"RETHINKING" LOW-LEVEL RADIOACTIVE WASTE DISPOSAL

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ABSTRACT

Approximately 15 years ago, the National Academy Press published "Rethinking High-Level Radioactive Waste Disposal". The principles developed there could and should be equally applicable to low-level waste disposal. Since the present methods of low-level waste disposal are legally prescribed, this paper deals with what should be done when the present landfills fail. The objective would be to incur the lowest social costs-minimizing the public, worker, environmental and economic impact. Since our knowledge of the future is imperfect, we cannot know the state of the science nor of the public health in the future. Therefore, we cannot design the perfect covers or liners lasting 300 to 1000 years or more. We should design the simplest replacement of covers and liners or their equivalents. We should also take into account the state-of-the-art in monitoring devices as this will determine how much prevention and at what cost and how much remediation and at what cost should be anticipated. This assumes that thermodynamically stable forms are too expensive and exogenous events continue to occur. The state-of-the-monitoring devices could include instruments such as chemical analysis on in-situ chips and nanotechnology allowing in-situ flow monitors that almost do not impinge on flow paths. In addition, the rise of human biomonitoring of environmental chemicals should be taken into account. After failure of the initial design, one needs to redo the risk analysis taking into account the reduction or increase in the source term, the changes in hydrogeological conditions, changes in the concentrations in the environmental media, new monitoring and remediation techniques, changes in expected ecological end states, changes in medical sciences, new laws and regulations and changes in social conditions and expectations at that time. It is strange that at this time, 20 years after the low level waste regulations, 10CFR61, were issued that there is no conceptual mathematical model that is peer reviewed and validated against data that takes all of the relevant processes, such as the performance of the covers and liners, into account. It is also extraordinary that present regulations, 40 CFR197, do not allow one to take into account changes in the human condition such as diet changes and the battle against cancer over these future time periods.

New designs for arid regions would differ substantially from those for humid regions. These designs would take into account the principles developed in the "Rethinking" report and advice such as Occam's Razor, simplify. The simplest and most easily replaced designs that would still meet regulatory requirements, whatever they would be, would be used. At present, the evapotranspiration design would be chosen. We can not now determine what would be the best design in the future. Because liner replacement would almost certainly be more hazardous than the consequences it is designed to prevent and the costs would not be commensurate with the benefits, berms and cutoff walls would be substituted instead, if needed. For humid regions, "impermeable" covers would be installed and berms and permeable reactive barriers added, if necessary.

Scenarios taking into account changes in the hazards of the present system over time are being developed. The costs, benefits and risks for these new designs over time would be calculated. The costs, benefits and risks for these new designs would be compared with the legally mandated design at that time. The objective would be to protect real people from real risks over time rather than hypothetical people from hypothetical risks some time in the distant future.

INTRODUCTION

It has been 44 years since the first international meeting on radioactive waste disposal was held. At that meeting there was a great deal of discussion about deep geological disposal, vitrification of high-level waste and means of disposing low level waste. (1) There was no discussion of public acceptance because there was overwhelming public acceptance. Since that time there has not been a single deep geological repository for high level waste put in service, there is turmoil in the establishment of low level waste sites in the USA (only Envirocare opened in 1980 and not a single compact site has opened) and public fear of radioactive waste disposal eclipses that of automobile deaths and smoking. (2, 3) Surely it is time to reexamine what has gone wrong. We are flooded with suggestions on how to regain public trust. (4-7) None of these suggestions can guarantee that attempts to site and build disposal facilities will be successful, only that if they are not adopted, the effort will most likely fail. We can revert to the Socratic view of equity that the only way to regain public trust is not by words but by deeds. (8) Those deeds are both administrative and technical. Further as Sun Yat-Sen has said "Trust is earned by many deeds, and lost by only one." (9)

