deleterious health effects to nuclear workers from low-doses of radiation, providing evidence that the general public should not be exposed to the radiation-dosage allowed to a nuclear worker

(1) "The relative risk of leukemia in male workers and that of brain cancer in female workers were significantly higher in the group of people who had been exposed to more than 5 mSv/year"

http://www.ncbi.nlm.nih.gov/pubmed/23343985

(2) "*Risk of cancer from occupational exposure to ionising radiation: retrospective cohort study of workers in France, the United Kingdom, and the United States (INWORKS)*"

"Results suggest a linear increase in the rate of cancer with increasing radiation exposure. The average cumulative colon dose estimated among exposed workers was 20.9 mGy (median 4.1 mGy). The estimated rate of mortality from all cancers excluding leukaemia increased with cumulative dose by 48% per Gy (90% confidence interval 20% to 79%), lagged by 10 years. Similar associations were seen for mortality from all solid cancers (47% (18% to 79%)), and within each country."

http://www.bmj.com/content/351/bmj.h5359

"This study provides strong evidence of positive associations between protracted low-dose radiation exposure and leukaemia."
http://www.thelancet.com/journals/lanhae/article/PIIS2352-3026%2815%2900094-0/abstract

This study also showed risks at 1.1 mSv a year; these were observed risks, not extrapolated from the Atomic Bomb Survivors Study, explained further here:

http://www.ianfairlie.org/news/update-new-powerful-study-shows-radiogenic-risks-of-leukemia-in-workers-more-than-double-the-previous-estimate/

(3) "Cancer mortality among two different populations of French nuclear workers" found "Significant dose-effect relationships were observed" at mean external photon dose of 3.7 and 12.9 mSv

http://www.ncbi.nlm.nih.gov/pubmed/21479948

(4) "A case control study of multiple myeloma at four nuclear facilities"

"After accounting for age, birth cohort, a measure of socioeconomic status, and active worker status, external radiation with a 20-year exposure lag was related to all causes of death (2.68% increase per 10 mSv) primarily due to an association with cancer mortality (4.94% per 10 mSv)."

http://www.ncbi.nlm.nih.gov/pubmed/1999879

(5) "Among men, leukemia and cancer of the pleura, the tissue covering the lungs and lining the chest cavity, caused an abnormally high number of deaths, while female workers had elevated rates of kidney and skin cancers."

"Nuclear plant workers show higher cancer risks"

http://www.reuters.com/article/2008/01/25/us-nuclear-plant-idUSCOL57399020080125

(6) "A case-control study of leukemia at a naval nuclear shipyard"

"For electricians, the Mantel-Haenszel odds ratio (ORMH) was significantly elevated for all leukemias ... particularly for lymphatic leukemia... For welders, the odds ratio was not significantly elevated for all leukemias...but was significantly elevated for myeloid leukemia"

http://www.ncbi.nlm.nih.gov/pubmed/3458360

III. The studies below show deleterious health effects at very low-doses of radiation

(1) 5 mSv - "Application of these findings to the post-Chernobyl state of events suggests that an increment of up to 20% in thyroid cancer might occur in a population exposed to 5 mSv as an aftermath of a similar accident. "

http://www.ncbi.nlm.nih.gov/pubmed/3326979

(2) "Excess mortality rates of 2.2 and 12.5 deaths per million person years per 10 mSv (1 rem) were estimated for leukaemia and all cancers, respectively."

http://www.ncbi.nlm.nih.gov/pubmed/3926232

(3) 10 mSv - "The risk of getting cancer from radiation (in BEIR VII) is increased by about a third from current government risk figures (FGR13): BEIR VII estimates that 11.42 people will get cancer if 10,000 are each exposed to a rem (1,000 millirems or 10 mSv). The US Environmental Protection Agency Federal Guidance Report 13 estimates that 8.46 people will get cancer if 10,000 are each exposed to a rem."
http://www.nirs.org/press/06-30-2005/1

(4) 10 mSv - "Dose-dependent analyses of risks in the high exposure group indicated that for each cancer the risk increased at exposures above 10.0 mSv."

