ASSURED ISOLATION FACILITIES: SOLVING THE PROBLEM OF SAFELY MANAGING LOW-LEVEL RADIOACTIVE WASTE

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ABSTRACT

No new full-range low-level radioactive waste disposal facility has been established since the seventies in the United States. The cause is the fundamental inability to defend the unavoidable uncertainties within a site's natural system and its subsequent long-term performance assessment. Using Title 10 of the Code of Federal Regulations Part 61 (10 CFR 61), a disposal facility must rely on a site's natural characteristics for radioactive waste isolation. The standard of proof for a 10 CFR 61 disposal facility has seemingly escalated from "reasonable assurance" to "beyond a reasonable doubt" or even to "a scientific certainty." The result has been a proliferation of temporary "interim" storage sites scattered throughout this nation as a result of the use of nuclear power and medical, industrial, and research applications. Clearly the situation presented by extended temporary storage sites represents a risk to the general public that cannot continue. Although it seems impossible to establish a 10 CFR 61 disposal facility, the wastes still need to be centralized for safe isolation.

The logical solution to this problem is licensing and building an "assured isolation facility" as a materials licensed facility under applicable portions of 10 CFR 20, 30, 40, and 70. An assured isolation facility is a management system for safely isolating waste, while preserving options for its long-term management. The resulting robustly engineered facility would have a system of continuous monitoring, accessible facilities, planned preventive maintenance, and sureties to address contingencies or implement future alternatives. The primary advantage of assured isolation is that the facility is not dependent on natural characteristics for radioactive waste isolation. Instead, the facility relies on a system of active inspection and preventive maintenance on a well-engineered structure. Because licensing is not done under 10 CFR 61, the licensing uncertainty that has plagued expensive disposal programs to date is eliminated. Building an assured isolation facility can therefore solve the problem of safely managing low-level radioactive waste for the indefinite future.

INTRODUCTION

In 1998, numerous reports and news articles have been written (e.g., 1, 2, 3, and 4) on the events and decisions that have caused the virtual derailment of the long-term prospects for new and existing low-level radioactive waste disposal facilities. Texas, California, Nebraska, New Jersey, North Carolina, and Pennsylvania have joined Illinois, Michigan, Ohio, and others on the growing list of casualties. The newly elected governor of the state of South Carolina campaigned on the issue of closing the Barnwell low-level radioactive waste disposal facility. If South Carolina decides to shut down Barnwell, there are no other alternatives for the safe long-term management of all classes of low-level radioactive waste for most of the nation.

Recent examples of the growing paralysis of low-level radioactive waste disposal facility siting efforts are the land transfer impasse with the Federal government at Ward Valley, California and the denial of the license applications for the proposed Sierra Blanca disposal facility in West Texas and the proposed Boyd County disposal facility in Nebraska. The Ward Valley facility was to have served the low-level radioactive waste disposal needs of the Southwestern compact region (California, Arizona, North Dakota, and South Dakota). The Sierra Blanca facility was to have served the low-level radioactive waste disposal needs of the Texas compact region (Texas, Maine, and Vermont). The Boyd County facility was meant to take waste from the Central compact region (Nebraska, Kansas, Louisiana, Arkansas, and Oklahoma). Sierra Blanca, Boyd County, and very likely Ward Valley have joined the growing list of low-level radioactive waste disposal facility siting failures (although at the time of this writing there are still long-shot chances that the Ward Valley and Boyd County facilities could open). As with all low-level radioactive waste disposal facility siting processes, Sierra Blanca, Boyd County, and Ward Valley have included very expensive processes of site characterization and evaluation.

How we got to this discouraging point in the low-level radioactive waste disposal saga is a long and complex story. One of the milestones of that story is the passage of the Low-Level Radioactive Waste Policy Act of 1980 (this law was later amended in 1985 and is now known as the Low-Level Radioactive Waste Policy Amendments Act). This legislation was passed at a time when less sophisticated methods of siting, disposal, engineering, and management were the norm. Prior to that time, low-level radioactive waste disposal facilities such as those at Sheffield, Illinois, West Valley, New York, and Maxey Flats, Kentucky were closed due to a variety of environmental problems. At the time of their operation, they followed the then current, perfectly acceptable siting and disposal practices for “permanent” disposal. These practices were later determined by the regulatory agencies to present an unacceptable risk to the public. Responsible agencies have had to conduct extensive ongoing remediation efforts to stabilize these sites for the protection of public health and safety. As of now, institutional control and active remediation and monitoring will be necessary for the foreseeable future at these sites.

