NEW DISPOSAL SITE DEVELOPMENT AND TECHNOLOGY

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ABSTRACT

Chem-Nuclear has been active in the area of new site development since the late '70s with specific efforts directed toward development of sites in Colorado, New Mexico, Texas, and South Dakota. This site development activity was in direct response to the 1980 Low-Level Waste Policy Act and the need for a regional disposal program. However, the 1985 Amendment to the Act, signed into law in January 1986, required a different focus because it clearly led toward an increase in the number of compacts from that envisioned in the 1980 Act.

Further, the new sites to be developed as a result of the compact process require (for the most part) the use of aboveground engineered disposal technology. Although shallow land burial, as practiced at the Chem-Nuclear Barnwell disposal facility, has been proven to be an environmentally safe practice and a cost-effective means of disposal, public perception and local acceptance requires a much more complex approach for the disposal of low-level radioactive waste (LLRW). States involved in the siting process for new compact disposal facilities are requiring aboveground engineered structure as a means of disposing of LLRW. Chem-Nuclear has examined and evaluated many different technologies and has had extensive discussions with the developers of the proposed technology. To assure new site technology requirements are met, Chem-Nuclear has selected the French technology and is the licensee for these new facilities through the U. S. subsidiary, NUMATEC. We are committed to the most well-developed, advanced and operationally proven technology in the world -- this, with our strong team, demonstrates our commitment to the low- level waste disposal business as it has evolved through the compacting process. We have mounted a strong and dedicated effort for the bidding of the North Carolina and Pennsylvania sites. The following is a discussion of the technologies and approach for the development of these new sites.

EVOLUTION OF LOW-LEVEL WASTE DISPOSAL TECHNOLOGY

The technology for the disposal of LLRW has been evolving, from the first use of simple landfills in the early 1960s to the present engineered shallow land burial, with emphasis on trench design and waste form as currently practiced at the Chem-Nuclear Systems' Barnwell Site, to the state-of-the-art triple barrier technology from France. Figure 1 illustrates this evolution.

France has a major program for nuclear power development with over 70% of its power coming from such plants. With this development, France, a highly populated country, made a major commitment to the safe, publicly acceptable disposal of low-level waste, first beginning with Center de La Manche which opened in 1969 in Normandy. The practice at this facility has evolved through the years and in 1978 was redesigned to employ an engineered disposal structure. This facility will reach full capacity in the early 1990s, and a new facility has been sited. This new facility, Center de l'Aube, represents the second generation in the evolution of the proven French technology. This facility is currently under construction and is scheduled for full operation in 1990.

The technology uses a disposal method described as mounded concrete bunker. The use of the enhanced technology represents well over ten years of experience with over ten million cubic feet of waste disposed. The technology has been proven through design, operation and licensing.

REQUIREMENTS FOR NEW U.S. LLRW FACILITIES

Besides complying with 10CFR61, new LLRW disposal facilities must place emphasis on:

- retrievability of all disposed waste;
- isolating the waste from the environment during and after disposal;
- designing with engineered multiple barriers for waste containment;
- monitoring the effectiveness of the engineered barriers;
- meeting public concerns on facility siting, operation, and closure;
- computer tracking of individual waste packages;
- achieving the lowest practical radiation exposures for both the general public and the facility personnel; and
- maintaining operational and closure procedures that safeguard public health and safety during the entire operational, active maintenance, and institutional control periods.

SITE CHARACTERIZATION AND SELECTION

Site characterization and selection will include a screening process to identify suitable locations for further detailed characterization. This characterization will involve detailed evaluation of the final candidate sites, the results of which will, in conjunction with sociopolitical and

