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NUCLEAR WASTE

TOO MUCH TOO SOON

by

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INTRODUCTION

The world is now more than 35 years into the nuclear era. Yet the initial radioactive waste produced in the early 1940's are still stored in tanks and their ultimate deposition is still in doubt. At the same time, radioactive wastes are accumulating at an ever increasing rate at nuclear power reactors. As a consequence, the pressures are mounting to find a "solution" to this radioactive waste problem. Although there appears to be a more considered perception of the waste problem on the part of the present Administration, based upon the history of the bureaucracies and industries involved, it is reasonable to propose that the response to the growing pressures to find a solution will result in hurried and inappropriate actions. Actions that could well convert the present difficult situation into an impossible situation in the future.

While it is agreed that now is the time for action, it is not the time for hurried and inappropriate action. To illustrate the magnitude of the problem, this report begins with a discussion of the looming logistical problem involving the management of nuclear waste materials. This will be followed by the historical background of the nuclear bureaucracy and industry that will be charged with the responsibility of disposition of the waste. It will be shown that this history does not argue well for the future. The report will conclude with a discussion of the evolving criteria for waste disposal and the depressing implication of this evolution. In short, this report is intended as an environment alert to call this problem to the attention of the Citizenry and Congress and to indicate that their close involvement in its solution is absolutely essential.

THE LOGISTICS

Over the past several years, considerable attention has been focused on nuclear fuel reprocessing. President Carter, in his April 7, 1977 statement on nuclear power policy, stated

> . . .we will defer indefinitely the commercial reprocessing and recycling of the plutonium produced in the U.S. nuclear power programs. From our own experience we have concluded that a viable and economic nuclear power program can be sustained without such reprocessing and recycling. The plant at Barnwell, South Carolina, will receive neither federal encouragement nor funding for its completion as a reprocessing facility.

Even prior to this shift in U.S. policy, it was apparent to the U.S. nuclear industry and bureaucracies that commercial reprocessing plants were not going to be brought on line fast enough to handle the rapid increase in spent fuel discharges, particularly under the rather high nuclear energy growth projections of the Federal government and the industry. It was apparent then (and it is a reality today) that utilities urgently needed additional spent fuel capacity.

Because this bottleneck appeared at the reprocessing link in the back end of the nuclear fuel cycle, and because reprocessing was thought to buy time -- a decade -- before permanent disposal of the waste was required, little attention, until very recently, was given to the logistics problem at the final repository itself. A cursory look at this logistics problem suggests that this may be another Achilles' heel of the nuclear industry.

The nature of this problem can be illustrated by examining just one of the disposal requirements - the disposal of the spent fuel elements from commercial power reactors. Table I presents the consequences of two scenarios, each identified by the nuclear generating capacity in the year 2000. The 148 Gwe scenario represents the nuclear power capacity already committed, that is, existing reactors, plus those that have at least reached the limited work authorization or construction permit stages in the licensing process. These would of course all be on line well before 2000. The 380 Gwe scenario is an Administration figure that is often linked to President Carter's 1977 National Energy Plan, although no figure for 2000 is presented in the Plan itself.

For both scenarios, the annual and cumulative spent fuel production in Metric Ton of Heavy Metal (MTHM) are presented for the years 1990 and 2000. Spent fuel is shipped today in trucks that are designed to carry about 0.5 MTHM per shipment, or railroad casks holding 4.5 MTHM. One-half a metric ton of heavy metal corresponds roughly to one PWR fuel assembly or 2.5 BWR assemblies. (About 60 PWR and 150 PWR assemblies are removed at each refueling.) Based on today's shipping capability, Table I also gives the annual and cumulative truck and rail shipments for the two scenarios. We use the DOE assumption that 90% of the spent fuel is shipped by rail. The total number of shipments, truck and rail, of course will increase if the percentage of rail shipment is less. In the unlikely extreme, if all shipments were by truck, the number of shipments would be 10 times larger than the truck shipments indicated by Table I.

TABLE I*

			Nuclear Growth Scenarios**	
Assumed Nuclear Capacity in yr. 2000			148 Gw	380 Gw
Annual spent fuel production (MTHM/yr.)	1990		3,700	4,200
	2000		3,500	8,100
Cumulative spent fuel production (MTHM)	1990		34,100	34,800
	2000		71,000	97,000
Annual shipments***	1990	truck	540	540
		rail	540	540
	2000	truck	740	1,200
		rail	740	1,200
Annual number of Assemblies****	1990		7,830	7,830
	2000		10,730	17,400
Cumulative truck shipments	1990	truck	3,360	3,360
		rail	3,360	3,360
	2000	truck	10,600	12,240
		rail	10,600	12,240
Cumulative number of Assemblies****	1990		49,000	49,000
	2000		154,000	177,000

* Data in this table taken from Report of Task Force for Review of Nuclear Waste Management, February 1978, Draft, U.S. Dept. of Energy, Directorate of Energy Research DOE/ER-0004/D.

** 148 Gw represents existing plants plus all plants that have proceeded beyond the limited work authorization or construction permit stages of licensing.

