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Sandia Laboratories Technical Capabilities

Auxiliary Capabilities

Environmental Health
Information Science

MASTER



Sandia Laboratories

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Printed September 1975

SANDIA LABORATORIES TECHNICAL CAPABILITIES

AUXILIARY CAPABILITIES

ENVIRONMENTAL HEALTH INFORMATION SCIENCE

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ABSTRACT

This report characterizes some of the auxiliary capabilities at Sandia Laboratories. These auxiliary capabilities provide essential support to the line organizations.

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SANDIA LABORATORIES

Sandia Laboratories is an engineering laboratory in which research, development, testing and evaluation capabilities are integrated by program management for the generation of advanced designs. In fulfilling its primary responsibility to the Energy Research and Development Administration for the weaponization of nuclear devices, Sandia Laboratories has acquired extensive research and development capabilities and has made numerous contributions to scientific and engineering fields. With the redirection of national priorities, the expertise thus accumulated is also being used to meet important nonweapon goals. The purpose of this document is to catalogue the many technical capabilities of Sandia Laboratories that are being applied to the solution of diverse engineering problems.

Sandia – which is located in Albuquerque, New Mexico; Livermore, California; and Tonopah, Nevada – is operated by the Bell System for the Energy Research and Development Administration on a no-fee, no-profit contract with Western Electric. The FY 75 budget for the Laboratories was \$248.7 million, of which \$190 million was committed to weapon programs, \$7.1 million was spent in energy programs, and \$7.7 million was spent in the study of nuclear fusion and fission. The remaining \$43.9 million was applied to reimbursable funding of projects for other federal agencies. In the distribution of these funds, 20 percent was expended in analytical system studies and exploratory development, 67 percent in development activities, and 13 percent in applied research.

The Laboratories' staff at the beginning of FY 76 was 6405; of these, 5500 were located in Albuquerque, 866 in Livermore, and 39 in Tonopah.

The capital investment for Sandia Laboratories is \$322 million. Major test facilities used to simulate the severe environments specified for Sandia designs are included in this investment.

FOREWORD

The technical capabilities of Sandia Laboratories—the basic tools used to solve research and development problems—are catalogued in this source report.

The capabilities listed are all in current use. They are presented without reference to specific programs or organizations. It is intended that the description of these capabilities will allow those concerned with planning to directly associate our resources to the technical requirements of studies being considered. The report is also a source of technical information for other laboratories, federal agencies, and for our own staff.

Supporting information is provided in the form of "highlights" which show applications of the capabilities. These highlights, or selected accomplishments, are presented at the end of each listing of capabilities to illustrate the sophistication of that activity.

Fields of technical competence are identified. An executive summary containing general descriptions of these activities is published as a separate document. For those wishing greater detail, each field is fully described in its own document. Finally, for those interested in the total capabilities of the Laboratories, all the separate documents are published in a single compilation bearing its own number. The publications and their identifying numbers are given below.

C. Donald Lundergan, Technical Editor
P. L. Mead, Publication Editor

FUNCTIONS REPRESENTING THE TECHNICAL CAPABILITIES OF SANDIA LABORATORIES

Executive Summary (SAND74-0091)

Aerosciences	SAND74-0075	Instrumentation and Data Systems	SAND74-0083
Applied Mathematics	SAND74-0079	Materials and Processes	SAND74-0073A
Biosciences	SAND74-0076	Measurement Standards	SAND74-0077
Computation Systems	SAND74-0080	Physical Sciences	SAND74-0074
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Earth Sciences	SAND74-0085	Assurance	SAND74-0090
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Engineering Analysis	SAND74-0087	Auxiliary Capabilities	SAND74-0082
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		Information Sciences	

Sandia Laboratories Technical Capabilities (SAND74-0092)

ACKNOWLEDGMENT

This report was prepared at the request of R. L. Peurifoy, Jr., Director of Systems Development. The information given herein represents the efforts of so many people that it is not possible to give adequate credit to them all. However, there are several whose special efforts warrant acknowledgment, and they are listed below:

Aerosciences - W. H. Curry; Applied Mathematics - R. J. Thompson; Biosciences - C. A. Trauth; Computation Systems - A. R. Iacchetti; Design Definition and Fabrication - F. L. Baker, K. E. Weidner; Earth Sciences - C. W. Young; Electrochemical and Electromechanical Technologies - N. E. Brown, K. Gillespie, B. H. VanDommel; Electronics - J. E. Gover, E. G. Franzak; Engineering Analysis - S. W. Key; Environmental Health - W. D. Burnett; Information Sciences - D. K. Seager; Instrumentation and Data Systems - W. V. Hereford, W. K. Paulus; Materials and Processes - R. W. Rohde; *Measurement Standards* - J. A. Southwick, M. C. Jones; *Physical Sciences* - L. L. Bonzon, A. J. Chabai, R. T. Johnson, J. H. Renken, A. J. Toepfer; Safety and Reliability Assurance - B. R. Emrick; Systems Analysis - V. L. Dugan, R. G. Clem; Testing - G. W. Barr.

The aid of A. N. Blackwell and the helpful suggestions and comments of H. T. Stump and R. W. Rohde are greatly appreciated. The help of the technical writers L. C. Baldwin, C. K. Lumpkin and W. L. Garner is also gratefully acknowledged, as is the skill of the compositor, Mrs. Julia Polito.

ENVIRONMENTAL HEALTH

ABSTRACT

This report characterizes the environmental health capabilities at Sandia Laboratories. Selected applications of these capabilities are presented to illustrate the extent to which they can be applied in research and development programs.

ENVIRONMENTAL HEALTH*

The primary responsibility of the environmental health function is the evaluation and control of hazardous materials and conditions. The evaluation and control of toxic materials, nonionizing radiation such as laser beams and microwaves, and ionizing radiation such as from radiation machines and radioactive sources, are examples of the activities of environmental health programs. A chemical laboratory is operated for the analysis of toxic and radioactive substances and for the bioassay program to provide an index of internal exposure of personnel to toxic and radioactive materials. Instrumentation support and development is provided for environmental health activities. A dosimetry program is maintained to measure personnel exposure to external ionizing radiation. A radiation counting laboratory is maintained. Reentry safety control and effluent documentation support are provided for underground nuclear tests at the Nevada Test Site.

Environmental Health Laboratory

<u>Professional Staff</u>	<u>Investment in Equipment (in \$1000)</u>
18	\$926

*Compiled February 1975

Hazard Control

Programs are aimed at evaluating potential hazards to personnel that may exist in current and proposed research and development activities. Emphasis is placed on maintaining the state of the art in personnel-protection techniques.