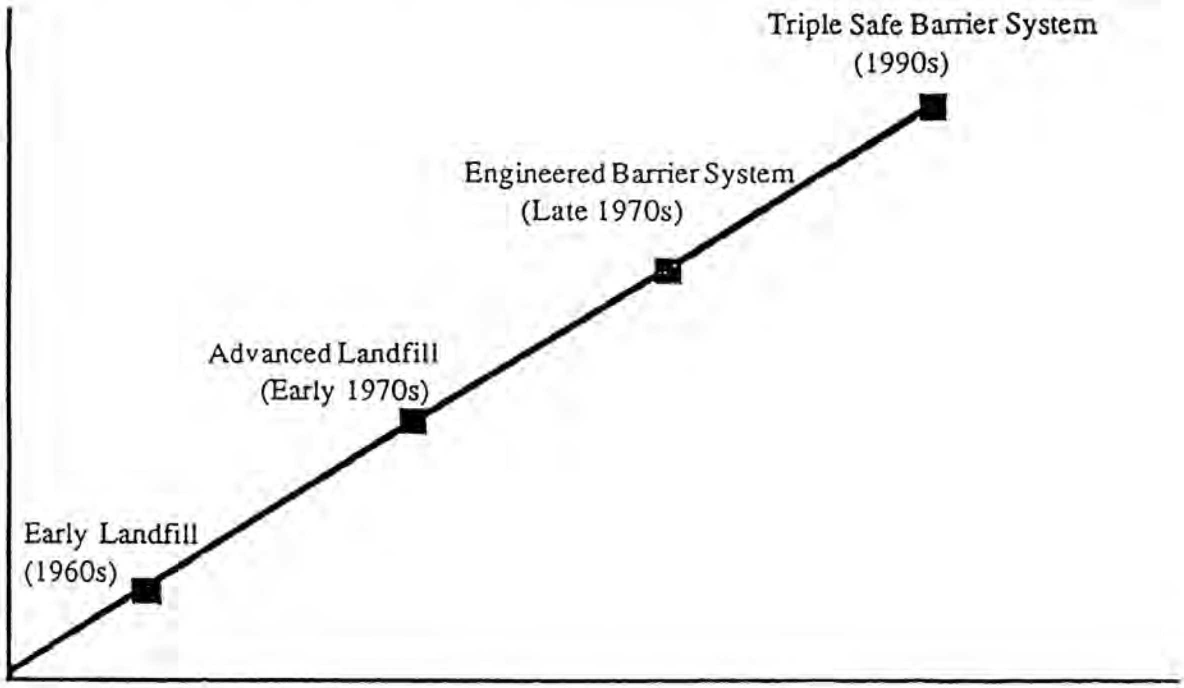

Fig. 1. Evolution of LLRW Disposal Technology.

economic considerations, lead to selection of the final site. The site characterization and selection process will

- ensure the existing soil, geology, groundwater parameters, and other geotechnical characteristics will be compatible with the requirements of the facility;
- compare the site characteristics with the performance requirements presented in the applicable state statutes and 10CFR61; and
- ensure the facility will be compatible with the surrounding community.

Since public approval of the facility is critical, the facility developer must establish participation and information programs to ensure responsible dialogue and involvement with community leaders, local chambers of commerce, and the general populace in the entire process.

TRIPLE SAFE DISPOSAL DESIGN

This triple barrier design emphasizes the importance of containment and immobilization of radioactive materials. First, the use of special solid waste forms, and the utilization of a grouted overpack for containment of the special waste form (see Fig. 2) combine to comprise the first barrier of the triple barrier design concept. The second barrier is the engineered disposal facility. This includes a thick concrete module with a monitoring system for periodically verifying waste package integrity. Class B & C wastes are placed near the center of the module with the lower activity Class A waste placed at the perimeter of the disposal module. A detection system is built into each module and sampled through a gallery. Waste handling, overpack loading, and waste placement occur within a movable, wheel-mounted building which has its own filter system. This building moves from a completed module to the next newly constructed empty module (see Fig. 3). The modules are arranged in multiple rows, allowing fabrication on an as-needed basis to help minimize the current cost of disposal. This approach also minimizes the quantity of waste in an open module. The overpacks containing the wastes are lowered into the monoliths by crane a layer at a time, and the voids are filled with sand or gravel. After completion, a thick concrete cap is poured over the overpacks within the module and then a permeable membrane is placed over the cap. Once the modules are complete, they are covered with layers of clay and soil, hence the name earth-mounded concrete disposal modules. Each of the disposal modules has a capacity of about 150,000 cubic feet, depending on the type of overpack and the waste form used.