380 Gw is often referred to as the National Energy Plan reference projection.

*** Assumes 0.5 MT/shipment by truck; 4.5 MT/shipment by rail. Shipments - 90% by rail and 10% by truck. Spent fuel is assumed to be cooled for 5 years.

**** Assume a mix of 30% BWR and 70% PWR which equates to 1.3 fuel assemblies per truck. Assumes spent fuel cooled for 5 years.

The 1990 figures for both scenarios are about the same. If the lower values are used and it is assumed that the fuel assemblies are shipped after 5 years of cooling to a repository that operates 200 days/yr for 8 hrs/day, then the repository would have to handle 40 fuel assemblies/day or 5/hr - one every 12 minutes. If the repository operates 300 days/year, around the clock, then the corresponding load on the repository is one fuel assembly every hour.

The logistics problem is actually worse than the above would indicate. First, because it assumes that a permanent repository will be available before 1990 so that there is no backlog of spent fuel in 2000. Second, it assumes that only one repository is needed. Both assumptions are highly questionable if not flawed.

Presently, the DOE assumes that a geologic retrievable storage facility could be operational around 1988 at the earliest. This early schedule should not be taken too seriously. It doesn't reflect all the uncertainties in the project that could lead to further delays. The only major experimental facility now planned is the <u>W</u>aste <u>I</u>solation <u>P</u>ilot <u>P</u>lant (WIPP) at Carlsbad, N.M. WIPP is designed to gather data to demonstrate the feasibility of radioactive waste disposal in bedded salt using waste generated by the military program. Although WIPP is scheduled to be available in 1985, it is unlikely to meet this timetable. It could possibly be made operational in the early 1990's time frame if its use is restricted to the storage of transuranic (TRU) waste and a limited R&D program to collect data on high-level waste. This is reasonable because the TRU wastes are not hot thermally and thus it could be argued that heat loading would not challenge the long-term integrity of the repository. At a minimum, 5 to 10 years of data at WIPP will be essential to "confirm" the geologic concept. It is worth noting that the term "confirm" is rather meaningless as applied here since no one really knows what it takes to "confirm" the integrity of the repository in operational terms. This, of course, heightens the concern that the pressure now being applies to construct a repository will lead to an inadequate and potentially hazardous facility.

At the present time, no site has been selected for a commercial repository. Thus, this facility can not come on-line as early as WIPP. DOE has recently slipped the earliest date from 1985 to 1988 for operating the first commercial repository with a possible additional delay of 5 years. Judged by the history of the program additional delays should be anticipated. Moreover, prudence requires that the initial rate of utilization of the facility should be much lower than its design rate. This lower initial rate is essential for the first 5 to 10 years (preferably much longer) while the integrity of the repository is being "demonstrated or confirmed." Consequently for the purpose of assessing the logistics problem, it should be assumed that the full scale operation of a facility to handle commercial spent fuel is unlikely to take place much before the year 2000. In fact, an earlier date represents an inappropriate and potentially hazardous action.

The logistics problem is worse if one is not simply trying to keep up, but also contemplates moving the backlog of spent fuel that would have built up in the years prior to start-up of the repository. Consider, for example, the 148 Gwe scenario and assume a 5 year spent fuel cooling period. If one further assumes that the backlog is to be moved in 10 years, beginning in 2000, then from Table I, it is seen that the annual truck and rail shipments would each be 1800 (i.e., 740 + 1060), or 18,000 in the extreme if all shipments are by truck. Under the previous assumptions including operating around the clock 300 days/year this would correspond to handling one fuel assembly every 15 minutes.

Next it should be noted that one repository for commercial spent fuel by the year 2000 may not suffice. The capacity of a repository is a function of the acreage of the mine floor and the spacing of the canisters of waste. The canister spacing is in turn governed by considerations related to both long-term geologic integrity of the mine and the shorter-term desire to retain an option to retrieve the waste. The long-term integrity depends in part on the cumulative heat generated by the fuel over the long-term. Retrievability is a function of the pillar strength and room closure rate and the latter is in turn dependent on the short-term heating effects, and therefore the age of the spent fuel when it is placed in the mine initially. None of these parameters are fixed at this time, thus, while several estimates of repository capacity have been made, these vary widely because of different assumptions related to the above parameters. For example, the California Energy Commission has assumed a spent fuel repository capacity of

35,000 MTHM.[1] The Geologic Projects Division at Sandia Laboratories has estimated a repository capacity for spent fuel of about 40,000 MTHM based on an assumed repository size of 2000 acres and a heat load constraint at time of emplacement of 23.5 Kw/acre.[2] The NRC has adopted this estimate for the purposes of estimating the land use requirements for disposal of radioactive waste in the S-3 proceeding.