On the technical side, there have been innumerable meetings on what to do about high-level waste. and continue to this day. (7, 10) However, most are about fine tuning present plans or else delaying the decision till some future time, 50-100 years. (11) Perhaps the most radical suggestion for US wastes was made at the meeting in 1999 that resulted in the publication of reference 5. There, I suggested that before we made the final push for the licensing application for the disposal of high-level waste in Yucca Mountain that we ought to consider the possibility of using the WIPP (Waste Isolation Pilot Plant) for high-level waste disposal. I laid out the pros and cons for each site but was greeted with shouts of "agent provocateur" determined to derail high-level waste disposal in the US. With the license application scheduled to be submitted this year, perhaps it is time to turn to potentially greener pastures-low-level waste (LLW) disposal

It can be argued that an immediate solution to the low-level disposal problem is more important than that of high level waste because we have been and are storing spent fuel and high level waste for 50 and more years and vitrified high level waste for at least 20 years. This is done with existing technology and without technical detriment though it could be argued that the failure to successfully dispose of the high level waste is a major obstacle to the continuation and expansion of nuclear power. However, this paper is about a safe, economical and publicly accepted solution to the LLW problem and not the preservation of the nuclear option. It is clear that without a solution to the low- level waste problem, many important medical, industrial and research efforts would be severely impacted. Over 20,000 commercial users of radioactive materials generate some amount of LLW. These users include approximately 100 operating nuclear power reactors, associated fuel fabrication facilities, and uranium fuel conversion plants. Hospitals, medical schools, universities, radiochemical and radiopharmaceutical manufacturers and research laboratories are, among others, users of radioactive materials which produce LLW. (12) Therefore, it is time to take a new look at the low-level waste problem. This has been done in other countries such as France where they have just commissioned a very low-level waste disposal site for wastes with minimal amounts of radioactivity (13) and the UK where a BEPO is now being prepared for the Dounreay decommissioning wastes (14). In the US, both NRC and EPA have published advance notice of regulations for these very low-level radioactive wastes. (15,16) Further, the National Council on Radiation Protection and Measurements has just issued a monograph on LLW for small users (17) that includes a review of the regulatory reguirements.

We have to look at the present regulatory situation and how low-level wastes have been handled under this regulatory system. The problems of disposal of uranium mining and milling wastes present many of the same problems. Therefore, these recommendations for low-level radioactive wastes should also, in general, apply to uranium mining and milling waste and hazardous chemical wastes. Obviously, this means that they should also apply to mixed radioactive and hazardous chemical wastes. To keep the paper to a manageable level, we shall not deal with Transuranic Wastes (TRU), Discrete Radiation Sources, NORM (Normally Occurring Radioactive Materials) and TENORM (Technically Enhanced NORM) though the suggestions are also applicable there. An excellent review of the present regulatory regime for LLW has just been published by the National Academy Press. (18) The Committee on Improving Practices for Regulating and Managing Low-Activity Radioactive Wastes defines "low-activity wastes" as "low-level radioactive waste and similar wastes handled by the Department of Energy, slightly radioactive solid materials, discrete sources, uranium and thorium ore processing wastes, NORM and TENORM". The report does "provide a summary of the sources, forms, quantities, hazards, and other identifying characteristics of low-activity waste in the United States; and (2) review(s) and summarize(s) current policies and practices for regulating, treating, and disposing of low-activity waste". This work is reported upon in this meeting, Wm'04. (19) We shall not repeat that work. In phase two they will "assess options for improving regulations and practices". Based upon discussions with the staff of the study, the approach in this paper is not within the purview of that Committee. In addition, the discussion of hazards posed by the wastes discussed in their report are not quantified, the doses from existing disposal sites are not discussed nor is the number of people affected or the cost of avoiding these doses indicated

However, a little more background than provided in that report is necessary to understand why we are in such a predicament today for disposal of low level waste. In 1943 when the Clinton Works were established in Oak Ridge for the production of enriched uranium and plutonium for the nuclear weapons program, there were no laws or regulations concerning radioactive wastes. The science of ground water flow was poorly developed and that of the movement of pollutants dissolved in the ground water is even less well understood. Consequently, though there was attention given to protecting the environment, low level wastes were deposited starting in 1944 under conditions that were thought to be safe but that would not be allowed today. The same was true at all of the other sites of the Atomic Energy Commission. However, since there was no legal definition of low-level wastes, each site decided upon its own classification and how to dispose of each class of waste. It should be remembered that at that time there were no gamma or alpha spectrometers so the exact radioactive content was not known. Protecting against external radiation to the workers was the principal consideration. It was also believed that protecting against radioactive materials would also protect against hazardous chemical materials. Therefore the contents of these earlier wastes have been primarily determined by considering the activities that produced them. There is great uncertainty associated with these numbers.

