Processing and Disposal of Radioactive Waste by the Waste Management Group at LASL Thomas K. Keenan

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Processing and Disposal of Radioactive Waste by the Waste Management Group at LASL

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WASTE MANAGEMENT

Mankind has had to deal with or "manage" its wastes since history began. The Bible (Deut. 23:13-15) contains rather specific instructions for Jewish warriors as to waste management of personal egesta. The quantity and types of waste have increased remarkably since those early times. The Industrial Revolution of the 18th century added a huge new spectrum of solid and liquid discharges to agricultural and municipal wastes. Along with the growing number of waste types, our knowledge of the hazards associated with routine wastes has advanced and changing attitudes have demanded ever more sophisticated techniques for isolating these wastes from man and his environment.

The Los Alamos Scientific Laboratory (LASL) in northern New Mexico has carried out studies using various kinds of radioactive materials since the mid-1940s. LASL programs historically have emphasized weapons development, but now include other energy interests (fission, fusion, solar, geothermal, etc.) along with fundamental physics, metallurgy, and chemistry research. Although some radioactivity is and always has been present in the atmosphere and earth's crust, the discovery of nuclear fission has created additional significant quantities of radioactive materials to be managed. LASL, involved from the beginning of modern nuclear energy studies, has compiled a good safety record in disposing of its nuclear wastes.

Many LASL programs generate radioactively contaminated wastes. The nature of the work results in the bulk of these wastes being contaminated with alpha radioactivity typical of uranium and transuranium elements. LASL is self-contained in handling and disposing of its wastes; only rarely are any sent to or received from other facilities.

The Waste Management Group at LASL is responsible for the handling, processing, and appropriate disposal of radioactively and chemically contaminated waste products. Approximately 12 million gallons of contaminated liquid wastes and 9 thousand cubic yards of contaminated solid wastes are processed yearly. Routine processing waste management activities include a variety of technical operations. Research, development, and demonstration studies to improve waste treatment methods have been ongoing LASL efforts for years.

LIQUID WASTE TREATMENT

Liquid wastes originate at many LASL facilities and are treated at two separate plants in conventional water purification equipment. The treatment removes most of the radioactivity in the wastes by controlled precipitation of ferric hydroxide, followed by ion exchange if necessary. Settling tanks and filtration are used to separate the precipitate (called sludge) from the treated water. The piping system permits recycling of the liquid through the

plant when additional contamination removal is necessary. Figure 1 shows some of the treatment plant equipment. This process removes more than 99.9% of the original transuranium radioactivity. The sludge containing the radioactivity is dried and placed in 55-gallon fiber drums for disposal by land burial.

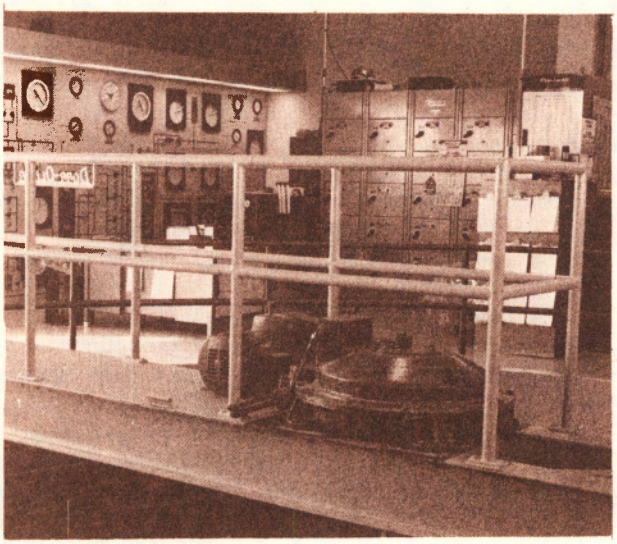

Fig. 1.

SOLID WASTE TREATMENT

The US Department of Energy standards require that all *solid* wastes contaminated with radionuclides at a concentration above 10 nanocuries of transuranium (TRU) alpha activity per gram of waste must be segregated, specially packaged and handled, and stored for 20 years while a permanent disposal site is being selected. A curie is a defined unit of radioactivity. The prefix "nano" means one billionth part.