http://www.ncbi.nlm.nih.gov/pubmed/17690532

(5) 10 mSv - relative risk = 6.9% per 10 mSv

http://www.ncbi.nlm.nih.gov/pubmed/10813507

(6) 53 mSv - "A non-neoplastic disease component of excess mortality rate emerges at 6 R day-1 and above"

http://www.ncbi.nlm.nih.gov/pubmed/11898837

(7) Increases in Cataracts - "As the radiation dose increases, the prevalence of posterior eye changes increases."

http://www.ncbi.nlm.nih.gov/pubmed/25789258

(8) "The evidence presented suggests an association between cardiovascular disease and exposure to low-to-moderate levels of radiation"

"Radiation as a risk factor for cardiovascular disease"

http://www.ncbi.nlm.nih.gov/pubmed/21091078

IV. The studies below show different types of damage to cells from exposure to low-dose radiation, such as mutations, lipid peroxidation, DNA damage, RNA damage, cell cycle arrest, genomic instability, bystander effects, and cells responding DIFFERENTLY to repeated exposures of low-dose radiation, all of which highlight why hormesis can never be a one-size-fits-all radiation-exposure-model

(1) "These data provide direct evidence that a single alpha particle traversing a nucleus will have a high probability of resulting in a mutation and highlight the need for radiation protection at low doses."

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC20515

(2) "Lipid peroxidation is also produced at low doses of ionizing radiation, even close to the normal background one, independently of its type (X-ray or γ-radiation), (Petkau, 1971; Petkau 1972; Riley, 1994). Once initiated in the membrane, the damaging chain reactions propagate by themselves."

www.actabp.pl/pdf/4_2011/489.pdf

Note: "Lipid peroxidation refers to the oxidative degradation of lipids. It is the process in which free radicals "steal" electrons from the lipids in cell membranes, resulting in cell damage." https://en.wikipedia.org/wiki/Lipid_peroxidation

(3) 2.5 and 10 mSv - "DNA damage in Chinese hamster cells repeatedly exposed to low doses of X-rays"

http://www.ncbi.nlm.nih.gov/pubmed/15162033

(4) 50 mSv - "unexpected sensitivity, leading to a significantly higher frequency of mutations than would be predicted by a back extrapolation from the data for higher doses, was observed in the dose range below 5 cGy, where the mean number of alpha-particle traversals per nucleus was significantly less than one (0.05-0.3). The frequency of mutations induced by a single alpha particle traversing the nucleus of a cell was increased nearly fivefold at the lowest fluence studied."

"Unexpected sensitivity to the induction of mutations by very low doses of alpha-particle radiation" http://www.ncbi.nlm.nih.gov/pubmed/10521933

(5) "Transformed and non-transformed cell types responded differently to direct and indirect damage using low-dose repeat exposures to ionizing radiation" http://www.ncbi.nlm.nih.gov/pubmed/16076751

(6) 0.696 to 39.088 mSv - "Gene expression profiles in radiation workers occupationally exposed to ionizing radiation"

"Gene expression analysis revealed statistically significant transcriptional changes in a total of 78 genes..."

http://www.ncbi.nlm.nih.gov/pubmed/19218781

(7) "a low radiation dose causes similar miRNA expression changes to the highest dose" and "ionizing radiation at specific high and low doses leads to cell cycle arrest and a possible initiation of apoptosis"

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4278272/

(8) "Many scientists now conducting direct low dose research have been

surprised to discover such effects as genomic instability, the bystander effect, an increase in Relative Biological Effect (RBE) at low dose, mini-satellite damage and non-homogeneous distribution of radionuclides, especially for internal exposures, which significantly effect absorbed dose estimates at low levels of exposure." Dr. Rosalie Bertell
dwmi.homestead.com/**Health_Effects_of_Tritium**_final_1_.doc

(9) "Ionising radiation induces complex, global cellular responses, such as genomic instability (GI) in both irradiated and never-irradiated 'bystander' cells that receive molecular signals produced by irradiated cells. GI is a well-known feature of many cancers, increasing the probability of cells to acquire the 'hallmarks of cancer' during the development of tumours."

http://www.ncbi.nlm.nih.gov/pubmed/25897137

(10) "These findings suggest that epigenetic reprogramming is possibly involved in the development of radiation-induced genomic instability and thus, may have a causative role in the development of AML."

