HAZARDOUS WASTE INCINERATION AT LOS ALAMOS NATIONAL LABORATORY

TYPES OF WASTE GENERATED

As by-products of its research programs and operations, Los Alamos National Laboratory (LANL) generates a variety of chemical and radioactive wastes. Hazardous chemical wastes consist primarily of solvents and chemical reagents used in processing operations and laboratories. Most of the radioactive waste consists of solids such as trash, packing materials, plastics, rags, and the like, from laboratories and operating areas where radioactive materials are handled. Los Alamos generates no high-level radioactive waste.

Depending on their source and composition, wastes from LANL may be classified as follows:

Transuranic (TRU) wastes—TRU wastes are defined as materials contaminated with long-lived transuranic radionuclides at levels greater than 100 nanocuries (10^{-9}) of alpha radioactivity per gram of waste (uranium mill tailings average around 5 nanocuries per gram). TRU materials make up only about 10% of the total radioactive waste generated yearly at LANL.

Low-level radioactive waste—Materials that are only slightly contaminated with alpha activity (less than 100 nanocuries per gram) and/or contain fission or activation products are classified as low-level radioactive waste.

Hazardous chemical waste—Hazardous chemical wastes are those listed and regulated under the Resource Conservation and Recovery Act (RCRA). These include chemical wastes specifically listed as toxic or hazardous under the regulation as well as chemicals having certain hazardous characteristics such as corrosiveness or combustibility.

Mixed waste—Materials contaminated with both radioactivity and the chemical constituents regulated under RCRA are called mixed wastes

A large portion of the Laboratory's wastes in the low-level radioactive and mixed-waste categories are so designated because they are "suspect" wastes; that is, they have very low or undetectible levels of radioactive and/or chemical contamination. To ensure that these materials are handled safely and properly, the Laboratory treats suspect wastes as if they contained significant levels of radioactive or chemical contamination.

WASTE TREATMENT, HANDLING, AND DISPOSAL

LANL will attempt to reduce the amount of radioactive and chemical wastes generated at the Laboratory through recycling and waste-minimization programs. These efforts, however, cannot totally eliminate the need to store, treat, and ultimately dispose of the remaining wastes.

TRU wastes are packaged and stored on site in such a way that they can be retrieved when an approved TRU burial facility becomes available. Low-level radioactive waste is buried in landfills on-site. Under the Laboratory's environmental monitoring program, these on-site landfills and storage areas are evaluated regularly to ensure that they are in compliance with applicable environmental regulations.

Because prudent waste management practices as well as current regulations preclude the disposal of hazardous chemical wastes in landfills, LANL now sends most of these materials to off-site commercial treatment and disposal facilities. However, no such facilities are currently available to treat radioactive and mixed wastes. Consequently, the Laboratory must store, treat, and/or dispose of these wastes on-site, as appropriate. Storing the waste without treating it, however, is not an environmentally sound long-term option, and indefinite on-site storage of untreated, unstabilized wastes could eventually pose potential hazards to the public and the environment.

Incineration is a proven technology for the treatment of chemical, radioactive, and mixed wastes. In the case of chemical wastes, high-temperature incineration eliminates the toxicity and hazardous nature of a wide range of chemical compounds because it destroys the chemical bonds. The compounds are reduced to their individual elements, which then reform into relatively innocuous substances that, once removed by pollution-control equipment, are concentrated and solidified prior to disposal. Incineration of radioactively contaminated combustible wastes, although it does not destroy the radioactivity, significantly reduces the volume of waste, typically yielding volume reductions of greater than 100 to 1. Thus the technique compares favorably with other technologies such as supercompaction, which yields volume reductions of only about 7 to 1. The net effect of reducing the volume of waste by incineration is that the useful service life of storage and disposal facilities is extended substantially, which enables us to use these limited resources more efficiently.

The leaching of soluble materials into soil and subsurface groundwater is a primary mechanism whereby wastes—chemical or radioactive—find a pathway into the environment. The incineration of plutonium-contaminated waste produces a stable, high-fired plutonium oxide that is virtually insoluble. Nearly all of the plutonium remains in the incinerator for eventual discharge with the bottom ash. When incinerator ash is further treated by cementation and then enclosed in sealed containers, the resulting waste form is stable and chemically inert.

