AN ECONOMIC PERSPECTIVE ON EPA'S PROPOSED AMENDMENTS TO 40 CFR Part 191

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ABSTRACT

This paper provides an economic overview of the U.S. Environmental Protection Agency's proposed amendments and additions to 40 CFR Part 191, standards for disposal of radioactive wastes. These amendments contain groundwater protection requirements and individual dose requirements and currently apply mainly to transuranic waste disposal. The costs and risks of transuranic disposal in various media are profiled and the real economic impact of these amendments is discussed.

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is responsible for developing generally applicable environmental standards for the management and disposal of spent nuclear fuel, high-level waste, and transuranic (TRU) radioactive wastes. To this end, EPA promulgated standards on August 15, 1985 (40 CFR Part 191). In 1987, however, following a legal challenge, those parts of the standards dealing with disposal (Subpart B) were remanded to the Agency for further consideration by a U.S. Court of Appeals (1). The Waste Isolation Pilot Plant Land Withdrawal Act of 1992 (WIPPLWA) reinstated those portions of the 1985 disposal standards not specifically identified as faulty by the court. These reinstated portions and the standard itself will apply to spent reactor fuel, high-level radioactive wastes, and transuranic wastes. They do not apply to sites developed under Public Law 97-425, the Nuclear Waste Policy Act of 1982. At the same time, important amendments to the standard were made by EPA to add groundwater protection requirements and individual dose requirements. These provide assurance that groundwater and individuals will receive adequate protection.

With this reinstatement and the exclusion of sites as specified, the only sites to which the individual dose requirements and the groundwater protection requirements in the amendment currently apply are for TRU waste disposal. The focus of this paper is then the economic and health impact of the groundwater protection requirements and the individual dose requirements as they apply to TRU waste disposal. In general, this paper is an extended abstract of the Economic Impact Analysis prepared in support of the amendments (2).

This paper is divided into three sections. This first section briefly describes the groundwater and individual dose requirements contained in the amendments, the geologic options for meeting the amendments, the assumptions on which the paper is based, and the analytical approach to the estimation of the impacts of the proposed regulation. Section Two outlines the processes by which the wastes are generated, the volumes of waste that must be disposed of, and describes the cost and health effects associated with each option. Section Three is a brief sensitivity analysis. It examines the impact of changes in the level of the standard and in the modeling assumptions used. These are indicators of the robustness of the paper's findings.

REQUIREMENTS, ASSUMPTIONS, APPROACH

Requirements

The individual protection portions of the proposed amendments require that disposal systems for TRU waste shall be designed so that, for 10,000 years after disposal, undisturbed performance of the disposal system shall not cause the annual committed effective dose, received through all potential pathways from the disposal system, to any member of the public in the accessible environment, to exceed 15 millirems (annual cumulative dose equivalent) (3). The proposed groundwater protection requirements limit radioactive contamination in both public and private sources of drinking water to the Maximum Contaminant Levels (MCL's) found in the Agency's proposed National Primary Drinking Water standards (40 CFR 141) over the same 10,000 year period.

Assumptions and Caveats

This paper reflects the generic nature of the analysis of the sites upon which the costs and health effects are predicated. It discusses four options for the host media for the repository: salt, for which the most detailed cost and health effects information is available, and three other options: basalt, granite, and tuff. Cost information on these last three options is not available. Because of their generic nature, the results of the risk calculations are not intended to project actual risks expected at particular sites. Such projections will only be possible after the potential sites are more fully characterized. Modeling efforts that extend over a period of 10,000 years require a number of assumptions to be made that inherently have uncertainty associated with them.

The cost data for TRU waste disposal at a salt site (and used in this paper) were obtained from the Department of Energy (DOE) and are 1990 figures (4). More recent cost estimates were unavailable from the DOE for disposal of TRU in salt. Data on population risks and individual exposures are from the BID.

While only disposal costs for a salt site are known with any precision it is estimated, based upon the cost differential between salt and other media for the disposal of high-level waste, that costs could vary downward by as much as 20 percent (tuff) and upward by as much as 50 percent (granite).