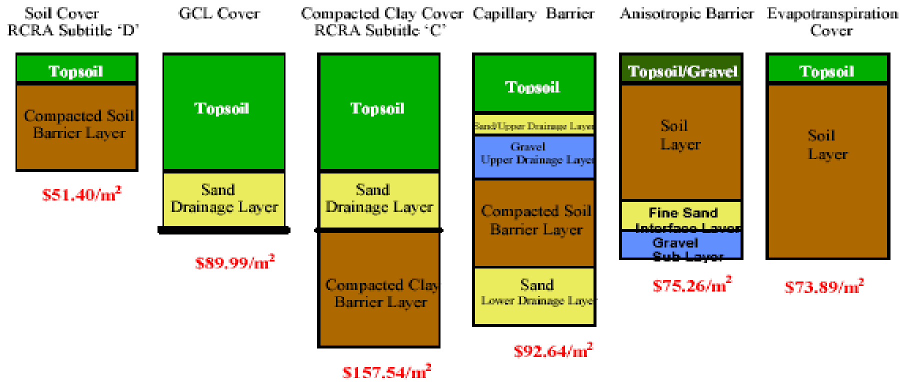
After the start the civilian nuclear energy program, these same types of wastes were sent to the AEC sites for disposal. By 1962 the volumes had become so great that the wastes were to be sent to commercial disposal sites. Between 1963 and1971, six commercial low-level waste sites were established across the country. (20) At this time there were still no federal or state definitions of low-level wastesBy 1979, three of these sites closed (West Valley, New York, 1975: Maxey Flats, Kentucky 1977: and Sheffield, Illinois 1978) because of unsatisfactory operating experience though no public health hazards were identified. A fourth site (Beatty, Nevada) closed in 1993 because it was full. Only Barnwell, South Carolina and Hanford, Washington remain open today.

Meanwhile, things were progressing on the legislative front. Low-level wastes are defined in the Atomic Energy Act as amended by exclusion. They are not spent nuclear fuel, high level waste, transuranic waste nor AEA section 11e.(2) byproduct material. The Nuclear Regulatory Commission published regulations for low-level waste in the Federal Register on December 27, 1982 as 40 CFR 61. In the Nuclear Waste Policy Act of 1982 and amendments the definition of low-level wastes was restated. Because the three remaining commercial sites were unhappy with being forced to take all of the nation's wastes, the Congress passed the Low Level Waste Policy Act of 1980 and amended it in 1985. The Law made clear that states or compacts of states would be responsible for low-level wastes from civilian uses and that DOE would be responsible for defense low-level waste. The NRC would license the state facilities and the DOE facilities would be governed by DOE rules and orders, today by Order 435.1. Today, 23 years after the 1980 law was passed not a single state or compact low-level waste site has been established. The impasse has come about for a variety of reasons and despite $600 million dollars spent since the Act's passage to 1999,(21) it is not likely that there shall soon be a compact based low-level waste site. It should also be noted that of the 3 sites open today for commercial low level waste burial, all have limitations. Envirocare, Clive, Utah will only accept Class A low-level waste as well as NORM, 11e.(2) Byproduct material and mixed hazardous chemical and radioactive waste. Richland ,Washington will accept all classes of low-level waste, exempt sources and byproduct material, NARM and Norm. However, it only accepts waste from the Northwest Compact States (Alaska, Hawaii, Idaho, Montana, Oregon, Utah Washington and Wyoming) and by contract with members of the Rocky Mountain Compact (Colorado, New Mexico and Nevada). The Barnwell, South Carolina site accepts all classes of low-level wastes from all states except Northwest and Rocky Mountain Compact states but is scheduled to stop taking wastes except from Atlantic Compact states (Connecticut and New Jersey) after 2008. DOE, after a review, has decided that the Hanford Site and the National Testing Site in Nevada will be the regional LLW sites for DOE sites though Los Alamos National Laboratory, Savannah River Site, Idaho National Environmental and Engineering Laboratory, Oak Ridge Reservation will continue to dispose of their own low-level waste.

