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SOME NON-SCIENTIFIC INFLUENCES ON RADIATION PROTECTION STANDARDS AND PRACTICE

Lauriston S. Taylor*

I. INTRODUCTION

In the practical application of the principles of the achievement of protection against harmful radiation effects, our greatest obstacles today do not include a lack of knowledge about the biomedical effects of ionizing radiation. Today, we know about all we need to know to adequately protect ourselves from ionizing radiation.

Let me repeat that. Today, we know about all we need to know to adequately protect ourselves against ionizing radiation. Therefore, I find myself charged to ask: What is the problem and why is there one? I suspect that most of us here today know in a general sort of way where the problem lies and that basically it is not a scientific one. Rather, it is a philosophical problem with all the ramifications implied in the term. Or perhaps it may be a political problem, that is, one requiring prudence and sagacity in devising and pursuing measures adapted to promote the public welfare, or perhaps the problem may not be as much protecting ourselves against radiation as protecting us against ourselves. In any case, I sometimes think that today we are – in many areas – tormenting ourselves through our obsession with health (W.P. 8-28-79).

The control and management of any toxic agent, including radiation, requires a critical knowledge of the properties, characteristics, and biomedical effects of the agent. Furthermore, if control is to be absolute in the scientific sense, there must be either an establishable threshold below which there is no effect, or total elimination of the agent.

It is obvious that as far as we know today, neither of the above points can be met for ionizing radiation. Therefore, we must resort to other means, either political or philosophical or both, to arrive at some acceptable solution to the radiation control problem.

In developing my theme I shall mention, at least briefly, several non-scientific factors which may influence protection practices directly or indirectly and thus, in turn, influence the setting of our numerical protection standards. By and large, it is usually the needs of practice that dictate the setting of standards and the standards themselves must always represent some degree of compromise between a politic use of radiation and its elimination.

Little said today can be new or innovative but will be designed mainly as reminders to radiation protectionists of the things that they should be aware of and prepared to discuss in public forums. Some items need to be promoted; others rationalized, and still others, defended. Throughout, in relations with the public, we must avoid being patronizing and avoid any appearance of self-promotion.

Let us turn now to a brief discussion about the state of our current knowledge of the biomedical effects of ionizing radiation.

II. BIOLOGICAL EFFECTS OF RADIATION

Collectively there exists a vast array of facts and general knowledge about ionizing radiation effects on animal and man. It cannot be disputed that the depth and extent of this knowledge are unmatched by any of the myriads of other toxic agents known to man. It is because of this knowledge, portions of which have become known to the public, that the public has come to expect sharp, clear, definitive, and undisputed answers to any questions involving radiation. This is an understandable, if somewhat

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* Formerly President of the National Council on Radiation Protection and Measurements

irrational, position. However, it leads to the difficulty that when there may be some indication of a lack of knowledge by, or disagreement among, scientists, the public feels that somehow they have been let down or led astray by the scientific community. A good example of this is the current so-called "controversy" within the protection community centering around the effects of radiation delivered in low doses at low dose rates. Were it not for a few congressional committees, more interested in headlines than facts, aided and abetted by a willing press and a few publicity-seeking "scientists", it is likely that the question would drone on in the normal scientific meetings and committees at a proper pace, commensurate with its importance. It's not that it is unimportant, but its priority should be low compared with so many other insults that man faces.

Let us quickly review some of the facts related to ionizing radiation and the injuries that may be caused by it.

Ionizing radiation, delivered in sufficiently large amounts, can cause determinable effects or injuries to any biological system. However, for any particular effect observed, radiation would not necessarily have to have been the causative agent.

Radiation effects are generally proportional to dose when delivered acutely in moderate amounts, say 100 rads upwards, to the regions observed. Precise proportionality is difficult to establish.

There may be long latent periods between the time of exposure and the appearance of any effects that might reasonably be attributed to that exposure. Large doses above 500 rads can show effects within minutes or hours. Low doses below 50 rads may not show any effects for periods up to several tens of years, if ever. In general, the lower the dose and the rate at which it is delivered, the longer will be the period of latency before the effect manifests itself. We have here a generally inverse relationship between dose and latent period. The problem becomes especially critical in the low-dose region, say below 25 or 50 rads, delivered acutely, for which the latent period may be three or even four or more decades. During that long a period any individual would be subjected to hundreds of other insults, any number of which might produce the same effect as the radiation.

