

Solder Leveler May Be Saving Industry \$250 Million/Year

T.A. Allen and Bob Sylvester were just trying to solve a problem.

In so doing, they created a machine that reshaped an industry and, in the process, developed a technique that experts believe saves \$250 million annually in faulty printed circuit boards

That machine was born in the Labs' printed-circuit shop. It's called the hot air solder leveler — a name that also serves well as a quick description of its purpose. The machine coats and levels solder on a printed-circuit board (see "How It Works" on Page Four).

Made for Fewer Failed Parts

The invention of the two Sandians — both now retired — did not create a new product, but it did allow that product to be made more easily and with fewer failures. And that's what T.A. Allen wanted to do all along.

In the late '60s, T.A. was a section supervisor in what's now Electronic Process Development and Fabrication Dept. 7410. His section was charged with making printed circuit boards to be used in the VELA satellite detection system.

When the section began making the boards, it

used a rather primitive method to get a smooth solder coating on the conductive pathways of the board and on the interior surfaces of the holes that connect both sides of the board.

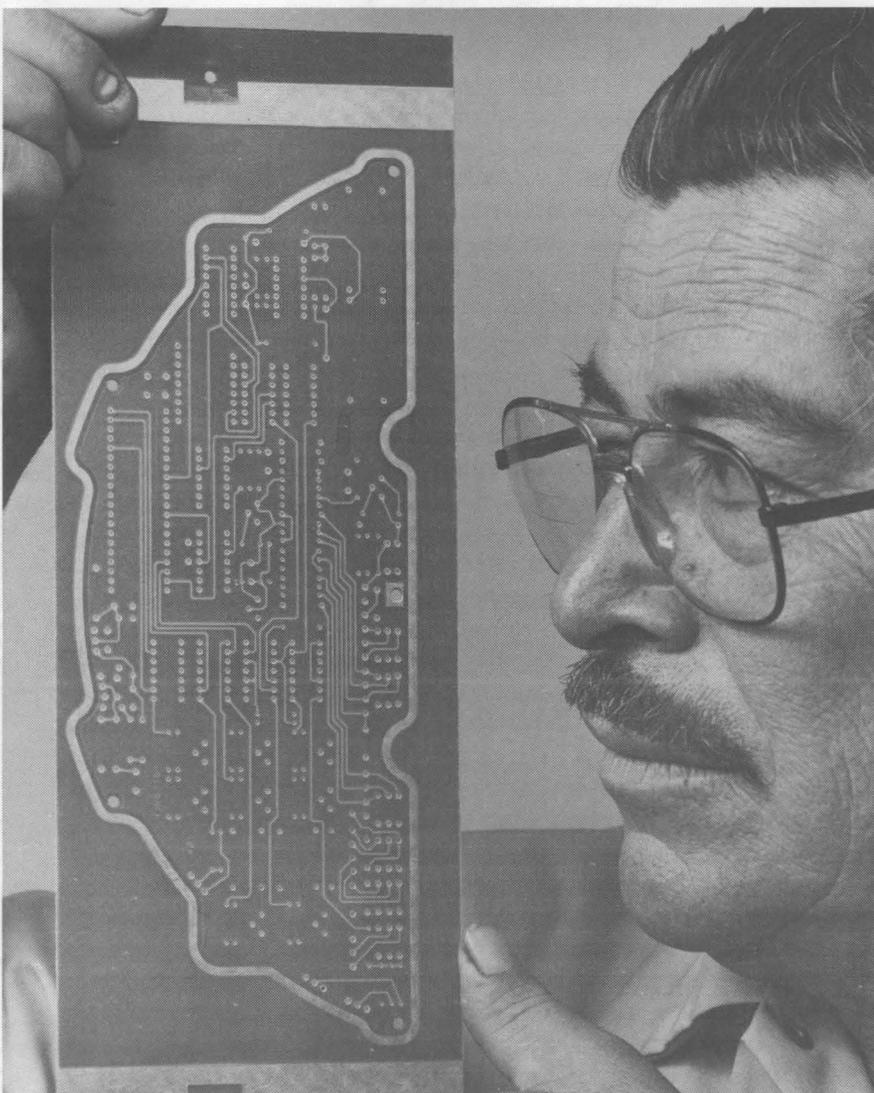
"The military required that its boards be solder-dipped and reflowed to the point that the holes would be open, yet have enough solder left for a flat-pack application," T.A. says. "The way you did that was to dip the board in a tank. Then you would hold the board in place with pliers on the edge of a garbage can and take seven paper towels — not six, not eight

— and strike the board against the edge of the garbage can, buffering it with the paper towels.

"All the solder would go out of the holes, and it made a beautiful board, but it was damaging to the board, and it was highly operator- and process-sensitive."

Had to Be a Better Way

T.A. figured there just had to be a better way, but he knew it wasn't the other method used at the time
(Continued on Page Four)



ONE OF MANY prototype printed-circuit boards designed and produced by Electronic Process Development and Fabrication Dept. 7410 is shown by Richard Chavez (7413-1). All of Sandia's prototype boards and many that are made by commercial manufacturers are produced using the hot air solder leveler, invented and refined in the early '70s by T.A. Allen and Bob Sylvester, both now retired from the Labs. A 1973 Sandia news release announcing the invention resulted in a flood of inquiries from US and foreign companies. Several eventually developed their own levelers under no-fee licenses from DOE.

Sandia Technology: Moving It From the Middle

The fact that one of Sandia's biggest tech transfer hits should come from Directorate 7400 is no surprise. The folks in 7400 usually find themselves in the middle, and that's a good place to be for technology transfer, says Jim King. As Director of Materials Process Engineering and Fabrication 7400, Jim's in charge of the group that often serves as the interface between design engineers and manufacturers.

"One of our missions is to work with component designers to fabricate prototype hardware and materials and to prove-in processes," Jim says. "Often, we can't just open a materials handbook and pick out something that's readily available. In concert with other groups — particularly the 1000 and 2000 organizations — we are required to develop new technology to function in rigorous, hostile environments.

"And it's our relationship as a primary contact point with manufacturers that gives us the opportunity to move technology into the marketplace."

Sandia: A Pressure-Packed Place

If You've Got Pressure, Better Call the Experts

Every kid soon learns: A balloon — a pressure system of sorts — can take only so much force on the inside surface before it pops.

There aren't many balloons at Sandia, but there are many pressure systems, and the Labs goes to great lengths to ensure that they don't "pop" or otherwise malfunction and endanger employees. Jim Volkman, a contractor pressure safety consultant in Project Design Definition III and Contract Drafting Div. 2853, says there are about 2000 pressure systems at the Labs in Albuquerque. Some 1200 are used by Facilities 7800 in boilers and HVAC (heating, ventilation, and air conditioning) systems; the rest are used in research and development facilities — primarily in the technical line organizations.

"We have a wide range of systems," says Jim. "Everything from vacuum systems with negative
(Continued on Page Twelve)

**New Tech Transfer Office
Established at Livermore —
See Page Three**



LAB NEWS

VOL. 41, NO. 15 SANDIA NATIONAL LABORATORIES JULY 28, 1989

23 Directorates Hit 97% or Better

Bond Allotment Above \$3 Million for First Time

Most Sandians agree that investing in US Savings Bonds makes sense. That's confirmed by the results of the 1989 Bond drive.

This year, Sandia employees will invest a record amount — \$3,096,941 — in Bonds, for the first time surpassing the \$3 million mark. The allotment is a 5.5 percent increase from a year ago, according to Gary Mauth (9220), 1989 Savings Bond chairman.

'Outstanding Participation Record'

"As usual, the Bond effort received tremendous support from employees at all locations — Albuquerque, Livermore, Tonopah, and Pantex," says Gary. "It's clear that Sandians recognize 'the Bond advantage.'"

Final 1989 Bond drive stats show that 96.6 percent of Sandians now buy bonds. "Historically, Sandia has had an outstanding participation record — the kind of record befitting a national lab," notes Gary.

Four directorates achieved 100-percent participation: 200, 400, 3500, and 6500. The "Almost-100 Club" (98 percent or better) consists of 100, 1100, 1200, 1400, 1500, 2500, 2800, 6300, 6400, 7200, 8100, 9100, and 9200. Honorable mention for 97-percent-plus participation goes to 2300, 5200, 6200, 7100, 7500, and 8200.

The total Bond allotment translates to an average \$31.46 per month per employee, compared to \$29.55 a year ago. About 47 percent of Labs employees are at or above the Bond-a-month level.

"Our outstanding campaign results aren't an accident," says Gary. "They directly reflect much enthusiasm, hard work, and time on the part of members of the Savings Bond Committee and the other key players on the Bond-drive team — the VP and directorate reps.

"Thanks to each of them — and the many Sandians who support our Bond effort each year." ●PW

This & That

Is This the Person to Whom I'm Speaking? -- Harriet Mason, Division 5261 secretary, took an unusual call several weeks ago. The caller asked, "Is [certain name] there?" Harriet replied that she didn't know anyone by that name and that the caller must have a wrong number. So, the caller asked, "Can you take a message?"
* * *

Now, Which Way's the Ocean? -- Wes Pfarner (9243) thinks the US Postal Service and our own mail services section don't always get enough credit. Wes recently received a packet of information mailed from California only two days earlier. It was addressed to San Diego National Lab, P.O. Box 5840, M/S 9243, Albuquerque, NM. 87105; Attn: Wes Pfarner. The mail stop line (division number) was the only correct one in the address.
* * *

Not Just Hot Air -- The hot air solder leveler invented at the Labs about 20 years ago by T.A. Allen and Bob Sylvester (both ret.) is one of Sandia's tech transfer successes (see page one). First used to coat and level solder on Vela satellite components, hot air solder levelers are now used by printed-circuit board manufacturers throughout the world, saving industry an estimated \$250 million annually.

An AT&T spokesman told the LAB NEWS that our parent company uses hot air leveling on about 70 percent of its printed-circuit boards. Bob could hardly believe it when he learned that recently: "How much?" he asked. When 70 percent was repeated, he said, "That's great!" Although he retired from the Labs in '82, Bob says he's busier than ever as airport manager and city engineer in Granite Shoals, Tex.

T.A., still an Albuquerque resident, says, "It's difficult to believe that the two of us really made that kind of an impact. I guess it still hasn't totally sunk in yet."

Credit for this issue's tech transfer stories goes to Ace Etheridge (3161), Rod Geer (3163), and Charles Shirley (3162). Thanks, guys.
* * *

Maybe It's the Rare Air -- From a recent ad for a vendors proposal preparation workshop, sponsored by another well-known DOE lab in New Mexico: "This workshop is intended to provide vendors offering common use commodities with various aspects of information that are necessary to prepare effective competitive proposals in the systems contracting environment. It will also address effective presentation of the information. . . ."
* * *

Love the Perks, Boss! -- Earlier this year, when my department manager and I were discussing the possibility of my taking this job, he said there were inherent benefits that I'd realize, but he didn't elaborate. Now I know: the view from my office window of beautiful sunrises over the Sandia Mountains, never any problem finding a parking spot, and no traffic jams on the way to, or from, work.
* * *

But, I'll Bet It Isn't Near Muddy Boggy Creek -- I recently noticed an ad in an early 1989 Sandia bulletin listing houses of transferred employees, including some AT&T. There was a house listed in New Jersey -- on a street named Possum Way. I thought only Okies (yup, I'm one) named streets after such things. ●LP

Curtis Domme Suffers Severe Burns in Accident

One of Sandia's most serious personal injury accidents occurred on Saturday, July 15, when an employee was severely burned while re-energizing a 2400-volt switch during scheduled maintenance on Substation 15 just outside Bldg. 822.

Curtis Domme, an electrical tradesman in Utility Systems Div. 7811, suffered the injury. Joe Allen, 7811 supervisor, sustained burns on his hands while helping to extinguish the fire. As of Tuesday, July 25, Curtis was in critical, but stable, condition in the Burn Intensive Care Unit at UNM Hospital. His wife Bess works in Analytical Chemistry Div. 1821.

The Department of Energy is investigating the accident, and Sandia management has begun its own review to determine what actions may need to be taken to prevent a recurrence of the accident. Says Bob Peurifoy, VP 7000: "While we have an excellent safety record, this accident once again reminds us that in matters of safety, it's present performance -- not past -- that counts."

Countdown to 40

Thirty Since '49

Sandia Corporation will be 40 years old on Nov. 1, 1989. Until then, the LAB NEWS will publish related short articles and historical tidbits in most (if not all) issues.

As of this month, Sandia still had 30 active employees who began their careers here before Nov. 1, 1949, the date that Western Electric (now AT&T Technologies) began operating the Labs. They include (in order of most years of service): G.C. Hollowwa (3411), Jack Suttman (9123), Ted Church (7290), Jo Davis (7531), Homer Crumley (3714), Fred Deiber (2852), Bob Statler (7137), Frank Duggin (8534), Merrill Jones (9215), Jim Winter (7813), Howard Devaney (2542), and Billy McConnell (7812).

Also Herb Anderson (7223), Billy Duggin (1221), Zachary Ortiz (5213), George Walker (7252), John Dickinson (7137), Marcie Samuelson (3428), Emanuel Alford (8161), Joe Sanchez (3424), Joe Apodaca (3428), Calvin Cox (7137), Ken Wiley (7135), Clyde Babcock (3155), Jesse Rehberg (9214), Frank Speakman (7411), Dick Andres (7135), Hal Rarrick (7540), Stan Reynolds (7535), and Chuck Wells (7818). ●

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SOME OF THE STUDENTS working at Sandia this summer gather about Howard Adams, Executive Director of the National Consortium for Graduate Degrees for Minorities in Engineering, following his talk at a student luncheon earlier this month. Sandia is a member of the consortium of companies and universities dedicated to helping minority students earn master of engineering degrees. Adams also met with recruiters and outreach staff in Equal Employment Opportunity and Affirmative Action Div. 3511 and with VP Dan Hartley (6000), chairman of Sandia's Affirmative Action Council. Patricia Salisbury (3511) coordinated Adams' visit.

Not Just Energy Technology**Mike Dyer Heads New Technology Transfer Office**

Mike Dyer, who's been supervisor of Combustion Applications Div. 8362 for the past eight years, now heads a recently established technology transfer office at Sandia, Livermore. Though Mike reports directly to Org. 8300, his new activity will serve all the technical directorates.

"The title of Mike's new position, 'Technology Transfer Liaison,' describes its intended function," says John Crawford (8000). "That's to facilitate technology transfer activities at Livermore and to provide an effective bridge between Livermore and the Technology Transfer organization in Albuquerque.

"Mike not only has a strong technical background, but has also shown a personal interest in technology transfer. The creation of a special office and management-level position dedicated to this effort formalizes our commitment to transfer as much technology as possible to private industry."

Mike says the main thrust of his new job (a one-to-two-year assignment) will be to encourage and assist the people at Livermore to take a more proactive role in interfacing with industry — on a level similar to that of the combustion energy programs in recent years.

'Up to Us to Reach Out'

"This technology transfer effort won't include just energy technology," Mike comments. "Sandia's broad technical base makes it possible to also share knowledge in a great many other areas. It's up to us to reach out to industry and set up a dialogue between our technical staff and theirs.

"My job will be to facilitate and encourage con-



MIKE DYER: "The line organizations are key players in the transfer process, and I'm counting on their support to ensure a successful program."

tacts between our technical staff and the technical people at private-sector companies."

"We've been working closely with industry for the last dozen years in the engine program and have found that we have a lot to teach each other," comments Peter Mattern (8300). "Technology 'exchange' is perhaps more descriptive of our interactions with industry than is technology 'transfer.'

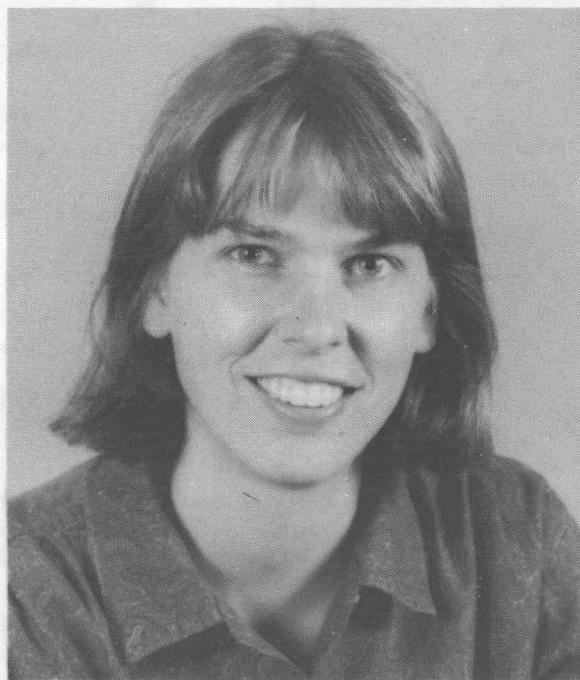
"'Exchange' implies a mutual respect for each other's role in the process, and that attitude is important in information-sharing interactions — whether they involve basic research, manufacturing, or something else."

Mike adds, "Generally speaking, we haven't concentrated on developing products for industry or the consumer marketplace. That's where private in-

dustry can be very helpful; it brings these skills and perspectives to the table to complement our strong technical understanding of the underlying science."

Mike also points out that he can't do the technology exchange job alone: "The line organizations are key players in the transfer process, and I'm counting on their support to ensure a successful program."

