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Informal Report

**Waste Management Programs and Capabilities
Within the Los Alamos Scientific Laboratory**

University of California

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LOS ALAMOS SCIENTIFIC LABORATORY

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Informal Report
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Waste Management Programs and Capabilities Within the Los Alamos Scientific Laboratory

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WASTE MANAGEMENT PROGRAMS AND CAPABILITIES WITHIN
THE LOS ALAMOS SCIENTIFIC LABORATORY

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ABSTRACT

This document briefly outlines the various programs in radioactive waste management and some related fields which are currently being pursued at the Los Alamos Scientific Laboratory. Some additional proposed or known potential programs are also outlined, and some of the existing capabilities and facilities of the various divisions of the LASL which could be utilized in the solution of waste management problems are also described. This summary is intended to show the objectives and scope of our current programs, to aid in the evaluation and coordination of these programs, and to help us identify areas in which we can and should make additional contributions because of our particular capabilities and facilities.

EXECUTIVE SUMMARY

In this document we have briefly outlined the various programs in radioactive waste management and in some related fields which are currently being pursued at the Los Alamos Scientific Laboratory. Some additional proposed or known potential programs are outlined, and some of the existing capabilities and facilities of the various divisions of the LASL which could be utilized in the solution of waste management problems are also described.

In the first major section of this report, these programs are listed only by title within major categories, with some repetition where there are multiple categories of applicability. In the next section, the programs are given by Laboratory division with a short statement for each program giving its objectives or pertinence, and, for each funded waste management program, its FY78 funding level and estimated future trend. (In most instances exact FY79 funding levels are not yet known.) Relevant capabilities and relevant facilities of the Laboratory divisions involved in these programs are synthesized in the next two sections.

A summary of this type, of course, cannot do justice to the evolving nature of the research described nor to the full details of the individual programs. More complete or up-to-date information can be obtained, whenever desired, by contacting the Division office associated with the program. The LASL technical organization is given in the last section.

This summary is intended to show the objectives and scope of our current programs, to aid in the evaluation and coordination of these programs, and to help us identify areas in which we can and should make additional contributions because of our particular capabilities and facilities. It should also provide a basis for the formulation of new proposals, and for the development of a coherent and worthwhile program of radioactive waste management activities at the Laboratory. We also hope it will be of value to outside agencies in assessing our current programs and our potential for contributing to the solution of problems in this area which is so important to the nation in its utilization of nuclear energy.

PROGRAMS BY TITLE AND CATEGORY

Site Selection

Geologic-Geochemical Environment

Mathematical Modeling

Field Testing and Model Verification

Detection and Monitoring

Systems Analysis

Waste Handling, Processing, and Recycling

SITE SELECTION PROGRAMS

<u>Program Area</u>	<u>Division</u>
Currently Funded Programs	
NTS Terminal Waste Storage Program	CNC, G, J
Evaluation of Transuranium Contaminated Waste Burial Sites	H
Radioactive Waste Burial Technology	H
Cohabitation of Weapons Testing and Waste Management Activities at the NTS	J
Related Programs	
Site Selection for Nuclear Weapons Tests	J
Ground Motion Studies	J
Large Scale Technical Field Programs	J
Potential Programs	
Natural Fission Reactor Investigations Pertinent to Site Suitability Criteria	CNC
Geologic and Geophysical Characterization of a Site; Technical Field Programs	J

PROGRAMS IN GEOLOGIC-GEOCHEMICAL ENVIRONMENT

<u>Program Area</u>	<u>Division</u>
Currently Funded Programs	
RAD Waste Degradation Studies For WIPP	CMB
Radionuclide Migration Project	CNC
NTS Terminal Waste Storage Program	CNC, G, J
Waste Isolation Safety Assessment Program	CNC
Natural Fission Reactors	CNC
Evaluation of Transuranium Contaminated Waste Burial Sites	H
Transport of Waste Radionuclides through Soil	H
Ecological Behavior of Waste Materials at Los Alamos and Trinity Site	H
Related Programs	
Dissolution of Rocks and Minerals	CNC
Heats of Formation of Minerals	CNC
Geothermal Circulation Loops and Element Migration Studies	CNC
Permeability and Trace-Element Studies	CNC
Potential Program	
Field Measurements for In-Situ Waste Management Experiments	J

PROGRAMS IN MATHEMATICAL MODELING

<u>Program Area</u>	<u>Division</u>
Currently Funded Programs	
Radionuclide Migration Project	CNC
Evaluation of Transuranium Contaminated Waste Burial Sites	H
Related Programs	
Porous Flow and Hydrofracture Models	J
Distributions of Cracks in Rocks	T
Development of the Data Base Characterizing the Radionuclide Decay Chains for Waste Materials	T
Computer Modeling of Fluid Flow through Porous Media	T
Potential Programs	
Porous Flow, Hydrofracture, and Ground Motion Modeling	J
Computer Modeling of the Transport of Radioactive Waste in Geological Media*	T

* A proposal exists.

PROGRAMS IN FIELD TESTING AND MODEL VERIFICATION

<u>Program Area</u>	<u>Division</u>
Currently Funded Programs	
Radionuclide Migration Project	CNC
Natural Fission Reactor (OKLO) Program	CNC
Radioactive Waste Burial Technology	H
Cohabitation of Weapons Testing and Waste Management Activities at the NTS	J
Related Programs	
Large Scale Technical Field Programs	J
Safeguards Material Measurement and Accounting - DYMAC	Q
Potential Program	
Geologic and Geophysical Characterization of a Site; Technical Field Programs	J

PROGRAMS IN DETECTION AND MONITORING

<u>Program Area</u>	<u>Division</u>
Currently Funded Programs	
TRU Waste Treatment Demonstration and Assay Instrumentation Development	H
Detector Development	J
Related Programs	
Safeguards Measurement Technology, International Safeguards & Training	Q
Nuclear Material Detection and Surveillance	Q
Nondestructive Assay Technology for Uranium Resource Evaluation	Q
Monitoring of Nuclear Weapons Tests	J
Potential Programs	
Advanced Detector and Monitoring Techniques	J
Field Measurements for In-Situ Waste Management Experiments	J
Waste Management by Measurement*	Q
Active/Passive Neutron Assay of Fission Product TRU Waste	Q
Leached Hulls Monitor	Q
Transfer of Safeguards Material Management Technology for Waste Management	Q

* A proposal exists.

