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Contents

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Introduction to the Los Alamos National Laboratory

Linking the Rio Grande Valley and the Jemez Mountains, New Mexico's Pajarito Plateau is home to a world-class scientific institution. Los Alamos National Laboratory (or the Laboratory), managed by the Regents of the University of California, is a government-owned, Department of Energy-supervised complex investigating all areas of modern science for the purposes of national defense, health, conservation, and ecology.

The Laboratory was founded in 1943 as part of the Manhattan Project, whose members assembled to create the first nuclear weapon. Occupying the campus of the Los Alamos Ranch School, American and British scientists gathered on the isolated mesa tops to harness recently discovered nuclear power with the hope of ending World War II. In July 1945, the initial objective of the Laboratory, a nuclear device, was achieved in Los Alamos and tested in White Sands, New Mexico. Today the Laboratory continues its role in defense, particularly in nuclear weapons, including developing methods for safely handling weapons and managing waste.

The 43 square miles of the Laboratory are divided into 47 technical areas that are used for building sites, experimental areas, waste disposal locations, roads and utilities, and safety and security buffers. An experimental area is located west of the Laboratory in Sandoval County at Fenton Hill. The Laboratory shares the county with two residential communities: Los Alamos townsite and White Rock. Most of the land surrounding the Laboratory is undeveloped, owned by the Pueblo of San Ildefonso, the Bureau of Land Management, the Santa Fe National Forest, the General Services Administration, and Bandelier National Monument, or is rural, supported by ranching and light farming. Santa Fe, the state capital, is 25 miles southeast of Los Alamos; Española is located 20 miles to the east; and Albuquerque, New Mexico's largest city, is 60 miles to the south-southwest. In 1995, approximately 241,000 people lived within a 50-mile radius of the Laboratory. The Laboratory and its contractors employed over 12,500 people; the Laboratory is the largest employer in Los Alamos County and northern New Mexico. Other local economic activity is fostered by technology transfer and tourism.

Diversity is inherent in the geography and ecology of Los Alamos. The terrain of the Pajarito Plateau, where Los Alamos is situated, alternates between mesas and deep canyons. The natural borders of Los Alamos—the Rio Grande and the Jemez Mountains—are significantly lower and higher in elevation than the mesas, which range from 6,200 feet to 7,800 feet. Six vegetation types: piñon-juniper, mixed conifer, ponderosa pine, juniper-grassland, spruce-fir, and subalpine grassland are well-represented in the Los Alamos environs. Hundreds of species of wildlife, ranging from aquatic invertebrates to large mammals, reside on or nearby Laboratory property. In 1977, the Department of Energy designated the Laboratory as a National Environmental Research Park, where research may be carried out to study and preserve the environment. Researchers from the Laboratory use the opportunity to study the wildlife and plantlife of northern New Mexico but also attempt to track the effects of past and present Laboratory activities on the local ecosystems.

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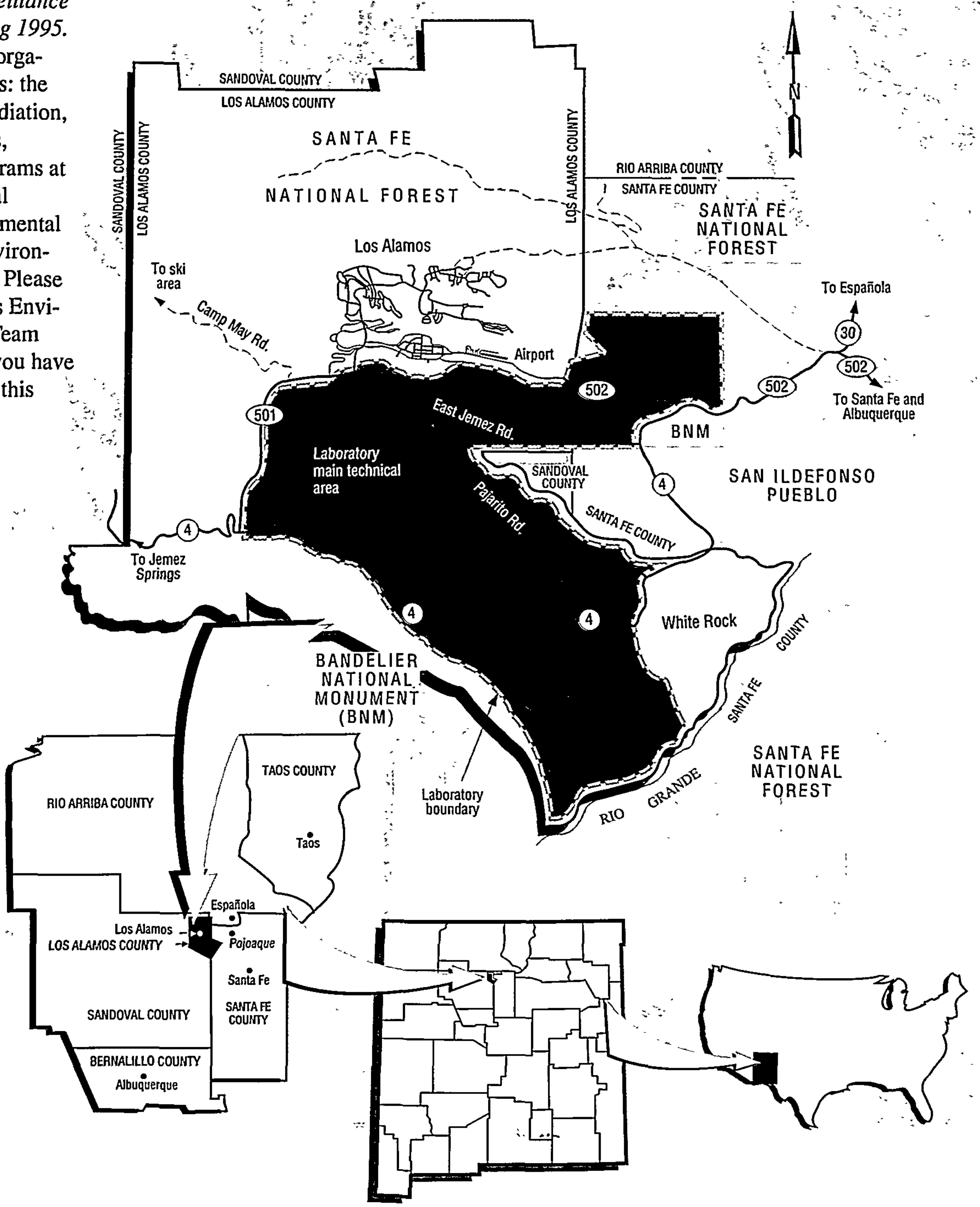
DISCLAIMER