Los Alamos Treatment Development Facility, which houses the controlled-air incinerator.

THE INCINERATOR

The Los Alamos Controlled-Air Incinerator (CAI), a highly modified commercial incinerator, was originally developed to demonstrate volume reduction of combustible, solid radioactive wastes. In service as a research incinerator since 1979, the CAI has undergone extensive modifications and testing for the treatment of both radioactive and chemical wastes, including radioactively contaminated solid and liquid wastes, liquid PCBs, and other hazardous and toxic chemicals. Used primarily to reduce the volume of combustible TRU wastes, the CAI also has a permit for PCB incineration under the Toxic Substances Control Act and currently operates under interim status for hazardous chemical waste incineration through the RCRA.

In 1986 the Laboratory conducted an incinerator trial burn performance test in accordance with RCRA regulations for issuing permits for hazardous chemical waste incinerators. This test was supervised by personnel from the New Mexico Environmental Improvement Division and the U.S. Environmental Protection Agency. Carbon tetrachloride and trichloroethylene, two chemical compounds that are difficult to incinerate, were fed to the CAI, and the incinerator effluents were sampled and analyzed to determine the destruction and removal efficiency of the incinerator and its "offgas" pollution-control equipment. (Offgas is a term used to describe the exhaust gases leaving the secondary chamber of the incinerator.) The results of this test show that the CAI meets or exceeds the performance standards for RCRA hazardous waste incinerators* and that this technology is a safe and effective means of destroying hazardous chemical compounds.

Operating personnel inspect the incinerator and waste storage areas regularly, monitoring the operation of the equipment and verifying the integrity of the waste containers. In addition, personnel from state and federal regulatory agencies periodically inspect the facility and review its operating records to ensure that it is in compliance with the conditions of the permit.

THE TECHNICAL DETAILS

The heart of the CAI is a dual-chamber controlled-air incinerator. Initial combustion takes place in the primary combustion chamber (PCC), which operates at a temperature of 1400-2000°F. The PCC can accept up to 125 pounds per hour of solid wastes, or 200 pounds per hour of liquid wastes. Solids are fed to the PCC by a ram feeder mechanism and liquids by a liquid-injection burner capable of firing on natural gas, fuel oil, or liquid waste feed blends.

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Offgases leaving the primary chamber pass through a connecting duct to the secondary chamber. The secondary chamber, which operates at 2000-2200°F, completes the destruction of any volatile organics leaving the primary chamber. The burner in the secondary chamber is fired on natural gas only. Temperature controllers and safety interlocks ensure that no waste is fed until the chambers have reached the proper operating temperatures.

Combustion air is supplied to each burner by dedicated forced-draft fans. Separate induced-draft fans provide negative pressure to both the combustion chambers and the process offgas treatment system. Glovebox enclosures surrounding the chambers, coupled with negative operating pressures supplied by the induced-draft fans, serve to prevent any fugitive emission of organic gases or radionuclides to either the operations area or the surrounding environment.

An extensive offgas treatment and pollution-control system removes particulates and other combustion by-products leaving the secondary chamber. This system consists of the following components:

- Water-Spray Quench Column
- High-Energy Venturi Scrubber
- Packed Column Absorber/Demister
- Offgas Superheater
- Primary High-Efficiency Particulate Air (HEPA) Filters
- Carbon Bed Adsorber
- Secondary (Final) HEPA Filters
- Scrub Solution Recycle/Cooling System

The critical components in the offgas treatment system are the HEPA filters, whose purpose is to capture radionuclide and other particulates. To ensure the integrity of the HEPA filters, and to extend their useful service life, the CAI makes use of pre-HEPA filtration offgas conditioning. This conditioning is accomplished by the quench column, venturi scrubber, packed bed absorber column and demister, offgas superheater, and roughing filters.

The quench column, through the injection of an atomized, cooled recycle scrub solution, cools the offgas from its high incinerator exit temperature (2000-2200°F) to around 160°F. Particulates in the gas leaving the quench column are removed by the high-energy variable-throat venturi scrubber, located between the quench and absorber columns. The venturi scrubber serves to remove most of the offgas particulate before the HEPA filtration step, extending the service life of the filters. Acids in the saturated gas phase leaving the venturi are removed by counter-current contact with a cooled mixture of recycled scrub solution and fresh water in the packed column absorber.