Mike's responsibilities include planning and facilitating partnerships between Sandia and industry, developing or enhanced contacts with target industries, organizing workshops and a lecture series on emerging issues faced by industry and by Sandia, and serving as the information clearinghouse on intellectual property and patents generated by Sandians. ●BLS



JILL HRUBY

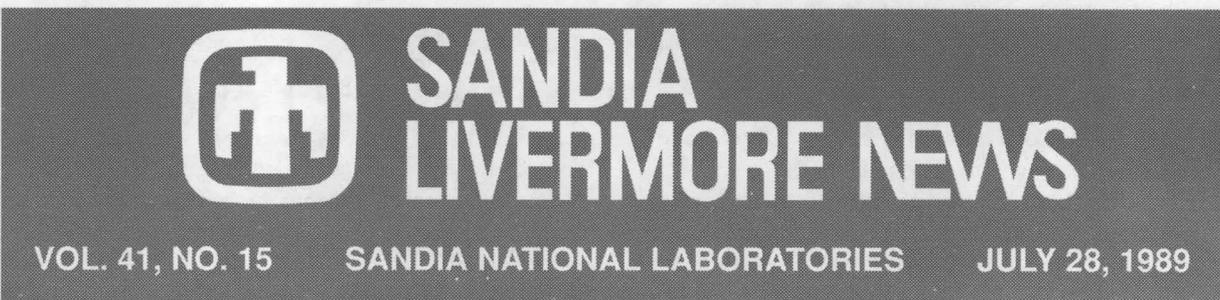
Supervisory Appointment

JILL HRUBY to supervisor of Inorganic and Physical Chemistry Div. 8313, effective July 16.

In 1983, Jill joined the Applied Mechanics Department, where she worked on thermal analysis in support of weapon and solar-energy programs. Later, she became lead engineer for the solid particle receiver program in the Solar Central Receiver Department. In 1986, she transferred to the Engineering Technology Department, where she was involved with the x-ray laser program and advanced gas transfer technologies.

She has a BS in mechanical engineering from Purdue University and an MS in the same field from UC Berkeley.

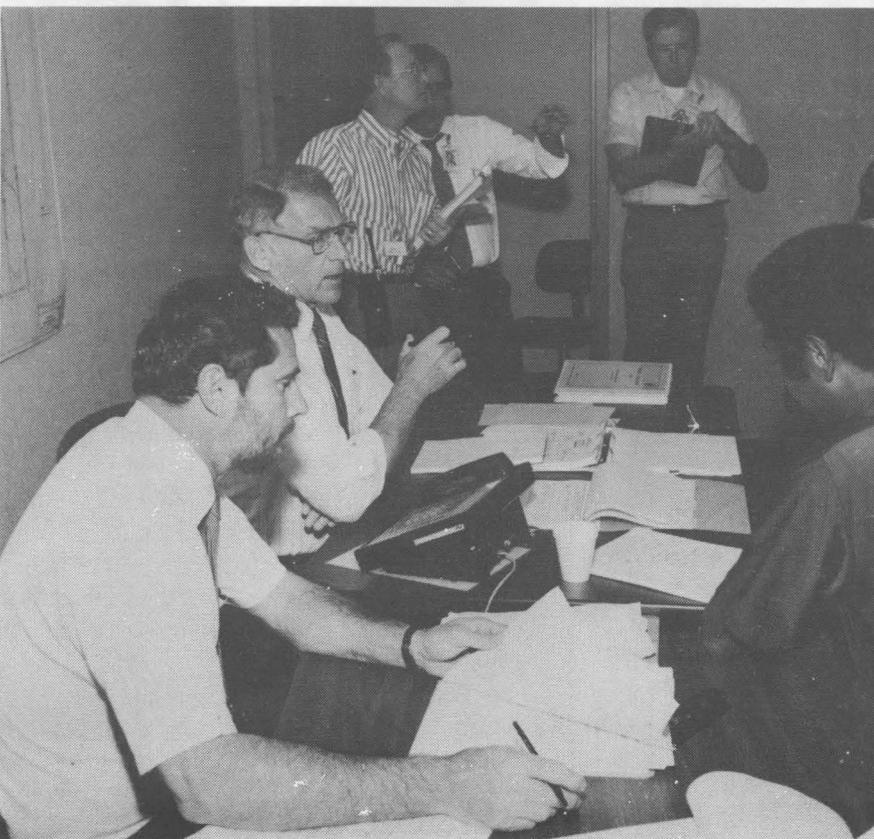
Jill's spare-time activities include backpacking, skiing, and gardening. She and her husband Don Sweeney (8435) live in Alamo with three daughters.



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FIRST USE of the Emergency Operations Center (EOC) at Livermore occurred last month during an emergency preparedness drill. The scenario involved three building emergency teams and these Sandians in the EOC: (from left) Paul Brewer (8500), VP John Crawford (8000), drill director Donn Wright (8514), Peter Mattern (8300), Jeff Manchester (8526), and Bill Ormond (8514). A full-scale, on-site emergency preparedness exercise is scheduled next month.

(Continued from Page One)

Solder Leveler

to blow the solder out of holes in the boards. That method was hot liquid leveling.

"You would take your board and dip it into a solder pot several times, and then superheated molten salt would spray the board just like a garden hose washing off a picket fence," T.A. explains.

But this method had at least two drawbacks, the most significant of which was a solder residue too thin to meet military specifications. "It also was a fire hazard," T.A. says. "It would smoke and the vapors would burn."

T.A. began thinking about using gas rather than liquid to spray and level the solder. About that same time, Bob Sylvester, a process engineer, transferred into the department, and the two men began working on developing the hot gas leveling process.

"When we first experimented with removing the solder with a hot gas jet, we used nitrogen because we thought there might be oxidation. It worked; we didn't get any oxidation. But after going through the shuffle with nitrogen bottles, we said, 'What the heck, let's try compressed air,'" Bob recalls.

"So we put on a filter to remove impurities, used air, and still there was no evidence of oxidation. Then, all we had to do was develop a machine."

T.A. says it took about a year to design and build the first prototype. He designed the air heater, and Bob designed the machine's controls and the air knives — the slots through which the air was directed onto the solder.

'Both of Us Are Innovators'

"We didn't stumble into this," T.A. says. "Both of us are innovators. We wanted to supply boards while not completely tying up the shop."

With that immediate problem solved, the two inventors realized their brainchild could make a significant contribution to technology outside the Labs. But first they had to convince some Sandians of its value.

Bob recalls that T.A. simply decreed that all circuit boards coming from his shop would be solder-coated and hot-air-leveled.

"That was a bit unusual — for a shop to tell a bunch of engineers how it would be done. But, thank goodness, we had T.A. He's an excellent salesman. It didn't take him long to convince our engineers that this is an excellent method," Bob says.

Getting the good news to private industry also required overcoming some resistance, T.A. says.

He sent the design to Sandia's patent office. "They turned it down at first. They didn't think it was patentable. So I said, 'OK, we'll just go public with it. This is just too good to pass up.' That's when I sent a copy of the papers to Corry McDonald."

In the early '70s, Corry McDonald (ret.) coordinated the Technology Utilization Program, which sought to make information available to private industry on unclassified technology developed at the Labs. T.A. credits Corry, a mechanical engineer and inventor in his own right, with getting the patent office — which was guided by the Atomic Energy Commission's very conservative policies — to take a second look at the hot air solder leveler.

"Corry looked at it and went back to the patent office and said, 'Do you really want to turn this down?'" T.A. says.

Corry also secured the hot air leveler's recognition by *Industrial Research* magazine as one of the 100 most significant new technical developments in

1976, a year after the patent was issued.

"I believe that was the first I-R 100 award for Sandia," Bob says.

T.A. says a Sandia news release announcing the invention resulted in a flood of inquiries from private industry. The release was issued in February 1973. By June 1974, the Labs had fielded inquiries from more than 130 domestic companies and approximately 20 foreign ones seeking information about the hot air leveler. Several of those companies eventually developed

"... after going through the shuffle with nitrogen bottles, we said, 'What the heck, let's try compressed air.'"

their own hot air solder levelers under no-fee licenses from DOE (see "Worldwide Impact").

Gerald Cessac, supervisor of Printed Circuit Div. 7413, says Sandia still levels all boards that come from the 7413 shop. "I would estimate that we do about 1000 panels a year," he says. "That's not very many, because everything we do is a prototype."

The Sandia shop is in the process of acquiring its third-generation hot air leveler. The prototype machine did 9-by-12-inch panels. The current machine, made by Electrovert, has the capability to level boards as large as 20 inches square. The one that will replace it can do boards 24 inches square.

T.A. remembers with no trace of sentimentality when his and Bob's machine was replaced with the Electrovert model.

"We retired the first machine about three or four years ago. My boss at the time wanted to enshrine it in the lobby, but I just snuck it out to salvage," he says.

That act may have served to perpetuate the machine more than enshrinement would have, because today, somewhere in Ohio, it's still leveling boards. T.A. says he learned of its continued operation through a salesman. The salesman was calling on a small circuit shop and asked the shop owner where he got his hot air leveler. "Oh, I bought it out of salvage at Sandia," was the reply.

It was a shrewd economic move for the shop owner. Odilon Cardenas, owner of a California company — Solder Station One — that does hot air solder

leveling for printed-circuit board makers, says a new leveler today can cost between \$35,000 and \$300,000.

Trading 40 Hours for 65

Nowadays, T.A. and Bob are spending time tinkering with machines not as arcane as solder levelers. After he retired in '82, Bob moved to Granite Shoals, Tex., a town of about 2200 people on the shore of Lake LBJ near Austin. As the town's airport manager and city engineer, Bob says he traded a 40-hour week at Sandia for a 65-hour week.

While Bob spends his time with airplanes and sewer systems, T.A. spends his with ham radios, cameras, and a recreational vehicle. He says he's been approached by some companies involved in the hot air leveling process to work with them as a consultant. "But I tell them if I had wanted to keep working, I would have stayed at Sandia," he says.

T.A.'s would-be recruiters probably first became acquainted with him when his name was mentioned in technical papers about the leveler. Papers were written by several engineers associated with companies who manufactured the machines and by T.A. and Bob, who each made a presentation to a professional group. T.A. addressed a California Circuits Association annual meeting, and Bob made a similar presentation to the American Society of Manufacturing Engineers in Detroit.

As part of the technology transfer process, the two inventors also received industry visitors seeking information about hot air leveling, and they sometimes visited companies making the machines. They still remember the warm welcomes they received at those factories.

"Around Sandia, we were just a couple of the guys, but when we went to those companies, we were treated like VIPs," T.A. recalls.

This communication between the inventors and commercial manufacturers was part of the process that produced a new generation of machines with capabilities vastly greater than the original prototype.

"Everybody has improved it a little," says Solder Station One's Cardenas.

Bob Sylvester agrees: "Once commercial manufacturers get an idea, some of their debugging makes a better machine than we could make in the lab."

•AEtheridge(3161)

How It Works

Hot Air Leveler: Flux Is Key to Success

A solder coating on a circuit board serves two purposes: It protects the tiny copper circuit paths, and it provides a metallic base to which miniature electrical components such as transistors can be attached.

Leveling processes were developed by the printed circuit board industry to obtain even coatings. After a board is coated, the solder is leveled with blasts of hot air to ensure an even coating and to remove solder from holes that act as electrical connections between both sides of the board. Excess solder can cause bridging, or unwanted connections, between the tiny pads on which components are placed.

Before the hot air solder leveler, there was a hot liquid leveling machine. The board would be inserted into a machine and sprayed with a hot solution of polyglycol. At least 12 sprayings were necessary to produce a uniform coating and clear the holes. In addition to being time-consuming and damaging the board with repeated thermal shocks, this method simply was not as effective as the hot air method. It didn't always completely remove the solder from the holes, and it didn't leave a solder coat thick enough (at least 0.0003 in.) to meet military specifications for printed circuit boards.

With the hot air solder leveler, a freshly dipped board passes one time between a pair of slots, or air knives, positioned above the solder pot. The slots are slightly offset so air from one

slot does not blow directly into the air path of the other. An arrangement of heating elements connected to narrow spiral tubing produces superheated air adjustable from about 375° F to more than 600° F.

Flux Moves Ahead of Air

Oxidation of the solder is prevented by a fine wave of flux that moves across the solder in advance of the air as the board is withdrawn from the pot. The flux is a solution in which boards are dipped before the solder bath to enhance their fusibility with the solder. It does this by dissolving oxide films that may be on the board.

T.A. Allen says he and co-inventor Bob Sylvester didn't realize when they began experimenting with the hot air leveling process that the flux was the key to anti-oxidation. Neither did researchers outside of Sandia who had been experimenting with the process.

"The other guys would take the flux off, not leave it on," T.A. explains. "They would blow it with air, and the air would oxidize all that nice solder."

"We didn't know how it worked in the beginning or why it worked so well, but after a while we realized it was the flux that was doing the work. It created an ideal environment for hot air leveling. It dissolved and washed off all the contaminants. You can't oxidize solder under flux."

SANDIA

SANDIA

**SANDIA
TECHNOLOGY
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Hot Air Solder Leveler**Worldwide Impact on Printed Circuit Board Industry**

"Rarely has a new process made such an impact on the printed-circuit industry and generated such worldwide interest," Paul Bud wrote seven years after Sandia announced the invention of the hot air solder leveler by T.A. Allen and Bob Sylvester (both ret.).

Bud, now deceased, was one of the persons showing interest in the new machine because his employer, Electrovert Inc., was one of the first manufacturers of a commercial hot air solder leveler.

Today, Odilon Cardenas says, there are 11 companies making the machines. Cardenas also was among the first to recognize the value of the machine. He used it to start a company that now employs 140 people. Based in Santa Ana, Calif., the company —

"He looked at the boards and said, 'You just saved me \$4200.'"

Solder Station One — is a leader in leveling printed circuit boards. Cardenas says his company's annual revenues are between \$10 million and \$12 million, and his customers include most of the big names in the electronics industry.

Cardenas recalls when he learned of Sandia's development of the hot air leveler.

'Air Leveling Was the Answer'

"We were trying to find something like that," he says. "I saw a sample board, and I knew air leveling was the answer . . . so I decided to open a service."

Cardenas came to that decision after talking with Gyrex Corporation officials, who were impressed enough with the new process to become an early competitor of Electrovert and Hollis Automation in making and selling hot air levelers.

"Hot air leveling is a major part of our business," says Gyrex president Gary Clancy. "It has been a real benefit to the electronics industry, and certainly to Gyrex."

Clancy estimates that about 70 percent of Gyrex's business involves solder coating and hot air leveling. "Not all the technology is directly related to Sandia, but hot air leveling certainly has been significant," he says. The Gyrex president estimates the company sells an average of one hot air solder leveling machine a month and has leveled "millions of boards."

Gyrex was founded about 18 years ago in Santa Barbara, Calif. In those early days before the development of the hot air leveler, Clancy says the company had about \$2 million in annual revenues from other equipment serving the circuit board industry. Today, he puts those revenues in the \$10 million range. Forty percent of the company's business is export.

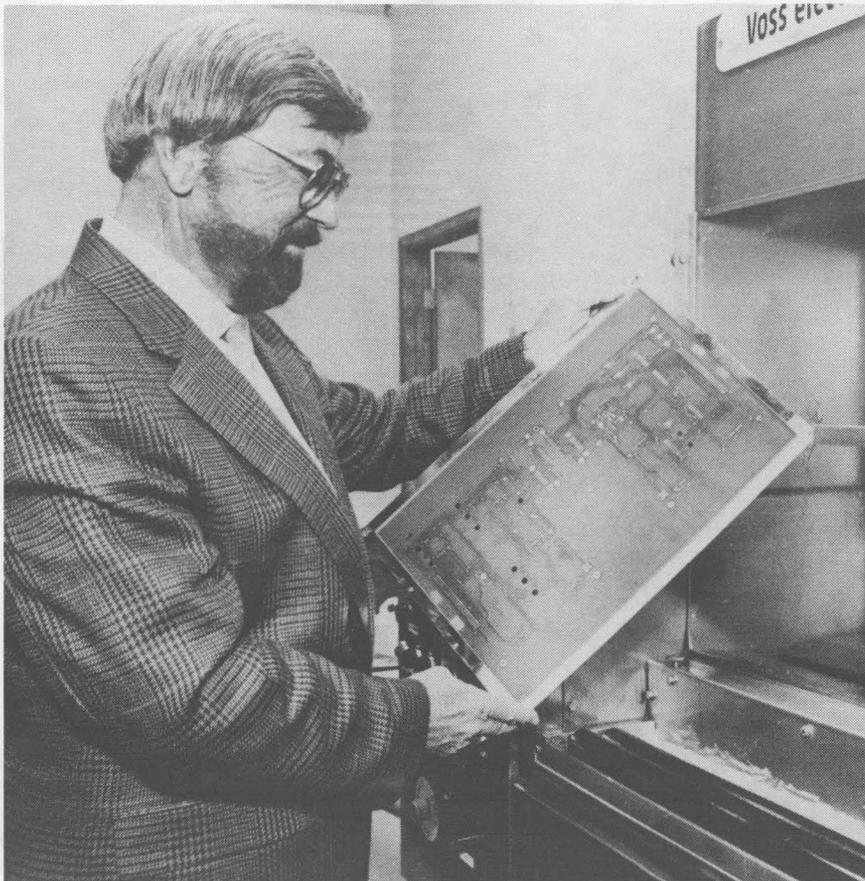
Indeed, foreign companies were early boosters of the new technology. In his 1980 article written for an industry quarterly, Paul Bud pointed out that hot air leveling was accepted more readily in other countries than in the US. An example was Bud's own employer, based in Canada.

T.A. Allen says American printed-circuit board users were slower to embrace hot air leveling because they had invested heavily in earlier technologies, while Europeans were just beginning to enter the industry. When hot air leveling proved to be a superior technology, US companies adopted it to remain competitive.

Majority of Sales in Europe

Bill Down and Donald Elliott designed the first Electrovert hot air solder leveler. Both are still with Electrovert. Down is technical director with the company's American subsidiary, Electrovert USA, in Arlington, Tex. Elliott is director of advanced technology at Electrovert's Montreal headquarters.

Down says most of Electrovert's initial sales were



T.A. ALLEN (ret.), co-inventor of the hot air solder leveler, looks over a Voss model at Albuquerque's General Technology Corp.

in Europe. A major step in getting acceptance of the process in the US, he says, was a study of surface coatings and solderability problems — by the Institute for Interconnecting and Packaging Electronic Circuits.

"It concluded that hot air leveling was at least as good as, and in some cases better than, fused tin-lead electroplate."

