High-Level Dollars, Low-Level Sense

About the book

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The management of radioactive wastes, which contain materials that remain hazardous for up to millions of years, is one of the most vexing, contentious and costly environmental issues of our time. Almost since the inception of the nuclear age, radioactive waste management has been plagued with failures, poor science, cost overruns and unanticipated environmental events.

The authors discuss the reason for these failures, clearly explaining the inconsistencies of waste classification regulations, and exposing some of the scare tactics used to push risky new disposal sites on the public.

> "High-Level Dollars, Low-Level Sense is a devastating analysis of the attempt to manage radioactive wastes generated by the production of nuclear power and nuclear weapons…Makhijani and Saleska have written what might well stand as the epitaph of nuclear technology."
> — Barry Commoner, Center for Biology and Natural Systems, Queens College

The authors then move beyond their criticism of existing flaws to propose an alternative unified approach to address the problem in a fiscally prudent and environmentally sound way. We have provided portions of the book below (Preface, Introduction, and Conclusions).

You can download the entire report as a PDF file. *Download is free,* donations are welcome.

Preface from *High-Level Dollars, Low-Level Sense*

The management of nuclear waste, which contains materials that remain hazardous for up to millions of years, is one of the most vexing, contentious, and costly environmental issues of our time. Nuclear waste management has been plagued with failures, poor science, and unanticipated environmental events — such as rapid migration of radioactive contaminants from the soil into groundwater — which have made a mockery of many a computer model.

The scene is also littered with institutional and regulatory failures and absurdities. In the United States today, nuclear wastes are classified, not so much according to the threat they pose to human health or the environment, but according to the process which produced the waste. For example, a catchall category called "low-level" waste contains some components which are more radioactive than some "high-level" waste. Some wastes have health criteria which govern their disposal. Other wastes do not. Some wastes are designated as suitable for shallow-land burial. Other wastes of comparable danger are designated for disposal in a deep underground repository. There are no adequate programs to address whole categories of other wastes of comparable danger, notably soil contaminated with plutonium and other long-lived radioactive elements, which may, by default, be left lying around endangering public health and the environment for thousands of years.

This welter of problems, along with concern for future generations and environmental degradation in general, has given rise to vigorous public opposition to nuclear waste disposal sites wherever they have been proposed in recent years. Such opposition does not derive simply from a “not in my backyard” syndrome. That syndrome does play a role and it is understandable in view of the long-lived nature of the threat. People’s fears, however, also stem from the problems which have arisen from the basic conflicts of interest in the institutions — notably the Department of Energy and the Nuclear Regulatory Commission — which have regulated nuclear waste disposal. These institutions have an agenda — sometimes stated, and sometimes only implicit of producing nuclear weapons and promoting nuclear power. For more than a decade, the executive branch of the U.S. government has also explicitly and vigorously pursued that same agenda, coloring the actions of the institutions which operate under it. Under present institutional arrangements, these goals have been in basic conflict with providing sufficient time and resources to protect future generations as best we can from a considerable threat to the environment which our activities have created in the form of long-lived nuclear waste.

From these conflicts of interest have arisen failures which have been costly both to the environment and to the public purse. We undertook this work in order to discuss the failures in all areas of nuclear waste disposal, focusing especially on the problem of classifying nuclear wastes in a manner that corresponds to the threats that they pose. This has enabled us to propose a unified approach to the management of the problems that cuts across current waste categories. We also can see clearly the need to minimize generation of long-lived radioactive wastes.

Proponents of quick land-based disposal of nuclear waste often resort to scare tactics in order to push new disposal sites on the public. These range from an avowed need for more nuclear power plants to threats that huge portions of medical care system may shut down because there are no new disposal sites. This is a perceived urgency which does not arise from any technical problem. There are ways to provide for interim storage of nuclear wastes which pose far smaller threats than quick land-based disposal and hurried transportation. There are also ways to minimize use of long-lived radioisotopes, especially in medicine, and the medical community has begun taking steps over the last many years in that direction. The perceived urgency arises more from artificial deadlines that Congress and governmental agencies have created, largely in response to pressure from industry to quickly dispose of the wastes. Such artificial deadlines can and should be changed, so that the environment, public health and the public purse may be better protected.