PROGRAMS IN SYSTEMS ANALYSIS

<u>Program Area</u>	<u>Division</u>
Related Programs	
Limits/Standards for Radionuclides in Environmental Media	H
Safeguards Material Measurement and Accounting - DYMAC	Q
Safeguards Systems Analysis, Conceptual Design and Evaluation of Fuel Cycle Facilities	Q
Statistical Support for Nuclear Accountability Program	S
Sensitivity Analysis of Transient Reactor Analysis Code (TRAC)	S
Potential Program	
Nuclear Fuel Cycle Options Model	S

PROGRAMS IN WASTE HANDLING, PROCESSING, AND RECYCLING

<u>Program Area</u>	<u>Division</u>
---------------------	-----------------

Currently Funded Programs

²³⁸ PuO ₂ Safety and Environmental Support	CMB
Release Rates of Reactor Products from Stored Fuel Elements, Synthetic Uraninite, and Natural Reactor Ore	CNC
UO ₂ and ThO ₂ Skull Melting	CNC
Filter Test Methods for Air Cleaning	H
TRU Waste Treatment Demonstration and Assay Instrumentation Development	H
Waste Management Requirements for Alternative Fuel Cycles	H
Stabilization of Uranium Mill Tailings	H

Related Programs

Chemistry of Oxo-Complexes of the Light Actinides, Theory and Experiment	CNC
Ceramic Heat Pipe	Q

Potential Programs

Laser Spectroscopy	AP
Advanced Chemical Processing	AP
Silicate and Titanate Analogues of Natural Minerals as Waste Forms	G
Incinerator Off-Gas Treatment Program*	H
Exhumed Waste Processing Studies*	H

* A proposal exists.

PROGRAMS BY LABORATORY DIVISION

Objectives

Current and expected funding levels

APPLIED PHOTOCHEMISTRY (AP) DIVISION

<u>Program Area</u>	<u>Principal Objective</u>
	Potential Programs
1. Laser Spectroscopy	Determine absorption frequencies and cross-sections; necessary chemical processing.
2. Advanced Chemical Processing	Utilization of laser photochemistry for chemical processing and separation; investigate possibilities of waste volume reduction, reduced energy or reagent use, isotope separation, etc.

CHEMISTRY-MATERIALS SCIENCE (CMB) DIVISION

<u>Program Area</u>	<u>Principal Objectives</u>	<u>FY78 Operating Funds (\$K)/Source</u>	<u>Future</u>
Currently Funded Programs			
1. $^{238}\text{PuO}_2$ Safety and Environmental Support	Provide independent assessments of safety aspects of space and terrestrial nuclear power systems; to determine chemical responses of $^{238}\text{PuO}_2$ fuels in contact with the environment.	390/NRA-DOE	Continuing
2. TRU Waste Treatment and Disposal	In support of H Division (project 3)	/Thru H Division	Continuing
3. UO_2 and ThO_2 Skull Melting	In support of CNC Division (project 6)	/Thru CNC Division	Continuing
4. RAD Waste Degradation Studies	Study the radiolytic, thermal, catalyzed pyrolytic, and chemical and biological degradation gases produced by the interaction of radioactive waste and the storage media.	352/ONWM-DOE/SL	Continuing

CHEMISTRY NUCLEAR-CHEMISTRY (CNC) DIVISION

<u>Program Area</u>	<u>Principal Objective</u>	<u>FY78 Operating Funds (\$K)/Source</u>	<u>Future</u>
Currently Funded Programs			
1. Radionuclide Migration Project	Quantify the distribution of radionuclides around underground nuclear explosions; determine the potential for migration of radionuclides produced in nuclear tests including time-distance relationships under various test conditions; perform laboratory leaching and sorption studies.	175/NVO-DOE	Continuing
2. NTS Terminal Waste Storage	Evaluate the major geologic formations at the Nevada Test Site (NTS) as to their suitability for deep geologic storage; investigate Eleana argillite, Climax Stock granite, and a variety of tuffs; perform laboratory sorption studies under equilibrium and non-equilibrium conditions.	225/NVO-DOE	Expanding
3. Waste Isolation Safety Assessment Program	Radionuclide transport studies; a general study of the sorption properties of materials potentially useful for deep geologic storage; study sorption mechanisms using granite and argillite; study chemical behavior in basic media.	127/ONWI-DOE	Expanding

CHEMISTRY NUCLEAR-CHEMISTRY (CNC) DIVISION

<u>Program Area</u>	<u>Principal Objectives</u>	<u>FY78 Operating Funds (\$K)/Source</u>	<u>Future</u>
Currently Funded Programs			
4. Natural Fission Reactors	Measurements of the extent of fission product migration and the influence of geological environment on retaining residues from a two billion year old reactor.	250/ONWI-DOE	Expanding
5. Release Rates of Reactor Products from Stored Fuel Elements, Synthetic Uraninite, and Natural Reactor Ore	Development of an apparatus to control oxidation conditions and measurements of reactor product release rates at temperatures like those in geologic storage and with controlled oxidation conditions.	300/ONWI-DOE	Expanding
6. UO ₂ and ThO ₂ Skull Melting	Determination of reactor product retention in large crystals of UO ₂ or ThO ₂ .	100/ONWM-DOE	Continuing
Related Programs			
7. Dissolution of Rocks and Minerals	Determination of the rates of dissolution of rocks and minerals, and the solubilities of pure minerals in aqueous solutions under static and flowing conditions up to 300°C.		
8. Heats of Formation of Minerals	Measure the heats of formation of minerals using a molten salt calorimeter.		

CHEMISTRY NUCLEAR-CHEMISTRY (CNC) DIVISION

<u>Program Area</u>	<u>Principal Objectives</u>	<u>FY78 Operating Funds (\$K)/Source</u>	<u>Future</u>
	Related Programs		
9. Geothermal Circulation Loops and Element Migration Studies	Determine rock-water interactions in a controlled temperature gradient; study element sources, migration mechanisms and sinks in geologic systems.		
10. Permeability and Trace-Element Studies	Measure the matrix permeability on samples from a variety of sites; observe connected porosity using radiotracers, autoradiograms, and scanning electron microscopy; determine trace elements by neutron activation analysis.		
11. Chemistry of Oxo-Complexes of the Light Actinides, Theory and Experiment	Extend the knowledge of the chemical and structural properties of the early pentavalent oxo-complexes and other related compounds; perform horizontal comparisons of chemical bonding along a series of actinide compounds; gain understanding of behavior of these elements under the "oxo-favoring" conditions frequently encountered in waste handling schemes and in the biosphere.		
	Potential Program		
12. Natural Fission Reactor Investigations Pertinent to Site Suitability Criteria*	Measurement of ¹³⁵ Cs retention in uranium ores and characterization of fission product mobilization processes for model development.		