For one thing, hot air leveling results in more consistent coatings than those found on plated boards. In the February 1985 issue of *Electronic Packaging & Production*, Robert Keeler wrote: "The use of solder coating and leveling to 'repair' a tin/lead plated board is fairly common in the industry. . . . When such repair is called for, it is usually due to a plated layer that is too heavy in lead or tin — either situation indicating that the layer will not fuse properly."

T.A. remembers when he demonstrated this repair function to a Sandia visitor who had brought some defective boards with him. "I ran the boards through our machine. They came out perfectly. He looked at the

American printed-circuit board users were slower to embrace hot air leveling because they had invested heavily in earlier technologies.

boards and said, 'You just saved me \$4200.'"

Consultants report that defective circuit boards cost the industry millions of dollars a year. Writing also in *Electronic Packaging & Production* in February 1983, Donald Elliott pointed out that the costs of these bad boards escalate as they go undetected through the assembly process. "A \$20 board can escalate to as much as \$5000 by the time a failure is discovered — a failure that could have been detected in fabrication," Elliott wrote.

Bob Sylvester says bad boards that have been hot-air-leveled are easy to detect. "If there's a little bit of contamination, the solder won't stick, and you'll see it right away. That board never gets delivered."

Jim Raby, a solder consultant, says the savings that hot air leveling has afforded industry are astonishing: "If you figure half of the solderability problems are with circuit boards, then hot air leveling saves the industry at least \$250 million a year." Raby heads Soldering Technology International in San Dimas, Calif.

No one seems to be keeping statistics on how much revenue is generated annually because of hot air leveling, but Raby and other industry sources say a

\$150 million figure would not be unreasonable, considering that about a dozen companies manufacture levelers, and that at least that many offer leveling services to printed circuit board makers.

Companies benefiting from hot air technology range from young, single-location operations to electronic giants.

General Technology Corporation of Albuquerque is among the former. It acquired a hot air leveling machine from Voss Electronic Inc. in May 1988. GTC vice-president David Salazar says the company fabricates mostly prototype boards for a number of well-known electronics companies.

Salazar sees the use of hot air leveling growing as manufacturers continue to move toward surface-mounted devices, which tend to have very fine geometries susceptible to bridging. Currently, GTC uses hot air leveling for about 15 or 20 percent of its production.

On the other end of the scale, Bob Bell, application engineer at AT&T's Richmond, Va., printed wiring products facility, says about 70 to 75 percent of that plant's production undergoes hot air leveling.

"We use the HASL method extensively. While it's no panacea — the coating is too thin for some applications — it's widely used," Bell says.

Opportunities in Chemical Industry

The technology also spawned opportunities in the chemical industry. London Chemical Company (Lonco) of Bensenville, Ill., has developed 17 different flux solutions to serve the hot air leveling process, says Lonco sales and marketing coordinator Jim Norris. He estimates that his company has about 10 competitors in the flux business.

"It definitely has been good business and will continue to be," he says.

Norris won't hazard a guess on just how big the industry has become, but he says, "If you're looking at equipment and chemicals, you're talking about a huge amount of money. We're still chasing the rainbow."

One of Norris's aspirations is to share in whatever pot of gold is at the end of that rainbow. Even though he's in the chemical end of the business now, Norris made one of the early inquiries to Sandia about the workings of T.A. and Bob's machine. He was in the equipment end of the business then and had a plan to manufacture and market a hot air leveling machine.

He says he's perfected his idea over the years and still has hopes of finding backers and manufacturing the machine. "I've built a little prototype, and now I'm ready to do something with it," he says. ●



BOB SYLVESTER

In This World and Out of It!

Sandia's Novel Glasses Used Many Ways

Special glasses developed at Sandia are going places — on this and other planets.

On planet Earth, they're helping maintain a secure US energy future, saving lives, expanding man's knowledge of the universe, and aiding US industrial competitiveness.

By the end of this year, for example, some sophisticated downhole logging equipment that helps locate hard-to-tap oil and gas will feature Sandia's patented S-glass.

A major US electronics company has a proprietary use for tiny bits of S-glass in a high-resolution computer monitor that it's developing. The reason: to improve reliability and display quality.

How about those other planets? Well, actually, there's only one. By the end of 1989, Sandia's TA-23 glass is scheduled to be on its way to Jupiter in batteries that power a probe investigating the Jovian atmosphere. Another new TA-23-glass-equipped battery application: "thinking" heart pacemakers. The

By the end of 1989, Sandia's TA-23 glass is scheduled to be on its way to Jupiter.

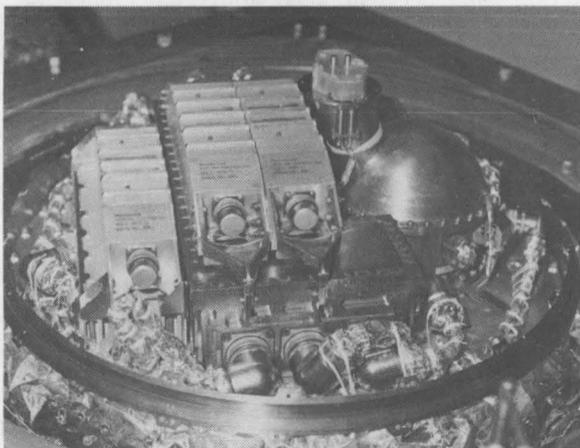
glass also is in long-life batteries that power life-saving implantable cardiac defibrillators.

Though their chemistries and physical characteristics are quite different, TA-23 glass and S-glass are used in similar ways. They achieve critical, long-lasting glass-to-metal seals where other glasses have failed.

S-Glass — All the Right Stuff

S-glass is actually a glass-ceramic made from a mixture of silica, boric oxide, alumina, phosphorus pentoxide, and alkali metal oxides. It has a very high coefficient of thermal expansion. Glass-ceramics — crystalline forms of glasses — are stronger, more durable, and less likely to crack than their conventional non-crystalline counterparts. They can also survive high temperatures and pressures, and can be tailored to have various electrical properties.

Premature failure — after only 12 to 18 months — of D-cell-sized lithium/sulfur dioxide batteries used in several weapon applications drove development of TA-23 glass. Research showed that failure



LITHIUM SULFUR DIOXIDE flight batteries, which use TA-23 glass headers, mounted on the main equipment shelf of Project Galileo probe spacecraft.



DICK BROW, (right, 1846) holds a CABAL-12 glass-equipped battery header like Honeywell has begun to use in some long-shelf-life batteries. Randy Watkins (7476) has a CABAL-12 sample made in Sandia's glass lab. The large CABAL-12 boule was made by Schott Electronics, a leading manufacturer of specialty glasses, including Sandia's TA-23 and S-glass.

was caused, in large measure, by lithium-induced corrosion of high-silica glass in the glass-to-metal seal. The corrosion ate away the glass insulator separating

The domestic well-logging industry could soon be buying about \$5 million worth of these special connectors a year.

the lithium anode from the cathode and weakened the glass's structure, causing a failure as a result of glass cracking or a short circuit.

A multi-organization team developed TA-23 and techniques to process it. The glass contains about 20 percent less silica and significantly more alumina than glasses typically used as electrical insulators.

Cooperation Breeds Success

Sandia's glass R&D and resulting technology transfer have occurred primarily because of the cooperative efforts of scientists, engineers, and technicians in Materials Process Engineering and Fabrication Directorate 7400 and Process Sciences Directorate 1800. Key contributions also have come from Components Directorate 2500, which uses glasses in weapon components and batteries.

"The dollar volume of products using Sandia-developed glasses is difficult to ascertain," says Jim King (7400). "We'll have to wait until the products have been on the market for a few years."

But when those figures do start coming in, Jim doesn't expect to be disappointed.

"We've been living and practicing technology transfer in our group for a good number of years. Of course, we're developing technology for use in

weapons, but — in parallel — we work to adapt these technologies to broader uses in the marketplace. Glass is a model of that approach.

"I've been amazed," Jim continues, "to learn about the extent that S-glass has become a technology transfer success. I didn't realize there were so many applications for the high-strength headers that this type of glass permits to be made."

Former Sandian Rod Quinn, now director of the Exploratory Research and Development Center at Los Alamos National Laboratory, recalls, with a bit of nostalgia, his glass tech transfer days at Sandia: "We — and by 'we,' I mean lots of people in 7400 and 1800 — spent many hours talking with people in industry. We'd show visitors around R&D labs, we'd take them to battery labs, and we'd have them spend a lot of time with processors in the glass labs."

Sandia Encourages Visits

Those important industry visits continue today. "In fact, we prefer that interested companies visit Sandia," Jim King explains. "It saves time and lets

"Our records identify 19 manufacturers exclusive of integrated contractors who are using the material."

company representatives observe, on a firsthand basis, our processes and equipment."

Since Sandia's S-glass received a US patent (No. 4,414,282) in the names of inventors Howard McColister (DMTS) and Scott Reed (both 7476) in 1983, it's been building an impressive tech transfer dossier.

"Our records," says Frank Gerstle (7476), "identify 19 manufacturers exclusive of integrated contractors."
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(Continued from Preceding Page)

tors who are using the material. Eleven have licensed the patent from DOE.

"All the products made by these companies," Frank continues, "use the unique capability of S-glass to form a hermetic seal between high-strength, corrosion-resistant metals."

Al Young, manager of special projects for Connector Systems, a division of BIW Cable Systems, Santa Rosa, Calif., is an S-glass enthusiast.

Pending resolution of a final technical issue — demonstrating predictable voltage from firing to firing in S-glass-equipped electrical connectors — he believes the domestic well-logging industry could soon be buying about \$5 million worth of these special connectors a year for its downhole well-logging equipment. This equipment must operate reliably at 30,000 psi and 600°F temperatures in 60,000-ft.-deep

A leading manufacturer of pacemaker batteries is sold on the low-corrosion qualities of Sandia-developed TA-23 glass.

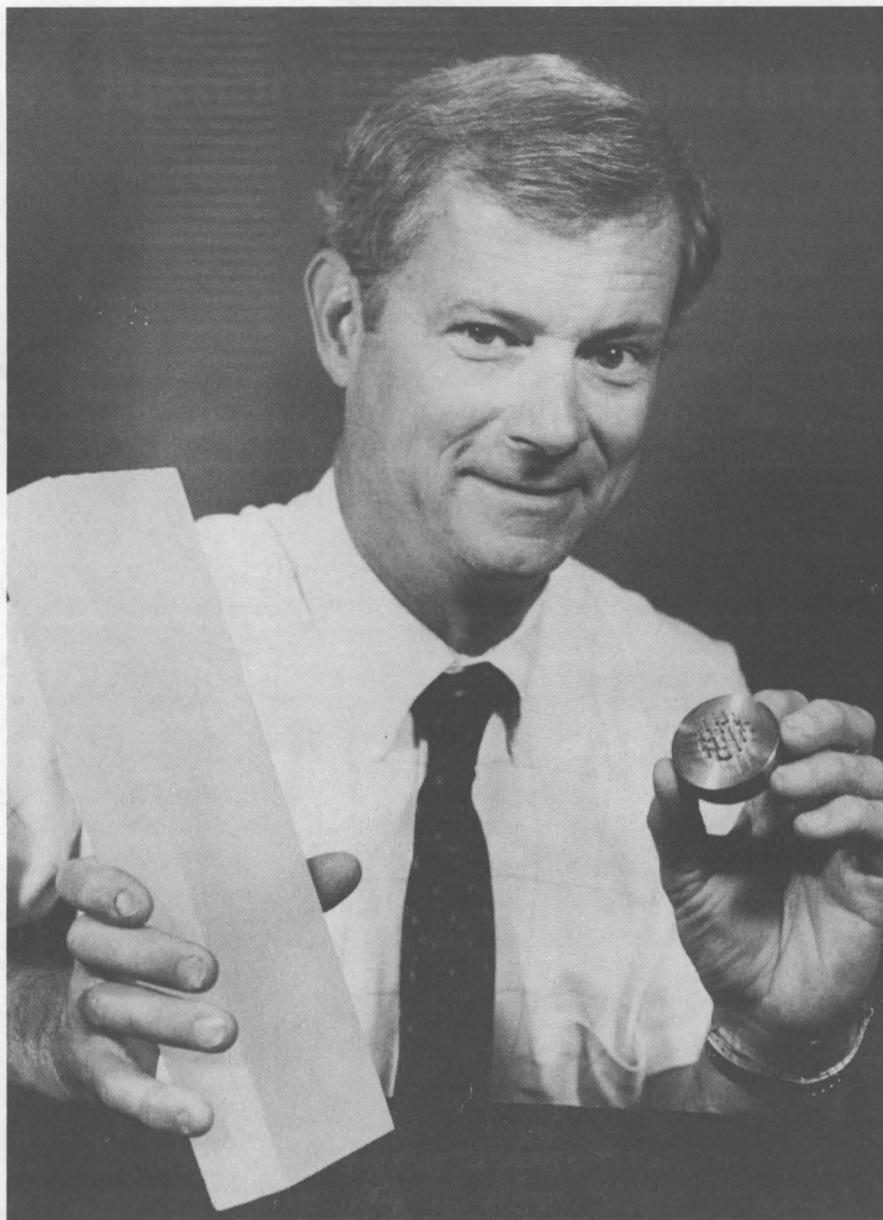
drill holes. That's an environment in which S-glass has performed reliably.

"The market is there — oil field services companies — and eagerly waiting," Al says.

Connector Systems has another interest in S-glass: It appears suitable for use in improved electrical connectors for flight recorder "black boxes."

The electronics company interested in S-glass for its proprietary product learned about the Sandia development in early 1988 from a consultant who works closely with Ron Loehman (1840). "We were working to solve a problem with a new generation of computer monitors," recalls a director for the company (which doesn't want to be named). "We had already investigated several candidate glasses. When we learned about S-glass, we latched onto it and threw away the others."

Esther Takeuchi, research and development manager for Wilson Greatbatch LTD, a leading manufac-



HOWARD McCOLLISTER (DMTS, 7476) with a large piece of bulk S-glass made by Schott Glass Technologies and part of an electrical connector, which relies on small dabs of S-glass to ensure reliable performance.

turer of pacemaker batteries, is sold on the low-corrosion qualities of Sandia-developed TA-23 glass.

"Within the past couple of years, our product line has been expanded to include lithium silver vanadium oxide batteries for implantable cardiac defibrillators," she says. The modern-day technological wonders have been implanted in several thousand people in the US who have survived near-death due to cardiac fibrillation.

"The main reason we used TA-23 glass headers in these batteries is to achieve a five- to ten-year operational life," Esther says.

Wilson Greatbatch LTD conducted performance tests on batteries that used different types of glass. "Cells without TA-23 sometimes suffered from sudden voltage drop caused by glass corrosion," Esther recalls. "Additionally, it was almost impossible to predict when the voltage drops would occur."

Unexpected power losses in implantable medical devices like cardiac defibrillators, which must be extremely reliable, can be disastrous.

"They [the devices] aren't implanted to improve quality of life, but to preserve life," Esther explains. "Recipients very likely wouldn't be alive today without their implants, and if something goes wrong — a sudden loss of power, for instance — they could be in real jeopardy. By using TA-23, we knew we'd get reliable battery performance."

"In fact," she adds, "without TA-23 glass, I question whether long-life reliable batteries for implantable defibrillators would be available today."

All told, Esther says, Wilson Greatbatch LTD probably will sell thousands of TA-23 glass-equipped batteries this year, with steady growth anticipated in the future.

Medtronic, a leading heart pacemaker manufacturer, also puts its trust in TA-23 glass.

"We use Sandia-developed technology a lot," says John Taylor, project engineer for Promeon, Medtronic's research arm. "TA-23 glass will go into batteries for some of our new pacemakers [expected to be on the market soon] that will be able to sense oxygen, carbon dioxide, and blood pressure as a means of determining the need for increased or decreased pacing."

So TA-23 glass is being used in human implants that save lives, and S-glass is a key ingredient in equipment that will operate more than 10 miles below the earth's surface. But what about Jupiter?

Sandia Glass Takes a Trip

When the oft-delayed Project Galileo spacecraft finally launches from the space shuttle this fall (the launch window is mid-October to mid-November) on a six-year trip to Jupiter, Sandia glass and battery experts will be keenly interested (along with Labs microelectronics experts who designed and built many of the radiation-hardened chips on board the spacecraft).

When Galileo's three-ft.-diameter, saucer-shaped probe drops deep into the giant planet's atmosphere, it will be powered by a pack of Honeywell's specially designed D-cell-sized batteries that rely on TA-23 glass headers for long shelf life.

Ed Stofel, a lead battery engineer for Hughes Aircraft Co.'s Space and Communications Group, explains: "When the technique for launching Galileo from the shuttle had to be changed, the flight's duration expanded from about 18 months to almost six years. That meant we had to change to long-life lithium sulfur dioxide batteries to power the probe

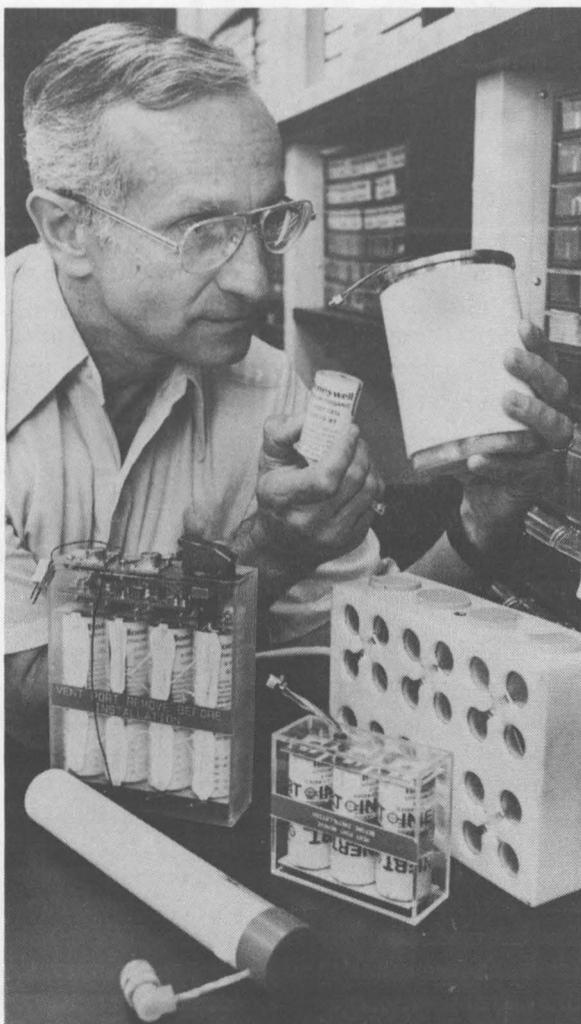
"When we learned about S-glass, we latched onto it and threw away the others."

when it separates from Galileo's orbiter.

