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WHAT SHALL BE DONE ABOUT THE "MAXIMUM PERMISSIBLE DOSE"?

At the present time the "Maximum Permissible Dose" established by the Guidelines of the National Radiation Council happens to coincide with the national average of radiation exposures which is 0.17 rem/year. This average is due to natural background radiation (0.1/rem/year) and needed diagnostic x rays (0.07 rem/year). Recently it has been proposed that the "Permissible Dose" be lowered at least to 0.017 rem/year.

In the following, arguments will be given for maintaining the present standards. Suggestions are added concerning needed research and better procedures of enforcement.

The present guidelines for "Permissible Doses" should not be lowered for the following reasons:

1) On the basis of common sense the present guidelines are safe.

The main reason for this statement is that the guideline coincides with the average exposure due to causes other than atomic energy developments. This exposure has existed for a long period and furnishes a strong link with experience.

It is generally recognized that the danger to an individual is small if 0.17 rem/year is added to the existing average of 0.17 rem/year. The fact that the chance of damage is so small makes it most difficult to find and to prove damage at these low levels of irradiation.

The opposing argument is that exposure of millions of people may result in numerous cases of damage, even though the probability for any individual is small. This argument must be recognized. At the same time, one should remember that the best evidence we possess is the fact that radiation backgrounds, which vary with location, have not given rise to catastrophic or even to clearly demonstrable effects. Thus, worldwide average irradiation is a valuable source of information concerning the effects, or rather the absence of the noticeable effects, of low-level exposures. It is difficult to perform experiments which have validity similar to this source of information.

For the sake of comparison one may raise the question what would happen if all pollutants, such as stack-discharges and automobile exhausts would be limited to amounts equal to natural background. In that case automobiles of the present type would be eliminated and most of our industries would be shut down. If such regulations were to be enforced only hydroelectric plants, nuclear plants and installations driven by these plants would survive.

The comparison is, of course, unfair. Many substances released into our environment are not found in any appreciable amounts in the natural state. Furthermore, in case of chemical pollutants it is extremely hard to demonstrate that the released material is harmful or that it is completely safe.

In case of radioactive releases, we are in a more fortunate position. We know that all kinds of hard radiation delivered to the living cell has the same kind of an effect. Moderate differences do occur between x rays, β-rays, γ-rays, neutrons, and cosmic rays. But drastic differences and consequent surprises are ruled out by the uniform nature in which such radiations affect chemical and biochemical substances.

It is, of course, true that different cells and tissues have widely different sensitivities to hard radiation. Therefore, the radiation guide must be applied with care. In general, one may argue that no human organ should receive more additional radiation than is delivered to that organ by the original average radiation. Thus, no organ should be exposed to more than corresponds to twice the average radiation. This is, in general, how the present radiation guide is applied.

Finally, one should note that many radioactivities, in particular a great fraction of the most common β-activities, are easily discovered and measured. This facilitates monitoring. It also raises public awareness. In case any exaggerated claim is made about radioactive hazards this awareness can give rise to unnecessary alarm. In view of all these circumstances it is wise to base guidelines on old and established averages.

2) Lowering the "Permissible Dose" to a .017 rem/year would hardly save any lives. On the other hand, such an action would result in a loss of considerable benefits and would also give rise to needless complications.

If one applies an estimate of radiogenetic leukemia cases, if one assumes that all cancerogenesis by radiation behaves like leukemia, and if one further assumes that the whole United States population is exposed to the "Maximum Permissible Dose", one obtains by straight multiplication that in the long run more than 16,000 additional cancer cases per year should be expected.

Some doubts exist about all the assumptions which have been mentioned. But the weakest point in this line of argumentation is the assumption that, indeed, all of our population should be exposed to the "Maximum Permissible Dose". Enforcement did proceed and will continue to proceed in practice along such lines that even exposure of quite limited groups of people to more than the "Maximum Permissible Dose" becomes quite unlikely. The result is that doses less than the "Maximum Permissible Dose" are also delivered on relatively rare occasions, particularly since everybody applies considerable safety factors. If actual exposures due to

local releases from reactors or Plowshare explosions are taken into account, one finds on the basis of the remaining conservative assumptions that not more than one additional cancer case per year within the United States should be expected in the long run.

A somewhat greater number of cases might conceivably occur due to the widespread distribution of materials released from reprocessing plants. However, these gaseous products will show great local concentrations near the reprocessing plants and thus the "Maximum Permissible Dose" as applied to the neighborhood of the reprocessing plant will again introduce effective controls. I did not intend to undertake the arduous and uncertain task of evaluating actual damages. The intent of the above figures is merely to indicate how grossly one would be misled if one would take the 16,000 additional cancer cases per year as an effective estimate of what does occur or is likely to occur.

Procedures exist in many cases by which radioactive body-burden can be removed if this body burden should exceed the "Maximum Permissible Dose". Thus occasional exposure of people to excessive radiation can be counteracted and the relatively small hazard to a limited number of people need not be incurred. All of this can and should proceed under the present guidelines.

One case where a "Permissible Dose" of .017 rem/year may lead to substantial complications would be in the international field. Release of tritium and radio-krypton from reprocessing plants may lead in the future to radiation in excess of .017 rem/year. I believe that this can be avoided but as yet methods have not been worked out and it is not possible at the present time to give conclusive statements concerning the necessary costs.