The third barrier is the site itself. A site will be chosen having favorable hydrogeological characteristics. During the operating period, normally 20 to 50 years depending on the compact, and during the institutional control period, normally 100-500 years depending on the requirement, this barrier is actively monitored. Its key function is after the end of the institutional control period during the free access to the site. The near-surface disposal area, having been filled, is earth-mounded; this is back-filled with gravel, clay and

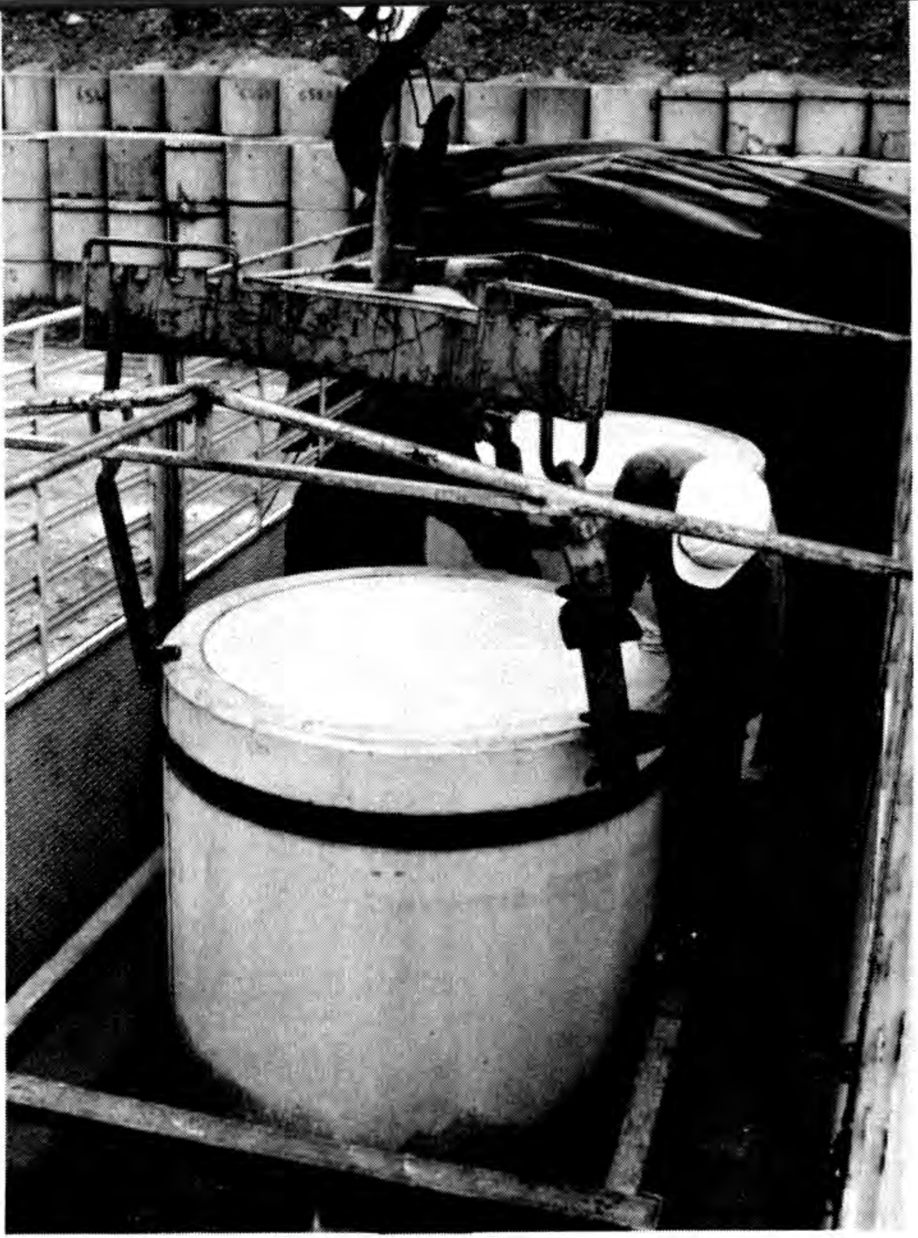

Fig. 2a. Filled Overpack Being Prepared for Transport to the Disposal Module at the Center de la Manche, France.