Offgas leaving the packing flows through a 6-inch-thick demister pad, which captures the entrained water mist. Cooling of the saturated offgas stream in the absorber packing through direct liquid-gas contact removes a significant portion of the water content by condensation, thereby reducing the total offgas volume. This reduction in water content and offgas volume eases the operating loads on the offgas superheater, HEPA filters, and process induced-draft fans. Further offgas conditioning is provided by the offgas reheater. Moisture-saturated exhaust gas leaving the absorber/demister is reheated to above the dew point before it enters the HEPA filters, which precludes the condensation of moisture in the filters and helps prevent the filters from clogging.

The CAI employs nuclear-grade HEPA filtration for offgas polishing downstream of the wet offgas treatment system. Although the preceding offgas treatment system effectively removes particulates from the offgas stream, radiological concerns arising from TRU incineration dictate the use of HEPA filters. Both the manufacturer and the Department of Energy test each filter to certify that it can capture a minimum of 99.97% of all particulate of 0.3 microns (one micron is one millionth of a meter). Capture efficiencies are greater for particles larger or smaller than this size.

The HEPA filtration system is made up of eight individual HEPA filter enclosures forming four separate filter modules. Each module consists of a prefilter and a primary and secondary HEPA filter in series. Two of these modules (a total of four filters) are operated in parallel at all times. Thus, the offgas flow is split between two modules (banks) of four filters. The remaining two modules serve as a

*The performance standards are specified in Title 40 of the Code of Federal Regulations, Chapter 1, part 264.343.

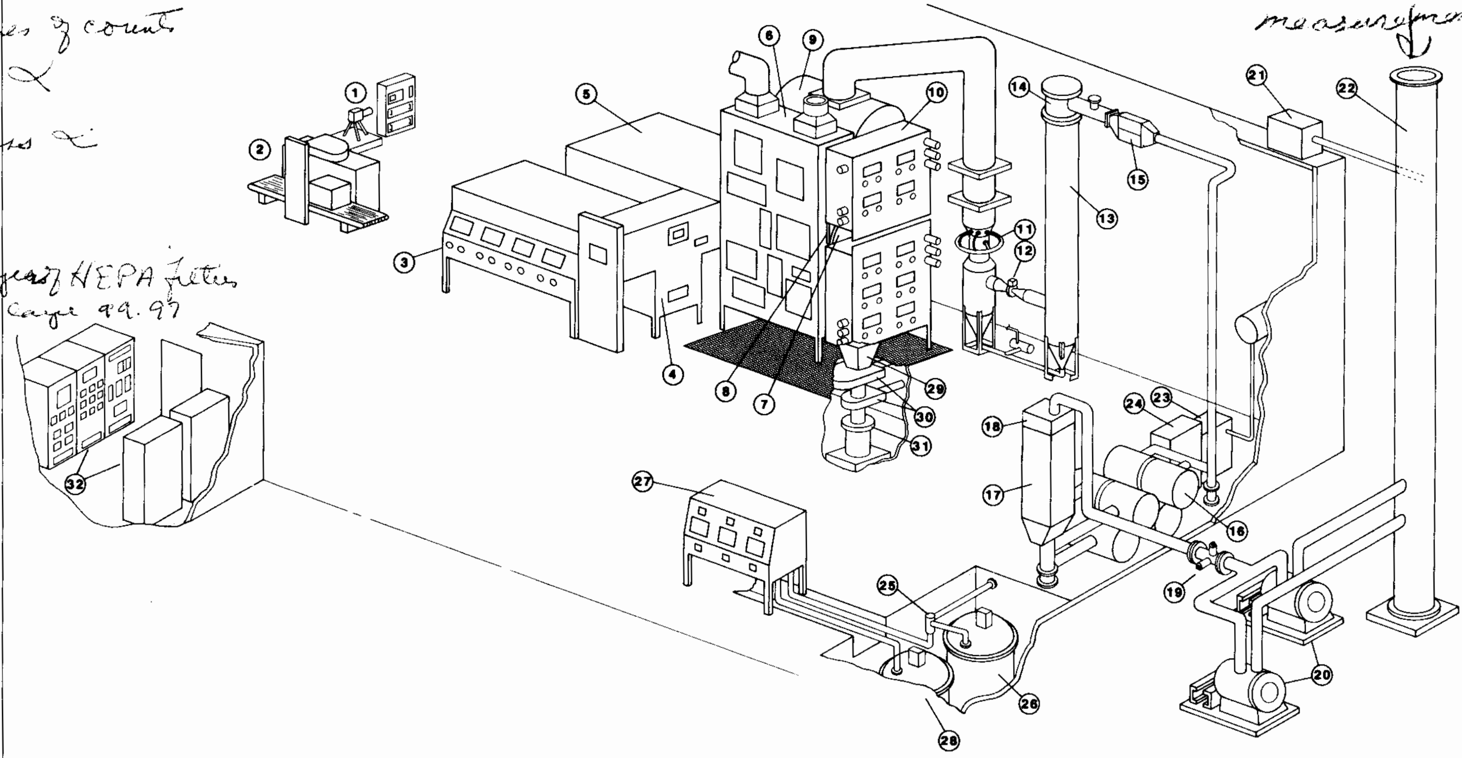
Everything is explained in this paper, very well. However, to back all this by actual measured numbers LANL should provide information on both background measurements and during ① Aryeburn ② RCRA and ③ TRU waste operations of Pu-α activity and gross α activity at point (22) ~~and the surrounding areas.~~