So, are we talking about an unsolvable problem here? We think not. We are not talking about transuranic waste, high-level nuclear waste, spent nuclear reactor fuel, or even greater-than-class C low-level radioactive waste. What we are talking about is only classes A, B, and C low-level radioactive waste, which would be almost entirely decayed in about 500 years. Any real danger from these waste classes occurs during the first few decades of their lives. After that, the risks associated with these wastes are quite small.

Despite the low long-term risks, as a society we have been unable to solve the problem under the traditional disposal approach. It is obvious that an honest reassessment of the current status of low-level radioactive waste management in the United States needs to be made. The state of Texas can be taken as an example of the magnitude of the problem and the consequences of letting it remain unsolved. There are some 977 potential generators of low-level radioactive waste and several dozen temporary storage sites scattered across the state at nuclear power plants, and medical, industrial, and research facilities. The statistical probability of the occurrence of a dangerous incident to the public and the environment would be greatly lessened if these wastes were gathered together at a single controlled location. Additionally, at a single location, the financial and technical efficiency of a responsible institutional system would be greatly enhanced. So how can we accomplish this in a manner that protects public health and safety and the environment for the indefinite future if we cannot site new disposal facilities?

ASSURED ISOLATION FACILITY CONCEPT

A viable alternative to the current impasse of siting new low-level radioactive waste disposal facilities is the development of an "assured isolation facility." Assured isolation is not the same as either disposal (as envisioned in Title 10 of the Code of Federal Regulations Part 61) or temporary (interim) storage. A disposal facility carries with it the notion of being a "permanent" solution for the long-term management of low-level radioactive waste. (We say "permanent" while recognizing that existing disposal facilities in general have had to undergo continuing institutional control and sometimes extensive remediation efforts in order to continue to meet their performance expectations.) Temporary (interim) storage is a stopgap solution of an indeterminate, short time which, in essence, acts as an operational buffer zone. An example of this would be a facility or broker accumulating enough waste to justify a shipment to a long-term management facility. Assured isolation, on the other hand, isolates the waste through engineering and active, rigorous institutional control. This concept, which has now been well-developed, is being examined by the responsible state agencies in Texas, Connecticut, Ohio, New Jersey, North Carolina, New York, Massachusetts, and Michigan (1, 2, 3, 4).

While the assured isolation concept pulls together and synthesizes what we have learned over the last few decades of low-level radioactive waste management, it is obviously not entirely new. It is a natural evolution of ideas and pieces of ideas found here and abroad. A similar approach can be observed today in the Netherlands (5) where surface isolation is being practiced. The Netherlands uses nuclear power and also benefits from medical, industrial and research applications of radioactive materials. As with most countries, the Netherlands is bound by the prohibitions of the current international transboundary agreements to retain these wastes. It is firmly convinced that safe surface isolation is a viable option for low-level radioactive wastes. Its experience clearly indicates that a service lifetime of at least 300 years is technically achievable.

The assured isolation concept has little altered from its original presentation by Newberry, Kerr, and Leroy (6) in 1995 and their subsequent papers, which clearly established the philosophical and technical basis for the concept (7, 8). (It is interesting to note that at the time of the first article in 1995, the authors believed that the proposed disposal facilities at Ward Valley and Sierra Blanca would be successful and were the right thing to do given the facts that they were "…in ideal locations, the projects are substantially on the way to completion, and each enjoys the necessary degree of political support within the respective states.") It was originally called an "assured storage facility"; this later changed to an "assured isolation facility" because of the confusion (within the low-level radioactive waste industry) with the term "temporary" or "interim" storage. These terms have very specific meanings within the low-level radioactive waste industry, but make little difference to the general public. Recent papers on the economics of an assured isolation facility (9) and licensing of an assured isolation facility (10,11) have fleshed out the concept to a status of real viability. The definition (7) of assured isolation is: "a management system for safely isolating waste, while preserving options for its long-term management, through robust, accessible facilities; planned, preventive maintenance; and sureties adequate to address contingencies or implement future alternatives."