For the past twenty years, the Laboratory has published an annual environmental report. This pamphlet offers a synopsis that briefly explains important concepts, such as radiation and provides a summary of the monitoring results and regulatory compliance status that are explained at length in *Environmental Surveillance at Los Alamos during 1995.* This information is organized in five sections: the Fundamentals of Radiation, 1995 Risk Estimates, Environmental Programs at Los Alamos National Laboratory, Environmental Monitoring, and Environmental Compliance. Please call the Laboratory's Environmental Reports Team at 505-665-0231 if you have any questions about this pamphlet.



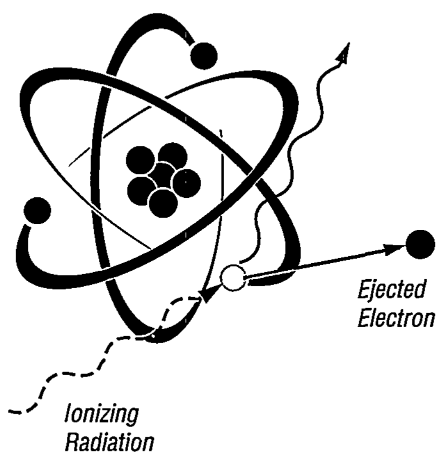
The Fundamentals of Radiation

Much attention is focused on the Laboratory's use of materials containing radiation. Many of the Laboratory's activities include handling radioactive materials or operating radiation-producing equipment. But what is radiation? Why does it merit special attention?

To understand radiation, we must first understand the atom. Submicroscopic in size, atoms are the smallest units of chemical elements. But even the tiny atom can be divided into smaller components: protons, neutrons, and electrons. The protons and neutrons are bound together in the center of the atom, the nucleus, which is encircled by the electrons. A stable atom has the proper combination of protons and neutrons. When the balance of protons and neutrons is disturbed, the atom becomes unstable. In an attempt to achieve stability, the atom will break down or decay; atoms of different elements decay at different rates. Energy, in the form of particles or waves, is released as atoms decay. This energy is called radiation. Radiation is emitted by the unstable isotopes of elements, that is, atoms with unbalanced numbers of protons and neutrons.

Radiation is classified according to whether or not it can strip electrons from an atom. Nonionizing radiation does not contain enough energy to remove electrons from an atom. Visible light, radio waves, and microwaves are examples of nonionizing radiation. Ionizing radiation, which possesses enough energy to eject electrons, is found in several forms, including alpha particles, beta particles, gamma rays, and x-rays. Ionizing radiation requires special attention because its effects can be damaging to people. If the atoms inside a human cell are ionized, the cell's structure may be affected, and the cell may die. In some cases, however, this is desirable. Ionizing radiation is used to combat cancer. Radiation treatments damage the reproductive capabilities of a cell or the cell itself, slowing the spread of the disease.

Ionization



background radiation

Although some radiation is manufactured by human activities, most of it can be attributed to natural sources. Naturally occurring radiation, also called background radiation, is received by the Earth and its inhabitants every day. Although our understanding of radiation is relatively new and constantly being enhanced, radiation has always been a part of life on Earth. Radon in the air, uranium in rocks and soil, potassium fundamental to our bodies, and ultraviolet rays from the sun all contribute to the yearly natural exposure to radiation. Exposure to natural radiation depends partially on where one lives and what house-building materials are used.

human-produced radiation

Radiation is also produced by medical procedures and industry. Medical x-rays are a source of radiation, as are consumer products such as tobacco products, porcelain dentures, televisions, smoke detectors, and microwave ovens. Some of the radiation in the environment is beyond an individual's control. It is due to fallout from past weapons testing in various countries and nuclear research.

shielding

Alpha particles are heavy and slow, with very little ability to penetrate the body. Alpha radiation can be stopped with a sheet of paper or an intact layer of skin. Its danger arises from inhalation or absorption through open skin; once inside the body, alpha radiation can damage sensitive tissues.

Beta particles are lighter and faster than alpha particles, with greater penetrating ability. Clothes, wood, aluminum, and plexiglass are effective shields from beta particles. Externally, beta radiation may harm skin or eyes; internally, it can damage tissues.