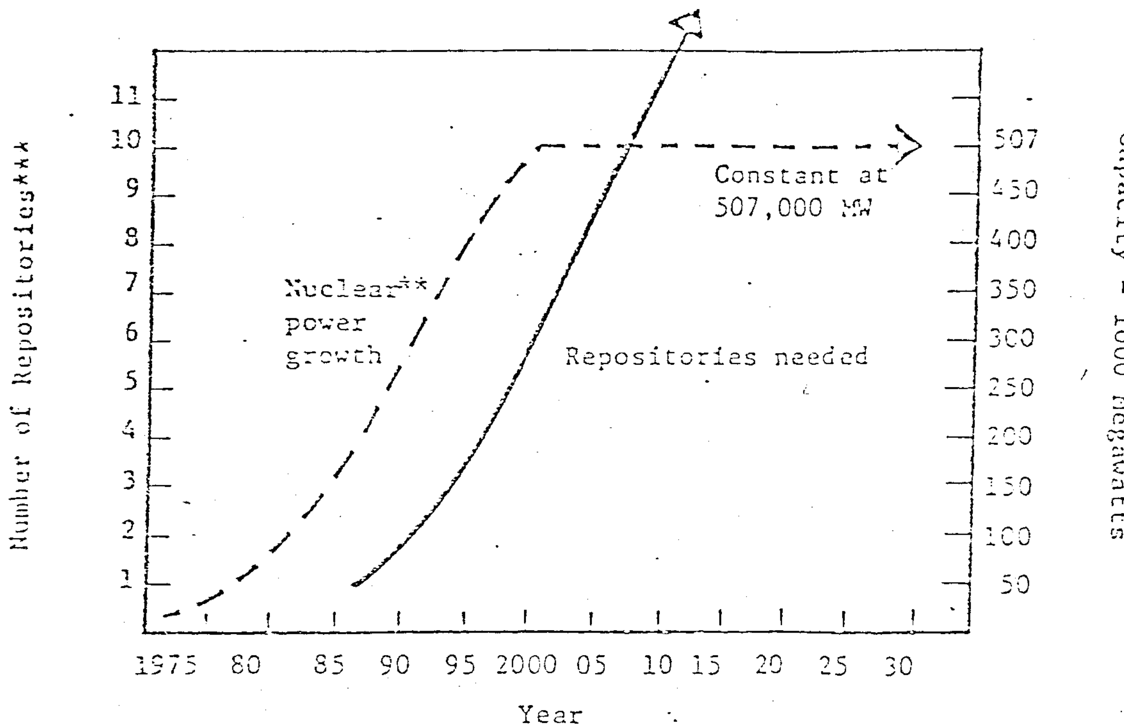
The DOE has calculated a repository capacity of 100,000 MTHM assuming spent fuel is cooled 5 or 10 years before being placed in a 2000 acre mine. This assumes that the initial heat loading is limited to 99 Kw/acre. This latter constraint assumes spent fuel retrievability is maintained for 5 years. If 25 years retrievability is desired, then the heat load constraint is reduced to 36 Kw/acre and the 2000 acre repository capacity is limited to 36,000 MTHM.[3]

As seen by comparing these capacity figures with the cumulative spent fuel production entries in Table I, the number of repositories prior to 2000, and the rate at which repositories will have to be licensed thereafter is strongly dependent not only on the nuclear growth rate, but also on a number of repository design parameters that are at present very uncertain.

Figure 1 is reproduced from a recent report of the California Energy Commission.[4] While it is based on a higher nuclear commitment (507 Gw instead of 380 Gw in 2000) it is interesting to note that under their assumptions a new repository is required every 2 to 3 years, a rate that would appear exceedingly difficult, if not impossible, to achieve. The 380 Gw projection leads to a new repository every 4 to 5 years - not much better.

Figure 1

NUMBER OF REPOSITORIES NEEDED TO CONTAIN
HIGH-LEVEL WASTE FROM NUCLEAR REACTORS



The difficulties experienced to date in the search for an actual repository site should be viewed in the context of the number of repository sites that <u>will have to be found</u>. In the modest case of a nuclear commitment held constant at 507,000 MW capacity (the U.S. Nuclear Regulatory Commission's late 1976 <u>low</u>, <u>no breeder</u> forecast), a new repository would have to be opened every 2 - 3 years.

