

Laboratories Accomplishments 1987

Expanding on a LAB NEWS feature begun seven years ago, *Laboratories Accomplishments 1987* sums up what we, Sandia National Laboratories, consider our principal achievements for the year just past.

The work summarized here has been submitted by organizations in Albuquerque, Livermore, and Tonopah. No attempt has been made to rank items. The responsible organization is given in parentheses after each item.

Nuclear Weapons

- During 1987, we participated in six flight tests of the Navy's **Trident II** missile at Cape Canaveral. All flight objectives were achieved, demonstrating the capability of our mechanical and electronic systems to meet or exceed all technical requirements of this new weapon system. Proof tests conducted at the Nevada Test Site also confirmed that components could survive environments normally damaging to electronic systems. All activities on Trident II, required by the Navy to be operational in 1989, are on schedule. (5150)

- **Trident II Arming, Fuzing, and Firing (AF&F) system** components completed a number of successful flight tests as development neared completion. The flights exercised the full range of normal and default programmer modes that provide high reliability for the AF&F system. The force-balance integrating accelerometer (FBIA), the first high-precision inertial measurement component that Sandia will send to stockpile, met its stringent accuracy requirements. The radar demonstrated its full range of capabilities. The integrated firing set and dual strong link met all performance expectations; they provide the principal nuclear safety protection for the weapon. In addition to their successful test performance, all pre-production activities on the contact fuze and the environmental sensing device — and the qualification of all commercial semiconductor devices — were completed on schedule. All of these components remain on schedule for AF&F first-production this year. (2000)

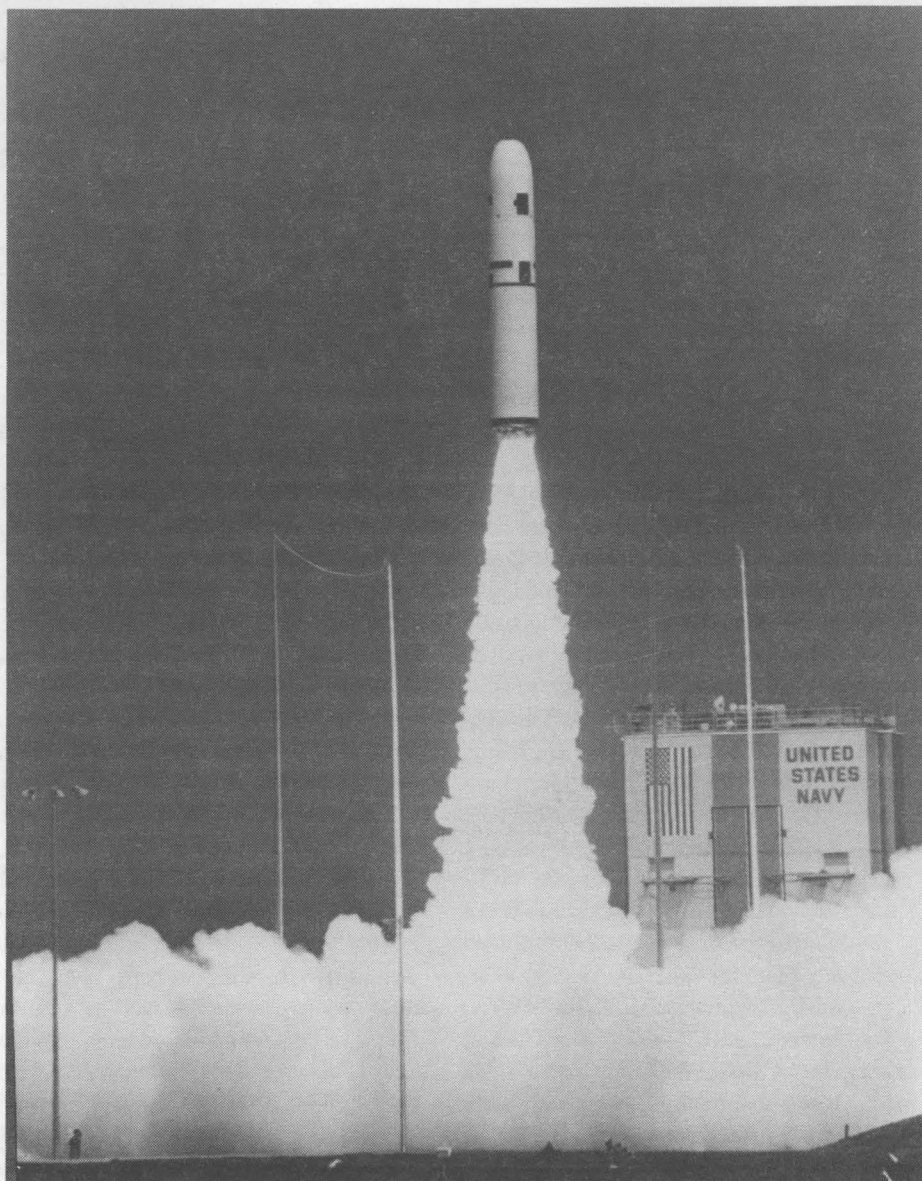
- We continued integration of the **W80 Common Warhead** into new Navy and Air Force weapon systems. The W80-0 is deployed in the Sea-Launched Cruise Missile (SLCM), the W80-1 in the Air-Launched Cruise Missile (ALCM). Compatibility demonstrations between the W80-0/SLCM and various surface ship- and submarine-launch systems were conducted. W80-0 environmental shock testing was conducted aboard a Ticonderoga-class cruiser during the *USS Mobile Bay* ship-shock trials. W80-1/

ALCM environmental and launch tests were completed for carriage certification on the B-1B Common Strategic Rotary Launcher (CSRL). (5110)

- In a special project for DOE/AL, we completed an analysis of the **risk of disruption** in nuclear weapons production. The production of nuclear weapons and stockpile maintenance items requires coordinated production and shipping activities among DOE plants. Using analytical techniques developed in the previous year, we computed the maximum permissible outage times for all processes in the complex. To achieve the maximum benefit from the risk analysis, we developed strategies to aid plant and DOE managers in the efficient reduction of risk. (6320)

- We worked closely with Los Alamos in refining design concepts for a rigid **Strategic Earth Penetration Weapon (SEPW)**, currently in Phase 2. Ten large-scale SEPW Davis gun tests were conducted at Tonopah Test Range (TTR) during the year. The tests helped establish penetrator survival limits relative to impact velocity, angle-of-incidence, and angle-of-attack. Analysis indicated that penetrator case weight could be reduced by 20 percent by using titanium rather than steel, but that aluminum cases — which looked promising in scale-model tests — would not survive the penetration environment; the latter was confirmed in a TTR Davis gun test. Future tests at TTR will evaluate titanium as a case material. (5160)

- Underwater stability and drag of proposed **antisubmarine weapon systems** are strongly affected by the hydrodynamics of high-speed water entry and cavitation phenomena. We developed a code, SANDRAG-H, for calculating the flow field, drag, and stability of sharp-nose vehicles traveling underwater at high speeds and small angles-of-attack. To validate this code and others, water-entry tests were performed at the Naval Hydroballistics Facility. Models equipped with on-board data recording systems were launched into water at speeds up to 700



TRIDENT II, with a Sandia-developed Arming, Fuzing, and Firing system aboard, blasts off from Cape Canaveral during a flight test last year. All activities on this new weapon system, required by the Navy to be operational in 1989, are on schedule.

fps. The tests provided the first successful measurements of cavity pressures at speeds above 300 fps. (1550)

- We completed development and acceptance procedures on the **Automated Permissive Action Link (PAL) Code Handling System**. This system provides the US European Command an automated method of replacing nuclear release combinations in its weapons and maintains accurate records of theater readiness (while reducing cost through reduction of manpower-intensive operations). The system has three components: the Automated PAL Controller, the Portable Data Module, and the Headquarters Code Processor. This project demonstrates an effective application of technology that yields improved capability while reducing overall costs. (5120)

- We successfully demonstrated several key elements of a terminal-fix system for high-accuracy **missile navigation and guidance**. The system is based on locating distinctive waypoints in radar images of terrain. The radar imagery, produced by a high-resolution synthetic aperture radar (SAR), represents a significant advance in Sandia radar technology. The SANDAC V (SANDia Airborne Computer) controlled navigation and motion-compensation for the system. (SANDAC V entered production last year at Honey-

well as part of a non-exclusive technology transfer agreement.) Real-time determination of aircraft position during the demonstration was provided by the Sandia Aided Inertial Navigation Testbed (SAINT). (2330/2340/9130/7130)

- We conducted three air drops and four rocket launches at the **Kauai Test Facility** in late April and early May. The air drops and one of the rockets were associated with the wrap-up of the Sea Lance/Nuclear Depth Bomb Phase 2 effort. Three rockets carried advanced-development water penetrators into the Navy underwater range off shore. (7520)

- The **MIDDLE NOTE** and **MIS- SION CYBER weapon effects tests** were conducted in March and December. Our experiments, using new data acquisition systems developed to replace those lost in 1986 (when some photographic systems were fogged by radiation), were highly successful. We achieved greater than 99-percent data return for the W76/Mk4, W88/Mk5, and other experiments (advanced development, radiation output, experiment protection). With the successful transmission of 1-GHz analog data over 10-km single-mode fiber-optic lines, our recording systems can be above ground for future tests. The successful containment effort incorporated Sandia-designed closure systems. (7110/7120)

- Two electrodynamic shakers were coherently controlled to reproduce reentry-induced vibration on a **Trident II** test unit. Simulations of this kind are necessary to define environmental specifications for warhead components. Reentry vibration is highly dependent on the body's station. This is the first successful testing using digital computers that were networked to simultaneously impose four required spectral distributions up to 2 kHz in frequency. (7540)

- We established a **Training Aids Laboratory** (now operational) to support nuclear-weapons-stockpile activities. The

Laboratory contains state-of-the-art video and audio equipment for the production of a wide variety of training tapes. Other features include a digital videodisk system for the storage and manipulation of still photos and electronic information. Videotapes on weapon maintenance, Explosive Ordnance Disposal (EOD), weapon overviews, retrofit operations, and technical tips for field use will be produced for distribution to worldwide military training locations. Additional weapon tapes will be produced to support management needs. (7210)

Components

- We discovered a new twist on neutron-induced **single-event upsets** (disruptions) in performance of electronic devices. We found that uranium contaminants in IC (integrated circuit) package lids could be fissioned by neutrons, producing high-energy ions that deposit more energy in silicon than does a direct neutron interaction with the semiconductor material. Measurements confirmed that single-event upsets in microelectronics too often occur when ceramic lids are exposed to the neutron fluences expected in strategic radiation environments. We also determined that gold-flashed Kovar lids could replace ceramic lids on IC packages used in strategic applications. (2150)

- We designed, built, and tested a high-rate lithium/thionyl chloride "**C**"-cell battery that does not explode when subjected to severe abuse. Lithium/thionyl chloride batteries have the highest energy density of any practical battery (20 watt-hours in a "**C**"-cell versus 3 Wh in a regular "**C**"-size flashlight battery). We have not previously made extensive use of this type of battery in nuclear weapons primarily because of safety concerns; however, as designed, this battery eliminates those concerns. It represents a large step in our goal to provide batteries with maximum energy density for DOE applications. (2520)

- **Welding phenomena** are difficult to study experimentally because events in and near the weld zone, which is physically inaccessible, occur at high temperatures and change very quickly. Using the three-dimensional heat conduction code TACO, we developed analytical techniques to investigate the influences of weld parameters such as arc current, arc travel speed, geometric irregularities, and torch misalignment. Related studies consider the convective heat transfer due to motion of liquid metal in the weld pool. Comparison between the analysis and both the measured temperatures and the observed weld shapes has been very encouraging. (8240/8280)

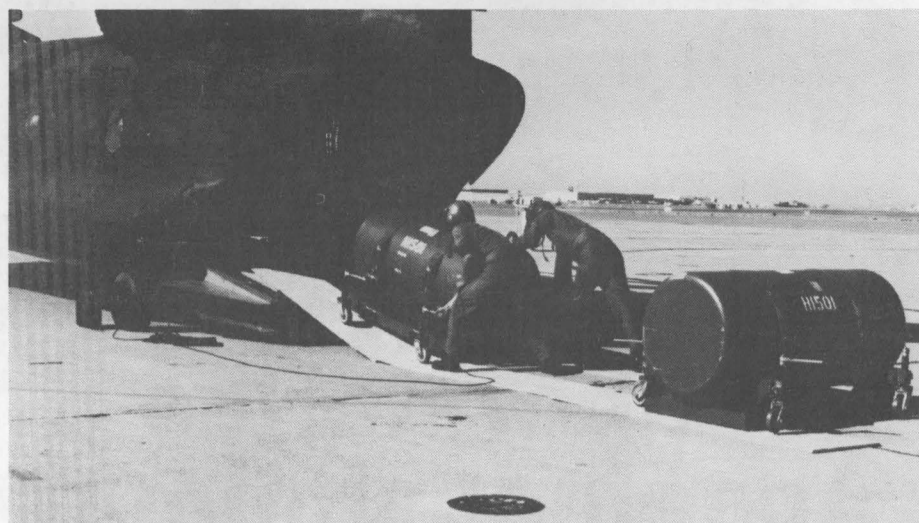
- We developed a remote visual

inspection capability for **inspecting weld areas** with severely limited access, such as weld underbeads in reservoirs. These fiberscopes, as small as 1 mm in diameter and 150 mm long, have an integral light source and can be connected to a video camera. The images can be computer-enhanced, and presented as hard copy. (8440)

- We completed two major **radiation-hardened integrated circuit designs**, both emulations of commercial products. The Intel 80C51 microcontroller simulation with on-board Read-Only and Random-Access memories will find applications in future weapons programs requiring small size and/or classified program memory. The National 32C016 CPU upgrade (with ancillary components) will be used in more computation-intensive applications. Both computer chips are designed to be radiation-hardened to high total dose exposure, as well as to environments containing high-energy ions that cause operational disruption in non-hardened designs. Development fabrication of both devices will occur at AT&T Bell Labs, with National also fabricating the 32C016. (2110)

- We developed a new process for the **Trident II radar** that allows low-value, close-tolerance resistors used in stripline circuits and standard high-value resistors used for other circuit functions to be fabricated on the same thin-film hybrid circuit. Before this development, the low-value resistors — purchased as separate components — had to be solder-attached. The development provided a more reliable resistor and simplified RF circuit design, and has resulted in a low-value resistor that can be designed into stripline circuits with minimal impedance variation. (7410)

- We developed a **molded desiccant foam** (MDF) that can be used in applications where both structural support and desiccating (drying) capability are required. This new material is being used in new nuclear warheads, where it will provide improved environmental control



ARMY FLIGHT CREW loads HARC (Helicopter Accident-Resistant Container) onto a CH-47 helicopter. Container provides increased safety for nuclear materials inside it should an accident occur during transportation.

and weight savings. In addition, there has been widespread industrial interest in this material, and we are working with a number of non-Sandia organizations to help evaluate MDF for their applications. (8310)

- We completed the development of the **explosive timer-driver** for the neutron generator used on the W88 system. This subsystem consists of flat cables, detonators, and precision timer-driver assemblies, all of which use high-density, thermally stable explosives. The detonator is a slapper (flying plate) detonator that has been designed to initiate hexanitrostilbene (HNS) explosive, a material that is less sensitive, more thermally stable, and denser than explosives used in exploding bridge wire detonators. (2510)

- In response to a DoD request, we fielded the HARC (**Helicopter Accident-Resistant Container**) last summer. The container provides increased safety for nuclear materials inside it should an accident occur during transportation. In order to meet military schedules, deployment began less than three months after this request. The container is based on design and testing performed by SNLA in the 1970s. Availability of development hardware from that program enabled us to provide completed units on time. (8160)

- The joint Sandia/AT&T 1-micron, rad-hard IC (**integrated circuit**) **technology exchange** program is progressing on or ahead of schedule. The results obtained so far indicate that we will be successful in meeting our goals of establishing a major new microelectronic capability at Sandia. As an example, our coordinated efforts to develop a hardened 256K SRAM (static random-access memory) are going

well. Also, using the joint Sandia/AT&T technology, AT&T has produced two 16K SRAM lots at the 2-micron level. These wafers show an excellent probe yield, and we anticipate their delivery to various satellite programs. AT&T will also process lots of Sandia 2-micron, 2-level metal designs to prove design compatibility with the joint 1-micron technology. (2180)

- To satisfy a need to program an electronic component with unique binary identification numbers at time of manufacture, we developed a tantalum nitride **thin-film resistor fuse array**. Each bit of the unique number is programmed into a pair of resistors. Programming is performed by passing a constant-current electric pulse through one of the two resistors, fusing that resistor into an open circuit. A PT (product tester) has been designed to automatically generate the unique numbers and to sequentially fuse each of the resistors in the array. (8150)