Unfortunately, these problems are not new. In 1989 the Office of Technology Assessment published "Partnerships Under Pressure: Managing Commercial Low-Level Radioactive Waste" (22) detailing the problems only 5 years after passage of the Low-Level Radioactive Waste Policy Amendments Act was passed. (23)

Similar tales hold for uranium mills and tailings wastes, transuranic wastes and mixed hazardous chemical and radioactive wastes. Their history is well covered in many places.. There has been a great deal of research on alternate covers and liners for near surface facilities and for deep geologic repositories. However, they almost all concentrate on how to prolong the effective lifetime of the facility or to reduce its costs. All, of course, need to meet the individual dose criteria, flux, or risks that are the legal requirements for all of the facilities. For hazardous chemical waste sites the means of meeting these criteria are prescribed. (24) Examples of alternative designs are shown in an Office of Technology Assessment report (22), Dwyer's cover analysis (25), EPA's comprehensive review of the operation of landfills (26) and the UK's review of designs for Dounreay low level wastes (27). These alternative designs include Above-Ground Disposal in Concrete Vaults, Intermediate- Depth Disposal in Augered Holes, Deep-Geologic Repository, Below-Ground Vault, Above Grade Tumulus, and Long-Term Above Ground Storage. One could bound the options for low level waste from the present system in the USA, near surface trenches, to the Cadillac of near surface systems, the French Centre de l'Aube (28), and underground systems, the Swedish SFR Repository located near the Forsmark Power Station and below the Baltic Sea (29).

Waste Containment System Components



- Field trials of various cap configurations at Sandia
- Cost of construction is considered
- Need to consider life cycle cost: construction, operation, and maintenance

Source: Dwyer, Steven F. 1998. Construction Costs of Six Landfill Cover Designs. Sandia Report SAND98-1988.

These suggested designs all have one thing in common-they are trying to design the perfect facility that will last the 30, 100, 500, 1000 and 10,000 years required by the regulations and protect people and the environment for those times. Unless they can design a thermodynamically stable facility and rule out exogenous events, it is a quest for the impossible. It cannot be done! What should be done is to protect real people and the environment from real risks in real time. One needs to take into account what has taken place in the past, the present situation and the potential futures. The only thing certain is that things will change. The volume of wastes sent for commercial disposal has decreased by 94% since 1980 (30). The amount of radioactivity being sent to commercial will decay to 2.6% of the original inventory in 100 years (31). Public attitudes will change. The nation's governors asked the Congress to give them responsibility for developing low level waste disposal facilities-resulting in the passage of the Low-Level Radioactive Waste Policy Act of 1980. Now, they don't want to hear the word and are closing existing sites to outsiders even though it brings in a great deal of revenue. Other changes will occur in doses to humans and the environment, costs, ethical views, regulations, understanding of diseases, advancement in technologies and the degree of uncertainty associated with all of the above. Ethical views will change as evidenced by what has happened concerning high level wastes within the last 10 years. In 1995, the Nuclear Energy Agency of the OECD stated "..our responsibilities to future generations are better discharged by a strategy of final disposal than by reliance on stores which require surveillance,…" (32). Yet, the National Academy of Sciences/National Research Council recently has stated, in accordance with the NEA, that the time period to effectuate a repository system will be very long and that is good as one will learn as one goes along and that future generations will have a say in what happens to the waste. (33)

Have these billions of dollars spent on LLW been worthwhile? Not according to all. A noted political scientist, Aaron Wildavsky, wrote "The billions of dollars we spend ensuring against remote possibilities at abandoned waste sites must be seen as billion might otherwise be invested, publicly and privately, in health, wilderness protection, education and other things that we value". (34) He also said to me "future generations will curse you the money you have wasted on a non-existent problem." (35)