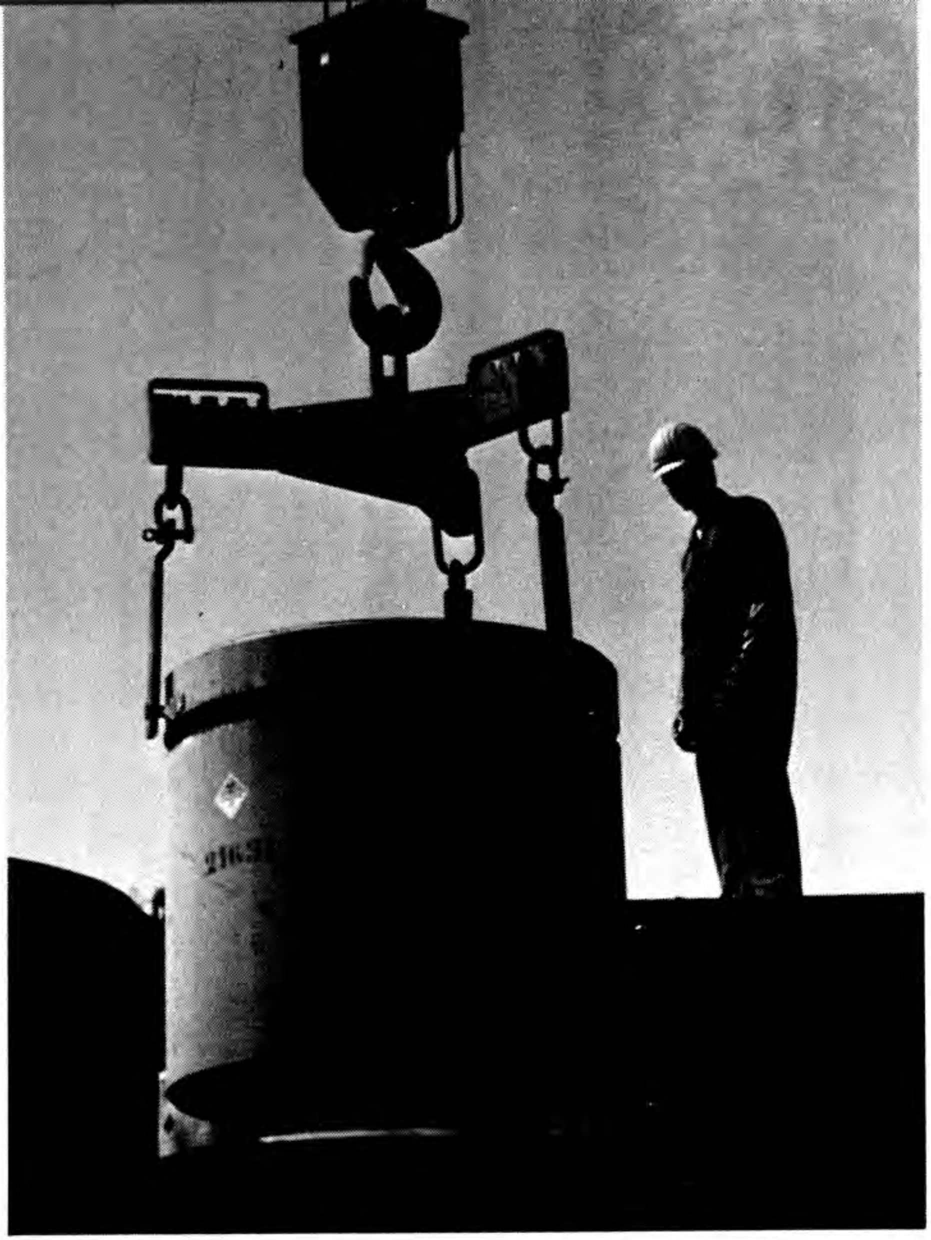

Fig. 2b. Overpack Being Placed in Disposal Module at the Center de la Manche, France.