LASL's solid wastes are sorted into retrievable (more than 10 nanocuries of TRU alpha radioactivity per gram) or nonretrievable (less than 10 nanocuries per gram) categories, and they are packaged as they are generated. Retrievable wastes are placed in polyethylene-lined steel drums or fiber glass-coated plywood crates for storage. Nonretrievable wastes are packaged in cardboard boxes, fiber crates, or barrels and transported to the burial area. Some low-activity waste packages are compacted and baled in a 100,000-pound press for a volume reduction ratio of about 5:1 before burial. Large, bulky items contaminated at less than 10 nanocuries per gram are simply buried as is. Figure 2 shows some items in this category in a burial pit awaiting backfilling.

Solid wastes are sorted by a LASL-developed electronic device called MEGAS (Multiple Energy Gamma Assay System), which determines the level of radioactivity in fiber boxes of low-density wastes. Figure 3 shows this

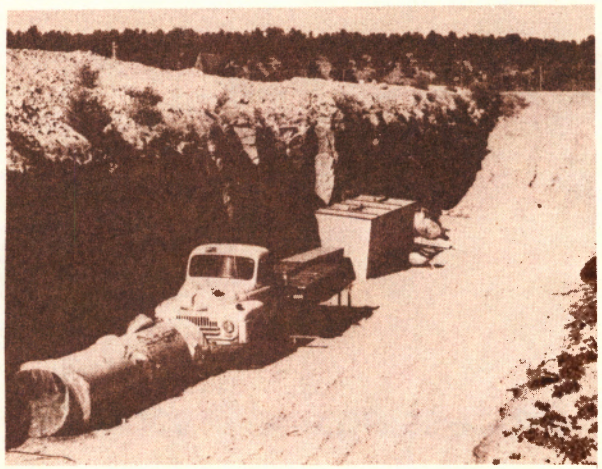

Fig. 2.

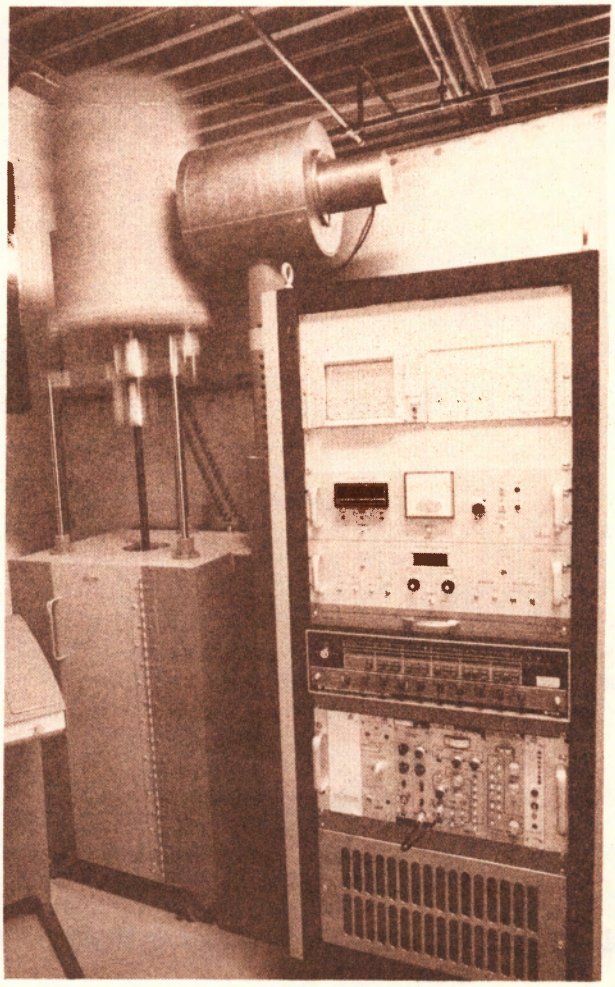

Fig. 3.

device. Use of the MEGAS data indicates that more than 90% of the waste boxes from the major LASL plutonium processing facility can be consigned to burial rather than to the more expensive retrievable storage. A computer-based system maintains records of all containers and their locations in the burial or storage facilities.

Both burial and storage operations at LASL are carried out in excavated tuff.* Tuff, the primary geologic structure underlying the Los Alamos area, is a consolidated volcanic ash. This material is extremely dry (approximately 2-4% moisture content), and rainfall in the area is low (around 12 inches per year). These dry conditions are ideal for shallow land burial and storage because they minimize the possibility of TRU radionuclide migration in water out of the containment area. The lack of migration of TRU elements from the pits has been verified by field experiments. The LASL disposal site has sufficient space to meet foreseeable needs.

