

Novel Shower Alarm Commended by Tiger Team

The Tiger Team's final report about environmental, safety, and health (ES&H) conditions at Sandia, Albuquerque hasn't been released yet, but some good news has already surfaced.

According to the Tiger Team's draft final report, a new piece of hardware developed by Ceramic and Glass Processing Div. 7476 was a definite hit with the visitors.

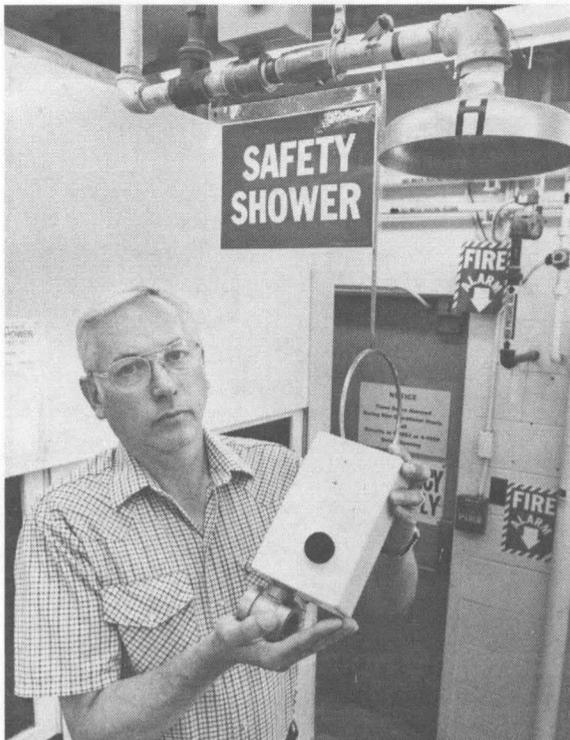
"Several months ago during one of our safety meetings," says Frank Gerstle, 7476 Supervisor, "someone asked what would happen if a worker spilled a hazardous chemical on himself or herself while nobody else was in the room. In such a situation, it's difficult to disrobe, call Medical, and operate an emergency shower all at once, especially if you're in pain." In the case of an acid or solvent spill, for example, it's recommended that a victim stand under an unheated shower for at least 15 minutes.

Seeking Simplicity

The problem prompted Frank and Ron Snidow (7476) to look for a commercially available alarm unit to add to the emergency showers in their division that would alert other workers whenever the shower was activated.

One system they looked at, a freon-filled high-pressure horn, was not feasible for use with an emergency shower. "Its decibel level was too high and could cause hearing damage, and it had to be activated separately from the shower," says Ron. "We also wanted to avoid using a product containing freon, if possible."

The second type of alarm unit they found, an electronic alarm that sounded as the shower lever was pulled, was expensive (\$1,200 each) and required independent electrical wiring. They decided



TIGERS SAID "KUDOS" recently to Ceramic and Glass Processing Div. 7476 for its use of a specially designed alarm that sounds when someone uses an emergency shower in the glass lab. Cliff Condit (7414), seen here holding one of the devices, and Chuck Baldwin (former contractor) designed the alarm.

that the craftsmen in Manufacturing Technologies Org. 7400 could invent a much less expensive alarm system for use with emergency showers.

Cliff Condit (7414) and Chuck Baldwin (former contractor) had the solution. They installed a flow switch (a tiny lever activated by the force of

flowing water) inside a pipe joint and attached it to a cigar-box-sized metal casing. The casing contains a battery, electronic alarm, and small speaker. Once the system is inserted into an emergency shower's piping, Ron says, this relatively simple alarm sounds whenever the shower is turned on — automatically.

"The cost to design, fabricate, and paint each unit is about \$270," he says, "but units could be manufactured in quantity for much less — possibly half." "Frank's division has had four of the alarms built, one for each emergency shower in the Glass Lab."

Kudos to Sandia

When the Safety and Health Subteam Tigers visited Frank's division, they liked how the relatively simple, easy-to-test device was applied to laboratory safety and included it as one of two "Noteworthy Practices" in the Safety and Health section of the Tiger Team's Albuquerque-site draft final report, released May 24. (The other "Noteworthy Practice" in this section of the report is the ES&H requirements chart, posted at various locations around the Labs.)

Ron says teamwork played a major role in developing the idea for the alarm. "We'd be hard-pressed to say who actually thought of it," he says. "Somebody at the meeting brought up the idea, and others refined it until it made sense."

"By spending extra time thinking through an accident scenario," says Frank, "we identified an area where the seriousness of an injury could be reduced by adding a simple alarm device."

Frank says that if other organizations at Sandia are interested in using the device with emergency showers or eyewash stations, they can contact him on 5-8337 or Ron on 4-1031. ●JG

Ion Microtomography

New Tool May Aid Industry And Medicine

A powerful new tool for characterizing the shape and density of materials is believed to hold promise for use in a variety of industrial and medical areas, including the study of cancer and Alzheimer's disease.

Called ion microtomography (IMT), the emerging technology produces detailed images of slices of objects much like the more familiar medical X-ray CAT (computer-aided tomography) scan. However, images produced through IMT are approximately 1,000 times more detailed. Its high resolution allows it to "see" constituent parts as small as one micron. (The diameter of a human hair is about 100 microns.) The images can also be manipulated by computer to produce different perspectives and cross-sectional views.

Researchers at Sandia, Livermore are leading the development of IMT in collaboration with Lawrence Livermore National Laboratory (LLNL). They are also working with scientists at the University of Melbourne, Australia.

Like other tomographic techniques, the distinct advantage of IMT is that it allows researchers to analyze a specimen or sample without slicing, damaging, or disassembling it. Processes — such as staining, freezing, and slicing — used to

(Continued on Page Three)

LAB NEWS

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SANDIA NATIONAL LABORATORIES

JUNE 14, 1991

Kwajalein Co-Workers in 1963

Two Sandians Reunited After 30 Years

In the early 1960s, two fledgling Western Electric employees — Tom Poteat and Tim Taylor — helped develop a missile system that can now be called the great granddaddy of many of today's anti-missile missiles.

Back then, Tom (7311) was an electrical engineer, Tim (9211) a technician. The two worked together on Kwajalein Island, the birthplace of the anti-missile missile (located approximately 2,000 miles southwest of the Hawaiian islands). "Our

jobs were on the exciting new Nike Zeus anti-missile missile system — real Buck Rogers stuff at that time," says Tim.

Nearly 30 years later, the two former Western Electric employees (see "The Western Electric Connection," page four) have been reunited at Sandia, Tom as a quality engineer and Tim as a satellite systems engineer. They recognized each other at a recent two-day quality workshop that

(Continued on Page Four)

REMINISCING over lunch are Tom Poteat (left, 7311) and Tim Taylor (9211), who became reacquainted at a recent Sandia Quality meeting. The pair worked together in the early 1960s at Kwajalein Missile Range on the Nike Zeus anti-missile missile system. The Nike Zeus was the first defensive missile system with the capability to detect, track, and intercept high-altitude missile targets.



How Sandians Predicted Oil Warfare Effects — See Page Six

This & That

Quick, Quiet Contributions — All but the greenest newcomers to Sandia have heard it many times: This is a “can-do” place — a place that can respond quickly and forcefully when asked to do a critical job in the national interest. This is reinforced by Assistant Editor Charles Shirley’s articles in this issue about some of Sandia’s contributions to Desert Shield and Desert Storm. These articles document the Labs’ work to determine impacts (military, health, and environmental) of Iraqi use of oil as a weapon in the Gulf War. Led by Dennis Engi (6601) and Virgil Dugan (6000), the fast-track project involved a multidisciplinary team from Albuquerque and Livermore that put in some long hours and cranked out some vital war-planning info quickly and quietly. The work has been deemed so sensitive that only recently has it been possible to discuss it in detail; coverage begins on page six.

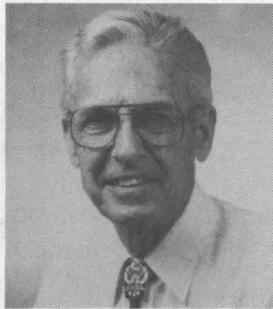
* * *

“Award-Winning Reporters” Needed — We like to recognize Sandians and retirees who receive awards and honors — work-related and community-related. Has your friend, colleague, boss, or employee been honored for good works in a community or professional group? Named a fellow in a professional society? Received a best-paper award? If so, keep the LAB NEWS in mind so we can give these folks a nod or two; call us on 844-7841, or better yet, send a note with a few details to Division 3162.

* * *

Another Healthy Sandian! — In the last issue, we featured Bill Walker (7267), who at 74 is the oldest Sandian, and who hasn’t taken a day of sick leave since he had an operation in October 1955.

Now we learn that Gene Emerson (3223) hasn’t taken sick leave since joining the Labs on July 14, 1955. Gene’s Sandia career will total 36 years exactly one month from today.



GENE EMERSON (3223)

* * *

Wouldn’t You? — Those two words came to mind immediately as I passed LAB NEWS writer Linda Doran’s office several days ago. The words came in response to a “screaming” headline in a tabloid newspaper article that Linda had clipped and posted: “Farmer Shoots 23-lb. Grasshopper.” A farmer was pictured with rifle in one hand and four-foot-long hopper in the other. Even bigger news, however, would be if an armed farmer *didn’t* shoot a 23-lb. grasshopper.

* * *

We’re Recyclable — The LAB NEWS can be recycled along with regular Sandia office (typing/copying) paper in the recycling bins located in Albuquerque Bldgs. 640, 804, 821, 823, 831, 832, 836, 856, 864, 869, 887, 890, 891, 892, and 9981. We’d much rather you deposit your used LAB NEWS copies there instead of lining the bird cage with them, but if you must, please place this column *down* when you do.

* * *

Upset Stomachs — That’s what most of us at the LAB NEWS got last week when we were judging the “World’s Ugliest Tie” entries submitted by Sandians. Looking at that collection of outdated patterns and ill-used colors was enough to try the toughest tummy. See story and photo on this page. Thanks to Ace Etheridge (3161) for modeling the ties for the judging panel. (I tried to resist the urge to say Ace looked better than usual, but obviously couldn’t.)

●LP

‘World’s Ugliest Tie’ Contest Ends in a Tie

By Larry Perrine, Editor

When are all entries in a contest “real losers?” The entries in the LAB NEWS’ “World’s Ugliest Tie” competition. This assemblage of ill-fated fabric has been judged by the LAB NEWS staff, and the big winner is — make that big winners are — Mark Crawford (3423) and Kary Ledbetter (3145).

Mark and Kary’s entries tied for first (with nine points each) in the initial vote in which each LAB NEWS staffer awarded three points for his/her top (ugliest) selection, two points for second, and one for third. However, because we were determined to select the “world’s ugliest tie,” we conducted a follow-up “ugly-tie-breaker” vote in which staffers voted for one of the two. Mark’s “simulated tiger skin” entry nosed out Kary’s “revolting texture and style” entry in a 4 to 3 vote.

Two entries tied for third: Scott Rowland’s (7844) “putrid orange and green spacescape” (designer definitely had a bad day), and another entry by Kary, the aptly named “obnoxious colors,” a not-subtle combo of pea green, gold, and silver.

In fifth place was Phil Montoya’s (5200) unnamed entry, a brown and blue bull’s-eye pattern that, if you were shot while wearing it, could be ruled justifiable homicide.

Another notable vote-getter was the only bow tie entered — a combination of hot colors that you might see while passed out from eating bad pork. Brandon Ahrens (7267) entered it, saying he once worked for a company that required men to wear ties. See Brandon for more details about that.

Dishonorable Mention

● Chuck Miller’s (9221) “spaghetti stain special,” a genuine-looking spaghetti stain overlaying a pattern of crossing dark blue, light blue, and white stripes. LAB NEWS photographer Mark Poulsen thinks this tie may have been made from leftover fabric from ’64 Dodge Dart seat covers.

● Bob Alexander’s (3215) “Mexican Madness” special. It’s a yellow/black/beige mixture of old-Mexico-style designs. “Try to match this baby to any suit,” he says. Thanks, Bob, but they haven’t made that suit yet — at least I hope not.

● Jim Blankenship’s (3401) untitled, multi-pattern, four-inch-wide, green, gold, and white monstrosity. The saving grace for this one is that about nine out of 10 spills would automatically be disguised in the pattern.

Thanks to everyone who entered. We’ve asked them to leave their entries at the LAB NEWS office (Bldg. 814, Rm. 1) for viewing through Friday, June 21. Feel free to stop by and see them on your lunch break, but you might want to eat and let it settle before viewing this collection!



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COLOR NEEDED! — Black and white printing just doesn’t convey the true ugliness of these top ties in the LAB NEWS’ “World’s Ugliest Tie” contest. Mark Crawford (3423, center) models his winning “simulated tiger skin” entry. Josh Ledbetter (left) models the “revolting texture and style” entry (yellow, brown, gold, and purple) that tied for first, and David Ledbetter models a pea green, gold, and silver entry that tied for third place. Josh (age seven) and David (age 10) are the sons of Kary Ledbetter (3145).

(Continued from Page One)

IMT: New Tool

prepare tissue samples for analysis under a microscope often destroy internal structures of interest.

"The scientist can essentially get inside the specimen without slicing or destroying it," notes physicist Art Pontau of Fusion Research Div. 8347. "That's the real strength of the technique."

Working with Art on the project are Dan Morse (8347) and Arlyn Antolak (8341), as well as several LLNL and University of Melbourne researchers.

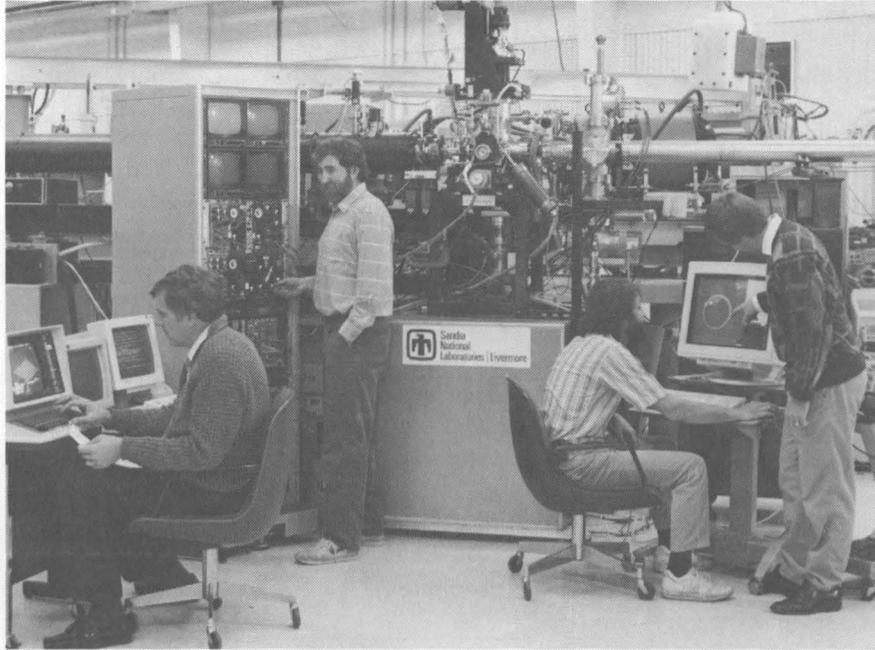
IMT Causes Less Tissue Damage

IMT is particularly useful for samples with low total density or where small density variations make X-ray analysis difficult. For example, IMT has been used to produce three-dimensional renditions of small junctions between two glasses with different densities.

For biomedical specimens, IMT can have the added advantage of causing significantly less tissue damage than other imaging techniques. Unlike X-ray CAT scans, IMT uses concentrated proton beams with energies in the mega-electron-volt (MeV) range. The positively charged particles pass completely through the sample to a silicon surface barrier detector while transferring only a portion of their energy to the specimen. X-rays, however, are absorbed and release much of their energy within the specimen, causing cell damage.