"We looked to TA-23," Ed recalls. "We had Tekna-Seal [Brooklyn Park, Minn.] make some test battery headers with the glass. Then, on very short notice, I'd call Ed Beauchamp [DMTS, 1845], who'd always been able to accommodate us by quickly testing the glass."

"As it worked out," he continues, "there's a beautiful match between the capabilities of batteries with TA-23 glass and planetary probes. Because of the glass, we won't have to worry about corrosion or about batteries shorting."

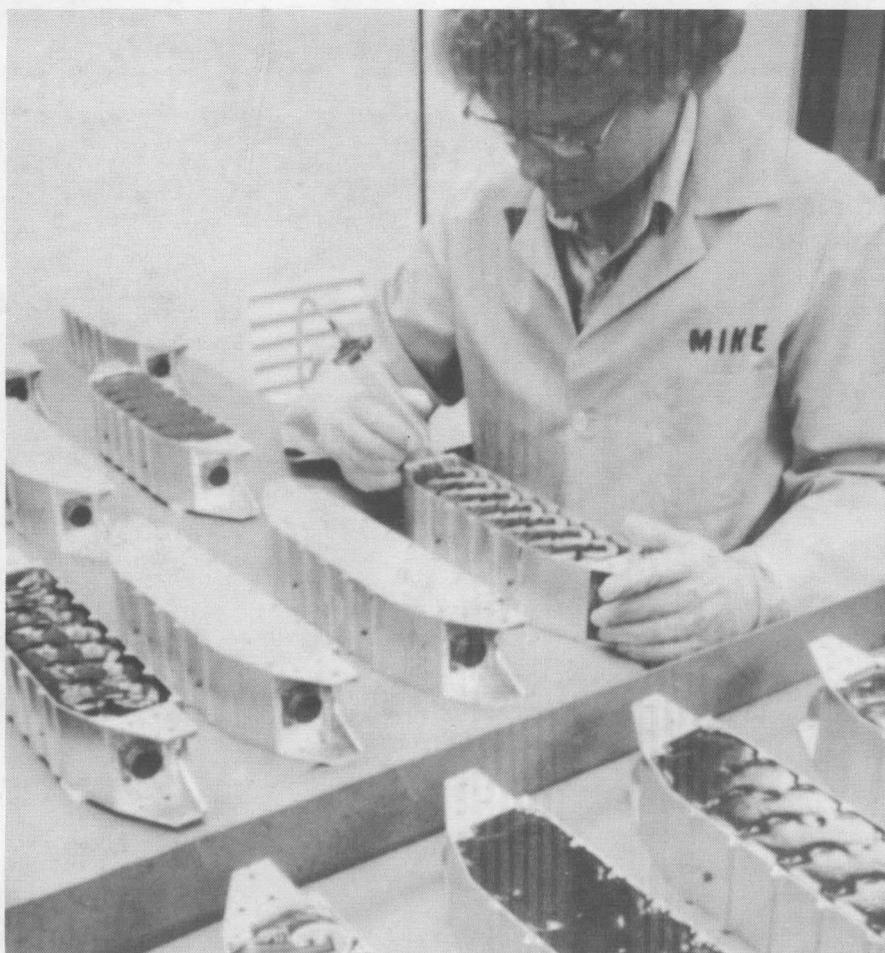
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IT'S EASY FOR Sam Levy (2853) to come up with a collection of power packs with the Labs' award-winning TA-23 glass in their cells. Here, the basic 3-volt lithium sulfur dioxide D-cell — in Sam's right hand — as it's used in different Sandia applications.

HONEYWELL TECHNICIAN Mike Gusenko builds some Galileo probe test power packs that hold 13 D-cell-size 3-volt lithium sulfur dioxide batteries. The batteries use Sandia's TA-23 glass in the headers to achieve an extremely long shelf life.

(Honeywell Photo)



(Continued from Page Seven)

Novel Glasses

Electro-Glass Products (Norvelt, Pa.) is one of the leading suppliers of TA-23 glass. It makes the glass as a pressed powder, called a pre-form.

"We learned about TA-23 about 10 years ago," recalls Jim Schmidt, Electro-Glass president. "Randy Watkins, Ron Stone [both 7476], Bob Eagan [1800], Carl Pennington [2543], and Carrie Nelson [former

Sandian] were all key contacts. We've had a terrific relationship with Sandia. It's also opened up a new market for us — about \$150,000 a year in sales of TA-23 powdered pre-forms."

Here Comes CABAL

What does the future hold? Watch out for CABAL-12 glass, says Jim King.

As good as TA-23 has proved to be, Sandia's lithium-corrosion-resistant CABAL (calcium-modified boro-aluminate) glass family may be better. Every TA-23 user or manufacturer contacted by LAB NEWS re-

cently also knows about Sandia's CABAL work, spearheaded by Randy Watkins and Dick Brow (1845).

CABAL glasses, which are silicon-free, have better corrosion resistance in lithium/electrolyte environments than TA-23, which won a prestigious R&D 100 (formerly IR 100) Award in 1984 as one of the top 100 new products of the year. CABAL glasses also require much lower melting and sealing temperatures than TA-23.

"Recently, the need was established at Sandia for a glass with even greater lithium corrosion resistance than that demonstrated by TA-23," says Randy. "Basically, we wanted to extend battery lifetimes to more than 25 years."

A collaborative effort was established between departments 1840 and 7470 to look at the problem. "Rather than modify TA-23," Randy explains, "we chose to investigate new glass systems by identifying potential glass compositions based on thermodynamic stabilities of oxide constituents in the glass with respect to reaction with lithium metal."

John Taylor (the project engineer for Promeon) is one of those looking forward to the day when heart pacemakers can use CABAL glass.

"Over the years, Sandia has done just about everything it could have to let industry know about the high-performance glasses we've developed," says Bob Stromberg of Technology Transfer Management Staff 6110. "We've handed over information. We've made visits. We've encouraged visits here."

"In addition, during the past 10 years, [Glass Formulation and Fabrication Sec.] 7476-3 has used a unique approach to tech transfer. It has sent some samples of Sandia-developed glass — four different types, I believe — to about 80 companies. This group, led by Ron Snidow, thought that approach would be one of the most efficient ways for the companies to see firsthand just what our glasses can do."

•RGeer(3163)



A Slick Refining Job by Sandia

Molybdenum Disulfide Film Used as Special Lubricant

Things may run more smoothly in space because of a technology that's been refined at Sandia and made available to aerospace manufacturers.

Larry Pope, supervisor of Inorganic Process Div. 7471, says the effort was a joint venture between 7471 and Surface and Interface Technology Div. 1834. The two divisions refined a process to deposit

It has the advantage over oil of not migrating and contaminating instrument parts.

molybdenum disulfide film as a lubricant in applications where oil is unsuitable. Such applications are common in the extreme temperatures and vacuum of space.

Recently appointed 7471 supervisor, Larry was in 1834 when the project began about three years ago. Also working on the project in 1834 was Janda Panitz, Dick Curlee, supervisor of the Physical Electronics Section, directed the work for 7471.

Because molybdenum disulfide is a solid, it has the advantage over oil of not migrating and contaminating other instrument parts, Larry explains. Lubrication is accomplished by an atomic arrangement that creates a kind of molybdenum and sulfur sandwich.

Slippage Inside the Crystal

"These films work by slippage inside the crystal," he explains. "Envision a layer of molybdenum atoms with a layer of sulfur atoms above and below. The molybdenum atoms are the meat, and the sulfur atoms are the bread. A stack of sandwiches forms a crystal. The slippage occurs between two adjacent slices of bread, where there is weak bonding."

Sandia didn't originate the idea of using molybdenum disulfide as a lubricant, Larry says. It has been used for several years. Rather, Sandia's contribution has been to refine the process for Sandia applications.

Lubrication is accomplished by an atomic arrangement that creates a kind of molybdenum and sulfur sandwich.

"We did studies to define the deposition parameters for improved adhesion to steel substrates and completed storage tests to characterize the effects of humidity," says Larry. "Additional tests were completed to evaluate the effects of laser treatment and ion implantation of molybdenum disulfide films."

"As a part of that study, we developed a sputtering system to apply the film. Basically, we took the existing technology and refined it. The sputtering sys-

tem has been transferred to Allied Signal (formerly Bendix-Kansas City), and the experimental results have been made available to the outside world."

In addition to Allied Signal Aerospace Company's Kansas City Division — the Sandia contractor that is continuing to work on refinements of the process — other manufacturers and service companies have been made aware of the technology. One of these is Hohman Plating, a Dayton, Ohio, company that does commercial application of solid film lubricants.

If development of the process were likened to a relay race, Allied Signal would be the third runner, taking the baton from Sandia. Larry says Allied Signal has not begun commercial application of the process yet but is moving toward that goal.

Interest Across the Atlantic, Too

Other companies, including most of the major American aerospace manufacturers, have been informed of the technology through publications and personal briefings, Larry says. "There also is interest in Europe. The National Center of Tribology in the United Kingdom is looking carefully at laser treatment of the films," he says.

Tribology — the study of effects on interacting surfaces in motion — is Larry's specialty, and he's a member of two national panels involved with that particular field as it relates to space vehicles. One of the study groups is an advisory panel to the Strategic Defense Initiative Organization. The other group is concentrating on getting molybdenum disulfide films into space vehicles.

"Our goal is to take this technology and have it space-qualified in three or four years instead of the 10 or 12 that it typically takes," Larry says. •

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Overwhelmed With Inquiries . . .

Labs Team Fields About a Thousand Requests for Epoxide Coating Formula

Sandia is about 1600 miles from Jack Dean's business, but he has no problem recognizing the Labs' name when he hears it.

The head of a coatings company on the southeastern shore of Lake Erie, Dean says a technology developed at Sandia already has resulted in two contracts and spurred him to begin researching other related techniques.

The technology, developed by Ken Wischmann (DMTS) and Howard Arris, both of Organic Materials Div. 7472, is a tough epoxide protective coating that cures within a minute under ultraviolet light. John Sarkis, Project Design Div. 2852, designed and built the ultraviolet curing apparatus.

Made from "off-the-shelf" ingredients, the Sandia epoxide protective coating has properties similar to others available commercially, but those coatings are proprietary. The Sandia formula is non-proprietary.

'This Was Unbelievable . . .'

After the technology was announced in a Sandia news release in March 1986, Ken received about

The coating can be brushed, dipped, or sprayed on virtually any clean surface.

1000 inquiries, he recalls. "I was overwhelmed," he says. "In the past when I published something, if I received 15 or 20 inquiries, I felt flattered. This was unbelievable — all those people I talked with."

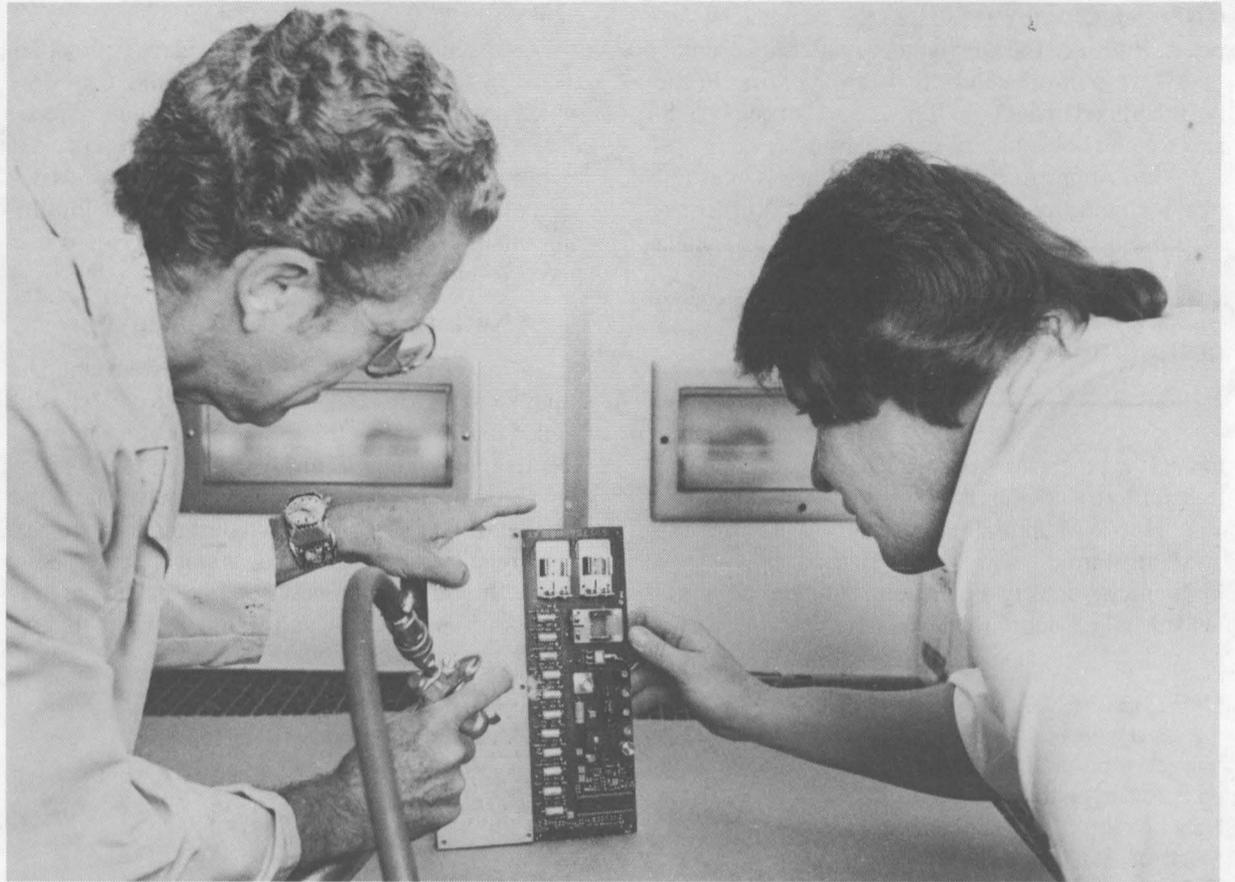
One of the people who contacted Sandia was Jack Dean, president of Erie Creative Coatings of North East, Pa.

"Howard Arris came to our plant and was very helpful in showing us the technology," Dean recalls. Using the technology transferred by Howard, Dean's company began coating a weapon component manufactured for Sandia by Bell Aerospace.

Dean's company recently completed one coating contract for Bell and has begun another one, which he expects to run for at least six more months.

"We've started to advertise that we have UV coating capabilities, and we hope to get additional customers for other applications," he says.

Dean says his company also has begun to re-



Ken Wischmann (DMTS, left) and Howard Arris (both 7472) spray a tough epoxide coating on an electronics assembly. The coating, developed by Ken and Howard, cures within a minute in a special ultraviolet apparatus designed and built by John Sarkis (2852). The non-proprietary coating formula is one of Sandia's all-time tech transfer "best-sellers."

search ultraviolet curing for other coating materials. He says success with the Sandia-developed technology is responsible for his interest in expanded coating capabilities.

"I'll probably give Howard a call and ask him what he knows about using UV light to cure other plastic and metal coatings," Dean says.

Dean says the ultraviolet curing method has advantages other than just expanding business. It's also an energy saver. Other coatings used for similar purposes are solvent-based and can take hours or days to fully cure.

Attractive for Space Hardware

The coating, which can be brushed, dipped, or sprayed on virtually any clean surface, also has other

advantages over solvent-based coatings, such as being more flexible and tougher and having better adhesive qualities. One property of the coating — negligible outgassing after it's fully cured — makes it particularly attractive for space hardware.

But Ken recalls that he received inquiries from companies whose lines of business ranged from the cosmos to cosmetics. As is the case frequently when Sandia shares its ideas with private industry, Ken and Howard got few reports back on what, if any, use the companies made of the technology.

"I'm quite sure some have played with the formulations, but we just don't know whether they are using them for commercial uses," Howard says.

One company that Howard knows is using the technology is Vanguard Electronics, based in Gardena, Calif. The company uses the coating on components manufactured to Sandia's specifications for Allied-Signal.

"All of the chip inductors manufactured by Vanguard for Allied-Signal have UV coatings," Howard says. "They don't have any other commercial applications, but I know they are interested in developing other applications." ●

How an Improved Air Bearing Came to Be

Helping Make Way for New Technology

Sometimes tech transfer takes the form of Sandia's recognizing that an existing technology is inadequate and providing opportunity for improvement. A case in point is a type of air bearing used to support centrifuge spindles designed for high-g, high-precision testing.

In the early '80s, such a centrifuge was needed as part of a test system for the force balanced integrating accelerometer (FBIA) used in the W88 warhead for the Trident II missile. Jim Kannolt (DMTS, 7265) was mechanical project engineer for the system.

"The contractor who was to fabricate the centrifuge had a standard air bearing," says Jim, "but I knew the design wasn't stable enough for our application.

"We had an outside consultant — Ronald Woolley, a Fellow of the University of Southampton in the United Kingdom — who came up with a method that would work. It's a matter of getting the orifices through which air comes into the bearing exactly right. I give Mr. Woolley 100 percent of the credit for doing that."

The whole test system was a large effort, says Jim — over a hundred companies were involved — and was a joint project of Sandia and Bendix-Kansas City (now Allied-Signal). Jim called on Sandia's shops (7400) to make the most critical hardware — which involved close tolerances, special finish requirements, dimensional verification, and unique electrical interconnections.

For a while, things were pretty tense because of the risk of combining several advanced technologies.