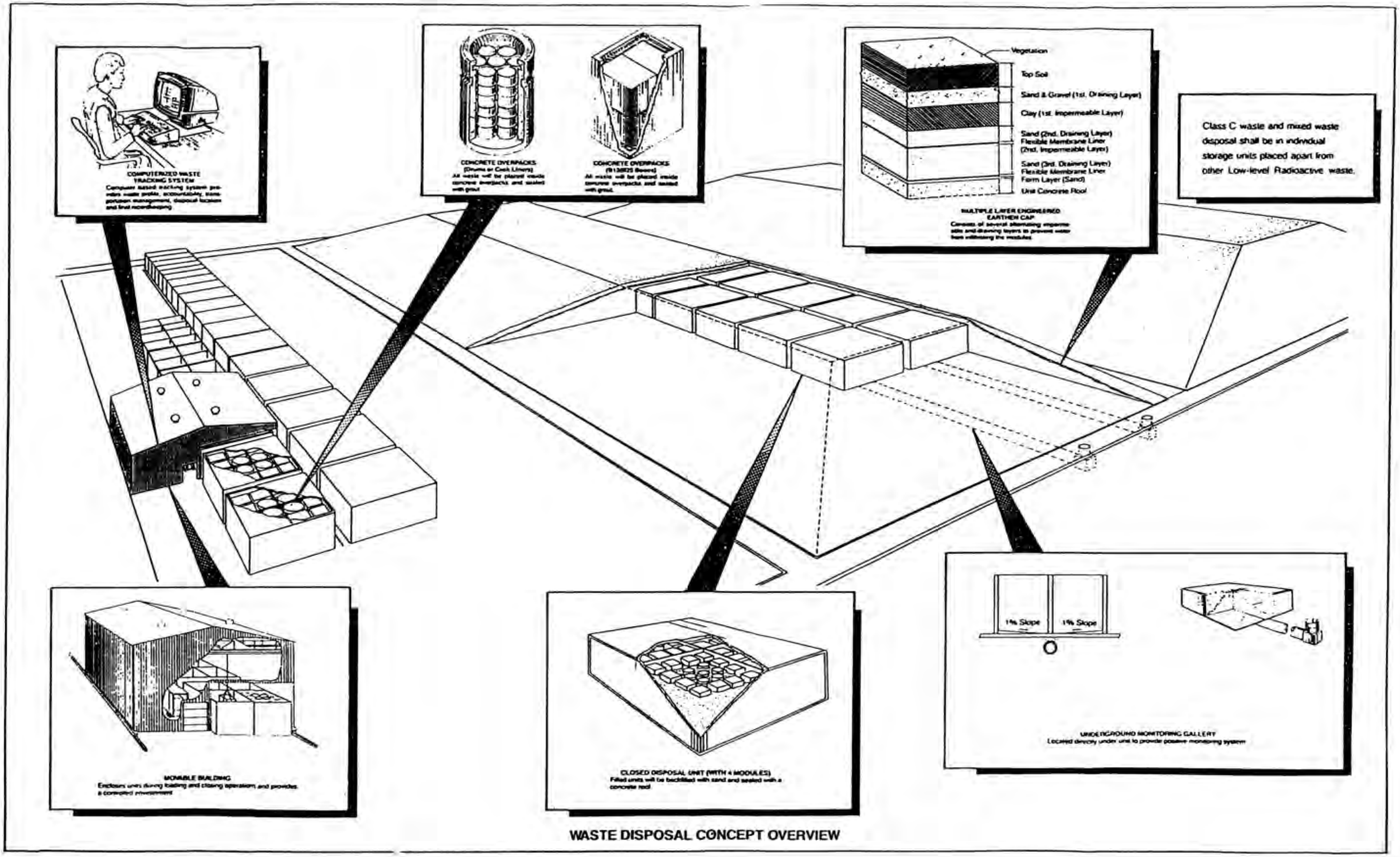

Fig. 3. Sketch Illustrating Each of the Multiple Barriers.