The technique, which was developed for defense work, could also have important industrial uses for materials used in microelectronics, non-destructive testing, and fission and fusion research, Art explains. For example, IMT could be used to examine small structures or to inspect thin coatings on silicon chips for uniformity. It also has potential for inspecting extremely small manufactured parts for flaws and weaknesses without the need for sectioning.

In nuclear fission energy research, IMT has been proposed for fuel pellet safety analysis. The integrity of the coatings on fuel pellets needs to be checked to ensure containment of their fuel and



ART PONTAU and Dan Morse (from left, both 8347), Dave Weirup (LLNL), and Arlyn Antolak (8341) conduct research on ion microtomography at LLNL's Multi-User Tandem Laboratory. The accelerator produces a concentrated proton beam, which is swept back and forth across a specimen to produce cross-sectional views.

fission products. The fuel pellets, less than one millimeter in diameter, for the Modular High-Temperature Gas-Cooled Reactor — a DOE program to develop a new reactor for tritium production — are made of uranium-containing fuel coated with carbon and silicon carbide.

Because the pellets are made of materials with widely differing atomic numbers, X-ray tomography is an ineffective analysis method. High-energy X-rays are necessary to penetrate the uranium, which renders the lighter carbon invisible. IMT is relatively insensitive to chemical composition and could be used to verify the integrity of the fuel pellets, Art says. The technique, which is sensitive to the total number of electrons per cubic centimeter, is able to image light materials in the presence of heavy ones.

Used in Fusion, Biological Research

For inertial confinement fusion (ICF) research, small spherical targets are compressed using very high-intensity laser or particle beams. The goal is to compress the deuterium/tritium fuel in the target to the point where it fuses and produces energy. The uniformity and sphericity of the targets are crucial for optimal performance, and IMT is being

used to characterize these targets, allowing evaluation of production processes.

Sandia and LLNL researchers have examined various samples using IMT by placing them in a vacuum chamber at Lawrence Livermore's multi-user tandem accelerator. Special lenses produce a two micron-diameter ion beam, which is swept back and forth across the specimen. At each spot,

"The scientist can essentially get inside the specimen without slicing or destroying it."

ions passing through the sample are intercepted by a detector, which measures each ion's energy.

Energy loss information for each cross-section is accumulated in a computer and used to calculate the density of material within that cross-section. Densities calculated for each tomogram (slice) are a complicated function of numerous variables. Hundreds of thousands of density determinations can be required for each slice, and hundreds of slices may be desired.

In a recent experiment with mouse intestine cells sealed in a glass tube, the beam was stepped across the sample at the same latitude 795 times. The sample was also rotated along an axis perpendicular to the beam 1,250 times, resulting in nearly 1 million measurements for each cross-section.

The computer uses data from repeated slices to map out spatial variations in electron density and produce a rendition of a three-dimensional object on a screen. The image can be rotated, a portion sliced away to reveal the interior, or various planes passed through it to achieve different views.

Potential Tool in Alzheimer's Research

The goal is to get a snapshot of not just a slice of the sample but also to be able to relate it to what lies above and below for a complete diagnostic picture, Art says. This capability could be used to study cancer cells, which don't grow in the same regular pattern as normal cells. The telltale plaques of Alzheimer's disease, which have a different density than surrounding brain tissue, could also possibly be studied using IMT, he adds.

Using the IMT technique, researchers hope to soon be able to look at individual cells in tissue samples and organelles within those cells. Sandia, Livermore researchers are currently building a second-generation IMT system with improved resolution. The current world record for resolution — about 1/20 micron — using an ion beam in the mega-electron-volt range is held by the University of Melbourne and was achieved while examining the edge of a silver specimen.

Practical IMT has been possible only in the past few years because of advances in computer power and other improvements. Sandia has improved the technology — invented some 20 years ago — and has extended its applications, achieving higher resolutions than ever before.

●JClausen (3161)



SANDIA LIVERMORE NEWS

RACE RESULTS — Jim Reitz (center, 8451) and Carol Caldwell (right, 8541) captured first place in the 1991 2,000-meter Directorate Challenge at Sandia, Livermore. Second in the women's class was Nina Bergen (left, 8177). Following Jim in the men's class were Thomas Jenson and David Tomchak, (both contractors). Second and third in age-adjusted score were Bill Wilson (8210) and Joe Treml (8451) for the men, and Betty Pimentel (2913) and Nina for the women. The traveling Directorate Trophy for most participants went to Ron Detry's 8200/2910 group.



Welcome

Livermore — Barbara Troen (8284). *Other California* — Linda Houston (8526), Karen Hoexter (8524), Juanita Jones (8354), Teresa Lee (8533), Robert Wood (8513).

Take Note

Ray Rychnovsky (8432) took two first-place honors for his photography at the recent meeting of the Outdoor Writers Association of California in both the color and black-and-white categories.

(Continued from Page One)

Kwajalein

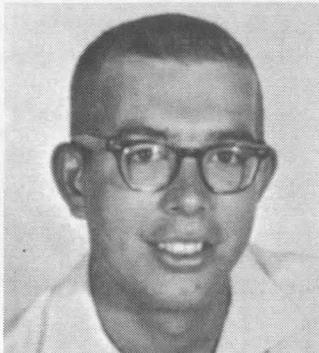
Tom was teaching to Tim's department. "There's always a special bond between people who accomplish something together," says Tom.

ICBM Interception Is Possible

The Nike Zeus system was the first defensive missile system with the capability to detect, track, and intercept high-altitude missile targets — presumably enemy ICBMs — and destroy them in flight. The system used a ground-based transmitter and receiver to track enemy missiles. The three-sided, rotating transmitter bounced signals off high-altitude targets on the horizon, while the huge, rotating dome-shaped receiver scanned the horizon at 10 rotations per minute. The receiver was surrounded by a network of antennas for better reception.

When an enemy target was detected, a separate discrimination radar identified the flight characteristics of the incoming missile using reentry physics. Once the reentry was characterized and the missile's trajectory was tracked long enough to extrapolate a likely flight path, the Nike Zeus missile was shot and detonated within lethal distance of the target. (For most tests, gunpowder flashes were used. A tactical Zeus missile would have contained a nuclear warhead.)

Tom says tracking and intercepting ICBMs in this fashion was a new concept in 1963. "The buzz-phrases associated with the technical challenges of the project were 'hitting a fly in the sky' and 'hitting a bullet with a bullet,'" he says. "Van-



Tim Taylor (9211) in 1963

The Western Electric Connection

Sandia has something in common with two of its employees — Tim Taylor (9211) and Tom Poteat (7311). The Labs and both employees reported to Western Electric during their early work years.

When American Telephone and Telegraph (AT&T) began managing Sandia in 1949 at the request of President Harry Truman, Sandians became employees of the Sandia Corporation, a subsidiary of Western Electric. At that time and for years to come, Western Electric was primarily AT&T's manufacturing arm.

Western Electric became AT&T Technologies in January 1984, and Sandia continued to be managed by the group until it was absorbed into AT&T on Dec. 31, 1989.

denberg [Air Force Base, California] shot the ICBMs, and we tracked them as they reentered, demonstrating for the first time that an ICBM could be tracked and intercepted successfully."

On July 19, 1962, a Nike Zeus was successfully detonated for the first time within "lethal distance" of its target — a mock ICBM launched from Vandenberg. (See "What's New at Kwajalein Missile Range?") The Nike Zeus soon became part of the Sentinel System and later the Safeguard System, until it was preempted by the SALT II treaty negotiations begun in 1972.

Rotating Receiver Dome

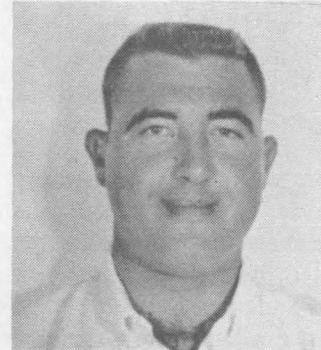
Tim and Tom met while they were both working in the 2-million-pound rotating receiver dome, the largest rotating mass in the world at that time. (The prototype for this dome was built at White Sands Missile Range.)

"An equipment room was bolted onto the inside floor of the hemisphere," says Tim. "To get inside, you had to crawl up underneath and enter from the center of the floor, sometimes while it

was rotating. Ten rpm isn't very fast at the center of the room, but the centrifugal force near the outside made movement difficult."

Tom says the dirt mound atop the missile silo that housed the Zeus missile on Kwajalein, nicknamed Mount Olympus, reached an altitude of about 40 feet above sea level. It was the highest point for thousands of square miles, he says. The island's average altitude is only about 4 feet above sea level.

The Nike Zeus missile itself was a three-stage rocket with exo-atmospheric thrusting, meaning its trajectory could be adjusted using radio guidance after it left the earth's atmosphere. "It worked something like the Patriot missile does," says Tom. "The Patriot is much smaller, doesn't leave the atmosphere, and uses phased-array radar tracking and radio guidance, whereas the Nike Zeus used a rotating antenna."



Tom Poteat (7311) in 1963

Kwajalein in the '60s

Work at Kwajalein during the Nike Zeus project was hectic, says Tim. "There was usually more overtime than regular time, and a six-day work week was standard," he says. "Sometimes we'd start working at 7:30 a.m. for a launch at noon one day, and still be working at noon the next day. We'd get sleep one hour at a time."

Back then, missile technology was not well-developed. It was difficult getting all the technology to work together at once, explains Tom, and successes were rare.

"Range chicken" was the favorite game of the engineers, he says. "Before a launch, everyone at PMR [Pacific Missile Range, including Vandenberg]

(Continued on Next Page)

Five Decades of Military Significance

What's New at Kwajalein Missile Range?

On July 1, 1946, an historic US nuclear test took place as a B-29 bomber named "Dave's Dream" ascended from Kwajalein and dropped its destructive cargo on neighboring Bikini Atoll — the first of many nuclear weapon tests in the Marshall Islands.

Since then, Kwajalein Island, the largest island in the Kwajalein Atoll, has served other important military functions. During the Korean war, the island served as a key refueling and communications center for US warplanes and ships in the region. Later, a series of ground-based radar experiments and missile tests — including test flights of the Nike Zeus anti-missile missile system — were carried out on the island.

"The island is rich with history," says Tim Taylor (9211). "Until World War II, there were natives living on the island. When we lived there, you could find remnants of Japanese bunkers and air raid stations, and over by the golf course there's a Japanese cemetery."

Historic WWII Battle

During World War II, Kwajalein was the focal point of an eight-day battle between US and Japanese forces. The Japanese withstood repeated shelling attacks and air raids by the US Army while launching a series of destructive counterattacks. The Army took control of the island on Feb. 5, 1944, after 30 years of Japanese occupation.

The Navy began constructing facilities on

Kwajalein immediately after the war. Its remote location and stable weather conditions (typhoons rarely affect that area of the Pacific) made the island ideal for US nuclear experiments and missile launches.

In December 1961, 15 years after the Bikini Atoll test, the first missile was launched from Kwajalein. The Nike Zeus launch was the first in a long series of tests on missiles created to intercept and destroy enemy targets in space. Researchers chose Kwajalein for these tests because it was located 4,800 miles from Vandenberg Air Force Base on the west coast, an ideal distance for tracking and intercepting test missiles.

More Tests to Come

Control of the island was relinquished to the Army in July 1964. Since then, hundreds of tests have been carried out using Kwajalein as a ground base for missiles and missile-carrying aircraft.

Experiments during the Safeguard era included tests on the Sprint and Spartan missile systems. Other missile systems tested by the Pacific Missile Range and monitored from Kwajalein during the past 30 years include the Peacekeeper, Minuteman, Trident, HOE (for Homing Overlay Experiment, now called GBI for Ground-Based Interceptor), and ERIS (for exo-atmospheric reentry vehicle interceptor system). In addition, Kwajalein has been used as a test station for ground-based radar systems and re-

mote tracking sensors for NASA and NORAD.

Recently, says Keith Miller (9145), Kwajalein has been the testing center for US offensive strategic weapons and Strategic Defense Systems. Sandia researchers have played a vital role in these tests during the last 10 years by designing, fabricating, and testing high-performance reentry bodies capable of withstanding high-velocity reentry into the atmosphere.

In defensive studies, Sandians have offered technical expertise for essentially all non-nuclear ground-based interceptor tests and lethality experiments. In addition, Sandia has contributed to many Strategic Defense System sensor and discrimination technology tests on the island. Recently, Sandians have participated in two Ground-Based Interceptor tests and designed a payload for an Airborne Surveillance Testbed (AST) experiment.

In the coming decade, says Marlyn Sterk (9141), Sandia is likely to contribute its unique expertise to advanced reentry body research, ground-based interceptor flights, and airborne sensor test-bed studies. In addition, he says, Sandia could become involved in tests on emerging technologies such as space-based surveillance technologies and interceptor systems.

[Editor's Note: Our special thanks go to the US Army Strategic Defense Command Historian's Office in Huntsville, Ala., for providing post-WWII historical information about Kwajalein.]

Sandians Demonstrate Concept Feasibility for SDI Use

Thousands of Warheads/Decoys Could Be Tracked Using Massively Parallel Computing

The Strategic Defense Initiative (SDI) program still has much to prove and demonstrate, but some recent dramatic advances in Sandia's Parallel Computing Science Div. 1424 have demonstrated the feasibility of tracking and computing the trajectories of many thousands of warheads and decoys at once.

Jim Tomkins and John VanDyke (both 1424) have demonstrated this feasibility using Sandia's massively parallel computers to track and correlate — in real time — more than 10,000 objects at once. And they are showing that the next generation of computers will be capable of tracking hundreds of thousands of objects in real time. (Real time means the computer can process the data as fast as it would be received in a real strategic encounter.)

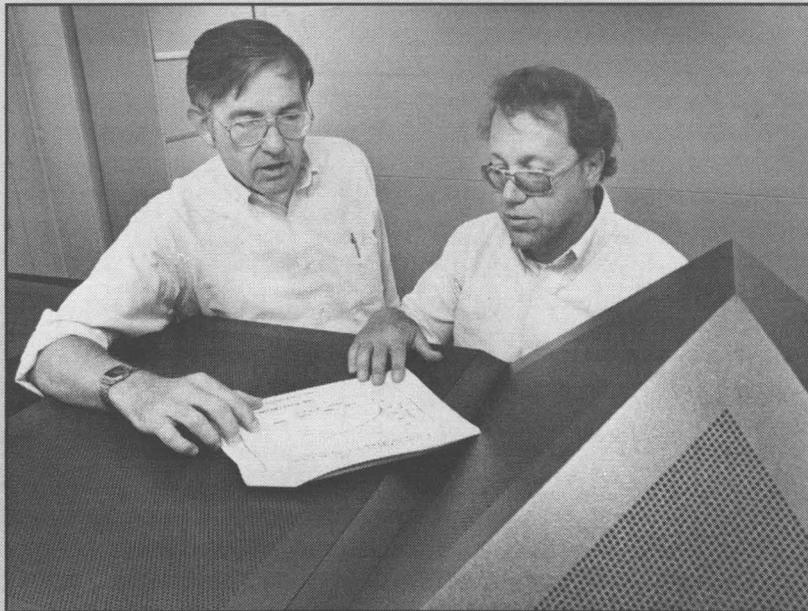
There has been skepticism that computer codes could handle the computational complexities involved in tracking and correlating in mid-course the trajectories of hundreds of thousands of warheads and decoys from ballistic missiles in a simultaneous massive attack. Until recently, complex codes that perform realistic tracking of barrages of missiles have been able to track at most a few hundred mid-course warheads and decoys in real time.

Far Beyond That

The Sandia results — the tracking of 10,000 simulated objects — go well beyond that.

Furthermore, says Jim, extrapolation shows that on the biggest parallel processing super-computer available today, more than 50,000 objects could be tracked in real time. On the next-generation machine beyond that, the code should be capable of tracking in real time 100,000 to 500,000 objects.

The Sandia studies use massively parallel processing. This involves specially modified computer codes and a computer with a thousand or more processors working on different parts of



SANDIA RESEARCHERS John VanDyke (left) and Jim Tomkins (both 1424) study missile intercept data produced by a massively parallel computer (foreground).

a complex computational problem simultaneously. (See Dec. 21, 1990, LAB NEWS for details about Sandia's pioneering role in massively parallel computing and how it is being applied to the Labs' technical work.)