RESEARCH AND DEVELOPMENT

Waste management personnel also pursue development and demonstration of new or improved methods of volume reduction, sorting, processing, monitoring, environmental interaction, assaying, and packaging of contaminated wastes. One of these programs is the investigation of a volume reduction method based on controlled-air incineration (CAI).

The purpose of this CAI engineering study is to develop and demonstrate an effective, safe, and reliable process for volume reduction and chemical stabilization of TRU-contaminated solid wastes. The results of the study can be used to compare efficiencies and costs of the CAI and other incineration systems.

The CAI uses two burning chambers. The first operates at about 1500°F, with enough air to minimize particulate suspension in exhaust gases. The second operates at 2000°F, with excess air to complete combustion of the gaseous by-products generated in the first chamber. The LASL CAI, which was purchased from an industrial manufacturer and installed in 1975, is shown in Fig. 4. The as-received equipment was tested extensively with more than a ton of nonradioactive, combustible wastes having the composition expected from a radioactive-materials processing area. Based on data from these initial combustion tests, the incinerator has been modified for operation with transuranic-contaminated solid wastes. These design changes consist primarily of the addition of a waste feed preparation system and an off-gas scrubbing system, and modification of all joint seals to ensure containment of radioactive materials.

The feed preparation system is enclosed in a series of gloveboxes (engineered containment systems) in which all waste handling takes place. A MEGAS is included to

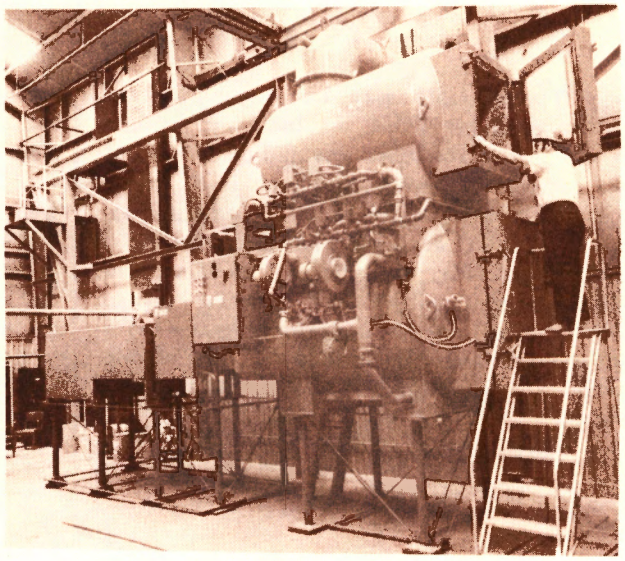

Fig. 4.

assay the radioactivity level of incoming waste packages, and an X-ray scanner (similar to those used in airports) is used to detect noncombustible or undesirable objects that may have been inadvertently included in a waste package. Any item that is incompatible with the incineration process is removed from its waste package within the glovebox. The packages are moved into the incinerator by an automatic ram feeder. The hot off-gases are cooled in a scrubbing system, which also removes particulates and noxious gases. The residue from this process is finally passed through a high-efficiency filter bank to remove the last traces of particulate contamination.

An elaborate system of interlocks and emergency systems protects against primary power loss during operations. Sophisticated instruments for both the incineration system and the off-gas treatment system permit constant monitoring of operations as well as collection of significant engineering data. Figure 5 shows the CAI system as modified for radioactive service.

LASL waste management engineers are also studying ways to fix or immobilize the ash product from the CAI. Programs involving fixation materials and processes are going on in many countries besides the United States. These materials and processes are being evaluated to choose the most appropriate one. In addition, close liaison is being maintained with other laboratories that are developing waste standards for a terminal isolation facility, because the immobilized CAI residues must meet those standards. The recovery and use of plutonium and other TRU elements from the ash are also being investigated.

Other research and development studies in progress in the LASL Waste Management Group include a detailed examination of the effects of aging on wastes and containers that have been stored for several years, and the

*See LASL Mini-Review 78-5 for a more detailed review of solid waste processing.

development of better waste assay, decontamination, and waste recovery techniques. This combination of continuing liquid and solid waste processing and disposal along with waste process engineering research, development, and demonstration projects gives LASL broad-based expertise in the technical evaluation and investigation of waste handling, processing, and disposal problems. The Waste Management Group is also assessing various technical operation options now under investigation in the United States for the Department of Energy and will formulate overall plans for future waste management requirements.