other materials, covered with an impermeable layer of clay, which is then covered with several other permeable layers of soil, sand and gravel to direct rainwater off to the sides of the disposal modules. A top layer of soil is added and planted with local vegetation. The total thickness of the earth cap is about 10 feet and when complete presents a surface geological and vegetation profile that is pleasant to the eye. An important feature in the Chem-Nuclear approach is the overpack design to accommodate the size and shape of waste packaging used by the various generators in order to maximize the loading efficiency within the individual overpacks and eliminate repackaging of wastes. The concrete modules have, in turn, been designed based upon the mix of rectangular and circular overpacks required to accommodate the respective volumes of the different waste types generated. The result will be a very efficient use of the disposal space within the disposal modules, yielding loading efficiencies more than twice those of competing designs, and therefore reducing significantly overall cost by reducing both the number of disposal modules required and the extent of earthen disposal cap that must be constructed over the closed modules.

ALTERNATIVE DISPOSAL DESIGNS AND TECHNOLOGIES

There are four basic alternative waste disposal system designs that could be considered for new, aboveground LLRW disposal facility. These alternative designs are variations of the basic triple safe design described in the previous section. Each of these designs utilizes engineered barriers to isolate the waste from the environment. They either have fewer barriers or they segregate the waste classes in a different manner. They are identified below:

Triple Safe Design - Earth covered concrete modules containing concrete overpacks

- Alternative 1 - Earth Covered Concrete Overpacks
- Alternative 2 - Earth Covered Waste Module
- Alternative 3 - Earth Mounded Concrete Bunker.

Each of the alternative designs is a derivative of the triple safe design and makes less use of multiple engineered barrier technology. On an absolute scale, the alternative designs offer a reduced level of waste isolation from the environment. However, each alternative is expected to be less costly. The following discussion presents each of the alternatives and contrasts them with both the basic triple safe design and each other.

Alternative 1 - Earth Covered Concrete Overpacks

In this design, the disposal facility consists of a concrete pad on which concrete overpacks containing waste packages are stacked. Void spaces between overpacks are filled with sand or gravel. A multiple-layer engineered disposal cap is placed over the overpacks and functions as the closure for the waste disposal system. The design totally eliminates the waste module structure. Water detection and collection are provided by drains that empty into drain monitoring tanks located below the concrete pads. This concept represents the simplest alternative to the triple safe design.

Alternative 2 - Earth Covered Waste Module

In this alternative design, a concrete waste module is constructed. Waste packages, without concrete overpacks, are stacked inside from the top. The module is backfilled with gravel or sand, and a concrete roof is constructed on top of the module. The module is then covered with a multiple-layer earthen disposal cap. Unexpected moisture detection and collection would be performed via a module monitoring system located below the disposal module. This alternative design is similar to the triple safe design except that it does not place the waste packages in concrete overpacks.

Alternative 3 - Earth-Mounded Concrete Bunker

This alternative design concept treats Class A and Classes B/C wastes with two distinct disposal technologies. The Class B and C wastes are positioned in concrete overpacks within a waste module. This approach is identical to the reference design in the means of disposal of Class B and C wastes. The Class A waste is stabilized and placed above the waste module. Voids between packages are filled with sand or gravel. Two variations of this concept are disposal of the Class A waste in either a concrete overpack or direct disposal of the Class A waste container. Closure of the entire waste disposal unit is accomplished with the placement of a multi-layered earthen cap. Both disposal units drain any collected moisture to monitoring tanks located at a level below the waste module.

A comparison of the alternative disposal technologies is presented in Table 1. All concepts offer a reduced margin of safety relative to waste isolation from the environment when compared to the triple safe design.