- We achieved a dramatic reduction in size in the MC3852 **quartz crystal oscillator** (clock), used in the Code-Activated Processor (CAP) for weapons control. Typical quartz clocks using printed-wiring-board technology occupy 0.25 cubic inch. The new clock integrates the quartz resonator and oscillator circuitry in a common leadless chip-carrier occupying less than 0.05 cubic inch. This integration required new fabrication and assembly processes at Bendix-Kansas City and GEND. Unique solutions to problems with the new processes and packaging required close coordination and support of several SNL organizations, as well as the process development staffs at BKC and GEND. (2530/1800/7410)

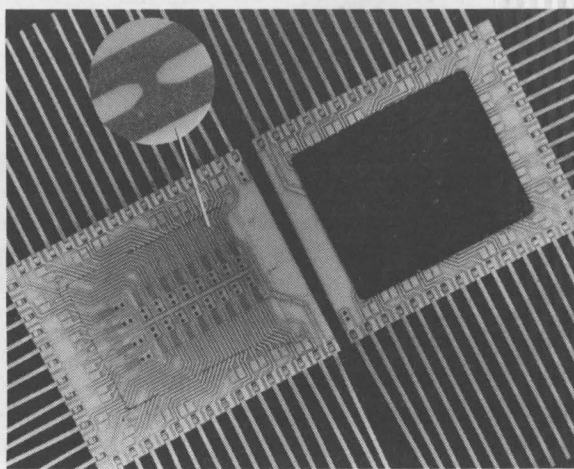
Supporting Technologies

- We completed development of a promising **new source of XUV** (soft X-ray/UltraViolet) radiation. The XUV system consists of a high-power KrF (krypton-fluoride) excimer laser that strikes a metal target to produce a hot plasma, which radiates in the XUV region. A high-throughput monochromator disperses energy from the radiation to provide a continuous source of tunable radiation. Performance testing indicates that the present output flux exceeds design goals by a factor of ten, making the laser plasma source (LPS) competitive with existing synchrotron radiation beam-lines at photon energies below 120 eV. The LPS is being used to study materials properties important to X-ray lithography. (8340)

- In a new **supercomputing initiative**, we developed algorithms that achieve unprecedented 1000-times "speedups" using a supercomputer with 1024 processors and a hypercube architecture. As recently as a year ago, computer scientists thought it was impossible for computing power to grow in proportion to the number of processors. We achieved speedups of 1020, 1019, and 1016 — very near the theoretical maximum of 1024 — on three practical, full-scale scientific-application problems. (1410)

- A Sandia-patented **electrode gap controller** for vacuum arc remelting (VAR) was developed and tested under industrial conditions. Control of the electrode gap will help to provide better homogeneity for both uranium alloy and

THIN-FILM RESISTOR FUSE ARRAY programs an electronic component with unique binary identification numbers at time of manufacture. Inset shows individual resistor fuse.



superalloy ingots. During the past year, Retech has purchased a license for this patent and is marketing the controller. (1830)

- Expanding on our previous work on optical target recognition algorithms, we are developing a real-time, high-speed **digital correlator**. We completed the conceptual design of a correlator with a 188 MFLOP (million floating point operations/sec) sustained processing rate capable of recognizing two targets per second. The correlator uses a 10-stage pipelined architecture that is fault-tolerant to all single-unit failures and many multiple-unit failures. We initiated the design and fabrication of a two-stage prototype system that we will use to demonstrate the feasibility of the overall architecture. (8430/8150)

- A Sandia-proposed scheme, used in a demonstration conducted jointly with Spectra Technologies Inc., resulted in a greater than 100-fold improvement in efficiency for **sum-frequency mixing** to generate coherent vacuum-ultraviolet radiation in the 130-nanometre (nm) region of the spectrum. The method, based on the mixing of optical beams of longer wavelength in atomic mercury vapor, has shown that efficiencies of several percent can be realized, in contrast to values of 0.01 percent typically observed. Moreover, the 250-microjoules of radiation at 130 nm demonstrated thus far is not only a world's record, but establishes the technical feasibility for scaling up the source to the 1-joule level and beyond. (1120)

- We demonstrated and quantified the crucial role of **material microstructure** on the shock-wave initiation sensitivity of the granular explosive hexanitrostilbene (HNS), and have developed an equation of state for this material that accurately predicts impact-generated pressures and temperatures. This equation of state and the understanding of the role of microstructure were used to develop a predictive user-oriented slapper detonator model for HNS. (1130/1530)

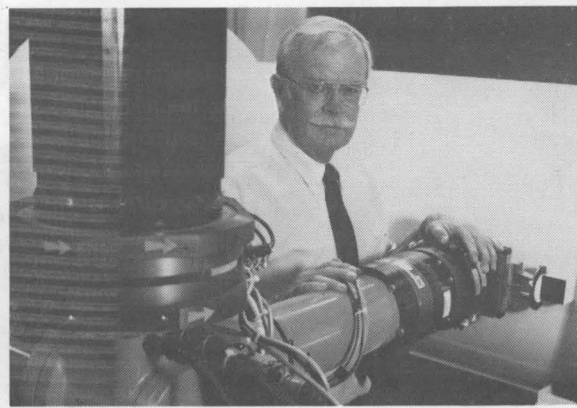
- We demonstrated the operation of several **new photonic devices** based on epitaxial semiconductor quarter-wave multilayer structures. These include optical switching devices (both absorptive and dispersive), surface-emitting lasers, and optical modulators (driven optically and electrically). These devices utilize bulk or quantum-well materials grown by molecular beam epitaxy or chemical vapor deposition. They are compatible with existing microelectronic processing technology and are attractive for applications such as integrated optics, fiber-optic communications, and optical computing. (1140)

- Our research into intelligent machine technologies resulted in a unique **advanced robotic system** for performing radiation surveys of nuclear waste shipping casks in unstructured environments. Technical innovations include computer-based robot motion planning with collision-avoidance, hybrid force/position robot control, and multiprocessor-distributed system control with error recognition and recovery. Research on oscillation-damped movement of large suspended objects initiated with this system has the potential to reduce transport times more than an order of magnitude. (1410)

- We completed a calculational study that compares the relative effectiveness of high-yield nuclear surface bursts and earth-penetrating weapons for **destroying**

hardened military targets. The study employed detailed radiation-hydrodynamic calculations to systematically evaluate the influence of burst position on ground shock and air-blast lethal radii for various cases. Study results confirm the effectiveness of earth-penetrating weapons for holding deeply buried targets at risk. (1530)

- We developed a new technology for preparing low-density (0.04 to 0.5 gram-per-cubic-centimeter), microporous (0.5 to 10 micron) **carbon foams**. These unique, open-celled foams are being prepared in support of several high-energy physics programs (for example, inertial confinement fusion). The carbon-foam technology makes use of thermally induced phase separation of a polymer solution to prepare a low-density, microporous polymer foam. The choice of polyacrylonitrile (PAN) as the polymer makes possible the controlled thermal decomposition and carbonization of the polymer foam to a carbon foam. Other demonstrated applications include the use of these carbon foams as catalyst supports and in the preparation of electrically conductive composite materials. A patent disclosure describing the carbon foam process has



ADVANCED ROBOTIC SYSTEM (demonstrated by Sig Thunborg, DMTS, 1411) performs radiation surveys of nuclear waste shipping casks in unstructured environments.

been filed. (1810)

- We developed a novel method to prepare the **ceramic superconductor** $YBa_2Cu_3O_{7-x}$ (a compound of yttrium, barium, and copper oxide). The method uses solution chemistry to prepare a highly reactive powder that is subsequently heated in oxygen to form the superconducting material. While the superconducting transition temperature is similar to superconductors recently made by the traditional method, our powders are more homogeneous and have a finer particle size, making them better suited for certain applications (for example, printing superconducting lines for microelectron-

ics applications). Furthermore, we have used these powders to prepare thin films (about 1 micrometre) of $YBa_2Cu_3O_{7-x}$. We are currently investigating processing conditions to optimize the superconducting properties. (1840)

- As part of the **FALCON reactor-pumped laser** research program, we are investigating the feasibility of developing large-scale laser systems pumped directly by fission energy from a nuclear reactor. A significant FALCON milestone was achieved last year with the successful demonstration of reactor-driven lasing in the Xe/Ar (xenon/argon) laser. (1120/6420)

Arms Control Treaty Verification Technologies

- We developed an **expert system** (ES) that can reduce the amount of human intervention necessary to process and use seismic data, particularly large data sets coupled with complicated numerical analysis codes. This analytical tool performs three main functions: (1) constructing and updating a database, (2) analyzing the data, and (3) enhancing the ES. The first application of the ES is for the evaluation of seismic-array data to determine optimal array configurations for test ban treaty applications. The ES's overall format should make it easy to apply to new problem areas. (9110)

- At the request of DoD's Defense Advanced Research Project Agency, we developed a 25-element, short-period **seismic array** that was deployed in September near Karasjok in northern Norway. The array, which operates unattended and transmits authenticated data via satellite, will complement a similar array in southern Norway in the detection and location of underground explosions. Arrays of the type deployed in Norway could be placed in the Soviet Union to monitor compliance with treaties restricting underground testing of nuclear devices. (9240/9110)

- We developed the Portal and Perimeter Monitoring System (PPMS) for performing **on-site inspection and verification** of arms control treaties. The PPMS is designed to be deployed at facilities producing treaty-limited items. Portals monitor egressing traffic to verify that such items are not covertly contained within the vehicles, and the perimeter system verifies that portals are not bypassed. The portal sensor suite measures vehicle size and weight and controls traffic, while video cameras document portal activity. The perimeter system is a fence; its integrity is monitored with an optical-fiber loop threaded through it. Video cameras provide surveillance of perimeter zones. The system incorporates data-authentication and tamper-protection hardware to prevent alteration of sensor data. A data-

acquisition, communication, and display system provides for review of data at a local data center and a remote monitoring center. A prototype of the portal system prescribed by the provisions of the proposed INF treaty is scheduled to be deployed at Sandia in 1988. (5210/5240)

- We completed the design of a new **satellite instrumentation payload** that incorporates extensive on-board computing to achieve near-autonomous in-orbit operation. Command, control, and data-storage requirements were met by using a total of eight separate microprocessors and eight megabits of random-access memory. All of these radiation-hardened devices were provided by SNL's Center for Radiation-hardened Microelectronics. (9220)

- We developed noise-resistant techniques to measure the deflection of the earth's surface due to the passage of various types of vehicles. The capability to perform such **vehicle detection** has many applications in intrusion detection, surveillance, tracking and targeting, and treaty verification. Three types of sensors based on earth strain, inertial reference, and simple bubble level have proven to be useful in vehicle detection. The sensors can detect lightweight vehicles at a few metres, tanks at 50 metres. (9110)

- Four ground-based stations for the **Remote Atmospheric Monitoring Program** (RAMP) were deployed in the southern hemisphere for a one-year test and evaluation of their ability to monitor the atmosphere for particulate radioactive materials. Scientific studies, as well as verification activities, can be supported with daily or weekly nuclear spectral information from remote locations transmitted via satellite link. The RAMP system significantly increases the ability to identify and quantify short-lived radioisotopes in the atmosphere. The system is designed to be operated by available personnel with minimal training, thereby permitting its use at almost any facility where people

are present at least once a week for a few hours. (9240)

- We developed a 64-element (8x8-pixel) hybrid **Focal Plane Array (FPA) detector subsystem** for satellite deployment. The FPA was fabricated using an approach in which each element of the HgCdTe (mercury/cadmium/tellurium) array is bonded to a co-planar silicon processing array containing circuitry to amplify and filter signals from all 64 pixels in parallel. Exceptionally low-noise/high-frame-rate performance was achieved. (9220)

Pulsed-Power Development

- The **Saturn X-ray simulator** became officially operational on Sept. 18, 1987, with its first radiation-producing shot. The first shot was an unqualified success, marking the first time ever that an accelerator of its size and complexity had produced a successful radiation environment during the first exercising of all accelerator components integrated and functioning together. The pulsed-power portion of the accelerator, which is capable of delivering some 25 trillion watts of power to the experimental section of the machine, performed flawlessly. The radiation environment produced with the multiple-ring diode was as expected, and radiation effects testing on Trident II AF&F hardware began. Saturn is the nation's most powerful X-ray simulation source. Substantially larger weapon components than ever before can now be tested above ground, thus greatly improving support to underground testing. (1230/1250)

- For the first time, **triggered gas switches** have been synchronized to nanosecond standard deviation in timing at multimegavolt levels with adequate reli-

ability for making multimodule accelerators. Versions of this switch technology make it possible for the Particle Beam Fusion Accelerator II, Saturn, Hermes III, and Radlac II accelerators to meet their output specifications. The technology is being transferred to private industry. (1240/1250)

• Ion beams have been produced by an Applied-B diode on the Particle Beam Fusion Accelerator II at a rate of one shot

per day. Ion efficiencies of more than 70 percent are typical. Initial focusing experiments with protons have produced focal spot sizes that meet the requirements for inertial confinement fusion (ICF) targets — although at a reduced power level. This achievement demonstrates substantial progress in developing a technology capable of generating and focusing lithium beams for ICF. (1260)

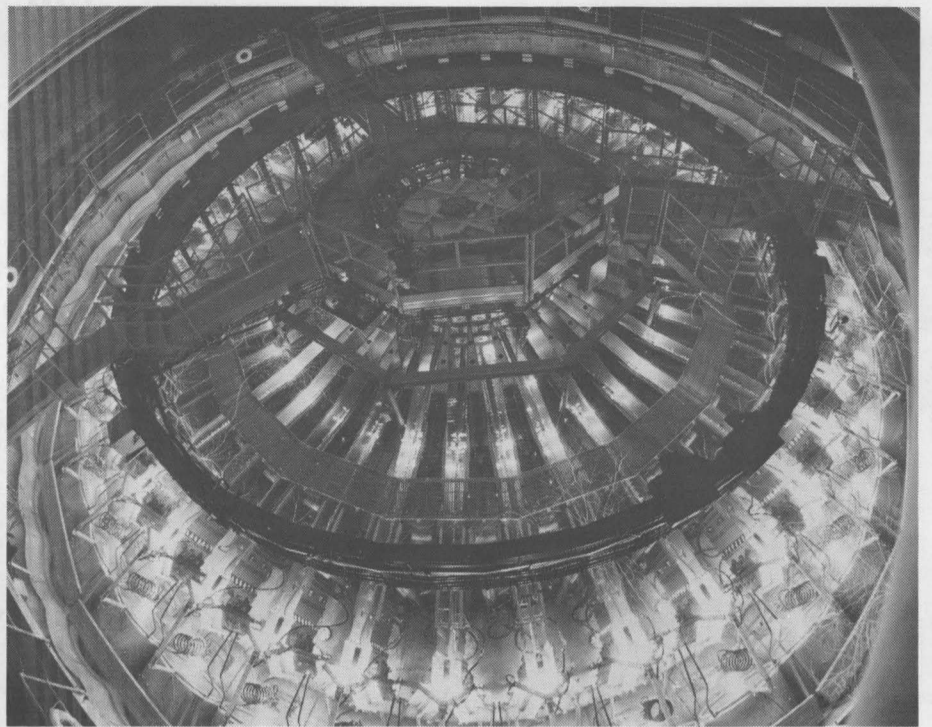
Safeguards & Security

• We designed and demonstrated a prototype **Video Imaging System** for Detection, Tracking, and Assessment (VISDTA). In many fixed-site or mobile security applications, the operator of a thermal-imaging camera also functions as a detector, continuously scanning the scene for hostile activity; this is a tiring and inefficient procedure, prone to operator mistakes and burnout. VISDTA automates the scanning and detection functions by integrating a high-resolution, passive, thermal-imaging camera; a low-light television camera; and an eye-safe laser range-finder with digital video processing and precision positioning. The field for scanning and detection of changes can be a 360-degree circle with a radius of a few hundred metres to a few kilometres. After an operator initiates automatic scanning of the area of interest, detection algorithms process video from the thermal imager or low-light camera. Changes are tracked within the scene for a period of time before an alarm is declared. The

operator is then called to assess the alarm. (5230)

• We developed an automated **item-monitoring system** to meet DOE's more stringent requirements to protect against a malevolent insider at Special Nuclear Material (SNM) handling facilities. The system consists of an item-movement detector and a bar-code reader that transmit movement and authorization information via an RF modem to a personal computer. The computer verifies authorized SNM and personnel activity and generates an alarm if unauthorized events occur. Successful demonstrations at three operating DOE facilities resulted in reduced manpower requirements and radiation exposure. (5210/5240)

• Managers in Emergency Operations Centers (EOCs) require timely and accurate information to effectively manage a crisis situation. We developed and demonstrated a computer-based **automated information management system** that provides managers information in the form



SATURN ACCELERATOR, a 2.0 MeV X-ray source and the most powerful X-ray simulator in the US, had its first firing of all 36 modules in September.

of text, video, and voice. The system is user-friendly, in that a touch screen is the only system interface that a manager needs. The system includes many features such as video overlay annotation in real time; text information storage and recall, and hard copy; and display of all information on individual personal monitors on a large screen. (5240)

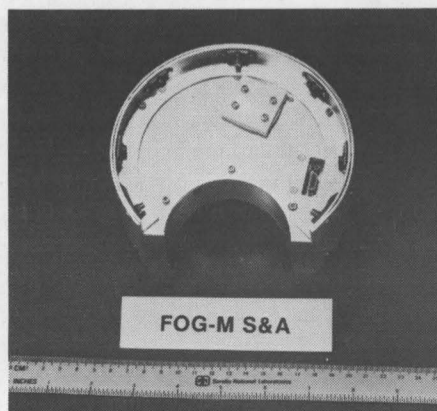
• We developed a prototype **infrared (IR) imaging device** employing uncooled pyroelectric technology. The unit is capable of producing low- to medium-resolution IR images from a very-

low-power, integrated-circuit sensor operating at ambient temperatures. Since it incorporates no moving parts or cryogenic cooling system, such an imager is ideally suited for various surveillance and remote-sensing applications. As a part of this project, we developed methodologies for processing the raw sensor output to form useful thermal images. Our current research is directed toward modifications that show promise of yielding significant improvements in sensitivity and resolution. (9110/9120/9240)

Other Defense-Related Work

• The **Fiber-Optic Guided Missile (FOG-M)** is a guided weapon under development by the US Army Missile Command for use against helicopters and armored vehicles. The safing and arming (S&A) device, developed by Sandia, is the first such all-electronic unit to be approved by the Army for a conventional weapon system. During the past year, development units were designed, built, and tested to assure compliance with functional and environmental requirements. (2360/9120/ 2510)

• A new type of contactless **electromagnetic launcher** (called the reconnection launcher), which is in early development, accelerated a 1/3-lb. aluminum projectile to 1200 mph with an average acceleration of nearly 30,000 times normal gravity. This is the highest velocity reported for contactless launchers. (1220)



SAFING & ARMING DEVICE for the Fiber-Optic Guided Missile (FOG-M) is the first such all-electronic unit to be approved by the Army for a conventional weapon system.