** From GESMO (NUREG-0002), Vol. 2, p. 111-30 (NRC's <u>low</u>, <u>without breeder</u> forecast.)

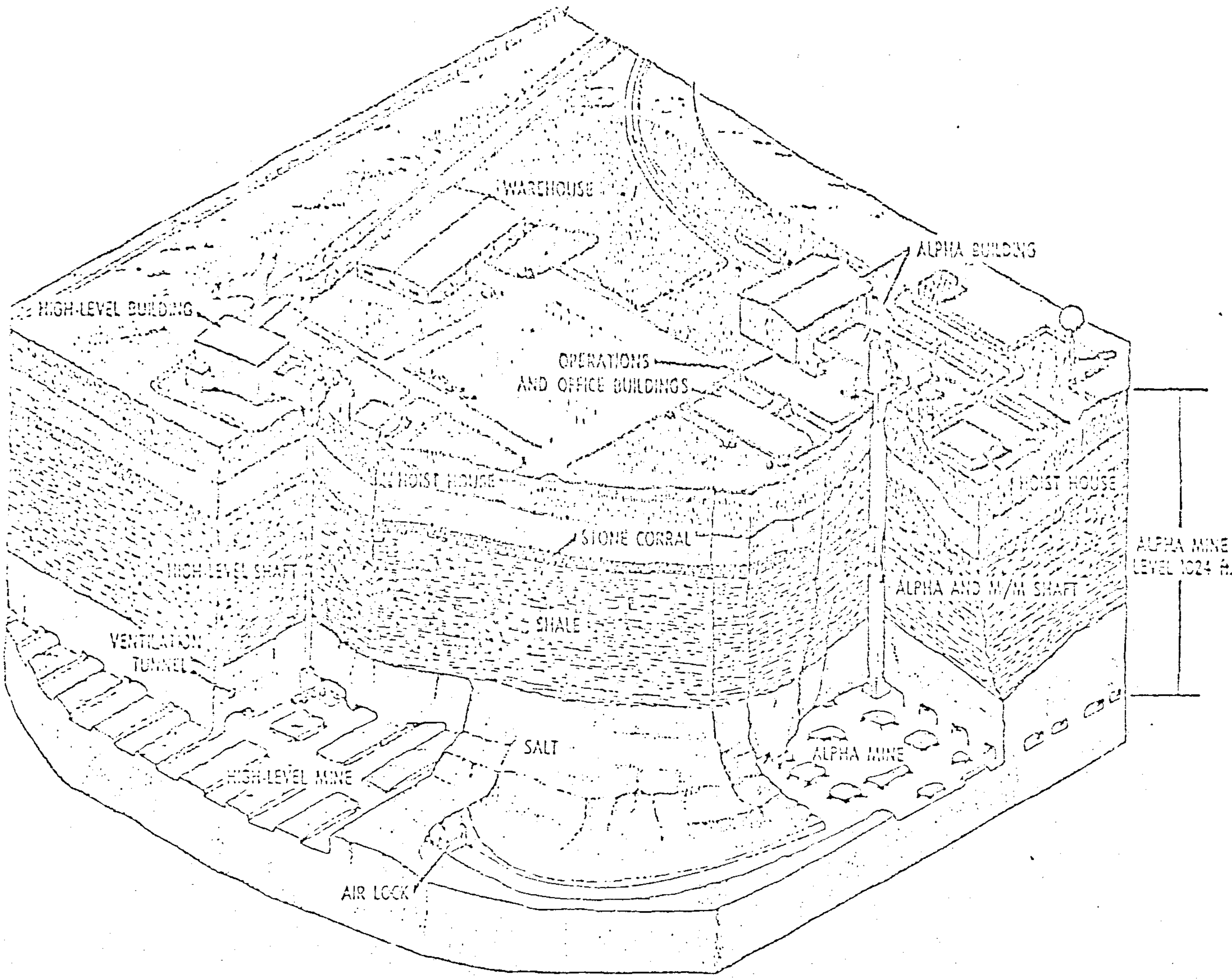
*** Based on repository capacity of 35,000 MT waste, and each 1000 MW reactor discharging 30 MTU per year

It is also instructive to examine conceptual diagrams of proposed high level waste facilities for geologic disposal in order to appreciate the logistics problem. The old Lyons, Kansas, facility is depicted in Figure 2. This facility was scrapped in 1972. Interestingly, the design of this facility shows only one elevator shaft for handling high-level waste, all shipped by rail. Obvious concerns are whether geologic repositories of this type can be constructed and licensed fast enough and whether their respective high level waste shafts and burial equipment can reasonably be expected to handle the equivalent of one fuel assembly every 15 minutes.

It is important to note that only the logistics of disposal of the spent fuel from commercial reactors was considered above. To this must be added the radioactive waste from the military program and those associated with the decommissioning of nuclear facilities and power reactors. After examining these problems, the GAO stated:

> The problems that nuclear related operations leave behind are increasing because of the expansion of nuclear technologies. All of those involved -- the Energy Research and Development Administration, the Nuclear Regulatory Commission, State Governments, and industry -- are partly to blame for what has happened.
>
> ERDA has accumulated a large number of excess facilities which will involve a monumental clean-up effort. At this point in time, it lacks the necessary information to even plan this task. It does not know the radiation and contamination problems at its facilities, the decommissioning methods that should be used, the corresponding costs, or priorities. ERDA has begun to gather this information at one of its reservations, but this is only the beginning.

Figure 2



FEDERAL REPOSITORY

While elimination of these excess facilities is important, it is also important that ERDA begin to consider and plan for decommissioning in all future projects. This requires that decommissioning costs be recognized at the outset of a project.

Similarly, NRC, which has responsibility on the commercial side, has not developed cost estimates, acceptable methods, or standards needed by industry to plan decommissioning or disposal of their facilities. NRC has not paid much attention to one of the biggest problems that may confront the public in the future -- this is, who will pay the cost of decommissioning nuclear power reactors. It has not made any plans or established any requirements for advanced accumulation of funds for decommissioning reactors or any facilities it licenses with the exception of uranium mills. (5)

* * * * * * * *

Answers to basic questions are missing which preclude developing a strategy for solving a problem that we are losing ground on. (6)

HISTORICAL BACKGROUND

From the perspective of the design engineer the logistics discussed above represent a straight forward design problem. To him, there appear to be no technological obstacles that prevent these projected requirements from being achieved, at least conceptually. The engineer would attempt to demonstrate this using time and motion studies. The problem conceptually would not be altered significantly if the engineer were told to design a geologic facility capable of handling 15,000 non-radioactive concrete cylinders per year spaced so many feet apart on the mine floor, with the additional requirement that the cylinders be handled remotely. In the conceptual design of the WIPP, the remote handling facility is projected to be capable of handling 6500 canisters per year, assuming three operational shifts per day (during the pilot plant phase only

300 canisters are expected to be received over an extended time.)(7) Furthermore, there are existing underground mines 2000-3000 feet deep that haul tons of rock to the surface in elevators that are loaded at intervals on the order of 3 minutes. Conceptually, waste disposal as an engineering problem appears no more difficult than designing from scratch a plant that bottles soft drinks, it's just a matter of scale.

