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THE LINEAR HYPOTHESIS - AN IDEA WHOSE TIME HAS PASSED

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INTRODUCTION

There are three things I would like to have you take away from this paper:

1. A clear idea of what the linear hypothesis is and how it came about
2. How the hypothesis was corrupted and what has happened to the nuclear industry as a result of the corruption
3. One possible solution to a major problem for the nuclear industry

There may be many of you who already know what the linear hypothesis is and how it came about. To those people, my apologies, and, if you hear anything that doesn't agree with your experience, please make the appropriate statements during the question and answer period. But, I do want all of us to be "on the same wavelength" as I develop the ideas in this paper. For time savings I will refer to the linear hypothesis as the LH. So, first, some history.

HISTORY

About 1928, some deleterious effects of high doses of ionizing radiation were clearly observed. A concerned group of international workers with radiation and radioactive materials got together to establish some standards for radiation protection. They recommended some numerical values for maximum permissible doses, but, because they couldn't establish a threshold for radiation effects, they said: "The most conservative approach would be to assume that there is no threshold and no recovery, in which case even low accumulated doses would induce leukemia in some susceptible individuals, and the incidence might be proportional to the accumulated dose."¹

The International Commission on Radiological Protection (ICRP) turned that statement into what we now call the linear no-threshold hypothesis and stated it as: "One such basic assumption ...is that...there is...a linear relationship without threshold between dose and the probability of an effect."² The National Council on Radiation Protection and Measurements (NCRP) stated the hypothesis as: "In the interest of estimating effects in humans conservatively, it is not unreasonable to follow the assumption of a linear relationship between dose and effect in the low dose regions for which direct observational data are not available."³

Two concepts developed from the LH, namely: The As Low As Reasonably Achievable (ALARA) and Collective Dose (CD) Concepts .

ALARA

The ALARA concept was first set forth in 1958 by the ICRP as follows: "It is emphasized that the maximum permissible doses recommended in this section are *maximum* values; the Commission recommends that all doses be kept as low as practicable, and that any unnecessary exposure be avoided"⁴

COLLECTIVE DOSE

The CD concept was first set forth in 1977 by the ICRP as follows: "Collective dose is the average dose to a group of individuals multiplied by the number of individuals. Collective dose is expressed in man sieverts." We will talk more about these two concepts later.

STANDARDS SETTING

Please note that the LH assumption/hypothesis was initially intended to be used only for standard-setting. Everyone knew that it didn't necessarily represent reality. However, along came the government regulators.

REGULATORY AGENCIES

All of the federal regulatory agencies generally adopted the ICRP and NCRP recommendations and gradually turned the ALARA recommendation into a requirement until, today, there are thousands of individuals working diligently in parts of the nuclear industry to keep doses ALARA. At great expense.

Also CD has crept into the regulatory agenda, particularly into Environmental Impact Statements where millions of people are hypothesized to receive fractions of a millirem over thousands of years so hypothetical cancers can be said to occur, so billions can be spent to prevent those tiny doses.

CORRUPTION

More insidiously, however, has been the corruption of the LH from "a little radiation MAY produce harm" to "low doses of radiation WILL KILL you." The assumption has become reality for millions of people.