Of special interest in this case is that the radionuclides just mentioned may be distributed on a worldwide scale. While the United States is at present in the leading position in production of nuclear energy and while I consider it likely that we can afford the cost to avoid the uncontrolled release of tritium and krypton from reprocessing plants, I find it hard to predict what will happen in many other countries which will need and demand nuclear energy, and which may have to apply more stringent economies. Guidelines which we introduce will have to be agreed upon by the international community. If we should attempt to take a strict attitude which will permit averages of exposures to radioactivity to rise by no more than a small percentage, it may turn out to be difficult to impose such limitations outside the borders of the United States.

It might appear to be wiser to make our laws more liberal and to make sure that these laws are applied and followed within the United States in an effective manner.

In this way we can accomplish by example what might otherwise be difficult to enforce.

One should pay particular attention to the benefits which result from the application of nuclear energy and to the elimination of some of these benefits if the radiation guide should become too rigorous. Substitution of nuclear plants for electric generators which burn fossil fuel will decrease air pollution. This latter danger to health is great. It is known that during a sustained inversion in the area of New York City the number of deaths in New York City hospitals increase by several hundred. It is possible to use cleaner fossil fuels but this runs into economic and political difficulties. One should give much higher priority to the reduction of the use of sulphur-containing fuels than to the further reduction of radioactive release. Alternatives which would permit to lower the release of sulphur oxides should be clearly spelled out.

A second benefit which might suffer unnecessarily by strict regulations is the Plowshare project. Due to exceedingly great caution, the development of that project has been slow. We have to rely on plans and guesses concerning possible benefits.

In general terms it can be said that the benefits would accrue in transportation and in mining. The ultimate advantages could be greater than those which one can derive from nuclear reactors.

One potential application of Plowshare is specifically relevant to pollution abatement. With the help of Plowshare one can create safe storage space at great depths for radioactive and chemical wastes. These contaminants would be effectively eliminated from the biosphere.

3) A drastic reduction of the "Permissible Dose" has been proposed by Gofman and Tamplin to the Sub-Committee on Air and Water Pollution in the following words: "We shall present to you hard evidence that leads us to recommend that this be reduced <u>now</u> to 0.017 Rads or even less. And we shall present to you the estimated disastrous consequences to the health of the public if this recommendation receives less than immediate, serious attention."

The disastrous consequences mentioned here consist of the additional 16,000 cancer cases per year which have been discussed and shown to be inapplicable under the preceding discussion. It is also to be noted that the statements of Gofman and Tamplin are not based on hard evidence as claimed.

The statements of Gofman and Tamplin are actually based on two assumptions.

One is that the probability of damage is proportional to the amount of irradiation (assumption of linearity and absence of a threshhold). The other is that continuously delivered dosage has the same effect as rapidly delivered dosage.

There is only one example where to my knowledge proportionality between dosage and its effects has been supported by consistent observations. This is the case of mutations caused by irradiating spermatozoa, that is, mature male sex cells which consist of a cell nucleus and a propulsive mechanism but no cell body. In all other cells connected with genetic effects (spermatogonia and the female oocytes) in which a substantive cell body is present, repair mechanisms seem to exist. This has been demonstrated by the work of W. L. Russell and his co-workers in Oak Ridge during the past two decades. In cancerogenesis on which the argument for reducing the "Permissible Dose" is based, a cell body is present. Therefore, one can argue against the basic assumptions which have been used at least as easily as one can argue for them. Actually, most of the observations on cancer production are connected with sudden irradiations at much higher levels than corresponds to present "Permissible Dosages". Under the conditions of great and sudden irradiation the protective or repair mechanisms afforded by cell bodies are known to be less effective than is the case for protracted irradiation at a low level. Therefore, the assumptions made in connection with cancerogenesis are probably pessimistic and the evidence cannot be considered hard in a proper scientific sense.

In order to increase both knowledge and safety, and in order to find practical ways in which to enforce guidelines, and avoid unnecessary loss of benefits, the following suggestions may be made:

A. Careful statistical studies should be carried out of the effects of excess radiations where ever they exist. Colorado and the Monazite-rich regions of Kerala and Brazil are examples. Such studies will be difficult. Not to attempt them would be a mistake.

B. Added attention should be given to the various processes by which radioactivities can be concentrated in nature, in the biosphere, and particularly in the human body. Such studies are underway and they should be much more strongly supported. It is by such studies that one can avoid surprises and foresee the most practical methods by which excessive amounts of radiation can be prevented.

C. Expressions such as "Maximum Permissible Dose" should be avoided. Instead it would be reasonable to compare the effects of all radioactive releases with the effects of average radiation exposures. (Apart from the use of the words, this corresponds to present practice.)

When the effect of released radiation reaches at any instance the average radiation (that is, when the effects of the United States average is doubled) in any human organ, or when there is enough fallout to threaten such a concentration in a human organ, protective measures should be taken at the expense of the parties responsible for the radioactive contamination. These protective measures may consist in the removal of some radioactivity from the affected people. In case of tritium contamination, methods for doing this are available. In case of strontium or iodine there are methods to accelerate elimination. With more research and development these methods can probably be improved. In other cases contaminated materials could be removed from the food chain. These protective measures shall proceed promptly whenever the affected people request it.

It should be realized that at present protective measures are only partially effective. In the important case of tritium they are quite effective.

By making them available one can greatly reduce needless worry. Thus, in the long run one can hope to hold actual damage to a minimum even in the few cases where releases exceeding the national average have taken place. In this way it can be made clear that the result of inadvertent release will become primarily an inconvenience to the affected people. It is improper to concentrate on the frightening aspects of improbable fatalities when there are good prospects that methods for preventing such fatalities can be developed.

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