Jim and John demonstrated the new abilities

Great Job, Says Ed

"This demonstration of the potential of massively parallel computing for possible use in the SDI program is a very fine piece of work by Jim Tomkins and John VanDyke," says Ed Barsis, Director of Computer Sciences and Mathematics 1400 and acting Director of Engineering Sciences 1500.

"This work — supported by the Strategic Defense Initiative — builds on other major advances that Sandians have made in the past few years. The work isn't just useful for SDI — it can be applied in many other areas such as computer design of materials and microelectronics."

using a tracking/correlating code that was written initially for serial computers. They rewrote it significantly, making many improvements in speed and storage efficiency, and converted it for use on a Sandia first-generation massively parallel hypercube computer containing 1,024 processors.

The Sandia code introduces a level of "noise" into the sensor data to simulate the errors and uncertainties expected from real sensors, thus making the tracking problem more realistic and difficult.

From this "fuzzy" sensor data, which is position information, the code distinguishes those points that represent the paths of particular objects. It then computes the most probable ballistic trajectory for each object, predicting each object's eventual impact point on the Earth's surface. This information would be essential for computing anti-

missile intercept points.

Since undertaking the project, the Sandians have demonstrated dramatic improvements in the computing time required to track a given large number of objects.

Only One of the Tasks Required

However, Jim and John are quick to point out that the Strategic Defense Initiative tracking problem is far from being solved. This work employed idealized sensor data, included most but not all of the complexity of the problem, and didn't address the accuracy of the tracking. Moreover, tracking is only one of the important computational tasks required for the SDI to become a reality.

"At the time this project began, the state of the art, at the level of complexity that includes noise sensors and multiple possible trajectories, was a few hundred objects," says John. "We've taken that code and demonstrated the feasibility of tracking tens of thousands of objects at once and in real time. We think that's a considerable advance."

●KFrazier(3161)

(Continued from Preceding Page)

Kwajalein

berg and Kwajalein] worked like mad, trying to overcome problems with their equipment," he says. "When the controller asked for launch verification, everyone held their response, hoping the other guy was experiencing more problems than you. I think it's still being played today."

The inhabitants of Kwajalein at the time, numbering near 5,000, lived in a group of houses and trailers (for families) or common quarters (for single men). A high school, movie theater, two swimming pools, local paper, radio station, and nine-hole golf course made island life bearable, says Tom. "The only hardships we faced were getting cooking supplies and groceries," he says. "We literally had to run down to the pier when the boat arrived to get fresh produce."

Both agree that despite the hardships, there were advantages to working on the remote island. Their pay was tax-exempt and there was no place to spend their checks on the island, says Tim, who returned to New Mexico State University in 1964 with the money he earned. He came to Sandia in 1967 after earning a bachelor's degree



KWAJALEIN ISLAND in the 1960s was scarcely more than an airstrip (bottom center), collection of trailers and living quarters (upper right), and technical facilities (scattered along the inside of the "boomerang"). The mound marking the underground Nike Zeus silo, called Mount Olympus, is visible on the lower left tip of the island. As many as 5,000 people (workers and their families) lived on Kwajalein at one time.

in electrical engineering. He later earned a master's in electrical engineering at UNM while working at Sandia.

After he left Kwajalein, Tom worked at White Sands Missile Range and Vandenberg and earned a master's at NMSU. Later, he worked for AT&T as a resident visitor at General Electric and Raytheon, developing the Nike Zeus system. He

came to Sandia in 1989 as a quality components engineer, after earning a PhD at Rutgers under AT&T auspices.

"We've gone out to lunch a couple of times to reminisce about the old days," says Tom. "I think the months we spent on Kwajalein were some of the most exciting times of our lives."

●JG

Long Hours, Short Deadline

Sandians Confronted 'What Ifs' about Persian Gulf Warfare — Burning Oil Wells, Fire Trenches, Spill into Gulf

One of the first reports published by Sandia this year carries the title "Potential Impacts of Iraqi Use of Oil as a Defensive Weapon." Its sponsor is DOE's Office of Foreign Intelligence (OFI). Both the timing — just before Desert Shield became Desert Storm — and the title show that it is neither a routine publication nor a routine problem.

In fact, during the first weeks of January, the conclusions of the Sandians who worked on the problem were quickly passed along to the top echelon of the government, drawing the attention of the White House, intelligence agencies, and high-level military planners.

The report came from a multidisciplinary team that was created late last November in response to contacts Dennis Engi (6601) had developed with the US intelligence community. Sandia's ability to assemble such a team in a matter of hours and deliver results in a few weeks gave US planners information they needed during the final stages of preparation for war. In some cases — such as the question of how smoke plumes from burning oil wells or fire trenches might affect optical targeting systems (see "Sandians Foresaw Kuwait's Darkness at Noon," page nine) — the Sandia team raised issues that had apparently not previously come to the attention of the planners.

Because of the many variables of the conflict and the many sources of information going to the US command, no one can say precisely what effects the

"It was like solving a set of simultaneous equations . . . everything related to everything else."

Sandia study had. But judging from responses to Dennis' briefings to government and military officials in early January, Sandia's results received highly placed attention and were influential in the planning for Desert Storm. These briefings usually began with an intelligence report for the day, given by the OFI program manager for the study, Maureen Crandall, and continued with Dennis' presentation. A recent letter from Energy Secretary James Watkins (reproduced on this page) confirms the impact of the Sandia work.

Environmental and Engineering Questions Predominated

The Sandians' investigation, though certainly addressing issues that had military implications, was for the most part not stated in specifically military terms. Many of the analyses — such as effects of oil spills on land and water, possible damage to Kuwaiti oil reservoirs that the wells tap, and health effects of smoke plumes — are cast in environmental or engineering terms and have long-term implications for the region. A follow-up study of health effects, based on what actually happened (and continues to happen, as the wells still burn) has just been completed to supplement the first study that was based on estimates of what might happen (see "Jury Still Out on Some Health Effects," page ten).

Virgil Dugan (Acting VP of Energy Programs 6000) maintained close contact with the project and subsequent events. Both he and Dennis point not just to the urgency of the immediate situation last autumn and winter, but to the groundwork that had been laid for Sandia's cooperation with US intelligence organizations. Virgil says, "There's been a growing interest within US intelligence agencies over the last several years in energy and other technologies that are im-



MEMBERS of the Kuwait study team included (standing, from left) Norm Warpinski, John Waggoner (both 6253), Wayne Einfeld (6321), Sharon Walker (3211), and (seated, left) Bernie Zak (6321) and Mike Edenburn (6601). All team members are listed on page eight.



The Secretary of Energy
Washington, DC 20585

May 26, 1991

Dr. Al Narath, President
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185

Dear Dr. Narath:

I would like to express my appreciation for the excellent support Sandia National Laboratories (SNL) provided me and the Department of Energy (DOE) through the Office of Foreign Intelligence during Operations Desert Shield and Desert Storm. In particular, I want to commend the work of Dr. Dennis Engi and his team. Sandia's outstanding efforts during this time of crisis met the Department's highest standards of performance and are an excellent example of the expanding and important role our National Laboratories can play in international issues.

Last fall, Dr. Engi and his team began a study of the potential military, environmental and oil reservoir impacts in Kuwait from Iraqi acts of sabotage and malicious damage. The study, published in January, also provided the Intelligence Community and military planners with mitigation and response options for reducing the consequences of various scenarios. Having been personally briefed on the results of the study, I felt it warranted the immediate attention of the White House and the Department of Defense. Multi-agency briefings were subsequently arranged and given. The study and briefings, together with a training video Dr. Engi and his team prepared on how to circumvent oil-related threats, were of great benefit to Desert Shield and Desert Storm operations and have been highly praised throughout the U.S. government.

The contributions Dr. Engi and his team made to Operations Desert Shield and Desert Storm, and to DOE, were significant. Sandia's timely and responsive analyses had a direct impact on the success of U.S. endeavors. The team's professionalism and excellent work reflect highly on SNL and on Dr. Engi and the many Sandia people who participated in this work. Please extend my appreciation for a job well done to Dr. Engi and his team.

Sincerely,

James D. Watkins
James D. Watkins
Admiral, U.S. Navy (Retired)

portant to industry in the US, as contrasted with intelligence that's primarily interested in military affairs. We in Energy Programs have been more and more involved with the various intelligence sectors, from the standpoint of helping them understand technologies and the implications of technological developments — or in some cases, the lack of developments. It's not been so much a matter of formal programs as helping out from time to time."

Dennis was in Washington late last November having informal discussions with a few members of the intelligence community who had been in contact with Sandia over the last few years. He learned that intelligence reports from Kuwait indicated Iraqi troops occupying that country had placed explosives on wellheads in the oil field. DOE's Office of Foreign Intelligence was quite interested in what would happen if the charges were set off and the wellheads were severed.

"Because we have capability in fossil energy," says Dennis, "it seemed worthwhile for me to see if we could help. Very quickly, the answer turned out to be yes. Jay Stewart, the OFI director, was really eager to get an understanding of reservoir damages and ecological stresses."

Dennis boarded a plane for Albuquerque that evening. "On the way back," he recalls, "I sketched out the kind of program that would satisfy OFI's needs. By the time the plane landed, I had identified the kinds of team members we needed. The way it went was something like this: Petroleum engineers would help us understand reservoir damages, and would also provide information to combustion people who could tell us what the combustion products would be. The combustion products would become source terms for atmospheric scientists, who would work out where the plumes from burning oil would go. This would provide input for analysis of health and ecological effects."

Spectrum of Expertise Was Here

The team's January report included a diagram similar to the one on page nine, showing how each segment of the investigation interacted with others. Within Sandia, Dennis had available nearly the complete spectrum of people needed — petroleum engineers, atmospheric scientists, a meteorologist, a human toxicologist, and others. Out of more than a dozen team members, only one came from outside Sandia — Loren Potter, a retired UNM ecologist who analyzed the

(Continued on Next Page)

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effects of spilled oil and airborne pollutants on plant life.

Virgil praises Dennis' organization of the problem and the team: "I think a key was Dennis' being able to structure the problem in such a way that we could define the interfaces between the various issues. Each person was able to work on his or her problem and contribute information to others. It was like solving a set of simultaneous equations — each piece couldn't be done in isolation, because everything related to everything else."

By the end of November, the team was at work. For the next several weeks, members concentrated on their interlocking pieces of the investigation. They had initial data from intelligence agencies, plus more that was received in response to questions that arose in the course of the study. Some data sources were in the published literature. Other information came from experts in various fields — such as the control of burning wells — who were willing to share proprietary knowledge. In particular, says Dennis, the president of Wild Well Control, Joe Bowden, spent hours on the phone explaining how companies like his deal with out-of-control wells, and also provided written and videotaped reference material.

How Many Wells?

No one knew what would actually happen in Kuwait, of course, so analyses had to be done for several scenarios. The team considered three possibilities for the number of wellheads blown up: 100, 300, and 900. The middle number was the base case; the others were considered extremes, with 900 approximately equal to all the wells in Kuwait. They also considered different fractions of the wells that would catch fire, causing different levels of ecological stress and different optical effects. As it turned out, events in Kuwait were between the base and most severe cases — more than 500 wells are still burning.

As the team continued its work through December — often during evening and weekend hours — Dennis stayed in contact with various sources of information. Virgil says, "It was almost like fighting a war. Dennis was on the phone constantly. Information was flowing back and forth between the intelligence agencies and the military and Dennis, and then between Dennis and the people here at Sandia. The loop was going round and round and round, as everybody tried to get a good understanding. We would get questions, and we would respond to them to make sure others had the benefit of whatever we knew at the time. We were also putting questions into the loop for input into our analyses."

Other conduits of information were more local. Many of the team members had to do large literature searches as quickly as possible to find data and formulas they needed for their analyses. Mike Edenburn (6601), who worked on the effects of oil spilled into the Persian Gulf and on the Iraqis' oil-filled trenches, says, "We asked the Technical Library for literature searches on various things, such as oil spills and the Gulf. We got extremely helpful responses from them. They were doing the searches and coming up with long lists of references within a day. Then we would request the sources we needed."

One of the team's atmospheric scientists, Bernie Zak (6321), seconds Mike's praise for the librarians' help. "Over the last several years, I've come to use their services more and more — I figure they almost double my productivity. In a project such as this, their help is invaluable."

Ready for Publication

By the end-of-year holidays, the Sandia team had reached its basic conclusions. They found that plumes from burning oil would make some areas' days darker than night, but pollutants from the oil smoke would not be an immediate health threat to

most people. Oil spilled on the ground would kill vegetation and threaten shallow aquifers and water wells near the coast; however, most vegetation would recover within a year. An oil spill many times the size of that from the *Exxon Valdez* could be released from storage, damaging marine ecology, the fishing industry, and four countries' water-desalination facilities. Oil flowing uncontrollably from wells might amount to several million barrels a day, and some reservoir damage would occur, but the reservoir damage would probably not be extensive. The Iraqis would be able to fill trenches with oil and ignite it as a defense.

During the last days of December, the report and a series of viewgraphs were prepared. "We had help from Peter Moore of Tech Reps, and other people there whose efforts Peter coordinated," says Dennis. "They were super in the support they gave to the project."

Bernie Zak says, "Peter was truly a pivotal figure in all this. I was originally concerned that what

"In a project such as this, the Technical Library's help is invaluable."

might come out of the whole effort would be sort of a mixed bag, but besides getting the material into a consistent format, Peter made sure that everything followed logically."

Briefings and More Briefings

Even before the report was in publishable form, Dennis and Virgil were off to Washington to give briefings. Beginning the first full week of

January, Dennis was presenting the Sandians' results to a number of DOE officials, including the OFI sponsor and Secretary Watkins.

For a while, it seemed that everyone who heard the briefings thought of someone else who would benefit from them. Before the week was out, Dennis had addressed audiences at the White House, the CIA, and the US Central Command (CENTCOM) in Tampa, Fla. CENTCOM videotaped the briefing and put the tape on a plane to the theater commanders in Saudi Arabia.

The next week was a virtual repeat, as Dennis spoke to more DOE people, ARAMCO (the Arabian-American Oil Co.), the Joint Chiefs of Staff, and representatives of several US cabinet members.

As the briefings continued, Dennis received more and more questions about response options. So the team members back at Sandia found themselves fielding short-turnaround inquiries dealing with, for instance, chemical or biological warheads on Scud missiles, the effects of hydrogen sulfide from "sour" wells on US gas masks, and long-term health effects of burning oil. The last item turned into a follow-up study, just completed, with results that Dennis is in the process of presenting to interested agencies.

"We Were Asked; We Answered"

Looking back, Virgil reflects on the value of the project and its conclusions. "It's hard to know precisely where we had an effect," he says. "We were asked questions, and we answered them. Maybe the most direct military value of our work

(Continued on Page Eight)

Also Proposed: Amphibious Vehicle for Oil Pools**Oil-Well Recovery Concepts Include Remotely Operated Bulldozers**

"A name that doesn't appear as an author or team member on any of our Desert Storm work is Joe Bowden, the president of Wild Well Control. But he was extremely helpful both in our 'Oil as a Defensive Weapon' project and in another project on technology for well recovery." The words are those of Dennis Engi (6601), who led several Sandia studies for the Persian Gulf war effort.

Dennis and other members of a Sandia team investigated the feasibility of applying Sandia technologies to improve conventional procedures and equipment for bringing out-of-control wells back under control. The team included, besides Dennis, Rick Beasley (Supervisor of Advanced Projects Div. V 9128), Bill Caskey (Advanced Technology Div. 5267), Max Newsom (Manager of Advanced Projects Dept. 9120), John Waggoner (Geotechnology Research Div. 6253), and Peter Moore (Tech Reps).

High-Tech Well Control?