The inherent difference between disposal and assured isolation is the basic dependency of disposal on the natural system and specifically its geological, hydrological, and climatological components. The fundamental element for the acceptance of any disposal site is the production of a computer-based model and performance assessment. Rating risks inherent in the components of a natural system is at best a guessing game that is always taken to the most conservative extremes--extremes that are often taken several orders of magnitude beyond reality. What geologist, for example, is willing to predict that an earthquake will never take place at any

locality? Would he or she be willing to say that there will never be any further eruptions in a volcanically active area? What climatologist would be willing to predict with precision the weather pattern five centuries into the future? Engineering and institutional parameters are much more reasonably quantifiable and realistic.

Newberry, Kerr, and Leroy (6, 7) conceptually visualize the disposal system as a pyramid with the base of the pyramid being the natural system. The natural system is overlain by the engineering system and the institutional system tops it off. In assured isolation, the conceptual system is completely overturned. The base of the pyramid becomes the institutional system, engineering overlies it, and it is topped by the natural system. The key to the concept is that assured isolation is based on rigorous institutional responsibility and control. This works synergistically with the engineering system. Continued preventive maintenance extends the life of the engineering indefinitely and this enhances the capability of responsible institutional control by providing access, monitoring and retrievability. The reliance on the natural system for safety and licensing is therefore much reduced.

DISPOSAL FACILITY DESIGN AND PERFORMANCE ASSESSMENT

When Title 10 of the Code of Federal Regulations Part 61 (10 CFR 61) was promulgated, the only low-level radioactive waste disposal facilities were shallow-land burial facilities containing wastes that were usually packaged in wood or metal although 10 CFR 61 does not require all waste to be packaged. This design was consistent with the best engineering practices at the time. Because of the reliance on the natural system, a disposal facility is not presumed to require any human intervention more than 100 years after closure. This forces license applicants to develop computer-based mathematical models called performance assessments to show that the long-term performance of the disposal facility will have a reasonable assurance of being satisfactory. Unfortunately, as with all models and predictions, these performance assessments are subject to much uncertainty and are often challenged on the basis of their assumptions. To opponents and often the general public, they can appear to be a dense, unintelligible computer game designed to come out with the answer the modelers wanted in the first place.

ASSURED ISOLATION FACILITY DESIGN

The conceptual design introduced in the first article on assured isolation (6) contains some similarities to an above-grade disposal facility design by Westinghouse Electric Corporation for the Illinois siting program in 1988. Holland, Hoffman, and Meess discussed the Illinois disposal facility design in a paper (12) published in 1989. Unfortunately for low-level radioactive waste management programs everywhere, the Illinois program never made the conceptual leap to the assured isolation concept discussed by Newberry, Kerr, and Leroy in 1995 (6,7,8).

The design and operation of an assured isolation facility also take into account and mitigate or eliminate well-known problems that are inherent to extended temporary storage sites such as those discussed in a 1985 report by Siskind, Dougherty, and Mackenzie (13). Such problems include waste and container degradation and corrosion, gas generation, and chemical interactions among others. Although that report (13) is not directly relevant to assured isolation facilities and is somewhat dated in its content, Newberry, Kerr, and Leroy (6) considered and incorporated conceptual design features that would address all of the potential problem areas discussed in the report.

The assured isolation facility model is envisioned (6) as a series of above-grade, concrete, side-loading vaults with internal access that would be subject to active inspection and preventive maintenance. The solid waste would be packaged in modular, reinforced concrete packages

(overpacks), which would be easily retrievable from the waste vaults. A running inventory, which incorporates information documented on the Nuclear Regulatory Commission's Uniform Low-Level Radioactive Waste Manifest, would be kept to determine total radioactive content of each overpack, vault, and the facility as a whole.