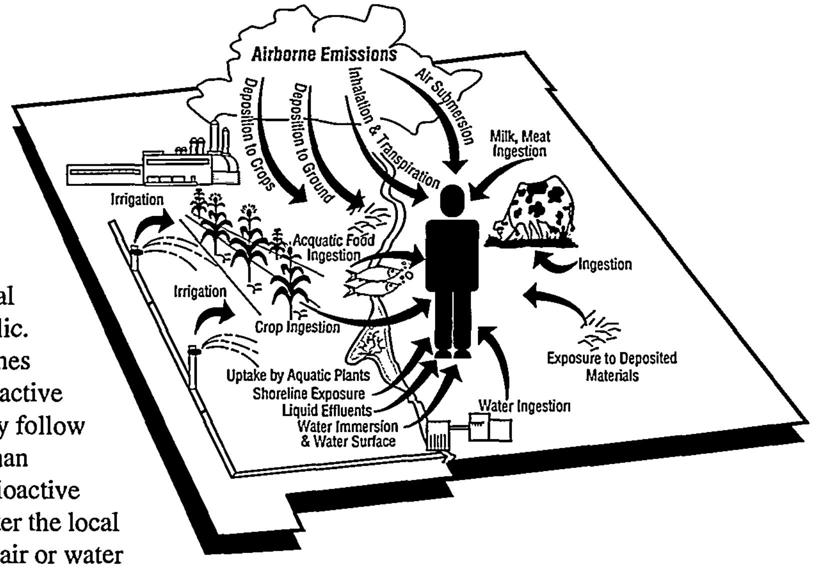
X-rays and gamma rays travel over long distances and easily penetrate the body. Shields of lead, concrete, or steel are required to block x-rays and gamma rays, which pass through and may damage human tissue.

Neutrons are uncharged heavy particles contained in the nucleus of every atom heavier than hydrogen. They induce ionization only indirectly in atoms which they strike, but can thus damage body tissue. In general, efficient shielding against neutrons can be provided by water.

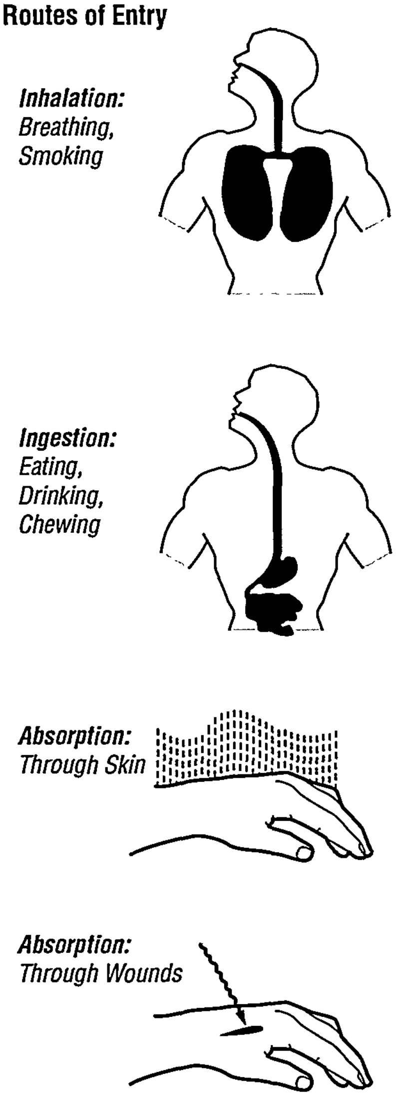
pathways

Both background and human-produced radiation have the potential to reach the public. A pathway outlines the route a radioactive contaminant may follow to reach the human population. Radioactive releases may enter the local environment by air or water and pass through soil, plants, livestock, or wildlife, ultimately reaching humans via inhalation, ingestion, or external exposure.