A few years ago, parts of the chemical industry were given to painting similar scare scenarios about chlorofluorocarbons, which are destroying the earth’s protective layer of stratospheric ozone. It was stated that we may have to give up refrigerators and computers and automobile air conditioners if CFCs were reduced by even 50 percent by the year 1998. The threat to the ozone layer from these compounds has proved to be so severe, however, that it has clearly become necessary to phase out these chemicals altogether, and other ozone-depleting chemicals besides. Today, under pressure from an international treaty which requires the total phase-out of these chemicals by the year 2000, as well as more stringent local laws, many industries now find that they can get rid of them well before 1995! Moreover, many of them are saving money as they do it.

Careful consideration of alternative energy sources, energy conservation, the use of short-lived radionuclides in medicine and research, and the end of the Cold War may enable a phase-out of the generation of long-lived radioactive wastes except for some minor medical and research uses. While such considerations are beyond the scope of this book, we urge that this matter be taken up as a matter of high priority in public policy, even as we hope to put the attempts to address the problems of the long-lived radioactive wastes which already exist on a sounder technical and institutional footing. That is the subject of this inquiry. These issues must be addressed both out of concern for the protection of public health and the environment and as a matter of financial prudence.
This study was funded in part by the Nuclear Waste Projects Office of the State of Nevada, which operates in part under Department of Energy contract DE-FG-08-85-NV10461. The rest of the funds for its preparation came from general support funds provided to the Institute for Energy and Environmental Research (IEER) by the Public Welfare Foundation and from IEER's own institutional funds and from a gift of Dr. Gopi B. Makhijani.

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During the research phase of this project we were greatly and ably assisted by the efforts of former IEER staff member Deborah Landau, to whom we owe a debt of thanks. We are also greatly indebted to David Dembo of The Apex Press, who worked with us during the final stages to convert the manuscript into a published book.

Those acknowledged here do not necessarily in any way endorse the findings, conclusions, or recommendations of this study, the responsibility for which lies solely with us. We also, of course, take full responsibility for any errors.Arjun Makhijani
Scott Saleska

Chapter 1: Introduction from *High-Level Dollars, Low-Level Sense*

The management and disposal of long-lived radioactive wastes — the great majority of which are the result of nuclear weapons production and commercial nuclear power generation — has been a technical and political problem for many decades.

There are many types of radioactive wastes, varying in radioactivity level, longevity, and hazard. Much (although by no means all) radioactive waste is subsumed under two broad categories, named "high-level waste," and "low-level waste." The other principle categories of nuclear waste are transuranic waste, and uranium mill tailings. Although many of the attempts to address the "nuclear waste problem" have focused on one or another of the above categories, it is a principle thesis of this study that these categories are fundamentally misconceived, and that this misconception has led to many of the problems that continue to exist for nuclear waste disposal.

One common factor for all categories of nuclear waste is the presence of at least some amount of long-lived radionuclides. It is on the management and disposal of these most long-lived components that this study has focused, regardless of which official waste “category” such components happen to fall into.

In addition to examining the characteristics of some of the most hazardous and long-lived waste forms, we have also addressed the question of adequacy of the current policies for managing them. We identify fundamental problem areas in the technical, regulatory, and managerial aspects of present programs, and suggest an alternative structure to correct deficiencies in each of these areas.

To this end, this book is organized in the following manner. Chapter 2 provides an overview of the radioactive waste problem, including the origin of nuclear wastes, and the characteristics of each of the currently defined radioactive waste categories, along with the amounts and locations of the waste. Chapter 3 contains an explanation and critical analysis of the various components of the current approach to management of these wastes. Chapter 4 lays out our proposal for an alternative, integrated approach to waste management that addresses many of the deficiencies and shortcomings which we identify in Chapter 3. Finally, our findings and recommendations are summarized in Chapter 5.