The concrete vaults would be designed to contain overpacks stacked two or three high. Each overpack would contain solid waste as received in the original shipping containers. Usually shipping containers are metal drums or boxes or larger cask "liners." Newberry, Kerr, and Leroy (6,7,8) also suggest the addition of a simple, non-engineered local earth source to cover the concrete vaults to reduce such problems as freeze/thaw cycles. Continuous inspection and preventive maintenance of the facility negate the need for a more sophisticated building cover system. Each module of the vaults could be built on an as-needed basis and would individually contain approximately one or two years' accumulation of waste. This modular construction would allow taking advantage of continuing engineering advances in construction techniques and materials; design improvements; and flexibility of operations, in case the decision to retrieve waste is made for some unforeseen reason. Modular construction will also respond well during severe events such as earthquakes and tornadoes.

The use of side-loaded buildings is suggested (6) because this would allow the use of forklifts rather than cranes. Adoption of a side-loading system would also permit roof, support, and overpack inspections to be made. There also would be no necessity for precipitation protection (e.g., rain cover), as the wastes would be kept air dry. Retrievability and potential redistribution of the radioactive waste would obviously be much more efficiently accomplished with this type of system.

The concrete overpacks would be aligned in rows within each module of the vault. Within each vault a central aisle, wide enough for the effective use of forklifts, would be left open for possible future movement and redistribution of the overpacks. Granular, water absorbent materials would be added to fill void space within the concrete overpacks. This granular material would prevent liquid accumulation within the overpacks and would act as an acid/base buffer and radioactive material retardant.

Reinforced concrete would probably be used for vaults and overpacks because of its ease of construction, handling, consistency, and durability; however, the assured isolation concept recognizes that advances in material science might make the use of technologically superior materials possible. The sequential construction of each module of the vault allows the incorporation of new materials and construction techniques.

Each module of the concrete vaults of the assured isolation facility, as noted, should allow sufficient space in the building's central aisle to allow easy movement of forklifts, if retrieval of the overpacks becomes necessary. Additionally, there should be enough space above the overpacks to allow for the use of a robotic inspection system, television, and/or other monitoring systems. These internal systems would detect deterioration of the walls, ceilings and overpacks. The object for remote inspection and monitoring is to minimize the potential radiation dose for the workers at the assured isolation facility.

Additional monitoring and inspection can also be done from the outside of the vaults. External monitoring could be done via access tunnels, collection drains, and monitors to evaluate the continuing integrity of the assured isolation facility.

As stated before, because an assured isolation facility is subject to continuous inspection and preventive maintenance, it would not need to meet the site characterization requirements

necessary for a 10 CFR 61 disposal facility. The problem of selecting a natural site *and successfully licensing it in spite of the unavoidable geological and hydrological uncertainty of that site* then disappears. Siting and licensing an assured isolation facility become much simpler. An assured isolation facility could be built practically anywhere. Volunteer locations would be able to be considered as possible sites thus increasing the likelihood of public and political acceptance.

In Texas, for example, the pragmatic solution to the problem of placement would seem to be locating the facility in the less densely populated regions of either northern or western Texas. An assured isolation facility could be built virtually anywhere in this area. Establishing an assured isolation facility would address the most critical need: the immediate centralization of waste into a single locale from the nearly thousand separate generator and temporary storage localities throughout the state as well as that now temporarily stored in Maine and Vermont. This action would allow Texas to fulfill its obligations under the compact and would make available to it the monies that Vermont and Maine are to contribute to the project under the compact.

ECONOMIC CONSIDERATIONS: THE LIFE CYCLE COSTS

Newberry, Kerr, and Leroy (6, 7) indicated in their early qualitative estimates of the life cycle cost of an assured isolation facility in comparison to a 10 CFR 61 disposal facility, that an assured isolation facility would be about the same or somewhat less expensive than disposal. The 1996 comparative cost element analysis (7), which was qualitative, includes four major areas of consideration. These are:

1. pre-operational costs (site selection, site characterization, license and permit preparation, license review, and construction of support facilities and initial waste units);
2. operational costs (construction of waste units, receipt and emplacement of waste, environmental monitoring, and administration and record keeping);
3. closure and post closure costs (scheduled closure, site monitoring and inspection, and facility maintenance); and
4. financial assurance for remedial contingencies.