Man has always lived in a radiation environment which, except for a very small increment due to weapons testing, has been essentially constant. Galactic radiation levels have changed little, except for rare but very large changes associated with reversals of the earth's magnetic field.

There is uncertainty about the existence of threshold effects for ionizing radiation. There are very few threshold effects, although there are clearly some.

For the purpose of numerical protection standards, it is assumed that unless the contrary is clearly identified, any radiation may cause an effect, if not an injury. The development of a clear-cut position on this question runs into complications. Here we encounter a further difficulty. If one is concerned about the degree of hazard in the region where effects cannot be found or identified, to what extent should an attempt be made to further "reduce the hazard" to some fraction of what could not be found in the first place? The question is "how large is half of something that cannot be measured?"

Dose effects are not cumulative; there is some process of repair or recovery or replacement of cells, both of a genetic and somatic nature.

Today we know enough about dose-effect relationships to state unequivocally that at least for low-LET radiations the relationships cannot be strictly linear over the whole dose range and that even for high doses they are probably not linear.

The difficulty is that since we do not know the precise relationship - and perhaps it doesn't make much difference anyway - it is assumed, as a matter of cautious procedure, that the dose-effect relationships are linear throughout the entire dose range. This assumption is constantly being subjected to hard scrutiny because, taken too literally, it may lead to unnecessary and unjustifiable restrictions on the use of ionizing radiations.

From the mere fact that radiation may cause some identifiable effect, it does not follow that the effects are necessarily detrimental.

For purposes of protection against ionizing radiation, we have to deal with effects; detrimental effects; risks; quantities observable or unobservable; and so on. We have now ventured outside of the scientific arena.

III. NON-SCIENTIFIC ASPECTS OF RADIATION PROTECTION

Over the past several decades, there has been a gradually developing consciousness of the inadequacy of scientific data or reasoning that alone will lead to the establishment of unequivocal numerical radiation protection standards. In the late 1940s it was clear to the NCRP, and probably to other bodies, that non-scientific factors would be involved in permissible dose standards. In 1957 I argued (cite):

"Radiation protection is not only a matter for science. It is a problem of philosophy, morality, and the utmost wisdom." At later times I have added "economics, politics, and public involvement" but actually they are all segments of an overall philosophical approach. I shall select a few of these for special comment.

PHILOSOPHY. Absence of a threshold leads immediately to the difficulty that there is no line of demarcation between the regions where scientific evidence does or does not exist; where evidence is not found, it is simply assumed to exist - a judgmental decision. It is obvious that, in reaching such a decision, a very non-scientific matter would play an important role. I refer to the pure emotions, not only of some scientists themselves but also of the lay persons who understand only bits and pieces of the problem and who realize that they have to depend upon the scientist.

"What are the judgment elements entering into a standards setting process?" Basically, the arguments would center around the degree of risk that those who were setting the standards would be willing to inflict on others or, as a part of the public, to accept for themselves. How do you evaluate and describe quantitatively a situation, or more likely a combination of situations, each having its own set of values and its own descriptive units, and none having any unique relationship to ionizing radiation. For example, what is an effect and what is an injury and when is one not the other?

Comparisons of effects and injuries have been attempted in a variety of ways, particularly in the last decade or so, and it would seem that the only comparison unit which has come to our imagination has been monetary, such as the dollar or the mark. The arguments for choosing monetary value seem at times to be frivolous, but for obvious reasons nothing better seems to have turned up. The problem becomes even more involved if one tries to evaluate, let us say, pain or mental anguish which can be two obvious "effects" that might be caused by radiation, but still short of death.

Let us consider that risk, however we decide to describe it, is roughly proportional to radiation dose. Why are people willing to accept any risk at all? This argument applies to practically everything we do in life, with radiation being perhaps one of the smallest risks that we normally have to contend with. For all practical purposes, it is only in the use of medical procedures involving radiation that the risk, if any, is compensated by some benefit to the person at risk. It is also the area where one is most likely to find the situation that the risk of not carrying out some action (for example, an x-ray examination) is more hazardous than any conceivable risk to an individual from radiation.