• We successfully propagated a 2-MeV, 1-kA, 1-microsecond electron beam 56 metres on a plasma channel — the **longest electron-beam propagation** yet achieved. A theoretically predicted instability (electron-ion hosing) was observed to grow, saturate, and damp. The propagation mode has several SDI applications. Beam propagation was performed in the EPOCH (Electron Propagation on CHannels) laboratory. (1270)

• We completed work for the Air Force on an Ada **software engineering development system** that is being used in the implementation of real-time data acquisition and display systems for satellite ground stations. The effort included development of an Ada Graphical Tool (AGT) that produces a precise graphical representation of any Ada source file. (9220)

• We developed an approach for an **upgraded system** to support Marine security guards at Department of State (DOS) foreign posts. The system automates administrative tasks, assists crisis management, centralizes control and display of security equipment, and monitors for tampering and operational integrity. The design applies to a range of foreign posts by providing levels of functionality and complexity commensurate with varying security measures and available technical support. Portions of the system were built for proof-of-concept in October, and we provided design guidelines to assist DOS in further development of the system. (5260)

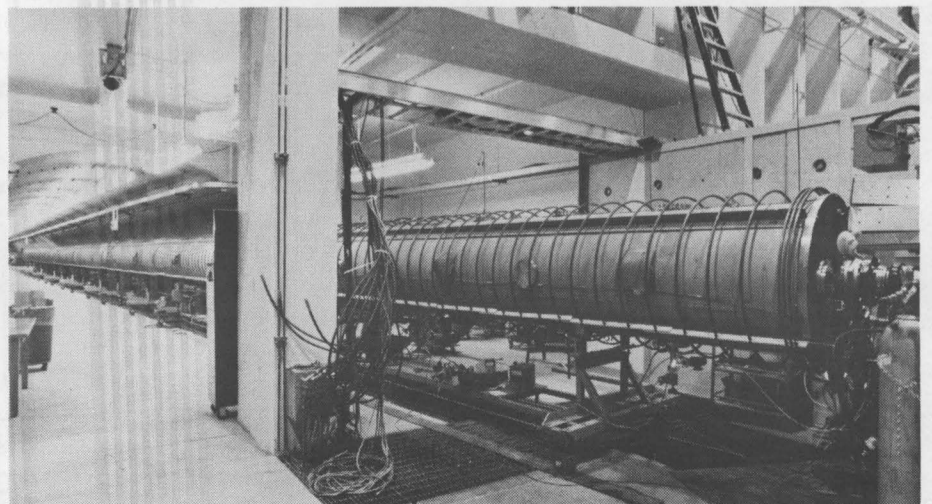
• The AURORA model for **simulation of Soviet strategic nuclear attacks**

on CONUS (Continental United States) has been significantly enhanced. Working closely with the Organization of the Joint Chiefs of Staff and the US Space Command, we developed algorithms for target-to-aim-point aggregation, optional weapon-to-aim-point assignments, and employment of all force elements in the Soviet triad. The current capabilities of AURORA make it the most flexible tool available for analysis of Soviet attack options and strategic defensive-threat scenarios. (8470)

• In conjunction with designing and fabricating a **portable controller** for the US Army Missile Command's Teleoperated Mobile Antiarmor Platform (TMAP), we conducted experiments at Sandia's Mobile Vehicle Test Range to evaluate remote, off-road driving performance using three forward-looking

video systems. In addition to comparing black-and-white, color, and steering-coupled cameras, one study evaluated — as an alternative to real-time, remote-vehicle operation — a new simulation technique using video tapes of off-road driving. If proven valid, the laboratory-simulation approach could help identify ergonomic design criteria and provide a cost-effective, safe means of comparing numerous combinations of video-system parameters considered for use in teleoperated vehicles. (5260/7220)

• We delivered the Proof-of-Concept/Experimental Testbed (POC/ET) system to the Strategic Air Command (SAC) and Joint Strategic Target-Planning Staff (JSTPS) in October. POC/ET is a multi-shelter suite of equipment that will be used to validate advanced concepts leading to enduring **nuclear command-**



EPOCH (Electron Propagation on CHannels) Facility was used to propagate an electron beam 56 metres on a plasma channel, the longest e-beam propagation yet achieved.

Radically Different Battery Invented

Since the mid-50s, Sandia has designed and developed a whole family of thermal batteries, the primary source of electrical power in nuclear weapons. Although the various types of thermal batteries depend on a variety of chemical elements and their reactions, they are all similar in that —

- to generate their short, one-time bursts, they must be activated by heat (which means that “thermally activated batteries” is a more precise descriptor of the devices);

- creating that heat (via a chemical heat source) typically takes several seconds; and

- they have a long shelf life (typically 20 years or more, unlike the simple galvanic and acid batteries used in, say, flashlights and automobiles). It's this long life, of course, that makes them indispensable for stockpiled weapons (see “One Key” story).

A new battery invented by Bob Graham (DMTS), Bill Benedick, and Bruno Morosin (all of Shock Wave and Explosives Physics Div. 1131, headed by Bruno) is radically different in two out of three ways.

First, it's not activated by heat in the usual way. It's activated by a shock wave generated either by mechanical impulse or small explosive charge. Second, shock-activation means almost instantaneous — within millionths of a second — activation. And, thanks to reliance on an inert electrochemical electrolyte similar to that used in traditional thermal batteries, its shelf life is just as long as theirs.

It's true that similar shock-activated power sources have been studied through the years, at Sandia and elsewhere. “But they've all had the same limitations — low energy density and very short pulse duration,” says Bob. “Until now, we've never had a power source that you could turn on in this time frame *and* that could continue over a relatively long period of time.” (Currently, demands for instantaneous power in a weapon are met by, for example, piezoelectric and ferroelectric devices, but they can produce only a short burst of voltage.)

Experiments with the current design have produced electrical pulses lasting nearly one second. But, because the new battery differs from a thermal battery only in its activation phase, its electrical pulse is expected to be just as long (typically many minutes) and as strong as the thermal version. “Lengthening the pulse is very useful because power has to be available at the time you need it, for as long as you need it,” explains Bob. “If you have a surge of only microseconds, you have to put it to work under very restrictive conditions.”

Forgot the Chemistry

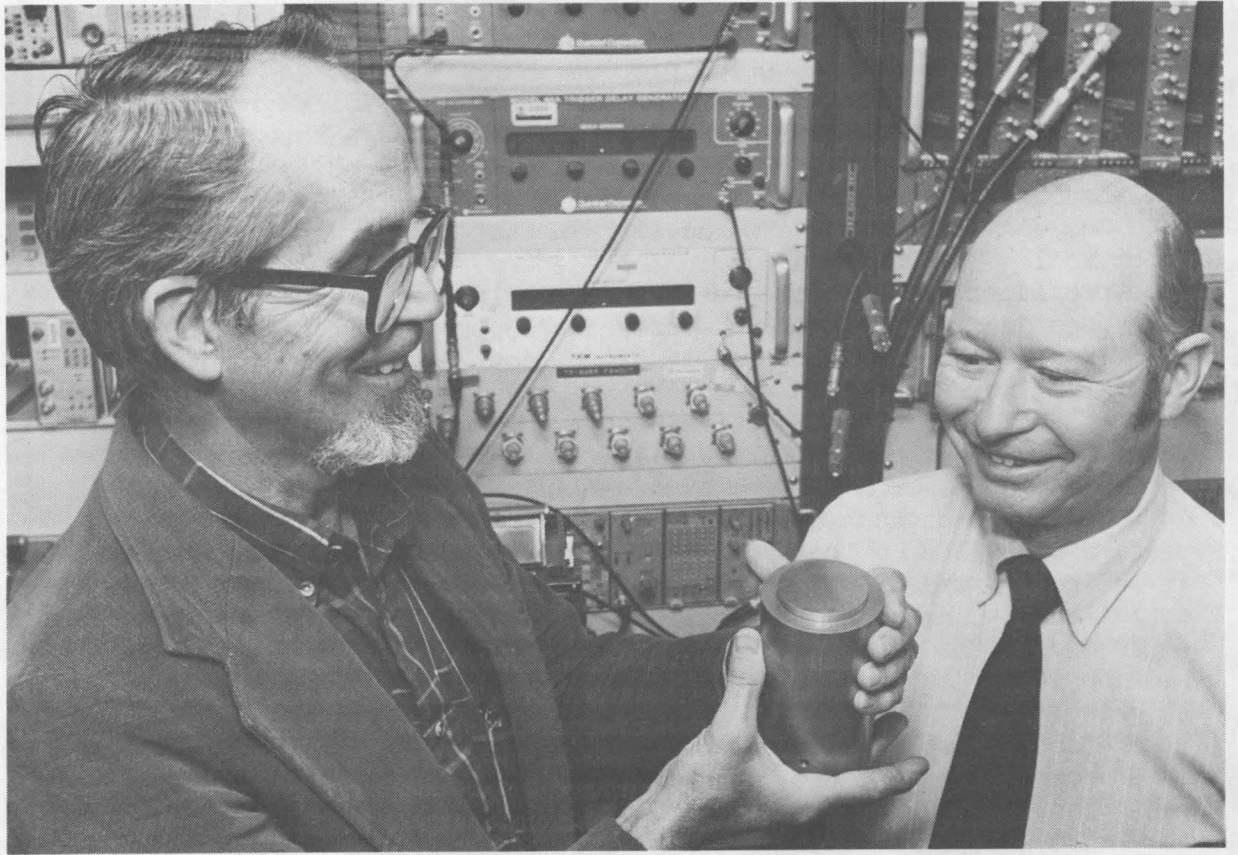
Bob and Bruno began work on shock-initiated thermal batteries nearly two years ago, and now are listed along with Bill as co-inventors on a patent application filed by the DOE. The work grew out of a six-year project to look at the shock-induced chemical reactions of solid-state materials. (That project originated in Bob's research into the shock-chemistry work being done in the USSR.)

Their concentration on thermal batteries somewhat unexpectedly — as they investigate chemistry of electrolytic materials.

“Previously, we had considered the study of materials under shock from the physics point of view,” says Bob. “We forgot to consider the chemistry. But, once we realized we had something, we moved quickly to understand it.”

In the laboratory, the team applied carefully controlled shock pulses to a specially configured electrochemical cell and measured the resulting current. In these experiments, a solid electrolyte was sandwiched between anode and cathode and subjected to a planar shock pulse initiated by detonating a small charge of high explosive. In its solid state, the electrolyte is incapable of supporting the exchange of

(Continued on Page Four)



THE RESEARCHERS — Bob Graham (DMTS, left), Bruno Morosin, and Bill Benedick (not shown) of Div. 1131 have invented this shock-activated thermal battery. Unlike current thermal batteries, which are activated by heat produced by chemical reactions, this one is activated by a shock wave. It produces electrical power almost instantaneously. This single-cell unit is bulky because it's an experimental version that contains various data-acquisition devices.



AND THE DEVELOPERS — Jere Harlan (2512, left) and Don Bush (2525) are among the component development people working to convert the shock-activated thermal battery concept into a practical battery for weapons and, conceivably, other applications where electrical power is needed temporarily but quickly. DOE is currently seeking a patent on the new device. Like heat-activated thermal batteries, this one should have a shelf life of some 20 years.



LAB NEWS

VOL. 40, NO. 4 SANDIA NATIONAL LABORATORIES FEBRUARY 26, 1988

‘Black Hat’ Team Members Sought

Nuclear Security Systems 5200 is looking for 10 to 20 Sandians to help evaluate the effectiveness of various nuclear safeguards and delay systems.

The “black hat” team will match wits and tools against the prototype designs to discover any weaknesses. Early on, the team will work with the Safe Secure Trailer designed for transporting nuclear materials, but other such systems will need the same kind of adversarial attention later.

Prospective team members will have to

undergo physical and stress tests in Medical and must become proficient in using hand, power, and thermal tools as well as self-contained breathing apparatus.

If you're looking for an intellectual and physical challenge — and if you're strong, agile, and enthusiastic (and if your supervisor approves your spending one to four days per month contributing to a major Labs mission other than your assigned tasks) — please contact Marty Kodlick on 4-3447 or Kay Lang (both 5262) on 4-1286.

Antojitos

"Labs Accomplishments": Why Do We Do It? That's a question I avoid even asking when we're (that term translates as "Phyllis Wilson") in the middle of the production process.

But the question deserves answering, not only for us in the LAB NEWS but for all the people across the Labs who contribute to the process -- whether or not their projects were selected for inclusion -- and for our readers, inside and outside Sandia.

One answer to "why do we do it?" is that it's a kind of Sandia honor roll -- if your project is represented, it means your vice-president chose it over others for inclusion (each vice-presidency is allotted no more than 15 project write-ups).

In other words, each line itself -- not the president, not a committee, not Washington -- chose the projects it included, and with no aim other than to reflect its best (unclassified) efforts for the year. That means authenticity -- and that's what makes these Labs Accomplishments worthwhile.

Another important answer is that here is assembled, once each year, a disparate but coherent body of achievement. Disparate in that it reflects a wide range of scientific, technical, and support activities. Coherent in that it reflects Sandia's overriding mission -- to ensure the safety and security of the nation. Today's special section is the only place you can get this sense of scope.

* * *

"Labs Accomplishments": Who's Involved? After the people in the line organizations submit their accomplishment write-ups, an ad hoc team goes into action. Many write-ups arrive in 3162 looking as if they were written to communicate only with the writer's department manager -- which they probably were -- not with the outside, not-necessarily-technical world. So Phyllis, Jim Mitchell (3160), and I work on clarity. Arlyn Blackwell and Dean Thornbrough (400) work on consistent categorization; this year they merged some old headings into new ones to provide a better feel for the across-the-Labs cooperation it takes between technical and support organizations to do the things we've done.

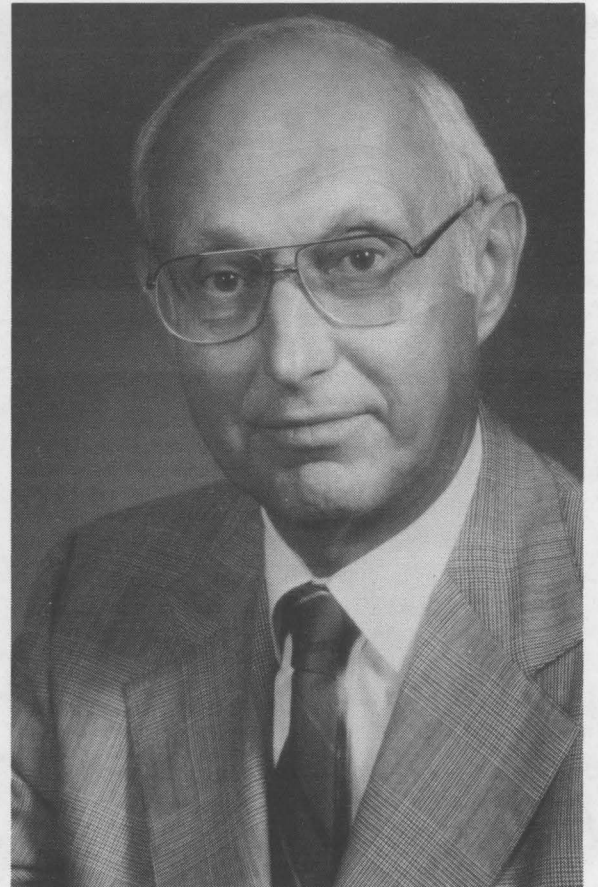
Dick Craner and the classifiers (3180) check everything for classification and sensitivity; Joe Szymanski (4051) looks for any patent problems. And Irwin Welber (1), Orval Jones (20), and Lee Bray (30) share the task of ensuring that the Labs Accomplishments do indeed reflect accurately the accomplishments in which we all, collectively, take pride.