In October 1995, the U. S. Department of Energy's National Low-Level Waste Management Program, at the request of the Connecticut Hazardous Waste Management Service, contracted a cost comparison of assured isolation and traditional disposal. Rogers and Associates Engineering Corporation completed the study (9) in March 1998. This study's life cycle cost comparisons, which are quantitative, are summarized in four distinct phases: pre-operational (pre-construction, construction); operational; closure and post-closure; and institutional control. As the assured isolation facility has constant inspection and preventive maintenance built into it, closure and post-closure were treated differently than for traditional disposal.

The analysis uses an above-grade, reinforced concrete, engineered, earth-covered vault system. All wastes were to be placed into cylindrical, reinforced concrete canisters. The volume of Connecticut low-level radioactive waste was estimated to be 1,454,000 cubic feet (41,177 cubic meters). It was assumed that 15% of the waste (214,000 cubic feet or 6,060 cubic meters) would be class B and C waste. Canisters would be received and placed within the facilities over a period of 50 years. The study (9) further assumes that enough money will be collected during the operational phase to ensure that all activities following cessation of the operational phase either of the disposal facility or the assured isolation facility will offset future costs.

The report developed six scenarios each for both a traditional disposal facility and an assured isolation facility (9). Each scenario was a plausible combination of 14 different possible options for the life cycle phases of each facility. The major points for the differing present value life cycle cost estimates for each facility are: (1) disposal is more expensive particularly in near-term pre-operational costs such as site characterization and licensing and (2) assured isolation is more expensive in operations and the longer term inspections and preventive maintenance.

The bottom line of the Connecticut comparative life cycle cost study (9) is that dependent on pre-operational costs, assured isolation may result in lower present value life cycle costs than traditional disposal. Present value life cycle costs range from an estimated $340 to $410 million dollars for disposal and $330 to $350 million dollars for assured isolation. Estimated present value unit costs per cubic foot range from $520 to $630 ($18,361 to $22,245 per cubic meter) for a disposal facility and $510 to $530 ($18,008 to $18,741 per cubic meter) for an assured isolation facility.

The problem with any present value life cycle cost analysis is that it is based on a series of broad and always debatable assumptions and degrees of conservatism, much as with problems inherently encountered in computer-based, performance assessment models. The Connecticut study (9) does, however, move the cost assumptions to a more quantitative form than the original more qualitative level intuitive analyses (6,7). Taking into consideration both sets of analyses, it appears that the present value life cycle costs are nearly equivalent with a possible slight advantage to an assured isolation facility. Difference in cost, therefore, is not a reason to choose one alternative over the other.

LICENSING AN ASSURED ISOLATION FACILITY

It should be quite sobering for all of us to realize that there has not been a single full-range, new low-level radioactive waste disposal facility placed into operation since 1971. And no new low-level radioactive waste disposal facility has yet been successfully licensed and opened under the 10 CFR 61 process. It is obvious that, in order to safeguard the public from potential incidents and accidents associated with literally thousands of temporary low-level radioactive waste sites scattered across the nation, responsible action must be taken now. The current and past on again/off again situation demonstrated by the Barnwell facility is no longer an acceptable political, ethical, or financial situation. Additionally, based on the legal, political, regulatory, and public perception morasses encountered at Ward Valley, Boyd County, and Sierra Blanca, it is logical to conclude that we may never be able to license and build a new low-level radioactive waste disposal facility under 10 CFR 61 or its state equivalents. The conclusion that we cannot safely dispose of the waste is simply unacceptable from a public health standpoint; current and future low-level radioactive waste will not disappear by simply wishing it away. The only realistic and doable alternative available, therefore, would seem to be building an assured isolation facility, a concept that has now come of age. The movement from concept to reality however, requires a clear and pragmatic licensing route forward. Fortunately, we have just such a route.

