



SANDIA'S OUTGOING PRESIDENT, Irwin Welber (center), and his two executive vice-presidents, Lee Bray and Orval Jones, held their third annual "State of the Labs"

interview last month. The discussion ranged from technical programs to administrative concerns, from "non-permanent compensation" to future challenges.

**State of the Labs**

# 'Exceptional Service in The National Interest': That's Why We're Here

*Continuing a tradition that began with former President John Hornbeck some 20 years ago, the LAB NEWS and other members of Public Relations Dept. 3160 recently interviewed President Irwin Welber and Executive Vice-Presidents Orval Jones and Lee Bray on the current "State of the Labs." The articles in this special section are a condensation of that interview.*

**SLN:** Before we look at what kind of a year 1988 was for Sandia, let's provide some context. What happened on the national level that affected Sandia?

**Welber:** In a word, "environment." It's now in sharper focus than ever before. And it's fair to say that '88 was the year that environmental concerns became dominant. Whether it's DOE's Environment, Safety, and Health [ES&H] issues, which became extremely visible during '88, or even broader national concerns — the greenhouse effect, acid rain, holes in the ozone layer — the environment has captured the attention of Congress and the public. And Sandia is feeling the impact.

**SLN:** Have these environmental concerns had a direct effect on Sandia?

**Welber:** In the ES&H area, yes. We felt it was so important that we recognize our increasing responsibility for the environment that we created a directorate [3200] for that purpose.

And right now we are in the process of examining our 1989 budget in view of the need to start promptly on environmental cleanup. So it's having an impact today.

**Bray:** We've even had some money pulled back.

The DOE is aggregating some \$233 million from various sources, and Sandia's piece of that is about \$25 million.

**Welber:** That's the immediate impact, and you can be almost certain there will be continuing impact.

**SLN:** How are you deciding where to find that \$25 million?

**Bray:** Let's put that figure into perspective. It's about two and a half percent of our total budget. The funding we forecast from reimbursables may not be accurate within that tolerance. So what it really says is that we have to look on the reimbursable side for every opportunity to make up some of the shortfall. If it doesn't, we're prepared to manage to it.

**Welber:** [Controller] Paul Stanford and his people do a fantastic job of managing our finances.

**Jones:** But we're taking very seriously our responsibility to the DOE-wide environmental cleanup [LAB NEWS, Feb. 10, 1989]. We're tightening the belt, stretching the bucks wherever we can. That runs from traveling on the cheaper airplane to being very, very careful about what we buy — prioritization. Our MA [Military Application] program budget is

down about three percent — we did not keep up with inflation this past year — and we're very fortunate in that we have the flywheel of our work for others, which helps us level that out for '89, but it's a worrisome trend.

**SLN:** So our reimbursables program — our

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**It's encouraging that other government agencies come to us to help them with their work.**

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—Jones

*"work for others" — is increasing as a proportion of our total budget?*

**Jones:** Yes, and it's encouraging that other government agencies come to us to help them with their work. It helps us maintain Sandia as a full-service national resource, which is our goal as the executive management. But the erosion of funding from our prime mission — Military Application work — is disturbing because eventually you don't have a prime mission, one that ensures some level of con-

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tinuous funding as an investment in the nation's defense. That's a real concern.

**Bray:** The point is, this \$233 million is small, relatively speaking. The important thing is what it suggests about the future.

**Jones:** Before he left office, former DOE Secretary Herrington said that the total ES&H cleanup bill was on the order of \$81 billion. That just emphasizes Lee's point — a few hundred million is paltry when we're talking about numbers approaching \$100 billion. It means that the R&D community is going to see some tight times again, and we're going to have to stretch our money as effectively as we can.

**Welber:** Couple these ES&H problems with the deficit, which is becoming increasingly burdensome to this country, and it spells very tight times ahead.