Since risk questions do not really have discrete and scientific solutions, we are compelled to accept a philosophical approach. What is needed, on top of our scientific knowledge, which I contend is adequate at this point, is a large supply of basic wisdom and understanding. Question: Who has it? To whom do you look for it? How far can it alone suffice to complete the problem and develop a rational action policy?

The past supply of wisdom has come mostly from the scientists themselves , who consciously or unconsciously, recognizing the limits of their scientific knowledge, have made strong and important judgment actions regarding the amounts of radiation considered to be acceptable for radiation workers or the public or the patient. This has not been a bad thing because, after all, the scientists involved cover a wide range of disciplines, ways of living, nationality, ethnic background, and everything else that makes for an effective melting pot.

That this has been effective is evidenced by what I consider to be the fantastically fine radiation safety records that they have accomplished. No one has been identifiably injured by radiation while working within the first numerical standards set by the NCRP and the ICRP in 1934. The theories about people being injured have still not led to the demonstration of injury and, if considered as facts by some, must only be looked upon as figments of the imagination.

I do not argue for leaving the philosophical decision process in the hands of the scientist where, by default if nothing else, it has largely rested for the past 80 years. Nor do I argue for removing the process entirely from his hands; a combined scientific and non-scientific approach is indicated. A difficulty here is the current public attitude that if a person has worked in a field (e.g., radiation) he must be suspected of some kind of conflict of interest if he becomes involved in any related decision-making process. Actually, because of their basic training and their having to be imbued with a basic sense of objectivity, a good argument can be made that scientists, as such, are about as devoid of special interests as any group that may be found.

Aside from our experienced scientists, trained in radiation protection, where do we look further for our supply of wisdom? Personally, I feel strongly that we must turn to the much larger group of citizens generally, most of whom have to be regarded as well-meaning and sincere, but rarely well-informed about the radiation problems that they have to deal with.

To return to the basic philosophical question of setting standards for protection we can, with some over-simplification, reduce the problem to two choices. One choice is to more or less follow the present course of theorizing that we are dealing only with a single, linear, no-threshold, dose-effect relationship. However, in doing this we must take more specific steps in the future to keep in front of the public that (1) this is only a theory; (2) it is used only because we don't know the precise relationship; and (3) it is probably conservative, for most practical purposes.

The second choice would be to follow the practices used for many decades by the toxicologists. For permissible concentrations of some toxic substance they would set a level somewhat below that at which any effect could be found. A judicious blending of the two philosophies (and that is all they are) may well provide us with the most sensible solutions to the protection problem.

Before leaving the basic philosophical questions, there is one more item that must be considered and one which has personally worried me since the day that it was first introduced. That question relates to the system by which we have different kinds and classes of permissible exposures, or dose limits, for different classes of people. On technical grounds, I would not argue either as to the pragmatic need or to the acceptability of such a procedure. However, on philosophical grounds, we have problems. Technically, the differential is acceptable.

A logical question may be asked - why should our workers be subjected to higher radiation levels than the general population? The answer is along the lines given above, but it is rarely understood that way. From a philosophical point of view, a strong argument could be made for setting the same standards for radiation workers as well as for the public. On the other hand, for sound pragmatic reasons, and because thus far there is no evidence of injury even to radiation workers, this would certainly introduce a tangible and unacceptable economic cost for a gain that cannot be quantitated.

POLITICS. As already noted, to be politic means "to be prudent and sagacious in devising and pursuing measures adopted to promote public welfare." (Webster). In the sense of radiation protection and in many other matters as well, political consideration really means the pragmatic combination of all of the elements bearing on a particular situation.

In the case of radiation protection, we might almost group all of the elements which I have listed above under politics and we might add some such as legal considerations, economic considerations, social considerations, etc. In this sense, the scientist generally, and the radiation protectionist particularly, must devote more thought and attention to constructive and objective politics, including direct approaches to people through the Congress, the press, and the telecommunications media. He must develop constructive and especially objective discussions and explanations for what is happening in the field of radiation.

From about 1946 to 1977, practically all federal matters in the United States relating to ionizing radiation were handled through the Joint Committee on Atomic Energy. The Joint Committee, with a stable membership from both the House and the Senate, was dedicated to developing facts and an understanding of atomic energy, rather than looking for newspaper headlines and votes. Among its many studies and reports, 21 major efforts dealt with radiation protection alone.