Chapter 5: Summary and Recommendations from *High-Level Dollars, Low-Level Sense*

Summary of Findings

1. *Radioactive waste is inappropriately defined.*

   There is a fundamental problem with the way in which current government regulations categorize radioactive waste. For example, despite what is implied by their names, the two categories of waste named “high-level waste” and “low-level waste,” are defined without systematic reference to their actual radioactivity levels. Instead, they are defined solely by the process which produced them. “High-level waste” is defined as spent reactor fuel, or those wastes resulting from the reprocessing of spent reactor fuel. “Low-level waste” is actually a catch-all category that is defined simply to include all radioactive waste that is not high-level waste, transuranic wastes, or uranium mill tailings.

   Thus, the current radioactive waste categorization is in the untenable situation of sometimes labeling as “low-level” radioactive wastes which are actually several times more radioactive than other streams of radioactive waste which the current system labels “high-level.” So, for example, the average radioactivity in the most radioactive portion of commercial low-level wastes (at 300 curies per cubic foot) is actually three times more radioactive than the average radioactivity in high-level wastes from nuclear weapons production activities. Even a typical reactor stream of low-level waste, which is routinely buried in shallow land trenches, is significantly more radioactive than some of these military high-level wastes. Many of the longer-lived and more dangerous categories of low-level waste, which is disposed of in shallow land burial, is also more radioactive than transuranic waste, which has been designated for disposal in a deep geologic repository.

A related problem with the existing definitions for radioactive waste is that they are without reference to the longevity of the waste's radioactivity. Both high-level and low-level wastes as currently defined can contain significant quantities of both long and short-lived radionuclides. Since essential aspects of the radioactive waste disposal problem are in large part defined by the longevity of the waste's hazard, this also makes little sense.

2. *Existing regulations and plans for long-lived radioactive waste management and disposal are irrational and incoherent.*

Improper categorization of radioactive waste has been a principle obstacle to rational waste management policies. A central problem has been the substantial quantities of long-lived wastes involved in "low-level" waste categories. For example, long-lived plutonium-239 and other radionuclides have leaked from the now-closed low-level waste disposal facility at Maxey Flats, Kentucky.

Currently operative regulations for the disposal of low-level wastes, although much-improved since the time of Maxey Flats operation, continue to be fundamentally irrational. They are internally inconsistent, and therefore clearly inadequate. For example, the Nuclear Regulatory Commission (NRC) regulations currently require institutional controls at low-level waste disposal facilities for up to 100 years, because, according to NRC, "low-level" waste classes A and B will decay to the point where they will present "an acceptable hazard" to any later intruder by the end of this time frame. However, this statement is logically and physically incompatible with the numerical limits also contained in those same NRC regulations. In fact, some forms of waste, if retrieved from the disposal site after the 100-year period had elapsed, and then re-buried as if for the first time, would have levels, according to the same NRC regulations, such as to require a 100-year institutional control period all over again. Indeed, even according to the NRC regulation's own definitions of what is "hazardous" and what is "acceptable," wastes could be buried which will be unacceptably hazardous for thousands of years beyond the time when the regulations say they should pose an "acceptable hazard." Hence, the internal inconsistency of the regulations and definitions.

The U.S. Environmental Protection Agency (EPA) has the authority under law to promulgate low-level waste standards, and has actually formulated comprehensive standards for this purpose, but disagreements with the NRC and Department of Energy (DOE) arising due to the fact that EPA's standards are more comprehensive and stringent have prevented their official publication. EPA's low-level waste standards are intended to provide comprehensive and consistent coverage across both commercial and military facilities, and to protect groundwater. Since existing standards are severely lacking in these areas, the lack of EPA low-level waste standards is a serious defect in the U.S. low-level waste program.