Despite the billions already spent on waste disposal, what do we really know? At the WM'03 Conference, Steve Piet wrote "A peer reviewed conceptual model, validated against data, that defines the important features, processes and events controlling the aging of barriers, their materials and the transport of contaminants, has not been developed." (36) For ecological futures, the views have changed markedly, "It is now generally agreed among ecologists that succession is a stochastic process that may take different courses and proceed at different rates depending on the type of disturbance that initiated it, the state of surrounding communities, and the environmental variance during its course." (37) When we have no clue as what the natural end state will be, it is not very promising for trying to predict the end state with these exogenous variables. Even natural analogues have not proven very useful "No one natural analogue is completely comparable to a future condition of an engineered cover, and for many long term performance issues, no analogues exist" (38). Finally, how good are we at predicting even the flow of ground water and not the more difficult to model dissolved solids in fractured rocks? Figure 2 modified from a NAS/NRC figure (39) shows that even the best scientists did not fully understand this flow and only modified their modeling after measuring the water movement through the 60-300 meters of the vadose zone.

The performance of existing covers is below expectations.(40) It is clear that "failure" in the usual meaning of the word, rather than the no migration of tailings from the facility as used by DOE, will likely occur well before the end of the design period and certainly well before the time of potential peak dose. Though "failure", offsite transport of the mill tailings, has not occurred, erosion of up to 3 feet in the cover has occurred and root penetrations of up to 3 feet at some sites have also occurred within the first 10-15 years. At NRC licensed sites, repairs due to flood erosion have already occurred.(41) It is clear that a new approach is needed that takes into account these realities.

Following the principles outlined in Rethinking High-Level Radioactive Waste Disposal (42), we can outline similar principles for low-level wastes. The object should be to (a) obtain lowest social costs, (b) minimize public and worker health impacts, and (c) minimize economic impact. We need to recognize that our knowledge of the future is imperfect. We only know that everything will change including the source term, the hydrogeology, the receptor and society. As the Chinese philosopher, Lao Tzu, noted almost 30 centuries ago "Those who have knowledge don't predict. Those who predict don't have knowledge". Not knowing the state of science, technology nor of society in the future, we cannot design the perfect cover.

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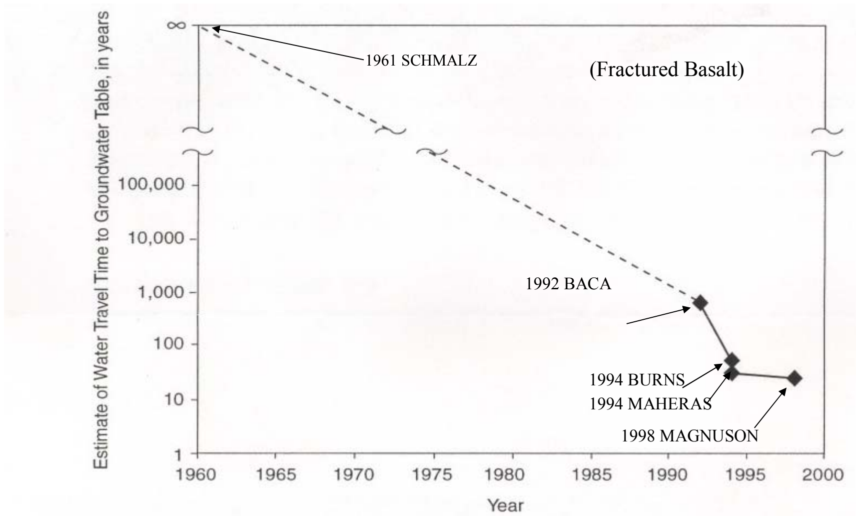