* * *

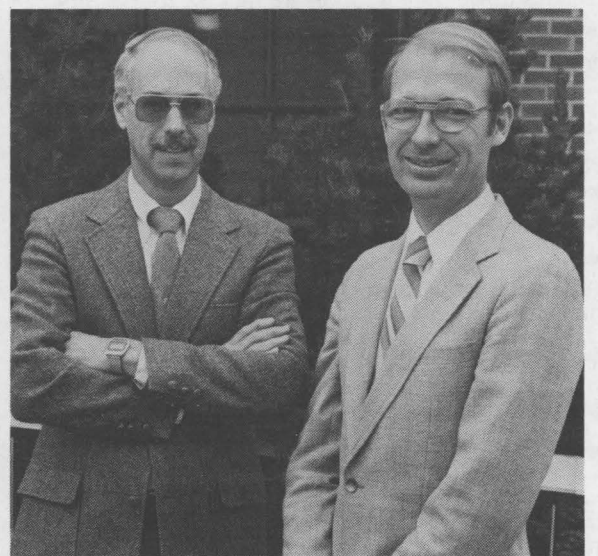
"Labs Accomplishments": Note a Trend If you think you notice an increase in the number of write-ups credited to two or more Sandia organizations, you're right. Five years ago, 92 percent of the write-ups listed only one organization; this year it's 73 percent. So? In a word (or two): matrix management -- more crossing of organizational lines to get the many kinds of specialized talents it takes to perform a complex task efficiently and expeditiously. ●BH

* * *

Jucundi acti labores. (Latin: The memory of past labors is pleasant.)



PRESIDENT IRWIN WELBER has been elected to membership in the National Academy of Engineering, one of the highest professional distinctions that an engineer can earn. He was chosen for his "major contributions to the advancement of capacity and economy in satellite, microwave radio, submarine cable, and digital transmission systems." Before becoming Sandia's ninth president two years ago, Irwin had spent his career with AT&T Bell Labs, most recently as Vice-President, Transmissions Systems; his responsibilities included design, development, and systems engineering of all transmission facilities. George Samara (1130) is the only other on-roll Sandian who's a member of the Academy; former presidents George Dacey and Morgan Sparks, former executive vice-presidents Tom Cook and Jack Howard, and former vice-presidents John Galt and Gene Reed are also members.



HOWARD STEPHENS (6212, left) and JOHN SHARP (2825)

HOWARD STEPHENS (DMTS) to supervisor of Process Research Division 6212, effective Feb. 1.

Howard joined the Labs in March 1970 as a member of the High Temperature Properties of Materials Division (now the Thermophysical Properties Division). In 1978, he transferred to the NTS Waste Management Overview Division. He joined the Process Research Division in 1980.

His work has included developing calorimetric techniques, assessing geologic data for selection of nuclear waste storage sites, coal liquefaction research, and catalyst development and evaluation.

He has a BS in chemistry from California State University at Long Beach, and a PhD in the same field from Purdue. He is a member of the executive committee of the Fuel Division of the American Chemical Society.

In his spare time, Howard enjoys sailing, cross-country skiing, and woodworking.

He and his wife Virginia live in the NE Heights.

LAB NEWS

Published Fortnightly on Fridays

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Member International
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Supervisory Appointments

JOHN SHARP to supervisor of Product Data Systems Management and Development Division 2825, effective Jan. 16.

John joined Sandia in April 1979 as a member of the Solar Thermal System Analysis Division. In August 1981, he was temporarily assigned to SNLL's Solar Thermal Technical Program Integrator Division.

He returned to Albuquerque in January 1983 and joined the NWC CAD/CAM Integration Division. In June 1987, he transferred to the CAE Integration Division.

Since returning to Albuquerque, John's work has been in semantic information modeling. His recent work was on the White Star project, developing a database for selecting electrical components.

He has a BS in electrical engineering from Wichita State University, and an MS and a PhD in the same field from the University of Illinois.

John's spare-time activities include camping, fishing, and raising miniature rabbits.

He and his wife Pamela have four children and live in the SE Heights.

Coal Combustion: Common but Complicated

Reggie Mitchell (8361) truly believes in burning issues — specifically, in his case, the combustion of coal. For the last six years, he's worked to understand how coal burns.

That's not a trivial goal. Coal is the most abundant of our country's fossil fuels. So, even though it poses some serious pollution problems, it will be needed for many decades as other sources of fuel are exhausted or remain too expensive.

Working in the Combustion Research Facility, Reggie has concentrated on determining how fast coal char burns. (Coal char is coal's basic carbon structure, left after its light gases and tars have been driven off during heating). Such knowledge would help utility companies size their power plants; they need to know how much pulverized coal will be needed to produce the required heat. The rate at which burning coal produces pollutants, another of Reggie's concerns, is also important in learning to deal with its undesirable by-products.

"Utilities are attempting to reduce their capital costs through the extension of the lifetime of existing coal-fired plants and, simultaneously, trying to comply with a continuing stream of new restrictions on the emissions of combustion-generated pollutants from the plants," says Reggie. "So the changing, unpredictable quality of the raw fuel becomes an important issue.

"In the past, boiler design has been coal-specific, able to burn only one kind of coal efficiently. Now, with the kind of insights we're providing, operators may be able to gauge the effect of firing, for example, low-sulfur Western sub-bituminous coals, or other coals that have been cleaned, in boilers designed to fire Eastern bituminous coals.

"When you put coal into a hot environment, two things happen," Reggie continues. "First, the coal heats up and loses its volatile matter — which means it's coal char — through a process called devolatilization. That's similar to what happens when heat drives the moisture out of a popcorn kernel, causing it to pop. Second, you have the char burning down to ash."

Efficiency Not the Only Issue

It's the char's burn rate that ultimately determines the efficiency of the combustor. Efficiency, however, is not the only issue. "Not only must we know how fast coal burns, we must also determine how — and what kind of — pollutants are generated in the process, and what happens to the mineral



ASSISTED BY Scott Ferko (left), Reggie Mitchell (both 8361) conducts measurements on coal combustion using a lab reactor (right foreground).

matter in the coal," Reggie adds.

Two primary pollutants from coal combustion are nitrogen and sulfur. These elements become oxidized to form nitrogen oxides (NOx) and sulfur oxides (SOx). (Many researchers believe that these mix and further react in the atmosphere, contributing to "acid rain.") The non-combustible mineral matter, or ash, inherent in coal causes fouling, slagging, and erosion of furnace walls as well, and may cause shutdown of the entire boiler.

Reggie and his colleagues are conducting their research with pulverized coal — particles about 100 microns in diameter (smaller than a grain of sand). In the lab, the pulverized coal is injected into a small flow reactor in which the oxygen and temperature levels can be controlled. When the particles are injected, they heat up, losing their volatiles and leaving the char particles to burn.

Reggie conducts his experiments in conditions that are as close as possible to those of the coal-fired combustors used by the utilities. Although researchers have made burn-rate measurements on coal before, the measurements have not always been made at conditions typical of real-world combustors. Reggie's approach ensures that the characterization of the burning process is more realistic. "I'm using optical techniques, which are noninvasive, to measure the size, temperature, and velocity of the particles while they are burning inside the reactor." The basic technique employs an optoelectronic system that focuses on the burning particles and converts their light, via

a photomultiplier, into voltage signals.

Although he has concentrated on representative US coals, he has also looked at bituminous coals from Canada, brown coals from Australia, and even peats from Finland, among others. Coals are ranked from high to low, with those containing the highest carbon content at the top. "The wider the spectrum of coals you look at, the more you're going to understand the properties of the coal and how they affect burning behavior," Reggie explains. "Each type burns at a different rate and produces pollutants at different levels."

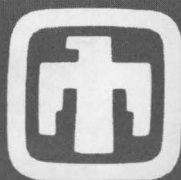
Many important questions remain to be answered. Future research, applying similar noninvasive techniques, will aim at linking these measured char reactivities to fundamental descriptions of the unreacted coal. In addition, there is considerable interest in developing predictive methods to relate the release of these mineral species to the measured rate of char oxidation.

Take Note

John Nuckolls has been selected as director of Lawrence Livermore National Lab, succeeding Roger Batzel, who is retiring after heading the Lab since 1971. Nuckolls, who has been with LLNL since 1955, is currently the Lab's associate director for physics. He will assume the director's position in April, and will be the Lab's seventh director in its 36-year history.

December Earnings Factors

	Earnings Factors
Savings Plan for Salaried Employees (SPSE)	
AT&T Shares	1.0107
Government Obligations	1.0101
Equity Portfolio	1.0771
Guaranteed Interest Fund	1.0075
Diversified Telephone Portfolio	
Unrealized Appreciation	1.0099
Realized Appreciation	.0094*
Savings and Security Plan — Non-Salaried Employees (SSP)	
AT&T Shares	1.0109
Guaranteed Interest Fund	1.0077
Diversified Telephone Portfolio	
Unrealized Appreciation	1.0100
Realized Appreciation	.0093*
*The 1 has been removed from the earnings factor. Current month's DTP earnings may be calculated directly: Earnings Factor x DTP Current Worth = Current Month's Earnings.	



SANDIA LIVERMORE NEWS

VOL. 40, NO. 4 SANDIA NATIONAL LABORATORIES FEBRUARY 26, 1988

Sympathy

To Jim Carrell (8445) on the death of his father in Grandview, Wash., Jan. 13.
 To Hazel Willyard (8535) on the death of her daughter in Stockton, Feb. 5.
 To Brad Mickelsen (8154) on the death of his grandmother in Othello, Wash., Feb. 6.

Welcome

Iowa
 Mark Brynildson (8315)
 Illinois
 Jim Handrock (8446)
 New Jersey
 Ann Yoshimura (8478)

Battery

ions necessary for the chemical reaction of a storage battery. In these experiments, however, the shock wave deformed and, very rapidly — in less than a microsecond — melted the electrolyte, permitting current to flow through.

The electrolyte used in the experiments was a solid eutectic made of potassium chloride-lithium chloride. (A eutectic is an alloy of two substances that undergoes melting and freezing at a temperature lower than either of the two substances.) The electrochemical cell included a lithium-silicon alloy as the anode, and a mixture of iron sulfide, the eutectic, and inert silicon dioxide as the cathode. The cell remained inactive (inert) until shock pressure melted the electrolyte.

David Webb (recently retired) and Lee Davison (1530) provided computer-generated predictions of how different densities of electrolyte respond to shock pressure and temperature. These predictions helped the team determine the shock-wave conditions needed to generate power with the new source. This research effort continues today: "We need to understand electrochemistry under high-pressure shock-wave loading," says Bob.

Only a Lab Device, Thus Far

The shock-activated battery concept has been proven in the laboratory, but shock-activated batteries suitable for use in actual weapon systems have yet to be engineered.

One Key to Long Stockpile Life

Sandia Pioneered Pelletized Thermal Battery

The thermal battery concept was invented by the Germans in the late 30s and early 40s, but they were never able to incorporate thermal batteries into their V-2 rockets, the type used against London in 1944.

After WWII, information on thermal batteries was conveyed, via the British, to the US — and Sandia. But it wasn't until the mid-50s that Sandia felt the new technology was mature enough to replace the "wet-cell" batteries used in nuclear weapons until that time.

Thermal batteries contain no liquids. They are "one-shot" electrochemical devices, non-functional at normal ambient temperatures. When power is needed, solid, heat-producing chemicals are ignited within the battery to produce temperatures in the 550-degree C range.

In seconds, the heat melts the solid electrolyte, and enough voltage (15 to 500 volts) is generated to power the weapon's electrical components.

Unlike wet cells (which must be recharged periodically), thermal batteries are inert until use and can reliably produce one surge of power at any time during the 20 or so years that a weapon might remain in the stockpile. Their long shelf life, therefore, helps to ensure a long stockpile life for a weapon.

Sandia's primary contribution to the thermal battery field was to perfect a "pelletized-cell" version in the early 60s. It allows a battery to be composed of three poker-chip-like cells rather than the 27 pieces that were formerly required, and it expands the battery's ability to withstand spin and shock.

Nevertheless, the work done thus far is helping other Sandians involved with battery and explosive component technology to determine the feasibility of building a practical battery capable of near-instant activation. In fact, the first prototype battery designs are currently being developed by Don Bush of Storage Batteries Div. 2525 and Jere Harlan, supervisor of Explosive Subsystems Div. 2512. However, as Bob notes, "well-engineered batteries are years away."

Eventually, the Sandia innovation should mean that similar batteries can be developed for other uses where extremely rapid activation is needed. Non-

weapon applications could include energizing measuring instruments or mechanical devices on a near-instantaneous basis. Impact events, with their resultant shocks, could actuate electrical current for a variety of uses, possibly without the need for additional sensors.

The new battery could also prove useful in emergency situations, say for aerospace programs, where long-shelf-life battery power may be required on a critical timing basis. "It's so radically different that other potential uses are still being conceived," says Bob. ●3161

Fun & Games

Corporate Cup — The first competition in this year's Coca-Cola Metro Mobile Corporate Ski Cup alpine and nordic events began Jan. 24 at Sandia Peak Ski Area. Gold medal winners included Larry Moore (2514), Mary Biggs, Frank Biggs (7112), Beth Gonzales (7484), Ednae Gross, Walt Herrmann (1500), Maureen Baca (3523), and Donald McKintyre (DOE). In the team standings, Metro Alpine category, Sandia Blue team is first with a score of 275, Sandia White team is third with a score of 227, and DOE is fourth with a score of 220. Sandia is first in the Metro Nordic team standings with 250 points, and DOE is second in the Mobile Nordic team standings with 127 points. For more information about Corporate Cup activities, contact SERP recreation director Stan Ford on 4-8486.

* * *

Ice Hockey — With fast breaks and a hat trick, Sandia's team won the first-ever Lab-vs-Lab ice hock-

ey game against Los Alamos on Jan. 30; score was 8 to 5. Sandia scored four times in the last 13 minutes of the game. Scoring leaders included left wing Paul Gourley (1143) with three goals (a hat trick), and center Len Connell (9013) with two goals. Guest goalie Rick Brovarney (KAFB) made 11 saves. Additional games are being planned. Interested hockey players should contact Rich Carson (2531) on 4-5015.

* * *

Golf — The Sandia Golf Association (SGA) will hold its annual membership-drive party on March 10 from 4:45 to 6:45 p.m. in the Coronado Club ballroom. Refreshments will be served. Membership is open to all employees, retirees, and dependents. League and tournament play on golf courses around the state is offered.

The SGA elected a new board of directors for the 1988 season. You may contact any of the following for more information on SGA: Mark Calvin

(3532), president, 6-9960; Evans Craig (2853), vice-president, 4-4606; Dan Buller (1111), secretary/treasurer, 4-7039; Ken Bercaw (7842), tournament director, 4-2175; Don Wrobel (1111), league director, 4-7302; Bill Curtis (2157), handicap director, 6-6045; and Jay Tidmore (3722), publicity director, 6-1858.

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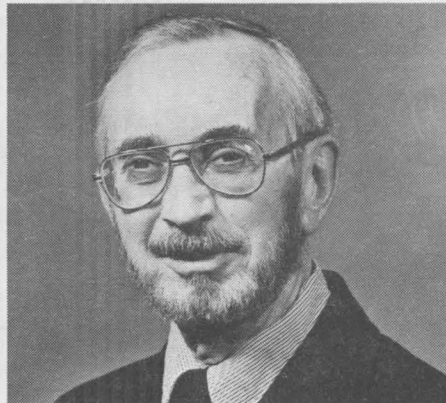
Boating Safety — The Coast Guard Auxiliary is again offering boating safety courses in both power- and sailboating. Classes will be held Wednesdays at 7 p.m. at the Armed Forces Reserve Center (700 Wyoming NE) for 13 weeks beginning Feb. 24. Instruction is free, but there is \$10 charge for material for the first member of a family for the course text; additional family members are charged \$3 for course worksheets. To preregister, call Ben Gardner (7411) on 298-0116, Earl Livingston on 298-5926, or Ed Williams on 821-2060.