Current Activities

- Toxic materials
 - Atmosphere sampling for gaseous and particulate matter
 - Particle-size analysis
 - Toxicity evaluation
- Nonionizing radiation
 - Microwaves
 - Lasers
 - Thermal effects
 - Ultraviolet and infrared light
- Ionizing radiation
 - Electron-beam fusion
 - Laser fusion
 - Radioisotope thermoelectric generators
 - High-energy pulsed x-ray machines
 - Pulsed research reactors
 - Mixed fission-product hot-cell work
 - Plutonium-in-air dispersal studies
 - Shielding calculations
- Noise
 - Industrial
- Sanitation
 - Food service
 - Potable water quality

Analytical Chemistry

Analytical methods are employed to determine qualitatively and quantitatively trace levels of chemical contaminants in air, solids, and liquids. (Item 1)*

Current Activities

- Analytical programs
 - Urine bioassay
 - Air, water, soil, and vegetation samples
 - Trace-metal analysis
 - Proprietary product identification
 - Method development

*See Highlights below.

Analytical methods

- Atomic absorption spectrophotometry
- Emission spectrography
- Visible, ultraviolet, and infrared spectrophotometry
- Gas chromatography
- Fluorimetry
- X-ray fluorescence spectrometry
- Liquid scintillation spectrometry
- Alpha and gamma-ray spectrometry
- Classical wet chemistry

Typical analyses

- Heavy metals
- Beryllium
- Organic solvents and compounds
- Tritium
- Actinides
- Fission products
- Halogens
- Air pollutants

Radiation Dosimetry

Thermoluminescent dosimeters are employed to quantize beta, gamma, and neutron personnel exposures over wide ranges. The exposed dosimeters are packaged in a way that permits automatic exposure readings, and a computer program is used for data reduction, record keeping, and report generation. It is also possible to measure high dose levels and rates by the use of activation materials such as gold, indium, and copper. (Item 2)

Current Activities

Thermoluminescent dosimetry

- Gamma
- Beta
- Neutron
- Criticality dosimetry
 - High-level gamma
 - High-level beta
 - High-level neutron

Applications

- Personnel
- Area
- Device
- Environment
- Accident

Instrumentation Development

Health protection equipment has been developed when needed devices were not available commercially. Most development has to do with special ionizing-radiation detection equipment and electronic accessories for laboratory operations. (Items 3-5)

ENVIRONMENTAL HEALTH

Current Activities

- Plutonium-wound counter
- Tritium-in-air monitor
- Shock-hardened gamma detectors
- Multichannel data handling
- High-dose-rate nonsaturating detectors
- Forward-light-scattering photometer

Radiation Counting Laboratory

A radiation counting laboratory is maintained to routinely investigate radioactive samples with activities in the picocurie range. Both qualitative and quantitative determinations are made. Automated counting systems are available for gross alpha and beta, alpha spectrum, and liquid scintillation counting. Punch tape data in the ASCII II code are generated for computer reduction. Low-background shields are available. (Item 6)

Current Activities

- Liquid scintillation
- Alpha spectrometer
- Beta spectrometer
- Gamma spectrometer
- X-ray fluorescence
- Gross alpha and beta multisample counters
- Low-level counting enclosures

Reentry Safety and Effluent Documentation

Experience has been gained in evaluating the extremely hostile environments associated with the underground testing of nuclear devices. Data from instrumentation are used to evaluate several environmental conditions such as high radiation and tunnel failure, to document "source terms" and released amounts of radioisotopes, and to develop procedures for safely reentering and rehabilitating a facility. The capability is available for working in and/or with high radiation-exposure levels, gross contamination, explosive-gas atmospheres, and highly toxic materials. (Refer to Item 1)

Current Activities

- High-level radiation contamination
- Surface reentry
- Underground reentry
- Long-term facility rehabilitation
- Decontamination
- Long-line (greater than 1 mile) gas sampling and component characterization
- Radiation-source term determination
- Gases
- Megacurie activities
- Effluent documentation of released gases
- Instrumentation hardening and multiple remote-readout capabilities

• • • • • HIGHLIGHTS • • • • •

Item 1. Remote Gas Sampling

After an underground test of a nuclear device, the gaseous environment is analyzed for the presence of toxic elements before personnel are allowed to reenter the test area. A system has been devised in which gas samples are drawn from the most distant parts of each side drift and other critical points, and are transmitted through piping to a portable laboratory where they are analyzed by means of a gas chromatograph. Explosive mixtures of flammable gases also have been measured on several occasions.

The long-line sampling system (Figure 1) has been used on 16 test events, during each of which 20 to 30 atmospheric samples were analyzed.