* A proposal exists.

GEOSCIENCES (G) DIVISION

<u>Program Area</u>	<u>Principal Objectives</u>	<u>FY78 Operating Funds (\$K)/Source</u>	<u>Future</u>
Currently Funded Program			
1. NTS Terminal Waste Storage Program	Evaluate a variety of tuff formations at the Nevada Test Site (NTS) as to their suitability for deep geologic storage; study regional geology, lithology, and petrology; perform rock physics studies on tuffs; perform field mapping and lithologic logging of a test well.	175/NVO-DOE	Expanding
Related Programs			
2. Hot Dry Rock Geothermal Energy Demonstration Project	Develop technology for establishing closed loop flow systems in deep, hot rock; study heat transfer in fractured igneous rock, remote fracture mapping, thermal stress cracking, effects of fluids on mechanical response, permeability, flow paths, high-temperature down-hole instrumentation, and rock-water interactions.		
3. LASL Alternate Energy Program-- Geothermal Space Heating	Study the feasibility of a geothermal facility for space heating in LASL; geological and geophysical exploration to determine the profile of basement rocks and possible ground water flow patterns.		

GEOSCIENCES (G) DIVISION

<u>Program Area</u>	<u>Principal Objectives</u>
	Related Programs
4. In-Situ Coal Gasification	Develop technology for gas production from coal seams by in-situ ignition of the coal; study fluid flow, thermal stress cracking, enhancement of permeability by chemical leaching, and connective heat transport in multiphase systems.
	Potential Programs
5. Silicate and Titanate Analogues of Natural Minerals as Waste Forms	Investigation of the feasibility of incorporating radioactive fission products into silicate and titanate analogues of natural minerals; study natural crystal chemistry using mineral synthesis electron microprobe, and x-ray diffraction methods.
6. Fission Product Migration in Large Thermal Gradients	Determine the direction of migration of fission products when placed in a large thermal gradient in a relatively small block of host rock.
7. Failure Mechanisms in Tuffs Under In-Situ Conditions	Study three failure modes that could result in increased fracture permeability: brittle tensile fracture, brittle compressive (shear) fracture, and tertiary creep failure; effect of temperature, pressure, and pore pressure.

GEOSCIENCES (G) DIVISION

Program AreaPrincipal ObjectivesPotential Programs

8. Low-Strain-Rate Behavior of Bulk
and Jointed Mafic Rocks

Study the mechanical properties of mafic igneous rocks on the Hanford Reservation; study the high temperature rheological properties of the rock matrix and its constituent minerals; study the shear and tensile strengths of jointed basalts sealed by zeolite minerals.

HEALTH RESEARCH (H) DIVISION

<u>Program Area</u>	<u>Principal Objectives</u>	<u>FY78 Operating Funds (\$K/Source)</u>	<u>Future</u>
Currently Funded Programs			
1. Filter Test Methods for Air Cleaning	Develop laser-based systems and test materials for in-place testing of HEPA filters.	190/ONWM-DOE	Decreasing
2. Evaluation of Transuranium Contaminated Waste Burial Sites	Develop system to assess adequacy of shallow land disposal site containment.	144/ONWM-DOE	Expanding
3. TRU Waste Treatment Demonstration and Assay Instrumentation Development	Develop and demonstrate controlled air incineration as technique for reducing waste volume and enhancing chemical form for disposal; storage controls on corrosion and radiolysis; demonstration of electronic waste package assay systems; modifications to incinerator for remote control operation; development of non-destructive waste assay systems for wastes from both DOE and commercial operations.	1826/ONWM-DOE	Continuing
4. Radioactive Waste Burial Technology	Develop site selection, site engineering, site monitoring technology for shallow land disposal; includes LASL sites.	510/ONWM-DOE	Expanding
5. Waste Management Requirements for Alternative Fuel Cycles	Identify types, quantities, forms, and any special problems associated with wastes from alternative fuel cycles.	130/ONWM-DOE	Continuing

HEALTH RESEARCH (H) DIVISION

<u>Program Area</u>	<u>Principal Objectives</u>	<u>FY78 Operating Funds (\$K)/Source</u>	<u>Future</u>
Currently Funded Programs			
6. Stabilization of Uranium Mill Tailings	Develop ecological information on the movement of materials from tailings piles and evaluate vegetative and mechanical stabilization techniques.	100/BER-DOE	Continuing
7. Transport of Waste Radionuclides Through Soil	Develop information on nuclide transport by soil type and as influenced by microflora on soils at commercial waste burial facilities.	240/NRC	Continuing
8. Ecological Behavior of Waste Materials at Los Alamos and Trinity Site.	Describe movement and effect of radionuclides in natural systems.	263/BER-DOE	Continuing
9. Limits/Standards for Radionuclides in Environmental Media	Establish environmental health limits for radionuclides in surface soils and for transuranic contaminants in materials going into shallow land disposal.	165/DOES-DOE	Continuing
Potential Programs			
10. Incinerator Off-Gas Treatment Program*	Develop and demonstrate gaseous treatment systems for incinerators.		
11. Exhumed Waste Processing Studies*	Develop volume reduction processes for waste exhumed from shallow earth burial sites.		

* A proposal exists.