In its place there are some two dozen congressional committees, lacking in stability and without an overview power. Rarely does the chairman or staff of these committees have any knowledge in depth of the broad subject of ionizing radiation. But equally distressing is their failure to keep each other informed as to their operations and intentions.

In spite of technical shortcomings in the political arena, both federal and state legislatures exert strong influences on the development of numerical radiation protection standards. Because of the likely influence on governmental committees by vocal but prejudiced witnesses or witnesses having some personal case to plead, we are today faced with the possibility of unreasonably restrictive limitations being placed on legitimate uses of ionizing radiation (cite: Mancuso, Bross).

THE MEDIA. One of the first political needs we must always recognize in dealing with groups of people is education. It is almost a cliché. We must be able to bring to bear and bring into perspective a wide variety of elements, many of them not seemingly interrelated and many expressed in terms of different quantities and different values. The prime agent of education (outside of formal schools) in these times is in the radio-television, newspapers, comic books, books generally, and books written by scientists. The order above is probably in that of declining readership. Of these, the "news media" clearly dominate, and here lies one of our most critical problems and the most fruitful area in which the radiation protectionist must assist in the education of the public. First, however, we have to persuade the media (and I use the term rather broadly now) that they have a national obligation to assist the country in educating its public about radiation matters.

Attacks on the news media for one reason or another are common as is their own defense under the First Amendment. The First Amendment to our Constitution in the United States is an essential bulwark of freedom and is not paralleled by any other countries as far as I am aware. However, in my opinion, the First Amendment also carries with it an obligation on the part of the press to completely and properly report the news.

In the case of ionizing radiation which, of course, is the area with which I am most familiar, there are constant and continuous violations of this principle. The press will report and accent the news items and details which it thinks the public wants to hear about and what will help sell their papers…the latter, apparently, being their prime objective. The media must make money to stay alive and viable. They must sell their products and avoid wasting time on non-paying items. Thus, consciously or unconsciously a selective process begins. They say that they are supplying what the public wants. But as far as the public is concerned, they take that because it is the only thing they can get. However, as inept as our press may be in the United States in some respects, it is at least open and uncontrolled by the government – uncontrolled even to the point where it will "steal" and publish such government secrets as can be found.

The fact remains that we need greater responsibility on the part of the news media in the objective presentation of uneditorialized news. As far as radiation is concerned, our people must somehow persuade the press that it is irresponsible to subordinate radiation facts to stimulate sales. This will be a slow and painful process, but any gain is worth the effort.

MORALITY. What can we say in dealing with the problem of protecting people from possible adverse effects of ionizing radiation? It must be clear from the discussions above that a slightly higher radiation exposure permitted to a group of people under a given set of conditions may cause more injuries or even deaths to that group, and we are faced with deep moral considerations.

For example, the theoretical risk for radiation workers receiving the full MPD (5 rem/year) is ten times the risk for individuals in the public who receive the full Dose Limit (0.5 rem/year). Such an unqualified statement by itself is just part of a simple and immoral numbers game of which we have all too many in the broad safety field. A person dying from occupational radiation exposure is no different from one dying from non-occupational exposure.

An equally mischievous use of the numbers game is that of calculating the numbers of people who will die as a result of having been subject to routine diagnostic x-ray procedures. An example of such calculations is those made before a Congressional Committee in 1967 which were based on the literal

application of the linear, non-threshold, dose-effect relationships, treated as a fact rather than a theory. By this procedure he calculates 30,000 deaths per year resulting from x-ray diagnosis. Of course, there has been no statistical or other verification of this calculation. Unfortunately, the technique has been picked up by others (cite: Gofman and Tamplin, Sternglass). These are deeply immoral uses of our scientific heritage.

Morality cannot be dictated by law or subjected to rule or control. Morality is almost invariably an individual matter and the best and most sincere and thoughtful of people probably have widely variant moral viewpoints on a given question. On the other hand, we cannot sweep our moral obligations under the rug, nor can we settle them or bring them into agreement by vote or edict or law. Dealing with the moral aspects of radiation protection problems demands a kind of leadership and guidance and overall understanding that is not easily found.