"Exposure to low-dose (56)Fe-ion radiation induces long-term epigenetic alterations in mouse bone marrow hematopoietic progenitor and stem cells" http://www.ncbi.nlm.nih.gov/pubmed/24960414

(11) "In general, ionizing radiation produces its biological effects by, either directly or indirectly, generating reactive oxygen species (ROS), leading to molecular changes; damage to DNA, lipids, and proteins..."

"Radiation-induced cognitive impairment-from bench to bedside"

http://neuro-oncology.oxfordjournals.org/content/14/suppl_4/iv37.full

(12) “Persistence of DNA double-strand breaks in normal cells induced by radiation-induced bystander effect”

http://www.unboundmedicine.com/medline/citation/21175351/Persistence_of_DNA_double_strand_breaks_in_normal_human_cells_induced_by_radiation_induced_bystander_effect_

V. The studies below prove that women and children are more sensitive to the effects of radiation, and deleterious health effects are seen at very low doses of radiation

(1) 6 msV - "Epidemiological evidence from the studies of *in utero* radiation exposure has shown that a dose of 6 mGy is associated with an increase in cancer risk"

Mole RH . Childhood cancer after prenatal exposure to diagnostic X-ray examinations in Britain. *Br J Cancer* 1990;62:152–68.

(2) 10 mSv - "The association between the low dose of ionizing radiation received by the fetus *in utero* from diagnostic radiography, particularly in the last trimester of pregnancy, and the subsequent risk of cancer in childhood provides direct evidence against the existence of a threshold dose below which no excess risk arises"

"It is concluded that radiation doses of the order of 10 mGy received by the fetus *in utero* produce a consequent increase in the risk of childhood cancer." http://www.ncbi.nlm.nih.gov/pubmed/9135438

(3) 10 mSv - "A detailed analysis of the many studies of childhood cancer risks from diagnostic *in utero* exposures concluded that a 10-mSv dose to the embryo and fetus does cause a significant and quantifiable increase in the risk of childhood cancer"
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC283495/

(4) **10 mSv** - "Case-control studies of childhood cancer and foetal exposure to diagnostic x-rays suggest that doses as small as 10 mSv increase the risk of cancer to a detectable extent."
http://www.ncbi.nlm.nih.gov/pubmed/12400960

(5) **16 mSv** - "X-ray doses as low as 1.6 rem increase a woman's chance of developing cancer, according to a 1974 study by Baruch Modan [Lancet (Feb. 23,1974), pp 277-279]

(6) **0.5-2.5 mSv/year** - "low-level exposure to ionizing radiation, including ubiquitous natural background radiation, also raises the risk of **childhood leukaemia**. Using two sets of recently published leukaemia risk models and estimates of natural background radiation red-bone-marrow doses received by children, about 20% of the cases of childhood leukaemia in Great Britain are predicted to be attributable to this source"

http://www.ncbi.nlm.nih.gov/pubmed/19151785

(7) **50 mSv and 60 mSv** - "Interpretation: Use of CT scans in children to deliver cumulative doses of about 50 mGy might almost **triple the risk** of **leukaemia** and doses of about 60 mGy might triple the risk of **brain cancer.**"

http://www.ncbi.nlm.nih.gov/pubmed/22681860/

(8) "there is clear evidence that, for **thyroid cancer**, the age of exposure markedly influences the risk of developing cancer in later life...there was a clear dose–response relationship for individuals exposed as children (ERR/Sv=9.5 for those exposed under 10 years old, and 3.0 for those exposed at ages 10–19 years)"

http://www.birpublications.org/doi/full/10.1259/bjr/25026140#ref-50

(9) Quote: "WHAT IS IMPORTANT IS THAT CHILDREN ARE DYING OF LOW DOSES" https://vimeo.com/33724891