Silverman and Bauser (10,11), to this end, have recently completed an extensive, two-volume study (*Licensing an Assured Isolation Facility for Low-Level Radioactive Waste*, DOE/LLW-250) on a recommended approach for licensing an assured isolation facility as a "materials" licensed facility under Nuclear Regulatory Commission regulations. This study, as was the Connecticut cost study, was contracted by the Department of Energy's National Low-Level Waste Management Program. The licensing study uses existing radioactive materials and low-level radioactive waste regulations and guidance to help define a workable licensing approach for an assured isolation facility. It drew guidance and recommendations from select portions of

10 CFR 61; Section 11.e (1) of the Atomic Energy Act of 1954, as amended; regulations in 10 CFR Parts 30, 40, and 70; radiation protection guidance from 10 CFR 20; and other related NRC guidance documents. The report convincingly demonstrates that an assured isolation facility is licensable under current NRC regulations and guidance.

Volume 1 of the report (11) is entitled *Licensing Strategy and Issues*. It provides background information, a description of an assured isolation facility, and describes the licensing approach and methodology. Volume 2, *Recommendations on the Content and Review of an Application*, identifies specific information that is recommended for inclusion in a license application for an assured isolation facility. In addition to recommended license application contents, Volume 2 also includes recommendations for regulatory personnel that might be asked to review such an application. In many respects, the volume is much like a NRC Standard Format and Content Guide and a NRC Standard Review Plan. Volume 2 also includes the reasoning for including or not including various regulations and guidance elements in the recommended licensing approach for an assured isolation facility.

Volume 1 of the study (11) identifies and discusses in some detail eight key licensing issues:

1. the application of 10 CFR 61 performance objectives to an assured isolation facility;
2. the application of 10 CFR 61 technical requirements to an assured isolation facility;
3. dose pathways;
4. financial assurance guidelines;
5. assured isolation facility license term;
6. physical protection and criticality safety (for special nuclear materials);
7. National Environmental Policy Act (NEPA) requirements; and
8. emergency planning guidelines.

Because of the comprehensive and thorough nature of the study (11) and the subtlety of several of the licensing issues, we strongly urge that interested readers obtain a copy from the National Low-Level Waste Management Program at the Idaho National Engineering and Environmental Laboratory (telephone: 208-526-7394). We will, however, try to summarize here several of the key licensing issues addressed in Volume 1 of the report.

1. The Application of 10 CFR 61 Performance Objectives to an Assured Isolation Facility

   There are four performance objectives for near-surface disposal in 10 CFR Part 61, Subpart C. They are (1) protection of the general public from releases of radioactivity; (2) protection of individuals from inadvertent intrusion; (3) protection of individuals during operations; and (4) stability of the disposal site after closure.

   After considering the bases and histories of these four disposal performance objectives, the study concludes that an assured isolation facility should operate under the radiation protection regulations established in 10 CFR 20 and should incorporate the “as low as reasonably achievable” philosophy for radiation controls. Part of the third performance objective is therefore applicable to an assured isolation facility. Because of the differing natures of 10 CFR 61 disposal and assured isolation, it concludes that the other three performance objectives are not applicable to an assured isolation facility.

2. The Application of 10 CFR 61 Technical Requirements to an Assured Isolation Facility

10 CFR 61.50 through 10 CFR 61.59 contain ten technical requirements for disposal:

1. disposal site suitability;
2. disposal site design;
3. disposal facility operation and site closure;
4. environmental monitoring;
5. alternative requirements;
6. waste classification;
7. waste characteristics;
8. labeling;
9. alternative classification and characteristic requirements; and
10. institutional requirements.

It is beyond the scope of this paper to discuss the study's conclusions on each of these technical requirements separately, but we can draw out some of the more important ones. The site suitability requirements were determined to apply only in a very limited way since an assured isolation facility would more properly be licensed under 10 CFR 30, 40, and 70. Most other aspects of site suitability as well as certain requirements of operations and site closure, environmental monitoring, etc. would not apply to an assured isolation facility because they are directed at closure and post-closure or even post-institutional control aspects of disposal. Interestingly, it was concluded that waste classification, waste characteristics, and labeling would apply to an assured isolation facility; this is not required for other facilities licensed under 10 CFR 30, 40, and 70. The reason that these requirements apply to an assured isolation facility is that "waste shipped to an AIF would, in fact, be intended for "ultimate" disposal within the meaning of 10 CFR 20.2006(b)(2); whether within the AIF itself, or at a disposal facility operating elsewhere, or a combination of the two."