Dennis first talked to Bowden during the last weeks of 1990, to learn about procedures used on blown-out wells and to get an estimate of the amount of time typically required to regain control — information that was needed for projecting damage to Kuwaiti oil reservoirs and estimating how long the wells might burn if they were set on fire. During these conversations, Dennis realized that Labs technologies might speed the methods that have long been used by well-control companies.

Several Sandians, from areas such as robotics, aerodynamics, drilling, and structural mechanics, visited Wild Well Control to gather ideas about matches with Sandia's capabilities. The resulting suggestions aroused DOE interest, so the Sandia team was put together to develop the concept further.

One proposal was for a remotely operated bulldozer. Bill Caskey says, "When there's a disaster where it's dangerous for people to enter, unmanned systems are typically thought of. In this case, there's heat, atmosphere you wouldn't want to breathe, and the possibility of setting off mines that are still in the oil fields."

Bulldozer with Navigation

"Remotely operated bulldozers have been used in the past, for instance at Chernobyl, but they're usually connected to the controls by wire and operated by direct viewing. We've developed systems for military use where the operator is out of the line of sight — there's a video camera on the vehicle and the operator uses the picture from it. That would be easy to do with a bulldozer. As one option for Kuwait, we also proposed adding a navigation system, because the visibility problems in the smoke might keep an operator from seeing well enough with the camera."

Bill says the Sandia team also proposed a teleoperated amphibious vehicle that could swim through pools of oil to assess wells' condition. That would be a longer-term development, because (as far as the Sandians know) no one has ever built a vehicle to swim in crude oil.

Another Sandia proposal is numerical simulation for scheduling operations in Kuwait, to make the most effective use of scarce resources such as water and specialized equipment. Similar Sandia-developed software is now used at the Strategic Petroleum Reserve to schedule operations.

So far, says Dennis, none of these ideas has been adopted by Kuwait, which would be the logical sponsor. But he hopes that Kuwaiti interest will eventually be kindled.

Wasted Oil, Damaged Reservoirs**Blown Wells: A Bad Dream Come True**

It was a question that might have come from an oilman's nightmare: What would happen if several hundred wellheads were blown up at the same time?

The question came to petroleum engineer John Waggoner (6253) last November, when he had been at Sandia for about nine months. He found himself part of the team formed by Dennis Engi (6601) to predict the effects of Iraqi forces' use of oil as a weapon.

John had to accomplish two tasks. First — and quickly — he had to estimate how much oil and gas might spew out of Kuwaiti wells if the wellheads were severed. Other team members needed that information so that they could analyze what would happen as a result of wells catching fire.

The second task — in which Norm Warpinski (6253) joined because of his expertise in rock mechanics — was to estimate what damage might be done to the Kuwaiti oil reservoirs (the underground oil tapped by wells) as a result of uncontrolled flow.

Brick Walls

"For a few days," says John, "I was investigating different ways of figuring out what the flow rates might be, and I was running into brick walls. I needed some pretty detailed, accurate information, which just didn't seem to be available. Then we received a report that provided the needed information."

The origin of that report was — and remains — a bit mysterious to the team, says John, but it did have the necessary data. "It didn't include complete well-by-well data," he says, "but something more like field by field. So even though we

When a well blows out, the call goes to a well-control company to cap it, not to Sandia to study it.

know that wells in the same field are usually quite different, we had to assume that all the wells within a given field were acting as an average. But even taking the data with a grain of salt, I think it represented fairly accurately what would happen in a global sense."

John converted the data in the report into regional averages covering four oil-producing regions of Kuwait. "In each region," he says, "there was an average production rate per well, measured in barrels of oil a day, and a gas-oil ratio. And, of course, we had the number of wells. I passed that on to Tom Fletcher [8361] and Ken Marx [8362] for combustion calculations. They had access to all the detailed information that I had, also, but I con-

sidered these regional averages to be my main input to their calculations."

Having spent a week or so to provide the source terms needed by other team members, John could turn to the question of reservoir damage.

"Norm and I identified the types of damage that we thought were likely to occur in this situation," says John. "Then we assessed the likelihood of each type of damage taking place. The analysis was both quantitative and qualitative — we used the real data that we were given, but we had to draw some qualitative conclusions about how the damage might be manifested."

Exploring Uncharted Territory

John and Norm were in uncharted engineering territory. The behavior and effects of out-of-control wells have not been carefully studied. "A lot of people are interested in well control," says John, "but they're mainly interested in preventing wild wells. Once a well blows out or catches on fire, the call goes to one of the well-control companies to get it back under control. No one calls Sandia and says, 'Can you come study this for us?'"

Nevertheless, John and Norm were able to make reasonable projections, some of which have since been borne out. For instance, John points out that Kuwaiti reservoirs contain oil and gas at high pressure, so machinery at the wellhead normally controls the pressure inside the well. Just enough difference is maintained between the reservoir pressure and the well pressure to make the oil flow at a desired rate.

"You might have a hundred-psi [pounds per square inch] pressure drop between the reservoir and the wellbore," says John. "If the wellhead is blown off, the pressure in the well decreases, and the pressure difference might become 500 or 1,000 psi, or even more. That increases the velocity of the gas and oil flowing in the reservoir near the wellbore, which can lead to failure of the rock around the well. It also increases the velocity of the fluid in the wellbore. That fluid — the mixture of oil and gas — always carries a little sand, and when the velocity is great, the abrasiveness can damage the tubing that lines the well."

Water Sucked into Oil

"Another form of damage we predicted is coning," he continues. "In these reservoirs, there's normally water in the rock strata below the oil reservoirs — water is heavier than oil. In the case I'm talking about, the wellbore can act like a vacuum cleaner in your house and, in effect, start sucking so hard on the reservoir that the water starts coming up and mixing with the oil that's flowing in the well. Some of the early pictures that we saw of wells on fire had steam com-

ing out, so we knew that coning had happened. The other forms of damage aren't as obvious at this point, so it will take more time to tell whether they have occurred."

Millions of Barrels a Day

The amount of oil lost to uncontrolled flow was another projection borne out by events. The team's report estimates the loss at 5 to 6 million barrels a day as the base case; recent observations indicate that about 6 million barrels a day are being lost.

Like the other team members, John put in most of his time on the project in late November and December. But once he and Norm had finished work on their two main tasks, there were further developments. As Dennis Engi (6601) briefed vari-

The report projects a loss of 5 to 6 million barrels of oil a day as the base case.

ous military and government officials, new questions arose. Says John, "Dennis came back with questions a number of times, for a month or so after the initial work. For instance, we were asked to predict quantitatively how the reservoir damage would affect production rate — in effect, a plot of production over time. That wasn't part of the original thrust of the project, but it's certainly important, and those graphs ended up in the report."

All in all, it wasn't a typical assignment for a relatively new Sandian, who might be expected to still be learning the ropes of working at the Labs. "It would be hard to find an assignment that was more interesting, more important, or more immediate in how it applied to the real world," says John. "The quick-response teamwork was what people have described to me as the traditional Sandia way to handle a problem." ●CS

(Continued from Page Seven)

Persian Gulf Warfare

was in providing the military with an indication of the kind of environment that they might have to fight in. In fact, I have been told that some operational strategies were changed as a result.

"As far as responding to blown-up wells or oil spilled into the Persian Gulf, we were asked questions about mitigation or prevention. There weren't many good answers, because people on our side didn't have ways to control what happened. But I think our work heightened the motivation to at least be in a position to respond to these things once our side was in control of the territory. And now that the problem is no longer hypothetical, we can say that we helped start the process of assessing the environmental damage and the impact on human health and safety."

Whatever the contributions of this project, Virgil attributes them to Sandia's unique strengths: "That we were in a position to help indicates the strength of Sandia. We have a breadth of capabilities in fields that stretch all the way from understanding the details of oil production to understanding the combustion of oil to understanding atmospheric transport to understanding human toxicology. So we were able to look internally and gather the resources needed to address a truly complex problem." ●CS

'Oil As a Defensive Weapon' Team Members

Members of the team that analyzed what might happen if Iraqi forces used oil as a weapon are listed as authors of Sandia's report on that subject. Following are their names, arranged by organization:

Industrial Hygiene/Toxicology Div. 3211: Sharon Walker.

Geotechnology Research Div. 6253: Dave Northrop, John Waggoner, Norm Warpinski.

Underground Storage Technology Div. 6257: Grant Heffelfinger.

Risk Assessment and Transportation System Analysis Div. 6321: Hugh Church, Wayne Einfeld, Bernie Zak.

Waste Management Systems Div. 6416: Jim McCord.

Strategic Technologies Div. 6601: Dennis

Engi, Mike Edenburn.

Combustion Research Div. 8361: Tom Fletcher.

Combustion Applications Div. 8362: Ken Marx.

Non-Sandian coauthors of the report are Peter Moore (Tech Reps) and Loren Potter (retired UNM ecologist).

Dennis Engi notes that more than 25 other Tech Reps employees contributed to production of the team's report, many of them working evening and weekend hours to meet the publication deadline.

Virgil Dugan (6000) says about the team, "They were able to come up with answers that might, in a more relaxed time, take a year to get."



The Atmosphere and Burning Oil

Sandians Foresaw Kuwait's Darkness at Noon

Ignite several hundred Kuwaiti oil wells and 80 oil-filled trenches, plus miscellaneous standing pools of crude oil, and the effects begin to look like something best analyzed by people who understand large releases of smoke into the atmosphere — perhaps a team that has devoted some time to studying nuclear-winter scenarios.

As it happens, Sandia has such a group, within Risk Assessment and Transportation System Analysis Div. 6321. Three of its members

“We had the background in our files and in our heads.”

found themselves handling the atmospheric effects segment of the project to assess effects of Iraqi use of oil as a weapon.

“For more than three years,” says Bernie Zak, “our group contributed to nuclear-winter research by investigating smoke yields from fuel as a function of fire size. The fires ranged from lab-scale ones about 10 centimeters [4 inches] in diameter to about 30 meters [100 feet] in diameter. So we were the logical people for this piece of work. We had the background in our files and in our heads.”

Also involved in the investigation were Wayne Einfeld, who did the calculations of how smoke particles and gases produced by the fires would disperse in the atmosphere, and Hugh Church, a meteorologist who estimated expected weather conditions over Kuwait for the period under consideration.

Big Globbs or Fine Mist?

One of the questions that Bernie felt should be addressed was how large the droplets of oil coming from the wells would be. “If they were big globbs, dime-size or so, chances are that even if the well were on fire the droplets would fall back to earth and create a big pool fire. That’s quite a different situation than if you have micron-size particles coming out of the well, where nothing falls back to earth.”

The possible droplet sizes range over several orders of magnitude. “With that range of possibilities,” says Bernie, “sloppy calculations or some bad assumptions could make you miss the size by a country mile! But I don’t think we did.”

Bernie spent about two weeks working on this problem. For input data, he took the amount of oil that the reservoir team estimated would be coming out of wells (see “Blown Wells,” page eight), and calculated the velocity of the oil as it exited the well. Then he did some calculations on his own. Next, though he could locate nothing in the literature that addressed this situation for oil, he did find experimentally validated formulas for water coming out of pipes mixed with air. Substituting the relevant parameters for oil mixed with gas — different densities, viscosities, and so on — he found general agreement with his own calculations.

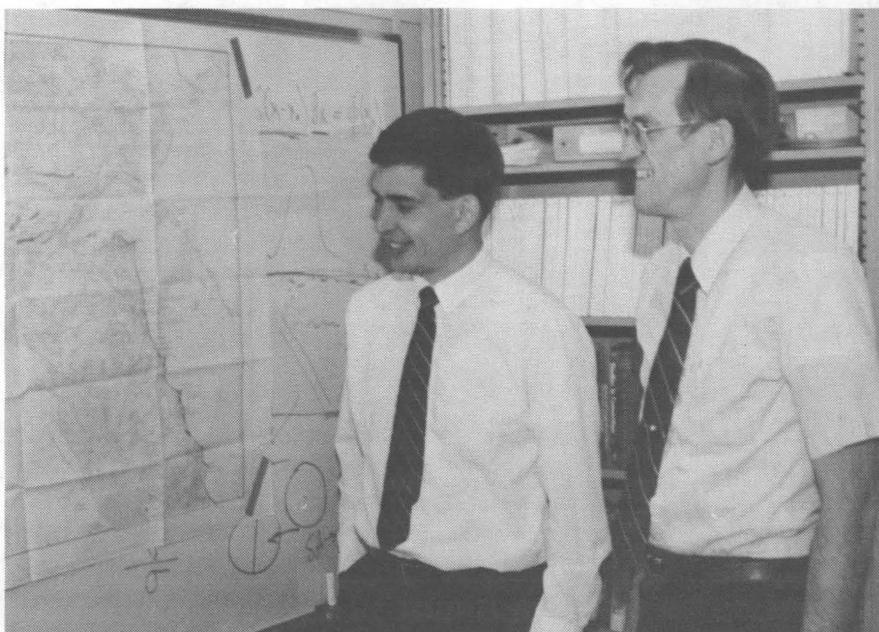
The conclusion: Average droplet size would be small, so they would burn in the air rather than falling to the ground. “Basically, each well would be a blowtorch,” says Bernie.

Coal Code Simulates Burning Well

At the same time, two researchers in the Combustion Research Facility at Sandia, Livermore were doing computer modeling of burning oil wells. Tom Fletcher (8361) and Ken Marx (8362) both work with codes that simulate combustion.

“We ended up using Tom’s code, which was originally written to model the combustion of coal particles,” says Ken. “He modified it for the oil well configuration, and we collaborated on a general analysis of the situation.”

For instance, since Bernie had not completed his droplet-size calculations, Tom and Ken had to



LIVERMORE CONTINGENT of study team, Tom Fletcher (8361, left) and Ken Marx (8362), view a map of Kuwait. Tom and Ken used a combustion simulation code to model the burning of oil wells.

decide what might be a reasonable range of values. They also had to consider chemical properties of the oil. “There was also the question of the effects of near-sonic velocities of the droplets coming out of the well,” says Tom, “and how to change the code for fuel burning as a jet in the open air rather than in a combustor.”

The modeling was done with relatively large oil droplets. Tom and Ken say they chose to use large droplets partly because they didn’t yet have Bernie’s conclusions, and also to get something approaching a worst case. Large droplets would burn inefficiently and produce more soot and carbon monoxide than small ones.

“When we got Bernie’s results,” says Tom, “we ran a case with smaller droplet size. It didn’t have much effect on the basic conclusions we were presenting.”

Running a Relay Race

They couldn’t have afforded the time to redo a complete set of calculations, in any case, because their results were needed for atmospheric dispersion modeling. Thinking of the project as a chain, they were one of the middle links, waiting for input for their own calculations and producing results needed for the next person. “It was kind of like a relay race,” says Tom.

The handoff in this relay was to Wayne Einfeld. “I was involved in calculating the source terms — the pollutant release rates from the burning oil — and doing some downwind dispersion modeling to estimate how the pollutants are diluted as they move downwind. The intent was to come up with ground-level pollutant concentrations downwind of the source, which could be used for the toxicology studies [see “When Smoke and Spilled Oil Reach Living Things,” page twelve].”

Taking the available data for the estimated amount of burning oil, Wayne applied emission factors to calculate the release rates of soot, sulfur dioxide, carbon monoxide (CO), and so on. “Because a well would be a burning jet rather than a burning pool, we used Tom and Ken’s values for

some things like CO and soot,” says Wayne. “But of course there were the oil-filled trenches to consider as well. We had information from intelligence agencies about the extent of the trenches and the amount of oil they might hold. So we had a sort of synthesis of pool burning and jet burning.”

For the dispersion calculations, Wayne used formulas that represent combustion sources as lines, rather than trying to consider each well or trench separately. “We didn’t have much information at that point about the spatial extent of the fields,” says Wayne, “so we used existing dispersion models and oriented the line sources perpen-

“Basically, each well would be a blowtorch.”