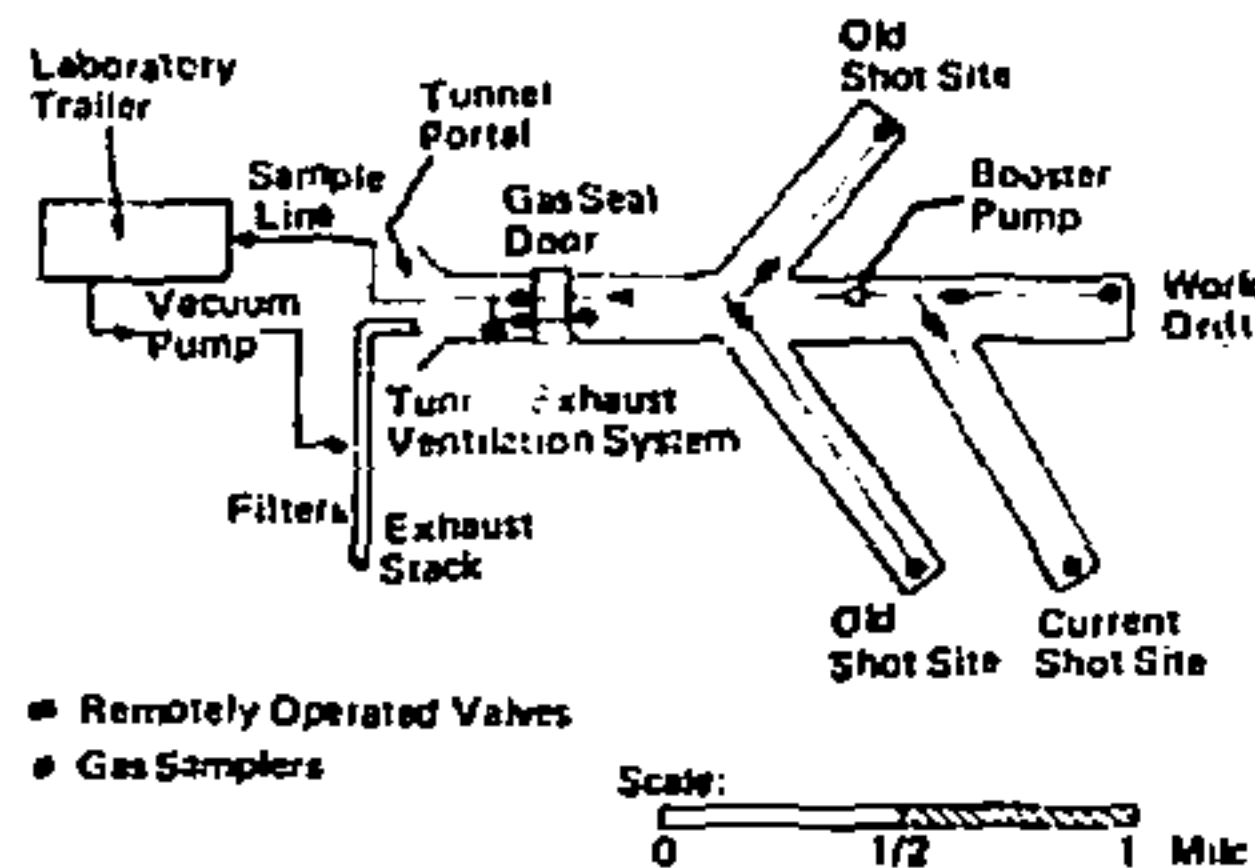


Figure 1. Long-line sampling system

Item 2. Thermoluminescent Dosimeters (TLD's)

A continuing radiation dosimetry program has been developed to monitor and document significant personnel exposures to beta, gamma, and/or neutron radiation. The system is based on uniquely identified thermoluminescent dosimeter packages (Figure 2) that can be automatically evaluated and reported in computer-compatible format. The computer reduces the data and performs accounting functions.

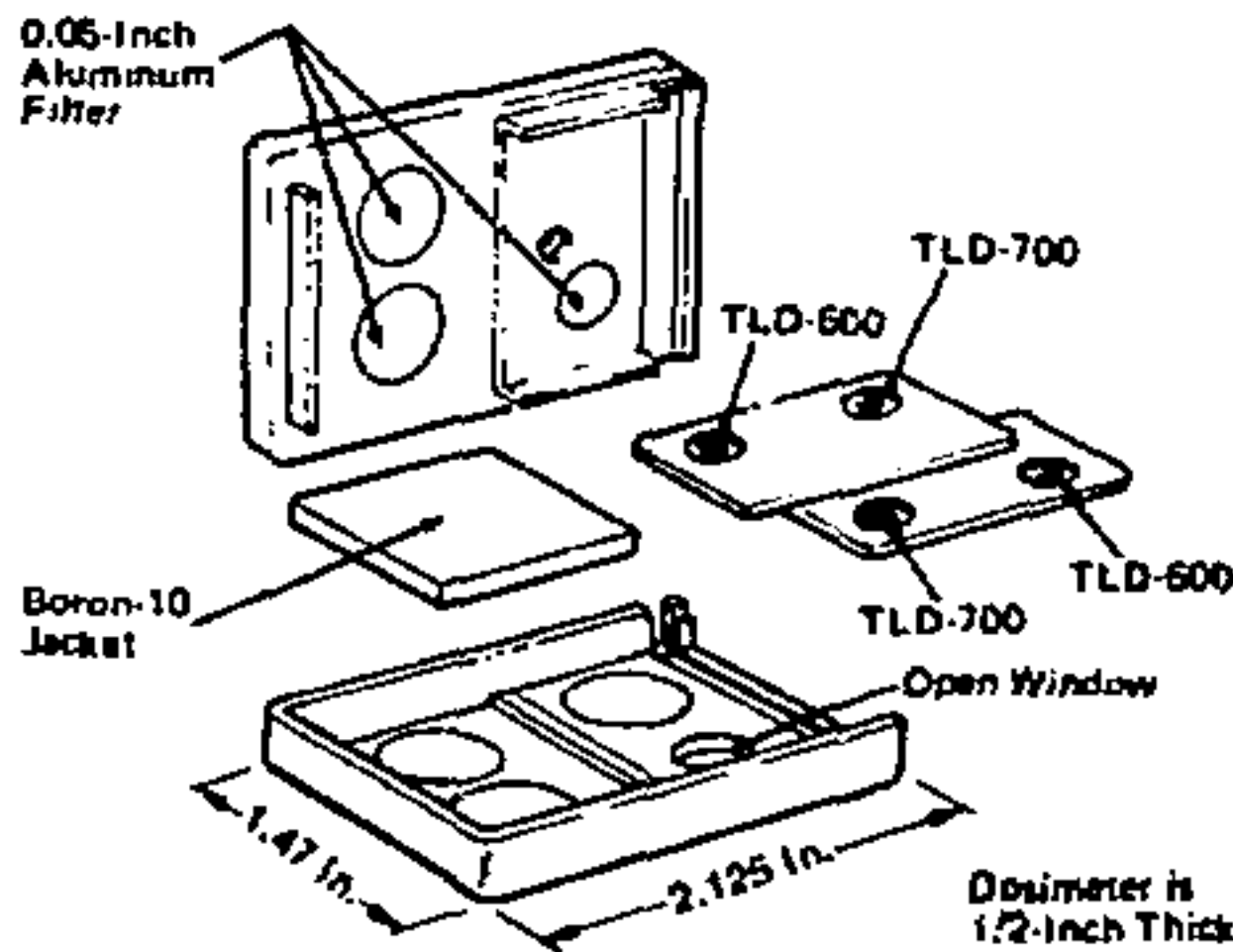


Figure 2. Thermoluminescent dosimeter cards and holder. (TLD-600 dosimeters are neutron- and gamma-sensitive; TLD-700's are gamma-sensitive and neutron-insensitive.)

Item 3. Shock/Temperature-Hardened Radiation Sensors

Enclosures housing radiation detectors and associated cabling have been designed and used to allow placement and long-term survival (of the order of days) of radiation sensors in the near vicinity of underground nuclear detonations. Sensors without this hardening could not survive stresses in the region where tunnel collapse occurs. About 70% of the sensors are now routinely recovered, usually in sufficiently good condition to be used on later tests.

The enclosures are designed to maintain sensor temperature below 65°C for at least 30 minutes in an atmosphere of 300°C and 600 psi.

Item 4. Pulsed Neutron Detector

A device was needed that would provide the health physicist a direct measurement in rem (roentgen equivalent, man) of single or multiple short bursts of neutrons. The system developed to answer that need (Figure 3) uses activation of rhodium metal by thermal and epithermal neutrons present at the center of a 10-inch spherical moderator. The resulting beta activity of the rhodium is detected by use of a plastic fluor in intimate contact with the metal.

The detector and its attendant conventional electronics provide a stable pulse-counting system that is semiportable. The equipment has been calibrated with pulses as short as 7×10^{-6} second and has a sensitivity as low as 5×10^{-5} rem. It is used around pulsed research reactors and in neutron-generator tube applications.