Analytical Approach

This analysis is unusual in that it does not include a formal cost-benefit or cost-effectiveness analysis of TRU waste disposal. Either analytic technique requires data on costs and effects of multiple options. For TRU disposal there are no canisters or improved waste forms to examine and there is no cost information detailing non-salt repository construction. A cost-benefit analysis is not conducted due to the absence of any historically acceptable option for TRU disposal other than geologic. This analysis can only assess the impact in absolute terms and relative to the containment standards reinstated by the legislation. Again, it is worth restating that only TRU disposal is discussed in this paper since it is the radioactive waste affected by the amendments.

All costs are expressed in constant 1990 dollars. After discounting costs at a 2 percent rate, a present value is obtained. This 2 percent rate is intended to reflect the real social cost of money. Undiscounted costs are also presented for some items. All costs are labeled as net present value or undiscounted. Unlike the cost of disposal, projected statistical health effects are not discounted. The application of any positive discount rate over the 10,000-year period of analysis to health effects reduces them to very near zero.

TRU SOURCES, COSTS, AND HEALTH EFFECTS

TRU Sources

Spent nuclear fuel, high-level waste, and TRU waste are the categories covered by the original 40 CFR Part 191. The amendments and additions to 40 CFR Part 191 considered in this paper are concerned exclusively with TRU wastes. TRU wastes, as defined in this rule, are materials containing elements having atomic numbers greater than 92 in concentrations greater than 100 nanocuries of alpha-emitting TRU isotopes, with half-lives greater than twenty years, per gram. TRU wastes result from reprocessing plutonium-bearing fuel or fabricating nuclear weapons. The waste form varies widely, but most of the waste can be described as contaminated plastic, rags, equipment, tools, contaminated organic and inorganic sludges, wood, rubber, metal, cloth, paper, and laboratory trash. Collectively, the volume of buried TRU wastes is 191,000 cubic meters while the volume of retrievably stored TRU wastes totals 60,600 cubic meters (5).

Sources of TRU Risks

The waste disposal system considered in the risk assessment that the EIA drew from (see the BID) is intended to be generic. It is based in part on the current national plan to develop mined geologic repositories for disposal of TRU wastes (6). Such repositories consist of underground mines or excavations with working levels between 300 and 1000 meters below the surface. Wastes would be packaged in metal drums and stacked in the mined waste disposal rooms. After emplacement of the waste, the disposal facility would be backfilled to enhance its mechanical stability and to retard the movement of fluids.

Salt deposits, located in several regions of the country, are viable candidates for a TRU repository because their very existence indicates little or no groundwater flow. Qualitative problems with salt do exist and are discussed in the BID. One such complication arises from the fact that if groundwater flow does change in the future such that water contacts the salt deposits, then the salt will dissolve and be carried away. Therefore, stability of existing groundwater flows is essential, and candidate sites must be expected to remain intact for thousands of years. Moreover, the probability of inadvertent drilling into the repository is higher for salt, as compared to other media, because salt formations are usually located in areas that contain commercially valuable resources.

Radionuclides may travel from the repository to the accessible environment in three general ways: 1) direct pathways to the land surface, such as might occur if future generations penetrated the repository during an exploratory drilling program and accidentally contacted the wastes, 2) vertical migration in slowly moving ground water to an aquifer and then to the surface, and 3) transport of radioactive gases to the ground surface from a repository in the unsaturated zone (7).

Population risks are developed by distributing expected radionuclide releases each year over the expected world population. The releases include those due to normal processes such as ground water flow and to extraordinary events also known as low probability events. These include volcanos, earthquakes, and inadvertent drilling by man. Population risk is not an element of the amendments. They are phrased only in terms of individual dose.

Individual exposures are estimated as the annual radiation dose an individual receives from consuming two liters of groundwater per day at a distance of 2000 meters from the boundary of the repository. Since the nuclear wastes will slowly migrate from the repository after the canister fails, the primary determinant of an individual's exposure is time. For a given waste form and canister life, the longer the time after placement of the TRU wastes, the greater the number and amounts of radionuclides in the groundwater. The low-probability events of drilling, seismic activity, and volcanic activity are ignored for individual exposure measures.