PREDICTED TIME FOR SURFACE WATER TO REACH THE GROUNDWATER TABLE

RESEARCH NEEDS IN SUBSURFACE SCIENCE (NRC,1999) 34

With the observed degradation of liners and covers including gullying, tree growth, sheep grazing on the site, etcetera within a few years of installation, it is clear that a new approach is needed. We need to recognize that our knowledge of the future is imperfect. We only know that everything will change including the source term, the hydrogeology, the receptor and society. Not knowing the state of science, technology nor of society in the future, we cannot design the perfect cover. Even if we were omniscient, the present value of the perfect cover might be more than the present value of potential lives saved. Even if we do not discount the value of lives saved in the future, the present value of the perfect cover might be more than the present value of a series of adequate covers. In keeping with the principles of sustainability, "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (43) we are not required to solve problems for all time but only to ensure that the future will be able to meet their own needs. Therefore, since we cannot know at that time the reduction in the source term, the concentrations in the environmental media, the state of monitoring technology, the state of remediation technology, the new laws and regulations nor the changes in social conditions and expectations, we need to provide flexibility in our recommendations for future.

When conditions become unacceptable, we need to redo the risk assessment taking into account all the changes that may have occurred, such as chemical analysis on an in-situ chip, measuring water and pollutant flow by in-situ monitors and decide upon the replacement design. Some of the uncertainty in the risk assessment would be reduced because having observed the flows of the pollutants during the intervening years, we would know which isotopes are being mobilized and therefore, which ones need to be contained. DOE has recognized that one should at least calculate risk-based end states so that one can determine the difference in costs when one takes into account other important factors such as culture, social norms, aesthetics and beliefs. (44) Since we recognize that the initial design cannot be perfect then we should decide upon a simple design that meets the legally mandated performance requirements but that is easily replaced assuming that the state of the art has not changed much but that does not preclude other designs depending upon the state of the art. We should not be bound by archaic regulations such as 10CFR197.15 that states "The DOE should not attempt to project changes to society, human biology or increases or decreases to human knowledge. In all analyses done to demonstrate compliance with this part

DOE must assume that all factors remain constant as they are at the time of license submission to the NRC." This is particularly out of date considering all the advances in medicine and human biomonitoring of environmental chemicals. (45) It also appears absurd to try to take into account catastrophic natural events without looking at their effects on the existing population rather than looking only at their effects on the nuclear object and its impact on the population. Further, rather than only looking at the "critical group" alone, we should also take into account the number of people affected and cost of the statistical lives saved. (46) The authors note that amount of compensation per expected fatality is 3-7 million dollars. OMB (Office of Management and Budget) has sanctioned the use of these values. The median cost per cancer case averted in the 150 hazardous chemical waste sites that EPA has selected remediation actions is $388 million without taking into account cost growth, discounting of benefits or conservatism in risk assessment. It can be inferred that the numbers for radioactive waste sites would be even larger since all the major DOE sites are in locations far from major population centers. These inefficient decisions add further weight to the argument that low-level waste remediation should be reexamined. It should be noted that such calculations are standard or implicit in all that we do including such things as the design of highways, bridges and automobiles.

With the insight from the risk analyses and taking into account whether the facility is to be located in the arid or humid region of the country, we would try to develop the most suitable liners and covers, if needed at all. It should be noted that 95% of all low-level wastes are classified as A, wastes with the lowest concentrations and the shortest half-lives. In arid regions, if still legally required, install systems that are used today. Otherwise, install the least costly cover that would still meet the dose requirements of today or of that time, if modified. It may be that a simpler cover, asphalt, or no cover would be required at various times in the future. If these simpler covers are not sufficient, than cutoff walls (permeable reactive barriers) to prevent ground water from reaching the wastes and to treat in-situ the polluted ground water that has been leached from the wastes could be installed. If further reduction were necessary berms to divert surface water from reaching the waste sites could be installed. They would be simpler, cheaper and less hazardous to install than removing and/or repairing liners to intercept and then treat the leachate. For humid regions, the approach outlined above would also be followed. It might be necessary to install "impermeable" covers to prevent rainfall from migrating into the waste system.