"The system had been given the worst rating on DOE's producibility index," says Jim. "The rating was essentially that it couldn't be built. That got the eye of Bob Peurifoy [VP 7000], and he said, 'Yes, it can be done, and Sandia's going to do it.' He followed the project closely — it was almost like having him as my project engineer — and in the end, sure enough, we did it."

Since the air bearing proved successful in the mid-'80s, centrifuges incorporating the same type have been introduced into both commercial and government installations. ●

Congratulations

To Deanne Constancia and John Schwartz (7263), married in Albuquerque, June 10.

To Linn and Mike (1534) Furnish, a daughter, Sarah Linn, June 12.

To Shirley McKenzie (3745) and Tony Lopez, Jr., (ret.), married in Albuquerque, June 24.

To Tracy Dunham (1821) and Steve Aire, a daughter, Sara Beth, July 6.

To Beverly (3152) and Alex (7813) Padilla, a daughter, Amber Brittany, July 10.



Tech Transfer in the Making**Sandia's Capacitor Winder Finding Uses Beyond Weapons**

When Marv Reichenbach (7484) improved an off-the-shelf capacitor winder in the mid-'70s, his modifications were overkill for most commercial purposes. But since then, laboratory models incorporating Marv's improvements — and costing in the neighborhood of \$100,000 each — have been bought and sold on both sides of the Atlantic.

More-sophisticated commercial needs, plus impending maturity of computer control to further au-

Winders available in the mid-'70s were comparatively crude.

tomate the process, are making the technology ripe for transfer to broader uses.

"Howie Mauldin [dec., former DMTS in 2000] got it all started," says Marv. "He had an idea for a high-energy-density, Fluorinert™-impregnated, extended-foil capacitor for weapons. The way it was to

be built, he needed a machine to wind it very accurately with precisely controlled tension. That's how I got started."

(Capacitors store energy as an electric field between two metallic conductors — unlike batteries, which produce electrical energy from chemical reactions. Capacitor winders roll the conductors, separated by plastic film, into a compact cylinder. Howie's design allows a large — fivefold — increase in the amount of electrical energy that can be stored in a given volume and weight.)

Nothing Left but the Nameplate

Winders available in the mid-'70s were comparatively crude, says Marv. "The one we had was designed for fabricating things like ballast transformers for fluorescent light fixtures."

Since the machine couldn't precisely control the tension of materials being wound into a capacitor, Marv modified it. That first one is still at Sandia. Says Marv, "If you're in our new winding area in the Process Development Lab, you'll find the first winding

machine that I modified. It still has the manufacturer's nameplate on it — Hilton Industries — but that's about the only part left of the original machine. We completely rebuilt it to get the precision windings we needed."

The major change was replacing a belt-brake tensioning system with a much more precise torque-motor system.

In the years since, Hilton Industries has supplied several winders with Sandia's design modifications to the General Electric Nuclear Devices facility in Largo, Fla. But the modifications have also reached users outside the weapon complex.

For instance, Maxwell Labs' Kurt Haskell says, "We bought a machine that uses several of Marv's ideas. A lot of its features are directly from Sandia drawings. Hilton made some more modifications, but the concept of our machine was based on the machine Marv built for Howie Mauldin. As a matter of fact, when Maxwell goes out to bid on contracts, we advertise that we have a capacitor winder based on the Sandia design and built by Hilton."

At least one Hilton machine, says Marv, was shipped to the United Kingdom.

Next, MacWinder?

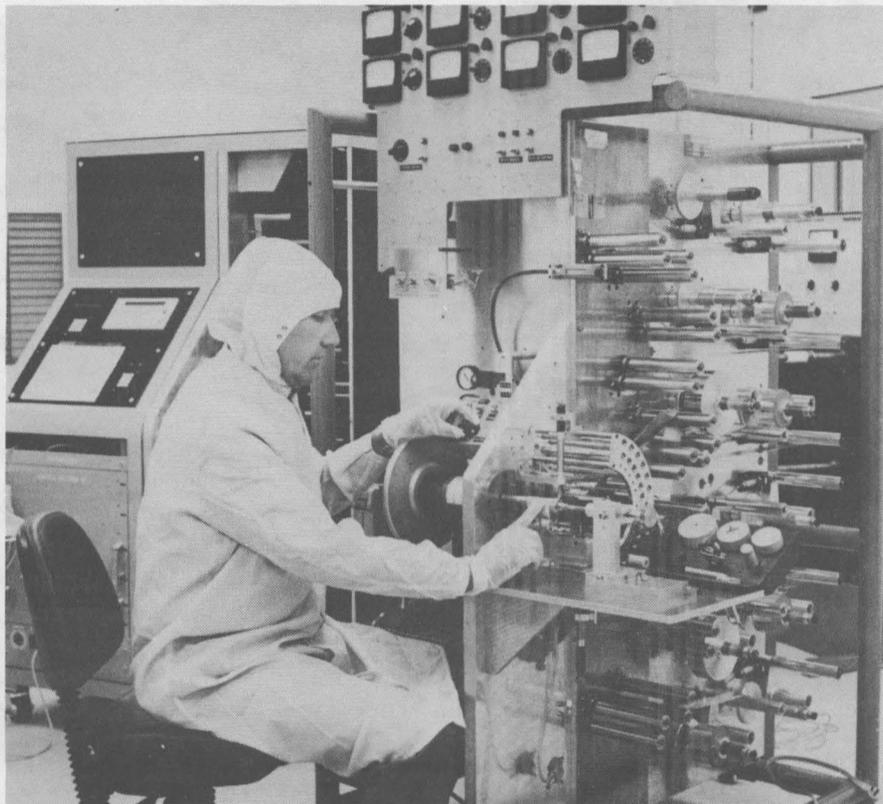
Sandia work on capacitor winders has gone considerably further since Marv's first one. Now Michael McDonald (7484) is working on a third-generation machine, controlled by a Macintosh computer, for Passive Components Div. II 2553.

Earlier versions were unsuitable for most commercial purposes, largely because they required the constant attention of an operator. But if computer-controlled winders prove feasible, they could help move precision-capacitor technology out of the lab and into broader applications.

"As high-energy-density capacitors become more producible," says Michael, "a lot of people outside the weapon community are going to find uses for them."

A 1984 *Design News* article on Howie Mauldin's capacitor listed some possible applications, including magnetic and inertial confinement fusion, strobe light sources, lasers, particle-beam technology, radar, communications, and medical electronics. Most of those uses have yet to be seen, but they appear to be brought closer by Sandia's combination of an improved capacitor design and an improved winder to make it. ●

MARV REICHENBACH (7484) makes a high-energy-density capacitor on the first winder he modified (in the mid-'70s). He's holding plastic film and metal foil on the take-up mandrel, where they are taped in place to allow winding from supply spindles. Meters above Marv's head show tension of each roll of material. Precise tension control allows winding to "controlled looseness" — a term coined by Howie Mauldin (dec.), inventor of high-energy-density capacitors. Loose winding allows later impregnation of the capacitor with an electrical insulating fluid to improve performance. In the background is the latest Sandia winder, for which Michael McDonald (7484) is developing a computer-control system.

**Medical Corner****Health\$mart Clarifications for Medical Care Plan**

by Jann Levin (3543)

Health\$mart has now been part of the Sandia Medical Care Plan for about four months. Overall, this program to help Sandians control rising costs is proceeding as expected.

You and your health-care provider still make all decisions about your care. The Health\$mart program is not determining your access to medical care. Once you have called HRM's ReviewPlus, you may proceed with whatever treatment you and your doctor feel is necessary. Provident continues to be the plan administrator and will continue to determine the applicable benefit. However, there is a penalty — \$300 in benefits if you fail to call HRM in those instances where Health\$mart requires.

HRM is also enhancing its phone system to eliminate recorded messages. An HRM representative on another call will know that a second call is coming in and will be able to respond. This new system should reduce the "telephone tag" that some Sandians and health-care providers have experienced.

Birth Centers

There are currently no licensed birthing centers in the Albuquerque area. Several local hospitals call

the room in which they allow an expectant mother to labor and deliver a "birthing center." This, however, is not a birthing center as referred to in Health\$mart. The Medical Care Plan pays 100 percent of usual and customary charges only for a birthing center that fits the following definition:

A delivery in a hospital or a licensed freestanding birthing center where services include prenatal, delivery and postpartum care in a homelike setting. The mother and the baby must be discharged on the same day as the delivery. *There would be no charge for hospital room and board.* If complications arise and the mother and/or baby are hospitalized, the benefits revert to the 90% inpatient benefits.

Diagnostic Surgeries

HRM does not review diagnostic surgeries (for instance, biopsies and scopes such as arthroendoscopy without any repair, breast biopsy, and laparoscopy). If the procedure develops into a full-blown surgery, the review is done afterwards.

Just as in any other emergency, the patient must call within 48 hours or two business days. If the surgery is on Sandia's incentive second-surgical-opinion list and HRM confirms medical necessity

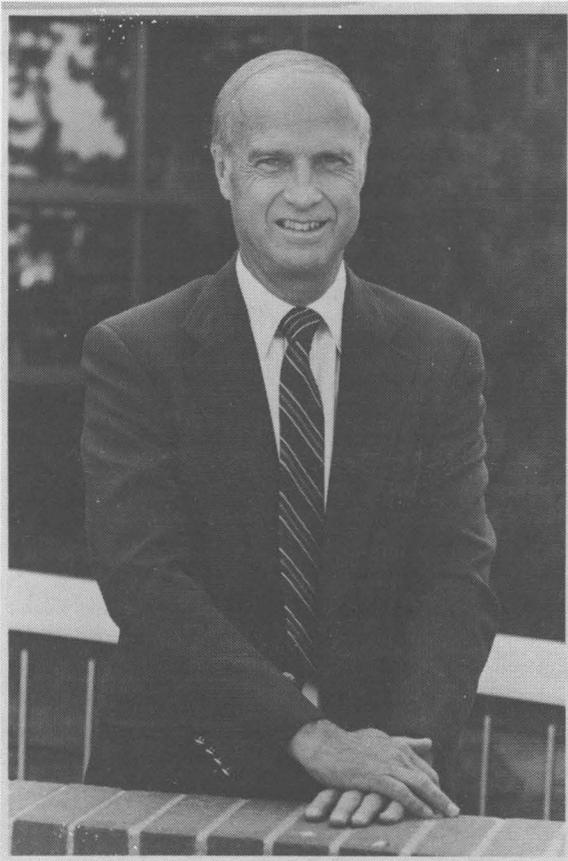
in the retrospective review, Provident will allow the higher 100% benefit to be paid.

Outpatient Psychological Counseling

After your third session with a psychological counselor, you must call HRM's ReviewPlus. They will open a file for your case and contact your provider. Your provider will discuss the diagnosis and treatment plan with the HRM reviewer, and HRM will recommend an initial number of sessions. HRM will contact your provider again before you complete all recommended sessions to review how your treatment plan is progressing. Additional sessions will be recommended by HRM if appropriate. Once you make your initial phone call, HRM and your provider will remain in touch.

The Sandia Medical Care Plan now covers 80% of usual and customary charges for outpatient psychiatric care. There is a \$30,000 annual benefit limit and \$120,000 lifetime benefit limit for inpatient or outpatient psychiatric and chemical dependency treatment. As before, the MCP covers only counseling that is medically necessary and rendered by a licensed provider. ●

Supervisory Appointments



JOHN KANE to manager of Survivability and Security Dept. 5220, effective June 1.

John's work has been in electronic circuit design since he joined the Labs in February 1960 as a member of the Product Acceptance Equipment Division. Two years later, he transferred to the Advanced Electromechanics Components Division. In March 1969, he was appointed supervisor of the Exploratory Systems Studies Division. Since then, he's supervised Advanced Systems, System Analysis, and Nuclear Security Systems divisions.

He has a BS from the University of Nebraska and an MS from UNM, both in electrical engineering.

In his spare time, John enjoys skiing, running, volleyball, and playing with his grandsons. He has four children and lives in NE Albuquerque.

SAMUEL MARTIN, JR. (DMTS), to supervisor of ESD Div. I 2541, effective May 16.

Sam joined the Labs in June 1961 as a member of

the Manufacturing Development Procedures Division. He transferred to the Static Test Division in 1962. He joined the Electromechanical Subsystems Department in 1963, where he was a design engineer and leader on projects for advanced development of fluidics, hydrazine rocket engines, an earth-penetrator fuze, solar collectors, production of the first large rolamites at Raymond Engineering, advanced development of silicon micromachines, metal rolamites for B61-6, 8, and B90, and the water entry detector for the B61 and B90 programs.

He has a BS from Texas Tech University and an MS in mechanical engineering from UNM. He worked for Pantex before joining the Labs. He recently received a Certificate of Achievement as one of 100 Outstanding Centennial Year Alumni from UNM.

In his spare time, Sam enjoys church activities, jogging, camping, fishing, and gardening. He and his wife Sue have two children and live in the NE Heights.



Sam Martin, 2541

Take Note

George Sloan's (2342) paper "A Fully Automated, Single-Connection Tester for T/R Modules" was voted best at the Automatic RF Techniques Group conference, held in conjunction with the IEEE-sponsored Microwave Theory and Technique conference in Long Beach, Calif., in June.

Stephen Brown (6232) has received the 1989 Rock Mechanics Award for Basic Research, for a paper titled "Fluid Flow Through Rock Joints: The Effect of Surface Roughness," published in 1987 in the Journal of Geophysical Research. The award is among those given annually by the US National Committee for Rock Mechanics of the National Research Council.

Business data-processing projects from Sandia are again being solicited for UNM's Anderson School of Management to use in a course on design applications for management information systems. Recent projects for Sandia have included a cost reporting system, an interlibrary loan system, and an accounting exception report system. Graduate students will carry out each accepted project, with a Sandia employee as consultant. Candidate projects must be completable within one semester. Linda Garcia (2626), on 4-8962, can provide further information.

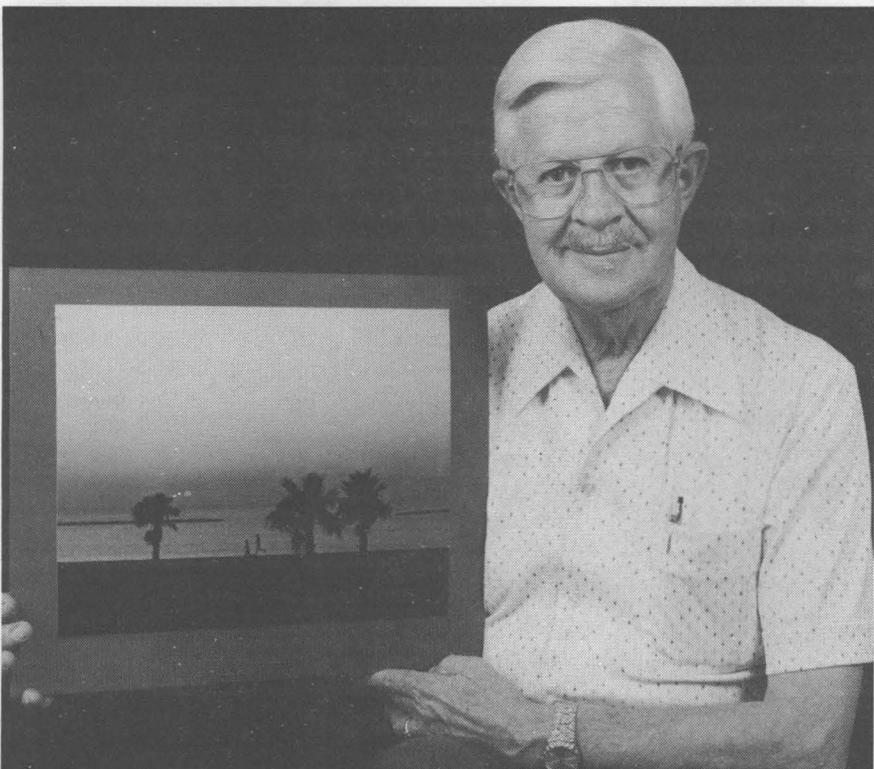
"The Day the Universe Changed," a series of 10 one-hour programs on the history of Western knowledge from ancient to modern times, begins on KNME-TV Monday, July 31, at 9 p.m. The first episode introduces the series thesis — that we are the product of our knowledge, and that our understanding of the world is constantly being modified by innovation and discovery.

Can It Track Bonnet Buzzers Too?



The world's tiniest bar-coded label — smaller than 0.09 inch square — is being developed by Intermecc Corp., Lynwood, Wash., and US Agriculture Dept. scientists in Tucson, Ariz. The researchers want to bar-code bees so they can use a laser scanner to identify which are entering and leaving the hive, reports the trade magazine *ID Systems*.

Jerry Bishop, *Wall Street Journal*



OSCAR GOODWIN, Still Photo Services Sec. 3154-3, with a Corpus Christi-area sunrise photo that he shot recently. Oscar, who has spent all of his 35-year Sandia career in various aspects of photography, has lots of scenic prints and other photos displayed in the Bldg. 802 lobby for the next few weeks. Some scenics were taken during a workshop that he took several years ago with Ansel Adams.



FBI DIRECTOR WILLIAM SESSIONS (left) was welcomed to Sandia by Executive VP Lee Bray (30) on July 21. The FBI director was briefed by several Sandians about Labs programs in security management, physical security development, sensors, and other special projects. He also reviewed FBI/Sandia interactions and learned more about the Labs' technical capabilities.

(Continued from Page One)

Pressure Safety Is A Top Priority

pressures of -15 psi to air guns with pressures above 100,000 psi."

"Any time you put pressure — negative or positive — on a liquid or a gas in an enclosed space, you have a potential hazard," says pressure safety consultant Ken Miles of Safety Engineering Div. I 3215. "That's why we have a Labs-wide network of pressure advisors [PAs] in the technical line organizations and other experts in specific areas — materials, applied mechanics, and welding, for example — who are available to assist in the design of safe pressure systems." Ken conducts one-day training sessions for line PAs and others interested in learning more about pressure safety concerns.