(10) Quote from Dr. Ernest Sternglass --->

"...The official measurements carried out by the Office of Radiological Health, and by the government, and the Public Health Service, they measured the radiation doses around the first big reactors in Dresden near Chicago, and they found that indeed there were doses almost as high as half of the normal background, and according to Dr. Stewart's finding, that would mean an increase of 40-50% in childhood cancers and leukemias around the fence of every nuclear plant." youtube /watch?v=hN7rcjSnxZs

(11) "The results comfort the underlying hypotheses of the radiation protection system in use. In particular, they show the existence of an increased risk for doses below 100 mSv of for exposures protracted over time. These results highlight the relevance of measures to reduce all exposures: accidental, medical, occupational or natural, and reinforce the importance of a prudent use of medical radiation, particularly for children."

"Cancer risk associated to ionizing radiation"

http://www.ncbi.nlm.nih.gov/pubmed/24298833

(12) "Overall cancer incidence was 24% greater for exposed than for unexposed people, after accounting for age, sex, and year of birth...We saw a dose-response relation...The average effective radiation dose per scan was estimated as 4.5 mSv."

"Cancer risk in 680,000 people exposed to computed tomography scans in childhood or adolescence"

http://www.ncbi.nlm.nih.gov/pubmed/23694687

(13) RADIATION GIVING WOMEN ENDOMETRIOSIS: "The increases in endometriosis were pronounced, even in the lowest dose groups, and no threshold value has ever been established. "

One possible explanation for this effect of radiation is interference with normal immune system function."

http://www.healthandenvironment.org/endometriosis/peer_reviewed

VI. Studies proving death, disease, and cancers at radiation exposure of 100 mSv and less, and even at just one exposure to a cell

(1) "It is calculated that 70 mrem [.7 mSv] per year would cause between 100 and 1,800 cases of serious, dominant or X-linked diseases and defects per year"

www.iaea.org/nis/collection/NCLCollectionStore/_Public/37/004/37004410.pdf

(2) The "Advisory Committee on the Effects of Ionizing Radiation" state that at 1mSv, there will be 3,000 extra cancer deaths per year.

So if we take their numbers, this means that at 10 mSv a year, you're giving the public an extra 30,000 deaths per year.

And at 100 mSv a year, you're giving the public an extra 300,000 deaths per year.

www.iaea.org/nis/collection/NCLCollectionStore/_Public/37/004/37004410.pdf

(3) Quoting Dr. Ian Fairlie: "In recent years, some scientists have promoted the view that there are no observable effects from radiation below 100 mSv, usually in their criticisms of the Linear No Threshold theory. However, many studies show radiation effects well below 100 mSv."

See the chart in this document for more proof of the deleterious health effects of low level radiation < 100 mSv:

http://www.ianfairlie.org/news/a-100-msv-threshold-for-radiation-effects/

(4) "*A Five-Point Summary*

Point One: The radiation dose from x-rays, gamma rays, and beta particles is delivered by high-speed electrons, traveling through human cells and creating primary ionization tracks. Whenever there is *any* radiation dose, it means some cells and cell-nuclei are being traversed by electron-tracks. There are about 600 million typical cells in 1 cubic centimeter.

Point Two: Every track --- without any help from another track --- has a chance of inflicting a genetic injury if the track traverses a cell-nucleus.

Point Three: There are no fractional electrons. This means that the lowest "dose" of radiation which a cell-nucleus can experience is one electron-track.

Point Four: There is solid evidence that extra human cancer does occur from radiation doses which deliver just one or a few tracks per cell-nucleus, on the average.

Point Five: Thus we know that there is *no* dose or dose-rate low enough to guarantee perfect repair of every carcinogenic injury induced by radiation. Some carcinogenic injuries are just unrepaired, unrepairable, or misrepaired. The 'troublesome trio.'

Conclusion: It is factually wrong to believe or to claim that no harm has ever been proven from very low-dose radiation. On the contrary. Existing human evidence shows cancer-induction by radiation at and near the lowest *possible* dose and dose-rate with respect to cell-nuclei. By any reasonable standard of scientific proof, such evidence demonstrates that there is no safe dose or dose-rate below which dangers disappear. No threshold-dose. Serious, lethal effects from *minimal* radiation doses are not "hypothetical," "just theoretical," or "imaginary." They are real."