RETIRING



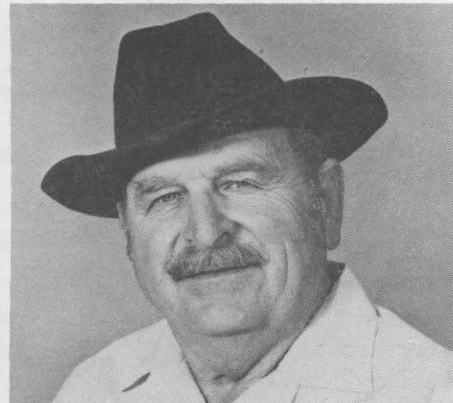
Rosa Steele (132)

26 yrs.



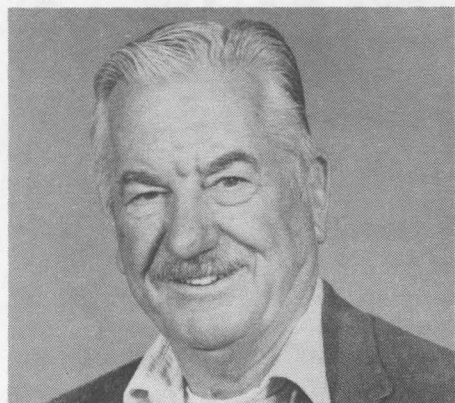
Bob Williams (3712)

30 yrs.



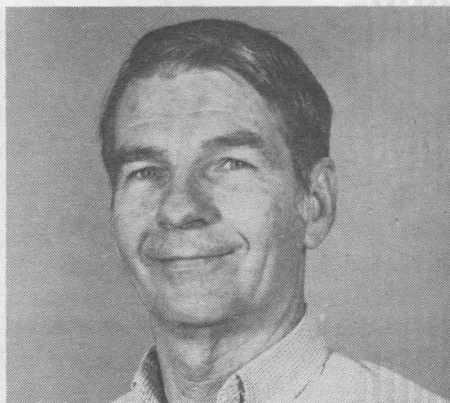
Stephen Zdunek (7818)

28 yrs.



Kenneth Edwards (5122)

35 yrs.



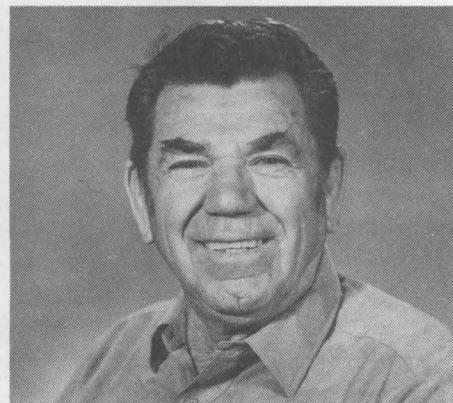
Gene Cook (7121)

31 yrs.



M. R. Gutierrez (1833)

29 yrs.

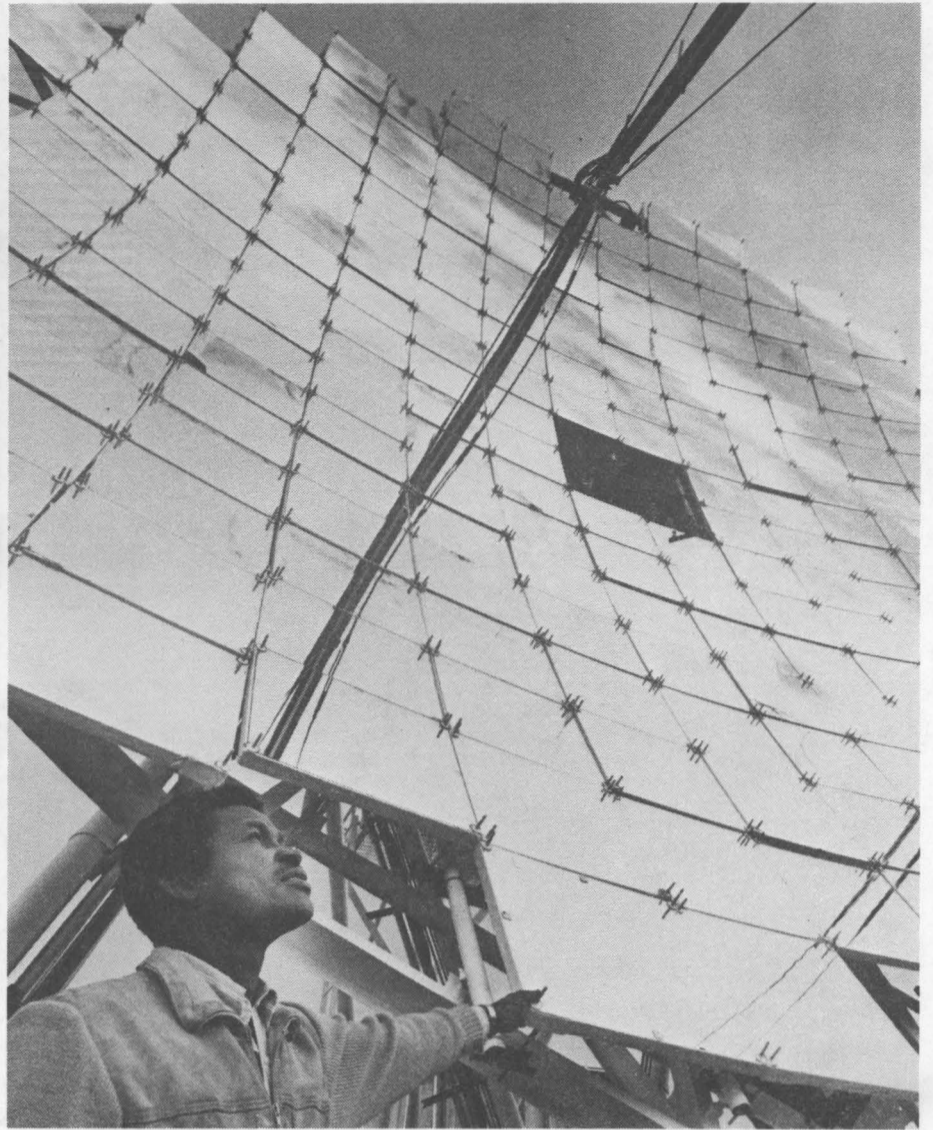


Louis Perea (7533)

30 yrs.



A DOZEN AFRICAN SCIENCE JOURNALISTS spent a day at Sandia recently as part of a six-week US program sponsored by the Center for Foreign Journalists in Washington. Goal of the program is to broaden African journalists' scientific knowledge and enhance the skills they need to cover science news for their readers and listeners. At Sandia, the group heard Dan Hartley (6000) discuss energy issues and research, Virg Dugan (6200) summarize advanced and alternative energy technologies, and Bill Snyder (6500) speak on nuclear energy. The group also toured the Solar Thermal Test Facility. In photo at right, Jacob Olukoshi of the News Agency of Nigeria peers at the concentrator at the focus point of a parabolic mirror array at the Distributed Receiver Test Facility in Area III. In photo above (from left), Shadia Abdel Rahman of Cairo, Peter Mwaura of the Pan-African News Agency in Nairobi, Kenya, and Josephine Mwasi of Nairobi listen to a Sandia speaker. On the day following the Sandia visit, the Africans attended a forum on "New Mexico Indian Science Challenges," sponsored by Futures for Children. Among the speakers were Mark Garrett (7535), Jim Shorty (3510), and Gary Nez (3411).



Take Note

Ken Hanks (7866), Dan Arvizu (6224), and retired EVP Jack Howard are three of the 100 Outstanding Alumni to be honored at the New Mexico State University College of Engineering centennial celebration in Las Cruces this weekend.

* * *

Have any furnished housing you'd be willing to rent out for the summer? Staff Recruiting and Employment Division 3531 is looking for housing for college professors and graduate students who will be arriving in May or June and leaving in August or September. If you have such rental property, please call 4-0970 or 4-8458 by March 2.

* * *

The 24th Annual Symposium of the New Mexico Chapter of the American Vacuum Society will be held April 18-21 at the Holiday Inn Pyramid. The meeting includes a three-day technical program, a four-day program of educational courses, and a two-day vendor equipment exhibit. Speakers include Car-

ol Ashby (1126) on "Laser-induced Etching," and D. R. Hamann of AT&T Bell Labs on "Hydrogen Vibrations on Transition Metal Surfaces." Papers in all areas of interest to the Vacuum Society are being solicited. One-page abstracts should be submitted to Randy Creighton (1126), NM/AVS Symposium Chairman, 4-3955. Deadline is March 4.

* * *

Couple of issues ago we ran a photo of Moises Lucero (3426) and his '73 Corvette at the World of Wheels car show. Other honors went to the '66 Chevy II Nova owned by Dennis Feeney (7813). It took first place in the custom conservative hardtop category and also received "outstanding individual display," "outstanding engine custom," and "outstanding custom in show" awards. Since then, he's gone on to win the same honors — plus an "outstanding detail custom" award — at the World of Wheels show in Pueblo, Colo.

* * *

World Experience teenage student exchange is looking for families in the Albuquerque area to host foreign exchange students between the ages of 15 and 18 in their homes beginning in August 1988. Students have their own spending money, and there is a tax deduction available for host families. More than 2000 students and families have participated in World Experience programs since 1977; George Kupper's (3723) daughter is involved in this year's exchange. Currently, 20 nations from five continents participate. For more information, contact Carlos Pagan on 242-7008.

* * *

Retiring and not shown in LAB NEWS photos: Alton Anderson (2565), David Denton (7171), Charles Berglund (3312), Merton Brooks (7472), Imogene Holmes (3531), Jesus Luna (2157), Betty Malpas (3141), John Malpas (7481), Howard Shaw (3428), and Daniel Sasmor (6454).

Deaths



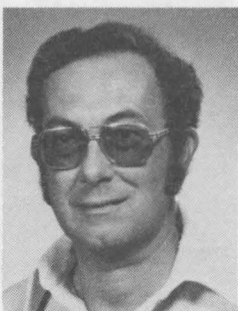
Dorothy Wall of Product Definition and Drawing Distribution Control Section 2831-1, died February 4 after a short illness.

She was 61 years old.

Dorothy was a senior clerk in the film bank, and had been at Sandia since December 1951.

She is survived by her brother.

* * *



Larry Verzi, supervisor of Administrative Section 3414-2, died suddenly Feb. 13.

He was 54 years old.

Larry had been at the Labs since September 1955.

He is survived by his wife, two daughters, and two sons.

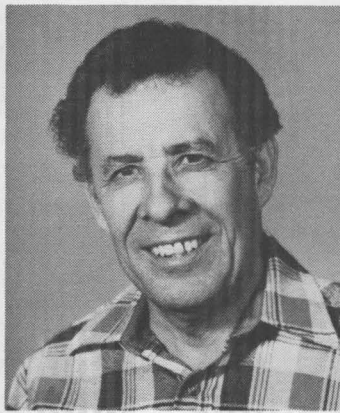


THE NEW MEXI-CHORDS, a 100-voice barbershop chorus, will join the New Mexico Symphony Orchestra for its second pops concert of the season March 5. Sandians and retirees singing with the group include (front row, from left) Charles Lowe (7234), Charlie Jackson (ret.), Gil Wallace (ret.), Lew Faw (ret.); (back row) Herb Howe (ret.), Wilson Brooks (9142), Jerry O'Brien (9224), Chuck Miller (2813), and Steve Billups (7233). The New Mexi-Chords are the reigning champions in the nine-state Rocky Mountain District of SPEBSQSA (the Society for the Preservation and Encouragement of Barber Shop Quartet Singing in America) and rank twelfth nationally out of nearly 700 choruses in the country.

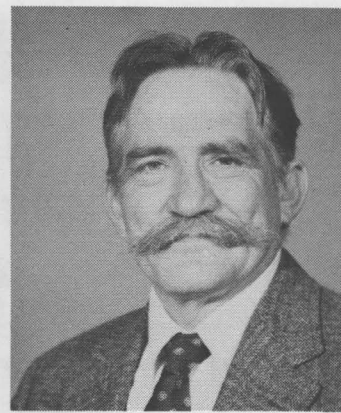
MILEPOSTS

LAB NEWS

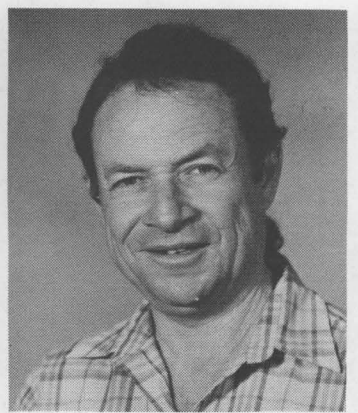
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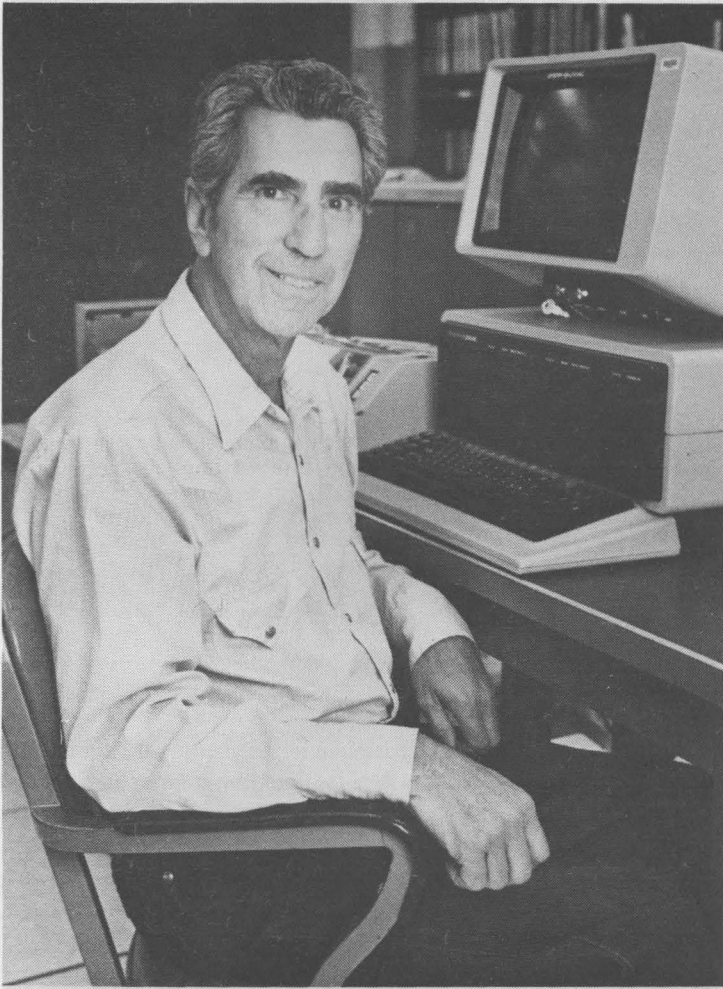
Jose Gutierrez (3425) 25