**Jones:** Yes, Gramm-Rudman-Hollings is still

the law of the land. It recognizes that the budget deficit must be dealt with and specifies what things must happen when the deficit is too large. So there's a fair degree of uncertainty.

Nevertheless, we feel reasonably good about our '89 budget. All in all, I think '89 will turn out okay — although quite tight.

**SLN:** *Is there a general philosophy on how we're tightening? Is it a matter of shrinking programs across the board, or is it cutting a function or a project?*

**Welber:** DOE has asked us the same question, and we're looking at it right now. So it's difficult to say what impact cutbacks would have. DOE really would prefer that we not impact existing programs — committed programs — such as Phase 3 [full-scale development] weapon work.

**Bray:** DOE, of course, would like to see us do more with less, and we'll do everything we can to do that. It's too early to tell how far we can go with that.

**SLN:** *Isn't dealing with budget fluctuations one of our responsibilities under the level-of-effort fund-*

*ing concept [which began in AEC days and which means that the laboratories receive a more-or-less constant amount of money each year]?*

**Jones:** That's true, although that amount has slowly declined over the years. Nevertheless, compared to many other government laboratories, it's relatively steady. In exchange for that, we do have a responsibility for balancing various demands that are placed on us. We have a heavy committed weapons workload right now, so with budget pressure on us, we honor first the committed weapons work. The

**A Sandia hallmark — the ability to move quickly when we need to. —Jones**

upshot is that our exploratory and our general tech base functions are facing a lot of pressure.

**SLN:** *Continuing with the context theme, let's look at the Sandia strengths that should attract the customers and programs that can help us compensate for tight budgets.*

**Jones:** Let me digress a moment here. "Cus-  
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**Administrative Highlights 1988**

**SLN:** *Do we have the proper mix of people around here? Are our 8000 or so people the right 8000?*

**Bray:** I think on balance we've got the right mix of people — for now. Roger Hagengruber [9000] and I have talked about the need to develop a more robust way of forecasting what Sandia will need two to five years out.

We have to recognize that reimbursables are a growing portion of our business, that they tend to come in smaller contracts, and they may or may not be as synergistic with our main mission as we'd like them to be. So talent needs in that area may or may not be identical to those on-roll today.

**SLN:** *Are we satisfied with the abilities of our current new-hires?*

**Bray:** We continue to get very good people. We're still looking at the possibility of hiring bachelor's level engineer people, but we're not ready to make a statement about that yet.

**Jones:** We did conduct a pretty thorough survey recently; it suggested no compelling desire in the line organizations to go into intensive recruiting of bachelor's degree engineers. There is a strong sense, in line with what Lee just said, that we need to think carefully about where our staffing is taking us so that the kinds of work we take on aren't going to the left while we're staffing to go to the right. I think that means that we'll need to emphasize engineering hiring as opposed to science hiring.

**Bray:** Today we tend to allocate hiring slots based on the organization's size and its past experience in net import or export of people. Well,

**The business that will be here five years from now . . . may be considerably different. We need a better crystal ball! —Bray**

that's a good system as long as you want the organization of tomorrow to be similar to what it is today. But the business that will be here five years from now — when those new-hires have clearances and enough experience to make strong contributions — may be considerably different. We need a better crystal ball! We may be doing all right, but it may be just happenstance.

**Welber:** That's why I've asked for a study of management effectiveness [see "Challenges for Future" section of main story]. After all, how do we know how well we're doing in assessing what the future is going to hold? And what kind of population will we need for that future?

**SLN:** *How many people do we expect to hire this year?*

**Bray:** The hiring picture looks a little higher than last year — 400 to 420 is our goal. We're

getting more retirements this year and therefore plan to hire a few more to maintain the current position.

**SLN:** *How are our hiring practices and our people already on-roll affected by Equal Opportunity?*

**Bray:** Equal Opportunity is, first of all, the law of the land. It's also morally right, and I believe it's good long-term business. I like to think that Sandia does a very good job in equal opportunity. I know that from time to time various individual members of protected groups feel as if they're not being properly represented.