Figure 3. Pulsed neutron detector

ENVIRONMENTAL HEALTH

Item 5. *Increased Sensitivity for a Forward-Light-Scattering Photometer*

A commercial smoke photometer for testing high-efficiency particulate air filters was improved by Sandia. The photometer was modified to collect forward-scattered light at angles greater than 20 degrees from the center axis, and to reduce stray light at lesser angles. It has been shown that peak intensity is attained at angles greater than 20 degrees (Figure 4).

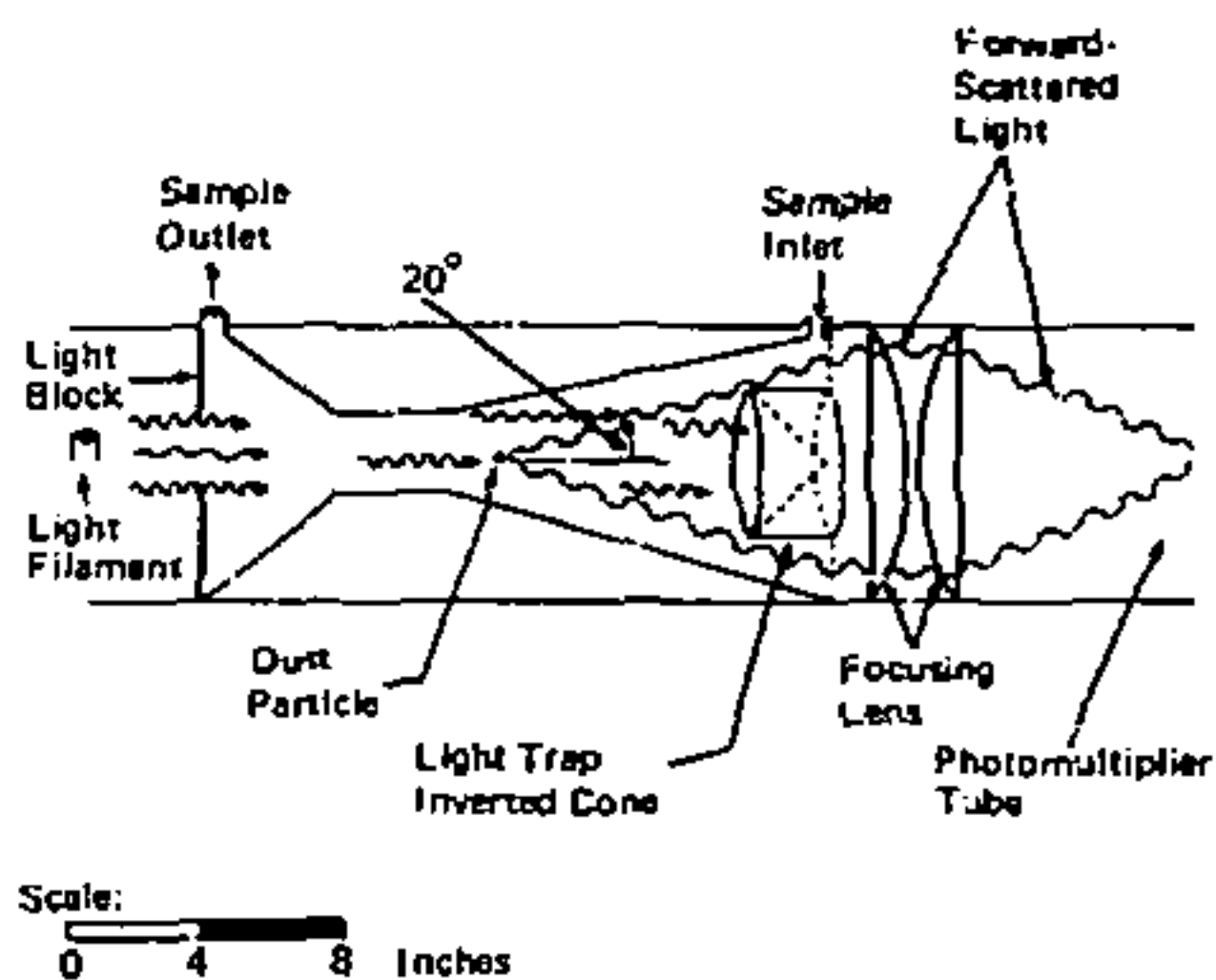


Figure 4. 20-degree angle forward-light-scattering chamber

Item 6. *Automated Alpha Spectrometry System*

Precise alpha spectrometry is normally performed under vacuum, and therefore is not compatible with conventional automated sample changers. A system has been developed that rotates samples into counting position without loss of the vacuum in the counting chamber. Information from the system is processed by multiple single-channel and/or multichannel analyzers with computer data-reduction capabilities.

The system (Figure 5) has a minimum detectability level of $3 \times 10^{-8} \mu\text{Ci}$.



Figure 5. Automated alpha spectrum system

INFORMATION SCIENCE

ABSTRACT

This report characterizes the information science capabilities at Sandia Laboratories. Selected applications of these capabilities are presented to illustrate the extent to which they can be applied in research and development programs.

INFORMATION SCIENCE*

The information science activity functions within the framework of Sandia Laboratories' technical libraries. Information science is oriented toward the efficient dissemination of information to technical and administrative personnel. Computerized systems are used to collect, process, and circulate books, reports, and other literature. Current awareness, reference, translation, and literature-search services are also provided.

Information Science Staff

	<u>Staff</u>	<u>Clerical Support</u>
Computer Management of Materials	5	39
Current Awareness Services	4	2
Reference and Translation Services	6	5

*Compiled May 1975

Computer Management of Materials

The computerized material-management system contains records of all library holdings and generates required processing lists and forms. System programs provide on-line input to and retrieval from the master file, on-line circulation transactions, and batch output of catalogs, inventory lists, overdue notices, purchase orders, claim notices, and special reports. (Items 1,2)*

Current Activities

- Master file maintenance
 - File searching (on-line)
 - Dictionary entry using random access by various keys
 - Boolean search logic
 - Display of complete master file record
 - Input editing (on-line)
 - Format editing of additions and modifications
 - Retrievable output to disk update file
 - File updating (batch)
- Circulation transactions
 - Circulation record searching (on-line)
 - Entry by borrower name or by call number
 - Display of current status
 - Input of current transactions (on-line)

Current Awareness Services

The goal of these services is to bring technical and administrative personnel into contact with elements of current literature that could influence laboratory studies. This is done by means of widely disseminated notifications about the availability of new and pertinent material. The process is called the current awareness service.