Harold Gough (7551) 20



Bob Silva (5122) 20



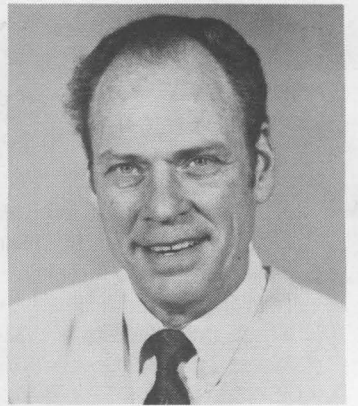
John Stathis (2632) 30



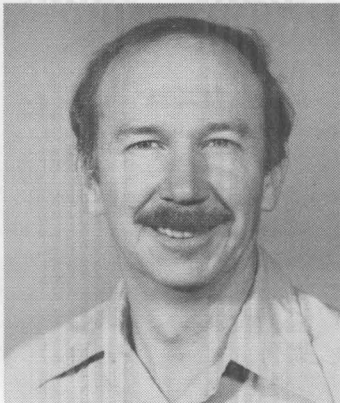
James McIntire (5213) 25



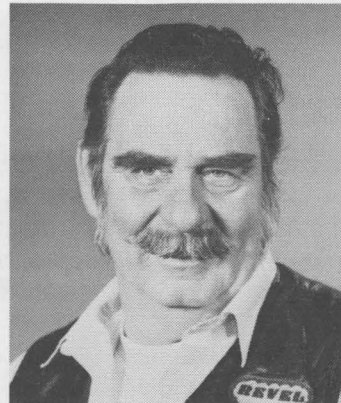
Mary James (151) 30



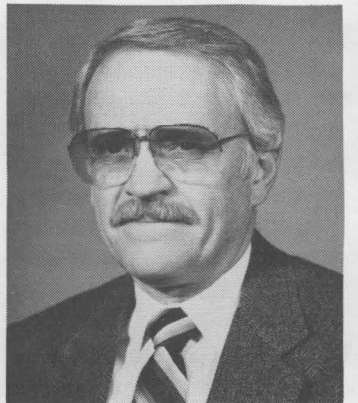
Harry Fisher (DMTS, 5145) 30



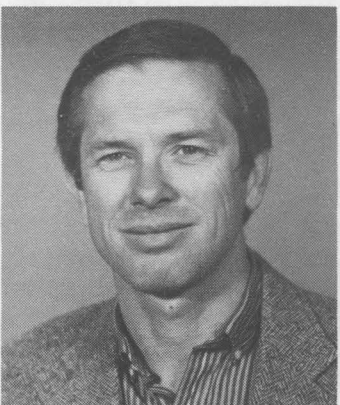
Dwight Lambert (6442) 20



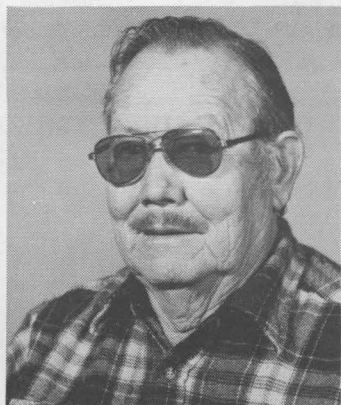
Revel Rainey (7811) 15



J. D. Martin (3400) 25



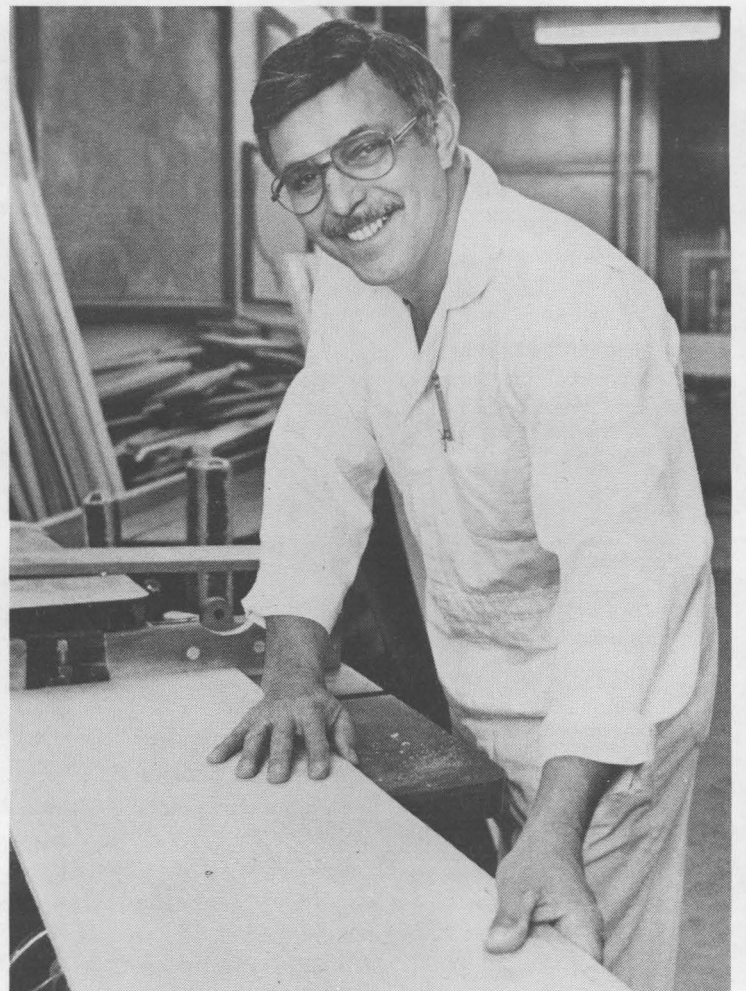
Steven Burchett (1521) 20



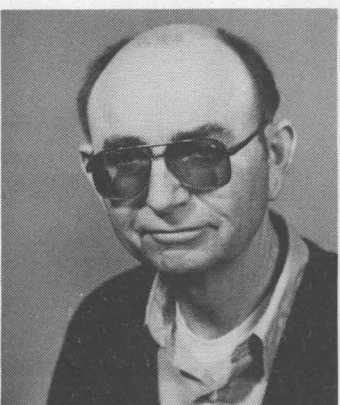
Frutoso Gurule (7812) 25



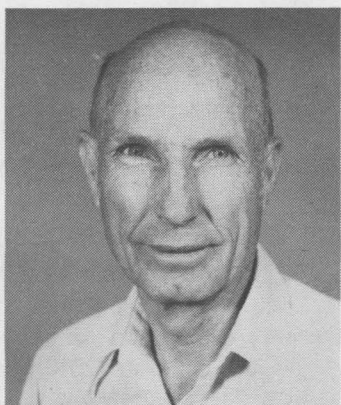
Ward Bower (6223) 25



Al Santistevan (7813) 20



Harkey Boling (3155) 25



Lynn Barker (DMTS, 1534) 25



Silviano Chacon (2541) 25

Get It Together with "Together" — Golden Oldies, Country/Western, Top 40

TONIGHT, "TOGETHER" helps you get that way from 8 p.m. to midnight. These music-makers feature a medley of melodies that merit a mention: oldies (but goodies), the latest in rock, c/w — you name it, they play it! Beforehand, elegant entrees available at the two-for-one special dinner are prime rib or snow crab. (Flash your membership card and get a delectable-dining discount.) Better head for the nearest phone and make a reservation right now (265-6791).

ALWAYS ON SUNDAY — and always from 10 a.m. to 2 p.m. That describes the best brunch in town, and there are two of them coming up in the near future: this Sunday (Feb. 28) and a week from Sunday (March 6). Start out with a complimentary glass of champagne or wine; then enjoy a bountiful buffet featuring a spread that will please every member of the family. Menus vary, but you can always count on that good green chile, omelets, ham (or turkey or baron of beef), etc., etc. Members get a discount (up to \$2/family); don't forget to reserve your space.

A DOGGONE GOOD TIME is what's in store for everybody at Family Night on March 5. The Disney classic, "Lady and the Tramp," features a pampered pooch (Lady) who falls for a mangy mutt (Tramp) from the wrong side of the tracks. Start out

with a low-cost buffet (available from 5 p.m. on), enjoy cartoons from 5 to 6, and watch the main feature at 6. As always, the movie is free; special treats include free popcorn and balloons for party-goers.

A CUT ABOVE THE REST is the best way to describe those wily T-Bird card sharks. They're putting their cards on the table March 10 and 24; both sessions start at 10:30 a.m. As usual, free refreshments and door prizes accompany the gaming.

CATCH THE STAGECOACH next Friday night (March 4) and gallop on over to Western Night, featuring a two-for-one chow choice of T-bone steak or shrimp. Afterward, it's stomp-and-shuffle time with those good old Poor Boys from Isleta (8 p.m. to midnight). Help out the ranch hands in the kitchen by calling in your reservation — pronto!

MEMORY LAPSE on your membership? This time of year is membership renewal time for those who don't take the payroll-deduction route. Don't get caught with your membership down — especially with pool and tennis seasons just around the corner. Stop by and see those "service-with-a-smile" folks at the office.

HITTING THE BULL'S-EYE is what it's all about when members of the C-Club Dart League get

together. Target date for spring-competition sign-ups is Tuesday, March 1, at 5:30 p.m. in the Fiesta room; free beer and munchies for all the signer-uppers. League teams meet every Tuesday night for fun and games, and — says League V-P Sandra Rodriguez (121) — beginners are very welcome. Give her a call for more info on 6-0618.

I FEEL A SONG COMING ON, and you will too — when you sign up for one (or more) of those terrific trips planned by the C-Club Travel Committee. How about these for starters?

Best of Britain (May 17-June 1) — Get the low-down on this tour of the British Isles at a presentation on March 9 (7 p.m., Fiesta room). Cost is \$1585/person (double), with price breaks for triple or quad occupancy. Guarantee your space with a \$150 deposit; final payment not due until April 1.

Down by the Riverside (April 29-May 2) — Laughlin, Nev., on the banks of the Colorado River, promises a high old time for all you closet gamblers on this foray into one-armed bandit territory. The \$162/person (double) tab includes RT charter bus fare, three nights' lodging at the Riverside Hotel/Casino, continental breakfast and lunch on the way, a buffet meal in Laughlin, box dinner on the return trip, and side trips: a boat cruise on Lake Mohave and tour of Davis Dam, and a visit to the old mining town of Oatman, Ariz.

Events Calendar

Feb. 26-27 — "Animals," NM Repertory Theatre's Acting Workshop presentation of vignettes exploring human behavior from the viewpoint of pets, prey, and laboratory specimens; 8 p.m. Fri. & Sat., Second Story Arts Center, Albuquerque Little Theatre, 243-4500.

Feb. 26-28 — "A Gilbert & Sullivan Gala," Opera Southwest/Albuquerque presentation, starring John Reed (London's D'Oyly Carte Opera Co.) and John Reardon (Metropolitan Opera and New York City Opera); 8 p.m. Fri. & Sat., 2:15 p.m. Sun. (Meet-the-Artists Champagne Reception follows Fri. & Sat. performances); KiMo Theatre, 243-0591 or 243-8492.

Feb. 26-March 6 — "For Colored Girls Who Have Considered Suicide When the Rainbow Is Enuf," a "choreopoem" by Ntozake Shange; 8 p.m. Fri. & Sat., 6 p.m. Sun.; Vortex Theatre (2004-1/2 Central SE), 247-8600.

Feb. 26-March 6 — "Nightclub, Confidential," musical comedy about the ups and downs of a group of nightclub entertainers; 8 p.m. Wed-Fri., 6 & 9 p.m. Sat., 2 p.m. Sun.; Albuquerque Little Theatre, 242-4750.

Feb. 26-March 6 — "Dinosaurs Past and Present," comprehensive exhibit of dinosaur paintings, sculpture, and models, organized by the Natural History Museum of Los Angeles County; 10 a.m.-5 p.m. Tues., Thurs., Fri. & Sun., 9 a.m.-9 p.m. Wed., 9 a.m.-6 p.m. Sat.; New Mexico Museum of Natural History (call museum for list of special events for this exhibit), 841-8837.

Feb. 27 — The New Song Quintet, ensemble reviving the tradition of poetic, meaningful, and musically innovative song; 8 p.m., South Broadway Cultural Center, 848-1320.

Feb. 28 — Mary McCaslin, vocal concert, sponsored by the New Mexico Folk Music Society; 7 p.m., KiMo Theatre, 848-1374.

Feb. 28 — Sinfonietta Four: New Mexico Symphony Orchestra plays Mozart, Paganini, and Partos; 8 p.m., Sims Auditorium, Albuquerque Academy, 843-7657.

Feb. 28 — Canterbury Concert Series: Carla Beauchamp on flute; 4 p.m., St. Thomas of Canterbury Episcopal Church, 247-2515.

Feb. 28 — "The Wedding Band," by dramatist Alice

Childress, focus on assimilation in interracial relationships, Black History Month workshop; 3 p.m., South Broadway Cultural Center, 848-1320.

March 5 — "An Evening of Lerner and Loewe," New Mexico Symphony Orchestra pops concert, with the New Mexi-Chords, conducted by Roger Melone; 8:15 p.m., Popejoy Hall, 842-8565.

March 6 — Concert, Albuquerque Civic Chorus, sponsored by Parks and Recreation Dept.; 7:30 p.m., First United Methodist Church (4th & Lead SW), 831-0093.

March 11-12 — Concert, New Mexico Symphony Orchestra, conducted by Neal Stulberg; music of Berlioz, C.P.E. Bach, and Morton Subotnick (world premiere); 8:15 p.m., Popejoy Hall, 842-8565.

March 11-13 — "The Seven Deadly Sins" by Kurt Weill, and "Cakewalk," presented by Southwest Ballet Company; 8:15 p.m., KiMo Theatre, 294-1423.

Congratulations

To Susan (6418) and Pat Dingman, a daughter, Carolyn Megan, Jan. 25.

To Cathryn and Ned (5165) Hansen, a son, Curtis Ned, Feb. 5.

To Alison and Keith (9011) Almquist, a son, Scott Trevor, Feb. 5.



1988 SECRETARIAL COMMITTEE — Its members, selected by SNLA vice-presidents, serve as the primary link between secretaries and management. The committee also stages an annual seminar for all secretaries, makes presentations on the profession to local high school groups, works with the Women's Committee on issues involving women at Sandia, and publishes SWAPS (Secretarial Writings & Professional Standards). This year's members (from left): Pat Rosario (2610), Linda Worden (5140), Debra Hamilton (1230), Jo Titman-Ryan (6330), Anita Smith (7810), Vee Histia (120, representing 4000 and 9000 as well), and Cindy Gregory (3420). *Ad hoc* members of the committee are: Carol Kaemper (21-1), Shirley Dean (22-2), Claire Evans (3523), and Ralph Bonner (3500).

and-control capabilities. This includes Emergency Action Message (EAM) generation and handling, multilevel security techniques, additional robustness (for example, utilization of MILSTAR — a military satellite), and the correlation of offensive and defensive strategic forces. (5250)

• We began the Airborne Remote Operated Device (AROD) program for the US Marine Corps in January 1986. AROD is a small, hover-capable **unmanned reconnaissance system** designed for frontline troops. Last year, we completed development of the on-board flight-stabilization system and the design of deliverable prototype flying units and portable ground-control units. We have demonstrated sustained stable flight for more than 30 minutes. We are currently fabri-



AIRBORNE REMOTE OPERATED DEVICE (AROD), a hover-capable unmanned reconnaissance system, is 30 inches in diameter and 65 inches tall. Light-colored cylindrical shape at top contains flight instruments and a computer that controls flight stability.

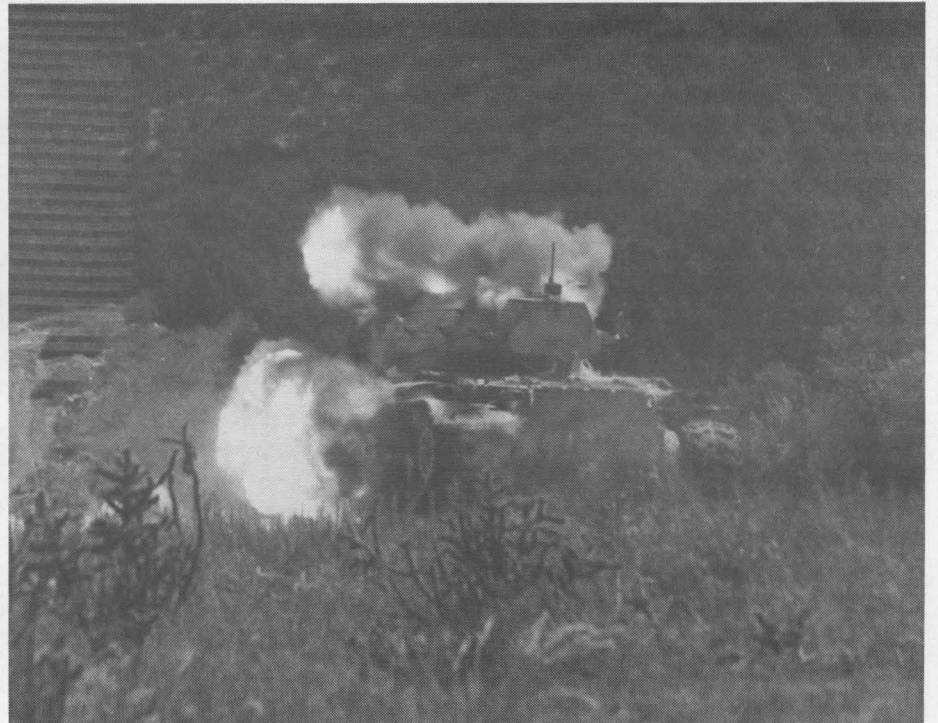
cating ten deliverable flight units and five ground-control units, which will be delivered to the Marines. (5260/1550/2540/7530/9130)

• We developed a comprehensive **computer-simulation package** for modeling performance of a satellite instrumentation system and its associated ground processing algorithms. Results of nuclear-burst scenario performance simulations led to design upgrades in both space and ground segments of this program for the Air Force. (9220)

• Unmanned weapon systems offer the opportunity to remove the soldier from the most hazardous areas of the battlefield. Under a program for the Army, we have been developing the various technologies required to realize these systems, and recently conducted a live fire demonstration of a concept called **Fire Ant**. The demonstration integrated three key technologies: teleoperated, mobile land vehicles; automated motion detection; and explosively formed projectiles. The demonstration resulted in the destruction of a surplus tank. (5260/9120/9130/7530)

• We developed and tested a **range-imaging active laser radar** for DoD. The laser radar uses a gallium-arsenide diode modulated at 4MHz. The beam is scanned with an X-Y mechanical scanner. The phase of the return signal is measured to obtain range to objects in the field of view. The range image is displayed on a video screen as a 64-x-64-pixel, pseudo-color map at four frames per second. During field demonstrations, the radar produced real-time images of a moving armored vehicle. The radar has applications in conventional weapons as part of fuzing systems that perform automatic target recognition and/or aim-point refinement. It also has potential application in robotic-vision systems, collision-avoidance systems, and autonomous vehicle-control systems. (9120/2530)

• We developed the **Tactical Remote Sensor System (TRSS)** for use by elements of the Marine Corps, Army, and Air Force. The TRSS is a set of unattended ground sensors used to gather battlefield intelligence. It can also be used to



SURPLUS TANK was destroyed in live demonstration of unmanned weapon system called Fire Ant.

assist with protection of high-value assets. The system includes seismic, magnetic, and infrared sensors and imagers. Information is transmitted via RF links to monitor units. All equipment is designed to be small, lightweight, and inexpensive. System effectiveness was demonstrated during extensive operational testing at Coyote Test Complex. (9240)

• Under the auspices of the Army/DOE Memorandum of Understanding, we developed an **automatic target acquisition (ATA) system** to process video data at real-time rates (7-10 frames per second). The algorithm — currently implemented using a set of image-processing boards — controls a multitarget, object-oriented tracker capable of detecting and tracking moving objects along any curvilinear path, while retaining the identity of each object from one frame to the next. Once a valid target is detected, the processor issues an alarm to the operator and continues to track the target until it leaves the scene or disappears from view. In addition to ATA applications on the battlefield, this type of system is potentially

very useful in safeguards and security applications where broad area coverage and/or quick response is required. (9130)



FIRE ANT — A critter that helped do in the tank shown above. An explosively formed projectile — the round element at top — is what does the damage.