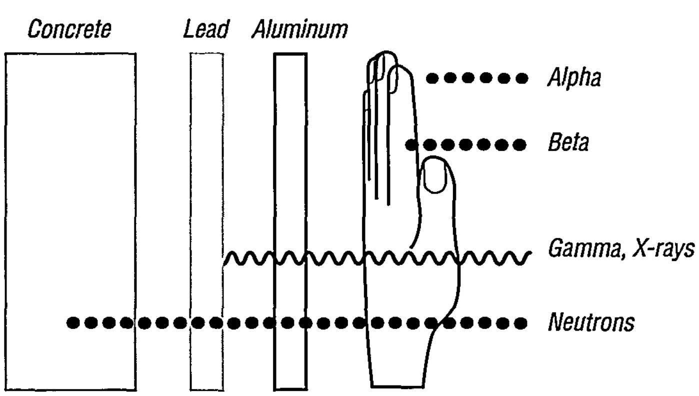
Pathways



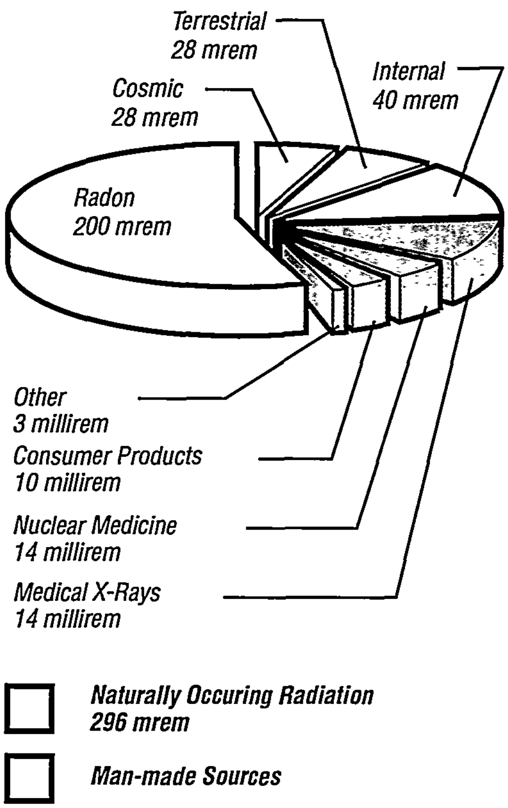
Routes of Entry



Types of Radiation



National Average Annual Dose



dose

The effects of radiation are related to dose, the amount of radiation received. To protect worker and public health and safety, the Department of Energy maintains dose limits based on guidance from the Environmental Protection Agency, the National Council on Radiation Protection and Measurements, and the International Commission on Radiological Protection. Radiation doses are measured in millirems and typically are assessed for the exposure of a full year. The maximum doses permitted at Department of Energy sites are in addition to radiation from background, medical, or consumer sources. The Department of Energy's public dose limit is 100 millirem per year from all pathways: inhalation, ingestion, external exposure. Estimates for radionuclide inhalation are adjusted for living indoors (shielding). Estimates for radionuclide ingestion are adjusted for the annual food consumption rate. The Environmental Protection Agency limits the effective dose equivalent (an estimate of the total risk of potential effects from radiation exposure) to any member of the public from radioactive airborne releases from the Laboratory to 10 millirem per year. Each agency has a specific way of calculating dose that involves unique computer methods and assumptions about shielding.

Units of measurement

Roentgen (R)

The roentgen is a unit for measuring exposure. It is defined only for the effect on air and applies only to gamma rays and x-rays in air. It does not relate biological effects of radiation to the human body.

1 roentgen = 1000 milliroentgen (mR)

Radiation adsorbed dose (rad)

The rad is a unit for measuring energy absorbed in any material. Absorbed dose results from energy being deposited by the radiation. It is defined for any material. It applies to all types of radiation. It does not take into account the potential effect that different types of radiation have on the body.

1 rad = 1000 millirad (mrad)

Roentgen equivalent man (rem)

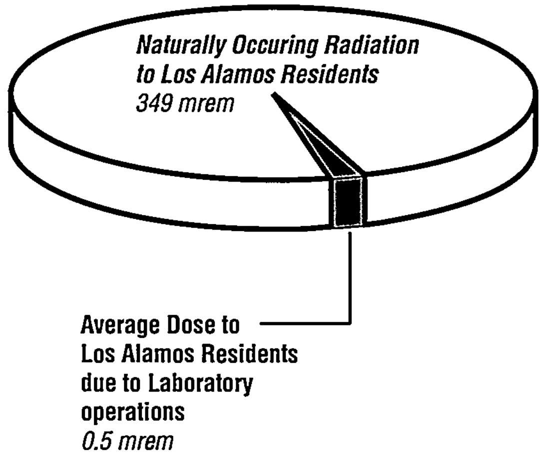
The rem is a unit for measuring dose equivalence. It is the most commonly used unit and pertains to people. The rem takes into account the energy absorbed (dose) and the biological effect on the body (quality factor) due to the different types of radiation.

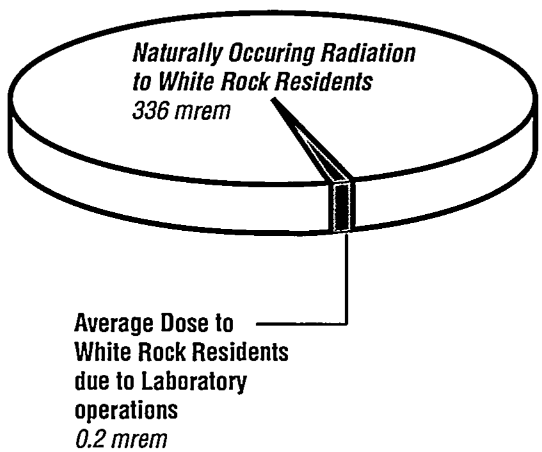
rem = rad x quality factor
1 rem = 1000 millirem (rem)

Radiation from cosmic rays, terrestrial radiation, and radon contribute the most to an individual's estimated dose. The maximum amount of radiation a person could have received due to 1995 Laboratory operations is 2.3 millirems. During the 1995 calendar year, a resident of Los Alamos received an average of 349 millirem from all sources, with 0.5 millirem due to Laboratory operations. In 1995, a resident of White Rock received an average of 336 millirem from all sources, with 0.2 millirem due to Laboratory operations. Naturally occurring radiation, medical exposure, and consumer products compose the balance of the average dose. There is more naturally occurring radiation in Los Alamos and White Rock residential areas as compared to the national average because of the high altitude and naturally occurring uranium.

The risk of cancer mortality for every United States resident is one chance in five. The added risk to any individual of cancer mortality due to Laboratory operations is less than one chance in one million.