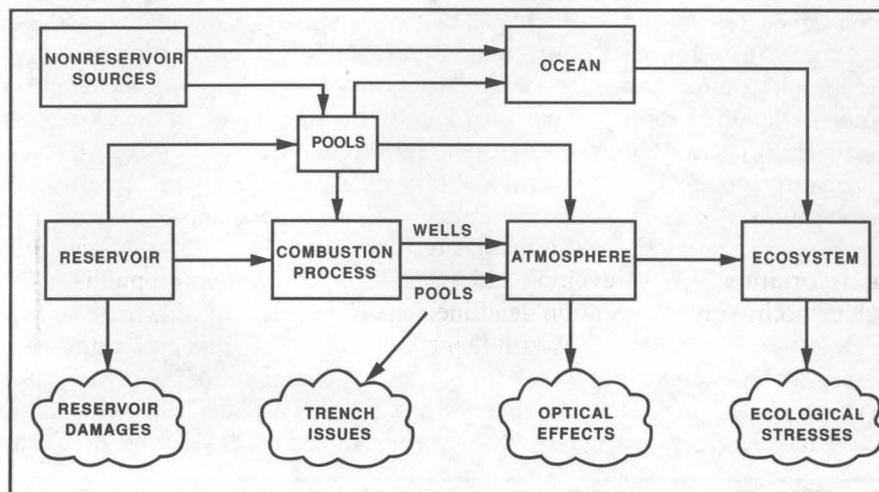
dicular to the prevailing wind, with the length of the line the same as the estimated width of the field. We were just estimating downwind concentrations as a function of distance, using meteorological inputs from Hugh Church about wind speeds, the stability of the atmosphere, and a few parameters like that. With more sophisticated models, which we didn’t try to use at that time, you can get contours of concentrations, so that you know how concentrated the plume is at different distances off the main plume axis for different distances downwind. We did some of that for a follow-up study.” (See “Jury Still Out on Some Health Effects of Burning Wells,” page ten.)

How Dark?

One of the benefits of the experience with nuclear winter research was recognition that a plume from burning oil would have optical effects as well as possible health effects — that is, the area under the plume would be darkened. But how dark?

“I brought up the issue of darkening,” says Bernie, “which apparently hadn’t been considered up to the time of our project. When we started doing calculations based on the optical properties of

(Continued on Page Ten)



INTERDEPENDENCE of study areas is emphasized by this project diagram, similar to one appearing in the final report. Team members responsible for areas at left and in upper rows provided information for areas at right and in lower rows.

CHECKING OUT transparencies for a briefing, Virgil Dugan (Acting VP-6000, left) and Dennis Engi (6601) discuss conclusions drawn by a Sandia team investigating effects of burning oil wells in Kuwait.



(Continued from Page Nine)

Darkness at Noon

soot, it turned out that if all the trenches were burning, daytime would have been far darker than a full-moon night. In fact, under certain scenarios, you literally couldn't have seen the hand in front of your face. Those scenarios didn't happen, but I understand that when planes flew through certain areas, the pilots had to fly using instruments because of the darkness.

"It's not just the visible light that's important here," Bernie continues. "There's also the question of how far you can see in the infrared wavelengths,

"Daytime would have been far darker than a full-moon night."

because things like range-finders, low-light-level devices, and other sensors use the infrared part of the spectrum." The conclusion was that in the plumes, hardware using infrared light would perform better than devices working in the visible wavelengths, but their performance would be significantly impaired — a serious consideration for forces using high-technology weapons.

The team members calculated all these effects for various regions of Kuwait and for various numbers of hours after trenches and wells were set afire — tactical information needed by people who would be planning an air or ground campaign. But

what about longer term effects? Might the release of so much soot in the air cause long-term climate change, in the same way that some nuclear-winter theories say the fires from a nuclear war could? At the time, headlines were reporting predictions of such effects.

The Sandia team's answer was no. "Compared to the modeling done in the context of nuclear winter," says Wayne, "we estimated that the release of particles in smoke from fires in Kuwait would be only a few percent. That didn't suggest a significant impact."

In addition, the team calculated that smoke from the oil-well fires would not go nearly as high into the atmosphere as assumed in nuclear-winter modeling, so it would be removed by rain and snow rather than staying in the atmosphere and encircling the globe. The smoke might cause regional climatic effects for a time, but not global ones. (Two articles recently published in *Nature* reached similar conclusions after more extensive modeling.)

Like other team members, those working on the atmospheric portion of the project had their own feelings about what they were doing. For one thing, many of them spent a lot of hours. "All the 'normal' work wasn't suspended," says Wayne. "There was a lot done for this project on evenings and weekends."

But there was also the satisfaction of doing the best possible job for a worthwhile, immediate cause. "It was good to be on a project where somebody needed the answers *now*," says Tom. "Sometimes when we work on more fundamental studies,

Team Assessed Effects

Unusual Explosive Would Have Posed Threat to Troops

At least one Sandia effort for Desert Storm cannot be discussed in detail even yet, but part of the story can now be told.

Before Desert Storm, US intelligence agencies believed that Iraqi forces might have placed a powerful, unconventional explosive in an unusual and potentially threatening location in Kuwait. They needed to know what would happen to oil-field equipment, to oil-delivery systems, and to human beings if the explosive were detonated. The answer could have determined where to send troops — and where not to send them.

In January, the question went to a Sandia team consisting of Mel Baer (Energetic Materials and Fluid Mechanics Div. 1512), Hugh Church, Wayne Einfeld (both Risk Assessment and Transportation System Analysis Div. 6321), Dennis Engi (Strategic Technologies Div. 6601), Paul Cooper (Engineering Projects and Explosives Applications Div. 9333), Peter Moore (Tech Reps), and retired Sandian Jack Reed (JWR, Inc.). Mel and Paul both worked last year on Sandia's investigation of an explosion in a gun turret of the *USS Iowa* (LAB NEWS, June 15, 1990).

In the end, the intelligence agencies learned that there was not an explosive where they had feared. But while the team was analyzing the effects based on the data they were given, the possibility seemed very real.

"The technical problem itself wasn't exceptional," says Mel Baer. "But we had only a few days to come to a solution, and there was the possibility that our own troops might have been involved in a disastrous explosion. That gave the assignment a special sort of immediacy." ●CS

it's not immediately clear who will be interested in the outcome."

"I'd echo that," says Ken. "Some of our research is abstract, and people tend to think of it as being 'ivory tower.' This was immediately useful."

"I'm glad Sandia has maintained its capability in atmospheric work," says Bernie. "Hugh Church is the Labs' only meteorologist, and with his expertise, plus the rest of us with experience in atmospheric studies, we were ready to jump right into this project." ●CS

Sandia Proposes Expanded Monitoring

Jury Still Out on Some Health Effects of Burning Wells

During December's work on the spread of soot and gases from burning wells, the Sandia team had to use simplified dispersion models and make rapid projections of effects on humans. A follow-up project has corroborated much of that work, but it also emphasizes that monitoring of weather conditions, emissions from burning wells, and pollutant concentrations is necessary to predict long-term health consequences.

The Sandia team doing the follow-up includes Hugh Church, Wayne Einfeld, Bernie Zak (all Risk Assessment and Transportation System Analysis Div. 6321), Dennis Engi (Strategic Technologies Div. 6601), Drayton Boozer (Exploratory Systems Development Div. 19131), Carol Gotway, Floyd Spencer (both Statistics, Computing, and Human Factors Div. 7223), John Waggoner (Geotechnology Research Div. 6253), and Peter Moore (Tech Reps).

Because acute, short-term effects can be observed directly, the team concentrated on pollutants that might cause chronic health effects af-

ter long-term exposure. They expanded the December study by using a more detailed dispersion model to plot pollutant concentrations and estimate where they were reaching danger levels.

Validation Needed

To be used confidently, computer models require validation. The Sandia team has recommended a monitoring program to obtain more accurate data and check the performance of the model. That involves obtaining measurements both for input to the model and for checking its output. One requirement for a monitoring program is obtaining a statistically reliable set of measurements. That's where Carol Gotway and Floyd Spencer came in.

"The immediate goal of monitoring is to get concentration measurements and use them to estimate the toxicological effects on human beings," says Carol. "The next goal is to validate the dispersion model. Validation involves two parts. The output of the model can be checked

against pollutant concentrations downwind of the burning wells. Those concentrations can be measured at ground level, with standard air-quality monitoring equipment.

"But there's also a lot of uncertainty about input to the model — what's actually coming off the burning wells. So the other part of the monitoring program is to sample the wells that are on fire by making fly-throughs to estimate total soot and other pollutant emissions — taking measurements in the plume. From a statistical point of view, it's relatively straightforward to determine how many wells should be sampled, and which ones, to get a good estimate of total emissions. Actually collecting the measurements, of course, is quite complicated."

Recommendations from the Sandia team include the frequency and number of wells to be sampled by fly-throughs, and additional ground-based sampling southward from Kuwait as far as Riyadh, Saudi Arabia.

Race between Filling and Seepage

Fire Trenches: Major Obstacle or Big Fizzle?

During the months that Iraqi forces occupied Kuwait, they constructed a series of trenches across southern Kuwait. Filled with oil and set on fire, they would create a formidable barrier to any army advancing from the south.

Or would they?

What if the oil seeped out of the trenches into the sand faster than it could be pumped in? What if the crude oil in the trenches would not burn? And if it did burn, how long would the flames last?

Either underestimating or overestimating the threat of these trenches could have impaired mili-

One basic question was whether the trenches could actually be filled.

tary planning and operations. Sandia's team was charged with finding out just how formidable the Iraqi fire trenches might be.

Primary responsibility for investigating trench issues went to Mike Edenburn (6601), who also analyzed the effects of an oil spill into the Persian Gulf.

"The trenches were, for me, a more straightforward issue than a spill into the Gulf," says Mike, "because we were dealing with physical mechanisms, not the complications of environmental effects. But still, not everything was clear-cut."

One basic question was whether the trenches could actually be filled, or whether seepage and evaporation would remove oil faster than it could be pumped in. Jim McCord (6416) did the seepage calculations, and Grant Heffelfinger (6257) did the evaporation calculations.

"We had information on trench dimensions, feeder pipelines, and things like that," says Mike. "The information came from intelligence sources that were never specified to us. We would get information, then Dennis Engi [6601] would go back to his contacts with lists of other information that would help our analysis."

Lead from *Newsweek*

"For instance, a basic parameter determining the seepage rate was the permeability of the soil. We got our first soil sample as a result of my reading an article in *Newsweek*. The article said that night-vision experts at Ft. Belvoir [in Virginia] were studying how the sand in the area might affect night-vision goggles. So I contacted one of the

people there, who sent us a sample. It came from about a hundred miles from the trench area. We did our analysis and determined a seepage rate. But we didn't have a lot of confidence in the rate, because of the distance of the sample from the trenches. When we passed that information on, it wasn't long before we were supplied with information about a soil sample from the trench area! Someone — we still don't know who — had obtained soil from the trenches and performed a seepage analysis because we needed better data."

Six Days to Fill

The size of the trenches and the capacity of the feeder lines indicated that the trenches could be filled in about six days, if seepage and evaporation were neglected. But given the seepage rate calculated from the soil samples, the trenches could not be filled simultaneously — oil would seep out faster than it was pumped in. On the other hand, the seepage of the first oil would clog the soil with paraffins, tars, and asphaltenes, raising the possibility of preconditioning the trenches by pumping oil into them before trying to fill them.

"In fact," says Mike, "the Iraqis did precondition the trenches. They pumped oil in, let it seep out, and then pumped more in. We don't know how effective that was, because when you're looking down on a trench from an airplane or satellite, it's hard to tell whether it's full of oil, or just coated with oil."

Assuming that preconditioned trenches could be filled, there remains the question of whether the oil will burn. Mike explains:

"After oil has been in an open trench for a while, its most volatile constituents — which are

"We concluded that the trenches would burn with a flame height of 15 to 20 meters . . . [for] about 24 hours."

also the most flammable — will evaporate. There was quite a lot of confusion about whether the oil left in the trenches would actually burn. Some people — not on our team — argued that after several hours it would be impossible to ignite the oil. I don't know where their information came from. We talked with people who have had a lot of experience with burning oil, and they all said emphati-

cally that, yes, you can start it burning. And I think that view prevailed."

24-Hour Burn

So the trenches would probably burn — but for how long? For instance, once set ablaze, would the flames end after a few hours? That would be an important question to an army preparing to cross the trenches.

"We concluded that the trenches would burn with a flame height of 15 to 20 meters [50-65 feet]," says Mike, "and that it would take about 24 hours to burn off the oil from a filled trench. The flame temperatures would be about 2,200 degrees F. One of the significant conclusions was that, if the flow of oil continued into the trenches, they would keep burning. Once the initial fill had burned down and it was just the oil flowing through the feeder pipes that was burning, the intensity would be much less, but the fire would not

"You approach a problem differently if your time is tightly constrained."

go out. That's assuming, of course, that the supply of oil to the trenches was not severed."

The question of the burning trenches was one in which team interactions figured. Wayne Einfeld (6321), whose main assignment was on the atmospheric effects of burning oil (see "Sandians Foresaw Kuwait's Darkness at Noon," page nine), supplied data about how fast the crude oil would burn in the trenches. Mike also notes that the experience of Thermal Test and Analysis Div. 7537, supervised by Ned Keltner, provided some information and also was the source of contacts with other people who had experience with the burning of crude oil.

Information from the trench analysis was also an input into the atmospheric effects analysis. "We consulted back and forth on the burning rate," says Mike, "and from that, Wayne Einfeld and Bernie Zak [6321] did their calculations about how much soot would be put into the atmosphere."

In the end, the trenches were not much of a factor in the war. The main offensive went westward around them. Just before that, according to *Aviation Week*, F-117 Stealth fighters destroyed the pumping stations that would have filled the trenches.

Overwhelming at First

Lest the Sandia analysis seem too simple and too purely logical, Mike admits to some moments of feeling daunted when the project began. "It could have been overwhelming. But early on, what I did — and I'm sure the other team members did something similar — was say to myself, 'OK, what can we realistically do in the time given?' You approach a problem differently if your time is tightly constrained. In this case, it meant we had no time to do any exhaustive tests or analysis. We had to talk to experts and put together a picture of what would happen on the basis of what they said."

"At times, we were frantic. Sometimes we worked considerably more than 40 hours a week. But we knew the deadline was approaching, and we knew that people needed our answers." ●CS

Oil-Field Video

Sandia Created Training Aids For Desert Storm Preparation

Only a small fraction of people in any army would know their way around an oil field. An even smaller fraction might comprehend the dangers of an oil field in which wellheads had been ruptured. Because of the possibility of American troops going to battle in the Kuwaiti fields, Sandia produced a training videotape to help them understand what precautions to take.

George Skinner of Video Production, Still Photo, and Film Processing Div. 3153 shot and edited the tape with the support of other division members. "George worked some incredible hours," says Dennis Engi (6601), "including an all-nighter."

John Gardner (3522) wrote the script, and retired Sandian Phil Mead narrated.

The final video included footage obtained from NBC News and from one of the three US oil-well firefighting companies, Wild Well Control. "We also had a lot of help from the

Tech Library," says George.

The final tape — produced after review of a first version — was completed within about two weeks of the decision to create a video. "After that, we didn't hear anything for a few days," says George. "Then early one morning, we were asked to dub 150 copies to put on a plane at 1 o'clock that afternoon. So we did — which was sort of the final flurry of the video project." The copies were shipped just before the beginning of the ground phase of Desert Storm.

As another form of training aid, reference cards summarizing oil-field hazards were created by graphic designers Toby Dickey and Jan Gaunce (both Communications Development and Support Div. 3151). "Although in the end these weren't used," says Dennis, "because they were superseded by the video, Toby and Jan did a lot of good work on them and let us keep that option open."



This newspaper can be recycled with Sandia office paper

Effects on Land, Air, and Water

When Smoke and Spilled Oil Reach Living Things

One of the final links in Sandia's chain of projections about events in Kuwait was the effect that Iraqi abuses of oil — spilling it, burning it, or blowing up wellheads — might have on living things.

This link included three areas: effects of air pollution on people, effects of spilled oil and air pollution on plants and the land environment, and effects of oil spilled into the Persian Gulf.