FIELD TESTING (J) DIVISION

<u>Program Area</u>	<u>Principal Objectives</u>	<u>FY 78 Operating Funds (\$K)/Source</u>	<u>Future</u>
Currently Funded Programs			
1. NTS Terminal Waste Storage Program	Measurement and analysis of ground motions from nuclear weapons tests; effects on possible waste repository sites at the Nevada Test Site (NTS).	60/NVO-DOE	Expanding
2. Detector Development	Develop detectors for determining the amount of radioactivity present in waste (in support of H-Division projects 3 and 4).	60/H-Division	Expanding
3. Cohabitation of Weapons Testing and Waste Management Activities at the NTS	Studies of joint use of the NTS for weapons testing and waste management activities.	/MA-DOE	Continuing
Related Programs			
4. Site Selection for Nuclear Weapons Tests	Geologic and geophysical characterization of sites for nuclear weapons tests; drilling of emplacement shafts.		
5. Ground Motion Studies	Estimate ground motion from nuclear explosions; effects of seismic disturbances.		
6. Large-Scale Technical Field Programs	Conduct large-scale field programs both for underground nuclear tests and for oil shale studies; field in-situ experiments to gather technical data; acquire and transmit data in extreme environmental circumstances.		
7. Porous Flow and Hydrofracture Models	Develop models with two-phase flow for weapons tests containment studies.		

FIELD TESTING (J) DIVISION

<u>Program Area</u>	<u>Principal Objectives</u>
	Related Programs
8. Monitoring of Nuclear Weapons Tests	Obtain extensive data from nuclear weapons tests; design, fabricate, and field sophisticated equipment for data acquisition and analysis.
	Potential Programs
9. Field Measurements for In-Situ Waste Management Experiments	Gather data needed for siting a waste repository; heater, radionuclide migration, rock mechanics, and porous flow measurements.
10. Porous Flow, Hydrofracture, and Ground Motion Modeling	Modeling of ground water flow and ground motion for siting a nuclear waste repository; hydrofracture analysis and analysis to determine relevancy of hydrofracturing phenomena to storage of waste in water bearing rocks.
11. Advanced Detector and Monitoring Techniques	Development of field techniques for monitoring nuclear waste in an experimental facility and/or in a permanent nuclear waste repository.
12. Geologic and Geophysical Characterization of a Site; Technical Field Programs	Locate sites and field large-scale technical experiments related to nuclear waste storage activities.

ENERGY (Q) DIVISION

<u>Program Area</u>	<u>Principal Objectives</u>
	Related Programs
1. Safeguards Measurement Technology, International Safeguards & Training	Develop and transfer technology for the measurement of nuclear materials, with emphasis on nondestructive assay methods.
2. Nuclear Material Detection and Surveillance	Develop methods and instrumentation for monitoring personnel and vehicles and other potential diversion mechanisms and for surveillance and item accounting of materials in storage.
3. Safeguards Material Measurement and Accounting - DYMAC	Develop, implement and test plant-wide, automated measurement and accounting systems; test and evaluate the Dymac Materials Control (DYMAC) System at the LASL TA-55 plutonium facility.
4. Safeguards Systems Analysis, Conceptual Design and Evaluation of Fuel Cycle Facilities	Model and simulate processes and measurement systems for assessment of safeguards for existing facilities and design of safeguards systems for future fuel cycle facilities; develop decision analysis; evaluate international safeguards strategies.

ENERGY (Q) DIVISION

Program Area	Principal Objectives
Related Programs	
5. Ceramic Heat Pipe	Develop high temperature heat removal devices for recovery of industrial waste heat; investigate feasibility of using heat pipes to remove heat from fuel cycle materials.
6. Nondestructive Assay Technology for Uranium Resource Evaluation	Apply gamma-ray and neutron computer codes to problems encountered in uranium exploration by borehole logging; alternative neutron assay applications.
Potential Programs	
7. Waste Management by Measurement*	Identify points in the fuel cycle where nondestructive assay (NDA) instrumentation can be used for waste management; develop and test NDA measurement systems for these problems including instrumentation for the Federal Waste Repository.
8. Active/Passive Neutron Assay of Fission Product TRU Waste	Construct and test a neutron interrogation and detection system capable of measuring fission-product contaminated ($\sim 10^3$ R/hr) TRU waste at the 10 nCi/g level in 55-gal drums - a reprocessing plant problem.

* A proposal exists.

ENERGY (Q) DIVISION

<u>Program Area</u>	<u>Principal Objectives</u>
	Potential Programs
9. Leached Hulls Monitor	Develop and test a nondestructive assay system for quantitative measurement of the fissile content of leached hulls from reprocessing plants.
10. Transfer of Safeguards Material Management Technology for Waste Management	Transfer and adapt technologies for the automated materials measurement and accounting safeguards systems for the purposes of efficient waste management at the source facilities.

SYSTEMS ANALYSIS AND ASSESSMENT (S) DIVISION

<u>Program Area</u>	<u>Principal Objectives</u>
	Related Programs
1. Statistical Support for Nuclear Accountability Program	Examine uranium and plutonium inventory data and shipper-receiver data for trends or significance in differences, including analysis of possible cumulative effects of measurement error.
2. Sensitivity Analysis of Transient Reactor Analysis Code (TRAC)	Determine the sensitivity of the calculated variables (outputs) of TRAC to the input variables.
	Potential Program
3. Nuclear Fuel Cycle Option Model	Trace and calculate the fuel use efficiency, costs, net energy, economics, effluents, and relative proliferation resistance of various nuclear fuel cycle options, considering different enrichment processes, reactor types, reprocessing and recycle options, etc.; use results to compare nuclear fission to other energy technologies and intercompare fission technologies, including implications for waste management.

THEORETICAL (T) DIVISION

<u>Program Area</u>	<u>Principal Objectives</u>
	Related Programs
1. Computer Modeling of the Transport of Radioactive Waste in Geological Media	To develop a modular computer code to use as a predictive tool in assessing the migration of radionuclides in geological repositories.
2. Distributions of Cracks in Rocks	To develop probabilistic analytical tools to describe the distribution of cracks in rocks.
3. Development of the Data Base Characterizing the Radionuclide Decay Chains for Waste Materials	To develop a data base for various physical properties of nuclei including decay probabilities; such data is essential for describing the chemical and thermo-mechanical properties of waste materials.
	Potential Program
4. Computer Modeling of Fluid Flow through Porous Media	To develop a computer code to describe the fluid flow through porous media.