SOURCE: "What Is Factually Wrong with This Belief: 'Harm from Low-Dose Radiation Is Just Hypothetical — Not Proven'" By John W. Gofman, M.D., Ph.D. Fall 1995

http://www.ratical.org/radiation/CNR/NoSafeThresh.html#refs

VII. Proof that radionuclides created in nuclear power plants are dangerous to humans, therefore ALARA should be kept, or better yet, LOWERED to "As Low As Absolutely Possible" ALAAP

As you know, thousands of man-made, anthropogenic radionuclides previously unknown to the earth and living cells have been created from nuclear energy, atomic tests, and nuclear meltdowns in the past 70+ years.

As an example, here are just four radionuclides and proof of their danger even at low doses →

(1) Carbon14 → "the nuclear power industry is the major producer of Carbon14" http://www.beyondnuclear.org/storage/carbon14epacmtsFINAL.pdf

"Carbon-14 is the main contributor to whole body and most of the organ doses from both nuclear plants."
http://www.ornl.gov/info/reports/1977/3445605115087.pdf

Carbon14 converts to CO2 in the atmosphere, so not only is Carbon14 hazardous to human health, it also increases greenhouse gases, contributing to climate change and air pollution.

* **a Pressurized Water Reactor releases 129.5 GBq of Carbon14 as gaseous waste**

* **a Boiling Water Reactor releases 250.0 GBq of Carbon14 as gaseous waste**

* **Reprocessing plants release 18,000 GBq of Carbon 14 as gaseous waste**

http://www.beyondnuclear.org/storage/carbon14epacmtsFINAL.pdf

Health effects of Carbon14 -->

> **Quoting Linus Pauling: "...[W]e calculate that the total number of cases of leukemia and bone cancer expected to be caused by carbon-14 is about equal to the number expected to be caused by fission products, including strontium-90"**

http://www.beyondnuclear.org/storage/carbon14epacmtsFINAL.pdf

> **"...a significant fraction of the carbon-14 taken in by either ingestion or inhalation is absorbed into the bloodstream, where it is transferred to all organs of the body. The health hazard of carbon-14 is associated with cell damage caused by the ionizing radiation that results from radioactive decay, with the potential for subsequent cancer induction."**

http://www.remm.nlm.gov/ANL_ContaminantFactSheets_All_070418.pdf

Percentage of Carbon14 released from a PWR plant goes to which body part:

Whole body 65.4%
Bone 71.7%
Lungs 46.7%
Thyroid 10.6%
http://www.ornl.gov/info/reports/1977/3445605115087.pdf

(2) Strontium90 →

(a) Strontium 90 causes miscarriages → "Strontium90 causes her (the mother) to reject the fetus as a foreign object."
http://nsarchive.gwu.edu/radiation/dir/mstreet/commeet/meet12/trnsc12a.txt

(b) "Radioactive strontium may cause cancer as a result of damage to the genetic material (DNA) in cells."
http://www.atsdr.cdc.gov/phs/phs.asp?id=654&tid=12

(c) "A small amount of strontium 90 is deposited in bones and bone marrow, blood and soft tissues when ingested. Can cause bone cancer, cancer of nearby tissues, and leukemia." https://www.ctbto.org/nuclear-testing/the-effects-of-nuclear- testing/general-overview-of-theeffects-of-nuclear-testing/