Summary of Annual Effective Dose Equivalents Attributable to 1995 Laboratory Operations

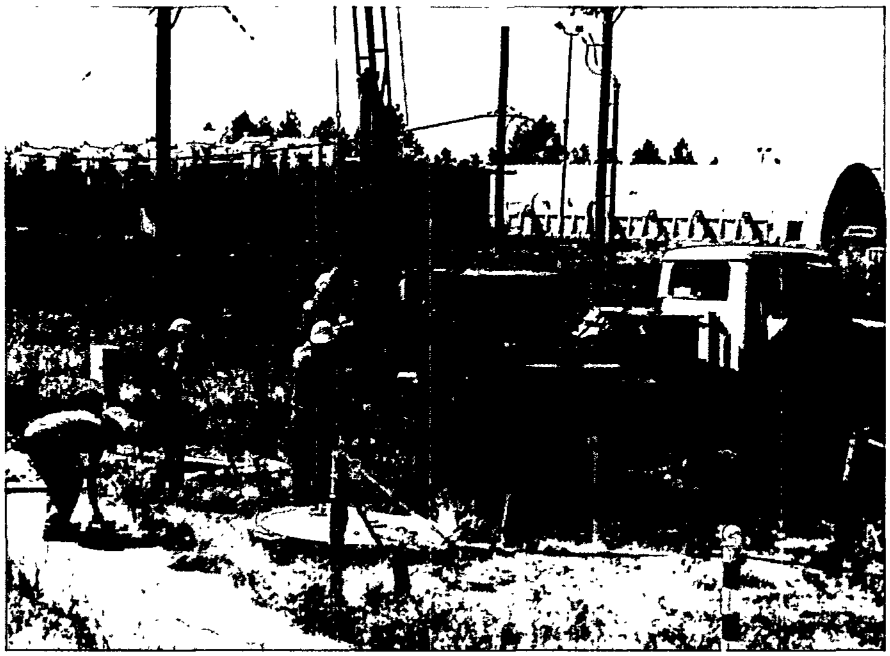




Many of the activities and operations at the Laboratory involve or produce liquids, solids, and gases that contain radioactive and/or nonradioactive hazardous materials. Such activities include conducting research and development programs in basic and applied chemistry and physics, testing and manufacturing explosives, cleaning chemically contaminated equipment, and working with radioactive materials. Laboratory policy requires that operations be performed in a manner that protects the environment and addresses compliance with applicable federal and state environmental protection regulations. This policy is in accordance with Department of Energy requirements to protect the public, environment, and worker health and to comply with applicable environmental laws, regulations, and orders. The Laboratory spent approximately 21% (or $209 million) of its 1995 operating budget on environmental programs designed to comply with this policy.

environmental protection

Personnel in the Laboratory's Environment, Safety, and Health Division prepare permits, interpret regulations, perform and document environmental monitoring and compliance activities, and provide technical advice in the areas of air, water, sediments, soil, food, biota, and hazardous materials. Data are also gathered on measurements of natural radiation and Laboratory radiation sources. Weather conditions are monitored to assess the movement of airborne contaminants to the environment. The Environment, Safety, and Health Division also conducts cultural and biological investigations across the site.



environmental restoration

The Laboratory's Environmental Restoration Project was established in 1989 to identify the extent of possible contamination at the Laboratory and the appropriate means for restoring contaminated areas to comply with applicable laws and regulations. The Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act govern these activities. More than 2,500 potential release sites have been identified at the Laboratory. Potential release sites are areas that may have been contaminated over the past 50 years and range from the size of a table top to areas of several acres. These sites include past disposal sites as well as areas where spills of hazardous materials have been reported. The Environmental Restoration Project is also responsible for decontaminating and decommissioning sites and facilities that are considered surplus, such as old buildings that are no longer in use.

waste management

A Waste Management program is in place at the Laboratory to monitor, treat, dispose, and/or safely store radioactive waste, hazardous chemical waste, nonhazardous waste, and municipal-type sanitary waste. No high-level radioactive wastes are generated at the Laboratory. In 1995, activities at the Laboratory generated 107,000 cubic feet of radioactive waste, 2,550,000 pounds of hazardous chemical waste, and 2,710,000 pounds of nonhazardous waste. Approximately 22% of the total volume of the Los Alamos County landfill is generated by the Laboratory. Pollution prevention and waste minimization activities are part of the Waste Management program. Accomplishments in 1995 include recycling or reusing more than 1,000 tons of materials that would have been sent to local landfill—from lead batteries and waste oil to office furniture and books—and distributing quarterly memos identifying excess chemicals available for exchange. An estimated 65% to 70% of chemicals available for exchange were successfully exchanged instead of disposed.

quality assurance

The Laboratory is committed to being a quality research and development center. Quality appraises the level at which a service or product meets or exceeds requirements and expectations. Laboratory workers, regulatory organizations, such as the Environmental Protection Agency, sponsoring organizations, such as the Department of Energy, and the residents and merchants of Los Alamos, White Rock, and other northern New Mexico communities act as customers and stakeholders who deserve quality from the Laboratory.

The Laboratory adheres to a three-fold management process to ensure quality. First, the Laboratory seeks to comply with Department of Energy orders, New Mexico environmental laws, and Environmental Protection Agency federal standards. Training programs are established to inform workers of the policies under which the Laboratory operates so that workers may perform their tasks in an appropriate manner. The second aspect of the Laboratory process is to continuously improve performance. The third part of the process is an assessment program, which includes self-assessments, group assessments, management assessments, and audits from outside the Laboratory. Operations and workers are held to these standards and procedures in order to best serve the Laboratory's customers and stakeholders and to constantly improve that service.

In the arena of environment, safety, and health, the Laboratory maintains air and water monitoring stations specifically to collect samples of data for quality checks. This monitoring is required by state and federal standards, but is also a part of the Laboratory's commitment to help ensure the safety of the public and the environment.