DIVISIONAL CAPABILITIES

AP-DIVISION CAPABILITIES

The Applied Photochemistry Division has demonstrated a laser scheme for isotope separation. The Division consists of four major groups which are roughly divided as to function:

- AP-1 Process and Laser Engineering
- AP-2 Laser Research and Development
- AP-3 Laser Applied Spectroscopy
- AP-4 Applied Photochemistry and Process Research

The principal elements of the AP-Division method for separating the isotopes of uranium are the use of UF_6 in a carrier gas as the process medium, the use of infrared and ultraviolet lasers to achieve the isotope separation, and the use of supersonic cooling to achieve the proper spectral simplification. Striving to achieve the scientific and technical demonstration of the concepts embodied in the laser isotope separation plan has led to the development of divisional expertise in: 1) laser spectroscopy; 2) on-line diagnostics with lasers; 3) optical system design and beam transport; 4) on-line computer control and diagnostics; 5) picosecond diagnostics; 6) gas dynamics and fluid mechanics; 7) mechanical design; 8) high-voltage engineering; and 9) various aspects of molecular beam systems, mass spectrometric diagnostics, supersonic flow diagnostics and component testing, and the preparation of nonlinear crystals.

The Division has pioneered in the application of supersonic nonequilibrium flow cooling as a tool for molecular spectral simplification, in the use of diode lasers as monitors of molecular density in supersonic flows, and in the design of new laser systems and the beam steering optics to shape and direct laser beams over meters of path length to specific target volumes in both static and dynamic gas systems.

The Division has expertise in laser induced fluorescence, in the use of two and sometimes three lasers as diagnostic tools in unraveling the intricacies of molecular interactions and reactions, in the design and control of supersonic flow systems, in the design of complete laser systems, and in electric and electronic engineering.

CMB-DIVISION CAPABILITIES

The CMB Division has extensive facilities and expertise in handling various radioactive materials in small to large quantities. They have extensive capabilities for studying radioactive wastes, waste processing, storage, and reduction in volume.

Divisional Capabilities

Group CMB-1 has equipment and expertise for handling ^{238}Pu and for studying its effects under various environmental conditions both terrestrial and aquatic. Group CMB-1 also has the expertise and facilities to study corrosion of containers, radiolytic and chemical attack of various waste matrices and containers, and of potential waste packaging materials in laboratory and in waste disposal environments. Investigations can be carried out at ambient or high pressures and temperatures. They are equipped to provide analytical chemistry support for a wide range of tests and studies in waste management.

Group CMB-8 has expertise in studying geologic disposal and the physical chemistry relative to geologic formations.

Group CMB-11 has capabilities and facilities for categorizing, sorting, and processing wastes, for reclamation of processing materials to prevent their becoming waste, for packaging studies, and for placing waste in simulated storage and monitoring it. They also have the facilities for handling large quantities of radioactive materials.

Group CMB-14 has the expertise and facilities for handling and investigating high α, β, γ , and neutron radioactive materials in well-equipped hot cells. They provide support to the program involving placing high-level wastes in a UO_2 matrix in deep geologic disposal. The facility is used to near capacity but could support a small effort in studying irradiated fuel wastes.

CNC-DIVISION CAPABILITIES

CNC Division is a small but very active division of LASL with strong interests in basic understanding and applications of nuclear chemistry, radiochemistry, geochemistry, actinide chemistry, and the structure, spectroscopy and reaction kinetics of inorganic substances.

Group CNC-2 has extensive knowledge of and experience in studying the kinetics of the oxidation reduction reactions of actinide elements. This capability and knowledge is fundamental in order to be able to study and understand the near-neutral solutions that may be present in geochemical environments. This group also has the capability of measuring the heats of formation of minerals and from these calculating the free energies of formation. These data allow the prediction of multicomponent equilibrium in geothermal systems. The rates of dissolution of rock and minerals and the solubilities of pure minerals can also be determined.

Divisional Capabilities

Group CNC-4 has significant expertise in the basic actinide chemistry germane to the design of improved waste treatment systems. The group has capabilities for the study and synthesis of improved, highly specific actinide complexing agents, for the study of the differential chemistry of actinides in unusual chemical environments and oxidation states, and for the application of state-of-the-art physical-chemical characterization techniques to process problems and design. These capabilities include equipment for multinuclear NMR, single-crystal X-ray diffraction, UV-visible spectroscopy, and IR-Raman spectroscopy.

Group CNC-11 has traditionally provided radiochemical diagnostics for LASL-sponsored weapons tests. Results from radiochemical and isotopic assay of weapons debris samples are interpreted in terms of weapons performance parameters (yield, efficiency, neutron fluence). A close coupling of basic and applied research has historically been a source of innovative progress. The group has strong interests in nuclear processes and theory, particularly fission, and, more recently, nuclear and chemical phenomena associated with mesons and protons at the 800-MeV LAMPF accelerator. They have specialized in the chemistry of fission products and heavy elements. Other group interests and capabilities related to waste management include: 1) fission-product behavior in high-temperature reactor fuel; 2) occurrence of Pu-244 and other long-lived nuclides in nature; 3) the Oklo natural fission reactor in the Gabon uranium deposit; 4) radionuclide distribution and transport in geologic media at weapons test sites and in fallout from weapons tests; 5) particulates and other pollutants in the atmosphere; 6) interactions of water with rocks in geothermal systems; 7) solubility of, and fission-product release from, UO_2 in a chemical environment; 8) mass spectrometry and electromagnetic isotope separation; 9) experimental chemistry and geochemistry; and 10) mathematical analysis and modeling.

G-DIVISION CAPABILITIES

The Geosciences Division (G-Division) was established in early 1977 in order to place many of the geosciences activities at the Los Alamos Scientific Laboratory under a single management. This change reflects an appreciation of the growing importance of geosciences in a national environment of increasing shortages of energy and resources.

The largest single program in the Geosciences Division is the geothermal program, particularly the research in hot dry rock at the Fenton Hill site near LASL. The Hot Dry Rock Geothermal Program involves fracturing of rock, the study of fluid flow through the fractured rock, and heat conduction by rock. The expertise of the geothermal program in these topics is directly applicable to problems of nuclear waste management.

Divisional Capabilities

G-2, the seismology and geophysics group, is principally concerned with research in various aspects of seismology and supporting branches of solid earth geophysics. They undertake studies varying from crustal structure and tectonics of an entire region to the detailed seismic response of a single small site. Mobile telemetry and recording equipment are used. A considerable effort has been focused on development and field use of portable seismic, gravimetric and geomagnetic instrumentation. Other activities include development of special purpose instrumentation such as tilt and strain meters and engineering seismology.