3. Dose Pathways

Analyses of dose pathways are critical factors for 10 CFR 61 disposal facilities, particularly with respect to groundwater. Groundwater is the most prominent pathway for 10 CFR 61 disposal facilities since they rely primarily on the natural characteristics of the site for long-term performance. In contrast, the groundwater pathway is non-existent in an assured isolation facility since an assured isolation facility incorporates ongoing inspection of the waste overpacks within the vault. In the absence of a groundwater release pathway, the major potential dose pathways for an assured isolation facility are direct gamma radiation, atmospheric transport, and, to a lesser extent, surface water (during an accident or abnormal condition).

4. Financial Assurance

Silverman and Bauser (11) conclude that, for an assured isolation facility, decommissioning funds will need to be available during the facility's license term. Four basic methods are available:

1. prepayment (a deposit of funds into an account prior to facility operations);
2. surety or insurance (e.g., letter of credit, surety bond, or parent company guarantee);

3. external sinking fund coupled with a surety method of insurance (i.e., one in which the insurance is reduced by the amount of money accumulated into the sinking fund on an annual basis); or
4. if the Federal, state or local government is the licensee, the licensee can guarantee that the funds for decommissioning will be obtained at such time as they are needed (since they have revenue-raising abilities).

5. Term of the License

Since assured isolation is a relatively new concept, nothing in either the Atomic Energy Act or the regulations of the NRC define a precise license term for an assured isolation facility. The study, however, points out that the NRC has adopted a policy of granting ten-year license terms for essentially all materials licenses; the study also notes that Louisiana Energy Services (a proposed uranium enrichment facility) requested a thirty-year license term. The study concludes that it would be reasonable for a license applicant for an assured isolation facility to request at least a ten-year license term. Because of the passive nature of an assured isolation facility, it suggests that it might even be reasonable to request a much longer license term of thirty years or more.

6. Physical Protection and Criticality Safety

The problems of physical protection and criticality safety for special nuclear material are not expected to be significant for an assured isolation facility on the assumption that the facility will not possess sufficient quantities of special nuclear material requiring a criticality accident monitoring and alarm system. If the assured isolation facility is anticipated to possess such quantities of special nuclear material, the study recommends examination of 10 CFR 70.24 and the latest draft or final NRC guidance on criticality safety for fuel cycle and special nuclear material licenses.

7. National Environmental Policy Act Requirements

The study is not certain and does not make a legal determination as to whether the NEPA and NRC's NEPA-implementing regulations (10 CFR 51) apply to an assured isolation facility. But the study does presume that the NRC will request an Environmental Report (ER). Submittal of an ER would trigger the NRC to prepare an environmental assessment and a finding of no significant impact or a full environmental impact statement.

8. Emergency Planning Guidelines

Based on an extensive analysis, the study concludes that it is appropriate to apply 10 CFR 30 emergency planning guidance to an assured isolation facility.

CONCLUSIONS

In the United States, no new full-range low-level radioactive waste disposal facilities have been established since 1971. The failure to do so has been due to the difficulties encountered in the defense of sites' natural characteristics and the unavoidable uncertainty of the characterization and performance assessment of those natural characteristics. It is not that such sites are technically unsuitable. On the contrary, most if not all proposed sites have been judged *by the knowledgeable technical community* to be suitable. The problem lies in the fact that the license

applicants have been unable to prove *to judges, lawyers, regulators, the general public, and opponents* that the sites will perform as expected with "reasonable assurance." The standard of reasonable assurance seems to have become a de facto "beyond a reasonable doubt" or "to a scientific certainty" standard. *Those* standards cannot be met with traditional 10 CFR 61 disposal approaches.