If you're contemplating adding lab apparatus that includes a pressure system, Jim Volkman suggests that you discuss it first with your line supervisor — who has the ultimate responsibility for such systems in his or her area — and with your line-organization PA.

Some 100 trained PAs are available. If you don't know who your PA is, give Jim — who keeps an updated roster — a call on the pressure safety hot line number: 4-3450.

More often than not, technical line organizations request drawings of a new lab setup from Design Definition Dept. 2850; if a pressure system is involved, department drafters flag the drawing for review by Jim and at least one other PA in 2850. If okayed, the drawing receives an approval decal and is forwarded to Paul McKey's Shop Overflow Liaison Sec. 7485-2,

where it's evaluated for "buildability" and a decision is made about whether the item should be built inside or outside of the Labs.

Unique Role

Dept. 2850 is involved with some 70 percent of items involving pressure systems at Sandia and conducts about 200 pressure system reviews a year. This pressure-safety review role in a drafting organization is unique among the national labs, according to Jim. "In most of the other labs, this review role, along with other safety responsibilities, is more centralized," he says.

The 30 percent of items not reviewed by 2850 generally involve instances when an organization goes directly to an outside contractor for a turnkey facility involving a pressure system. Line management

"Employees need to remember that there's always a hazard potential . . ."

must ensure that these systems meet the same requirements as other Labs pressure systems.

"During safety reviews, we look at the energy level of the pressure system," says Jim. "Energy level's determined by two factors: volume and pressure. For example, if the pressure is equal in two containers — one large and one small — the larger container, with greater volume, would have a higher energy level, because the energy is a product of pressure and volume."

All pressure systems at Sandia are subject to proof testing before the units are placed in service, Jim notes. Systems also require an adequate design safety factor (generally four times the maximum allowable working pressure) if they will operate in the vicinity of people. For systems with an energy level



THIS PRESSURE RELEASE was planned — it's a gas-gun shot — but it suggests the danger of an unplanned release if part of a pressure system failed.

above 1/10 pound of TNT, additional requirements include preparation of a Pressure Safety Analysis Report (a data package that includes design information and failure modes) and registry with Safety Engineering.

Jim is secretary of the Pressure Safety Advisory Committee (PSAC), a group established in the mid-'70s to administer the Labs' pressure safety program. PSAC determines pressure safety policy, maintains and updates a roster of line-organization PAs, publishes and updates the Pressure Safety Practices Manual (PSPM), and, in conjunction with the Safety Engineering organization, sets guidelines for pressure safety training.

The 12-member committee consists of pressure advisors from line organization SHEACs — Safety, Health, and Environment Appraisal Committees — and representatives from applied mechanics, materials, facilities, safety engineering, and hazards control organizations.

"PSAC's main concern is safety of employees," says committee chairman Jim King (7400), "and we take our responsibilities very seriously. Employees need to remember that there's always a hazard potential; catastrophic failures and gas leaks are major concerns.

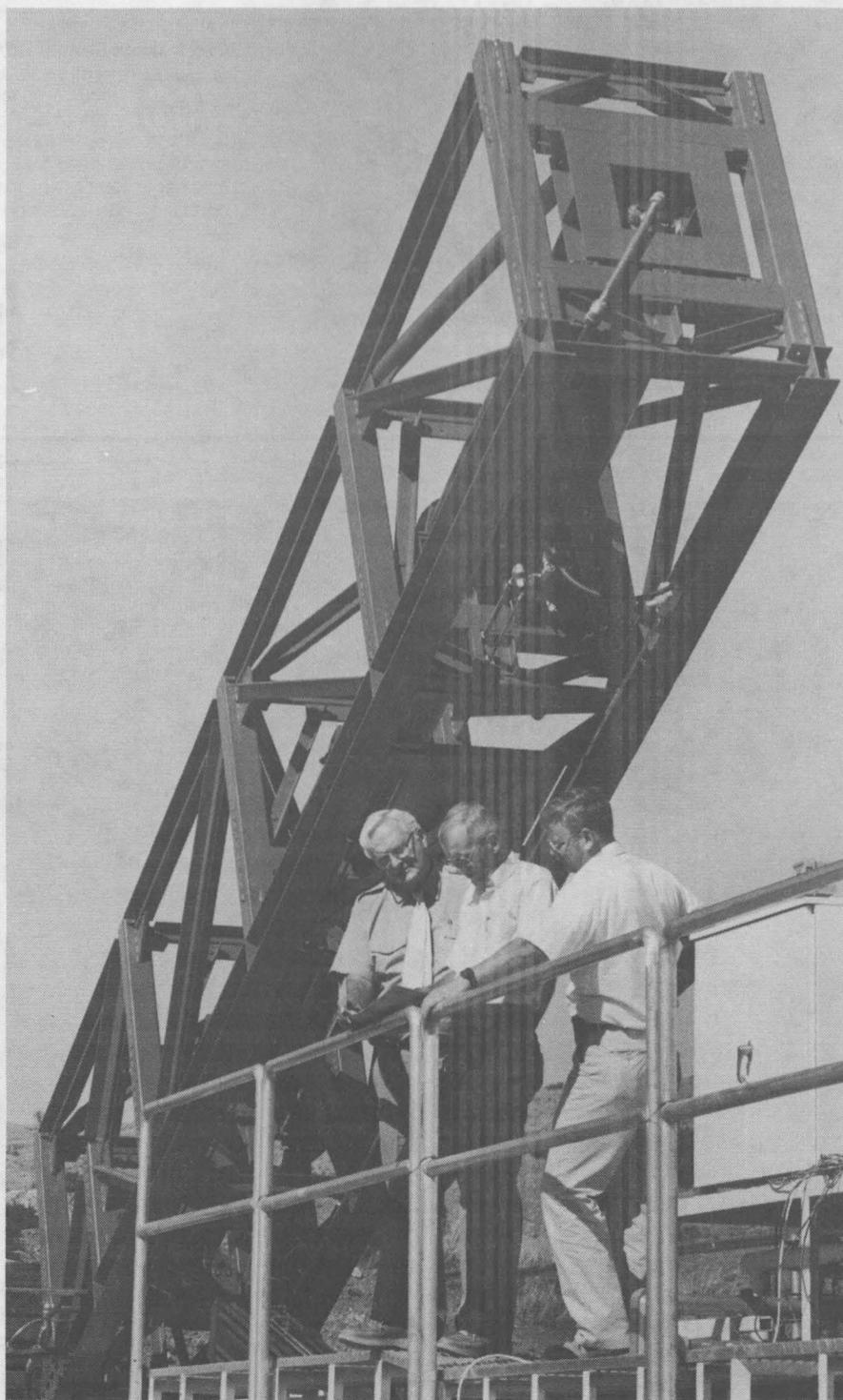
"To promote pressure safety awareness, we began publishing a PSAC monthly bulletin in May for members of the pressure community — line organization PAs, technical supervisors, VP SHEAC pressure advisors, and holders of the PSPM. These people need timely information on safety-code changes and reminders on policy. Both these publications help to get the word out."

The PA Bible

"The PSPM is — or should be — the bible for all pressure advisors and anyone else involved in the design or use of pressure systems," Ken Miles adds. The manual contains information on pressure safety requirements, where to get help on problems related to pressure safety, how to calculate energy levels, and regulations for equipment use. It's published in loose-leaf form, so that manual holders get immediate notification when safety requirements change.

Following up on its "safety-first" goal, PSAC last year led the initiative on negotiating a service contract for the regular testing of relief valves on all pressure systems in use at Sandia. According to Jim King, Rolie Baack (7265) was a key consultant during contract negotiations conducted by Sandia's Purchasing organization, and is the current contract administrator. Additional information about this service is available by calling the pressure safety hotline number: 4-3450.

•PW



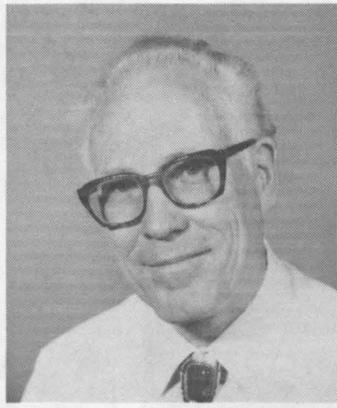
UNDER THE GUN — a six-inch-bore gas gun — are (from left) Jim King (7400), Jim Volkman (contractor) and Ken Miles (3215). Used to propel projectiles into geologic media at up to 2500 feet per second, the gun is a reminder of what high pressure can do — intentionally or not. Two storage tanks out of sight underneath can each hold 25 cubic feet of gas (air, helium, or a combination) at a pressure of more than 4000 psi, which called for strict attention to safety in design.