LAWS AND REGULATIONS. There is no question but that the legislative and regulatory action in relation to radiation protection presents one of our most formidable two-edged swords. On the one hand, it aids in providing a needed degree of uniformity in radiation protection procedures. It provides a base upon which action for redress can be taken as might be needed under a variety of circumstances. On the other hand, the very power behind the legal system tends to stifle initiative and innovation in many areas, invites litigation and other legal actions, and greatly increases the cost of radiation, not only in industry but perhaps more importantly in medicine.

As far as radiation matters are concerned, we cannot live without a substantial legal system to protect both industry and the public, but there are times when we wonder if the atomic energy and radiation oriented industries can survive much longer within the complex of laws and regulations that have been spun, especially over the last ten or fifteen years.

The growth of bureaucratic involvement in radiation matters during the past two decades in the U.S. Government almost boggles the imagination. The programs may be divided into four categories. (1) Those involving radiation as a tool; (2) Research and development; (3) Regulation of the safety and uses of radiation and radioactive materials; and (4) Military applications. Without attempting to be complete as to numbers or details, let us make a listing of the more or less current government units embracing major interests in matters of ionizing radiation.

There are at least fourteen agencies of which six have regulatory responsibilities. Six have research and development responsibilities and three have advisory roles. In the legislative branch of the government, there may be some twenty-four House or Senate committees playing some role in radiation matters (the exact identification of these is not easy).

With as many agencies and congressional committees, each vying for its piece of the budgetary pie or prestige with its constituents, is it any wonder that there is competition, overlap, waste, and confusion in the radiation regulatory field? The wonder is that there is not more. An excellent example of recent vintage was the struggle for leadership in the development of radiation protection standards, primarily between the EPA and NRC, but with DOE and BRH anxiously watching from the wings. This led to the so-called "Libassi Study" of all radiation matters in the government. A remarkably fine report was produced, including organizational recommendations made to the President.

The Kemeney Report to the President on the Three Mile Island incident directs attention to " … a preoccupation with regulations" by the NRC. It goes on "… we are convinced that regulations alone cannot assure safety. Indeed, once regulations become voluminous and complex as those regulations now in place, they can serve as a negative factor in nuclear safety." And later it states "… the nature of some of the regulations, ... may in some instances have served as a deterrent for utilities or their suppliers to take the initiative in proposing measures for improved safety. "

The principle of keeping radiation levels as low as practicable was intended to stimulate protection initiative and innovation. The implications arising from the attempted use of the "least practicable" concept in regulations are of concern. The attempt to specify by regulation what is "least practicable" appears to be an unfortunate melding of concepts which vitiates the merits on each side. It undoes the assured uniformity of regulations because deviation on a case-by-case basis would appear essential, and yet removes from those subject to the regulation the responsibility for ascertaining what need be done to

meet the "least practicable" criteria. Application of the ALAP principle should be primarily a political-management action presumably designed to promote the public welfare. But is it? Surely not, if it impedes independent initiative and innovation.

Another point of interest here has to do with Workman's Compensation in the nuclear or radiation industry. Let me hasten to add that I personally believe in Workman's Compensation as a legitimate charge against industry. In the U.S. we are having a gradual increase in the number of "radiation injury" compensation cases settled in favor of the worker, usually by compensation boards, but also by the various courts. Most of these cases center around individuals who have had very low doses in the course of their radiation work, but who have developed a malignancy. Of the cases that have come to my attention so far, most have incurred a lifetime exposure of not more than 5 or 10 rads acquired over a period of several years.

A malignancy may, as we know very well, be caused by radiation, although on the basis of our knowledge of dose-effect relationship, the likelihood would be extremely remote at the levels mentioned. On occasion, I have said sometimes seriously and sometimes facetiously that it would be less expensive and perhaps more humane if it were decided that any time a person who had worked at any time during his life with radiation and subsequently developed a cancer which might be ascribed to radiation, at any level, he be given free treatment, together with what would be a normal compensation for the family. With all of our national health plans in being or in prospect, this would scarcely add a drop in the bucket to overall health care in this country.