After much analysis, discussion, and study, it appears that an assured isolation approach will succeed where traditional approaches have not. This is primarily because an assured isolation facility does not rely on a site's natural characteristics for waste isolation and does not, therefore, have the inherent uncertainty associated with the characterization and modeling required by the traditional disposal approach. An assured isolation facility relies, rather, on advanced engineering and continued institutional control in the form of inspection and preventive maintenance.

Some might say that the preferred option would be the "permanence" afforded by a traditional disposal facility. Based on the record of performance to date however, it would be prudent to be very cautious in declaring the problem "permanently" solved. Earlier disposal sites have had to be reworked to current standards and will likely *never* perform as once expected without continuing controls. Remediation efforts are extremely costly and inefficient. Furthermore, there is no guarantee that future controls will be the same as they are today for disposal—they may be less stringent or more stringent. It is likely that they will be quite different from anything that we have now.

Clearly we must do something to safely manage the waste. As a country, we have spent over $500 million and over fifteen years without a disposal facility to show for it anywhere. And there are mighty dim prospects for those disposal programs not already dead in the water. We cannot continue to temporarily store wastes in every nook, cranny, building and broom-closet available in cities and towns across the nation. That approach is an accident waiting to happen. The waste should be centralized for safe management. Building an assured isolation facility, a centralized facility that is designed to incorporate the dynamic increase of knowledge and changing societal values in the future, offers a real alternative to traditional disposal approaches.

REFERENCES

1. S. VORENBERG, "Compacts Speculate on Possible Barnwell Closing; LLWPA Future," Nuclear Waste News, vol. 18, no. 46, p. 471 (1998).
2. S. VORENBERG, "Assured Isolation Offers Possible Escape from Low-Level Waste Woes," Nuclear Waste News, vol. 18, no. 48 (1998).
3. NATIONAL RADIOACTIVE WASTE MANAGEMENT EXCHANGE, November 23, 1998
4. T. HARRISON, Nucleonics Week, November 19, p. 13, 1998.
5. L. C. SCHOLTEN, H. W. de WIT, H. K. D. CODEE, and J. WELBERGEN, "Long Term Surface Storage of Low Level Waste," Waste Management '98, Session 33, Disposal Facility Development for Low Level Waste, 33 - 1, 7 p. (1998).
6. W. F. NEWBERRY, T. A. KERR, and D. H. LEROY, "Assured Storage Facilities: A New Perspective on Low-Level Radioactive Waste Management," Radwaste, vol. 2, no. 5, p. 24 - 31 (1995).
7. T. A. KERR and W. F. NEWBERRY, "The Assured Storage Integrated Management System: What is it and what will it cost?", EPRI International Low-Level Radioactive Waste Conference, New Orleans (1996).
8. W. F. NEWBERRY, T. A. KERR, and D. H. LEROY, "Assured Storage Integrated Management Systems: The Most Frequently Asked Questions," Vol. 3, no. 5, p. 20 - 25 (1996).

9. B. CHAU, A. A. SUTHERLAND, AND R. D. BAIRD, "Life Cycle Costs for Disposal and Assured Isolation of Low-Level Radioactive Waste in Connecticut," DOE/LLW-246, National Low-Level Waste Management Program (March 1998).
10. D. J. SILVERMAN and M. A. BAUSER, "A Licensing Approach and Strategy for an Assured Isolation Facility for Low-Level Radioactive Waste," Track 2.2, Paper 2, Assured Isolation Facility Licensing, Proceedings of the 19th U. S. Department of Energy Low-Level Radioactive Waste Management Conference, Salt Lake City, 10 p. (November 1998).
11. D. J. SILVERMAN and M. A. BAUSER, "Licensing an Assured Isolation Facility for Low-Level Radioactive Waste," DOE/LLW-250, National Low-Level Waste Management Program (July 1998).
12. J. HOLLAND, D. HOFFMAN, and D. MEESS, “Engineering a Low-Level Radioactive Waste Disposal Facility: The Illinois Design,” Waste Management ’89, Volume 2, p. 79-81, (1989).
13. B. SISKIND, D. R. DOUGHERTY, and D. R. MACKENZIE, “Extended Storage of Low-Level Radioactive Waste: Potential Problem Areas,” NUREG/CR-4062, Brookhaven National Laboratory, (December 1985)