Sources for current awareness announcements are new book and report acquisitions, recently published journal articles and conference papers, prepublication notices of journal articles and conference papers, and publication announcements of government reports. Services available include a computerized selective dissemination of information process using individualized interest profiles, and printed library publications (most of them computer-generated). Efforts are made not only to inform the using public of new material but to make this material immediately available. (Item 3)

Current Activities

- Selective dissemination of information
 - User-interest profiles of Boolean keyword combinations

*See Highlights below.

Computer matching with any or all data bases

- Journal articles
- Library book and report acquisitions
- ERDA reports
- DOD reports
- Search narrowing within fixed subject areas
- Computer-generated publications
- Library accessions
- Current journal articles in physics

Reference and Translation Services

Reference services are aimed at providing prompt replies to technical and administrative questions. Toward this end, subject specialists of the reference staff keep abreast of scientific interests by reading technical and progress reports, attending colloquia, and acquiring information from technical personnel. On the basis of this background they select material for the collection, conduct literature searches, prepare formal bibliographies and state-of-the-art surveys, and organize special collections. Reference personnel also function as consultants to groups wishing to organize their own information resources, provide translations of foreign language material, and arrange for inter-library loans of special material. (Items 4-6)

Current Activities

- Computerized searches
 - ERDA data bases via telecommunications network (RECON)
 - Library book file via teletype console link to Univac-1108
- Specialized data centers
 - Computer-indexed information centers file
 - Service contracts with bibliographic data centers
- Special collections and data bases
 - Environmental projects data base
 - Computer codes data base
 - Energy resource center
 - Terracyamics map file
- Consultation services
 - Referrals to sources of technical expertise
 - Referrals to sources of materials
 - Generation of indexes, manual or computerized
 - Circulation systems, manual or computerized
- Translation services
 - Obtaining foreign-language material
 - Service contracts with translation agencies
- In-house services
 - Oral reading
 - Foreign correspondence
 - Submissions to foreign-language journals
 - Formal translations

Item 1. Operations Overview

The data in Table 1 indicate the size and value in dollars of the technical library operation. In an average month the library processes approximately 6800 new items and circulates approximately 6700 items. The computerized material-management system that controls these items is depicted in Figure 1. It integrates all functions previously performed by manual operations.

processed daily. The input of new data to the master file takes place in two stages: on-line keying to a disk file followed by batch-mode updating of the master file. Items in the temporary disk file may be retrieved at any time until the batch update takes place. This description deals with the on-line editing portion.

Item 2. Input Editing (On-Line)

To speed processing of new library acquisitions and purchase orders, transactions against the master file are

Input procedures are of two types: addition of a new family of records for a new title, or modification (or deletion) of records for a title already in the master file. Input of new records or changes to existing records may be made in any sequence; records that pass the edit stage are sorted for placement in the update file on disk.

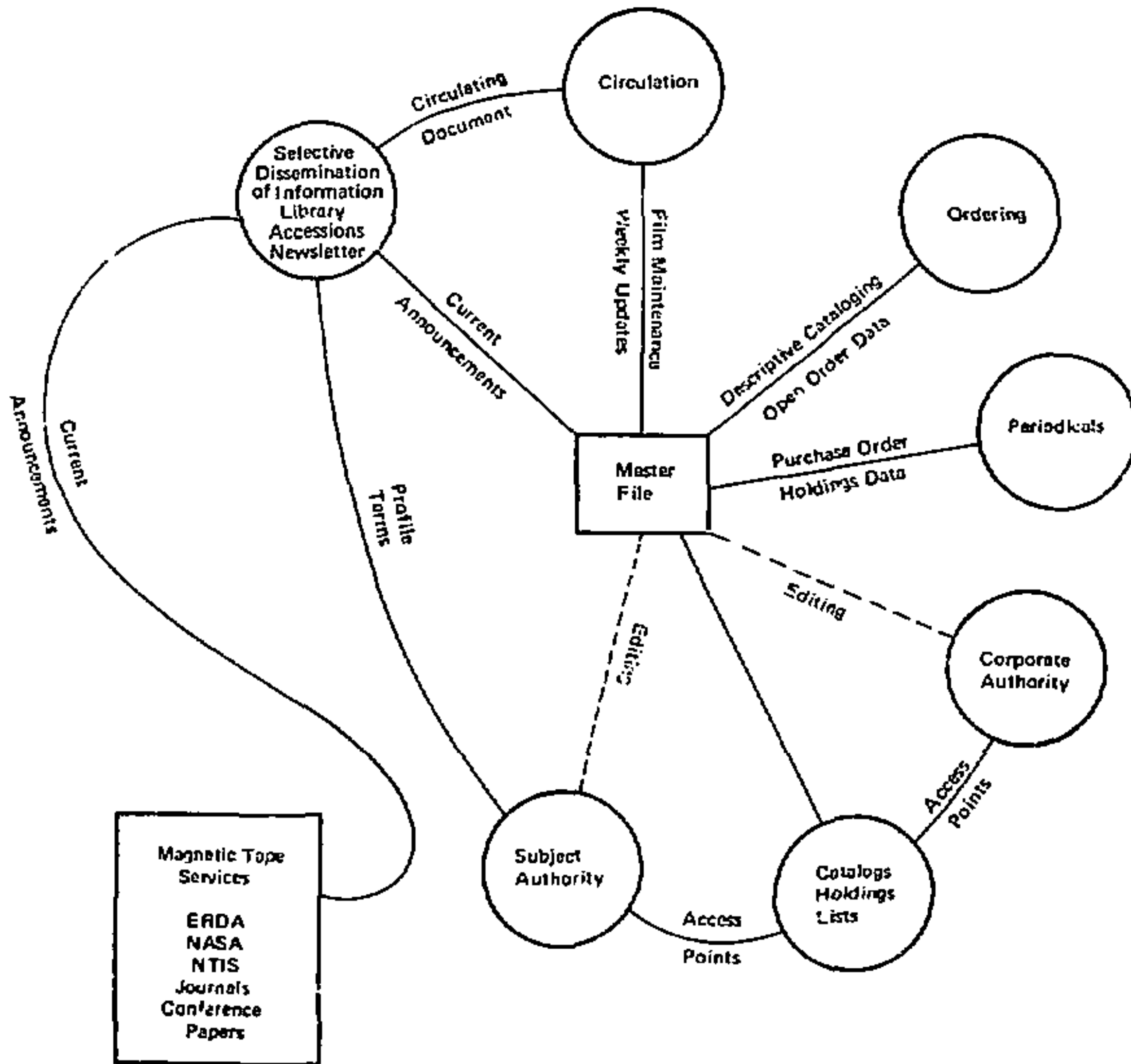


Figure 1. Integrated Livermore/Albuquerque library system

TABLE I
Collection Size and Value, Equipment Investment, and Service Contracts

	Collection		Equipment (excluding facilities, furniture, and shelving)	Service Contracts
	Size	Approximate Value		
Books:	47,000	\$587,500	Microform readers: \$ 34,300	Computer tape services (annual): \$14,000
Paper reports:	119,000	\$450,500	Microform storage: \$ 18,000	Bibliographic search services (annual): \$ 5,000
Microfiche reports:	420,000	\$870,000	Computer terminals: \$ 17,000	Translation services (annual) \$ 1,000
Periodical volumes:	34,000	\$800,000	Computer time (annual): \$120,000	
Periodical subscriptions:	2,000			
Periodical microfilm		\$ 60,000		
Titles:	220			
Reels:	3,700			