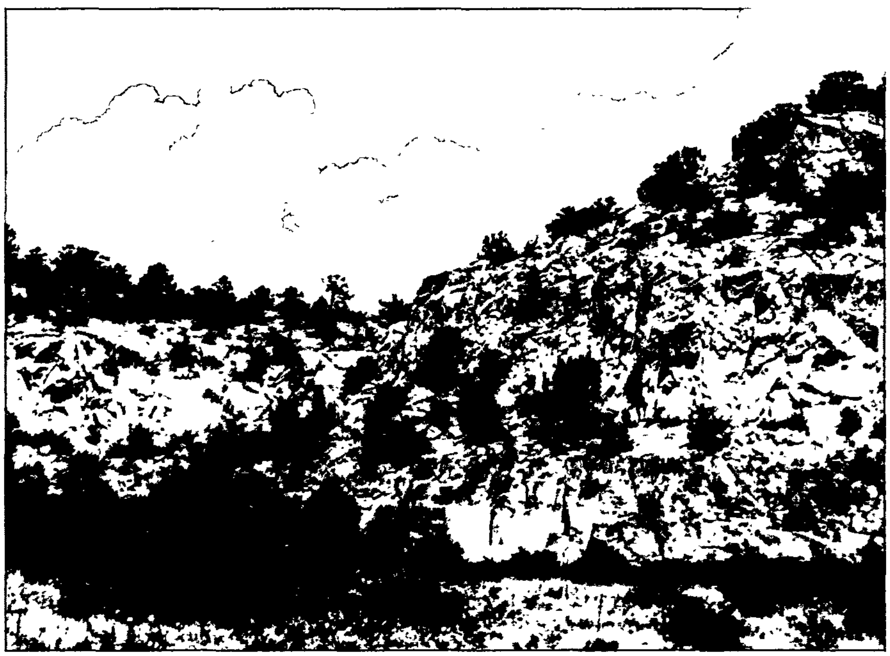
overview of University of California/Department of Energy performance assessment program

Beginning in 1996, the Laboratory will be evaluated by the University of California and the Department of Energy based on mutually negotiated performance measures that were established during meetings that began in January 1995. The performance measures that will be used to assess the Laboratory's environmental programs include radiation protection of the public; release incidents, including toxic chemical releases; exceeding the limits of regulatory permits, including cited violations, fines, and penalties; the status of commitments and milestones made to regulatory agencies; the status of the waste minimization and pollution prevention program; and a survey of regulatory agencies to determine how satisified they are with their interactions with the Laboratory. Additional information is available from the Northern New Mexico University of California Office, located at 1350 Central Avenue in Los Alamos.

Environmental monitoring is the sampling for contaminants in liquid effluents and gaseous emissions from Laboratory facilities, either by directly measuring or by collecting and analyzing samples in a laboratory.

Environmental surveillance is the sampling for contaminants in air, water, sediments, soils, foodstuffs, and plants and animals, either by directly measuring or by collecting and analyzing samples in a laboratory.

Environmental compliance is the documentation that the Laboratory complies with the multiple federal and state environmental statutes, regulations, and permits that are designed to ensure environmental protection. This documentation is based on the results of the Laboratory's environmental monitoring and surveillance programs.



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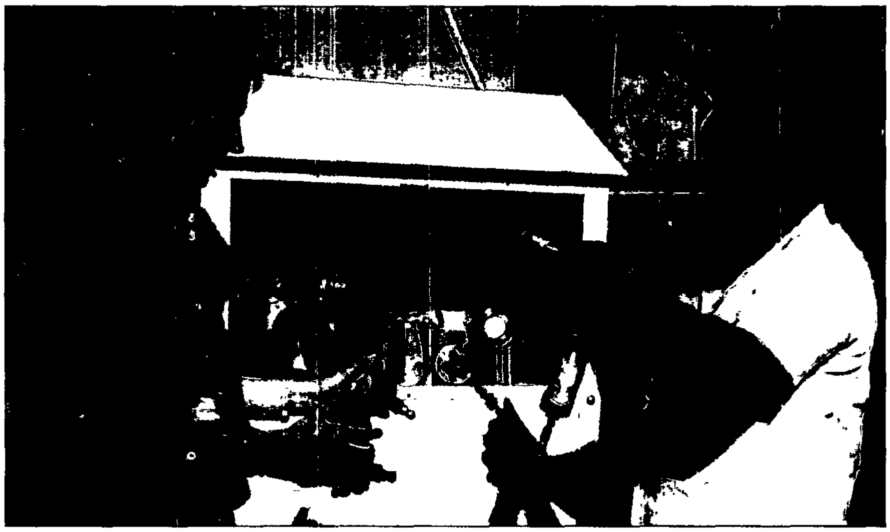
Several groups at the Laboratory are responsible for monitoring air, surface water, drinking water, groundwater, sediments, soils, foodstuffs, and plants and animals in order to track radioactive and nonradioactive substances in the environment. The release of large quantities of these materials, which are pollutants, may be harmful to health or the environment, so the Laboratory measures its emissions (gaseous waste discharged to the environment) and effluents (liquid waste discharged to the environment). Environmental monitoring samples are drawn from over 450 stations located inside the Laboratory's boundaries and up to 75 miles away, including all of Los Alamos County and portions of Santa Fe, Rio Arriba, Sandoval, and Taos Counties. In 1995, approximately 200,000 analyses for chemical and radioactive constituents are performed on more than 11,000 environmental samples each year.

external penetrating radiation

Levels of external penetrating radiation (the radiation originating from a source outside the body, including x-rays and gamma rays and charged particle contributions from cosmic, terrestrial, and man-made sources) are measured with thermoluminescent dosimeters. These dosimeters contain a material (the Laboratory uses lithium fluoride) that emits a light signal when heated to approximately 300°C. This light signal is proportional to the amount of radiation to which the dosimeter was exposed. The thermoluminescent dosimeter measurements indicate no detectable radiological impact to the public from Laboratory operations due to external penetrating radiation in 1995.