The above is consistent with the past statements of the nuclear industry and bureaucracies; namely that the nature of the radioactive waste problem is largely institutional and political and not technological. When one examines the logistics problem in the waste area, there are institutional, political and economic as well as technological considerations that lead to a far more pessimistic view of the future than the above conceptual design considerations would suggest. For example, after some 35 years, high-level radioactive waste disposal is yet to be demonstrated. Moreover, no one really knows what is implied by "demonstrating" a disposal concept or what is necessary for "demonstrating" a safe concept. There simply are no coherent criteria for establishing what constitutes an acceptable disposal concept.

These evolving criteria will be discussed in the following section of this report. But first it is instructive to look at the track record of the nuclear industry and bureaucracies that will be responsible for developing the criteria and constructing and operating the facilities. A track record that offers little promise for the future.

For more than a decade the nuclear establishment has been saying that the disposal of radioactive waste is not a difficult problem. This pronouncement has a hollow sound when one considers that no solution has been found during the 35 plus years of the nuclear age. Moreover this statement is contrary to the admonition of competent scientific authority and to the history of failures and false starts of the nuclear industry and bureaucracies - it is nothing less than deceptive public relations propaganda.

In May 1966 after some 10 years of study related to the AEC's waste management practices, the NAS-NRC Committee on the Geological Aspects of Radioactive Waste Disposal submitted its report to the AEC. In the report the Committee stated:

> Throughout the fabric of the 10-year history of the Committee's deliberations run some continuing threads of purpose and conviction. Prominent among them is the realization that none of the major sites at which radioactive wastes are being stored or disposed of is geologically suited for safe disposal of any manner of radioactive wastes other than very dilute, very low-level liquids.(8)
>
> * * * * * * * * *
>
> The Committee thinks that the current practice of disposing of intermediate and low-level liquid wastes and all manner of solid wastes directly into the ground above or in the fresh-water zones, although momentarily safe, will lead in the long run to a serious fouling of man's environment.(9)

Thus, even before 1966, the nuclear bureaucracy knew that competent scientific authority felt that their existing sites and practices were inadequate. The response of the AEC was not to correct the situation but to suppress the report. It was not until pressure was exerted from the U.S. Senate in 1970 that the report was released. In the meantime, the Committee that prepared the report was disbanded and a new committee was appointed with no overlapping membership. In other words, the nuclear bureaucracy had no compunction concerning the manipulation of committees of the National Academy of Sciences.

Nothing has been done concerning the NAS Committee warnings except that the burial of transuranium wastes has essentially stopped. This prohibition resulted not because of diligence on the part of the nuclear industry or government but because the Kentucky Department of Human Resources discovered that plutonium was migrating off site at the Maxey Flats burial site near Moorehead, Kentucky.(10) Similar migration has occurred at the Nuclear Fuel Services facility in West Valley, New York. As late as 1974, the AEC was saying that such migration was unlikely in total disregard of the NAS Committee warnings in 1966.(11)

The supressed NAS report was related to the wastes from the military programs. Most of the high level military wastes are still stored in steel tanks. Many of the tanks have leaked, over 500,000 gallons in all. The most notable case was in the spring of 1973 when 115,000 gallons of high level wastes leaked from a tank at Hanford over a 51-day period. Although the level in the tank was recorded each day, no one compared the readings.

Oil contaminated with plutonium wastes was stored outdoors in steel drums at the Rocky Flats Plant near Denver, Colorado. It was subsequently discovered that leaks from these drums had resulted in significant off site contamination by plutonium. This discovery was not made by the AEC but by a scientist member of the general public, Dr. Edward Martell. The AEC purchased some of the contaminated land and enlarged the fenceline of the facility. A multimillion dollar lawsuit is now underway over additional portions of the adjacent land.

Since their early beginnings, the nuclear industries and bureaucracies had planned to reprocess spent fuel in order to extract and recycle its plutonium content. Until the Carter Administration reversed this course these forces have always denigrated and ignored the concerns of outside competent authority related to the inevitable proliferation of nuclear weapons that would result from reprocessing and plutonium recycle. The AEC, for example, issued in 1966 an operating license for the Nuclear Fuel Services (NFS) reprocessing facility in West Valley, New York. This license was issued although there was serious doubt that the plant could operate efficiently and reliably. Moreover, the AEC supplied the facility with a baseload contract of fuels (from the military program). Without this baseload contract, the NFS would not have undertaken the venture. (12) What happened to NFS is now another example of false and deceptive moves on the part of the nuclear industry and bureaucracies. In early 1972, the plant, after operating at less than 1/4 of its design capacity (most under the baseload contract) was shut down for modifications. The reason, quite simply, is that it had become a radioactive nightmare. In 1976, NFS announced that it was terminating the reprocessing operation because the cost of modification made it uneconomic.