ECONOMICS. The possible influence of economics on the standards for radiation protection must be so obvious that it scarcely needs mentioning. There is constant pressure to lower protection standards by some radiation protectionists as well as "consumer advocates" and generally concerned members of the public. Too often their arguments are based mainly on the theoretical estimates of effects that have never been observed and in turn on calculations of the theoretical deaths or cancers due to specific sources of radiation exposure. Any degree of protection can be achieved - at a cost. The problem is to evaluate the risk, the cost of reducing it, and the gains to be achieved. The process is frequently referred to as balancing the risk vs. the benefit. The principle is so simple as to be disarming. The difficulty lies in the quantitative elusiveness of both risks and benefits.

In a medical installation it sounds like a simple action to reduce the leakage radiation from a therapy tube by a factor of 2, but before the chain of events is completed a new building structure may be called for.

In the case of power reactors the economics would be much more difficult to evaluate. Where the different radiation levels from a particular reactor are known, they are likely already to be too low to evaluate except in terms of assumed risk, by such theorizing as has already been discussed. So this is a case of reducing by some factor something that you did not know in the first place. If someone were today to decide on a reasonable de minimis level for radiation exposure, it would probably be found that most of our radiation installations are already well below it.

Risk comparisons can be made between effects at high doses where we do have information and those at low doses where we have no information. The numerical values of these risks are possibly basically without meaning but are at least internally consistent and so evaluation of the costs of increasing or decreasing protection in a given installation can be made in terms of the arbitrary risk numbers.

A different kind of economic problem arises in connection with regulatory operations. In the process of defending, say, a budget request, a federal agency will work up an elaborate cost-benefit tree designed to show that by a certain addition to their facilities or program, they can save so much radiation exposure per person averaged over the public. This, in turn, will reduce the risk to the public and hence reduce the number of radiation effects. But the bottom line is to show that these imaginary effects will reduce hospitalization, will reduce Medicare, so that there is an overall saving to the taxpayer.

I've seen at least one example where an agency showed a saving for a given program and yet someone on the outside used precisely the same input information to show that it would make a much more costly program overall.

IV. POSSIBLE CORRECTIVE ACTIONS NEEDED

EDUCATION. In the development of an overall understanding and acceptance of radiation as one of man's most valuable tools, we need two things: (1) better communication within and between scientific and technical groups on the one hand, and the general public on the other; and (2) much broader education of and dissemination of information to the public. Perhaps a third item should be added. These communication and educational projects should be carried out basically by non-governmental organizations, aided and assisted, however, by some limited government support.

As far as the public is concerned, there has been a mysticism about radiation and for reasons, some valid and some not, the public has come to recognize that it has on occasion been told untruths or part truths about some radiation matters, primarily by government agencies. I believe a good case can be made for some of the misinformation that has been supplied to the public. But in the matter of communication, the radiation protectionist profession must play a stronger role, together with coordinated and concerted effort by other national and international organizations having long familiarity and responsibilities with problems of radiation protection and measurements.

It is my belief that much of the blame for the public's fears and apprehensions with respect to radiation matters are due to our media - newspapers, magazines, radio, and television. No particular one is better or worse than the other. The difficulty here is that of the general public. But where must people go for their information? Primarily, to the press. Yet, in my opinion, the press is failing in its responsibility under its Constitutional freedoms. Let us make one simple clear statement before continuing. The media are in existence primarily to make a profit under our free enterprise system. At the same time, the media enjoy protection under at least our First Amendment in the gathering and dissemination of information, not to mention their editorial treatment, which is not news but opinion. We must not take any action which could conceivably destroy this basic freedom.

It should be required that in reporting a news event, the media report it all as it occurs, not only the segment that is in line with their publication policy. Mistakes in observation will be made; these are excusable. Mistakes, however, of selecting only certain aspects of a news item and suppressing others is a general, but totally unacceptable practice. The press rationalizes the situation by saying that they supply the public with what the public wants. As I have noted before, this is a very specious argument and it is self-defeating. The alternatives would be government controlled and supported media which totally reflect the policies of the government. That would be intolerable!