"The nuclear industry and their supporters have couched this whole argument in the context of dose. But actually it's not low dose that's the problem. It's INTERNAL RADIATION that's the problem...It's internal radiation from certain radionuclides that's dangerous, because the target for radiation effects is the DNA. And certain chemicals have a very high chemical affinity for the DNA. For example, Strontium90. For example, Uranium. For example, Plutonium. These substances, when they get inside you, they bind to the DNA which is the target for radiation effects, so although the doses from these things are low doses, it's not the low dose part of it that's the problem. Because dose is categorized as energy per unit mass. So they take the amount of energy that's produced by these substances and dilute it into the mass of your body, and you find that the doses are vanishingly small, but the dose to the DNA is NOT vanishingly small because these things are stuck to the DNA like glue, because they have this chemical affinity for them, so this is something that really has to be appreciated. And these substances are continually released from nuclear power stations, and in fact they can't be contained because the parent isotope of Strontium90 is a gas, so it can't be held inside the nuclear power station and all nuclear power stations have high levels of strontium 90 in milk that's taken from cows that graze near the nuclear power stations and of course people drink that milk and then you've got these high levels of childhood leukemia and so forth ... The problem is that you cannot contain this stuff even under normal circumstances." Quote of Dr. Christopher Busby https://www.youtube.com/watch?v=1AOF7fvEo48

(3) Cesium137 →

(a) "After entering the body, caesium is distributed fairly uniformly through the body, with higher concentration in muscle tissue and lower concentration in bones. Can cause gonadal irradiation and genetic damage."
https://www.ctbto.org/nuclear-testing/the-effects-of-nuclear-testing/general-overview-of-theeffects-of-nuclear-testing/

(b) Cesium137 can also cause radiation dermatitis, occular and reproductive effects, bone marrow aplasia, lesions, leukopenia, thrombocytopenia, lymphopenia, neutropenia, stomach cancer, leukemia, autoimmune disease, malignant neoplasms, and more...
http://toxnet.nlm.nih.gov/cgi-bin/sis/search/a? dbs+hsdb:@term+@DOCNO+7389

(4) Tritium →

"Tritium is a low energy beta emitter with low penetrating power that causes radiation stress primarily due to internal irradiation if the radionuclide is incorporated. This low energy however leads to a local concentration where it is deposited that may increase the biological consequences of tritium uptake in living matter. Ionising radiation emitted may cause various DNA lesions that appear in the exposed organism as physiological effects (behaviour, reproduction, genetic damage, etc.) (Straume and Carsen, 1993). For tritium these lesions are basically DNA ruptures on the two strands of the molecule, termed double-strand breaks (Moiseenko *et al.*, 2001), and constitutes a source of increased risk of inducing and transmitting genetic mutations between generations."

http://www.irsn.fr/EN/Research/publications-documentation/radionuclides-sheets/environment/Pages/Tritium-environment.aspx#10

VIII. The dangers of Radon

RADON:

(1) "Overall, these results suggest that cumulative radon exposure is a significant risk factor for lung cancer in women."

http://www.cheec.uiowa.edu/misc/radon.html

(2) > "16% of lung cancer deaths in Canada were attributable to indoor radon."

> "...indoor radon was significantly associated with deaths from chronic obstructive pulmonary disease, ie chronic bronchitis and/or emphysema."

> "There was a significant positive linear trend in deaths with increasing categories of radon concentrations ($p<0.05$)."

http://www.ianfairlie.org/news/recent-evidence-on-the-risks-of-very-low-level-radiation/

(3) "The lower the radon concentration in a home, the lower the risk of lung cancer as there is no known threshold below which radon exposure carries no risk."

http://www.who.int/mediacentre/factsheets/fs291/en/

IX. Debunking Hormesis

(1) This study found that hormetic effects were short-term, not long-term: "beneficial effects were weakened once LDR treatment was extended to 8 weeks"

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3961432/

(2) Hormesis supporters like to cite the cobalt-radioactively contaminated building study, HOWEVER, another study found that ---> "For exposed mothers, fertility decreased significantly when unprotected intercourse began during the period of living in the radiation-contaminated buildings..."

Conclusions: Our findings suggest that exposure to low-dose ionising radiation of cobalt-60-contaminated buildings may decrease fertility, especially in females."

http://oem.bmj.com/content/67/3/187.abstract

(3) "The question of adaptive responses has been documented *in vivo* and *in vitro* and has been thoroughly reviewed by the ICRP and UNSCEAR, who observed that the protective effect of the conditioning dose appears to last only for a few hours and the ability to induce an adaptive response differs between individuals, with some failing to respond at all."

