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RADIATION PROTECTION STANDARDS:
PAST, PRESENT AND FUTURE

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Introduction

As several times in the past, I'm pleased to have the opportunity to be with you today to participate in NRC's 2001 Regulatory Information Conference. We have another great turnout, and the Commission and staff appreciate your attendance and participation in the Conference. I am pleased to welcome our licensees, consultants, our foreign attendees, state and local government representatives, and members of the public. I would like to speak to you on a subject that may at first appear unusual for this forum but which has and will continue to have a profound impact on the nuclear power industry and our other licensees. The subject I'm referring to is that of radiation protection standards.

Radiation protection standards have changed many times since the advent of the discovery of radioactivity. These changes from that day to this have often been radical, and changes are likely in the future as we see today a burgeoning of widely varying standards that have resulted in what I believe to be an unprecedented complexity in the regulatory environment. Today we have one limit for occupational workers, another for members of the public, still another limit is established for decommissioning purposes, others are discussed for clearance of radioactive materials, and then, of course, there is Yucca Mountain. And in the midst of all...ALARA.

Brief History

A brief review of the history of these standards reveals the long way we have come thus far. I would recommend to you an intriguing book, published only last year, as a guide in reviewing this history. This book, entitled Permissible Dose, written by NRC's Historian Samuel Walker, chronicles the history of radiation protection in the twentieth century.

Mr. Walker begins by reminding us of the early days, before the days of fission and activation products, when the health effects of exposure to x-rays and radium alone were being explored; the days of Wilhelm Roentgen, Henri Becquerel, Marie and Pierre Curie. He reminds us of the death of Eben Byers by radium poisoning and the health effects of the radium dial painters early in the century. It was in the 20's and 30's when national and international advisory committees were first formed, and the first so-called "tolerance doses" were established. In 1934 the American committee agreed on a tolerance dose of 100 milliroentgens per day for whole body exposure, while the international committee set the same limit at 200 milliroentgens per day. It is astonishing today to be reminded that these levels were based on the amount of radiation dose that would cause erythema to the skin.

But with the bombings of Hiroshima and Nagasaki, new complexities entered the picture. With the dawn of the nuclear age came new standards for radiation protection. After the war the National Council on Radiation Protection and Measurements (NCRP) was established. Out of a concern about the likelihood of increased exposures from the arrival of the atomic age and growing use of radiation sources, this committee recommended for radiation workers what was called a "maximum permissible dose" of 300 milliroentgens per week, a level half that of the earlier standard. The onset of nuclear bomb testing and the growing public concern related to exposure to fallout fueled increased study of radiation health effects, especially those associated with latent effects such as cancer. As a result, in the late 1950's the International Commission on Radiological Protection (ICRP) and NCRP issued landmark guidance limiting worker exposure to 12 rems per year maximum with a 5-rem annual average. It was during these same years that the advisory committees published a recommended public dose limit of 500 millirems per year.

The rapid growth of the nuclear power industry in the 1960's fostered further concerns by the public and Congress that public exposure from normal plant operations would increase to undesirable levels. In 1969 John Gofman and Arthur Tamplin, both of whom were associated with the Livermore Laboratory, delivered a paper contending that if the entire population of the United States were to receive a dose of 170 millirads per year throughout their lifetimes, the result would be 17,000 additional cases of cancer annually. Although widely disputed by radiation protection professionals, this and other similar studies spurred further investigation of the hazards of radiation that eventually ushered in the concept of "as low as practicable" emission standards which later was revised to what we know today as ALARA.

At the same time the National Academy of Sciences formed a panel of experts known as the Advisory Committee on the Biological Effects of Ionizing Radiations, more commonly referred to today as the BEIR Committee. The 1972 report of the committee acknowledged that existing evaluations of radiation health effects were based largely on extrapolations from high doses and high dose rates, which were at best imprecise and at worst invalid. Nevertheless, the report contended that in the absence of better data there was no reasonable alternative to a "linear hypothesis," which assumed a straight-line correlation between dose and somatic damage and did not allow for a threshold below which no effect would be thought to occur. It projected that any amount of radiation would cause some harm to the population.

History records a series of pivotal events in the early 1970's as the Administration established the EPA. However, in order to advance an independence from foreign oil as a result of the energy crisis of that day, further reductions in regulatory limits were forestalled. The latter part of that decade saw the further work of the BEIR Committee and the later publication of what was known as the BEIR-III report in 1980. Committee members debated, sometimes heatedly, among themselves the effects of radiation exposure at low levels.

In the wake of the Three-Mile Island accident of 1979 and the Chernobyl accident of 1986 still more changes to radiation protection standards were to come. In 1987 the EPA published final guidelines, and in 1990 the NRC revised Title 10 Part 20 regulations which set the dose limits which are still in place today for radiation workers and members of the public. It should be noted in passing that this 1990 revision to Part 20 had been the first complete revision since 1960.

Another NRC proposal in the late 1980's did not fare as well: that of establishing radiation levels “below regulatory concern.” NRC was to discover that the level of radiation that it deemed below regulatory concern did not fall below public concern. Despite the agency’s endeavors to establish such a standard, this effort was abandoned in 1993.

And the story continues on to this day. Other standards have been proposed, such as the ICRP Publication 60 report of 1990 which advised that radiation workers not receive in excess of 10 rems over any 5-year interval, even though the report continued to admit to uncertainties for effects at low doses. Obviously the NRC has never chosen to follow suit with this recommendation. Finally, the latest examples of radiation protection standards setting is reflected in the decommissioning rule added to Part 20 in 1997, and in the future we could see a materials Clearance rule which is currently being studied in Europe.