Sharon Walker (3211) was responsible for the first of these. "I got data from the groups that analyzed the various scenarios," she says, "and used

"A major concern going into the study was that the pollutants could cause many deaths."

their figures for concentrations of things such as soot particles and sulfur dioxide. This allowed projecting human health effects in populated areas and for combat troops."

Given the information on the number of wells that might be burning, where smoke and gas plumes would travel, and what the concentrations would be at various distances from burning wells, Sharon found the prediction of health effects to be straightforward. "The literature contains studies of effects of air pollution in heavily industrialized countries," she says, "and also experimental data on laboratory animals. A major concern going into the study was that the pollutants could cause many deaths."

Less Severe than '50s London Incident

That degree of concern was eventually ruled out. One of the historical incidents most comparable to the situation in Kuwait was a London smog incident in the early 1950s, when for three or four days a temperature inversion trapped a blanket of polluted air. "The chemical makeup of the pollutants would be similar in the two cases," says Sharon. "It's estimated that 4,000 people died in London because of the severe smog conditions. In the predictions for Kuwait, we just didn't expect the levels that would cause anything like that number of deaths. The part of the population who would be most susceptible would be newborn babies, the elderly, and people who have respiratory problems."

Long-term health effects should also be

mild, at least compared with what might have been imagined without the Sandia analysis. One fortunate circumstance is that prevailing winds blow most of the pollutants away from population centers.

A continuing concern is how many additional lung cancers might be caused by pollutants from burning wells. The January report concludes that increases in cancers would be statistically undetectable. That projection has since been criticized in some quarters, but firm data do not yet exist to support a definite conclusion. A follow-up study by Sandia stresses the continuing scarcity of information to make confident long-term estimates and urges the collection of reliable data about meteorological conditions, the output of burning wells, and geographic concentrations of pollutants (see "Jury Still Out on Some Health Effects of Burning Wells," page ten).

Plants Not Hurt Badly

Another unknown going into the project was the effect of smoke or spilled oil on plant life in the Kuwaiti desert. "It seemed to me that a good person to do that work would be Loren Potter, who's an ecologist and professor emeritus retired from

The Gulf spill "was only a quarter of the maximum possibility. But it's still the world's largest spill."

UNM's biology department," says Sharon. So he became a member of the Sandia team.

Potter concluded that plant life in the desert would not be seriously harmed over the long term by either air pollution or spilled oil. Perhaps most susceptible to air pollution would be the least-natural vegetation — irrigated crops and city landscaping.

Threat of Gulf Spill

Harder to assess, and probably most serious in its ecological effects, would be a large oil spill into the Persian Gulf. Mike Edenburn (6601), who did the analysis for oil-filled trenches (see "Fire Trenches," page eleven), conducted this part of the ecological study as well.

"The team didn't have the prior expertise to draw all the conclusions," says Mike. "I had to

read a lot and call a lot of experts to make a reasonable projection."

Because of the short time and the number of unknowns in a case such as this, says Mike, the conclusions about effects of a spill are more qualitative than quantitative. One of the quantitative predictions, however, was alarming: Oil tankers

"It's going to take years to figure out what the overall effect is."

and coastal tank farms could release as much as 20 million barrels into the Gulf. Such a spill would dwarf the previous largest spills, about four million barrels each into the southern Gulf of Mexico in 1979 and the northern Persian Gulf in 1983.

"The final official guess of the actual spill size was something like 5 million barrels," says Mike. "Fortunately, this was only a quarter of the maximum possibility. But it's still the world's largest spill. And the two earlier large spills in the Gulf of Mexico and the Persian Gulf were from offshore wells, where the oil was released over months, not in a matter of hours like this one."

Despite the difficulties of the assessment, says Mike, he gained confidence in its main conclusions because of the authorities he was able to contact. "I got some names from the published literature, some through contacts with the UNM biology department, and some just following strings where one person would refer me to others. I guess I spoke with 30 to 40 people. By the end of that process, I had been in contact with a lot of the people who know the most about the effects of oil spills on marine life."

The report emphasizes that a large spill would damage marine life — the 1983 spill halted the Persian Gulf shrimp industry — and endanger desalination plants, which provide much of the region's fresh water. Spills here are especially damaging because the Gulf's shallow waters, small size, and slow circulation keep the oil from dispersing.

"The last I heard," says Mike, "the effects on desalination plants weren't as bad as we thought might happen. But much of the damage isn't visible yet. A lot of the oil will settle to the bottom and will have long-term implications for the food chain. I believe it's going to take years to figure out what the overall effect is." ●CS



DARPA DIRECTOR Victor Reis (second from left) visited Sandia, Albuquerque this week to discuss the nuclear weapon program. DARPA is the Defense Advanced Research Projects Agency, a DoD group whose primary function is development and demonstration of high-payoff technologies through innovative advanced research projects. With him are (left to right) Heinz Schmitt (Acting VP-5000), Special Assistant for Weapons Dick Brodie (25), and Steve Guidice, Assistant Manager for Operations and Weapons at DOE/AL.

Recertify Class II Dependents by June 28

If you have a Class II dependent enrolled in the Sandia Medical Care Plan, please see Doris Mason (3543), Bldg. 832/East (outside of Albuquerque, call Doris on 505-844-3545), to certify that your dependent is still eligible for coverage. Class II dependents include unmarried children over age 24, unmarried grandchildren, brothers and sisters, and parents and grandparents (or those of your eligible spouse). To qualify for coverage as a Class II dependent, the person must be financially dependent on you, have an annual income of less than \$8,800, and have lived with you for the most recent six months and continue to live with you (or in a home you provide). All Class II dependents enrolled before April 1, 1991, will lose their coverage on July 1, 1991, if their eligibility is not recertified by June 28. If there is a break in coverage, individuals not paying a \$67.50-per-month charge will be required to pay \$67.50 per month thereafter.

Sandia News Briefs

Romig Receives MAS Heinrich Award

Al Romig, Manager of Metallurgy Dept. 1830, has been selected to receive the 1991 Heinrich Award from the Microbeam Analysis Society (MAS). The award, one of three made annually by MAS, recognizes Al as the outstanding young scientist (under 40 years of age) in his field.

Al's award recognizes his research accomplishments in analyzing and modeling materials using an electron probe microanalyzer and analytical electron microscope. His recent research has explored electron scattering in solids and electron beam techniques for analyzing phase stability and diffusion in solders, weld seams, and coatings. The award will be presented in August in San Jose. MAS has approximately 1,500 members worldwide.

Robotic Control System is Economical, Flexible

Sandians in Advanced Technology Div. 5267 have developed a computer control system for telerobotic land vehicles that adds new capabilities without requiring major changes to software or hardware.

"The system's flexibility makes for an economical, expandable robotic vehicle," says Ray Byrne (5267).

The hierarchical system consists of distinct layers of "intelligence" that allow it to be upgraded to make robotic vehicles more intelligent and autonomous.

The least intelligent lower levels perform specific tasks such as steering. Higher levels, which can be expanded as needed, handle general operational functions such as instructing the vehicle to drive down a road.

The system was incorporated into a multipurpose telerobotic vehicle developed at Sandia named RAYBOT, and is considered especially useful for general-purpose research vehicles that must be easily upgraded and modified.

Research Benefits Microelectronics Industry

Sandia's Packaging Technology Div. 2134 is transferring microchip technologies developed in support of DOE weapons programs to the microelectronics industry.

Dave Palmer (2134) reports that several industrial firms have requested Sandia's help with test chip work, including Microelectronics and Computer Technology Corp., General Electric, National Semiconductor, Motorola, Atmel, ALCOA, and Delco.

Sandia is supporting industry through development of a family of unique test structures known as Assembly Test Chips (ATC) that provide quantitative, non-intrusive, objective measurements. They have four areas of application: qualifying assembly manufacturing lines, monitoring and restarting assembly lines, monitoring the packaging health of a system throughout its lifetime, and characterizing multichip module (MCM) technologies.

ATC is a family of three silicon chips that resemble an integrated circuit and contain up to 20 different sensor and transducer cells. The designs are fabricated in Sandia's Microelectronics Development Laboratory (MDL).

So far, Packaging and Interconnection Development Div. 2134 has provided 3,000 test chips to university and industry programs, and more than 100 companies have inquired about the chips, notes Dave.

Sandia Upgrades Guidelines for Reactors

Sandians in Nuclear Energy Technology Directorate 6400 managed a multi-laboratory effort to develop design guidance for New Production Reactors (NPRs), which must provide a level of safety that meets or exceeds that of commercial power plants, as required by DOE regulations.

To support this requirement, Ken Bergeron and Scott Slezak (both 6402) managed the effort to evaluate and quantify the potential severe accident challenges to the Heavy Water Reactor containment using a process similar to that used in NUREG-1150.

Dave Williams (6402), Randy Gauntt (6423), Emile Bernard (6402), and Bob Watson (6473) were also on the team that evaluated heavy water design, provided input to quantifying the challenges, and developed "success criteria" for evaluating the maximum permissible severe accident loads on the containment.

The purpose of the DOE requirements is to protect the public against severe core damage events. This requirement is met by incorporating accident scenarios into development of the design.

Braudaway Receives Distinguished Service Award

Dave Braudaway (7343) received the Instrument and Measurement Society 1990 Distinguished Service Award at the Society's annual meeting in Atlanta in May.

The citation honors Dave "for continuing and outstanding service to the Instrumentation and Measurement Society as President and Vice President of the Society, Member of the Administrative Committee, and a Director and Program Chairman of IMTC (Instrumentation and Measurements Technology Conference)." Dave is now Chairman of IMTC.

The award included a stipend of \$1,000.



PLUTONIUM AND PLUTO — Glenn Seaborg (left), who discovered plutonium and other heavy elements, and Clyde Tombaugh, who discovered the planet Pluto, share a lighter moment during a June 10 press conference at Sandia. Seaborg, a 1951 Nobel Prize winner and chairman of the Atomic Energy Commission (AEC) from 1961 to 1971, had just spoken at a Labs colloquium, emphasizing his AEC experiences and his studies of the heavy elements. Tombaugh, now retired and living in Las Cruces, discovered Pluto — the most distant planet in the solar system — in 1930 when he was a 24-year-old astronomer. Seaborg named plutonium after the planet Pluto after discovering the element in 1941. Until the colloquium, the discoverers had never met, and Seaborg thought it was time to do just that; he specifically requested that Tombaugh be a special guest.



A PANEL OF VISITORS led by Carol Hallett, Commissioner of the US Customs Service, and US Sen. Pete Domenici got a recent look at various Labs' technologies that might be useful in Customs' work in such areas as communications, surveillance, explosives detection, and robotics. The delegation included (from left) Al Chernoff, head of DOE's Kirtland Area Office; Domenici; Hallett; Rebecca Davies (US Treasury, Postal Subcommittee); and Jim Jacobs (5200), who described some of Sandia's robotics research to the group.

feed back

Q: Recycling our white paper is a marvelous idea, and I do my part, but I have a question about the propriety of recycling some materials. Of course, only unclassified information is recycled, but as any snoop worth anything knows, it's easy to glean interesting information from any adequate source of input. This isn't necessarily a security issue, but perhaps it is an issue of protecting our corporate plans, etc. When you consider the diverse organizations that recycle, you have a rather broad base from which to gather data.

If this is a problem, perhaps coarse shredders could be used at recycling collection points to make sure the information is rendered unusable before the paper is recycled.

A: Your observations concerning possible loss of information are timely and appreciated. When we implemented the current recycling effort, we developed procedures to deal with this potential. Paper destined for recycling is locked in a trailer in the Tech Area until it is ready to be transported to the recycling center. It is run through a tearing shredder and tightly bound in bales before being loaded onto a railroad car and taken directly to the recycling center, where it is dumped into a chemical bath that removes the print prior to the recycling process.

I appreciate your concern and recognize that this awareness of potential loss of information shows a healthy attitude toward the need to protect information.

Jim Martin (3400)

Q: Recently, I had to make 100 copies of five pages. Since the only working copier in Bldg. 887 (Purchasing) is slow and won't collate 100 copies at a time, I decided to use the larger machine next door in Plant Engineering. While I was waiting my turn, someone suggested I go use my "own" machine. Despite the rebuff, I made 50 copies with the large machine; it took about 10 minutes.

Then I came back and finished the copying on the one working copier in our building. It took me over an hour, because of the machine's limited collating capability and because I didn't want to hog the machine.

At one time, Purchasing was officially asked not to use Plant Engineering's copier, and Plant Engineering was asked not to use ours. My question is, shouldn't all Sandia copiers be available to all Sandia employees? Or why can't we in Bldg. 887 have an adequate copier to meet our needs?

A: All Sandia copiers should be available to all Sandia employees. Copiers are purchased or leased by Div. 3425. The Division also contracts for all copier maintenance. Other organizations do not "own" the machines.

Retiree Picnic Reminder

If you're planning to attend the annual retiree picnic on Thursday, June 27, here's a reminder on details:

The picnic takes place from 4 to 7 p.m. Parking is available at the C-Club, the KAFB chapel, the Que Pasa Recreation Center, KAFB Hospital, and the Sandia Base School east of the Club. A shuttle bus will run from parking lots on B Street to and from the Club's patio entrance near the swimming pool.

All reservations, including no-shows, must be paid for by Sandia Benefits Dept. 3540. If you have reservations and cannot attend, please notify Benefits before Tuesday, June 25, by calling 844-5072.

Convenience copiers located throughout the tech areas are not designated for high-volume production. SLI 1005, dated August 1989, states, "Quantities of 25 or more can be produced more efficiently and economically in the Duplicating Service Center." The normal procedure is to use the resources of Div. 3154, located in Bldg. 894, which has the capacity to perform such jobs as you describe.

Jim Martin (3400)

Q: It appears Sandia will stop providing employees with the Annual Benefits Statement (as discussed in the March 11 Weekly Bulletin). Have I been overly optimistic as a result of recent statements that the new Sandia policy is to improve communications? Will this information be available in the future? How will it be communicated?

A: In the past, several questions have been raised about the quality and usefulness of the information in the benefit statements. In an effort to improve communication, management decided to form a team to determine what information a majority of employees would find most useful. After the team makes a recommendation, a cost-benefit decision will be made to redesign or discontinue the statements. AT&T has already decided to discontinue individual benefit statements to employees.

This year, we will provide each individual with a pension calculation only, reflecting pension status as of Dec. 31, 1990. The rest of the information traditionally provided on the statement may be found on your pay statement, in the personal attendance records maintained by your secretary, or in the *Weekly Bulletin* when the annual statement for each plan is published.

We are interested in communicating benefits information to employees, but only if it is useful

and cost-effective. Once a decision is made, we will communicate it to all employees.

Ralph Bonner (3500)

Q: Sandia says one of its corporate values is respect for the individual. However, no Sandia employee is going to take this seriously as long as the intrusive, degrading "package inspections" are allowed to continue. It is impossible to feel respected when some stranger is rummaging through your purse, lunchbox, or briefcase. It is hard to think of anything that is more damaging to employee morale. Respect for the individual? Actions speak louder than words, and in this case, the message is unmistakable.

A: Sandia policy requires that every employee be treated with dignity and respect. However, Sandia must also conform with DOE Order 5632 pertaining to random 100-percent searches for entry into and exit from limited areas:

"Entrance inspections/searches of all personnel and of all vehicles and hand-carried items shall be conducted to prevent the introduction of explosives, weapons, or other prohibited articles.

"Exit inspections/searches shall be accomplished to prevent the unauthorized removal of SNM, classified matter, or other government property. All visitor hand-carried items (e.g. — briefcases, lunch pails, and so forth) and all service and delivery vehicles shall be inspected/searched. Articles hand-carried by employees and government-owned or government-leased vehicles may be inspected/searched on a random basis, so long as at least 5 percent of all such items are searched."