air

Air monitoring stations record concentrations of various radionuclides in the air. Concentrations of gross alpha and beta activity, tritium, plutonium, americium, and uranium are calculated. Gross alpha and beta activities are due almost entirely to the decay of natural radionuclides (primarily radon for alpha activity) and are dependent on variations in natural conditions, such as atmospheric pressure, temperature, and soil moisture. The differences typically seen in gross alpha and beta results for the various air monitoring stations are most likely attributable to these natural factors. The concentration levels of radionclides allowed in the air are controlled by the Department of Energy's derived air concentration guides and Environmental Protection Agency regulations. In 1995, the Laboratory's off-site concentration levels of tritium, uranium, plutonium, and americium were well below any applicable standards; on-site concentration levels did not exceed the Department of Energy's derived air concentration guides (Environmental Protection Agency regulations are not applicable to on-site air monitoring stations but were also not exceeded at these stations).

water

Within the Laboratory boundary, sources of surface water include spring snowmelt, summer storm runoff, and flow from outfalls that are permitted by the National Pollutant Discharge Elimination System, part of the Clean Water Act. Surface water is monitored on and adjacent to the Laboratory and at regional locations. Levels of plutonium, tritium, strontium, americium, uranium, cesium, alpha and beta particles, and gamma rays are measured at these stations. In 1995, all measurements were below the Department of Energy's derived concentration guides that limit potential exposure to the public for radioactive effluents in water. There has been a general downward trend in radioactive levels at most monitoring stations over the past three and a half decades. Surface water is monitored for its content of metals and inorganic chemicals to detect possible contamination resulting from Laboratory operations. Surface waters at the Laboratory are not a source of drinking or household water.

Groundwater is monitored to determine its quality. The main aquifer beneath Los Alamos is the primary source of drinking water for the

Comparison of 1994 and 1995 Releases of Radionuclides from Laboratory Operations

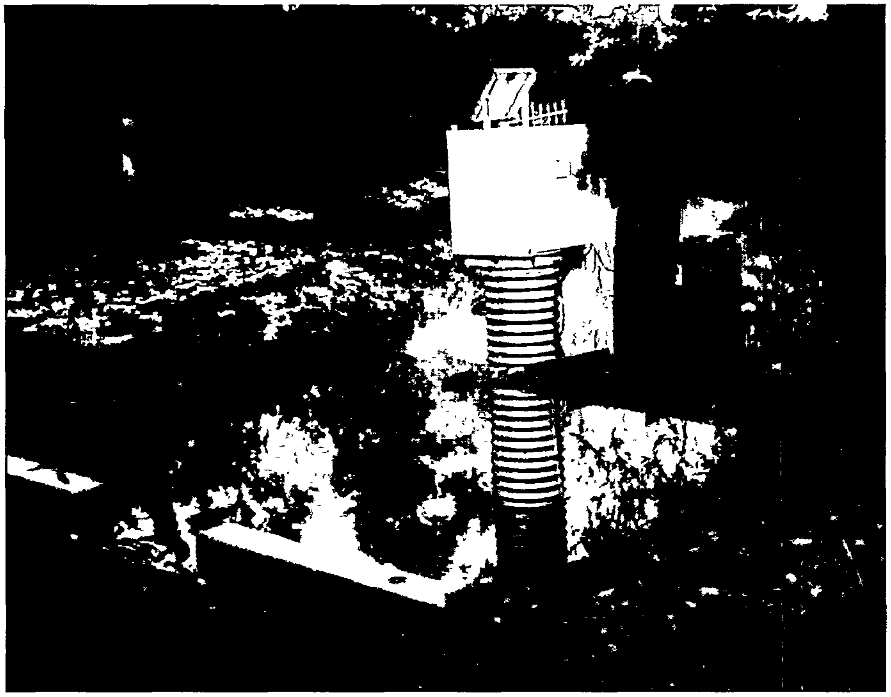
Airborne Emissions

		Activity Released		Ratio
Radionuclide	**Units**	**1994**	**1995**	**1995:1994**
Tritium	Ci	1,100	1,010	0.9
Uranium	µCi	380	160	0.4
Plutonium	µCi	13	59	4.5
Gaseous mixed activation products	Ci	50,200	44,370	0.9
Mixed fission products	µCi	450	44	0.1
Particulate/vapor activation products	Ci	0.4	0.3	0.8
Total	Ci	51,300	45,380	

Liquid Effluents

	Activity Released (mCi)		Ratio
Radionuclide	**1994**	**1995**	**1995:1994**
Tritium	2,230	731	0.3
Strontium -90	0.3	0.6	2.0
Cesium-137	8.5	6.6	0.8
Plutonium-238, -239, -240	3.2	4.0	1.3
Americium-241	3.1	1.4	0.5

Ci = Curie, which is the standard unit of measuring radioactivity; 1 Ci = 3.7×10^{10} nuclear transformations per second.
mCi = milliCurie, or 0.001 of a Curie
µCi = microCurie, or 0.000001 of a Curie



Laboratory and the residents of Los Alamos County. Operations at the Laboratory and discharges from county sewage treatment plants have resulted in detectable changes in water chemistry in some parts of the main aquifer. Several Laboratory test wells showed low levels of tritium due to Laboratory operations, but the levels were far below Environmental Protection Agency limits. Based on Environmental Protection Agency standards, however, these small changes have not degraded drinking water and are not a human health concern. There has been no significant depletion of the amount of water in the aquifer.