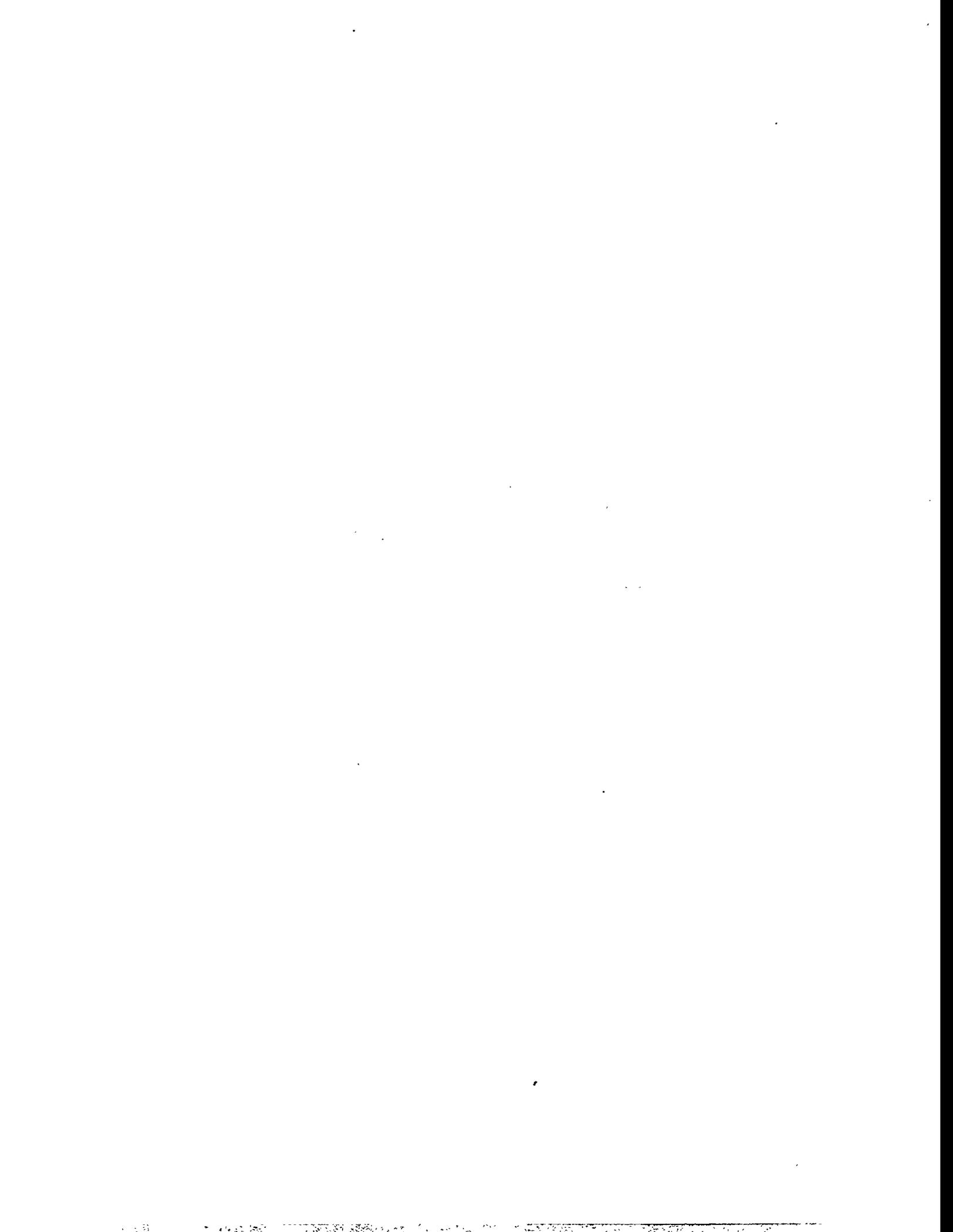
The EPA is particularly at fault by stating: "... it is assumed that there is no completely risk-free level of exposure."⁵ The public interprets that statement as: "radiation will kill me."

How did this corruption of the LH occur? It has happened over many years.

I submit that it occurred for at least three reasons:

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First, use by the federal regulatory agencies, primarily NRC, DOE and EPA of the linear hypothesis as the basis for their regulations and guidance.

The EPA has explicitly stated many times that it uses the linear hypothesis as the basis for its regulations and guidance. For example, the EPA 1987 Radiation Protection Guidance to Federal Agencies for Occupational Exposure states: "Based on extensive but incomplete scientific evidence, it is prudent to assume that at low levels of exposure the risk of incurring either cancer or hereditary effects is linearly related to the dose received in the relevant tissue. Thus, for these two types of effects, it is assumed that there is no completely risk-free level of exposure."⁶ This EPA guidance is the mandatory basis for all other US federal radiation regulation programs.

The problem is that the EPA doesn't emphasize enough the word "assume." So all the public hears is: "There is no completely risk-free level of exposure."

Second, laziness on the part of professional people and scientists in the nuclear industry to explain to the public the real idea: that, because we don't know low dose effects, if any, we are prudently assuming, for purposes of radiation protection, that low doses may cause harm. It is not easy for a scientist to say, "I don't know" when pressed for an answer by the public or, more importantly, by congress.

It is very hard for many scientists to make a categorical statement that low doses of radiation are safe even when they believe that they are. So I perceive that, rather than say, "I don't know if low doses are safe," the scientific community has simply let the corruption stand because it was easier.

One alternative to saying low doses are safe is to say: "low doses are not unsafe." One can place the burden of proof to demonstrate that such doses are, in fact, unsafe rather than fall into the trap of trying to demonstrate safety. I think most scientists would be willing to say: "low doses are not unsafe."

The third, and perhaps most important reason for the corruption is because a very dedicated and relatively large group of people, who have an agenda that includes the death of the nuclear power option, consciously, actively and vigorously have fostered the corruption. One reads in newspapers, news magazines and newsletters about the fact that a little radiation, no matter how small, is harmful. That statement is made most often by individuals who are against various nuclear facilities. Also, one hears the anti nuclear people make the corrupted statement on TV talk shows or in various 60-minute or 20-20 segments. The anti nuclear people write the corruption frequently to members of congress and various state legislators and governors. These dedicated people thus influence many less dedicated but well-meaning people to accept the anti nuclear point of view.

Let me restate the current paradigm as: "A little radiation, no matter how small, will hurt you."

How did the LH become corrupted from: "Low doses of radiation MAY cause effects," to "doses

of radiation, no matter how small, WILL harm you.”