? types of filters

types of count Pu α gross α

efficiency of HEPA filter each stage 99.97

direct measurements



1. Multiple Energy Gamma Assay System (MEGAS)
2. Micro-dose x-ray waste package scanner
3. Waste receiving glovebox with air-lock entry
4. Side ram feeder
5. Main ram feeder
6. Combustion fuel/air supply glovebox
7. Incinerator ignition (primary) chamber
8. Inter chamber
9. Incinerator combustion (secondary) chamber
10. Incinerator chamber access gloveboxes
11. Quench column
12. High-energy venturi scrubber
13. Packed column scrubber
14. Off-gas demister
15. Off-gas superheater
16. HEPA filters (first and second stages)
17. Activated carbon adsorber
18. HEPA filter (third stage)
19. Off-gas monitoring (CO, CO_2, H_2O) station
20. Process exhaust blowers
21. Continuous stack sample system
22. Facility and process vent stack
23. Scrub-water primary coolant heat exchanger
24. Isolated secondary coolant loop heat exchanger
25. Scrub-water hydrocyclone particulate separator
26. Scrub-water recirculating sump tank
27. Scrub-water blowdown filters
28. Facility liquid sump tank and transfer system
29. Gravity ash-removal hopper
30. Ash-removal valves
31. Ash-removal drum system
32. Process instrumentation and control panels

Transuranic and chemical waste incineration process.

backup for use during filter changeouts. The system is configured so that any two of the modules can be used at any given time to provide adequate filtration capacity.

The activated carbon bed adsorber, although originally intended for capture of fission activation products (primarily iodine-131) during an incineration research project, has remained in the system and serves as a final removal system for trace organic compounds. The housing for the activated carbon bed includes a downstream HEPA filter bank. This final bank of HEPA filters acts as a backup for the primary HEPA filters and also removes any entrained carbon fines from the offgas stream. Thus, the offgas from the incinerator receives triple HEPA filtration, in series, before it is released to the facility's exhaust stack. These filters alone remove more than 99.99999999% of all particulates in the offgas stream and provide positive assurance that no significant amount of particulates is vented in the stack gas.

The scrub solution recycle/cooling system provides cooled, filtered scrubbing solution to the quench, venturi, and packed bed absorber. The scrub solution leaving the process sump tank enters a hydrocyclone, which removes gross particulates, before the solution is cooled and recirculated to the offgas treatment system. The particulate-laden slurry produced by the hydrocyclone is filtered through polypropylene felt bag filters. The filtered solution is discharged, as necessary, to the on-site industrial waste treatment plant. The treatment plant accepts and treats radioactive liquid wastes from a variety of Laboratory sources.

The remaining residue of ash is discharged from the primary chamber of the incinerator through a gravity drop-out system, consisting of a hopper and two knife gate valves, into 55-gallon drums. The ash is assayed to determine its radionuclide content and is chemically analyzed to determine the appropriate handling and disposal procedures. Finally, the ash is solidified in a drum cementation process and is stored on-site pending its ultimate disposal.