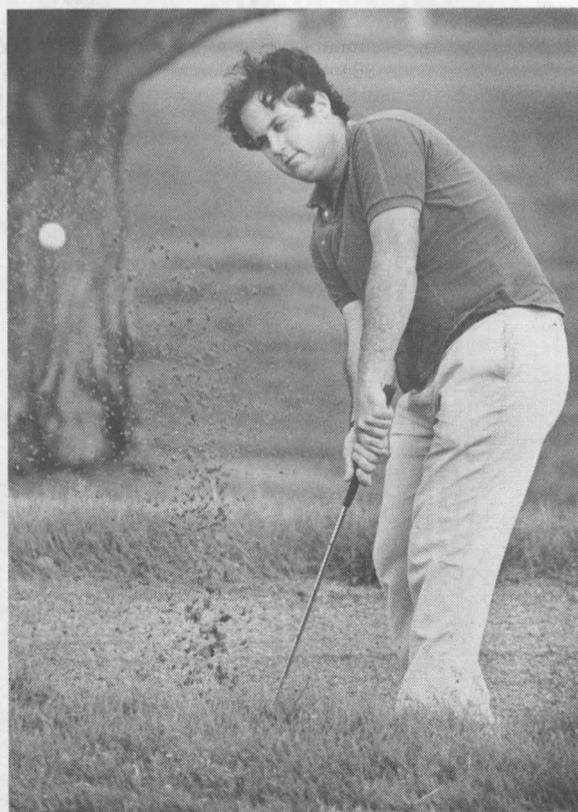
Security guards strive to conduct these inspections with minimal inconvenience or delay. Should you experience a problem during one of these searches, please contact 4-3155 and explain the problem to the desk lieutenant.

Jim Martin (3400)

Congratulations

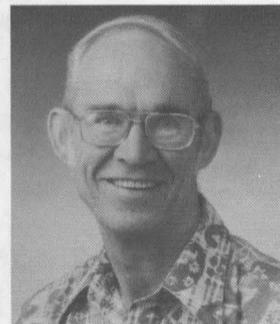
To Linda and Russ (1513) Skocypec, a daughter, Rachel Marie, June 4.

To Sarah Mathews and Ken Davis (2315), married in Albuquerque, June 15.



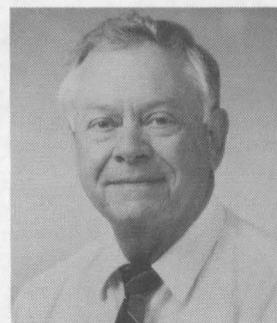
ERIC CHASON (1111) aced hole 6 (par 3) with a 7-iron on the Executive Course at Los Altos Golf Course on May 31. Eric was among several people in his division who played golf during a party held by members of Ion Solid-Interactions Div. 1111. Supervisor Barney Doyle says Eric plays golf only a few times a year.

Recent Retirees



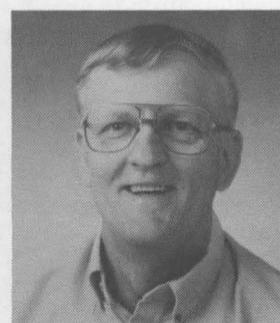
James Leeman
2361

27



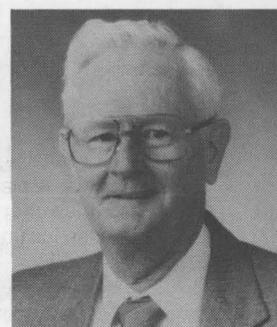
Dick Bassett
2565

40



Arlo Nord
7543

30



John Melvin
9244

34



George Peterson
9213

36

UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS

Deadline: Friday noon before week of publication unless changed by holiday. Mail to Div. 3162.

Ad Rules

1. Limit 20 words, including last name and home phone.
2. Include organization and full name with each ad submission.
3. Submit each ad in writing. No phone-ins.
4. Use 8 1/2 by 11-inch paper.
5. Use separate sheet for each ad category.
6. Type or print ads legibly; use only accepted abbreviations.
7. One ad per category per issue.
8. No more than two insertions of same "for sale" or "wanted" item.
9. No "For Rent" ads except for employees on temporary assignment.
10. No commercial ads.
11. For active and retired Sandians and DOE employees.
12. Housing listed for sale is available for occupancy without regard to race, creed, color, or national origin.
13. "Work Wanted" ads limited to student-aged children of employees.

MISCELLANEOUS

PUPPIES: Golden Retriever mix, 1 black female, 1 blond male, 5 mos. old, free to good home. McNabb, 883-2801.

MAG WHEELS from '86 Mustang GT (4), well-worn Eagle VR-60 tires w/new hubcaps. Clark, 294-3112.

STEEL FENCE POSTS & RAILINGS, approx. \$100-\$250; Rototiller, \$90; shredder/mulcher, \$60; Apache trailer, Mesa model, \$1,500. Asbury, 268-3542.

HYDRAULIC CRANE (cherry picker), Dayton model 3Z125, 1,000-lb. capacity, \$150. Castillo, 836-4213.

SOUSAPHONE, w/hard case, \$650; Flugelhorn, w/hard case, \$250. Stodl, 299-1828.

STORY/CLARK ORGAN, split-level keyboard, foot pedals (4 octaves), 9 different instrument settings, \$150. Johnson, 821-9006.

CARTOP CARRIER, 18 cu. ft., Sears, \$45. Landenberger, 294-4849.

SIGNS: "For Sale by Owner," 1 large, 2 small w/arrows, \$35. Tremi, 292-9219.

BORDER BLOCKS (21), 30¢ ea.; full-size knit bedspread, cream, \$10; Cross pen & pencil set, chrome, \$10. Smith, 299-7151.

AIR CONDITIONER, window unit, 9,000 Btu, \$150; beer-brewing equipment, 8 cases of bottles, \$35; push mower, \$30. Miller, 821-5935.

GERRY BABY BACKPACK, \$15; child's bicycle seat & helmet, \$15. Galloway, 281-5671.

LAWN MOWER, push type, \$10. Kirson, 293-5284.

CATS: 1 black male, 1 female tabby, both med.-length hair, both declawed, free to good home. Tribble, 881-1217.

WIND DEFLECTOR, for trailer towing, \$60; V-6 Buick engine, \$150; GM ignition module, \$15; '81 Olds. manual, \$8. Bentz, 299-3448.

SOFA, floral, 4-cushion, \$300; light-gold carpet & pad, approx. 39 sq. yds., \$125. O'Neal, 821-0566.

SOFA BED, double, \$150. Witek, 296-5198.

ROWING MACHINE, Healthmate Model 2050, \$50. Patrick, 265-4569.

SANTA FE OPERA TICKETS (2), opening night, June 28, "La Traviata," Section 5 (covered), \$115/ea. Brabson, 299-8114.

ELECTRIC TYPEWRITER, IBM Selectric, black, \$70 OBO. Rosul, 281-4114.

TRAVEL TRAILER, '85 King of the Road, 21-ft., self-contained, full-length awning, blinds, stereo, extras, \$5,000. Edmund, 881-7974.

CHANDELIER, 5-lamp, \$25; woman's golf shoes, size 6 & 6-1/2, \$15/pr.; record player, new, \$10. Mozley, 884-3453.

CHEST OF DRAWERS, med. dark brown, \$60 OBO; Kenmore dishwasher, under-the-counter, \$75 OBO. Kawola, 298-5813.

LA-Z-BOY DOUBLE RECLINER SOFA, \$150; Beta VCR, \$50; end table, \$10; computer game, \$5; clothing imprint program, \$5. Robinson, 293-7231.

KITTENS, 8 wks. old, free to good home. Moreno, 294-4268.

DOG KENNEL, Mason modular, 8' x 12', w/shade top & doghouse door, \$250. Savage, 296-0528 evenings.

TRS-80 MODEL III, 16KB, dual floppy, printer cable, w/Lazy Writer word processor & Profile III Plus database software and manuals, \$100 OBO. Moore, 296-6586.

JET SKI, Kawasaki Model 300, \$1,200 OBO. DeLoach, 839-9284.

CHILDCRAFT CRIB, oak, w/mattress, pads, & sheets, \$200; queen-size waterbed, 6-drawer pedestal, will trade for bunk beds & child's desk. Jennings, 268-8789.

THM 350 TRANSMISSION, make offer. Norwood, 266-2717.

GAS DRYER, Speed Queen heavy-duty, works, but needs new gas valve. Ostensen, 296-4227.

SCHWINN EXERCYCLE, speedometer, odometer, timer, Model XR-7, \$195. Kaiser, 828-1660.

CAMPER, 8-ft. overhead Williams-craft, w/3-burner stove, icebox, sink, oven, \$1,500 OBO. Snelling, 292-7460.

ARUBA VACATION, luxury condo in Aruba available 3 weeks in Sept., sleeps 6, \$600 per week. Martin, 898-2708.

TENT CAMPER, '90 Flagstaff Cobra, 22-ft. open, options, \$4,600; 12-ft. Port-a-Bote, motor mount, \$450; Sea King 7.5-hp outboard, \$200. Patrick, 265-4569.

HOME STUDY VIDEO, "Where There's a Will, There's an A," college version, purchased Dec. 1990, cost \$94.85, sell for \$45. Hale, 298-1545.

CAMERAS: Canon AE-1 35mm, 28mm lens, case, \$200; Pentax K1000 35mm, \$125. Harris, 299-4559.

OAK DINING TABLE, w/glass inset top, 4 matching cushioned chairs, \$325. DeReu, 275-2336.

DRAFTING MACHINE, Teledyne Post, includes scales, \$80 OBO. Gately, 271-1344.

GAS GRILL, Kenmore, w/20-lb. tank, \$50 OBO; Galaxie bug lure, lantern-style, 1-acre coverage, unused, \$30 OBO. Schmidt, 821-2917.

CAMELBACK CHIPPENDALE SOFA, blue floral, \$150; green barrel-back chair, \$25. LaGree, 293-2734.

BUNNIES, fluffy mini-lops, black or gray, \$12; Regal White California bunnies, \$10. Salgado, 883-0749.

WOMAN'S SHOES, size 6, never worn, Gonzales, 243-1434.

PATIO DOORS, sliding glass, 72" wide, aluminum frame, \$50 OBO. Pasterczyk, 255-2066.

PET PIGS, registered Chinese miniature potbellied pigs. Elliott, 898-8638.

LAWN MOWER, White's, 20-in., 3-hp Briggs & Stratton engine, \$80; 2 VW 4-lug rims w/tires, \$15/ea. Levan, 293-0079.

POP-UP TENT CAMPER, stove, wired for battery lights, water tank, sleeps 6, \$600; knitting machine, \$70. Ledbetter, 296-2138 evenings.

BICYCLE TRAINER/EXERCISER, Vetta, uses your bike, \$49 OBO; bike to use w/trainer, \$10. Abbin, 296-7678.

BICYCLE RACK, bumper-mounted, \$20. Hesch, 268-6122.

WURLITZER CONSOLE PIANO, solid oak cabinetry, cost \$3,000, sell for \$2,350. Hurley, 296-4697.

PUPPIES: Australian shepherd/golden retriever cross, 4 black w/brown, \$20/ea.; 3 blue merle w/brown, \$30/ea.; prices include first shots. Szklarz, 281-1096.

SERVICE MANUAL for '85 Honda Accord, \$10. Garcia, 293-3937.

GOLD JEWELRY, 18-kt.: woman's rings, size 8-1/4; bracelets; earrings; appraised from \$30 to \$1,000, asking \$20 to \$500. Pendall, 265-3008.

DOGHOUSE, wood frame, pitched shingled roof, \$30. Jackson, 293-0954.

SHAG RUGS, blue- & orange-tone, \$15 & \$50. Jeffers, 299-7020.

QUEEN SOFA SLEEPER, \$95; brown love seat, \$45; La-Z-Boy swivel rocker, \$70. Martel, 293-1892.

ANTIQUÉ SATIN DRAPES, full-length, brandy-colored decorator rods, used 1 year, covers 4-ft.+ windows, 4 sets, \$50/set. Turpin, 281-5933.

SOFA SLEEPER, brown, queen-size, \$100; folding Ping-Pong table, 3/4-in., on casters, \$50. Sandlin, 299-8786.

WICKER BASSINET, \$20; Brother electronic typewriter, graph maker, \$75; Yamaha guitar, \$90; Emerson tuner, 8-track record player, \$75. Mills, 299-2130.

SEARS UPRIGHT FREEZER, \$150. Burchett, 281-0708.

SWIFT 7x50 ARMORED BINOCULARS, \$25; Skynasaur 4-ft. stunt kite, \$20; Ray Ban Aviator sunglasses, \$15. Montoya, 296-4268.

KITCHEN CABINETS, counters, Americana range, sink w/faucet, 4' x 6' light fixture, remodeling sale, available end of June as they're removed. Northrop, 884-4718.

MARBLE PICNIC TABLE, very heavy, haul it away, 12323 Kinley NE. Barbera, 275-2562.

SEARS SUBMERSIBLE PUMP, 1/2-hp, w/all accessories for 4-in. well, \$325. Brumley, 877-2667.

QUASAR TELEVISION, 23-in., color, console, \$100. Apodaca, 299-8515.

PUPPIES: AKC-registered miniature dachshund, black, red, reserve now, 6 wks. old on July 4. Puccini, 255-0568.

CHILD'S CAPTAIN'S BED, foundation, mattress, 2 drawers below, \$75; 30 ft. of 5-ft. wire fencing, \$12. Goetsch, 892-8366.

LAWN MOWER, Sunbeam 20, 3-hp, \$30; Sears self-contained Pak-A-Potti, \$40. Stixrud, 298-0478.

KITTENS: 2 tiger-striped females, 2 black males, 6 wks. old, free to good home. Price, 897-0185.

FRANCISCAN POTTERY, Madeira, by the piece; black Spanish nightstand, \$10; unicycle, \$15; non-working H-89, free. Newcom, 293-5180.

SOFTWARE, Norton Backup, unopened, \$49. Mogford, 898-1416.

TRANSPORTATION

'67 OLDS. TORONADO, classic, loaded, no reasonable offer refused. Gutierrez, 864-4582.

SKI BOAT, '89 Ski Brendella Tournament, 19-ft., 351 engine, Southwestern colors, w/trailer & cover, \$14,700. Avila, 255-6568.

SUNFISH SAILBOAT, 13-ft., always stored inside. Hanson, 298-2120.

'80 PLYMOUTH ARROW PICKUP, w/camper shell, AM/FM cassette, 5-spd., sport wheels. Tjeltweed, 766-9282.

GIRL'S BIKE, 3-spd., \$35. Jeffers, 299-7020.

'81 FORD F-150, w/shell, 25K miles on rebuilt 302 V-8, 3-spd. w/overdrive, dual tanks, AC, AM/FM cassette, motor manuals, \$3,400. Bloom, 898-7805.

'78 CHRYSLER NEW YORKER, 106K miles, white w/red interior, AC, PB, second owner, \$1,500. Wagner, 823-9323.

BICYCLE, Fuji Royale II, 23-in., 12-spd., \$160. Bentz, 299-3448.

BOY'S BMX BICYCLE, Murray, 20-in., \$35; girl's bicycle, 20-in., \$20; 12-in. scooter, \$15. Witek, 296-5198.

'84 HONDA ACCORD, hatchback, 5-spd., 2-dr., 88,000 miles, \$3,000. Kulawinski, 281-8694.

MAN'S BICYCLE, 10-spd. LeGrande, 27-in., \$50; girl's bicycle, Huffy, 20-in., \$35. Patrick, 265-4569.

'74 PLYMOUTH SATELLITE, rebuilt 400 CID engine, transmission, & carburetor, \$450 OBO. Baney, 294-8970.

'71 OLDS. 98, 2-dr. sedan, 455 engine, \$795. Bunting, 294-3431.

'81 FORD PICKUP, F-150, Explorer package, red, w/camper shell, PS, PB, AC, AM/FM cassette, 95K miles, \$3,250. Perrine, 293-1429.

'31 MODEL "A" FORD COUPE, w/rumble seat, valued at \$14,000, sell for \$8,900. Claussen, 292-5733, leave message.

