U.S. NUCLEAR INDUSTRY PERSPECTIVE ON USEFUL IMPROVEMENTS TO RADIATION PROTECTION PRINCIPLES

Ralph L. Andersen, CHP
Nuclear Energy Institute
Washington, DC

Introduction

The current radiation protection framework[1] provides an adequate basis for protecting workers, the public and the environment. Nevertheless, international and national radiation protection organizations are presently engaged in updating, clarifying and enhancing radiation protection principles –and rightly so, given our culture of pursuing excellence in radiation safety through a process of continuous improvement. Accordingly, the nuclear energy industry appreciates the opportunity to provide its perspective on this effort.

The nuclear energy industry's perspective is shaped in several ways –as an operator, we carry out a primary responsibility for protecting human health and safety and the environment; as a licensee, we are responsible for complying with government regulations; and as an energy producer, we are responsible for the safe, reliable, and economic generation of electricity for consumers.

Our objective in regard to improving radiation protection principles is to help promote an outcome that has a clearly articulated basis in science, is flexible in regard to how it might be applied to a very wide range of current and future regulated activities, and is practical and cost-effective in terms of how it can be implemented and maintained.

Benefits of Nuclear Technology

Nuclear technology utilizes ionizing radiation in a number of ways that are beneficial to our society.

In the U.S., 104 nuclear power plants generate 20% of the nation's electricity. Of currently available energy sources, nuclear energy is among those with the least impact on the environment, especially in terms of unit energy produced. For example, nuclear plants do not emit gases potentially harmful to the environment –including those that have been associated with ground-level ozone formation, smog, acid rain and global warming. Nuclear energy is currently the lowest cost source of base load electrical generation in the U.S.

Although this paper deals primarily with the nuclear energy industry's perspective on possible improvements to radiation protection, our perspective is also reflective of other sectors that employ nuclear technology. There are over 20,000 licenses in the U.S., administered by the Nuclear Regulatory Commission and 32 Agreement States, which cover beneficial uses of byproduct, source, and special nuclear material. In addition, there are many thousands of State-administered uses of radiation, involving radiation-generating machines and radioactive materials that are naturally occurring or produced by accelerators.

---

[1] In the context of this paper, "radiation protection framework" refers collectively to the existing body of international and national radiation protection recommendations, as well as international and federal regulations for radiation protection.

In addition to the use of radioisotopes and radiation in medicine (covered in detail in another paper at this conference), radioactive material is also used extensively in a wide range of industrial applications and consumer products. Radioactive sources and machine-generated radiation are used in petroleum exploration, to ensure the strength, integrity, and quality of materials, to sterilize medical products and consumer goods, to improve food safety and abundance, to create fresh water supplies from sea water, and to provide power in diverse applications ranging from nanotechnologies to space exploration. Radioactive material is also used in consumer goods, such as smoke detectors, wristwatches and exit signs. And, perhaps most fundamentally, the role of radionuclides and radiation is critical in the conduct of virtually every type of physical, chemical, and biological research.

Principles for Change

Changes to the radiation protection framework should be undertaken with great care and should arise from an expectation of a substantive improvement to radiation safety without unnecessarily restricting access to the vast benefits of nuclear technology.

The motivation for making proposing changes should be compelling. Changes should be justified in the context of reflecting new scientific developments, solving defined problems, and/or reducing unnecessary complexity or cost.

Proposed changes should not upset the constancy and stability in the radiation protection framework that has evolved over the past century. Changes should maintain focus on basic objectives of radiation safety, which we suggest are to: assure adequate protection of people and the environment; support effective and efficient use of public and private resources; and promote public understanding and confidence.

In our own effort to understand the potential value of any proposed change, we will seek to find answers to the following questions:

1. What is the specific issue to be resolved?
2. How will the proposed change resolve the issue?
3. How will the proposed change affect the basic objectives of radiation safety?