Here's my perspective: If indeed the numbers are all exactly right over every month or other short time period, then they're contrived, and it seems to me that's inappropriate. So the fact that there are minor variances around the expected level is good news; it says that it's real — you expect some deviation, and I don't think we're running any greater deviation than one might expect.

**SLN:** *There seems to be a greater AT&T presence at Sandia these days. What's led to that?*

**Welber:** Well I think Tom Thomsen [President, Technology Systems Group, AT&T Technologies, Inc.] has felt that there wasn't enough contact among Bell Labs, AT&T, and Sandia, and he has asked his PR people, among others, to make sure they're aware of what's going on here. So today you find in the Bell Labs and AT&T publications far more reference to Sandia than before.

**Bray:** As we went into contract negotiations, we looked at reasons that AT&T should continue to be involved. That issue was driven by the divestiture and all the changes that occurred since the divestiture. We gave sufficient reason to continue the AT&T contract, but — given, for example, the ES&H problems in DOE and at Sandia — AT&T has to have a significant level of sensitivity now about our role: Are we likely to embarrass them? Is the next headline going to mention "AT&T Affiliate Sandia Albuquerque"

**I believe that AT&T's still driven by a very strong attitude of patriotic good citizenship. —Jones**

que" instead of "duPont Affiliate Savannah River"? AT&T understands that those possibilities are real and is concerned enough to want to be involved and protect its reputation.

**Jones:** Lee, I agree with everything you've said, and maybe folks did sit down and think it through that carefully. But, gosh, when [AT&T Chairman and CEO] Bob Allen was here and we

briefed all the Board members, I came away, frankly, believing that AT&T's still driven by a very strong attitude of patriotic good citizenship.

**SLN:** *One more question, about something we looked at pretty carefully last year: health-care costs. Did we make some progress there?*

**Bray:** We hope so. We've announced our new "HealthSmart" program, and we believe it will help to control our health-care costs and continue to ensure a high-quality health-care program for all our people.

We're increasingly concerned, of course, that our health-care costs have continued to outpace inflation — and Sandia's budget, from which the health-care program must be funded. In fact, our costs have risen 400 percent in the last 10 years. We hope that HealthSmart, which mandates a review of major procedures by a health-care utilization firm, will help us decrease the rate of increase [see "Changes in Medical Care Plan," this issue].

**Jones:** The point is that it's a continuing, even growing, problem.

**Bray:** Oh, it is. It's growing. Nationally, health insurance rates for the last part of '88 and all of '89 are expected to increase on the order of 35 percent. So, nationally, it's still moving every bit as fast as it has been, and I don't think it's going to slow down soon. And, believe me, everything you see from the federal government calls for more cost shifting to private industry.

**Jones:** Today, the medical skills exist to do total organ transplants, and those are enormously expensive.

**Bray:** That's part of the problem. We have the capability — or we think we do — to do those things, so we feel we can't give up. But they're so expensive.

**Welber:** On the other hand, there's a surplus of hospital beds in this area.

**Bray:** And in most places — and a surplus of doctors. There's opportunity for negotiation.

**SLN:** *How does the preferred provider option that's now a part of our dental-care plan fit in here?*

**Bray:** It's a very small step, but it's a start. What we did there was not to take the current benefit away from anybody but to provide an alternative. We had, at last count, 32 dentists signed up in the Albuquerque area. If we can get enough signed up, we might be able to tilt that thing a little bit and at least control the growth.

We're not going to save a lot now. But if we could start a similar program with the doctors and hospitals, we might be able to pull that cost-growth curve down. But it's really too early to say what we're going to do.

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tomers" is the right word — it's better than "sponsors" or "patrons" because it implies an obligation on our part to deliver a product or a service, not just to spend their money.