While radioactive waste management is a difficult issue by its very nature, it does not have to be irrational. For instance, radioactive waste management in Sweden is based on the principle that radioactive waste disposal methods should be determined by the longevity of the waste. Thus, long-lived wastes (whether they would be considered “low-level” or “high-level” in the U.S.) are slated for disposal in a deep geological repository. As a consequence, fully 40 percent of the volume slated for disposal in Sweden’s projected long-lived waste repository consists of reactor wastes which would be considered “low-level” in the U.S.

3. *The Department of Energy’s management of the repository program for long-lived radioactive wastes is exacerbating these problems.*

   The U.S. Department of Energy is responsible for developing geologic repositories for high-level and transuranic wastes. Over the past 15 years, timetables for both of the DOE’s major repository programs have slipped and costs have escalated. For example, an operational repository for high-level wastes is now, according to DOE projections, twice as far away as it was in the late 1970’s, and projected disposal costs grew by over 80% between 1983 and 1990.

   Despite the existence of at-reactor and onsite storage options for nuclear wastes and repeated failure within its repository program, a sense of urgency continues to pervade the U.S. attitude towards long-lived radioactive waste disposal. The nuclear industry in particular is anxious to have in place a program which will allow the government to take the waste out of their hands. As one nuclear utility executive recently put it, the government should take charge of spent fuel waste by 1998 (a target date in the 1982 Nuclear Waste Policy Act), and, he said, “I don’t care where you put it.”

   This situation is exacerbated by lack of NRC and EPA standards for repository disposal which correspond to longevity of the wastes and the health threats posed by many long-lived radionuclides.

4. *Taken as a whole, current policies entail high risks in terms of both economics and environmental protection.*

Economics

On the high-level waste side, where $3 billion has already been spent on a program for geologic repository disposal, projections of disposal cost per ton have increased by over 80 percent since 1983 (in constant dollars), from $179,100 per metric ton, to about $325,000 per metric ton.

The cost of the WIPP repository program, which should be more stable since the program is further along,shows similar increases. In just two years, the DOE’s cost estimates for the five-year period including the first several years of WIPP operation have more than doubled, from $531 million in 1989, to around $1.1 billion in 1991.

Seven hundred million dollars have already been spent on development of the low-level waste disposal sites according to fundamentally inadequate environmental standards. Most of these sites will likely miss legal deadlines established for their availability. Additional billions are being spent and will have to be spent to fix the problems from past shallow-land burial of low-level wastes at both commercial and military sites.

For instance, at the contaminated commercial low-level waste ¬disposal facility at Maxey Flats, Kentucky, when the clean-up is finally done, and all the costs accounted for, final disposal costs for wastes disposed of there may well be 10 to 50 times greater than the original disposal rates. At West Valley, New York, the bill for combined high-level waste management and remediation of problems with low-level waste disposal is now estimated to cost between $2.4 and $3.4 billion.1 These wastes resulted from a reprocessing plant for plutonium extraction which originally cost $35 million and was supposed to be a commercial, profit-making operation.2 Finally, a large proportion of the $150 billion cost of clean-up of the nuclear weapons complex sites is due to environmental threats created by dumping of radioactive and mixed wastes into the soil and the high-level wastes now sitting in 228 large tanks at Hanford and the Savannah River Site.

Billions of dollars have been or are slated to be spent stabilizing uranium mill tailings and preventing radium-226 and thorium-230 from getting into the groundwater. Yet, such programs are limited to 1,000 years of environmental protection, despite the fact that hazards will persist for the several hundred thousand years which will be necessary for the thorium-230 to decay substantially.

Environmental Protection

On the high-level waste side, the DOE’s program has become environmentally more risky due to the reduction in the number of potential repository sites to be characterized to one, despite its greater cost. The selection of Nevada as the only site to be characterized came about as a result of a process that, in part, started with the fact that the government already controlled the land, and ended in a decision in which politics overwhelmed science.

