Debate on radioactive

Do we know enough to dispose safely of waste that will remain radioactive for tens of thousands of years, or will any disposal program inevitably end up as an albatross around the neck of future generations?

No technical barriers

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The "energy crisis" of the 1970s brought with it an unparalleled awareness of this country's energy needs for the future. It became clear that an acceptable standard of living would require the use of all energy alternatives and significant expansion of specific ones. For any reasonable projection this translates into considerable dependence on nuclear energy to meet the energy demands of the next two decades while new technologies (such as solar) and improvements in existing technologies are brought to levels that can meet future demand.

With this realization, increasing concern has developed over the growing volume of radioactive waste produced by nuclear power. Indeed, critics have advocated no further expansion of nuclear energy until a satisfactory means of waste disposal has been demonstrated. This essay discusses several of the important questions that people want answered, such as how we can ensure that radioactive waste will be safely isolated from the environment for hundreds of thousands of years.

Methods of waste disposal

Because spent fuel from a nuclear reactor contains a significant amount of unused fissile uranium and plutonium in addition to the unusable "waste" products, it can also be regarded as a potential energy resource. Three options exist for handling the spent fuel. The first is to dispose of it permanently; this option is commonly referred to as the "throwaway cycle." The second is to store the spent fuel temporarily, pending a decision on whether or not reprocessing of spent fuel will be allowed. The third is to reprocess the spent fuel and recover the unused fissile uranium and plutonium for use in other nuclear reactors. Should we choose to develop breeder reactors to help meet energy demands at the turn of the century, it would certainly seem prudent to remain flexible and view reprocessing as a viable option.

Many intriguing disposal techniques have been proposed[1] and seriously considered, but most have been discarded as impractical, certainly before the year 2000. Ejecting waste into outer space would be enormously expensive; even the small chance of a launch mishap makes this option unacceptable. Development of the technology for transmutation, which consists of extracting the transuranics from the remainder of the waste through reprocessing and then "burning" them in commercial or breeder reactors, is not anticipated before the year 2000, if then. Burying nuclear waste in the Antarctic ice sheets raises questions about ice sheet stability. Not only might water within and beneath the ice sheets transport the waste to the biosphere, but the ice sheets themselves undergo rapid surges roughly every 10 000 years, and this could even be triggered prematurely by waste-generated heat. Subseabed isolation, whereby waste is emplaced in thick sediments or rock underlying the ocean, is a future possibility, but not until more is learned about possible thermal currents and any sediment or rock behavior that could cause the waste to move back into the biosphere. Another technique would be to drill superdeep holes (as deep as 20 000 feet) and dispose of highly concentrated liquid or solid waste. Heat from the waste would initially melt the surrounding rock; later the rock would resolidify, sealing in the waste which would become an integral part of the rock structure. However, drilling such wide holes to accommodate canisters still poses practical problems, and retrieving the waste would be virtually impossible.

Even if the technology were demonstrated for these disposal techniques, they would still be unacceptable because present government policy rules that waste must be recoverable from any storage site for the first few decades.[2] Not only must we be able to retrieve the waste in the event of leakage, but also to recover valuable unused plutonium in spent fuel, if that is the waste form. Although a few of these and related techniques show promise as future permanent disposal methods, government policy has eliminated all but one technique: burying the waste in excavated cavities in deep geologic formations such as salt beds, granite, or basalt.

Underground cavities

Construction plans for an underground repository are impressive. A network of tunnels and storage rooms would be excavated 2000 feet underground and connected to the surface by access and ventilation shafts (see figure 2). If the spent fuel is reprocessed, the waste would be contained in solid form, packaged in corrosion-resistant canisters, and then placed ten meters apart in holes dug into the floors of the facility. The annual waste from 400 commercial nuclear plants (the number of plants we would have in the US if all our electricity were derived from nuclear[3]) could be stored in an area no larger than half a square kilometer.[1] In fact, thirty tons of spent fuel from a 1000-megawatt reactor operating for one year would, after reprocessing, be reduced to two cubic meters, an amount that would fit easily under a dining table. The principal reason that the waste cannot be stored so compactly, but rather would need to be stored with space between canisters, is to prevent unacceptable heat buildup.

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