You asked about strengths. One of those I think we too often take for granted — but which should be recognized as a Sandia hallmark — is the ability to move quickly when we need to. We saw it this year in our retrofit of the B53, for example. We'll talk about that project later, but the point is, we must never lose that quick-response capability.

**SLN:** How about some other strengths?

**Jones:** As we work for more and more customers, I think we're realizing that what we can offer to the government is not only fast turnaround but also the capability to deal with high technical risk (which is often associated with fast turnaround), to give exceptional consideration to safety and reliability, and, of course, to offer an almost unmatched breadth of facilities in terms of hardware and software — plus the people with the talents to exploit those facilities. These are the areas in which we can offer a special service to the government.

I was reminded of that fact by a phrase in a 1949 Harry Truman letter, which is one of the documents that underlies our contract [the contract under which Sandia is operated by AT&T for the DOE]. The phrase is "exceptional service in the national interest." I think all Sandians could do well to think of that phrase; it's relevant to how we pick a job, how we do our work, how we treat our customers, how we spend the taxpayers' money.

"Exceptional service in the national interest" — that's why we're here. We can render special services that don't quite fit in industry. We're special. Those are the strengths we ought to emphasize.

**Bray:** It — that phrase — ought to be on everybody's wall around here.

**Welber:** One caveat here when we talk about the breadth of the laboratory: It's an area that has both pluses and minuses. At the Large Staff Conference that we conducted last fall, one of our speakers was John Foster, former director of Lawrence Livermore National Laboratory, then in the Defense Department, and currently with TRW. In noting the special position that Sandia occupies, he reminded us that we must be very careful in using our breadth so that we do not find ourselves in competition with industry.

Many large companies feel they have this breadth as well, so as we extol this strength, we have to be careful that we not sound as if we're competing. Ideally, we should have others — our customers — extol it. And that's another theme we'll want to comment on later [see "Challenges for Future" heading below].

**Accomplishments and Implications**

**SLN:** Given this context, how do you feel that we did during the year? Did we get the job done?

**Welber:** Yes, we did. The Sandians who worked so hard during 1988 really accomplished quite a bit in almost every area, especially weapons — where we really did a fantastic job — and in research — a number of breakthroughs there again. Just take a look at the "Labs Accomplishments" section of this LAB NEWS issue.

And I think our reputation continues to be looked upon as excellent in Washington, and that is going to help us through some of the severe times we face when, as we said, DOE funding may erode because of environmental problems.

**Jones:** A major accomplishment for us in this past year has been the completion of the development program for the W88, the warhead for the Strategic Navy's Trident II sub-launched missile. The FPU's [first production units] have been built, and we're now supporting the IOC [initial operational capability] phase — the first boats will go to sea on schedule.

When you look back at what we undertook in Trident II in total — the fuzing system, programmer, timers, and so forth — you realize it was an extraordinarily ambitious program. I'm much aware of the work by systems folks in 5000, components

folks in 2000, testing folks in 7000, above-ground test simulation folks in 1200. But throughout the Labs, Sandians have helped solve Trident-related problems, contributing everything from reliability assessments to the detailed testing programs.

Our submarine-launched nuclear weapons are one of the mainstays of the nuclear deterrent. Sandia remains committed to supporting that deterrent.

**SLN:** Was our Trident II performance related

**The Advanced Bomb [program] is an important portent of things to come. —Welber**

*to the Navy's choosing Sandia to help develop its new conventional weapon, the Advanced Bomb?*

**Jones:** No. The Strategic and the Tactical Navies tend to be separate.

**Welber:** But I think the Advanced Bomb is an important portent of things to come. It's an area we have not been involved in before, it's non-nuclear, and it's based on our reputation for getting things done. We'll be working with China Lake [the Navy's primary conventional weapons lab], which has traditionally had total responsibility for the Navy's non-nuclear weapons; that will require close, careful cooperation. But we're a partner on this thing now. I think the future's going to have more partnerships with both industry and other laboratories.