This abortive venture, authorized by the AEC, resulted in excessive radioactive contamination of the Wast Valley environment, excessive radiation exposure to the employees of the NFS facility and to more than 2,000 transient workers hired to do the dirtiest jobs. In addition, it left behind a facility highly contaminated with radioactivity and some 600,000 gallons of high level radioactive waste in a condition that will require an extensive research program to determine what should be done with the wastes.

Present estimates of the cost for decommissioning the NFS facility and managing the radioactive wastes run to 500 million dollars. The initial cost of the facility was less than 50 million dollars. It is uncertain, at this time, whether the State of New York or the federal government will have to absorb these costs - the owner of the NFS facility, Getty Oil, appears exempt.(13)

The people of the State of Illinois fared much better. The GE company was issued a license to construct a reprocessing facility in Morris, Illinois. However, after completion it was determined that the plant was inoperable. After spending $65 million and never reprocessing an ounce of spent fuel, GE abandoned the facility.

Notwithstanding the experience of NFS, Allied-General Nuclear Services (AGNS), having received a construction permit from the AEC, invested some $250 million in a reprocessing plant at Barnwell, South Carolina. Even before President Carter made this investment futile by banning reprocessing, AGNS stated:

> It is reasonable to assume that any significant investment by industry in reprocessing facilities is not likely to occur until the GESMO issue is resolved and reprocessing can be demonstrated to be a viable business venture. Therefore, AGNS has been forced by reasons outside its control to conclude that under the existing circumstances it is proper that the government fund any significant investment beyond that already committed. (14)

AGNS is presently fighting for a governmental bail-out. The outcome is uncertain. At the same time, it appears that the citizens of South Carolina were saved the problems of those of New York and that a $250 million bail-out, no matter how reprehensive, would be less expensive than the subsequent cost of decommissioning.

For years the nuclear industry and the AEC proposed that they had a solution to the high level radioactive wastes. This was to bury the wastes in an abandoned salt mine in Lyons, Kansas. In 1971, the AEC announced that it would begin a large scale demonstration project at the Lyons mine. In the environmental statement on this project, the AEC baldly asserted:

> By establishing this facility, radioactive wastes of the type previously described [including high-level wastes] will be permanently isolated from man's biosphere, thus providing a direct and lasting benefit to the environment. No significant impact on the environment resulting from the construction or operation of the proposed repository is anticipated. (15)

Contrary to this assertion of the AEC, private citizens, scientists and organizations as well as state officials in Kansas argued that the Lyons site had not been adequately investigated and that it was probably not a good site. These private citizens and scientists were correct and within a short period the

AEC abandoned the site and cancelled the project. Thus, even after over 15 years of study of the suitability of salt mine disposal in general and several years of investigation at the Lyons site in particular, a potentially serious failure in judgment occurred. It is questionable whether or not the AEC would have appreciated the potential hazards involved with the Lyons site if the citizens of Kansas had not spoken out.

After this fiasco, the AEC announced that it would build a Retrievable Surface Storage Facility (RSSF) which was to be suitable for a period of 100 years. Of course, this was just an easy way out - one that passed the ultimate problem on to future generations.

In 1975, ERDA (the successor to the AEC) cancelled the RSSF project and started to examine a salt deposit near Carlsbad, New Mexico. This is the area selected for the WIPP Project. A favorable site was selected by the staff at Oak Ridge National Laboratory. About a year ago the project management was shifted to Sandia Laboratories. After two test holes, ERDA wanted to begin mining. Sandia insisted on a third test hole. It was drilled and it hit a brine solution containing hydrogen sulfide and methane. At Sandia's recommendation the site has been dropped. Sandia is now looking at a site in the same deposit only about 5-8 kilometers away.

Clearly, if the U.S. has a large number of suitable sites, they are difficult to find. And as stated previously, a large number are needed and quickly if the expansion of nuclear power plants is to continue. Judging from their track record, one of false starts, lost races and deceptive tactics, the nuclear industry and bureaucracies will move to change the criteria for suitability as the pressure for waste repositories mounts. This will be the subject of the next section.

THE EVOLVING CRITERIA

In its suppressed report, the NAS Committee established some general criteria for the disposal of radioactive waste. Two of the criteria of importance here are:

(1) Safety is a primary concern, taking precedence over cost.

(2) Radioactive waste, if disposed of underground, should be isolated as permanently as possible from contact with living organisms. (16)

Later is their report the NAS Committee stated:

> The deliberations of this Committee continue to be guided by the basic rule that concentrations of radionuclides in waste materials should not be allowed to appear in the earth's biosphere before they have decayed to innocuous levels. This concept requires assurance that during any storage or disposal operations hazardous amounts of nuclides are isolated from the biologic environment, and that upon completion of the procedures the nuclides will remain isolated as long as they might constitute a hazard. For some nuclides this requirement means isolation for periods of 600 to 1000 years, periods so long that neither perpetual care nor permanence of records can be relied upon. All supplies of potable ground water, whether or not they are now being drawn upon, are considered as being part of the biosphere. (17)

With respect to the above, it is worth recalling that the Committee concluded that none of the existing governmental sites are in a suitable geological location. Although the RSSF was abandoned, present plans call for Away From Reactor Storage (AFRS) for spent fuel in government facilities. These facilities are to a considerable extent little more than a cosmetic. They will relieve the utilities of responsibility of waste management while transferring the problem to the government.