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2663578/

(4) "Ian Goddard Debunks MIT Study on Low-Level Radiation Exposure"

https://www.youtube.com/watch?v=UmQsPES1qxE&feature=youtu.be

(5) Do you really want to expose people to more radiation, when the

effects of radiation on the brain and brain function are devastating for a society's health and a huge financial burden on a country

Effects of low-level radiation on the brain:

*** “Accelerated aging of the blood vessels – especially of the brain”**

*** organic changes to the brain**

*** “cases of neurological-psychiatric illness were found to be a somatic effect of low-level radiation”**

*** “Reduced brain function”**

*** Schizophrenia**

*** “Psychological disorders suffered by many of the former adult inhabitants of the Chernobyl region could be a result of damage to the nerve cells by nuclear radiation”**

*** Mental illness**

*** "blood circulatory disorders of the brain (cerebrovascular dysfunction)”**

*** "Loss of the higher intellectual cognitive functions as a result of damage to the central nervous system"**

Also, tumors, anencephaly, babies born without brains...

http://www.chernobylcongress.org/fileadmin/user_upload/pdfs/chernob_report_2011_en_web.pdf

(6) A hormesis effect may be seen at one spectrum, yet harm occurs at

another. For example, Donaldson and Bonham, 1970, found an increase return rate of salmon after low-levels of radiation exposure, HOWEVER, in 1964 they showed increases in opercular defects in embryos at the same levels of radiation.* This again shows the lack of homogeneity of "hormesis."

(7) Different temperatures affect radiation responses ---> "temperature can modify biological response to radiation by more than an order of magnitude (causing fractionated or chronic doses to be more clearly additive)*

This means that people living in different climates can have less or more biological radiation effects, proving yet again how hormesis can never be a one-size-fits-all radiation-exposure-model

(8) Hormesis advocates like to say that people living in naturally high background radiation areas do not have greater health effects from the radiation. However, a 2002 study on people living in Ramsar, Iran states: "...we do not claim to have seen hormetic effects in any of those studied."

AND -->

"...the available data do not seem sufficient to cause national or international advisory bodies to change their current conservative radiation protection recommendations." Ghiassi-nejad, M; Mortazavi, SM; Cameron, JR; Niroomand-rad, A; Karam, PA (January 2002). "Very high background radiation areas of Ramsar, Iran: preliminary biological studies" (PDF). *Health physics* **82** (1): 87–93 [92]. doi:10.1097/00004032-200201000-00011. PMID 11769138. https://en.wikipedia.org/wiki/Background_radiation

X. Anthropogenic Radiation – examples of negative effects on the Environment, Animals and Fish, which is why there needs to be as little as possible man-made radiation added to the environment

(1) An experiment by Brookhaven where they irradiated an entire forest in Long Island found that:

* **"The radiation had killed off the armies of decay: fungus, bacteria, earthworms, etc."**
* **"the white oaks looked sick. Soon, they, too, were all dead--and standing"**
* **"Farther on, all the pines were dead"**
* **"Near ground zero, all plants were dead, but they had not decayed"**
  http://articles.latimes.com/2001/jun/10/opinion/op-8635

Trees are also not decaying around Chernobyl.

(2) Cesium137 is used in experiments when they WANT to mutate plants because Cesium137 is a known mutagen:
murphylibrary.uwlax.edu/digital/jur/2000/reynolds.pdf

Mutated plants, animals, and insects were reported after Chernobyl, Three Mile Island, Fukushima, etc.

For example, a 2012 study on pale grass blue butterflies in Fukushima found severe genetic mutations attributed to meltdown radiation.
http://www.nature.com/articles/srep00570

"Insects left disfigured by nuclear radiation"
https://www.newscientist.com/article/dn13760-insects-left-disfigured-by-nuclear-radiation/

>> Important to note: "most experts concur that increases in mutation rates should be considered detrimental" (Newcombe, 1971; UNSCEAR, 1977)*

Repeat: Mutations are DETRIMENTAL.