Data in each line or field should contain specific types of information, depending on the line number or field position. This information is machine edited before the record is released to sorting. For example, in the call-number field, each position of the number is checked to see whether it is alphabetic, numeric, or a dash, depending on the position. Any character that does not conform in type to that expected for the position is referenced with an asterisk. The incorrect entry with underscoring is displayed on the on-line terminal as shown in Figure 2, and will only be released to the disk file after appropriate corrections have been made.

Item 3. *Selective Dissemination of Information Algorithm*

Individualized current awareness announcements are generated weekly by computer to inform recipients about new books, reports, conference papers, and journal articles that match their interest profiles. These profiles consist of Boolean combinations of subject categories, authors, and keywords. The term-matching algorithm developed for this Selective Dissemination of Information (SDI) system depends on enumeration of the profile terms into 8-character numeric strings. The Boolean "or" operation is defined by terms enumerated into the same 8-character string. Boolean "and" (or "not") combinations of the profile terms are represented by 8-character composites. An example is given in Figure 3.

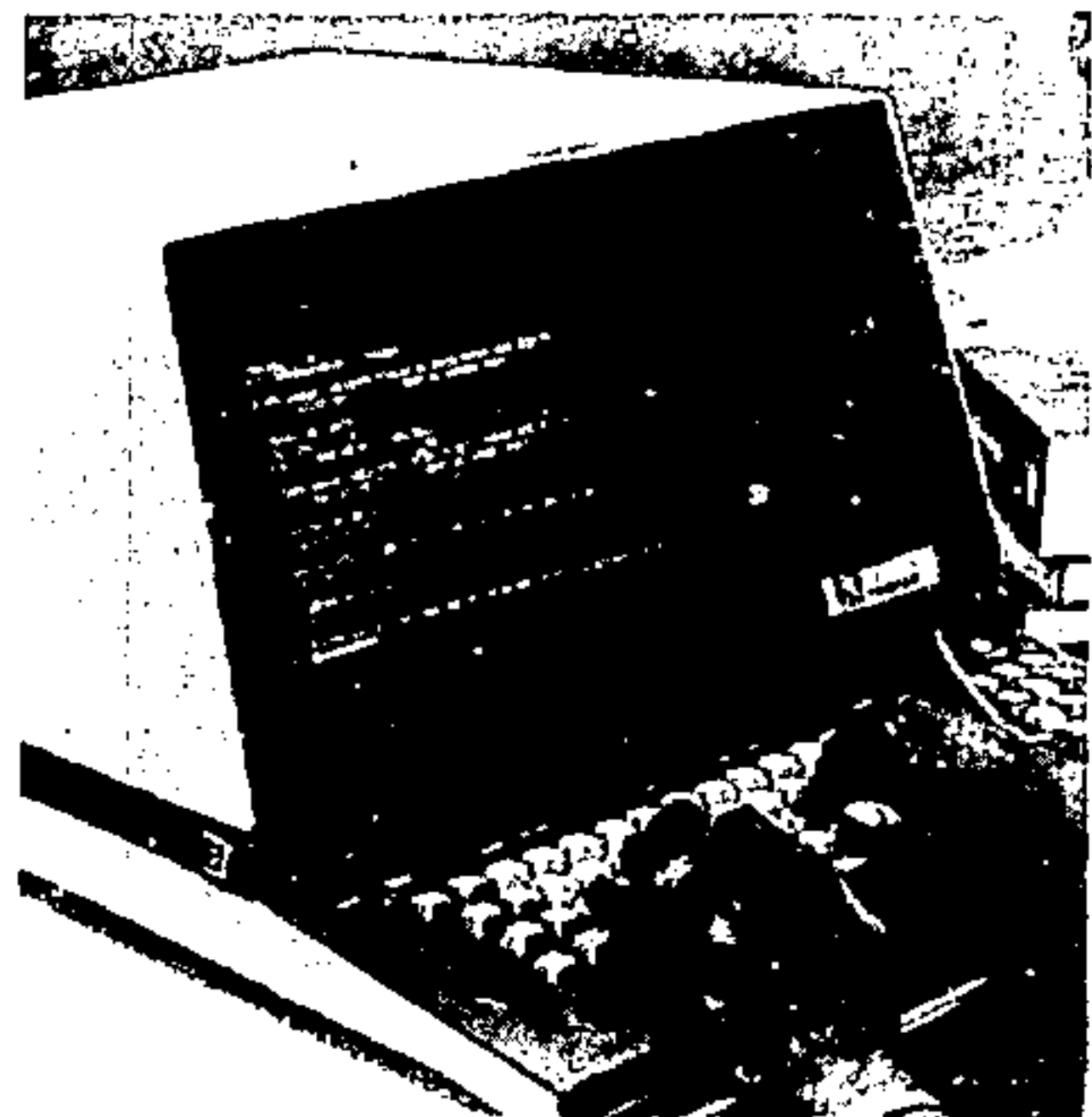


Figure 2. On-line modification of data files

Terms	Enumerated Terms	Boolean Combinations
Fracture	20000000	21200000
Steel	01000000	
Embrittlement	20000000	31200000
Hydrogen	00200000	
Jones JP	30000000	90000000
Alloys	01200000	
Metallurgy	01200000	
Corrosion	90000000	

Combination 21200000 = (Fracture or Embrittlement) and (Steel and Hydrogen) or (Fracture or Embrittlement) and (Alloys or Metallurgy)

Combination 31200000 = Jones JP and (Alloys or Metallurgy) or Jones JP and (Steel and Hydrogen)

Figure 3. Example of machine representation of Boolean combinations of Selective Dissemination of Information profile terms

At the time this computer program is run the SDI profiles containing alphanumeric terms, the enumerated value of these terms, and the enumerated Boolean combinations are processed against one of the SDI data bases. As each record or group of records representing a particular book, report, or journal citation is read in, the alphanumeric profile terms are matched against corresponding terms in the appropriate field (title word, author, etc.). If matches are found, the enumerated strings representing those terms are flagged. Then each character in the first Boolean pattern is matched against "ored" flagged strings. If every character in the pattern can be found in its designated location in the first flagged string, the citation is output as a "hit." If not, the next Boolean pattern is tried until all are exhausted. This algorithm allows both complex and simple Boolean combinations to be represented in just a few 8-character patterns. Highly specific or broadly general interest profiles can be written with facility.