Energy

• We completed activities on the **Multiwell Experiment** — a seven year program to study how to improve natural gas production from reservoirs typical of many found in the West. We characterized the 4000-ft.-thick Mesa Verde formation and its different reservoirs and showed that understanding the environment of deposition, natural fractures, *in situ* stresses, and specific stimulation phenomena is vital to improved recovery. These findings have been transferred to industry through extensive documentation and direct contact. (6250)

• A slanted core hole was drilled under the largest crater of the 600-yr.-old Inyo volcanic system at Long Valley Caldera, Calif. The hole is the fourth and final of a series drilled to better understand the **behavior of magma** in the shallow crust, and it provided important structural and thermal constraints for the west end of the caldera. Scientists from four DOE labs, two universities, and the US Geological Survey participated in the project. Sandia provided the leadership for both the scientific and technical aspects of the project. (6230/6240)

• We recently increased significant-

ly our understanding of the fundamental processes that control the operation of a **pulse combustor**. The concept of characteristic mixing, combustion, and acoustic times, combined with classical acoustic theory, has been used to tailor the performance of a research combustor. In addition, close ties have been established with US manufacturers to accelerate the development of high-efficiency, low-emission, prototype combustors exhibiting lower radiated noise. (8360)

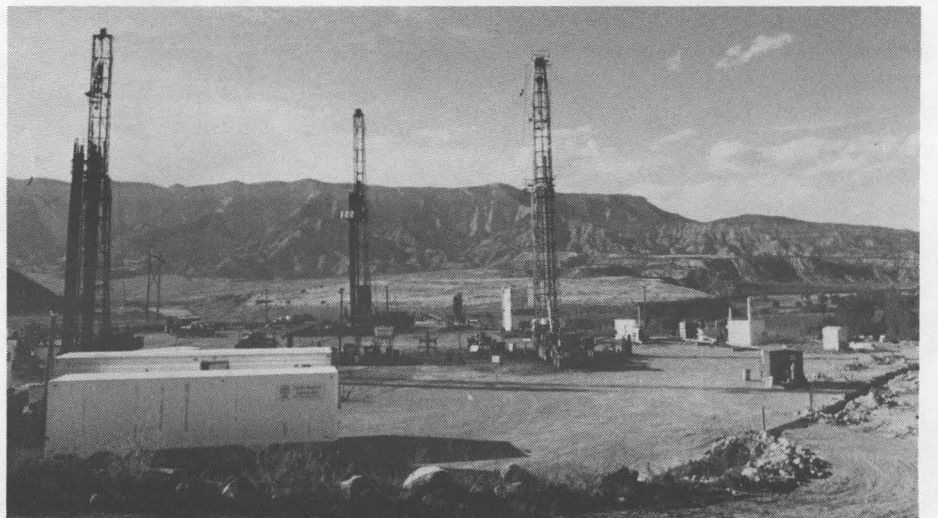
• We completed the draft-for-comment of the **Reactor Risk Reference Report** for the Nuclear Regulatory Commission. This study is a landmark in the application of integrated probabilistic risk-assessment methods to commercial nuclear power plants. It advances state-of-the-art techniques for applying event-tree, expert-opinion, and uncertainty analyses to significant reactor-safety issues. This work identified the major contributors to severe accidents and provided new insights that resulted in significant plant or procedure changes for improved safety. (6410)

• We established a high-performance graphics facility for **computer-aided de-**

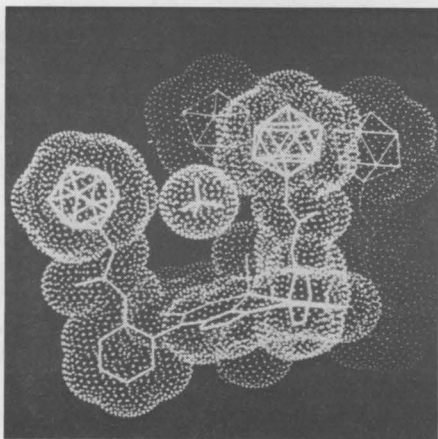
sign of catalysts. This includes high-resolution, three-dimensional display of molecular structures, and incorporates molecular dynamics. Initial work has focused on the design of tailored porphyrins to catalyze the direct conversion of methane to methanol. Several materials have been synthesized and spectroscopically characterized. Tests for catalytic

activity of the tailored metalloporphyrins are currently under development. (6210)

• We performed analyses of the observed responses of operating crews to abnormal events in the LaSalle nuclear power plant simulator. The analysis results provide the estimated probability of failure to initiate the correct action, as a function of time, for a wide variety of required



THREE CLOSELY-SPACED WELLS at the Multiwell Experiment near Rifle, Colo., form a unique field laboratory that's been used to collect data on how to improve natural gas production from reservoirs typical of many found in the West.



HIGH-PERFORMANCE GRAPHICS FACILITY for computer-aided design of catalysts provides depictions similar to this one of a methane molecule (sphere) within the binding site of a tailored porphyrin.

actions. These estimates, the first based on experimental data rather than expert opinion, will be used in a probabilistic risk assessment of LaSalle as a part of the **Risk Methods Integration and Evaluation Program**. (7220/6400)

- In our solar energy program, we made the first measurements of the shape of the beam reflected from our **stretched-membrane heliostat**. The heliostat was built under contract to Sandia and installed at our Central Receiver Test Facility in 1986. The mirror is holding up well to environmental exposure, and the shape of the beam is better than current glass-mirror designs. (6220)

- Construction of a 1/10 scale model of a reactor containment building — the **SURTSEY test facility** — was completed under a Nuclear Regulatory Commission-sponsored program. This 38-ft.-high, 12-ft.-diam. building, rated for pressurization to 150 psi at 225°C, is being used to study the threats to reactor containment buildings that arise in severe reactor accidents. We conducted three tests of the loads produced by expulsion of high-temperature melt from a pressurized vessel into the SURTSEY chamber. (6420)

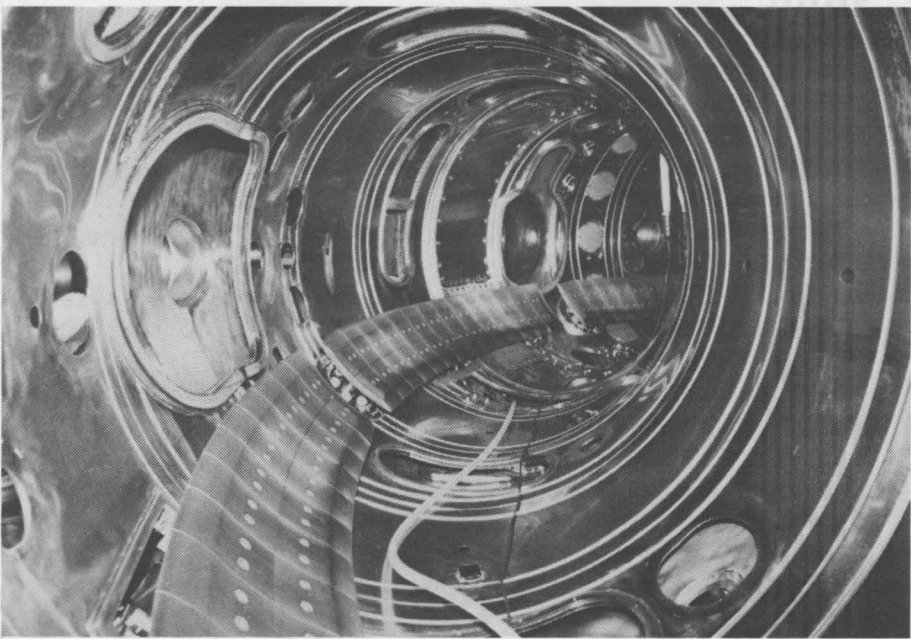
- We completed installation of the **Advanced Limiter Test-II (ALT-II)** system at a magnetic-confinement fusion facility — the TEXTOR tokamak at Juelich, Germany. Initial operation began soon after installation, and experiments continued throughout the year. Inside the doughnut-shaped TEXTOR tokamak, the limiter forms a belt that defines the edge of the hot hydrogen plasma. The limiter also removes neutralized hydrogen particles through ducts located behind the lim-

iter belt. The project is a joint collaboration of laboratories in Europe, Japan, and the US to produce fusion. Sandia served as the overall engineering coordinator for the project, and is also participating in the experimental physics program associated with the operation of the limiter. (6510/7400/8340)

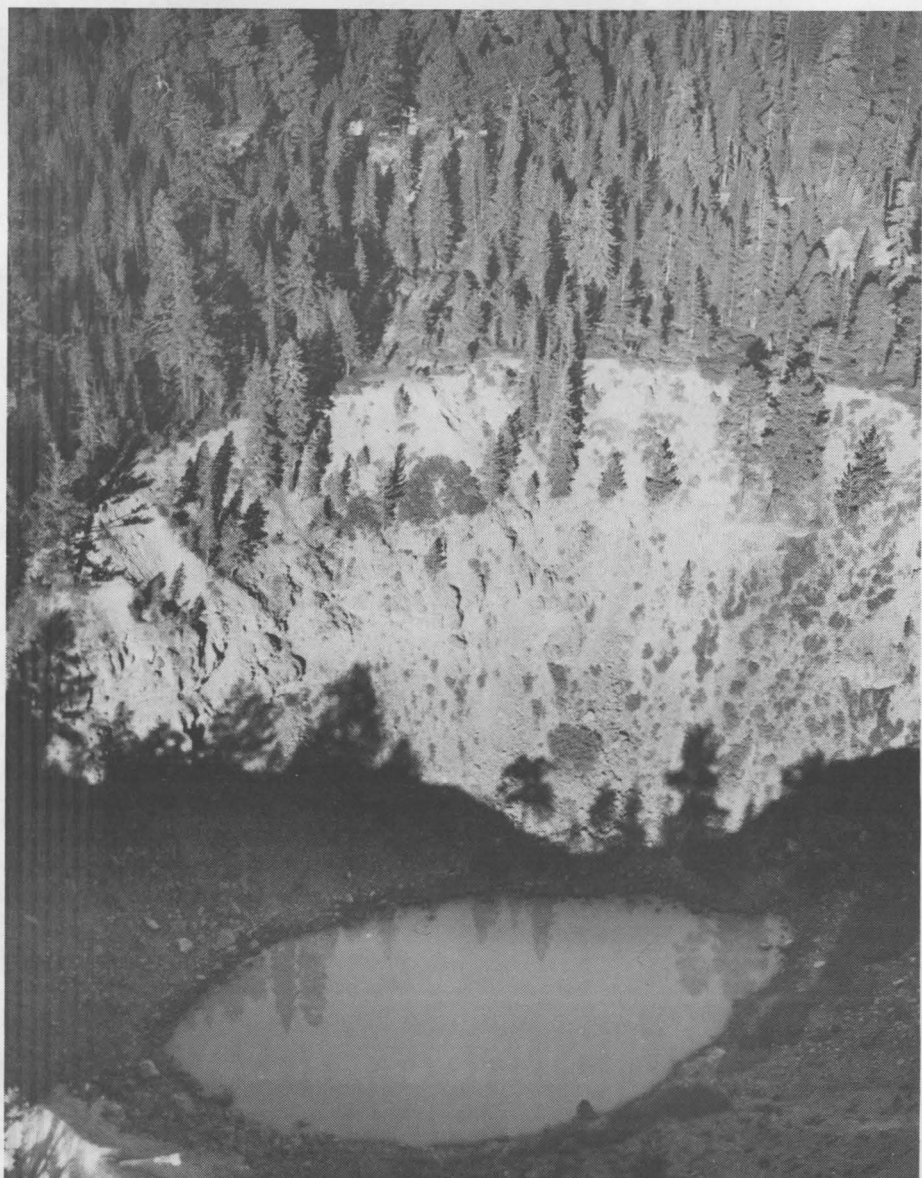
- Sandia's **Photovoltaic Design Assistance Center**, representing DOE, worked with the Organization of American States to increase the acceptance of cost-effective photovoltaic energy systems in Central America. We have been involved in training programs, presentations to government officials, and direction of specific pilot projects. In May, photovoltaic-powered vaccine refrigerators were installed in Guatemala, Honduras, and El Salvador (two in each country). These installations have been very successful, and we continue to help host-government efforts to obtain additional units. Also assisting in this effort are the Pan American Health Organization and the US Agency for International Development. (6220)

- We completed a modal test (experimental determination of vibration characteristics) of the 110-m **EOLE vertical axis wind turbine** in Quebec, Canada, in cooperation with the Canadian wind energy program. This test allowed verification of an important finite element computational model of the turbine. (7540)

- We completed a comprehensive preliminary evaluation of the **WIPP Seal System**. The evaluation was based on (1) laboratory and field-determined seal material behavior; and (2) *in situ* assessment of construction damage zones, brine transport, and scaled seal-system performance — both coupled with detailed structural and fluid-flow analyses. The design evaluation revealed no fundamental obstacle to effectively sealing the WIPP, and identified key experimental elements necessary to complete the design. We also developed a predictive model of brine transport from the intergranular boundaries in Salado-formation salt into the waste-disposal room of WIPP. The model, based on analysis of data from controlled experiments and observation boreholes, is for a very low-permeability geologic medium with pressure-driven flow. Preliminary evaluation of storage-room performance using a closure prediction based on *in situ* data shows that the room volume will have been reduced by 70 percent in 100 years — more than enough to entomb the waste. Predicted brine volumes in 100 years will be absorbed by the room backfill and, therefore, should not adversely impact



INSIDE THE TEXTOR TOKAMAK, a magnetic-confinement fusion facility at Juelich, Germany, the Advanced Limiter Test-II system forms a belt that defines the edge of the hot hydrogen plasma inside the doughnut-shaped tokamak.



OBLIQUE AERIAL VIEW of the South Inyo Crater and drilling operation at Long Valley Caldera, Calif. Drill site is partially visible through the trees above the crater's far rim. Inyo-4 drill hole passed beneath the center of the crater lake (bottom) at a depth of 1900 feet, and terminated beneath the crater's near rim at a depth of 2700 feet.

waste disposal at WIPP. (6330)

- We completed an overpressure test on the world's most complex model of a reinforced-concrete containment structure in July. The test culminated the Nuclear Regulatory Commission's research effort on the performance of nuclear **reactor containment buildings** that are subject to severe accidents. This containment integrity program had international participation, with six foreign groups and four US groups (including Sandia) performing pretest analyses of the containment model. Test results increased our understanding of the containment's behavior and provided a structural data base that can be used to qualify analytical codes, which can, in turn, be used to assess the capabilities of full-size containments subject to hypothetical severe accidents. (6440)

- We completed fielding and interpretation of two **regional-scale hydraulic tests** of Culebra dolomite, the major water-bearing zone in the Rustler formation at the WIPP site. These tests provided information on both local-scale and regional-scale effects of fracturing, and indicated present directions of fluid flow. Results indicate that fracturing does not generally need to be considered in modeling possible contaminant transport to the accessible environment. We also completed geochemical studies that indicated the hydrologic and geochemical regime of the WIPP site is transient. When combined, the hydrologic and geochemical studies indicate changes in directions of fluid flow within the Rustler during the last 10,000 years — precisely the time scale of regulatory interest in performance assessment of the WIPP. However, since the changes are in response to the end of significant recharge approximately 10,000 years ago, the findings — although more complex

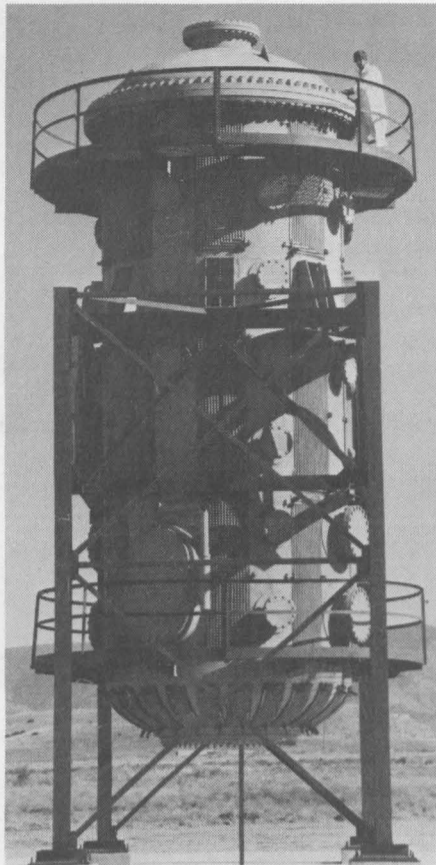
than previous results — are favorable for the long-term behavior of the WIPP site. (6330)

- We completed major portions of the Site Characterization Plan (SCP) for the **Yucca Mountain** site in Nevada as a civilian nuclear waste repository. We completed sections on geoengineering, repository design, rock mechanics testing, and performance assessment. This document summarizes Sandia's work during the last seven years, and develops site characterization plans for the next five to seven years. We also completed a Conceptual Design Report that presents a design for underground and surface facilities that would accommodate the equivalent of 70,000 metric tons of nuclear waste. Our work will allow the DOE to proceed with the final documentation for review by the NRC, the State of Nevada, and the public. (6310)



EOLE, a 110-m (360-ft.) vertical axis wind turbine in Quebec, Canada, includes Sandia-designed features.