(3) See *"Effects of Radiation on Aquatic Organisms and Radiobiological Methodologies for Effects Assessment"* at www.epa.gov with studies showing damage to fish and animals at doses of radiation LESS THAN 100 mSv

- **At only 3 mSv = fish embryo were effected**
- **At only 3.77 mSv = dogs became sterile after one year**
- **At only 8.77 mSv dose of C137 = significant increase in mutation rates in mouse spermatogonoia**
- **At only 25 mSv dose of Co60 = prenatal and post natal mortality observed in rats**
- **At below 100 mSv = gamete death and developmental abnormalities to the embryo and fetus have also been observed"**

(4) Nuclear power plants release large amounts of Carbon14, which is converted to CO2 into the atmosphere, and nuclear power plants also release METHANE into the atmosphere, thereby CONTRIBUTING to greenhouse gas problems, climate change and environmental pollution.

In conclusion,

(1) Studies available on hormesis were done using a very CONTROLLED medical-x-ray dose, which is impossible to do with nuclear power plants, with their Gaseous and Liquid effluents that increase and decrease subject to outages, weather, man-made error, pipe leaks, refueling, etc.

(2) Radiation-hormesis TARGETS specific cells, but how can you target a specific cell with a gas or liquid effluent released into the air or into the water? It would be like trying to nail jello to a wall, imho.

(3) How would you measure the dose that EACH and EVERY person in the U.S. receives, and every visitor to the U.S. receives, to make sure they don't go over the nuclear-worker dose or the "hormesis" dose ?

That would be a logistical and economic and financial nightmare.

(4) Numerous studies prove deleterious health effects of doses of radiation well under 100 mSv, as listed in this document

(5) Hormesis can never be a one-size-fits-all model for radiation protection, imho, because the radiation doses can never be strictly controlled, and because different types of radiation affect genes, cells, DNA, etc. differently...and each person reacts differently to radiation exposure....and even different climates cause radiation to behave differently. There are just too many influential variables.

(6) Man-made radionuclides have not been thoroughly studied regarding radiation-hormesis, and man-made radionuclides are what the NRC has oversight over

(7) Numerous studies prove the validity of LinearNoThreshold model, and it is tried and true protective model because it strives to lessen radiation exposure, not increase it

(8) Here are just some of the Dangers of low-dose radiation and increasing exposures could increase these Dangers

- **Cancers**
- **Cell damage**
- **Gene damage**
- **DNA damage, single-strand breaks, double-strand breaks, unwinding**
- **Damage to the mitochondrial function and mitochondrial DNA**
- **DNA lesions**
- **DNA genomic instability**
- **Leukemia**
- **Cell mutations**
- **Gene mutations**
- **Genotoxicity**
- **Chromosomal aberrations**
- **Heart disease, diabetes, circulatory disorders, neurological damage**
- **Stochastic effects**
- **Somatic effects**
- **Bystander effects**
- **Transgenerational effects**
- **Tissue-reaction**
- **Cataracts**
- **Tumors**
- **Liquid Peroxidation**
- **Cell Cycle Arrest**
- **Apoptosis**
- **Aplastic Anemia and Myelodysplastic Syndromes**

>> If the NRC is going to consider "hormesis" radiation amounts to the general public, then the public needs to be informed of ACCURATE and ALL releases from nuclear power plants which the public may be exposed to, in order to keep the publics' "hormesis" levels in-check.

To accomplish this, accurate radiation monitors would need to be installed around every nuclear power plant, with their radiation effluent releases measured and access of these measurements given to the public on a minute-by-minute basis. In addition, radiation detectors will need to be placed around every home so that each person can keep track of their radiation load. The cost to do this would be infinite. In addition, each person would need to be administered a dosimeter to have their radiation levels monitored.

>> Finally, this report which began with a quote from Discover Magazine will conclude with a quote from Discover Magazine:

"...sensitivities can vary from individual to individual by a factor of 10 to 100. A dose that stimulates hormesis in one person may well be toxic to another. That variability is a major reason why hormesis won't add new medicines to our cabinets anytime soon." http://discovermagazine.com/2002/dec/featradiation

Thank you very much for considering the research put forth in this paper.