LNT

Let me move on from this review of history to say that at the heart of all of these standard-setting issues is the question of radiation effects at low doses and dose rates. To this day our standards continue to be based on the supposition that the dose-response relationship considered to be linear at high dose levels can be extrapolated to lower dose levels. Data derived from studies of the effects of high doses encountered by the survivors of the atomic bombs that struck Hiroshima and Nagasaki have been extrapolated as a linear function to those receiving much lower doses, such as radiation workers and members of the public. As mentioned earlier, the theory that such an extrapolation is valid is known as the linear, non-threshold theory (or the LNT). In the opinion of some, the strict application of the LNT has lead to unnecessarily conservative and costly radiation protection standards, particularly as applied for the decontamination and decommissioning of licensed facilities. The problem is further complicated by the fact that many of the recommended dose limits and constraint levels that are thus derived are comparable to or smaller than background radiation levels.

Some evidence has been advanced that there may be a threshold dose below which there are essentially no health effects. Other evidence suggests even hormesis, that is, a benefit to low-level radiation exposure. But such evidence must become convincingly positive and be demonstrated in humans before there will be serious consideration to moving away from the current LNT assumptions that underlie the present radiation protection framework. I should note that there are also scientists who believe that there is evidence that radiation health effects at low levels are underestimated by the LNT assumption, although their views are not widely accepted.

The Present and the Future

Future studies of the validity of the LNT may have a profound impact on radiation protection standards and the nuclear industry. The current Main Commission and committees of the ICRP had their final meetings last October, and new committees have been appointed for the four years beginning 2001. Committee 1 has been invited to provide a summary of the biological basis of the ICRP's policies, to prepare a new text on the health effects of radiation, and to develop a comprehensive report on the biological effects of radiation. In particular, the Committee will review risk factors and the LNT.

Most of you are probably aware that last fall I was elected to the 13-member governing body of the ICRP. It is the first time that a member of the U.S. Nuclear Regulatory Commission or its predecessor agency, the Atomic Energy Commission, has been named to that world body. My term is for four years and begins in July. In addition to my work as an NRC Commissioner, I intend to devote such time as is necessary to help further the ICRP's work in providing sound recommendations and guidance on this and all aspects concerning radiological protection.

Such studies as those of the ICRP are essential to address the problem facing the regulators and the regulated community on how to translate our knowledge of radiation health effects into a regulatory framework that is protective of workers, the public and the environment and, at the same time, take into account the uncertainties about that knowledge, cost versus benefit, and the resulting need to make assumptions to construct a radiation protection system.

Public Perception

Finally this morning, I would like to point out that regardless of the direction that radiation protection standards take in the future, we all know that we are left with the public's perception of whether these standards are reasonable and protective, regardless of the validity of their underlying science. We all know that it is not enough to have standards that are reasonable and protective. We must also ensure that the public and our national leadership accept those standards and have faith in our ability to properly protect society. I mention this because here is precisely the place where we all can have a role in the future success of bringing to fruition progress in standards development.

It was only seven weeks ago that I participated in an international conference in Villigen, Switzerland, that related to this issue. The title of the conference was "Better Integration of Radiation Protection in Modern Society." I specifically led discussions related to the experiences of the conference attendees in regard to stakeholder involvement in radiological risk assessment and management.

There were several tenets that grew out of the conference in regard to public perception. Perhaps we know these through our own experience, but I recount them here for your reconsideration. First, society is willing to accept familiar or freely chosen risks more readily than those that are imposed upon them. And further, public risk acceptance usually occurs as a result of an offsetting public benefit to that risk. For example, the public is willing to accept an average 39 millirems per year from diagnostic x-rays because the procedure is familiar, freely chosen, and considered ultimately to be beneficial in terms of their health. However, the 0.05 millirem per year exposure from the nuclear fuel cycle is not readily accepted by the public because the immediate benefit is not identifiable and is a risk that they feel is imposed upon them.

The second tenet derives from the first. It is that the experts should not be the ultimate decision makers for public policy decisions that impose unsolicited societal impacts. Society views experts as fact finders and reporters, not decision makers. Society demands that the mentality of "science must prevail" be changed to one of "science must make sense." The decision making process succeeds when public involvement is engaged from the outset and continues to play an integral part throughout the process. Just as I mentioned earlier regarding proposed regulations for materials below regulatory concern, the NRC learned through this experience that the level of radiation that was deemed below regulatory concern did not fall below public concern. Experts tend to be quantitative in their assessments; whereas, the public tends to be more qualitative.

The third tenet discussed at Villigen was the need to improve our communication as industry leaders and regulators to avoid incoherence, hesitation, and confusion. Failure to do so results in uncertainty and skepticism by members of society. My earlier statement in regard to the growing number of conflicting exposure limits for individuals based on their varying roles, or for materials under varying circumstances, serves as a current example.

The last tenet discussed at Villigen was that the nuclear industry should not give up in promoting its safety record. In fact, it is the responsibility of the industry to do so, if it believes that what it has to offer society is ultimately the best for society. The events of recent months have for the first time in almost three decades brought into question the reliability of our domestic energy supply and has drawn high levels of political attention. License renewals have become a reality and even interest in facility construction is increasing. The time is ripe for the industry to re-initiate an open dialogue with the public.

Conclusion

In conclusion, the work before us all in developing reasonable, workable radiation protection standards is full of the promise of restoring public confidence in the nuclear industry and in our regulatory programs. We must not falter at this pivotal juncture in not only developing reasonable standards, but in learning from the mistakes of the past and moving forward in a manner that will be respected by the society of which we are a part.