The origin of the EPA's 10 000-year time frame for the high-level waste repository

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The EPA standard for HLW was founded not on best available science, but on "gray" literature and personal opinions.

During the development of standards for high-level waste (HLW), spent nuclear fuel (SNF), and transuranic waste, the U.S. Environmental Protection Agency (EPA) mandated that the performance of the disposal facility for HLW/SNF be computed for 10 000 years.[1] Briefly, the EPA announced its intention to develop standards for radioactive waste in 1976, published a proposed rule in 1982, and finalized regulations in 1985. As expected, there were numerous challenges to many parts of the EPA standard. These challenges can be generally categorized in two groups:

1. A large number of individuals and organizations within the scientific community severely criticized the EPA for what they considered to be the poor scientific foundation of the standard. This included a report[2] by the National Research Council (the research arm of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine).

2. A number of environmental and antinuclear organizations claimed that the EPA's rules were insufficiently protective of the environment.

Eventually, Congress mandated that the EPA support a study to be performed by the National Academy of Sciences.[3] Subsequently, the National Research Council performed at least two relevant studies.[4, 5] The congressional mandate included a requirement that the EPA incorporate the recommendations of the National Research Council in its standard. In a recent decision, a court found that in its revised regulations, the EPA disregarded one of the recommendations of the National Research Council.[6] The court instructed the EPA to go back and redo its standard. At issue was the decision of the EPA to construct the disposal facility to contain the radioactive materials for 10 000 years.

Although in the published regulations the EPA did not identify how the 10 000-year timespan was derived, at least one member of the working group (the author of this communication) that wrote the standard had a rationale for that choice. Unfortunately, the details of the computation are no longer available as they were discarded several years after the retirement of this author from the EPA. The principles of the computation, however, are fairly clear. The philosophical underpinnings for the computation were as follows:

1. A reasonable and logical computation of potential risk posed to the population by the disposal of HLW/SNF should be based on the comparison with the risk posed by uranium in nature. The reason for this is that the source of HLW/SNF is uranium, which is extracted from mines, processed, and eventually converted to HLW/SNF.

2. Uranium is found in a variety of concentrations in nature, particularly in considerable quantities in uranium mines. In general, uranium in a mine is in equilibrium with its numerous progenies, including ^{226}Ra.

3. If natural uranium, in equilibrium with its progenies, is placed in the disposal facility (or repository, as it is often called), given its half-life of nearly 10 billion years, the radioactivity content of the disposal facility remains essentially constant for many million of years.

4. In contrast to uranium, the radioactivity content of HLW/SNF is reduced significantly after it is placed in the disposal facility. The reason is that the half-lives of a rather large number of fission products are relatively short, ranging from a few decades to hundreds of years.

5. If, for whatever reason, the containment of the disposal facility breaks down, the risk associated with the release of HLW/SNF should not exceed that of uranium and its progenies in a mine.

The computations started by considering the isotopic compositions of uranium (isotopes U-234, -235, and -238) in equilibrium with their respective progenies. Subsequently, using certain assumptions, their doses and corresponding risks were computed. A similar computation was made for major fission and activation products present in HLW/SNF. It was found that the respective risks of natural uranium isotopes in equilibrium with their progenies became about the same as the risk of radionuclides present in HLW/SNF at about 900–990 years. Note that the risks associated with radionuclides such as ^{14}C, ^{237}Np, ^{129}I, and several others whose risks continued or peaked after 1000 years were more than offset by the risk of ^{226}Ra and several other progenies of uranium isotopes that were absent in HLW. These computations were comparable with those performed by others whose results ranged from 500 to 3000 years.

As with any modeling for environmental subjects, there were a number of uncertainties associated with these computations.

1. Of particular concern was the comparison of the disposal facility with uranium mines that have existed over geological times. The selection of a geologically appropriate site would significantly reduce or eliminate any disadvantage as compared to a uranium mine. The addition of the requirement to glassify HLW and engineering treatment of SNF would reduce any potential risk.

2. Although there were uncertainties related to the growth or decay of individual radionuclides, they were fairly small.

3. Similarly, risks associated with the intake of various radionuclides by the exposed population was no more uncertain than those associated with other environmental regulations.

4. The assertion that the risk of HLW/SNF peaks after 10 000 years is based on the incorrect assumption that the disposal facility must not only account for fission products but also for the growth of progenies of uranium—notably, radium. What is being overlooked is the fact that radium levels would have increased regardless of whether uranium is separated from the ore and processed or left in the mine.

Despite all of these, and consistent with the tradition of the EPA, a safety factor of 10 was used to compute the 10 000 years.

It is most unfortunate that neither the EPA nor the National Research Council chose to use the logic described above. The National

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Research Council in its 1983 report[2] devoted a few pages to "natural analogues." That discussion, however, dealt with the release of materials rather than the regulatory time.

Most recently, the EPA has proposed regulations to extend the regulatory time to 1 000 000 years.[7] Given human history, any time frame in excess of 10 000 years appears to be unreasonable. If the logic described above had been used in the original standard, there would have been no reason for this action. The National Research Council cannot be blamed for not having considered such logic, as the very distinguished panels of the National Research Council reviewed the EPA's activities rather than generating ideas of their own.

Another unfortunate subject was and continues to be the scientific foundation of the EPA standard. As the managers of the standard believed that they had the authority to promulgate the standard, they relied heavily on government reports and other materials that had not been subjected to independent peer review. A subject with such a significant environmental—including human health—impact, however, would have required nothing less than reliance upon best available science (BAS). The concept of BAS categorizes scientific information into personal opinion, gray literature, peer-reviewed information, and consensus-processed information.[8] One would have expected that the EPA would have relied overwhelmingly, if not entirely, on peer-reviewed and consensus-processed scientific information. It is particularly unfortunate that the EPA relied heavily on gray literature (internal government and contractor documents) and personal opinions described as "personal communications."

A subject such as the standard for high-level radioactive waste deserves reliance on scientific information of the highest quality. It is imperative that future documents rely on BAS. If requested, the scientific and engineering communities would have been well equipped and willing to provide relevant BAS information. The protection of the environment, including the protection of human health, mandates the disposal of HLW/SNF in a safe condition expeditiously. The experience with the Waste Isolation Pilot Plant, a facility for the disposal of transuranic waste, demonstrates that high-activity radioactive waste can be disposed of safely. This disposal not only reduces the cost of operation but also reduces environmental risks, including human health risks. Similarly, the current status of the storage of HLW/SNF is not only expensive, but also, and more important, it poses a higher potential risk compared with disposal in an acceptable facility. Those who desire to protect the environment should ensure that BAS is used in the decision and that the current status of the storage of these highly hazardous materials is replaced with a scientifically based means of disposal. Those who help to postpone a solution for the disposal of these wastes are not supportive of environmental protection.

References

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