Technology Transfer



SURTSEY TEST FACILITY was developed to study loads placed on nuclear reactor containment buildings during severe accidents.

- Through initiatives in organizations 4030, 4050, and 6231, a Sandia invention related to petroleum exploration was transferred exclusively to a **new start-up company** headed by an ex-Sandian. Under the Labs' consulting policy, other Sandia co-inventors will help commercialize the new product, a downhole seismic tool useful for detecting underground fluids (particularly oil and gas). (4030)

- Sandia offered temporary use of the RHIC (Radiation-Hardened Integrated Circuit) laboratory as a start-up site to **SEMATECH**, a consortium of US semiconductor manufacturers. New Mexico's SEMATECH proposal (including RHIC) was one of 12 in the final competition; however, SEMATECH chose Austin, Tex., as its site in early January. (400/2900/2700)

- Efforts of organizations 4030, 2510, 7470, and 1510 to transfer **semiconductor bridge technology** have result-

ed in the formation of a start-up company. The new company's products will include a variety of explosive devices with enhanced safety and precision timing — increasingly important factors for many applications. Research to support this effort will involve two of the university-based Centers of Technical Excellence established by the State of New Mexico: Energetic Materials at NMIMT (Socorro) and Materials Research at UNM. The Technological Innovation Program at UNM is coordinating the business aspects of the enterprise, and both on-roll and retired Sandia inventors are involved. As the effort matures, Sandia will interact with a central organization that will facilitate use of the new technology by commercial end-users. Sandia programs should also benefit from the additional research supported by commercial interests. (4030)

- Mentor Graphics (Beaverton, Oreg.) has decided to base its next gen-

eration of IC (Integrated Circuit) layout software on the **Sandia Layout System (SLS)**. Sandia has signed an agreement with Mentor Graphics for commercial development of SLS. Mentor Graphics has agreed to develop SLS into a fully integrated software product in its workstation IC design environment. This work will result in a fully refined — and commercially supported — product. Mentor is undertaking this effort at no cost to Sandia. The arrangement with Mentor was accomplished by Dept. 2110 staff, with assistance from Organization 4000. (4030)

- The Sandia inventor of an **anti-pollution process (RAPRENOx)** left the Labs with a waiver giving him rights to the invention and formed a new business called Technor in the Livermore area. Technor has obtained funding from private and government sources for research that should lead to a commercial product. (4030/8300)

Laboratories Support

- Sandia received the Government-Industry Data Exchange Program (GIDEP) **Industry Achievement Award** in 1987 for the following: (1) outstanding support of activities and participation in programs, (2) promotion of the use of GIDEP data at SNLA and SNLL, (3) effective and extensive use by a large "user area of interest" technical group, (4) submission of many SAND reports to the engineering data interchange, (5) management support of the GIDEP program, and (6) SNL's overall GIDEP policy. (2830)

- Tonopah Test Range has converted a WF-100 X-Band, 1-mil precision, conical-scan tracking radar into a highly mobile unit that will provide **expanded range coverage** in terrain-shadowed areas adjacent to TTR. The unit can operate as a stand-alone tracker and recording system at any location where single-target tracking and control is required. Two people can disassemble and reconfigure the system at a different site in eight hours, excluding transportation time. The radar system provides accurate tracking data for aircraft and missiles, range safety, and wind profile generation. The system has been initially deployed for tests at Kauai Test Range. (7170)

- In response to recommendations made during the last department managers' conference, we substantially restructured the **budget development process**. Case managers developed initial case budgets, which were then iterated between case and organization managers to produce final budgets. We also defined a budget appeal process and established an Internal Program Committee consisting of people from Indirect and Direct Support programs. (140)

- New technology that aids in management and distribution of **design definition information** is now available. We acquired and implemented a system that converts film and paper images to digital form for rapid viewing, high-speed distri-

bution, and storage on a variety of media, including optical disk. The production version of this system (slated for 1988) will provide electronic "film bank" capability, eventually replacing the 30-yr.-old aperture-card system with on-line access of images and electronic transmission between agencies. The new system will reduce costs and space usage while improving response time. (2830)

- Construction of the Radiation-Hardened Integrated Circuit (**RHIC**) **Laboratory** was completed. The facility is essential for the development of the next generation of radiation-hardened Ultra Large Scale Integrated (ULSI) circuits. The facility consists of a 12,000-sq.-ft. ultraclean room in a bay and chase configuration housed in an overall envelope of 174,000 square feet, which includes office, light lab, and central plant space. Key design features include a unique clean room floor and plenum system for vibration control, utility distribution, and air flow; a separate air supply system for bays and chases (wall channels); a state-of-the-art prefabricated make-up air system; and an innovative filter/ceiling grid system. (7840/2100)

- In May, we completed a six-year project to provide a **fiber-cable loop** that links communications centers in Tech Area I. The loop is expected to meet data-communications needs for the next 10 years. It will provide greater circuit capacity for distributed computing, video, security, and other applications. (2640)

- We continue to automate administrative functions in an effort to make them more cost-effective and more responsive to the programmatic needs of the Labs. Three recent examples of automation:

- (1) A **computer-aided publishing system** that will replace an obsolete system is being installed and debugged. Once operational, it will be used to produce publications such as military manuals and SAND reports. Electronic typesetting and

page makeup, as well as document composition without costly manual cut-and-paste operations, will provide high print quality and faster turn-around times than previously possible. (3150)

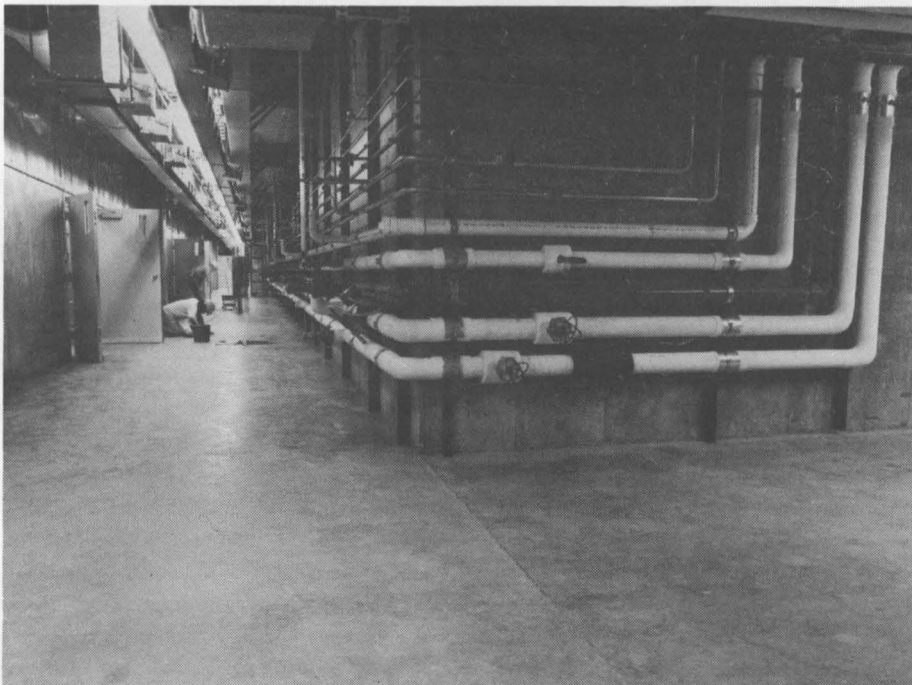
- (2) The PC/DAS (Personal Computer/Document Accountability System), which will replace the manual, card-oriented system for classified document accountability, will be the foundation of SNLA's **document-control program**. A micro-computer-based data-management system, the PC/DAS will maintain an accurate inventory of our classified documents, increase the security of our document data, and serve as an information-management and office-automation tool. (3410)

- (3) We have developed a system that permits directors and their office staffs to download data on their employees from the Labs' **Personnel Data Base** to a PC. The system runs on a variety of PCs, with no additional software required; it is a com-

ponent of the Management Information Data Access System (MIDAS), a menu-driven computer system that provides on-line management reporting of administrative data. MIDAS also added more complex and varied financial-reporting capabilities and semi-monthly financial reporting. (3530/2620)

- The second major portion of the **Simulation Technology Laboratory** line-item construction project was completed last year. The Saturn accelerator had its first firing of all 36 modules in September. Saturn, the most powerful X-ray simulator in the US, was designed to produce large-area fluxes of bremsstrahlung X-ray radiation. (7800)

- **New Computer-Aided Design (CAD)** systems, incorporating the latest technology for both electronic and mechanical design, have been installed in the Design Definition Department. The electrical design system is based on an



BASEMENT VIEW of RHIC (Radiation-Hardened Integrated Circuit) laboratory shows the maze of pipes, ducts, and wires needed to operate equipment in RHIC's clean rooms.

IBM 4381 processor that runs a commercial software package. (The selection was made jointly with Bendix Kansas City so that systems would be compatible.) The mechanical system is based on MicroVAX II computers that run the ANVIL-5000 design software. These systems will be the standard for design definition at SNLA for the next five years, and will replace all current CAD systems. (2850)

- More than 62 percent of the approximately 3300 Sandians invited to take part in the **Total Life Concept** health promotion program have participated since TLC began in January 1986. A cross section of the Labs' population, in terms of age, sex, and job classification, has become involved. Participants have made significant lifestyle changes — stopped smoking, lost weight, and/or increased exercise. The partnership of Sandia and Sandians in TLC provides mutual benefits: Employees enjoy improved health, and the Labs has a healthier, more productive work force. (3330)

- We established a **Computer-Aided Engineering (CAE)** Laboratory in Bldg. 892 to serve as a focal point for evaluation of existing and newly emerging CAE technologies and systems, and to facilitate training of Sandia staff on installed CAE systems. The CAE Lab and available support staff provide opportunities for hands-on evaluation of competing CAE equipment without capital outlay, on-site training (with significant cost savings on travel and collective discounts), and continuing updates and guidance. (2810)

- We installed a **Direct Numerical Control (DNC) system** that links 12 machine tools to our central Computer-Aided Manufacturing (CAM) VAX computer. The VAX computer is optimized for NC process-engineering through modern software and capable terminals. Through a link to Sandia engineering databases, we are now able to operate on information created throughout the Labs, and to pass NC programs directly to machine tools with improved communication speeds, higher data reliability, and significant cost savings. (7480)

- Security continues to improve its capability to protect classified information, materials, and government property from a variety of potential threats. Two recent examples:

- (1) With the cooperation of management and the line organizations, we introduced an **Internal Security (ISEC) program** to employees in a major LAB NEWS article. The program aims at identifying and thwarting possible espionage activities. Its primary thrust is education designed to raise the awareness of employees about the potential for espionage, the methodologies used, and the information that might be targeted. (3430)

- (2) With the help of Dept. 5210, we completed the demonstration phase of the **Sandia Security Upgrade** project. The project combines the Safeguards Control and Communications System and the Alarm Multiplexer Communications System developed by 5200 to provide a state-of-the-art intrusion-detection capability. Sensors, displayed on color-graphics terminals, are controlled by touch-screen switches; all activities are documented automatically. Redundant computers and dual-signal paths are used to improve system reliability. (3430/5210)

- Several improvements to **scientific computing** occurred last year. Super-



COMPUTER-AIDED ENGINEERING (CAE) Laboratory in Bldg. 892 will serve as focal point for evaluation of existing and newly emerging CAE technologies and systems.

computer users saw a doubling of the Solid State disk, which increases performance in the presence of large input/output; up to four processor units may be used on a single job. Distributed-computing users are now connected via a VAX network with up to 1-megabit/sec bandwidth, which — with additional capability on the supercomputer — permits some users to obtain graphical output at up to 500 kilobits/sec. The first application of a new optical disk-based recording system is being used to animate the output of a finite-element analysis program. A new PBX that will serve Bldg. 880 and Area IV is being installed to improve terminal bandwidth, and to support Ethernet and SNL local area networks. (2640/2630)

- Excellence through "quality of performance" has been a primary goal of SNL since its beginnings. We instituted a vigorous quality-assurance (QA) curriculum to emphasize this policy. The five-module curriculum presents the theory and application of QA at Sandia, emphasizing the philosophy of "do it right the first time." More than 300 staff and managers at SNLA and SNLL attended the QA presentations. (3520/7200)

- Purchasing awarded a **record \$5.1 million in contracts** to more than 30 certified 8(a) contractors (minority-owned businesses as defined by Public Law 95-5057) in New Mexico. These awards exceeded Sandia's goals of \$2.6 million in contracts and represent a doubling of the 14 minority suppliers who received contracts last year. The new group of 8(a) contractors is now beginning to move into the mainstream of Sandia's procurement base. (3730)

- We introduced significant changes in the **performance evaluation** and salary systems for MLS and MA employees. The "14-Level Plan" for MLSs, patterned after a similar salary plan at AT&T, compressed 20 point-based levels into 14 levels, each with a corresponding salary range. Performance designators for both MLS and MA groups were changed to descriptors that focus on job requirements. The new system gives supervisors more flexibility in correlating pay scales to performance levels. A comprehensive communication program, including major LAB NEWS coverage, conveyed the rationale underlying the changes to supervisors and employees. (3550/3530)

- A major step in a continuing program to improve internal communications was a **top-management briefing** for all Sandia management. Two in-depth presentations on the FY88 budget and its implications for Labs programs were moderated by 100, with input from Small Staff, 3500, and 3100. The briefing was shared with all employees via a LAB NEWS article, and a videotape of the briefing is available to all Sandians. (3160/3150)

- An Office Automation Subcommittee, consisting of secretaries from every SNLA vice-presidency, was charged with recommending a Labs-wide **standard for word processing** and word charts (for example, viewgraphs). After an extensive evaluation period, Small Staff accepted the committee's recommendation of MASS-11 (Version 7A) as the standard for both word processing and word charts. This standardization increases the efficiency of SNLA secretaries by allowing them to substitute for one another effectively (73 percent of SNLA secretaries are now using MASS-11). It also provides an economy of scale for acquiring and supporting word processing equipment. (Sandia Secretarial Committee)

- SNLL achieved major **security enhancements**, involving the construction of a 10,000-sq.-ft. "hardened" Security Building, as well as a complete upgrade of the Site Communications Control Center. A state-of-the-art alarm-monitoring and control system, with an enhanced personnel-access control system using high-energy, magnetic-stripe badge readers, is being implemented. Also, the Central Document Accountability System has been modernized with the implementation of a new on-line interactive system using bar-code technology to identify documents. (8530)

- A two-hour program, "**7000 Safety Days**," — presented in seven sessions, including one at Las Vegas, Nev., and another at TTR — was attended by almost all the employees of the Technical Support organization. In addition to presentations on environment, safety, and health (ES&H) protection responsibilities, the program provided information on resources, DOE and Sandia policies, and the *7000 Guidelines*, developed by the 7000 SHEAC (Safety, Health, & Environment Appraisal Committee) to pinpoint on-the-job organizational ES&H concerns. (7290)



Guide to This Issue

This LAB NEWS is actually two issues in one — peel off the outside eight pages and you have the complete "Laboratories Accomplishments 87" special section. The inside pages contain your "regular" LAB NEWS.

FY88 budget issues have delayed the publication of the annual "State of the Labs" interview with President Welber and Executive Vice-Presidents Jones and Bray for a month or so. If you wish to combine the "Laboratories Accomplishments 87" and the upcoming "State of the Labs" special sections to comprise what has been called Sandia's Annual Report, please save this issue.