SAFETY FEATURES

To ensure that the system operates properly, the CAI design incorporates numerous backup systems and automatic safeguards. Critical process parameters affecting the system's performance are continuously monitored and recorded. In the event of a process upset or failure, the waste feed shuts off automatically. Incinerator releases are monitored both at the stack and in the environment to confirm that the incinerator is performing as designed.

The primary function of the waste feed cut-off interlocks is to prevent the feeding of wastes under incineration conditions that are inadequate to ensure that the materials will be destroyed. During the startup and shutdown of the incinerator or during process upsets, the interlock system automatically stops all waste feed systems and prevents them from restarting until the incinerator is in proper operating condition.

The process parameters specified in the permit are based on operating conditions demonstrated during the RCRA trial burn and are tied into an alarm panel. If any parameter is exceeded, a block valve in the waste liquid feed line to the liquid burner will automatically close, and the initiation signal to the solid waste feeding mechanism will be automatically deactivated. Under any of these conditions, waste feed will be locked out until the problem is identified and corrected, and until all alarm conditions and process limits are satisfied.

In addition to these process safeguards, a number of safety systems are employed to provide backup process utilities and to ensure that the incinerator operates safely in the event of a process failure. An uninterruptable power supply and a diesel-powered generator will feed backup electrical power to the process and control panels if line power is lost. A pressurized water tank backs up the municipal water supply, providing an emergency water spray to the quench column. Should a primary pump fail, a secondary backup pump will supply scrub solution to the quench, venturi, and packed column absorber. A completely independent set of process HEPA filters is available for use when the primary filters are being replaced. In addition, in the event of a HEPA filter failure, the offgas flow is automatically rerouted through the HEPA filter system for the building, ensuring HEPA filtration of the offgas at all times.

POTENTIAL EFFECTS OF TRU AND MIXED-WASTE INCINERATION

Although the RCRA permit regulates only hazardous chemical waste operations, any potential release of radioactivity quite naturally raises legitimate concerns on the part of the public. For that reason, we briefly address that question here.

Thousands of materials, both natural and man-made, have been implicated as possible carcinogens. Some of the known sources of carcinogens are wine, many vegetables and spices, wood smoke, and naturally occurring radon as well as the more familiar tobacco smoke, gasoline, and vehicle exhaust. The important issue to be addressed when we are evaluating a potential hazard is not the type of material to which we might be exposed but the relative risks associated with the potential level of exposure.

→ The highly efficient control equipment employed in the controlled-air incinerator ensures that virtually all plutonium or uranium entering the CAI remains in the system. This strict control over emissions of radioactive substances precludes all but extremely low radiation doses. Estimates of potential radiation exposure from CAI emissions are based on the maximum level of anticipated waste-feed contamination and the maximum number of hours per year that the incinerator would be in operation. These estimates project the highest, worst-case overall radiation dose to any member of the public from incinerator operations at Los Alamos at less than 0.001 mrem/year. This dose is substantially below the limit of 25 mrem/year (for whole-body doses) established by the Environmental Protection Agency for doses from airborne emissions other than natural background radiation. As a matter of fact, the projected dose from CAI incineration of radioactive materials is so small that it cannot be measured in the environment—it must be estimated from calculations and modeling.

For some perspective on the relative risks associated with that very small exposure level, consider the following:

- The natural background radiation an individual receives merely from living in northern New Mexico averages 325 mrem/year.
- Naturally occurring background radiation levels increase with elevation because at higher altitudes there is less air to shield us from cosmic radiation. Thus, Santa Feans receive about 15 mrem/year more background radiation than do Albuquerque residents simply because of the difference in altitude. This 15-mrem/year difference is more than 15,000 times greater than the highest individual dose of 0.001 mrem/year that could be attributed to the operation of the incinerator.
- In about 20 seconds on an airplane, a traveler receives a 0.001-mrem radiation dose—the equivalent of the maximum dose potential from CAI operations during an entire year.

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Copies of this brochure may be obtained from Community & Public Affairs, Los Alamos National Laboratory, P. O. Box 1663, Los Alamos, NM 87545, (505) 667-7000

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LALP-89-30
July 1989