Why would such an approach be more likely to win public acceptance? It is clear that there is no guarantee that any methodology can guarantee success but some methods almost guarantee failure. There are ideologues on both sides of the question of the safety of radioactive waste disposal. Not much can be done to change their views. However, most people do not have such strong views on the matter. Some, who are more favorably inclined, could be labeled pro-technology and others, who are less favorably inclined, could be labeled anti-technology. This is, of course, a great simplification. However, it makes the point that the proper methodology, properly applied has a better chance of succeeding than the present approach. The present approach does not pass the credibility test. Why would anyone with common sense believe that we can forecast with great accuracy events, natural and manmade, that will occur one hundred and more years in the future? Looking at our past record, validation, quickly disabuses one of that notion. Further, why would one believe that technologists know what they are talking about when 2 Federal agencies, EPA and NRC, with equal credibility or lack thereof, treat relatively equivalent wastes, hazardous chemical wastes and low-level radioactive wastes, in such different ways. It is well known that hazardous chemicals vary in their degree of hazard and their rate of degradation, yet the EPA regulations treat them as all being equal. It is equally well known that low level radioactive wastes have different rates of decay and different health impacts and so NRC puts them into different classes and treats them differently. Further, EPA requires that the leachate from all such wastes be captured and treated. It is clear that such systems must fail with time. NRC, on the hand, requires that the leachate from low-level wastes sites be allowed to leak into the environment at controlled rates. Logic tells us that is what is going to happen eventually. How can both systems be correct? Why should the common citizen believe either agency? Finally, neither agency deals realistically with the long term viability of their systems. In 40 CFR

264 EPA regulations say "Post-closure care for each hazardous waste management unit subject to the requirements of 40CFR264.117 through 264.120 must begin after completion of closure and continue for 30 years after that date and must consist of the following:". Some of the wastes will remain hazardous for far longer than that time. The system may be operating properly at that time and fail after 50 years without recourse to the original operator.

In the proposed system, people would recognize that we don't know what the future will bring but that we can put bounds upon it and prepare to mitigate its effects. People would recognize this is similar to insurance. People have different views of risks and this is shown by the different deductibles they chose or to forego insurance altogether. The system is believable. Further, based on our present knowledge, it can be shown it poses less risk to workers and the public and at lower costs. The alternative, the cessation of the use of radioisotopes in medicine, research, manufacturing and nuclear power production or the storage of the wastes on many sites rather than a controlled few, is unsatisfactory. Faced with these realistic alternatives, it is hoped that the most attractive alternative would prevail.

Further, faced with the decreasing volumes of low level radioactive wastes and the increasingly expensive and difficult task of establishing new burial sites, it is time to look at other opportunities. DOE has consolidated its disposal sites and many of the DOE facilities are looking for new missions, it is not unreasonable to try to go back to the days when AEC sites were used for civilian low level waste disposal. It is time to see what it would take to make that possible.

I should like to close with an anecdote. I was recently in Wyoming with Chinese colleagues to visit uranium mining and milling remediaton sites, I was struck by the hundreds of millions of dollars being spent to protect a population that might be there from 200 to up to 1000 years in the future from statistical deaths. I wondered if our intergenerational concerns had not blinded us to our intragenerational concerns. In Wyoming, the median family income was $38,934 in 2000 whereas the national median income was $41,990. (47) Further, the three year average poverty rate for American Indians and Alaska Native population was 24.5%. The average poverty rate in the US was ll.3% and in Wyoming, 10.4 % in 2000. (48) Therefore, the poverty rate for American Indians and Alaska Natives was 2.5 times that of the national average and that of the entire State of Wyoming. I was further struck by the fact that because of the long term buildup of thorium and radium daughter products that the maximum doses would not occur for hundreds of thousands of years.(49) Does it make sense to spend those amounts of money now to protect these future generations while allowing so many local members of the population to live below the poverty level?

However, there are always problems in initiating a new regime. As Nicolo Machiavelli noted approximately 500 years ago about the difficulties of instituting a new order of things "the reformer has enemies in all those who profit by the old order, and only lukewarm defenders in all those who would profit by the new order." (50) Therefore, one of the challenges in implementing these recommendations would be how to reward those who embrace this new approach by returning to their sites or states some of the savings achieved by this new methodology

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