Item 4. Computerized Searches (On-Line)

On-line searching of computerized data banks allows technical personnel and the library staff to compile bibliographies or locate single citations in a fraction of the time needed with manual methods. The library has two on-line retrospective search systems: the RECON system sponsored by ERDA, and the ASTORS* system. ASTORS is a user interactive program written in COBOL, and it makes use of the Index-Sequential/Random-Access capability. It uses two disk data files: an alphanumeric

*Author-subject-title on-line retrieval system.

dictionary file that contains 304,000 records, each consisting of a search key and a master file entry number, and the master book file, which contains 393,000 records representing 39,000 book titles. The search keys available are author name, subject term, title word, and Library of Congress classification number.

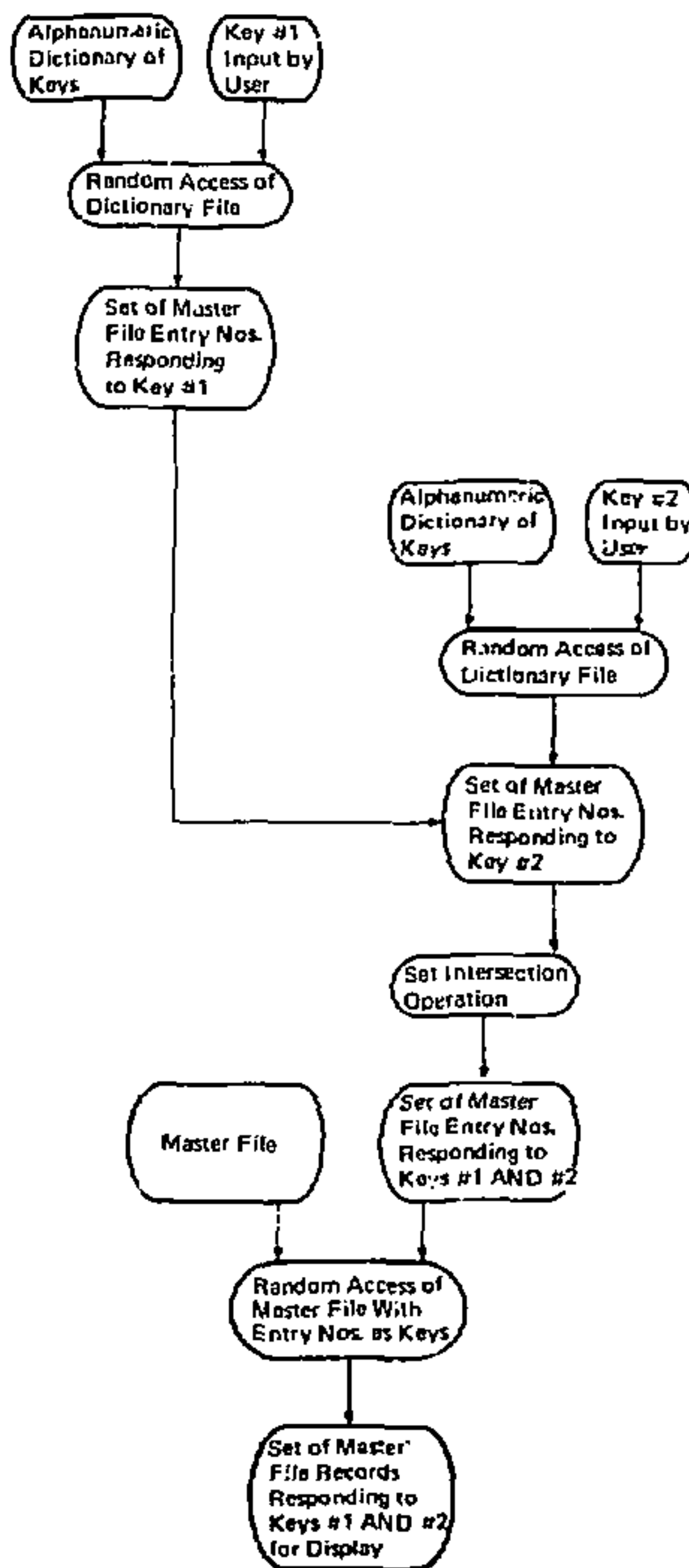


Figure 4. Illustration of ASTORS search with Boolean "and" condition

The chief advantage of the system is the rapid retrieval of book titles that fit user criteria. This is accomplished through Boolean search statements that combine search keys to eliminate all but the desired titles. For example, there may be 500 titles indexed by the term METALS and 200 by the term FRACTURE, but only 20 titles indexed by both these terms. Response to search requests is immediate (<1 second). The flow diagram in Figure 4 depicts the program logic for a search using a Boolean AND statement.

Item 5. Terradynamics Map File

The library's reference group organized a map file for the study of Terradynamics; i.e., phenomena attendant upon earth penetration by high-velocity projectiles. Detailed maps (in 8,000 sheets) of the geology, soils, and topography of 27 Eurasian countries were selected, acquired, classified, and catalogued in the library's master file. Coding permits the extraction of a specialized, computer-generated index of countries, subject words, title words, publishers, and authors.

The map files are managed and maintained by the Terradynamics organization, while the Reference group follows the state of knowledge and provides continuing selection of new materials.

Item 6. Energy Resource Center

The reference staff has organized a special collection of energy-related materials designed to provide background and current information to technical personnel. The collection contains basic bibliographies, current newsletters, an archive of journal articles, and a display of new library acquisitions.

A weekly-published Library News Bulletin announces new receipts and journal articles in the energy field. A computer-generated keyword index to items announced in the bulletin provides a bibliographic tool for retrieving items in the rapidly growing energy collection. A sample page from this index is shown in Figure 6.