The energy shortage facing our planet is authentic and is rapidly approaching a crisis stage.* Nuclear energy can help satisfy our escalating need for power while saving our coal and oil resources for other more urgent uses such as pharmaceuticals and plastics. The LASL waste engineering studies not only provide improved or more efficient means of processing, burial, and storage of LASL wastes, but also serve the nation by developing new and improved methods for handling waste products associated with the nuclear industry.

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*See LASL Mini-Review 78-15 for further information on energy reserves.

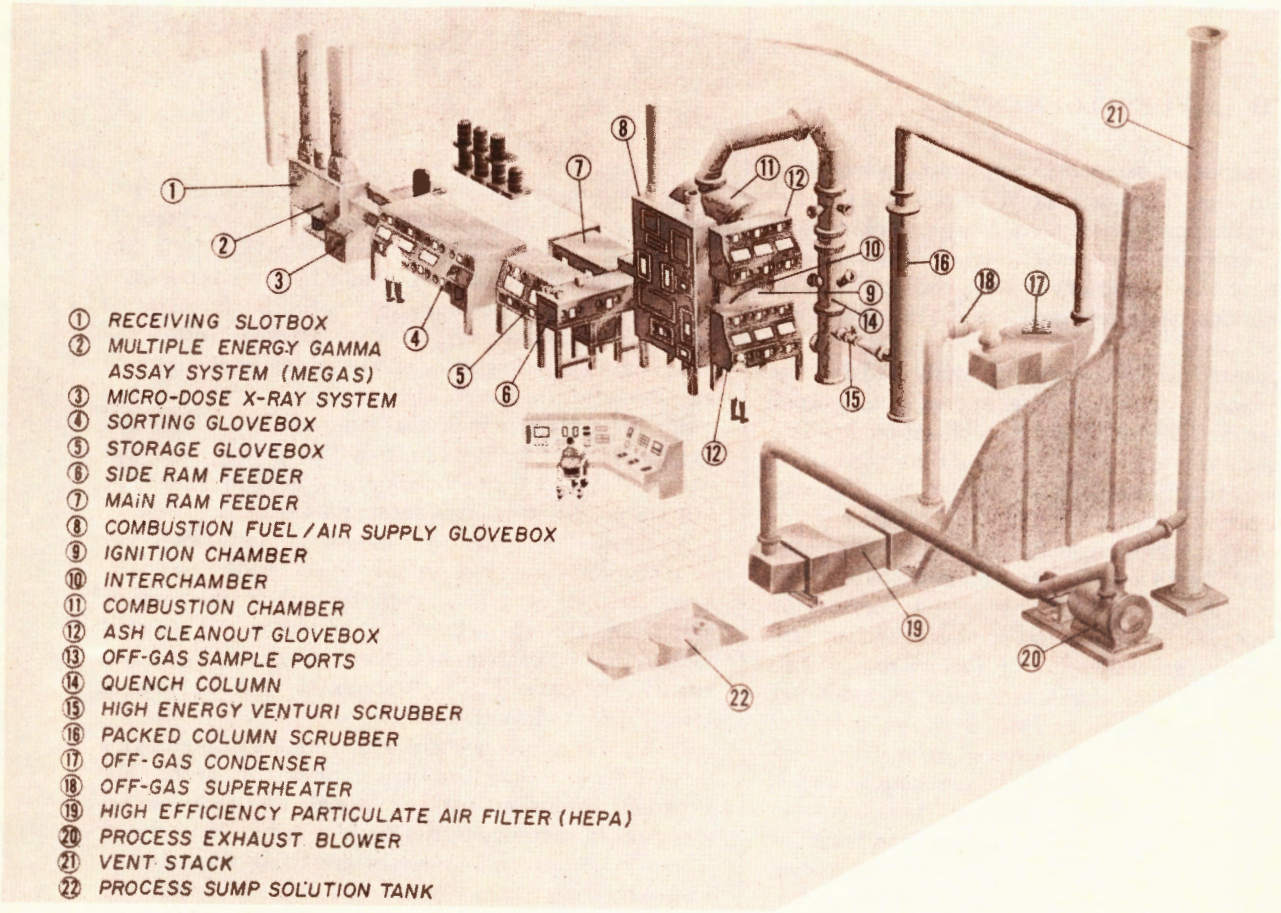

Fig. 5.

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Mini-Review readers are encouraged to correspond directly with the author.