ESTIMATES OF POPULATION RISKS AND INDIVIDUAL EXPOSURES

For the population risk estimates, the BID prepared for the amendment uses the concept of "complementary cumulative distribution functions" (CCDF) to show projected health effects for a variety of repository choices (8). For individual exposures, the BID estimates the annual radiation dose, measured in millirems per year, from consuming two liters of groundwater per day two kilometers from the boundary of the repository. Population risks are measured as projected statistical health effects while individual exposures (that is, millirem doses) are measured as the maximum annual dosage over 10,000 years.

The expected number of health effects for a repository with the characteristics of the one modeled is less than one over 10,000 years for the 5.42 million curies emplaced. Low probability events such as volcanic eruptions, earthquakes and inadvertent drilling are considered. Expected statistical health effects from granite and tuff are expected to be similar. For basalt, the health effects are likely to be higher, an estimated 15 over the 10,000 year period.

If the repository is assumed to be mined in bedded salt with no accessible groundwater pathway under undisturbed conditions, no nuclides are expected to reach a groundwater system. Gaseous release is not possible from bedded salt because of the saturated condition of the surrounding rock. Because groundwater is also the major pathway to the individual, the maximum individual dose over 10,000 years will be zero. This is true for all media studied, salt, basalt, granite and tuff.

TRU Costs

The repository and support facilities for which costs have been developed is designed to receive, inspect, and dispose of contact-handled and remote-handled TRU waste in a repository mined in bedded salt. The surface facilities at the repository include the waste handling building, shaft filter building, warehouses, etc. The underground facilities include the shafts that connect the surface to the underground repository horizon, the waste-disposal area, an experimental area, and an equipment and maintenance support area. The transportation system will use trucks to ship TRU wastes to the repository via pre-approved routes. The repository is projected to contain 5.42 million curies of TRU wastes consisting of the types and quantities of nuclides as specified in the BID.

Total costs over the life cycle of a TRU waste repository in a salt media are estimated to be $3.9 billion. Discounting this cost stream at 2 percent yields a net present value cost of $2.4 billion for such a facility (9).

Costs for canisters and waste forms are assumed to be minimal. Generally, the waste form is simply the form of the wastes as they leave the site where they were generated and/or stored. No particular engineered waste form is considered. Similarly, no particular engineered canister will be considered - the TRU wastes will be emplaced in the repository in the packages in which they arrive from the TRU waste generators and/or storage facilities. Costs for canisters are provided in a later section for information purposes but were not considered in this analysis because of their negligible impact.

REAL IMPACT OF 40 CFR 191 AMENDMENTS

The portions of 40 CFR Part 191 that were reinstated by the WIPPLWA included the containment portions of the standard. These provided strict limitations on releases to the general environment from the repository. Since these containment portions provide for much of the same protection as afforded by the groundwater and individual dose requirements of the amendments and since they effectively precede the amendments, they (the containment requirements) are the basis against which the impact of these amendments is measured.

The results of the risk analysis provide information on health effects and individual dose for all media. This information can be used to make the comparison between the containment requirements and the groundwater and individual protection requirements. These results show the amendments to have no economic impact; i.e., no additional technology is necessary to meet them. Modeling results for TRU disposal site in all media studied indicate that when the containment requirements of 40 CFR 191 are met, the individual dose requirements and groundwater requirements of 40 CFR 191 are also satisfied. More precisely, groundwater and individual doses were zero for all TRU disposal sites meeting the containment requirements. Under these circumstances, the amendments offer the assurance of protection but no additional protection.

This 'mutual protection' result stems from the fact that measures used to ensure that the containment requirements are met (and retard nuclides from entering the environment outside of the repository) also act to protect groundwater and the individual. The amendments to 40 CFR 191 may, however, impose small additional costs to DOE as they must demonstrate compliance with this portion of the standard in addition to the reinstated portions.

SENSITIVITY ANALYSIS

The preceding analysis looked at the impact of the amendments as they currently exist. In this section a sensitivity analysis is performed to determine the result of a change in the level of the standard, either relaxing or becoming more stringent, on the cost of the standard. This analysis indirectly examines the cost-effectiveness of the standard. The effect of varying the period of performance is also examined.