1. The regulatory agencies, particularly the EPA, did not and do not emphasize that their estimates of radiation effects are only that - estimates and do not necessarily represent reality. The EPA says: “It is assumed that there is no completely risk-free level of exposure.”⁵ but, after it says that once, it omits the “assumed” and states its calculated deaths as though they were real. The public reads right over the first “assumed” and only sees the deaths. So the EPA is guilty of not ensuring the public is correctly interpreting what the EPA writes.
2. The anti-nuclear people have gaily latched on to the corruption and use it for all it is worth to frighten the public about the effects of radiation. So the anti-nuclears are guilty of creating fear when there may be no reason to fear low radiation doses at all.
3. The nuclear industry itself has not countered the corruption whenever it was stated. So the nuclear industry is guilty of permitting the corruption to stand.
4. The public has accepted uncritically the anti-nuclear people’s untruth. So the public is guilty of not looking into the matter sufficiently.
5. The Congress, without thoroughly researching the basis for the ICRP and NCRP recommendations, has made conflicting and ambiguous laws that incorporate the corruption. So the Congress is guilty of perpetuating the corruption.
6. The media have accepted uncritically the anti-nuclear people’s untruth. So the media is guilty of not researching its sources thereby permitting the corruption to continue.

From the list above we can see that we are all responsible for creating and perpetuating the corruption.

How have the various players interacted to create the corruption? The anti-nuclear people have been the most active. They feed the media and the regulators biased information to further their agenda of destroying anything nuclear. The nuclear industry has not done enough to counter that information. Congress has not held the kind of hearings it did in the 50s and 60s to get the facts about things nuclear. The scientists have adopted the most conservative model and have not done enough to ensure the public knows it is only a model and the real radiation effects may be zero or even beneficial. The media are just as afraid of radiation as the public and use fear to sell their products. The public accepts the media information without question. So, all players interact with each other with a very detrimental result.

RESULT

What has been the result?

No new nuclear power plants in the US.
No fuel reprocessing.
No research on new reactor types.
No mixed oxide fuel use.
No breeder reactors.
No new radioactive material waste disposal sites.

I lay that result directly at the feet of the linear hypothesis.

Now, lest I be branded an extremist, I hasten to add that the nuclear industry is one of the safest, if not the safest industry in the USA. That record, in part, is directly due to the LH. Nuclear workers and the public are not exposed to radiation doses that can be observed to be harmful, now, and probably not ever, even if low doses really are harmful.

QUESTIONS

The significant question we must ask is: "Does this benefit really justify the cost when the death of the nuclear industry is foreseeable?"

Another, rather cynical question that must be asked is: "What vested interest does the radiation protection profession, instrument manufacturers, radon industry, industrious regulators, etc. have in keeping the LH alive?"

ALTERNATIVE

One should never have a criticism without an alternative. I suggest the following to replace the LH.

Establish two sets of standards, one having to do with human and environmental health and safety, the other for protection of manufactured items and premises. The safety standard could be some dose such as 5 rem per year. However, one would not necessarily want radioactive material all over everything such that a significant fraction of the safe dose were to come from contamination. The low level radiation detection instrument manufacturers, photographic film makers, computer chip manufacturers, low level counting laboratories, research laboratories, etc. would not like contamination by radioactive material in their facilities. So, the standards for protection of items and premises would probably be more stringent than the safety standards. The public would see that, even though the latter standards were more stringent, the stringency is needed to protect things, not people. They would see that a little radiation is not necessarily harmful.

An ancillary benefit of the demise of the linear hypothesis is the concomitant demise of the ALARA concept below the annual limit. Also collective dose at low doses goes away. Safety is not diminished or compromised by the loss of those two concepts, but much cost is saved.

BENEFITS

Finally, the benefits of the two-tier radiation standards system are:

1. It is safe until demonstrated to be unsafe.
2. It is simple.
3. It is cost effective.
4. It clearly separates human safety from "thing" safety.
5. It will alleviate public fear of radiation.

And, last, but not least, it will assist in ensuring the continuation of the benefits of the nuclear industry.

REFERENCES

- (1) ICRP-1, Recommendations of the International Commission on Radiological Protection, Adopted September 9, 1958, pg 4, ¶ (5).
- (2) ICRP-26, Recommendations of the International Commission on Radiological Protection, paragraph 27, 1977.
- (3) NCRP-39, Basic Radiation Protection Criteria, pg 55, 1971.
- (4) Recommendations of the International Commission on Radiological Protection, Adopted September 9, 1958, ICRP-1, pg 11, ¶ (45).
- (5) 52 FR 2822, Federal Radiation Protection Guidance for Occupational Exposure, pg 2824, 1/27/87.
- (6) 52 FR 2822, Federal Radiation Protection Guidance for Occupational Exposure, *ibid*.

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