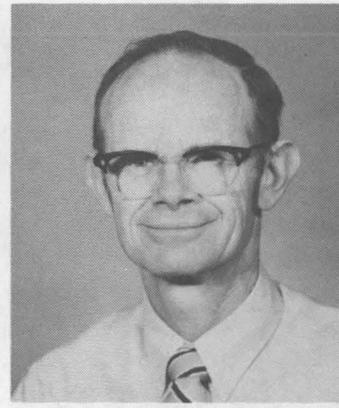
MILEPOSTS

LAB NEWS

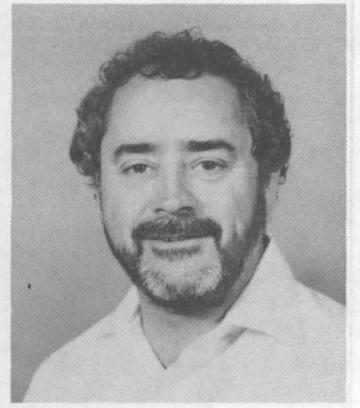
JULY 1989



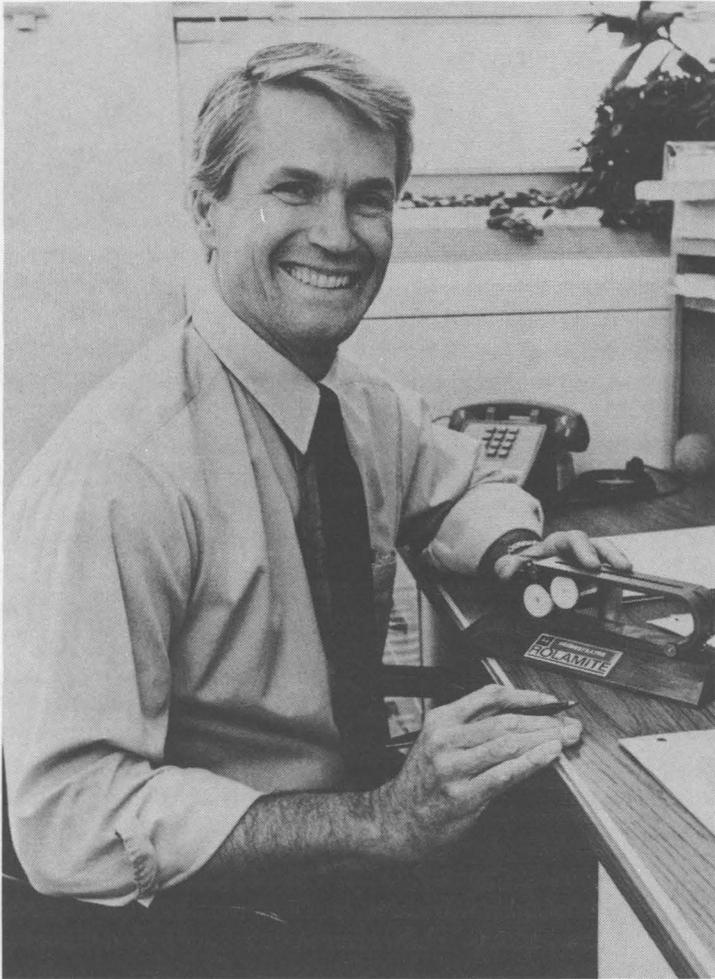
Don Roelle (9225) 30



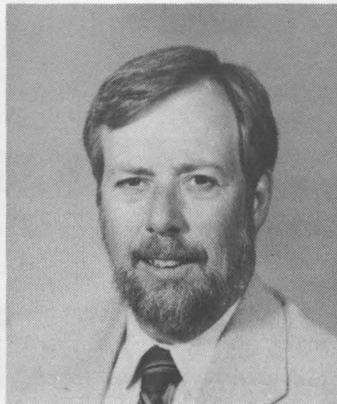
Bob Moyer (DMTS, 7242) 30



Rudy Armijo (2525) 25



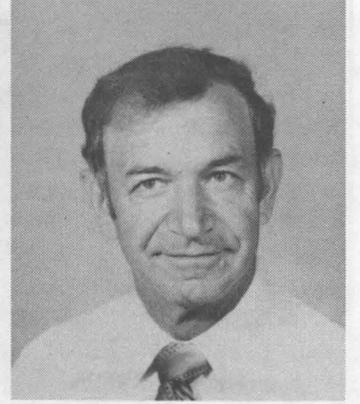
Joe Abbin (2542) 25



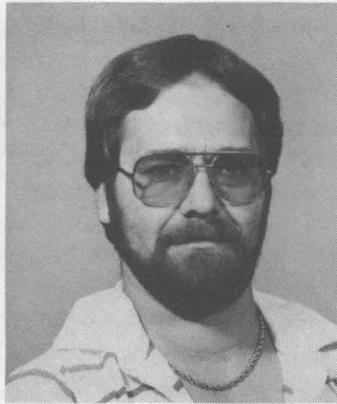
Jace Nunziato (1510) 20



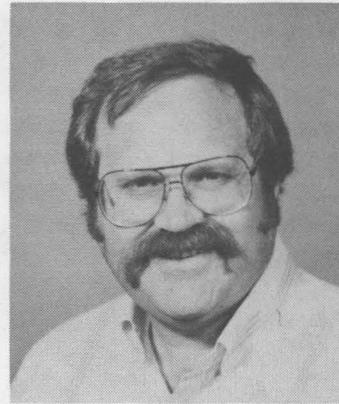
Glenda Maynes (2632) 15



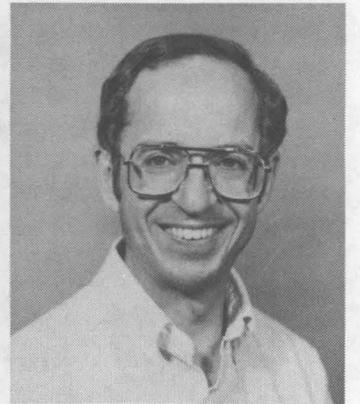
Fred Cericola (DMTS, 7542) 30



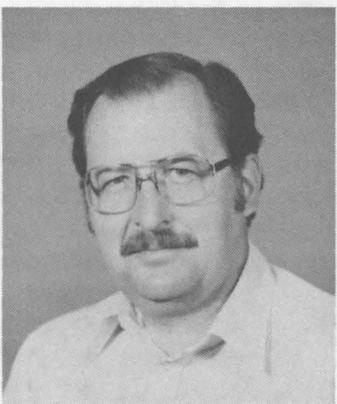
Ron VanTheemsche (2857) 15



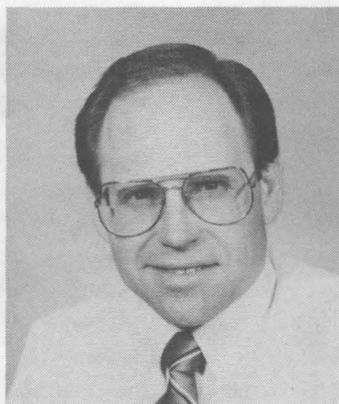
Ron Tucker (DMTS, 9132) 20



Jack Hudson (9111) 15



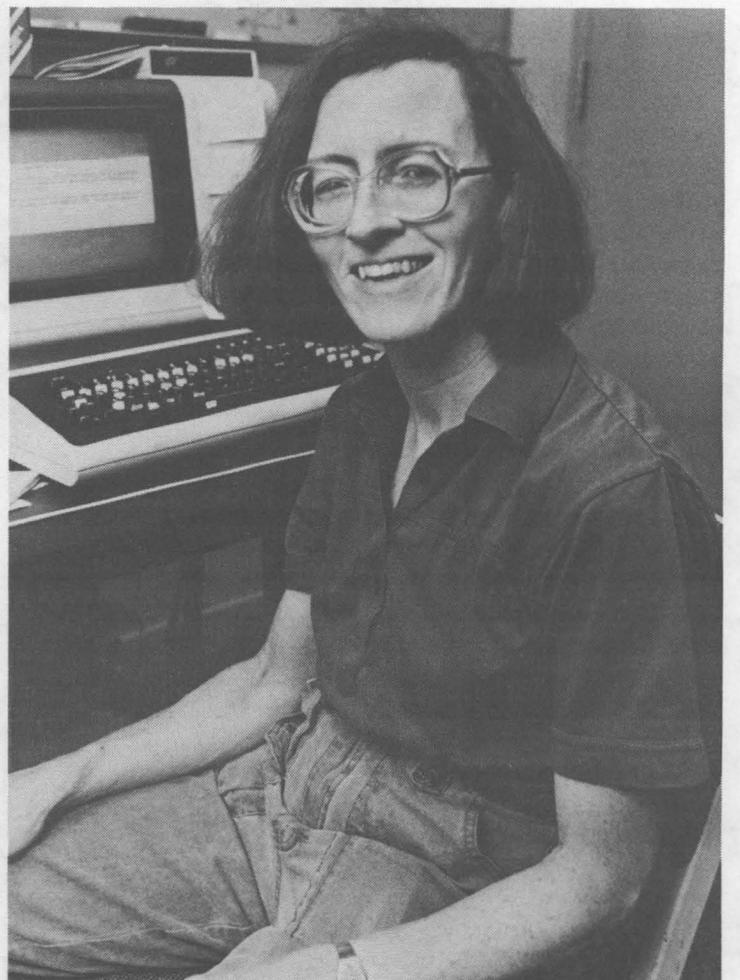
Terry Unkelhaeuser (2813) 25



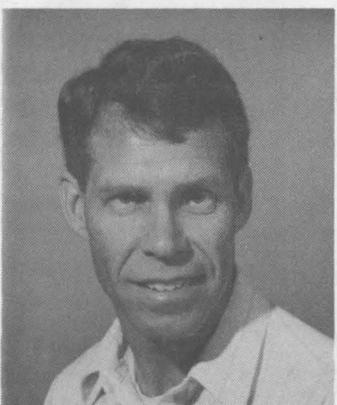
Gene Arnot (2851) 25



Marian Van Delinder (155) 20



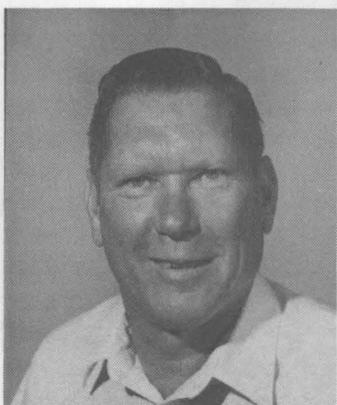
Mary Ann Sweeney (1265) 15



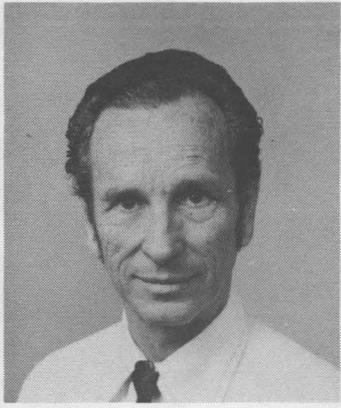
Marlin Kipp (1533) 15



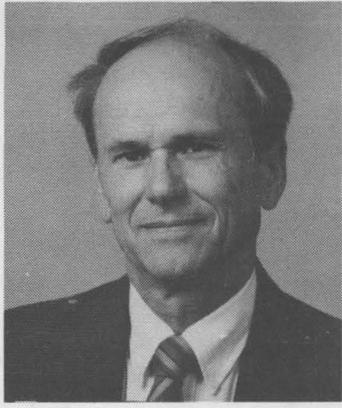
Sidney Thomas (7110) 35



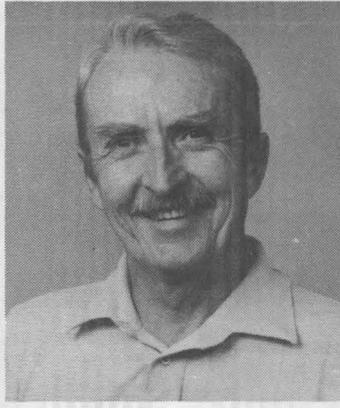
Bob Barton (3423) 20



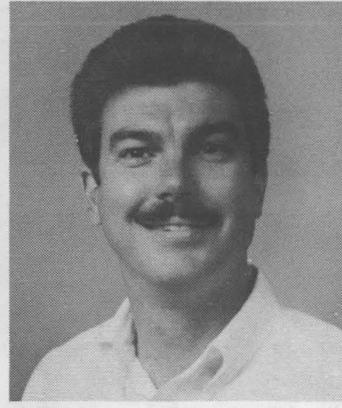
Raymond Peabody (7132) 30



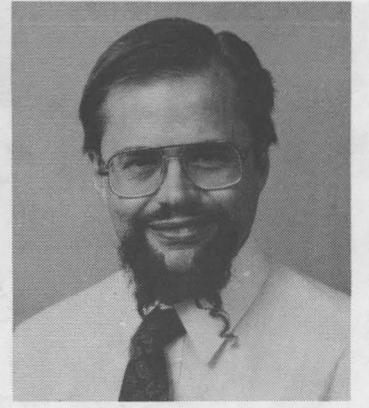
Leon Maschoff (9212) 30



Ken Ludwick (7813) 30



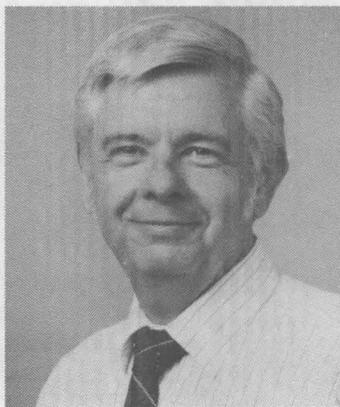
Steve Richards (2336) 20



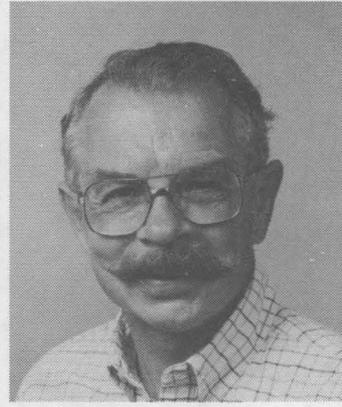
Bill Fienning (5147) 25



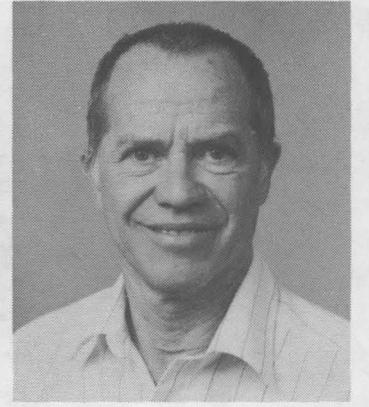
Dora Gunckel (6400) 20



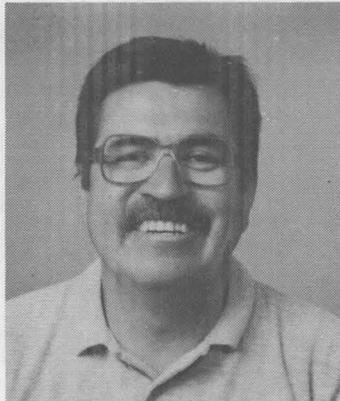
Dirk Dahlgren (6410) 25



James Bushnell (1412) 25



Richard Beasley (DMTS, 9122) 30



Richard Sanderville (3153) 15



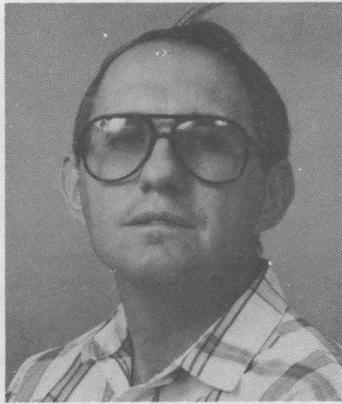
Ann Chipman (5171) 15



Duane Arlowe (DMTS, 5261) 30



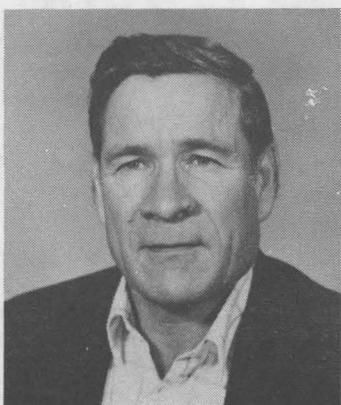
Ron Ewing (9111) 30



Larry Pucket (2851) 20



Rosie Jennings (2851) 20



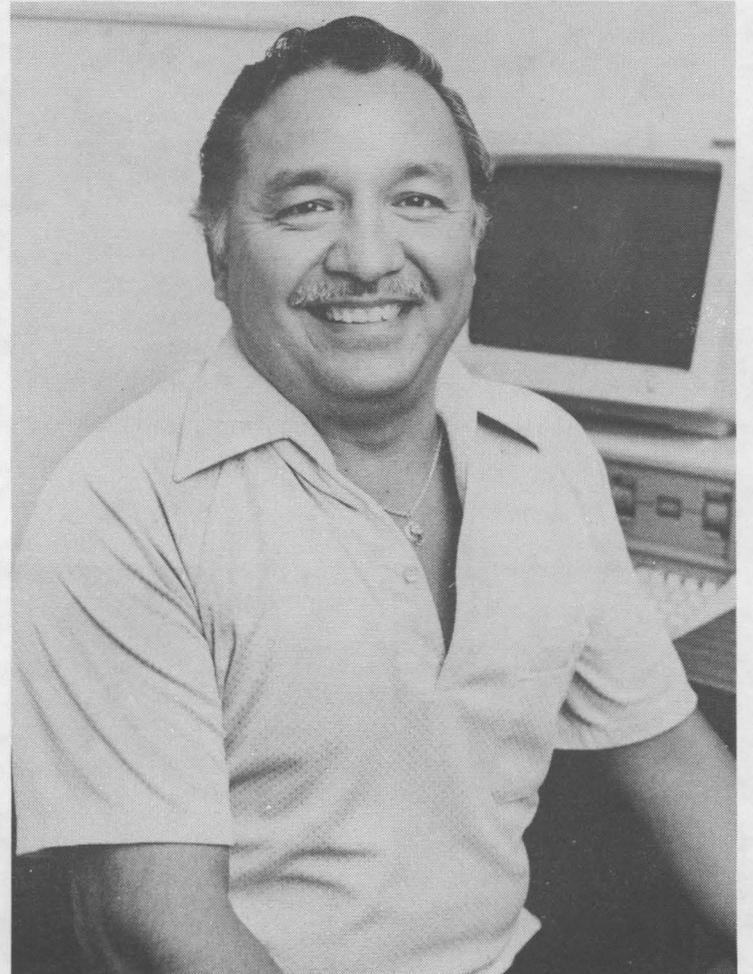
Bob Stinebaugh (6314) 30



Harriet Mason (5261) 20



Larry Nelson (2331) 30



Frank Arellano (6422) 25

Fun & Games

Tennis — Results of the June 24-25 Sandia Tennis Association tournament held at the Coronado Club courts: Men's A Singles — Ken Hanks (7823) defeated Ed Fronczak (7262); Men's B Singles — Robert Cutchen, son of J.T. Cutchen (2560), defeated David Sealey (3152-2). Men's Doubles — Dick Schlimme (DOE) and Art Hardeman (3734) defeated Ken Hanks and Ed Fronczak in three sets. Women's Round Robin Singles — Eden Tadios (1552) defeated

Damaris Pimentel (wife of Alex, 1823). Mixed Doubles — Fred (DMTS, 7542) and Sara Cericola defeated Roy Palmer (2635) and Terry Martinez (1240). For information on the Sandia Tennis Association, contact Kevin Maloney on 6-6578 or Ken Hanks on 4-1820.

* * *

Golf — Winning teams in the "Road Trip" Golf Tournament held at the Pendaries Country

Club golf course near Las Vegas, N.M., June 17 were: 1st — Al Maes (3724) and Manny Chavez (ret.); 2nd — Mark Calvin (3532) and Jay Tidmore (3722); 3rd — Howard Cilke (9212) and Don Robbins (2811); 4th — Fernando Dominguez (3212) and John Garcia (6423). The format was 2-man best ball. There was one flight, with prizes awarded to the top four teams.

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

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

MISCELLANEOUS

APPLIANCES: Roper gas range and dishwasher, harvest gold; Gibson refrigerator, 20 cu. ft., almond. Roach, 294-8432.

CAMPER SHELL for LWB, beige, includes boat rack, \$350 OBO. Gallegos, 836-0610.

CHEST FREEZER, Montgomery Ward, 18.5 cu. ft.; refrigerator w/11-cu.-ft. fresh-food section and 5-cu.-ft. freezer section underneath, Sears. Goin, 299-5271.

VGA MONOCHROME MONITOR, for PCs and compatibles, works w/Paradise, Vega, and other VGA cards, \$150. Malczynski, 255-1794.

HIMALAYAN-PERSIAN CAT, seal point, neutered, blue eyes, 2 yrs. old, declawed, \$75. Hogan, 292-8425.

MILLER PORTABLE WEEDER; 200-amp AC; Onan 2-cyl. engine, mounted on a heavy-duty trailer, extras. Marquez, 247-9408 or 344-8455.

TENT TRAILER, '88 Jayco fold-down, model 1206, sleeps 6, 21' when open, includes 12' awning. Whitley, 865-4390.

RARE COINS, below list: 1916-D dime (EF); cents: 1909-S-VDB (UNC), 1955 DD (AU); 1851 \$1 gold (UNC). Duncan, 281-8792.

ACOUSTICAL GUITAR, w/hard-shell case, \$175. Kallio, 296-4516.

FOUR 15" DIRECTIONAL MUD AND SNOW TIRES; four 14" highway tires; cab-over camper, for compact truck, w/refrigerator, furnace, more. Jones, 888-1564.

FURNITURE: kitchen, living room, bedroom. Chinn, 296-5172.

DREXEL COUCH, gray/tan/blue small stripe, \$200; Sealy Posturepedic queen-size mattress set, \$150. McKay, 291-8478.

BIC 250 WINDSURFER, starter outfit, \$275. Horton, 883-7504.

AMDEK COLOR MONITOR (CGA)/graphics card, \$250; swivel stand, \$15; keyboard drawer, \$25. Witek, 296-5198.

GOLF ITEMS: Spalding Pro-Line irons, 3-PW, \$240; 2 electric golf-bag carts, Li'l Joey, \$250 and \$295; other carts. Kaiser, 296-5215.

DP-2000 WORKOUT BENCH AND WEIGHTS, \$300. Steinfort, 865-8445.

KORG DIGITAL SAMPLING SYNTHESIZER (DSS-1), \$1500. Valdez, 265-2457.

OAK WALL UNIT, new, includes entertainment center, china cabinet, bookcase/desk; bed w/box spring, mattress. Gonzales, 299-1145.

ALUMINUM CAMPER SHELL, for full-size pickup, \$70. Ashcraft, 281-5993.

CHILD'S CAR SEAT, \$25; 2 child's bicycle seats, \$12/ea.; playpen, \$15. Vigil, 869-6870.

UPRIGHT FREEZER, 17 cu. ft.; rotary lawn mower; 6" jointer; 12" band saw; shop vac. Dugan, 821-1962.

GARAGE SALE: furniture, musical instruments, sports equipment, miscellaneous, 8 a.m.-4 p.m., July 28-29, 8225 Evangeline Court NE. Holmes, 292-0898.

WOMAN'S DRESS SHOES, size 11W, black flats, worn twice, \$30. Morrison, 275-8053.

WARD'S CHEST FREEZER, 15.7 cu. ft., \$300; car-top carrier, \$75; Tilt-N-Tote wheelchair carrier, \$150; wheelchair, \$300. Sharp, 293-1824.

MOVING BOXES, all sizes; infant car seat; fish-aquarium supplies, filters, plastic plants, more. French, 298-9292.

SOFA AND LOVE SEAT, traditional style, diamond-tufted, gold velvet. Drebing, 266-6688.

CRIB MATTRESS, water-bed type, \$20 OBO. Wetzel, 296-7570.

OVERHEAD CAMPER, 10-1/2' long, w/camper jacks, 30-gal. water tank, double sink, icebox, cabinets, more, \$800. Edwell, 299-4551.

MORTAR/CONCRETE-GRADE SAND, 1 yd.; plant mix, 2 yds., free if you haul. Vargo, 294-8226.

SCHRAEDER WOOD STOVE. Bender, 281-1989.

MAN'S GOLF CLUBS: 3-PW & SW, PGA Cameron reg. shaft, RH, \$235. Stang, 256-7793.

BACKPACK TENT, \$35. Patrick, 265-4569.

CONDO TIME-SHARE, 2-bdr., 4 miles from Disneyland/Epcot Center, week of Aug. 19-26, pools, golf, tennis, sauna, \$495. Champion, 299-0163.

WESTERN SADDLE, 15" seat, \$225; solid-mahogany desk, glass top, \$225; 9-ga. chain-link fence, 25' long, 5' high, \$25. Colgan, 869-2332.

TWO END TABLES, \$15/ea.; coffee table, \$20; man's golf clubs, w/leather bag, \$125. Aragon, 292-2893.

DP300 BODYTONE EXERCISE EQUIPMENT, \$100 OBO; artist's free-standing pegboard displays, \$125 OBO. Adams, 823-1845.

AKC-REGISTERED ROTTWEILLERS, 6 weeks old, champion bloodlines, dew claws removed, tails bobbed, starter kits and family tree included, \$350-\$450. Day, 281-3211.

KING-SIZE WATER BED, mirrored bookcase headboard, 6-drawer under-dresser, \$150; tot walker, \$20. Liguori, 256-3613.

ROLL-AROUND ENGINE STAND, 750-lb. capacity, mounting head rotates full 360 degrees, \$30; wheel ramps, \$8/pr. Litts, 884-9010.

RADIO-CONTROLLED RC10 ELECTRIC OFF-ROAD CAR, 1/10-scale, w/radio, extras; Sencore TF151A FET/transistor tester. Hannum, 296-2095.

REFRIGERATOR, white, 11 cu. ft., not self-defrosting, \$50; gas kitchen stove, gold, \$35. Kent, 256-1221.

59" ORGANETTE; sliding patio door, single-pane, 10' x 6'8", complete (greenhouse glass); Remington

100-E typewriter, long carriage. Neas, 293-3422.

FULL-SIZE VIOLIN, Wm. Lewis, \$675. Moss, 298-2643.

DOGHOUSE, never used, \$50; 4 traveling-cages for dogs, 4 dog beds. Hawk, 265-2228.

SPEAKERS, solid wood, 16" wide x 24" high, \$60. Mills, 897-2817.

TWO EXERCISER-REBOUNDERS, \$110 & \$150; old Southwestern jewelry. Staloni, 298-7903.

TWO-FAMILY YARD SALE, Saturday, July 29, 8 a.m.-4 p.m., 2513 Gretta NE, bicycles, truck window louvers, food processor, misc. Parson, 291-8394.

CAMPER: pickup bed liner, cabinets, bed, curtains, carpet, silver/blue, 4-piece plywood, fits '85+ Nissan. Kerschion, 281-1671.

DENVER BRONCO TICKETS: 6 season tickets or per game, 10 games (60), \$31 per ticket. McNeill, 883-9587 or 293-1234.

CRIB MATTRESS, \$13; Depression glass, iris and herringbone, 102 pieces, \$450. Goetsch, 892-8366.

ROOFTOP CARGO CARRIER, 16 cu. ft., \$60. Bouchier, 298-5845.