The doses from vitrified military high-level wastes alone, a small portion of the total radioactivity proposed to be disposed of could far exceed allowable standards due to the potential incompatibility of glass with the Yucca Mountain hydrogeological conditions.

The huge inventories of transuranic wastes in the form of contaminated soil which will be left unaddressed by the WIPP program means that this program is guaranteed to be a failure from the point of view of isolating transuranic wastes from the human environment. Moreover, the small proportion that may be disposed of in WIPP is by no means assured of isolation from the human environment even for a few thousand years, much less the hundreds of thousands of years it will remain threatening.

Likewise, despite huge cost escalations in the development of low-level waste disposal sites (unit disposal costs for some disposal sites in the 1990s are projected to be 600-700 times 1975 disposal costs), these still entail huge environmental risks for future generations because of the fundamental inadequacy and irrationality of the underlying regulations.

In sum, for a host of fundamental reasons, it is highly unlikely that minimization of risk to future generations or wise use of financial resources can be achieved under the present approaches for management of any category of nuclear waste. Far more likely is waste of money coupled with a festering problem, and potentially increasing risks from inappropriate policies.

Recommendations

The management of long-lived, highly radioactive waste has no safe or simple solution. It is a difficult, messy and costly problem. We have created a problem which will be a source of substantial risk to future generations, whatever we do today. It is therefore imperative that society minimize the generation of further long-lived radioactive wastes. Almost all long-lived wastes, in terms of the quantity of radioactivity involved as well as the physical volume, come from nuclear power and nuclear weapons production. The problem of the management of long-lived radioactive wastes makes it incumbent upon us that any further generation of long-lived wastes from these two sources, about which there is no social consensus, be subjected to careful scrutiny regarding the potential for phase-out. Generation of long-lived wastes from medical and research facilities should also be minimized by use of shorter-lived isotopes and substitute processes to the extent practicable.

It is of vital importance that we address the problem of the wastes which already exist with the greatest scientific and technical integrity so that future generations may be protected to the greatest extent possible. Steps must also be taken in the interim to see that the present generation does not suffer large releases and contamination due to accidents or poor interim management.

Based on the above findings and these general considerations, we make three overall recommendations regarding the U.S. radioactive waste management system: change radioactive waste classifications so that all long-lived wastes are managed according to an integrated hazard-and-longevity-based approach, re-structure the program for disposing of these newly defined long-lived wastes, and provide for extended onsite storage of wastes in the interim while the long-term problem is being addressed. Each of these entails a number of sub-recommendations, which are discussed below along with some of their ramifications.

1. Change how radioactive wastes are defined, and reclassify radioactive wastes and their disposal according to longevity and hazard level.

Since many of the problems of the current waste management system are due to the underlying fundamental inadequacy of waste definitions, an integrated approach which entails redefining wastes according to their longevity is needed. This includes reclassification of considerable quantities of commercial and military wastes that are now considered “low-level” into the long-lived category. Long-lived should be appropriately defined such that wastes containing significant quantities of cesium-137 and strontium-90 are considered long-lived. Evidently, what constitutes “significant” must be determined by health-based criteria and this must be the subject of careful scientific study and broad democratic debate.

An important consequence of this is to expand the amount of waste being sent to a repository. By analogy the Swedish approach, we expect that approximately 225,000 cubic meters of commercial reactor waste now considered low-level would go to a deep repository. Depending on the emplacement density of this waste, we expect that this amount would require an additional 140 to 1,200 acres of repository space in addition to the approximately 2,400 acres already needed for spent fuel and reprocessing wastes.

Although this does not include the consequences from reclassifying military low-level wastes, it is indicative of the scale of the problem.

The DOE made a partial step in this direction when it decided in 1970 to reclassify some of its “low-level” wastes as transuranic wastes and dispose of them in a repository. However, the application of this principle has been seriously deficient. First, the repository selection, characterization, and testing has been flawed. Second, the volume of wastes which fall into this category is far larger than the proposed repository in New Mexico will be able to accommodate.