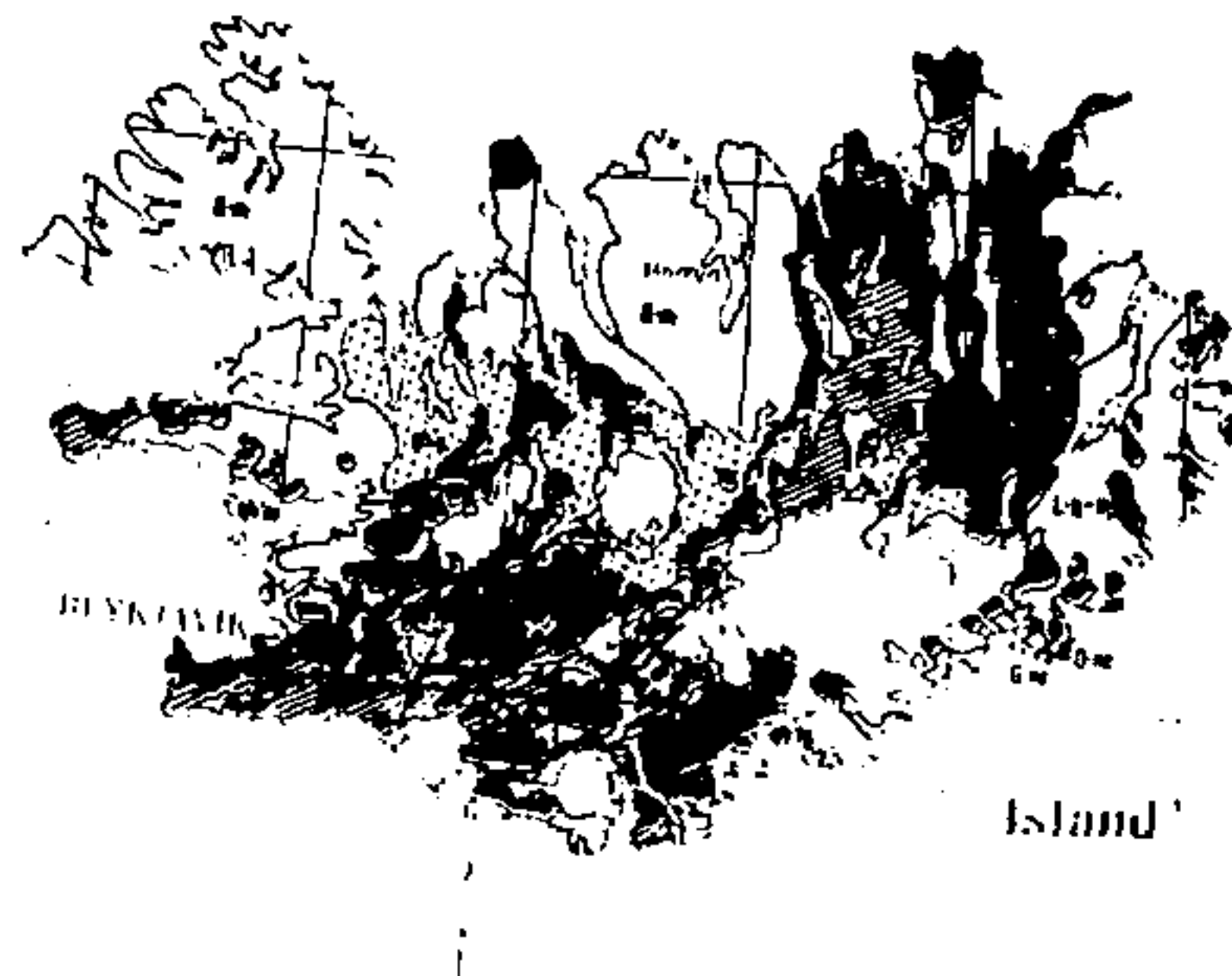


Figure 5. The Iceland section of a geologic map of Europe

INFORMATION SCIENCE

Sanjour Laboratory

NEWS BULLETIN INDEX

05/16/75

LAND-USE	> 750120B SEISMIC HAZARDS AND LAND-USE PLANNING
LARGE-SCALE	> 750210J UTILITIES EYE LARGE-SCALE ENERGY STORAGE
LASER	> 750320J NUCL : LONDON CONFERENCE HEARS OPTIMISTIC TALK ABOUT LASER ENRICHMENT > 750312J NUCL : ERDA AWARDS A \$350,000 LASER FUSION CONTRACT TO KMS > 750106J LASER FUSION : ONE MILEPOST PASSED - MILLIONS MORE TO GO > 750120J POSSIBILITY OF CONSTRUCTION OF A HIGH-POWER LASER UTILIZING AMPLIFICATION OF DIVERGING LIGHT BEAMS
LEVEL	> 750305R MANAGEMENT OF COMMERCIAL HIGH LEVEL AND TRANS - URANIUM CONTAMINATED RADIOACTIVE WASTES
LIGHT	> 750120J POSSIBILITY OF CONSTRUCTION OF A HIGH-POWER LASER UTILIZING AMPLIFICATION OF DIVERGING LIGHT BEAMS
LIMITATION	> 750203J STRATEGIC ARMS LIMITATION I : THE DECADES OF FRUSTRATION
LIQUEFACTION	> 750203H COAL GASIFICATION AND LIQUEFACTION SYMPOSIUM : UNIVERSITY OF PITTSBURGH, PITTSBURGH, PENN. - AIN
LIQUID	> 750320R PROPOSED FINAL ENVIRONMENTAL STATEMENT : LIQUID METAL FAST BREEDER REACTOR PROGRAM
LMFR	> 750127J THE LMFR : THE ONLY ANSWER
LOAD	> 750219J SOLAR HEAT GAIN THROUGH WALLS AND ROOFS FOR COOLING LOAD CALCULATIONS > 750312J SOLA : SOLAR HEAT GAIN THROUGH WALLS AND ROOFS FOR COOLING LOAD CALCULATIONS
LOCK	> 750210R LOCK SECURITY
LOG	> 750210J EVALUATING OIL SHALE BY LOG ANALYSIS
LONDON	> 750320J NUCL : LONDON CONFERENCE HEARS OPTIMISTIC TALK ABOUT LASER ENRICHMENT
LOOK	> 750319J NATI : FOUR CORNERS MATS AND OTHER LOOK > 750113J PROJECT INDEPENDENCE : A CRITICAL LOOK > 750106J TAKE A LOOK AT THE FIRST
LOS	> 750312R THE REGIONAL IMPACTS OF NEAR - TERM TRANSPORTATION ALTERNATIVES : A CASE STUDY OF LOS ANGELES
MAGNETALS	> 750210J CHEMICAL STRUCTURE AND PROPERTIES OF COAL XBIT - BEHAVIOR OF INDIVIDUAL MAGNETALS AND BLENDS IN THE
MAGMA	> 750120R HEAT EXTRACTION FROM A MAGMA RECEPTOR
MANAGEMENT	> 750305R MANAGEMENT OF COMMERCIAL HIGH LEVEL AND TRANS - URANIUM CONTAMINATED RADIOACTIVE WASTES > 750305J WAST : RISK ANALYSIS OF NUCLEAR WASTE MANAGEMENT SYSTEMS
MANDATORY	> 750113J MANDATORY CONSERVATION COMING SOON IN THE U.S.
MANTLE	> 750319J GENE : THE EARTH'S MANTLE
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Figure 6. News Bulletin weekly index for energy logics