Suggested Improvements

The efforts presently underway to update the radiation protection principles and regulations present an opportunity to address a number of issues that have emerged as a result of implementation of the current radiation protection framework. Several issues of particular interest to our industry include the following:

1. <u>Levels Requiring No Further Action</u> - Radiation protection recommendations should provide advice on the bases and approaches to be used in determining levels of radiation and radioactivity that require no further action to assure adequate protection of health and the necessary level of safety. Although no level of radiation or radioactive material should be considered "trivial" or "below concern," it is appropriate to conclude, on a practical basis, that there are levels below which further action is unlikely to provide a substantive improvement to radiation protection. In particular, guidance should be provided on the appropriate degree of conservatism that should be used for different applications, such as exclusion, exemption, and clearance.

2. Collective Dose - Practical guidance would be helpful regarding the proper and effective uses of collective dose. The collective dose concept has proven useful as a tool to promote improvements in exposure management, measure the effectiveness of actions taken, and stimulate worker engagement in radiation protection programs. The concept also has limited application in decision-making, e.g., in comparing alternatives. However, additional guidance is needed to help constrain misapplications, such as in predicting health effects among large populations receiving low average doses of radiation or in aggregating low doses over extended periods of time.

3. Safety and Security of Sources – In past years, the radiation protection framework has evolved to highlight the safety of sources, in addition to protection against radiation exposure. More recently, the focus has shifted to the security of sources, especially in response to the potential for theft and intentional misuse, e.g., by terrorists. New requirements seem to be tending toward prescriptive programs and formulaic approaches –perhaps out of necessity. In the longer term, it would be helpful to establish principles for developing risk-informed approaches to source safety and security, analogous to the application of probabilistic safety assessment (PSA) methods in reactor safety. Such an approach can help enhance flexibility in performance-based regulatory requirements, as well as to provide risk insights that can lead to improved designs for processes and hardware that are inherently more safe and secure.

Emerging Changes to ICRP Recommendations

Over the past several years, a number of proposed changes to the International Commission on Radiological Protection (ICRP) recommendations have been presented for discussion and feedback. More recently, details regarding some of the proposed changes have emerged that are of concern to the nuclear industry.[2] Two items of particular concern are highlighted below:

1. Occupational Dose – A value of 20 mSv per year has been proposed as an occupational dose constraint. This would reflect a significant departure from the current ICRP recommendation for an occupational dose limit of 100 mSv in 5 years, not to exceed 50 mSv in any single year.[3] Operational flexibility and worker employability will be impacted, primarily because a value of 20 mSv per year, if implemented in regulation, would result in a much lower "constraint" in practice (e.g., at a level of 80% of the limit, or 16 mSv per year) to avoid a violation. The significance of this can be seen from the following dose data[4] for nuclear power plant workers in 2001:

    - A total of 104,928 workers were monitored for occupational dose.
    - A total of 67,570 workers had measurable dose.
    - The average measurable dose per worker was 1.6 mSv.
    - 0 workers had annual doses >50 mSv.
    - 274 workers had annual doses >20 mSv.
    - ~800 workers had doses >1.6 mSv

[2] It should be noted that the ICRP's emerging recommendations are continuing to evolve, based in part on stakeholder feedback, including the feedback provided in this paper.
[3] The current US Nuclear Regulatory Commission (NRC) occupational dose limit is 50 mSv per year. The NRC does not employ a 5-year occupational dose limit.
[4] All occupational dose data is taken from NRC NUREG-0713, Vol. 23, Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities 2001, except for the five-year dose data, which was estimated from data from the nuclear energy industry Personnel Access Data System (PADS).

- A total of 55 workers had 5 year doses >100 mSv (for 1997-2001)

There has not been any apparent change to the scientific understanding of radiation risk since the issuance of the current recommendations. Further, under the current framework, utilizing the 50 mSv per year occupational dose limit and the principle of maintaining doses ALARA,[5] average and maximum worker doses have continued to be substantially reduced. For example, in the past 20 years, the average measurable dose received by workers has declined from 6.6 mSv to 1.6 mSv, and the number of workers with annual doses >20 mSv has declined from 8,489 to 274.[6] In summary, there does not seem to be any compelling reason for making such a significant change.