2. Restructure the entire long-lived waste management and disposal program.

The present process of site selection and characterization for the high level and transuranic waste repositories has been compromised both technically and institutionally. It has become necessary to abandon it. The low-level waste disposal site selection programs, are a welter of confusion based on an irrational NRC waste classification scheme that mixes intensely radioactive long-lived waste with short-lived waste, and the absence of any applicable EPA standards at all. There is no provision for long-term isolation of the long-lived components of uranium mill tailings.

The present programs for selection of disposal sites must be abandoned and replaced with an approach to long-lived waste management and disposal that has technical integrity and institutional competence.

Regarding the programs established for each of the categories of radioactive waste, our suggested alternative approach entails:

- Spent Fuel and High-Level Reprocessing Wastes: Cancellation of the high-level waste repository development program as currently being implemented by the DOE. All current investigations of Yucca Mountain should be halted, and the program should begin again with basic consideration of geology, and rock types, as well as consideration of alternative approaches such as sub-seabed disposal and, for already reprocessed wastes, transmutation.
- Transuranic Wastes: Along lines similar to those which apply to the Yucca Mountain program, a cancellation of the transuranic waste repository program at WIPP.
- Low-Level Wastes: Cancellation of siting for new low-level waste sites, with provision for monitored storage of low-level wastes, study of the feasibility of separating all long-lived components from them, as well as consideration of the feasibility of storing hospital and pharmaceutical and research wastes at the most appropriate, interim locations.
- At a minimum, no siting, construction or operation of new low-level waste disposal facilities should be allowed to proceed in the absence of comprehensive EPA standards for low-level waste disposal.
- Uranium Mill Tailings: An assessment of the feasibility of separating radium-226 and thorium-230 from uranium mill tailings to enable their integration into the long-term management program.

Addressing related institutional and policy issues entails a number of other steps, including:

- The removal of the DOE from the waste management program and the establishment of an independent radioactive waste management authority which does not have conflicts between

nuclear power and weapons production on the one hand, and environmental and health protection on the other.(*This includes the creation of new institutional arrangements for managing the research and development needed to create a program for long-term management of long-lived wastes.*)
- Implementation of policies designed to create substantial incentives for actions to minimize the generation of long-lived radioactive wastes.
- The establishment of consistent, health based standards governing nuclear waste management and disposal for all radioactive waste, irrespective of the process producing those wastes.

3. Provide for extended onsite storage of long-lived radioactive wastes at the point of generation as an interim management step.

In order to accommodate the needs of a restructured development program for long-term waste management, extended onsite storage will be needed for various categories of waste. This would include:

- Planning to allow up to 100 years of at-reactor storage of spent fuel (in dry casks) and other long-lived radioactive wastes to accommodate the reality that a long-term waste isolation option will not be available for many decades. Funds for extended onsite storage should come from the Nuclear Waste Fund.
- Likewise, planning to defer decommissioning of shut-down nuclear reactors by up to 100 years to lower disposal requirements, reduce risk, and integrate onsite storage with a realistic time frame of radioactive waste disposal.
- The stabilization of radioactive wastes including military high-level, long-lived low-level and transuranic wastes for storage on site in a manner that reduces the risk to workers and residents and which does not compromise in any essential way long-term management programs which may be put into place. Retrievable and carefully monitored storage in solid form in ways which minimize the risk of contamination of soil, water and air should guide the examination of options for interim storage.

Combined with onsite storage and deferral of decommissioning for nuclear reactors, a restructured long-lived waste disposal program will allow time for development of careful and sound understanding of geology and climate in selection of a disposal option, development of waste forms with better isolation characteristics and research on new technologies. This will allow the science to be done in parallel with the politics, in contrast to the present program where politics and policy goals in areas other than public health and environmental protection have tended to dominate.