Group G-6, Geological Research, is principally concerned with energy and environmental problems. Field geological and geophysical data and laboratory analytical and computational facilities are employed to understand, characterize, and evaluate various energy-related problems. Research techniques employed by Group G-6 include field and laboratory geology and petrology, electron microanalysis, electron microscopy, and x-ray diffraction, transport properties of rocks and minerals, rock behavior under static and dynamic loading, and numerical modeling of physical and chemical processes.

H-DIVISION CAPABILITIES

Historically H-Division has been responsible for waste management operations at LASL. Experience and capability in packaging, measurement, transport, treatment of liquid wastes, compaction of solid waste, burial, storage, disposal documentation and waste disposal site monitoring have evolved. In addition to these operational waste management responsibilities, H Division is conducting nuclear waste management research. These technology development programs began in 1972. The nature of this work has been in the areas of waste treatment engineering, aerosol waste collection engineering, waste-environment interaction studies, waste assay instrumentation development, and assessment and monitoring of shallow land radioactive waste disposal sites.

Group H-1 has expertise in radiation measurement instrumentation which has resulted in development and application of assay systems for waste packages and for monitoring nuclide migration in the environment.

Group H-5 has expertise in aerosol physics and engineering which has been applied to high efficiency particulate aerosol (HEPA) collection systems and to trapping gaseous species such as radioiodine. Recent emphasis has been on developing laser based aerosol penetration measurement systems to test HEPA filters in-place.

Divisional Capabilities

Group H-7 has expertise in waste treatment engineering. This group operates the liquid waste treatment plants and the solid waste disposal sites for the Laboratory. Research, development and demonstration work is ongoing on waste packaging and treatment. Current emphasis is on development of the controlled air incinerator (CAI) process for volume reduction of combustible waste. A full-scale incinerator has already burned several tons of non-radioactive but representative combustibles. Demonstrations using radioactive waste will begin in early CY79. The development work is carried out in the radioactive waste treatment development facility (TDF). The TDF is utilized for design and testing at production scale solid waste treatment systems. Process engineering capabilities include design and testing of all support and instrumentation systems for waste handling and assay, waste preparation, treatment (e.g., combustion), and handling of treatment residues.

Group H-8 has environmental and analytical chemistry capabilities. Measurement of radioactivity in soil and other environmental media down to natural background levels in thousands of samples per year is a routine capability via wet chemistry techniques.

Group H-12 has ecological, hydrological and geological expertise which is being applied to problems of environmental behavior and migration of radio-nuclides. Emphasis has been on near surface disposal of transuranic waste materials and the radioecological implications of these nuclides.

J-DIVISION CAPABILITIES

The primary J-Division mission is "to execute nuclear device tests and carry out experiments and calculations on device performance and effects." J-Division is comprised of scientific, engineering, and logistics groups. The efforts of the scientific groups include the acquisition and investigation of data derived from and pertinent to nuclear tests, to determine the performance of nuclear devices, and to study the various phenomena related to nuclear explosions. The engineering groups are responsible for the design, construction, and maintenance of field-test facilities, mechanical design of the specialized equipment used in field testing, electrical engineering tasks including data acquisition, recording, telemetry, and the timing and firing of tests, and special electronic design. The Division has the interest, experience, and potential to utilize its unique capabilities on the problem of nuclear waste storage.

Group J-3, Operations-NTS, is permanently located in Nevada and is responsible for providing operational, administrative, and personnel support for the Laboratory's weapons testing program at the Nevada Test Site (NTS).

Divisional Capabilities

Group J-6, Facility Production, with offices at both the LASL and the NTS, is responsible for the design, construction, maintenance, and operation of LASL field test facilities at DOE test sites. The group is concerned with the solution of problems associated with mechanical, electrical, civil, and drilling engineering disciplines. The group acts as the Laboratory representative to the DOE and its engineering and construction contractors for the design, construction, operation and maintenance of these test facilities. The group has the primary responsibility for the design, fabrication, proof testing and quality control of the emplacement hardware; it has responsibility for emplacement and stemming operations; it is responsible for the planning and drilling of emplacement holes and for the planning and conduct of postshot drilling operations to obtain rad-chem samples.

Group J-8, Timing and Firing, Phenomenology Support, has three sections. The Timing and Firing Section compiles device information, signal, monitor, and electroexplosive firing requirements, and evaluates this information to provide the proper system for the test execution. The Data Acquisition and Reduction Section is responsible for the instrumentation for, and recording of, such measurements as temperature, pressure, acceleration, and ground motion. The Special Engineering Section provides design, development, and fabrication of specialized field test equipment.

Group J-9, Underground Nuclear Phenomenology, is concerned with the containment of underground nuclear tests. Effort is concentrated on rock dynamics, gas flow, stemming designs, shock wave propagation studies, and the analysis of data from prior underground tests. J-9 participates in emplacement-site selection and prepares the containment evaluation documentation.

Additional capabilities, which may be relevant to waste management programs, are performed in other J-Division groups. These include atmospheric science, protection and safety coordination, administrative services, design and fabrication of sophisticated mechanical hardware systems, acquisition and reduction of field data, modeling of stress wave propagation, fluid and gas flow, and hydrofracturing, and extensive instrumentation research and development.

Q-DIVISION CAPABILITIES

Q-Division activities in the area of fission applications are nuclear safeguards, reactor safety, and heat transfer systems. The four Safeguards Groups in Q-Division have as their sole function the development of technology for the measurement, control, and management of nuclear materials, including most categories of waste relevant to waste management. Briefly, the disciplines and activities characterizing each of the Safeguards Groups are:

Divisional Capabilities

- Q-1 Development of nondestructive assay (NDA) techniques; test and evaluation of quantitative measurement systems; NDA technology training; NDA standards development.
- Q-2 Development of detection, surveillance and verification instrumentation; nondestructive verification of weapons components; search and recovery operations.
- Q-3 Design and test of plant-wide automated materials measurement and accounting systems that incorporate NDA instrumentation - Dynamic Materials Control (DYMAC).
- Q-4 Systems Analysis: Computer modeling and simulation of fuel cycle processes and measurement systems; conceptual designs of safeguards systems for existing and future nuclear facilities and alternative fuel cycles; assessments of safeguards effectiveness of nuclear material measurement and accounting systems.