Under present plans 6 or 7 AFRS facilities might be required. By repeating past mistakes, it is quite probable that these facilities will also be located in unsuitable geological locations and take on an air of permanency. To minimize transportation hazards, such facilities should be located at the ultimate disposal site. But only one tentative site has been selected, the site for WIPP. If anything, it is more likely that the AFRS will prejudice the site selection of commercial repositories rather than the reverse.

As a palliative to this problem, the NRC will prepare an environmental statement on these facilities. But the past history of the nuclear industry and bureaucracies demonstrates that such statements are prepared to support decisions already made rather than to make an adequate and honest environmental assessment. The environmental statement for the Barnwell Fuel Receiving and Storage Facility (BFRSF) is a case in point relative to spent fuel storage. The Natural Resources Defense Council comments on this Statement are attached to this report as an Appendix. These comments demonstrate that either the NRC was incompetent or the statement was fraudulent. It is difficult to imagine that the NRC was so incompetent. Rather, it appears to be a fraudulent statement.

The Environmental Protection Agency which will have considerable responsibility relative to radioactive waste disposal is now considering developing criteria for this disposal. Their Background Report on this subject indicates that under the pressure for licensing disposal sites, they are backing off from the criteria in the suppressed NAS Report that were presented above.(18) The EPA Background Report discusses determining an acceptable level of risk. It suggests that future generations, who will receive no benefits, could be subjected to the same risks as the waste producing generation. Moreover, it suggests that this acceptable risk could be determined through benefit-cost analysis. It is well known that benefit-cost analysis was not designed to make judgments about the fair distribution of economic well-being, either between people living in the present, or between people living in different generations of time. Benefit-cost analysis alone cannot decide whether it is just or fair for the present generation to impose upon the future generations the burdens of essentailly perpetual care for highly poisonous materials. Even if the benefit-to-cost ratio comes out greater than one, a waste disposal alternative may be unacceptable because the distribution of risk may be considered unacceptable. Moreover, neither the benefits nor the cost can be accurately estimated. To a considerable extent, this approach is a subterfuge used to license a less than optimum or adequate facility. An example of this is the BFRSF that was discussed above.

Turning now to the specific criteria for radioactive waste storage, one important specific criterion is the allowable heat loading. There is no firm basis for the present value used in planning. Nevertheless, as discussed earlier in this report using the same heal loading constraint, the DOE estimates a repository capacity of 100,000 MTHM, while two other competent groups estimate 35,000-40,000 MTHM. These values bear directly on the number of repositories required. Are 2 or 4 required in the year 2000? In addition, the heat loading determines both the short and long term integrity of the repository. In the short term, it determines whether the deposited material is retrievable.

Retrievability is also an ill-defined specific criterion. The NRC and DOE are discussing a 5 year period of retrievability. This time is to be used to "demonstrate" the suitability of the disposal site relative to long term integrity. Concerning this, the GAO states:

> NRC states that it is an unwarranted prejudgment for us to recommend that the period of retrievability be longer than 5 to 10 years. Although we do not recommend this, we point out that the 5- to 10-year period of retrievability may not be adequate to assess all of the effects heat producing high level waste will have on the geological medium, and USGS agrees with this position. (19)

The longer the period of retrievability required, the lower the allowable heat loading and hence the smaller the repository capacity and the greater the number of repositories required. Besides these interwoven uncertainties, what does retrievability imply about salt as the geologic medium of choice? How do you define a large body of rock or salt without disturbing it? How do you instrument a repository before and after it is sealed? None of these questions have been answered satisfactorily. The technology for sealing mine shafts and exploratory drill holes adequately to guarantee long term integrity has not been developed. There is no existing technology for the containment of radioactive gases in salt bed repositories, and this problem simply hasn't been studied adequately. There are similar lists of unanswered questions and imponderables related to mobility (leachability) of important radioactive isotopes in the waste, and thermal effects and chemical or electrolytic reactions, all of which need to be answered and resolved before a repository is selected, licensed and demonstrated.

Furthermore, suppose spent fuel disposal cannot keep up with the annual production, or can just barely keep up or barely work away at the backlog, and then postulate that the geologic repository does not prove out and the fuel must be retrieved. Can it? The logistics equation is hit with what mathematicians call a step function. Suddenly, the fuel that must be handled is much greater than otherwise anticipated. One now needs the equivalent of two new repositories and a much larger transportation capability to handle the spent fuel that must be moved from the old repository plus that which is being generated. Doubling the requirements can turn problems into nightmares.

Resolving the technical issues and determining disposal criteria will not be easy. One should have a high degree of confidence in the technology before one is prepared to permanently dispose of waste canisters at 15 to 60 minute intervals, day in and day out <u>ad infinitum</u>. And there is the rub. The nuclear industry and bureaucracies have gotten around such difficult problems before by licensing nebulous criteria rather than proven hardware.