'86 FORD RANGER PICKUP, Supercab, 5-spd., V-6, 42K miles, fold-out child's seats, truck box, \$4,500 firm. Shrouf, 821-0765.

'81 MUSTANG, 4-spd., new paint, brakes, Sansui w/equalizer, extras, \$2,100. Foster, 299-6240 after 6 p.m.

REPOS: '89 Ford F-150 XL, 4-spd., 39K miles; '87 Acura Integra, 5-spd., 63K miles; '86 Pontiac Firebird, AT, 101K miles; '76 Ford Ranchero, AT, 143K miles; bids accepted through June 20; we reserve the right to refuse all bids; subject to prior sale. Sandia Labs FCU, 293-0500.

'82 MOBILE TRAVELER MINIMOTORHOME, 21-1/2 ft., 350 Chev. engine, 28K miles, dash/roof AC, generator, \$11,500. Nielson, 292-6188.

HONDA SABRE MOTORCYCLE, 750cc, 5K miles, \$1,495 OBO; Nordic ski boat, 18-ft., 460 CID Ford engine, tandem trailer, \$6,500 OBO. Abbin, 296-7678.

'73 DODGE PICKUP, 1/2-ton, PS, PB, AC, sliding window, AM/FM cassette, 400 motor, \$1,200. Townsend, 275-8913.

MOUNTAIN BIKE: 17-in. GT Avalanche; Tange Prestige frame, fork, bars; Shimano, Onza, IRD components; \$675 OBO. Goodson, 265-2080.

'82 CORVETTE, 2-tone, glass T-tops, NADA avg. retail \$11,950, asking \$8,900. Buttry, 821-2660.

'85 DODGE CARAVAN LE, AC, AM/FM tape, trailer hitch, \$4,900 OBO. Hudson, 884-7621.

MAN'S 12-SPD. BICYCLE, Fuji Espree, large frame, 2 yrs. old, Shimano components, recent overhaul, \$150. German, 247-2882.

'76 TOYOTA LAND CRUISER, 4-WD wagon, Alpine stereo, 100K miles, \$2,300. Gerstle, 821-1112.

'88 CHEV. BERETTA COUPE, 2-dr., 65K miles, AT, AC, PS, PB, cruise, rear window defrost, tilt, \$6,675 book, sell for \$5,900. Rezac, 292-2669.

'82 TOYOTA PICKUP, 3/4-ton, long-bed, 5-spd., 55K miles, blue, AM/FM cassette, \$2,800. Murray, 299-7226.

'86 TOYOTA PICKUP, 1/2-ton, AC, PS, LB, X-cab, AM/FM cassette, sliding rear window, 57K miles, white w/gray interior, \$4,300. Loving, 291-0341.

'74 DATSUN 260Z, new paint, needs work, \$2,300. Torres, 299-5789.

'86 FORD ESCORT GT, one owner, 67K miles. Witt, 888-3307 after 5 p.m.

'90 MAZDA MX-6, blue w/blue interior, AT, AC, AM/FM cassette. Cloer, 296-5244.

'85 RENAULT ENCORE, 33K miles, AC, AT, AM/FM stereo, \$2,500 firm. Hultine, 891-9518.

'89 FORD AEROSTAR, XLT package, dual AC, 4 captain's chairs, extended 6/60K warranty available, 34K miles, \$11,995. Miller, 275-1609.

CENTURION 10-SPD. BIKE, make offer. Norwood, 266-2717.

REAL ESTATE

3/4 ACRE in Peralta, no restrictions, \$15,000, \$800 down. Garza, 877-5812 or 836-4811 after 7 p.m.

3-BDR. HOUSE, 2,100 sq. ft., 2-3/4 baths, den, sunroom, hot tub room, 2-car garage, fully landscaped, \$78,000. Padilla, 836-6956.

2-BDR. HOME South of Tijeras, 2 baths, 0.7 acre, 2 years old, brick floors, security system, \$84,900. Dubbert, 281-9269.

5-ROOM HOUSE, fireplace, hardwood floors, fenced yard, SE area, \$31,500 cash or \$34,000 REC w/\$5,000 down. Brumley, 877-2667.

3-BDR. BRICK HOME, 1,700 sq. ft., 1-3/4 baths, 2-car garage, hardwood floors, deck, corner lot, Ridgecrest area, assumable. Heaton, 265-8046.

3-BDR. HOME, Stardust Skies Mossman, 1-3/4 baths, living room, den, 1,810 sq. ft., on cul-de-sac, RV access, upgraded, \$111,500. Clevenger, 888-0201.

1 ACRE OF LAND near Edgewood Paradise Estates, water and electric at street, \$17,500. Depoy, 298-8308.

CABIN SITE, on the Brazos, 3+ acres, view near Corkins Lodge, approx. \$7,000/acre. Garcia, 293-3937.

2-BDR. TOWNHOME, 2-story, 2-1/2 baths, garage, fireplace, views, assumable loan. Guttker, 867-9133.

3-BDR. ROBERSON HOME, 1-3/4 baths, Snowheights area, immediate occupancy, \$69,000 cash. Goetsch, 298-0510.

10 ACRES, 7 miles south of Moriarty, \$10,000 cash, \$12,000 terms, will carry recontract. Smith, 1-384-5182.

WANTED

'86-'89 HONDA CIVIC, Hyundai, or Colt, 5-spd., beige/brown color, will buy or trade '79 Ford pickup 300, 4-spd. Garcia, 888-4735.

GOLF CLUBS, left-handed, man's. Bonzon, 828-1066.

TRAILER for 14-ft. boat, will pay cash. Hunke, 298-0667.

RV TIRE, 8:75x16.5; person who bought file cabinet, please call. Patterson, 299-1062.

SOUTHWEST TICKET, swap my Company Club certificate (expires June 1991) for one that expires after July 31, 1991. Harmon, 292-4304.

CAB-OVER CAMPER CORNER JACK, 9-ft. metal garage door, 2- to 5-hp air compressor, large dog crate. Bauhs, 281-2688.

CAMPER SHELL to fit '90 Toyota extended cab truck. Alderson, 293-5112 after 4:30 p.m.

BABY CRIB, w/mattress, in good condition. Mills, 823-4484.

'82 OR '83 DATSUN 280ZX 2+2. Bruce, 897-7416.

DEPENDABLE CAR, relatively low mileage, inexpensive, less than \$2,500. Dixon, 298-5617.

POP-UP TRAILER, small, in good condition; baby stroller, in good condition. Sanchez, 831-2645.

AMERICAN-MADE CAR or truck, pre-1975, non-running, for rebuilding project. Shank, 877-4497.

TWO-HORSE TRAILER, good condition. Burns, 281-3922.

TEENAGER WANTED for yard work, \$4 an hour to start, steady work through the summer, Candelaria and Wyoming. Maenchen, 298-9496.

1-TON DUAL-WHEEL PICKUP, 350 (or equivalent) engine, pre-'74 through early '80s model, any cab style, in very good mechanical condition. Loving, 291-0341.

LAPTOP COMPUTER, must be IBM-XT compatible, HDD, FDD 640K. Ludwick, 296-6447.

BABY CAR SEAT, good condition; BASIC on 8-in. CPM floppy. Stixrud, 298-0478.

LOST AND FOUND

LOST: opal/diamond ring, gold band, lost near Bldgs. 892/880, Gate 10 parking lot, Tues., June 4, great sentimental value. Scholl, 4-6334.

FOUND: black Swiss Army knife, in Bldg. 831 conference room; found turquoise TLC T-shirt outside Bldg. 831, north door. Kissam, 5-8038.

LOST: set of approx. 10 keys on leather keychain, in the Wyoming parking lot across from the Credit Union. Silva, 265-5523.



Coronado Club Activities**Summer's in Full Swing at Friday 'Dollar-Daze'**

FRI-DAZE FUN begins at 5 p.m. tonight, with music from D.J. Ron "R.C." Casias. The patio buffet will be served from 5 to 7 p.m., and the pool and patio will be open until 10. Then on Friday, June 21, "Dollar Daze" features music by the Brown River Band from 7 to 11 p.m. Dinner is served from 6 to 9, including deep-fried shrimp or prime rib (two-for-one priced at \$16.95), poached halibut (\$9.95), snow crab (\$9.50), and steak Neptune (\$9.95). The pool and patio, as always on Fridays, are open from 5 to 10 p.m.

DON'T BOTHER FATHER on Sunday, June 16. Instead bring him to a special Pop's Day pic-

nic at the Club from 11 a.m. to 6 p.m. Bob Weiler and Los Gatos entertain while you beat dad at basketball, volleyball, and horseshoes (let him win a game). An a la carte menu will be served from 2 to 6 p.m. Admission is free for members and \$3 for guests.

DON'T MISS Sunday brunch and tea dance with music by Bob Weiler and Los Gatos on Sunday, June 23. Brunch is served from 10 a.m. to 1 p.m., and the tea dance begins at 1 and ends at 4. Cost is \$6.95 for adults, \$1 for children 4 to 12 years old, and free for toddlers. Reservations recommended.

CLUB CLOSING — Thursday, June 27, the Club will be closed all day for the annual retirees picnic and get-together (4 to 7 p.m.). That means no lunch, no Thursday-night bingo, and no pool or patio all day.

MEET McCUTCHEON, Jim "Jaws" McCutcheon (Card Sharks organizer), that is, at the next meeting of the T-Bird Card Sharks, Thursday, June 20. No meeting will be held June 27 because of the Annual Retiree Picnic. Next month's meetings take place July 11 and 25. Meetings begin at 10 a.m. and end about 3 p.m.

Events Calendar

Events Calendar items are gathered from various sources. Readers should confirm times and dates of interest whenever possible.

June 14-16 — "School for Drugs," comedy by Grubb Graebner about Santa Fe politics, power, and strange bedfellows; 8 p.m. Fri.-Sat., 6 p.m. Sun.; Vortex Theatre, 247-8600.

June 14-16 — Festival Flamenco '91: UNM College of Fine Arts Theatre and Dance Department, concert of Flamenco dance, music, and song; 8 p.m. Fri.-Sat., 2 p.m. Sun.; Rodey Theatre (UNM), 277-4402.

June 14-25 — "One Woman," one performer, who happens to be a woman and happens to be black, explores the humor, joys, and sorrows of growing up in America; Theatre-in-the-Making presentation; 8 p.m. Fri. & Sat., CenterStage (3211 Central NE), 260-0331.

June 14-28 — Exhibit, "A Necessary Fence: The Senate's First Century," 14-panel poster display, replicated from an exhibit in the rotunda of the U.S. Capitol, exhibit shows how the Congress functions; 8:30 a.m.-5 p.m. Mon.-Sat., South Broadway Cultural Center, 848-1320.

June 14-July 28 — Exhibit, "Figure It In: The Human Figure in American Art Since 1945"; drawings, paintings, photographs, prints, and sculptures featuring the face and human body; 9 a.m.-4 p.m. Tues.-Fri., 5-9 p.m. Tues., 1-4 p.m. Sun.; UNM Art Museum, 277-4001.

June 14-July 28 — Exhibit, "Late Style," recent works by Charles Mattox, Enrique Montenegro, Lucy Lewis, Clinton Adams, Garo Antreasian, Beaumont Newhall, Ann Noggle, and Joe Herrera; 9 a.m.-4 p.m. Tues.-Fri., 5-9 p.m. Tues., 1-4 p.m. Sun.; UNM Art Museum, 277-4001.

June 14-Aug. 16 — Exhibit, "Raymond Jonson Paintings from the Chicago Period"; 9 a.m.-4 p.m. Tues.-Fri., 5-9 p.m. Tues.; Jonson Gallery (UNM), 277-4967.

June 14-Aug. 18 — Exhibit, "Treasures of the Tar Pits," ice-age fossils from the Rancho La Brea Tar Pits in Los Angeles, produced by the Natural History Museum of Los Angeles County, features complete skeletons of dire wolves, a coyote, a giant ground sloth, and a cast from the skeleton of a 9,000-year-old La Brea woman; 9 a.m.-5 p.m. daily, New Mexico Museum of Natural History, 841-8836.

June 14-Sept. 20 — Exhibit, "Impressions of Nature," features the work of F. G. Hochberg, co-founder of the Nature Printing Society and curator of Invertebrate Zoology at the Santa Barbara Museum of Natural History, images printed directly from natural subjects including plants, fish, and shellfish; 9 a.m.-5 p.m. daily, New Mexico Museum of Natural History, 841-8837.

June 21 — Poster signing: New Mexico Arts & Crafts Fair commemorative posters ("Picuris Kiva") personally signed by artist Ken Peterson (with Disney for 38 years, worked on animation for "Snow White," "Fantasia," and "Bambi"); posters on sale for \$25, proceeds help the Festival cover general operating expenses; 10 a.m.-noon, Sunwest Bank (East Central Branch, Washington & Central), 884-9043.

June 27 — Gala Preview Night, "Flavors of New Mexico," New Mexico Arts & Crafts Fair, refreshments, live entertainment, and door prizes donated by local artists; New Mexico State Fairgrounds, call for time & ticket information, 884-9043.

Sandia News Briefs**Design Software Allows Simultaneous Input from Different Sites**

Design engineers at different locations could all work on, see, manipulate, and change a design at the same time, using new prototype software developed by Sandia computer scientist Craig Dean (5173).

"Computer-supported collaboration will change the way people do their jobs by increasing the quantity and quality of interactions between co-workers," says Craig. "The notion is applicable to any situation where co-workers need to work together, but find it more convenient to be at different locations." Called interactive concurrent engineering (ICE) software, the technology allows high-resolution graphics output from a computer-aided design or other program to be viewed and manipulated simultaneously by people in several locations.

Smartt Joins Industrial Advisory Board of IEEE Software

Melissa Smartt (2810) has been named to the Industrial Advisory Board of *IEEE Software*, a publication of the Institute of Electrical and Electronics Engineers with 30,000 subscribers worldwide.

Melissa was invited to accept the post by *IEEE Software* Editor Carl Chang, who commended her "leadership in the field of information technology." She will work with other information technology leaders around the world. *IEEE Software* has great impact on setting directions for the software industry, says Chang.

Poteat Recognized by DOE for Establishing Quality Program

Tom Poteat of Quality Support Div. 7311 has been recognized for helping establish a Total Quality Management program at DOE's Albuquerque Operations Office and Area Offices.

Bruce Twining, DOE/AL Manager, presented Tom with the special award at a May 30 ceremony in Albuquerque. The award reads: "In recognition of outstanding contributions to the DOE/AL Leadership Through Quality effort and in appreciation of your role in advising the Quality Steering Committee and mentoring the facilitators."

Fun & Games

Biking — Attention, bikers. The Albuquerque Planning Department needs input for an updated Bicycle Master Plan, especially from volunteers in the NE Heights. Particular emphasis is on connecting gaps in the network of trails, lanes, and routes. Other possible actions include new stop signs, traffic lights, or bike push-buttons at intersections; new curb cuts in medians; and more routes, lanes, and trails. If you have suggestions, call Susan Kelly on 768-3926 at City Hall or John Finger (6252) on 266-8906.

Golf — The first Luna Vocational-Technical Institute (LVTI) Foundation Scholarship Golf Scramble will be held June 22 and 23 at the New

Mexico Highlands University Golf Course in Las Vegas, N.M. Profits will benefit LVTI students. The format is a five-person team (men's and women's teams), 36-hole scramble. Tee-off is at 8 a.m. Cost is \$57 and includes greens fees, breakfast, lunch, Saturday night mixer, and refreshments on the golf course. For more information, contact LVTI's Leroy Ulibarri on 1-454-2559.

Welcome

Albuquerque — Arthur Guenther (450).

Elsewhere: Colorado — David Shen (2134);

South Carolina — Ronald Farmer (6451); Texas — Nancy Jackson (6212).



GROUPS AS LARGE AS SANDIA can help develop markets for their own recyclable items. That was one of the messages that Madeline Dunn delivered to Sandians attending a June 3 meeting to find out more about Sandia's recycling program. Dunn is coordinator of the Keep Albuquerque Beautiful program. Don Schubeck (3412) coordinates the Labs' recycling program.