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THE HANDLING AND DISPOSING OF RADIOACTIVE WASTE

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The nuclear waste dilemma is one of the most perplexing of the many problems which the nuclear industry faces. From a strictly technical viewpoint, it is a non-problem but the social and political problems are real and substantial. Adequate technical solutions have been developed for handling and disposal based on reasonable and conventional extrapolations of experience. Because of the long times involved for ultimate sequestration, the methods obviously could not have been proven within the 40-year time span of nuclear energy. Furthermore, disposal methods can neither be demonstrated in real time nor are many of the key features which must be tested amenable to accelerated experimentation. This leaves a vulnerability to criticism. However, radioactive waste has an advantage compared to other hazardous wastes. It inevitably decays and becomes non-radioactive and, hence, non-hazardous in this regard.

In order to better understand the problems and to simplify their solution, the waste has been separated by definition into six categories. These are: 1) commercial spent fuel, 2) high-level wastes, 3) transuranium waste, 4) low-level wastes, 5) decommissioning and decontamination wastes, and 6) mill tailings and mine wastes. Each category represents a different problem and must be considered separately.

Spent fuel seems not to require comment except to note that present temporary storage methods have been quite trouble-free as practiced over the last 40 years and that ultimate disposal as intact fuel elements does not present significantly different problems from reprocessed, high-level waste. Such disposal, of course, would be wasteful of fuel resources.

High-level wastes from reprocessing plants probably have received the most study. In many ways they are the most difficult to deal with because they represent a significant source of heat as well as radiation and contain substantial quantities of very long half-life materials. However, extensive studies and experimentation have produced highly satisfactory and clear-cut solutions to their disposal.

My preference for high-level waste disposal is for placing it in deep-bedded salt or shale. Both are essentially impervious to water, can be found extensively at appropriate depths in geologically and seismically stable formations and are relatively easy to mine. Argillaceous rocks, commonly known as shale, adsorb most elements of the waste, thus, fixing them in place. The salt is plastic under pressure from the overburden of earth and in time will completely seal the emplacement tunnels.

A highly attractive disposal horizon is in bedded salt overlain with shale. This combination exists in large regions of the western United States where these formations have been stable for 200,000,000 years. Extrapolation of this stability to even the total decay of very long half life elements seems to be reasonable; even the 250,000 years required for essentially total decay of plutonium is credible. Also important are the facts that heat generation becomes insignificant in a few decades and that the activity has decayed to levels near those of the original uranium ore in times commensurate with even those for man-made structures, such as the pyramids of Egypt.

A salt bed perhaps 200 feet thick lying 1000 feet below the surface, free of flowing water, and overlain with impervious argillaceous rock indeed seems secure. One should be quite at ease living in a house adjacent to such a repository. Other geological formations including granite also appear to be adequately stable, but probably require that the waste be overpacked with shale or clay as added protection in the event of ground water intrusion.

Much R&D also has been applied to the waste form. There is merit to the premise that the geological formation in which high level waste is placed represents the security for its protection. If so, the waste form and packaging appropriately should address the problems of handling and transportation. However, the requirement that the waste form must be highly impervious to water seems to be firmly established in the social and political system. Thus vitrification in glass has been developed widely as a preferred form for high level waste.

In most countries, transuranic wastes which contain alpha bearing materials of high mass numbers and very long half-life are stored temporarily in secure repositories. An obvious solution for disposal of these wastes is to apply volume reduction technology and to place them in the geological repositories for high level waste.

The low level wastes present a problem primarily because of their relatively large volumes. Most of the activity in these wastes is of relatively short half-life such that the radiation essentially disappears in fifty years and is reduced to totally innocuous levels in 150 years. Thus, the practice has been to place the wastes in landfill operations not unlike those used for ordinary garbage, and, in fact, the problems of its retention are not greatly different from those for garbage. Equipment and techniques have now been developed to reduce the volume of this waste category by incineration, biological digesting and shredding. Improved techniques for packaging, packing in trenches and sealing the trenches, offer a high degree of stability for this waste disposal system. However, its security is dependent on the properties of the soil and the climate, thus careful environmental assessment is required for the choice of low level waste disposal sites.

An important technology which has been emphasized at the Oak Ridge National Laboratory is the use of concrete or cement grouts for the fixation of radioactive wastes. Grouting of waste trenches, fixation of old wastes in tanks and cementing in various geological formations seems to be practical, inexpensive and satisfactory. ORNL has been injecting radioactive waste into bedded Conasauga shale for 15 years with good experience (8 million liters of grout containing almost 600,000 curies have been injected). Also, specialized concretes have been made which are as impervious to water as is glass and which will retain structural integrity and hold most of the wastes at temperatures up to 900 degrees C.

Wastes from decontaminating and decommissioning nuclear facilities at the end of their useful lives are really only a special category of low-level waste. They are generally large in volume and low in radioactivity, and can be handled using the same techniques that are adopted for other low-level wastes.

Mill tailings and mine wastes represent a problem in stabilizing large piles of relatively loose waste which might be transported by wind or rain. The cost for stabilizing these tailings is substantial but, in the United States, represents only about 0.4 mills per kilowatt hour. Fortunately, in most places the mill tailings are in areas relatively remote from major human habitation. Early introduction of the breeder reactor could eliminate need for further uranium mining.

The plethora of research and development that has been accomplished during the past two decades is deficient only in that, because of sociopolitical interventions much has yet to be demonstrated under realistic field conditions. An important milestone toward the demonstration of the technology and disposal of radioactive wastes was taken recently when the U.S. Congress passed the Nuclear Waste Policy Act of 1982. It may be summarized in six important features:

1. A system of fees paid by utilities to fund waste activities that will permit the full cost of nuclear power to be borne by its benefactors.
2. A method for extensive state participation in the siting of waste facilities which provides the states a strong voice in the process and a means for resolving state objections.
3. A limited, temporary Federal storage program to assist utilities with a severe near-tem storage problem.
4. A strong commitment to permanent geologic disposal as the ultimate solution to the waste problem.
5. A study of monitored retrievable storage as an interim step toward permanent disposition.
6. A clear distinction between the handling of civilian and defense wastes.

It remains to be seen how well this legislation will serve, but initial progress toward its implementation has been good.

The technology for storage, handling, and disposal of radioactive wastes is at a relatively high level of development, and the total cost for the management of all nuclear fuel cycle wastes by the advanced methods that have been developed will add less than 10% to the cost of nuclear-generated electricity. Why, then, is the perception of waste disposal so bad? A recent speaker in Oak Ridge on the subject of high technology companies emphasized that we are now well into an age of communication. If so, how can we use these great capabilities to better inform the public and the decision makers? The problem appears to be world-wide differing only in degree for different countries.