2. Public Dose – The ICRP has proposed a public dose constraint of 0.3 mSv per year, which reflects a substantial reduction from the current recommendation for an annual limit of 1 mSv per year. Similar to the proposal for an occupational dose constraint, the more restrictive value for a public dose constraint lack a compelling rationale for change. Yet such a reduction in margin would produce significant impacts, often without any health and safety benefit.

   For example, "non-radiation workers" at nuclear facilities (e.g., office and warehouse workers) are typically treated as "members of the public"[7] in regard to incidental exposure received from facility operations. By definition, these workers receive doses below 1 mSv per year, as demonstrated by an appropriate level of surveys and monitoring (i.e., adequate to demonstrate that doses are less than 1 mSv per year). However, their doses may be in the range of 0.3 mSv per year (e.g., 0.001 mSv per workday). The 0.3 mSv value, if implemented in regulation, would lead to more extensive and precise analyses of doses, and possible reclassification of the workers as "radiation workers," which, in turn, would require training, individual monitoring, etc.

   Even more significant impacts would be likely for determining compliance in higher than average background radiation situations, as well as for operations that involve naturally occurring radionuclides that are difficult to distinguish from the ambient background. In the extreme, a 0.3 mSv constraint might even lead to reassessment of certain occupational groups, such as store workers and gardeners handling fertilizer.[8]

New Recommendations for Environmental Radiological Protection

There is wide acknowledgement that the current radiological protection system has in practice provided appropriate standards of environmental protection, but that it needs to be further developed for completeness to fill a conceptual gap and to address some specific outstanding situations.

The nuclear industry recognizes the importance of environmental stewardship and operates to high environmental standards. The radiological impact of nuclear sites and power plants in particular, are typically indistinguishable from naturally-occurring background levels. Even for

---

[5] ALARA refers to "as low as reasonably achievable."

[6] NRC NUREG-0713, Vol. 23, Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities 2001.

[7] As defined in Title 10 Code of Federal Regulations Part 20, Standards for Protection against Radiation.

[8] See, for example, the discussion in the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) 2000 Report to the General Assembly (p.544 of Volume 1), New York 2000.

sites with the most significant historical discharges, experience with the currently available biota dose assessment methodologies indicates that doses are significantly below levels at which any effects would be expected.

Against this background it is important that the future system of protection, whilst meeting the conceptual need, is capable of simple and practical application, and does not impose a disproportionate burden on the beneficial uses of nuclear technology including the availability of nuclear energy.

In particular, it should not require blanket application across sites with evident negligible environmental impact. The application of the system should be focused on those exceptional situations where there is a higher potential environmental impact – typically those situations where humans are excluded. In these situations it is essential that the system of protection is focused at the level of protection of species, populations and the ecosystem. The scientific framework must be developed with this as its focus.

The industry seeks to continue to work constructively both at the level of international debate and with the scientific community to ensure that its expertise and data can best contribute to the future developments in the field of environmental radiological protection. The industry welcomes the leadership shown by the international bodies IAEA, ICRP, and UNSCEAR and recognizes the importance of ensuring a clear direction for future work and the co-ordination of developing activities.

The nuclear industry has recommended that the three organizations collaborate on a joint "road map" that describes the shared vision, objectives, and path forward for developing and implementing an environmental radiological protection framework. The road map should include a description of a logical sequence of activities, milestones, and responsibilities for achieving the objectives. Most importantly, the road map should describe how and in what manner stakeholders will have the opportunity to participate in the development and implementation of the framework.

In Conclusion

The current radiation protection framework has proven to be effective and has supported safe and beneficial uses of nuclear technologies. Proposed improvements, e.g., to simplify and improve the clarity of the framework should be carefully considered with regard to avoiding unintended consequences and should focused on addressing a specific need. A continuation of the process of evolution, rather than revolution, is strongly encouraged.