Varying The Dose Level

As developed previously, the modeling results estimate that over the 10,000 year period of the analysis there is no release of nuclides to any groundwater pathway (and thus to the accessible environment) for all four media: salt, basalt, tuff and granite. These results imply that lowering the level of the standard (theoretically down to zero) would have no cost impact as it would require no additional containment technology.

Conversely, setting the level of the standard higher than currently proposed is estimated to have little, if any, economic impact. This ignores the potential cost savings associated with showing compliance with a less stringent standard (it may be that both the difficulty of showing compliance with a standard and the cost of this demonstration are correlated with the stringency of the standard). The same disposal technology is used regardless of the level of the standard since the most protective technology (i.e. media) is also the lowest cost technology.

1,000 Versus 10,000 Year Period of Performance

A 1,000 year time frame for the period of performance was previously considered by EPA as part of this amendment, as opposed to the current 10,000 year form of the standard. This time frame was discarded for reasons discussed in the Preamble to the proposed rule. However, the economic impact of a 1,000 versus 10,000 year standard is believed to be small. For the media best characterized and for which generic modeling results are available (salt, basalt, granite, tuff), it was estimated that there was no release of nuclides to the accessible environment over the entire 10,000 year period of the analysis (for undisturbed performance). With the assumption that these modeling results are robust enough to apply to real world repositories, extending the period of performance from 1,000 years to 10,000 years would require no additional engineering controls, given the proper selection of a media. Also, because minimal engineering barriers are employed, a shortened period of performance would not lead to more relaxed disposal methods or cost savings.

Additional efforts, including modeling, necessary to demonstrate compliance with the standards over the 10,000 year period (versus the 1,000 year time period) are believed to be small. The efforts to demonstrate compliance with the 1,000 year time period are not believed to be large relative to overall effort and the analysis for the 10,000 year period would only be slightly incremental to that for a 1,000 year period.

Modeling Parameters

The results discussed within the paper for the performance of the various media are not very sensitive to changes in critical modeling parameters. For salt, basalt, tuff and granite, the discharges to the local environment over the 10,000 year period of the base case analysis were shown to be zero (for more detailed results see the BID). Variations in the critical parameters of solubility, vertical hydraulic conductivity, and retardation were conducted and are also shown in the BID. Extreme variations in assumptions for both solubility and vertical hydraulic conductivity that would make the mobile nuclides more susceptible to transport out of the repository and into the local environment did not violate the standards over the 10,000 year period used in this analysis. Only the assumption of zero retardation resulted in a violation of the 10,000 year limit and then only in some media. This would indicate that the results of the modeling analysis are somewhat robust.

REFERENCES

1. Environmental Protection Agency, Draft Federal Register Notice for 40 CFR Part 191, August 14, 1992.
2. Environmental Protection Agency, Economic Impact Analysis for Amendments to EPA's Radioactive Waste Standards (40 CFR 191), December 1992.
3. Environmental Protection Agency, Draft Federal Register Notice for 40 CFR Part 191, August 14, 1992.
4. Letter from Mr. Arlen Hunt, Acting Project Manager of the Waste Isolation Pilot Plant Project Office, Albuquerque Operations Office, Department of Energy, to Mr. Elliott Foutes, Environmental Protection Agency, March 31, 1990.
5. Oak Ridge National Laboratory, Integrated Data Base for 1991: Spend Fuel and Radioactive Waste Inventories, Projections and Characteristics, DOE/RW-0006, Rev. 5, October 1991.
6. U.S. Department of Energy, Office of EnvironmentalRestoration and Waste Management, Final Supplement Environmental Impact Statement, Waste Isolation Pilot Plant, January 1990.
7. Environmental Protection Agency, Background Information Document for Amendments to 40 CFR Part 191, October, 1992.
8. Ibid.
9. Letter from Mr. Arlen Hunt, Acting Project Manager of the Waste Isolation Pilot Plant Project Office, Albuquerque Operations Office, Department of Energy, to Mr. Elliott Foutes, Environmental Protection Agency, March 31, 1990.