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General Comment

I am in favor of eliminating use of the LNT model of radiation effects.
Please see the attached file for detailed comments,

Thank you,

Jacquelyn Yanch
Falmouth, MA

Attachments

NRC-2015-0057

Comment on Docket ID NRC-2015-0057.

Submitted by: Jacquelyn Yanch, PhD

I am in favor of eliminating use of the LNT model of radiation harm and of the NRC's transition to a threshold approach to estimating radiation effects.

The NRC's adoption of the LNT model of radiation effects establishes their position that all radiation is dangerous, regardless of dose, regardless of dose-rate. This position is not scientifically defensible (see below), and further, its adoption by the very agency responsible for worker and public radiation safety before an accident will make it difficult, in the post-accident scenario, for any agency to engage in productive discussions with the public concerning when (at what dose-rate) to accept living in a contaminated environment and when to abandon a once productive, populated area. Discussions regarding such trade-offs will be critical should an accident contaminate a large, densely populated area or where options for permanent relocation are minimal or very undesirable.

The NRC must consider how establishing LNT as their radiation effects model during normal operations will impact the public's need for an accurate understanding of radiation risk in the event they must deal with a contaminated environment. Although the NRC has limited regulatory responsibility beyond the site boundary of a power plant, and although other agencies will deal with emergency actions and return-home dose-rates following an accident, the NRC has a moral responsibility to consider the impact its policies and positions will ultimately have on the public it serves.

Our radiation risk estimates have been generated for the express purpose of protecting workers and the public from man-made sources of radiation during routine facility operation. Several conservative assumptions are applied and these are clearly stated throughout the process. The largest of these is the adoption of the LNT model of radiation harm. Even though the risk that LNT predicts is often small compared to other risks, this point seems to be lost on a public that hears "there is no safe dose".

The NRC should eliminate use of the LNT because the need of the public to have a more accurate understanding of the effects of radiation supersedes the desire for building conservatism into the workplace radiation safety scenario. This process must begin now, before an accident has taken place.

Scientific Validity of the LNT model:

LNT is the most often used model of radiation effects, however it is not the model that best fits the actual data we have concerning the effects of long-term, low dose-rate radiation.

There have been many studies that demonstrate no deleterious effects and many others that demonstrate positive effects of long-term, low dose-rate irradiation of laboratory animals. NCRP 64 (1980) provides a significant discussion of these findings (ref. 3) and further references are supplied in many of the comments submitted by others. Numerous studies have demonstrated no deleterious effects in large populations living in high natural radiation background areas. These facts alone invite a new look at how radiation risk estimates are generated, a process that has not changed in several decades.

I will take this opportunity to discuss a recent study of radiation workers employed in France, the U.K., and the U.S.A. The results of this study were reported in two papers published this year in July (risks of leukemia, ref. 1) and October (risks of solid cancers, ref. 2). The study examined cumulative radiation doses and worker health records for over 300,000 nuclear power plant workers and thus is highly relevant for the specific population that the NRC oversees.

The purpose of this study was not to investigate which model of radiation health effects best fits the data. The authors state that "the objective of radiation epidemiological studies is generally to evaluate whether there is an increased cancer risk following radiation exposure". Therefore they performed a 1-sided *p*-test on the data and applied LNT, "the model generally used in studies of radiation effects."

For the purpose of addressing the petitions in front of the NRC at this time, it is unfortunate that the threshold approach or the hormesis models of radiation effects were not tested against the radiation worker data collected in this study. The investigators did, however, test the LNT model against a quadratic model with leukemia data. Interestingly, they found the quadratic model provided both a better fit to the data and a superior (by a small amount) Akaike Information Criterion (AIC) value. [The AIC is a method of comparing two models. It contains two terms: one term sums the differences between model-predicted estimates of risk and the actual data points, the other term provides a penalty for each degree of freedom in a model. Since the quadratic model has two degrees of freedom compared to only one for LNT, the quadratic model is penalized by the AIC. The fact that even with this penalty the quadratic model provides the superior AIC value indicates that this model fits the data substantially better than the linear model.]

The investigators took a different approach with the evaluation of solid cancer data (ref. 2). Here the LNT model results were compared with a model that included a dose squared term (presumably a linear quadratic model (LQ)) and the two models were compared relative to each other by the likelihood ratio test. Use of the linear quadratic model "led to little improvement in the model goodness of fit" relative to LNT. If the LQ and LNT models fit the data equally well, an obvious question is: how well would a threshold model fit the data? This question is also suggested by the data at 15 mrem and 250 mrem cumulative doses, both of which show negative rather than positive risk estimates (ref 2.). The same question can be applied to the leukemia data.

Although this study does generate risk estimates based on the LNT model, it cannot be said that this study demonstrates that the LNT model is the best fit to the data, nor can it be said that this study supports the position that all radiation is dangerous, no matter the dose, no matter the dose-rate.

My purpose with this discussion has been to demonstrate why transitioning away from the LNT has more scientific validity than maintaining this model as the NRC's position on radiation health effects. More importantly, I urge the NRC to avoid use of the LNT because of the message its use sends to the public, and the problems this message presents in the event of a severe reactor accident involving environmental contamination. Anticipation of these problems and their potential minimization, *a priori,* should be of paramount importance to the NRC.

References:

1. K. Leuraud, D. Richardson, E. Cardis et al, "Ionising radiation and risk of death from leukaemia and lymphoma in radiation-monitored workers (INWORKS): an international cohort study", Lancet Haematol 2015; 2: e276-81.
2. D. Richardson, E. Cardis, R. Daniels, et al, "Risk of cancer from occupational exposure to ionizing radiation: retrospective cohort study of workers in France, the United Kingdom, and the United States (INWORKS)", BMJ 2015; 351:h5359.
3. "Influence of Dose and its Distribution in Time on Dose-Response Relationships for Low-LET Radiations" NCRP Report No. 64, April 1980, National Council on Radiation Protection and Measurement, Bethesda, MD.