The AEC and now the NRC have been licensing light water reactors by considering certain classes of accidents as being "highly improbable" or "extremely unlikely" events. Although a large number of operating licenses and construction permits had been issued by 1972, it wasn't until then that the AEC initiated a study on reactor safety that was to determine the probability of reactor accidents. The final report on this study was issued some 3 years later in 1975. Licensing continued during this period.

The final report on this safety study, known as the Rasmussen Report, was embraced by the nuclear industry and bureaucracies. At the same time, it was severely criticized by outside competent authority including the American Physical Society.(20) In other words, the chance, probability or likelihood of such accidents is indeterminant and are not necessarily "highly improbable" or "extremely unlikely." These criteria are nebulous and based upon engineering judgment from engineers committed to the future of nuclear power.

A more recent example of this approach to licensing involves the Clinch River Breeder Reactor. (This project has subsequently been abandoned by President Carter.) In this case, even though the Preliminary Safety Analysis Report and the reactor design were not completed, the NRC Staff concluded that a certain class of accidents, known as core melt and disruptive accidents, can and must be reduced to a sufficiently low probability as to be excluded from licensing consideration. Again such accidents were said to be "highly improbable" or "extremely unlikely." The Natural Resources Defense Council, an intervenor in the CRBR licensing proceedings, pressed the Applicant (ERDA) and the NRC for a more precise definition of these terms. ERDA and NRC were asked whether these terms implied a chance equal to or less than 1 in 10, 1 in 1,000,000, some chance in between or smaller. ERDA and NRC stated that they had no precise definition of the chance. They couldn't say that the chance was less than 1 in 100 - they couldn't pick a maximum value out of a range of 1 million.(21) How nebulous can a criterion be?

CONCLUSIONS

Where does all this leave us? First, one must realize that the present commitments to produce more waste is some 25 years ahead of a demonstrated solution to the disposal problem, much less a demonstration that disposal can keep up with production. Second, stopping the licensing of new reactors does not stop the production of waste; existing plants will continue to generate waste. A moratorium on new construction stops the increased rate of waste production only after the plants under construction are completed. An analogue to this predicament would be an automobile that does not have brakes and has a 2 minute delay time incorporated between the accelerator pedal and the carburetor. Most people wouldn't drive such a car, particularly if they couldn't see very far down the road. If they did they would surely drive slowly until the controls were corrected. If one is not particularly confident that the Federal Government will be able to keep up in waste disposal around the turn of the century the present realities strongly suggest that measures should be taken soon to limit further increases in waste production.

There is a growing sentiment that a further commitment to nuclear power be deferred until there is an acceptable solution to the radioactive waste problem. This principle has been endorsed by the Council on Environmental Quality and is already public policy in Sweden and California. The CEQ has proposed setting a "nuclear deadline," such that by some near-term date a definitive widely accepted solution for safe, long-term management of wastes must be agreed upon after intensive public review; otherwise, no nuclear power licensing would be issued.[22] The present logistics problem certainly makes this policy appear infinitely reasonable.

But this leads directly to the most dangerous aspect of the problem: the impact this pressure can have on current planning. The prospects of a severe logistics problem ahead is already leading policy makers to conclude that they must solve the radioactive waste problem, and do so soon. This is an invitation to mistakes. Geologic media sites will be chosen hastily. Assumptions concerning long term integrity will be made in the absence of confirmatory data. Corners will be cut to meet unrealistic deadlines. There is a real danger that the Federal Government in the interest of promoting nuclear power will start repeating the same kinds of mistakes that led to the controversies over reactor safety and nuclear weapons proliferation. We are already seeing this in the approach the Government has taken toward establishing regulatory criteria for waste disposal. One would have presumed that first the criteria would be established, then the methodology to determine whether the geologic medium and site meet the criteria, and then the instrumentation would have to be developed to assure that the criteria are in fact being met. The Federal Government's present approach is just backwards in this regard. The geologic media of choice -- salt -- and the site -- yesterday it was Lyons, Kansas, today it is Carlsbad, New Mexico -- were chosen first, and now the NRC and EPA are being asked to develop the criteria.

Past experience indicates that these criteria will be compromised to satisfy the choice of medium and site in order to respond to the pressure for licensing a repository as soon as possible. After its study of this problem, the GAO concluded and recommended:

> After several decades of work, AEC did not, and ERDA has not yet (1) demonstrated acceptable solutions for long term storage and/or disposal of its high level waste and (2) satisfied the scientific community that present storage sites are geologically suited for long term storage or disposal. Therefore, we recommend that the Congress closely monitor, through the annual authorization and appropriation processes, ERDA's program for long term waste management. Specifically, such monitoring should focus on whether the program (1) is progressing in an orderly fashion, (2) is adequately funded, and (3) can be expected to produce answers to the many complex waste disposal problems. (23)

These recommendations make good sense. But Congress, up till now, has been much more of a junk yard dog for the nuclear industry than a watchdog for the public health and safety. It is, therefore, essential that every concerned citizen closely watch the nuclear industry and bureaucracies and prod their elected officials to take appropriate action. The option is a potential radioactive nightmare for this or some future generation.

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