WASHER/DRYER, \$100; stationary bicycle, \$50; ping-pong table, \$50; Christmas tree, \$40; Hollywood bed, \$30; queen-size water bed, \$80. O'Brien, 281-4350.

KITTENS: 4 white, 8 weeks old, 1 male; 2 calico, 12 weeks old, female; litter-box-trained, free. Klarkowski, 281-1005.

TRANSPORTATION

'66 OLDS. TORONADO CLASSIC, black, all original, needs engine, \$1000 OBO. LeMaster, 877-4884 before 4.

14' VAGABOND SAILBOAT, w/trailer; 15' Coleman canoe; Honda 360T motorcycle. Bluett, 281-1146.

'66 BMW R60 CYCLE, fairing, rack, accessories, 52K miles, new tires, \$950. Hess, 873-2131 or 877-3237.

'86 250R THREE-WHEELER MOTORCYCLE, \$900. Padilla, 296-5048.

YAMAHA SCOOTER, 80cc, 4K miles, \$450. Kallio, 296-4516.

WOMAN'S 26" 10-SPD. BIKE, \$65; boy's 24" 10-spd., \$40; girl's 20" bike, \$20; inflatable canoe, \$40. Patrick, 265-4569.

KZ440 MOTORCYCLE, w/windshield, luggage rack, helmet, \$475 OBO. Heifetz, 275-2648 leave message.

'86 MUSTANG 5.0L CONVERTIBLE, loaded, white w/red interior, 51K miles, \$9500. Bates, 898-0626.

MOUNTAIN BIKE, 12/15/18-spd. Carli, 298-9271.

'75 FORD 3/4-TON VAN, rebuilt engine, new radial tires, Reese trailer hitch, AM/FM cassette, cruise. Pruett, 293-6244.

MAN'S 12-SPD. CENTURION BICYCLE, w/headlight and generator. Bailey, 294-4218.

'82 HONDA SABRE MOTORCYCLE, 750cc, black, 5K miles, adult-ridden, \$1750. Abbin, 296-7678.

'73 BUICK LeSABRE, AC, AT, PB, PS, equalizer hitch, \$400. Greenway, 299-1104.

'86 FORD ESCORT WAGON, 4-spd., 29.5K miles, \$3600 OBO. Brown, 268-1243.

'88 GEORGIE BOY MOTORHOME, 32', 17K miles, all extras. Eiffert, 268-1854.

'83 YAMAHA 750 MIDNIGHT SPECIAL VIRAGO, 14K miles, new tires, bat-

tery, and helmets, \$1500. Pryor, 298-3788 or 294-6980.

'85 NISSAN 200SX TURBO, 57K miles, all available options, serious inquiries only, \$8300. Gentry, 298-3574.

GIRL'S 18-1/2" SCHWINN BICYCLE, \$45; boy's 16" bike, \$25. Lyo, 299-6470.

'78 CHEV. MALIBU SW, white, AT, AC, AM/FM cassette, extras, 45K miles on rebuilt 305, full shop manuals, \$1350. Feltz, 293-8732.

'89 OLDS. REGENCY BROUGHAM 98, sedan, \$17,495. Adam, 265-9105.

'83 HURST OLDS., 15th anniversary special, T-tops, AC, cruise, AM/FM cassette, more, \$10,000 OBO. Aragon, 292-2893.

14' ALUMINUM FISHING BOAT, trailer, swivel chairs, 25-hp motor, depth finder, \$1600; Suzuki TS-185, \$575; Honda Trail 90, \$325. Eaton, 869-2847.

'89 MAZDA 323, 2-dr. hatchback, red, 4-spd., AM/FM cassette, 600 miles, \$6700 OBO. Caress, 255-1800.

'87 FORD TEMPO GL, white, 4-dr., 34K miles, AT, AC, PB, PS, tilt, \$6800. Spear, 865-6335 after 6.

'85 NISSAN 300ZX, red w/leather interior, stereo, digital instrumentation, 37K miles, under warranty, \$10,800 OBO. Lenhart, 898-1200.

'85 CHRYSLER LeBARON GTS, PS, AC, FWD, turbo, stereo, 4-dr. hatchback, \$5395 OBO. Davis, 294-4614.

FIVE-MAN RAFT, Northwest River Supply Sprite, frame, oars, 2 life jackets, foot pump, \$650 OBO. Mills, 881-7884.

HONDA EXPRESS 50cc SCOOTER, \$100. Bouchier, 298-5845.

24' SEARAY CABIN CRUISER, twin 165-hp I/Os, full canvas, road cover, stove, icebox, toilet, trailer, \$11,000. Patton, 298-9987.

REPO: '86 Olds. Calais, 2-dr., 5-spd., 4-cyl., stereo tape deck, 62.7K miles, bids accepted through Aug. 8. We reserve the right to refuse all bids. Subject to prior sale. SLFCU, 293-0500.

'85 CHEV. BLAZER, full-size, 305 V-8, AC, PS, PB, 43K miles, blue & white, spoked wheels, \$8000. McNeill, 293-1234.

'85 CADILLAC SEDAN DeVILLE, 4-dr., 40K miles, \$10,900. Marrs, 821-5144.

'75 TOYOTA CELICA, brown, rebuilt engine, body damage, runs, \$150. Lieberman, 299-7739.

REAL ESTATE

ADOBE COUNTRY HOME, new, near Los Lunas, passive solar, on one acre, available on lease/purchase, \$110,000. Servis, 865-7629.

1-BDR. MARLETTE MOBILE HOME, 1 bath, 12' x 50', includes washer, dryer, range, and storage shed, \$5500. Kiffer, 296-8902.

1-BDR. MOBILE HOME, '74 model, 12' x 44', attached 8' x 12' workshop, exterior wall completely remodeled, all appliances, \$5495. Lindsay, 884-8744 or 881-0709.

FOUR-PLEX, 2-bdr. units, NE, assume loan, \$108,000, will trade for a house. Lyo, 299-6470.

20 ACRES in Moriarty, whole or part, \$2000/acre, will take real estate contract. Shunny, 265-1620.

2-BDR. MOBILE HOME, '82 Lancer, 14' x 76', 2 baths, pitched roof, storm windows, oak cabinets, wood paneling, shed, landscaped, Wyoming gate area, \$25,900. Rine-

hart, 275-0946.

CABIN SITE, 4 wooded acres in east Manzanos, area water. Zawadzka, 884-8956.

1-BDR. MOBILE HOME, '73 Contemporary, 12' x 40', w/appliances, storm windows, cooler, on S14, must be moved, \$4900. Ashcraft, 281-5993.

3-BDR. TOWNHOUSE, 2-1/2 baths, patio lot, trade for NE home approximately 2000 sq. ft. Jojola, 292-7962.

4-BDR. BRICK HOME, shaded yard, outdoor FP, 2200 sq. ft.; 22 wooded acres in Sandias. Clement, 299-2324.

2-BDR. TOWNHOME, 2-story, 2000 sq. ft., 4 yrs. old, custom built, extras, pueblo style, Southwest decor, 2 baths, 2-car garage, landscaping. Miller, 822-0008.

2-BDR. TOWNHOME, formal DR, LR/wFP and atrium, 2 baths, 2-car garage, 1790 sq. ft., assumable. Ramsey, 292-3736 or 299-6048.

4-BDR. HANSON HOME, 1-3/4 baths, FP, solar panel, Taylor Ranch, landscaping w/timed sprinklers, no-qualifying assumable. Troncoso, 897-1167.

1.95 ACRES REMOTE CHAMA RIVER PROPERTY, 635' river frontage, some improvements, \$27,000. Neas, 293-3422.

3-BDR. HOME, North Albuquerque Acres, 2 baths, passive & active solar, 1 fenced acre. Martin, 296-8154.

WANTED

BOX TURTLES, prefer female. Morrison, 299-4757.

HARP, either desk or floor model. Blackledge, 294-6030 evenings or 260-0062 days.

MOVING BOXES, sturdy, for moving household goods. Chinn, 296-5172.

BOOKS: "Roswell Incident" by Berlitz & Moore; "No Man Is An Island" by George Tweed; "Roswell AAF Base Yearbook — 1947" by Walter Haut. Harris, 255-6577.

OWNER'S MANUAL for '85 Pontiac Grand Am, to borrow. Huerta, 846-5934.

SAILPLANE WING for Goldberg Gentle Lady, built or not, covered or not; stand for 29-gal. aquarium. Kureczko, 281-8206.

GAS REFRIGERATOR, prefer trailer-type or butane. Pritchard, 299-3543.

HOUSEMATE to share NE Heights home w/swimming pool, \$225/mo., utilities paid. Smith, 291-9241.

LEAD-SHOT EXERCISE WEIGHTS, 2 ea. of 5 lbs. and 8 lbs. or combinations. Miller, 822-0008.

BUNK BEDS. Bender, 281-1989.

FOUR-HARNESS LOOM, at least 24" w/6 treadles. Berg, 884-5229.

TWO-MAN TENT, in good condition. Lovato, 836-3517.

VACUUM PUMP, good to 1/4 atmosphere. Stromberg, 255-6131.

MOTOCROSS ARMOR, gloves, knee pads, helmets, boots, etc. Marchi, 291-9681.

GARDEN TRACTOR that has or will accept attachments such as rake, lawn dethatcher, etc. Langkopf, 293-4076.

TANDEM INFANT STROLLER, will consider side-by-side; push-type reel mower. Underhill, 294-5774.

CATCHER'S MITT. Marrs, 281-9889.

'83-'86 FORD TEMPO, model GL or GLX, AT, PS, AC, radio, light color. Heid, 892-8608 after 6.

DRUMMER for rhythm and blues band. Sanderlin, 298-7147.

Coronado Club Activities

Flavorful Filets, Scrumptious Shrimp: Tonight's Fantastic Food Lineup

GIVE YOUR WEEKEND A SUPER START this evening by heading to the C-Club for a fabulous Friday-night dinner. Choose either filet mignon or peel-'em-yourself shrimp for just \$8.75. Afterward, it's dancing to variety music from Spinning Wheel (8 p.m.-midnight). Dinner reservations requested (265-6791).

EVERYBODY'S A WINNER at kids' bingo, because everybody always has a great time. And some *really* lucky kid will go away from bingo on Sunday, Aug. 6, with the grand prize — a Nintendo entertainment system. A low-cost buffet, served at 1 p.m., precedes the bingo action at 2. Cost is just \$2.50/player.

SPEAKING OF WINNERS, the T-Bird card sharks swing back into action on Thursday, Aug. 10, starting at 10 a.m. Come on out for carefree card games, convivial conversation, and gratis goodies.

NEXT FRIDAY NIGHT (Aug. 4), those inimitable Isleta Poor Boys strum their sagebrush specialties from 8 p.m. to midnight. Beforehand, chow down on prime rib or fried shrimp (\$8.95 a plate) — mighty fine trail food, we'd say.

ALWAYS ON WEDNESDAY — at least for one more month. That's when Family Nights in the

pool/patio area happen. Summer will be gone before you know it, so take advantage of the fun while you can. The grill and buffet line offer the finest alfresco fare — burgers, chicken, hot dogs, fresh salads, and more — so get out of that hot kitchen and relax under a shade tree, or treat yourself to a cool dip in the pool. The pool/patio area is open until 8 p.m., and regular admission rates apply: free/pool-pass holders, \$2/members without passes, and \$3/guests.

AND ALWAYS ON THURSDAY: That describes adult bingo nights on Aug. 3, 10, 17, 24, and 31. Card sales start at 5:30 p.m., and the early-bird game begins at 6:45. Card prices: \$5/single package (15 games), and \$9 or \$13 for a double or triple package, respectively. Bring along your Club membership card; it gets you a \$1 discount on the bingo cost.

ONLY ONCE — ON TUESDAY, Aug. 8, the Thunderbirds are sponsoring a meeting for all Sandia and DOE retirees to explore implications of the catastrophic insurance bill, including the Medicare surtax and possible Sandia extended-insurance duplicate coverage. A speaker from Sen. Jeff Bingaman's office will discuss the current plan and proposed changes. The meeting is set for 3 p.m. in the C-Club ballroom. More info from Bob Butler, 299-5626; Art Hasenkamp, 255-8946; or Nick DeLollis, 299-5384.

Sympathy

- To R.C. Chavez (3435) on the death of his grandfather in Belen, July 4.
- To Neal Counts (1232) on the death of his father in St. Louis, Mo., July 9.
- To Don Arquette (2342) on the death of his daughter in Albuquerque, July 17.
- To Sylvia (1841) and Jeff (1141) Tsao on the death of their son in Sioux City, Iowa, July 19.

Retiree Deaths

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|-----------------------------|----------|
| Ruth Simpson (74) | April 3 |
| Lois Swayze (76) | April 5 |
| Ruth Whan (57)..... | April 6 |
| Stanley Brooks (62) | April 12 |
| Gertrude Erb (77) | April 17 |
| John Paul (89)..... | April 17 |
| Ralph Martin (74)..... | April 19 |
| John Tolmie (77) | April 21 |
| Robert Bailey (61)..... | April 25 |
| Robert Murray (81) | April 28 |
| John Stamm (83)..... | May 6 |
| Verne Honeyfield (66)..... | May 28 |
| J. L. Hollenbeck (73) | May 31 |
| Burke Duff (83)..... | June 9 |
| James Pinkerton (84)..... | June 13 |
| Roy Allison (72) | June 14 |
| Fred Edwards (66)..... | June 17 |
| Earl Robbins (74)..... | June 18 |
| Marie Brenton (70) | June 19 |

Events Calendar

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

July 28-29 — "Alice in Wonderland," Albuquerque Children's Theatre presentation; 1:30 & 3:30 p.m., Rodey Theatre, 277-3121 or 888-3644.

July 28-29, & Aug. 3-5 — "American Humor," Theatre-in-the-Making presentation, Youth Performance Workshop performs stories by Mark Twain, L. Frank Baum, and Ambrose Bierce; 8 p.m., Center-Stage (3211 Central NE), 260-0331.

July 28-30 — "Dames at Sea," Albuquerque Civic Light Opera presentation of 1930s musical spoof; 8:15 p.m., 2:15 p.m. Sun.; Popejoy Hall, 345-6577.

July 28-Sept. 17 — "Art Since 1945," exhibit featuring paintings, sculpture, and prints from the permanent collection, highlighting later twentieth-century art (realism, geometric abstraction, and expressionism); 9 a.m.-4 p.m. Tues.-Fri., 5-9 p.m. Tues. evening, 1-4 p.m. Sun.; upper gallery, UNM Art Museum, 277-4001.

July 28-Sept. 30 — Exhibit, "Moon, Man, & Mars," commemorates 20th anniversary of man on the moon with video, still photographs, and a moon rock; guest curator, former astronaut and US Senator Harrison Schmitt; 9 a.m.-6 p.m., New Mexico Museum of Natural History, 841-8837.

July 29 — Summerfest '89, Korean Night: food, entertainment, and arts & crafts; 5-10 p.m., Civic Plaza, free, 768-3550.

July 29 — Santa Fe Desert Chorale, concert of works by living composers; 8 p.m., Keller Hall, 277-4402.

July 29-30 — "Sandia Mountain Discovery Days," a celebration to build awareness of the natural environment, featuring llamas, Indian storyteller Chief Michael Running Wolf from Canada, exhibits, booths, music, and food; sponsored by the Sandia Ranger District, US Forest Service, and the NM State Land Office; 9-4:30 Sat., 10-4:30 Sun.; Sandia Peak Ski Area, free, 281-3304.

July 30 — Sunday Blues at Madrid, NM Jazz Workshop presentation; 3-7 p.m., Oscar Huber Memorial Ballpark (Madrid), 255-9798.

Aug. 1 — Albuquerque Garden Clubs Dried Flower Arrangement Demonstration: master arrangers show how to make wreaths, centerpieces, and other items from dried flowers; also tips on how to select, grow, and dry materials; 7-9:30 p.m., preregistration requested, Albuquerque Garden Center (10120 Lomas NE), 296-6020.

Aug. 1-13 — 9th Annual Cowboy Classic Western Art Show; 12-4 p.m., Fine Arts Gallery, NM State Fairgrounds, 265-1791, ext. 228.

Aug. 2 — Our Lady of the Angels Feast Day: Bull and Corn dances; Jemez Pueblo, 843-7270.

Aug. 4 — Santo Domingo Feast Day: Corn dance; Santo Domingo Pueblo, free, 843-7270.

Aug. 4 — "Bach to Gershwin," Classical Concert III by Santa Fe Desert Chorale; 8 p.m., Keller Hall, 277-4402.

Aug. 4-5 — St. Thomas of Canterbury Music Se-

ries: two new operas by Alan Stringer, "Young Goodman Brown" (based on the story by Hawthorne) and "A Sunny Morning" (based on the play by the brothers Quintero), featuring soloists, chorus, Surgite Dance Company dancers, and orchestra conducted by Kay Shafer; 8 p.m., St. Thomas of Canterbury Episcopal Church (425 University NE), 296-9215.

Aug. 5 — Summerfest '89, Italian Night: food, entertainment, and arts & crafts; 5-10 p.m., Civic Plaza, free, 768-3550.

Aug. 6 — Renaissance Fair: knights in shining armor, music, dancing, food, sponsored by Albuquerque Parks and Recreation; Bataan Park (Lomas & Tulane NE), free, 764-1525.

Aug. 6 — Sunday Jazz at the Rio Grande Zoo, 2-5:30 p.m., Rio Grande Zoo, 255-9798 or 843-7413.

Aug. 10 — San Lorenzo Feast Day: Corn dances at Acoma and Picuris pueblos, free, 843-7270.



"WORK 101" — Eunice Young (standing, 9123) designed this special workshop for Sandia's YOTs (Youth Opportunity Trainees). "Over the years," says Eunice, "I saw a need for a workshop to deal with the issues young people face in making the transition from school to work." Decidedly popular with YOTs, the workshop was presented three times during this summer's YOT program. Students are selected for the program according to scholastic performance, school attendance, teacher recommendations, and economic need. Through the summer, they work in various technical and non-technical organizations at the Labs. Soila Brewer (3533) coordinates the program.