A range of techniques has been developed under the LASL Safeguards Program to measure quantitatively recycled scrap and to provide data for low-level trans-uranic waste with sufficient accuracy for sorting at the 10 nci/g fiducial for permanent burial. Cooperative projects to test and evaluate NDA instruments have been conducted with almost all of the major nuclear operations in this country, which include facilities for LWR fuel cycle and the production cycle for national security. Current efforts focus on the development of plant-wide automated materials measurement and accounting systems based on nondestructive assay instruments coupled to a computing system.

In other Q-Division groups, background capabilities relevant to waste management have been developed as a result of their participation in experimental and theoretical studies of the safety of reactor cores for LWR, LMFR, and HTGR reactors. The well-known LASL criticality safety studies are performed in Q-Division.

S-DIVISION CAPABILITIES

The Systems Analysis and Assessment Division was formed in April, 1978, to provide a division-level focal point for interdisciplinary systems analysis and assessment activities at LASL. The Division is chartered to conduct both qualitative and quantitative analysis and assessment. Its capabilities are being broadened to include technology assessment and environmental assessment functions. The Division is an interdisciplinary team of professionals with

Divisional Capabilities

expertise in such fields as sociology, economics, data base management, statistics, energy modeling, environmental analysis, geography, computer programming, engineering, physics, nuclear science, environmental planning, technical communication, and consumer information programs. Initially, the Division has two groups: S-1, Statistics; and S-2, Energy Systems and Economic Analysis.

- S-1 Statistics Group activities include statistical consulting, statistical research and methodology development, statistical training, and maintaining a library of statistical software. The areas of current research and development of statistical methodology related to nuclear waste disposal include: 1) statistical analysis of chemical data; 2) analysis of the effects of radiation on life processes; 3) curve fitting and modeling; 4) development of statistical methods for use in the safeguarding of nuclear materials; 5) analysis of uranium sample data from stream and aerial surveys; and 6) statistical reliability techniques and risk-cost-benefit analyses for reactor safety.
- S-2 Energy Systems and Economic Analysis Group activities provide an interdisciplinary group of physical and social scientists for the evaluation and assessment of the social, environmental, economic and legal aspects of energy related programs. Numerous examples can be provided to demonstrate that the problems of the energy crisis transcend technology and in many instances defy technological solutions alone. Such problems are addressed by the economists, sociologists, physicists, and engineers in the group.

S-Division capabilities include statistical methodology development, techniques of sensitivity analysis, systems modeling, computer generated graphics and mapping overlay system and data base management.

T-DIVISION CAPABILITIES

Groups of T Division perform basic research in medium energy physics, particle physics, solid-state physics, charged particle beam physics, molecular physics, theoretical chemistry, theoretical biology, and applied mathematics. Theoretical problems that fall within the areas of expertise of the various groups would be clearly of interest. More applied physics groups of the Division conduct research in particle transport modeling, nuclear data, fluid dynamics, and equations of state and opacity. These latter groups have skills that can be applied to the problem of modeling a repository to include source characterization, and radionuclide migration.

DIVISIONAL FACILITIES

AP-DIVISION FACILITIES

Tunable laser sources - Nd:YAG laser pumped optical parametric oscillator
 - HF laser pumped optical parametric oscillator

Semiconductor diode lasers

10m White cell for IR and UV absorption measurements

Optics control and measurement laboratory

Eclipse S/230 computer for control and data reduction

NOVA 3/12 computers and data acquisition systems

Streak camera

Supersonic flow systems

Gas dynamic testing laboratory

Laser applied spectroscopy laboratory

CMB-DIVISION FACILITIES

Hot cells for handling high-level gamma radiation

Shielded irradiated fuel storage

Environmental chambers

Soil columns

High-pressure chambers

Automated instrumentation

Excitation sources

High-temperature, high-vacuum furnaces

Induction Heating facilities for:

 Annealing

 Casting

 Decarburizing

 Melting

 Outgassing

 Preparation of ultra-high-purity alloys

 Sintering

 Soldering-brazing

 Spherodizing

Divisional Facilities

Equipment to perform the following procedures:

- Atomic absorption spectrophotometry
- Emission spectrophotometry
- Auger spectrophotometry
- Mass spectrometric determinations
- High-temperature mass spectrometry
- Photoelectron spectroscopy
- High-resolution emission spectroscopy
- X-ray absorption
- X-ray diffraction
- X-ray fluorescence
- Ion microprobe examination
- Electron microprobe examination
- Neutron activation analysis
- Neutron diffraction
- General wet chemical analyses
- Radiochemical analyses
- Spectrophotometry
- Electrometry
- Gas chromatography
- Thermogravimetry
- Thermal analysis
- Differential thermal analysis
- High-vacuum and inert gas fusions

Studies in:

- Environmental chambers
- Soil columns
- High-pressure chambers

- Chemical vapor deposition
- Physical vapor deposition
- Tritium handling
- Plasma arc spraying
- Flame spraying
- Thick film technology
- Scanning electron microscopy
- Mechanical testing
- Solid surface-gas reactions
- Low energy electron diffraction
- Gamma irradiation
- Proton irradiation
- Laser pyrolysis
- Metallography
- Electron microscopy
- Measurements of optical spectra to determine:
 - Wavelength
 - Spectra lines
 - Opacity
 - Radiation damage

Divisional Facilities

Fabrication of:

Plutonium metal and oxide
Uranium metal and oxide
Reactor fuels

Preparation of ultra-high-purity electrorefined plutonium metal.

Determination of high-temperature thermophysical, mechanical, and chemical properties of ceramics.