There is yet another criticism that must be directed to the media, namely, their constant use of a small number of individuals who are clearly out of step with the radiation protection community. In the U.S. alone there are some 3500 health physicists and 1800 radiological physicists. The National Council on Radiation Protection and Measurements has, over the years, utilized over 550 scientists covering every professional field having any conceivable bearing on radiation protection standards. Yet the media will, for some newly breaking news story, seek out some of a half dozen individuals who are willing to make willfully deceptive statements regarding radiation. Collectively, they account for more news lines than the hundreds of reliable professionals accepted by their peers. (I refer to them as the U.S. Six). If the media want to improve their professional image, they must studiously avoid the sensationalism produced by the U.S. Six, but which they presently believe sells their wares.

The U.S. Six has a strange mixture of talents. One or two still have some degree of professional reputation left and they will carefully hedge their statements as self-protection among their colleagues. At the same time, however, their statements are interlaced with enough of the usual fear catchwords which are often the only part captured by the reporter inexperienced in the nuances and matters of radiation protection.

SCARE BOOKS AND ARTICLES. Of a collection of "popular" books published over the last decade or so dealing with radiation matters there is not a single one which is not riddled with half-truths, untruths, and evidence of basic lack of knowledge of the subject. All carry a high level of sensationalism and an eye-catching title or subtitles. These books are usually written by individuals who have no basic background knowledge of nuclear energy or radiation.

Unfortunately, many people sincerely concerned about many of our present-day problems in the nuclear field read these books and believe that they read the facts. This happens simply because they do not know enough about the subject to recognize much or any of the guileful and misleading statements. The books that I have been speaking about have largely been written with a profit motive but there are occasional others, obviously written to support their opposition to nuclear power, government research support, and so on. In spite of being written by one-time scientists, their books carry all of the sensationalism of the media.

Before leaving this part of my discussion, I invite attention to yet another insidious practice designed to keep the public alarmed about radiation matters. This is the constant linkage made between the atomic bomb and any discussion about radiation, including medical and industrial applications. For example, in a television documentary presentation on ionizing radiation or a news story about some small accident in a nuclear installation, or a large or small accident in a nuclear power plant, practically the first thing that is presented to the reader or the viewer is a story about a bomb, a picture of a bomb exploding, reference to radiation through the term "fall-out", and so on ad nauseam. These are the catchwords.

Understandable, but equally preposterous, is why an article about a nuclear reactor accident, such as the TMI case, should always be preceded by some reference to the bomb or an explosion and fallout, the standard warfare terms, when the public has been informed by hundreds of good and reliable sources that a power reactor simply cannot explode like a bomb.

CREDIBILITY OF SCIENTISTS. In some respects, the scientist stands apart from most other individuals who can be placed in some definable pattern plan. In the first place, the average scientist starting in research is not very likely to have financial gain as his prime objective. He does have to earn enough to live in reasonable comfort, have some freedom from financial worries, and to have a family life. For the true researcher, the man at the bench, the highest real reward is in terms of a professional reputation, acceptance among his colleagues, his reputed objectivity, and his reputed intellectual honesty. If he fails in any one of these elements, he is destroyed.

The implication is implausible that nuclear or other researchers are susceptible to ready suborning by the people or the organizations who support them and make their work possible. Great play has been given to the disagreement between some scientists either as individuals or as part of some scientific groups. This is pictured by the media as chaotic, self-serving, cover-up, or such. Actually, it is the normal, proper, and healthy intercourse of scientists.

I plead that we cease the seemingly endless procession of studies, congressional committees, and hearings on the problem of "low level ionizing radiation", just to choose one of the problems that plague us today. About this, we know what we know and we know what we do not know; there is reasonable and rational agreement as to the degree of disagreement. So where does this leave us? Either we forget the whole "problem" or we theorize or postulate a dose-effect relationship.

However, this is what has led us to our present dilemma because these technical concepts have been grasped by the press, by the congress, by some government agencies, and hence by the public as established facts, rather than as the scientific ruminations, which they are.

Somehow, we as radiation protectionists must develop an unassailable counterforce against such misguided actions as outlined above. This counterforce should act with such strength and integrity and persistence as to compel public attention and respect.

Taylor LS. “Some non-scientific influences on radiation protection standards and practice,” in Radiation Protection: a systematic approach to safety: Proc. 5th Congress of the International Radiation Protection Society, Vol. I. Jerusalem, March 1980. Oxford; New York: Pergamon Press; 1980:3-15.