Design Selection

In summary, the three alternative designs are inferior to the triple safe design in all key areas except for economics. However, given the conservatism and proven experience of the triple safe design with regard to environmental protection and the straightforward manner in which it can be licensed, and the importance of a short licensing process to meet the January 1993 operations date, the overall system cost of the triple safe design should be the lowest.

LICENSING APPROACH

The French engineered barrier concept is licensed under criteria equivalent to appropriate U.S. federal and state safety standards. The licensing is based on two basic criteria: (1) no migration of contamination from the surface of the disposal facility to the human environment, and (2) no undue constraint on future generations from the disposal of low-level radioactive waste. The *Environmental Impact* Statement (EIS) and Safety Analysis Report (SAR) for the l'Aube facility have been prepared and are presently being reviewed by the appropriate agencies. A comprehensive review of the EIS and SAR includes a key review of (1) accident scenarios and provisions for mitigation, (2) pathway analysis, and (3) radionuclide concentration limits. The

TABLE I

COMPARISON OF LLW WASTE DISPOSAL TECHNOLOGIES

Advantages	Triple Safe Design	Alternate 1	Alternate 2	Alternate 3
1. Environmental Safety	+	-	-	-
2. Best Available Technology	+	-	-	-
3. Design Flexibility	+	+	-	-
4. Licensability	+	-	-	-
5. Operational Efficiency	+	-	-	-
6. Economics	-	+	+	+

KEY: + Improvement or equal to Triple Safe Design
- Less capability than Triple Safe Design

safety analysis considers the various time periods in the facility's life, e.g., operational, institutional control, and free access. The safety analysis evaluates both man-made and natural scenarios, including natural disasters such as floods, tornados and earthquakes, potential handling errors, fires, and potential construction or waste form defects.

The licensing process for the l'Aube facility is very similar to the licensing processes for nuclear facilities in the United States. For example, the l'Aube design is supported by an extensive Preliminary Safety Analysis Report, and the l'Aube site has been thoroughly evaluated in an Environmental Impact Survey. This documentation is available to support our triple safe design. This licensing effort required thousands of hours of engineering and scientific evaluations, examining the status of this technology and means of ensuring technical feasibility, environmental safety, and economic feasibility. The experience gained from having undergone a stringent licensing process elsewhere means that we have already identified and dealt with complex technical subjects, and can therefore work efficiently to expedite the licensing process.

Pathway analysis is a key component in disposal facility licensing. It is important to have a complete understanding of the dominant pathways for radionuclide migration and the design factors to mitigate radionuclide transport and human exposure. Pathway analysis is used to help set upper limits on allowable concentration of individual nuclides. The use of concrete overpacks for all waste forms makes this pathway analysis a much more straightforward, time saving task. The design is flexible in that it can be constructed in above-grade, mid-grade or below-grade, depending upon the natural geological protection afforded by the site characteristics. Furthermore, the modules can be readily adapted to meet the necessary criteria for EPA and NRC disposal of mixed waste.

The waste packages are in a retrievable form and are tracked through a computerized waste tracking system. The system tracks all LLRW generators, packages, and permanently records the location within the disposal module. The tracking system includes (1) verification of acceptable waste forms, (2) transport, scheduling, and management, (3) isotopic inventory and activity tracking, (4) disposal facility records and reports. Bar coding scanners are used to track waste packages through every step of the disposal process. Further, the tracking system contains the isotopic inventory and location of every package disposed in the facility.

SUMMARY

Chem-Nuclear is committed to the success of the compact process and to the use of state-of-the-art, licensable methods for engineered enhanced disposal of low-level radioactive waste. We are firmly committed to the use of the triple safe design for new facilities; it represents the best available technology, offers the maximum in environmental protection, is the simplest and quickest to license, offers the maximum flexibility to the generators in accommodating a broad variety of waste forms and packages, and at the same time represents the lowest overall system cost to the users of the facility. This conservative approach to the development of new facilities is vital in order to meet the January 1993 milestone for new facility operations.