CNC DIVISION FACILITIES

Chemical Laboratory Space

General-purpose laboratories	- one-man modules with hood (30)
- fume-hoods in larger rooms (30)
- rooms without hoods (7)
High-level chemistry areas	- hot cells (12 x 100 Ci, 1 x 1000 Ci) for gamma-active samples
- dry-box areas for alpha-active samples, 12 boxes, 3 hoods
Low-level chemistry areas	- "clean-room" for particulates
- clean laboratory for ^{244}Pu studies
- "clean hoods and clean benches"
- "clean-room" for sample dissolution
- "clean-room" for mass spectrometer sample preparation

Instrumental Areas

Counting rooms	- automatic beta counters
- alpha counters
- NaI and Ge gamma-ray spectrometers
- beta and alpha spectrometers
- computer control and data collection
- computer data reduction |
|----------------|--|

Divisional Facilities

Instrumental Areas (continued)

- Moiten salt calorimeter
- High-pressure, high-temperature solubility systems
- High-pressure flow systems
- Scanning-electron-microscope with non-dispersive X-ray analyzer
- Emission spectrophotometer in hot cell for high-level samples
- Atomic absorption spectrometer in fume hood
- X-ray fluorescence spectrometer; automatic read-out and data analysis
- Multinuclear NMR capability with FT and SC magnet
- State of the area IR-Raman spectroscopy facilities
- UV-Visible spectroscopy equipment
- Single-crystal X-ray diffraction equipment; automated single-crystal diffractometer
- Equipment for preparation of air-sensitive compounds
- Fluorination equipment
- Equipment for trapping metastable species
- Mass spectrometers
 - two surface-ionization, pulse-counting instruments in "clean-room"
 - three surface-ionization, faraday-cup
 - one "precision-ratio" gas-source
 - one gas-source two-stage for "heavy methanes"
 - two magnetic deflection isotope separators

Computers

- LASL Central Computing Facility
 - access through local computer-based-terminal
 - access through several local keyboard terminals
- Local computing capability
 - PDP-11 and PDP-9 equipped and available for Fortran language computing
 - PDP-11 and PDP-9 incorporated into counting room data processing system
 - several mini- and micro-processors used for data collection and reduction

Divisional Facilities

G-DIVISION FACILITIES

Controlled strain rate 1-GPa/gas triaxial apparatus for strength and deformation measurements.

1.4 GPa gas hydrostatic pressure apparatus for measurement of acoustic and electrical properties at high pressure.

3 GPa solid-media controlled strain rate device (Griggs apparatus).

Modified, microprocessor controlled Griggs apparatus for controlled stress and controlled strain tests; acoustic emission apparatus based on laser technology.

Thermal stress cracking equipment consisting of controlled oven and acoustic emission units.

Direct shear apparatus for measuring shear strength or friction between two surfaces.

40,000 lb. servo controlled testing machine for axial strength tests and low stress compression measurements at various temperatures.

Tinius Olsen testing machine for general materials testing.

Instron testing machine for fracture toughness and compressive strength measurements.

Triaxial pressure vessels for environmental tensile tests and moduli measurements.

500,000 lb. testing machine for use with the triaxial pressure vessels.

H-DIVISION FACILITIES

Two active and twenty inactive solid (radioactive and hazardous chemical) waste storage and burial areas.

Solid waste treatment (compactor) facility (1500 sq. ft.).

Process engineering radioactive waste treatment development facility (TDF) (3500 sq. ft.) includes a 45 kg/hr controlled air incinerator, X-ray package inspection equipment, waste assay instrumentation, waste shredder, and off gas treatment system; process equipment staging and warehouse area (2600 sq. ft.).

Divisional Facilities

Temporary waste package storage shed (600 sq. ft.).

Liquid waste collection system for major LASL laboratory areas.

Liquid waste processing facilities (30,000 gal/mo); includes sludge collecting and handling equipment and pug mill for waste-cement mixing.

Wet chemistry laboratories for processing soil/rock samples and drill core material with low-level concentrations of radioactivity.

Low-level radioactivity measurement laboratory including alpha, gamma spectroscopy, and neutron systems.

Greenhouse laboratory for plant uptake and soil migration studies.

Aerosol collection and measurement laboratories including laser-based instrumentation; instrumentation for aerosol and air cleaning studies is available; includes transmission and scanning electron microscopy, aerosol chambers and generators, and particle counting equipment.

Truck mounted auger; 100 ft. depth capability with selective core sampling.

Geophysical instruments: magnetometer; down-hole TV scanner; portaseismic; stratometer; Am-Be neutron moisture probe; psychrometers.

Nuclear Waste Management assay systems include scintillation, Ge(Li), ^3He , neutron, and proportional counting devices.

J-DIVISION FACILITIES

The very extensive facilities of J-Division are primarily related to the ability to conduct nuclear weapons tests in the field. Many of these facilities are in-house at LASL and represent state-of-the-art facilities. They include: extensive laboratories and associated equipment for the design and development of a wide variety of diagnostic techniques for measuring nuclear phenomena and for characterizing the in-situ environment surrounding a nuclear weapons test; design and fabrication of extensive mechanical systems; hardware and software for the handling and analysis of data; software for the analysis of phenomenology related to nuclear testing--from near the device to rock mechanics phenomena.

Divisional Facilities

In addition, J-Division's facilities are located with sub-contractors such as EG&G's optical, electronics, and software support. The extensive facilities for the support of field activities located at the Nevada Test Site should also be included in J-Division's facilities. These facilities include hardware and the know-how for characterizing a site, drilling, logging and construction.

Because of their extent, J-Division's facilities are only very briefly described here. They might be best summed up by stating that J-Division could readily field extensive waste management experiments with state-of-the-art facilities.

Q-DIVISION FACILITIES

Neutron and gamma ray spectroscopy laboratories for the development of NDA instruments for measurement of fissionable materials.

NDA standards laboratory including physical standards for fuel cycle materials.

Van de Graaff accelerator and two Cockroft-Walton accelerators.

Custom electronics laboratory.

Shielded cells and remote handling for radioactive materials including ^{252}Cf sources.

Critical assemblies including fast burst devices.

Heat pipe development laboratory.

Divisional Facilities

S-DIVISION FACILITIES

The major facility available to S Division is access to the LASL Central Computer Facility which consists of four CDC-7600 computers and a CRAY-1 class 6 computer. Extensive mass storage and other peripherals are also available. The Division also has special capabilities in computer graphic display systems and in computer mapping systems.

T-DIVISION FACILITIES

The major facility available to T Division is access to the LASL Central Computer Facility which consists of four CDC-7600 computers and a CRAY-1 class 6 computer. Extensive mass storage, graphics, and other peripherals are also available.

LASL TECHNICAL ORGANIZATION

This report summarizes the current, related, and potential waste management programs for those Laboratory divisions presently involved in such activities. These divisions do not constitute the only technical divisions in the Laboratory that could contribute to waste management activities. The organization chart given on the following page summarizes the LASL technical organization.

JUNE 1978