sediments

Sediments are monitored on and near the Laboratory and at regional locations for the presence of tritium, uranium, plutonium, cesium, and strontium. In 1995, data from sediment sampling was consistent with results from previous years; none of the sediment samples showed any concentration of radioactive substance that exceeded screening action levels (the level at which cleanup activity is required by the Environmental Restoration Project) except on Laboratory property in Mortandad Canyon. Sediments are also monitored for trace metals, such as antimony and mercury, and organic contaminants, such as polychlorinated biphenyls (PCBs). The 1995 results showed no concentrations above natural levels for trace metals and organic contaminants.

soils

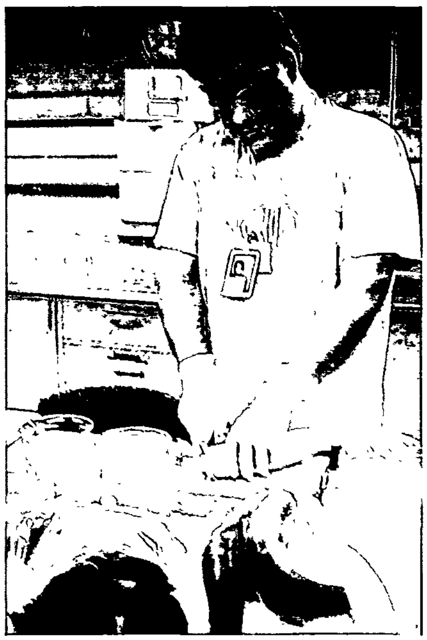
Soils are monitored both on and off site for tritium, strontium, cesium, uranium, plutonium, americium, alpha and beta particles, and gamma rays. All levels were within acceptable values, and no action was required to reduce levels of any radioactive element in the soil. Soils are analyzed for trace and heavy metals, such as iron, lead, mercury, and aluminum. In 1995, all samples were within acceptable levels for the Los Alamos region. Although some on-site readings for beryllium and lead were above background levels, the product of activities at the Laboratory's firing sites, concentrations were well below screening action levels, and no action was required by the Laboratory.

foodstuffs and associated biota

During 1995, produce, honey, milk, eggs, fish, and elk samples were collected from the Laboratory and surrounding areas, including several Native American Pueblo communities, to determine the impact of Laboratory operations on the human food chain.

Most produce, honey, milk, eggs, fish, and elk (muscle and bone) samples from Laboratory and perimeter locations showed no radioactivity distinguishable from that attributable to natural sources and/or worldwide fallout. Several exceptions were noted: there was more tritium in produce samples collected on Laboratory property than in regional areas; surface-feeding fish samples collected downstream of the Laboratory contained higher concentrations of uranium that fish samples collected upstream of the Laboratory; and two out of four elk muscle samples collected on Laboratory property contained detectable levels of tritium.

The concentrations of heavy metals, including beryllium and lead, in produce samples from Laboratory and perimeter areas were not significantly higher than samples collected farther away. The mercury levels found in fish samples collected downstream from the Laboratory was similar to the concentrations found in fish samples collected upstream from the Laboratory.

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The Laboratory operates under all applicable federal and state environmental, safety, and health laws, codes, orders, and standards. Environmental regulatory agencies include the Environmental Protection Agency and the New Mexico Environment Department. The Department of Energy issues orders that also regulate environmental activities at the Laboratory. The Laboratory is subject to the following laws:

Resource Conservation and Recovery Act (RCRA) and its Hazardous and Solid Waste Amendments (HSWA)

RCRA requires the Laboratory to regulate hazardous and solid waste, from its generation to its disposal. RCRA requires the Laboratory to attempt to reduce the amount of hazardous waste produced, the toxicity of generated hazardous waste, and to treat hazardous waste before its disposal. The Laboratory had frequent interactions with federal and state RCRA personnel during 1995. The Department of Energy (as the Laboratory's sponsoring agency) and the Environmental Protection Agency signed a Federal Facility Compliance Agreement addressing storage and treatment of mixed waste (waste that contains both hazardous chemicals and radioactive materials) on March 15, 1995. A proposed Site Treatment Plan was presented to the New Mexico Environment Department on March 31, 1995. The final plan was issued, after public comment and New Mexico Environment Department revisions, as part of a Federal Facility Compliance Order on October 4, 1995.

The Department of Energy and the Laboratory received two RCRA compliance orders from the New Mexico Environment Department in 1995. The first compliance order, dated March 22, 1995, was issued as a result of the New Mexico Environment Department's annual RCRA inspection in September 1994, which alleged 28 violations, of which 9 required corrective actions within 5, 10, or 30 working days. All corrective actions were completed on time. The New Mexico Environment Department proposed fines of $103,539; the final negotiated penalty amount was $48,329. The second compliance order, dated October 4, 1995, was issued as a result of the New Mexico Environment Department's inspection in September 1995 and alleged nine violations and proposed fines totaling $14,795. The final negotiated penalties totaled $11,190 for seven alleged violations, all of an administrative nature.

One underground storage tank was removed from Laboratory property during 1995. The New Mexico Environment Department conducted an inspection of underground storage tanks in January 1995, and the Department of Energy received two notices of violation as a result of the inspection. No petroleum release was associated with these findings. On February 24, 1995, compliance documents were sent to the New Mexico Environment Department with $200 for the fines associated with the violations.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

CERCLA outlines the appropriate responses to certain substance releases to the environment. Based on site assessments and inspections, the Environmental Protection Agency ranks potentially health threatening or environmentally unsound hazards at facilities. Special attention is given to these hazardous sites, which are maintained on a National Priority List. The Laboratory is not included on the