**Jones:** I'm pleased with the way it worked out. China Lake will be in charge of the overall program; our major contributions will be in the areas of the case, the aerodynamics for a penetrating bomb, and the AF&F [arming, fuzing and firing] system.

**Welber:** We really have expertise in those areas.

**Jones:** And, in the long run, we're well served by teaming with other government agencies.

**SLN:** Back to the Trident II — was it more difficult than the original work we did on Polaris and Poseidon? If so, what made it more difficult?

**Jones:** Well, certainly it was no more difficult than the original Poseidon, which was a quantum jump into the field of MIRVs [multiple independently targetable reentry vehicles] for the Navy. But I believe it was a more complex job than the W76, or Trident I, system. For example, our new RUPL [radar-updated path length] fuze.

**SLN:** Any unclassified details?

**Jones:** We can't go into any specifics here, but the big improvement since the earlier Poseidon/Trident I system has been a dramatic increase in the accuracy capabilities of the RV. That made feasible the new RUPL fuzing concept. Just before impact, it can now sense the ground with radar; that information, along with the path length measured from deceleration data, allows adjustment of the point at which the weapon would burst for maximum effectiveness.

It's really a dramatic change in the way the fuzing function is accomplished, and it poses some dramatic challenges. For example, measuring the path length requires very high-precision quartz timers that can withstand radiation exposure, long-life thermal batteries, on and on and on — new developments across the board.

There've been a string of Trident II test flights now, and Sandia components have worked flawlessly in every one of them.

**Welber:** That dramatic increase in missile accuracy you mentioned — that's a function of the tremendous advances made in semiconductor capability since Poseidon and Trident I days.

**Jones:** That's true. Another very large advance has come through Draper Laboratories' work in inertial guidance systems. That work opened the door for us to increase weapon effectiveness through the RUPL concept.

By the way, the Trident II was a very tough job for us, especially in this past year with some problems in our microelectronics facility — the fire there the year before, the realization that metallization fractures in alumina-coated lead-ins could occur with thermal stresses. Allied-Signal [formerly Bendix Kansas City] and Sandia, working together, have been able to pull the microelectronics chestnuts out of the fire and achieve the IOC date. I can tell you that that's been no small feat, and I think we can take a great

deal of pride in the way we've been able to pull together both within the Labs and within the Nuclear Weapon Complex to make that happen.

**SLN:** Let's talk about some of the other weapon programs — those that deserve some special attention here.

**Jones:** Well, another one that we can take pride in is the B53 retrofit program. A full weapon-development program typically takes eight years — if we're in a real rush, we might get it done in six. Now, although it wasn't nearly the magnitude of a full development program, the B53 bomb (which was brought out of retirement to stand alert) needed some safety upgrades. In just 11 months, we were able, working with the production complex, to do the design, development, and manufacturing and to get the retrofit kits out into the field. I take real satisfaction in that.

**Welber:** Another accomplishment that we pulled off in very short order was to improve the "use-control" on the Stinger missile. Our government wanted to make sure that Stingers, which are getting rather wide use throughout the world, could not be used against us and our allies if they fell into hostile hands. But they didn't want the weapon to be heavier or more difficult to use. Well, in very short order — six months or so — we came up with a solution that satisfied folks at General Dynamics (the manufacturer of the Stinger), who had asked us for help because of our experience in use control.

**Jones:** It's now been turned over to General Dynamics for inclusion in the system and in future production. But it was a nice, fast response again. Both of these are good examples of what I said earlier about quick turnaround as a hallmark of Sandia.

**SLN:** Any new weapon systems that you predict might reach Phase 3 in 1989?

**Jones:** I'll be very surprised if we don't have a TASM [tactical air-to-surface missile] for use in Europe, and I think there's a high likelihood that we'll be working on an FOTL (follow-on to Lance) missile, again for Europe. Just exactly how those systems are going to trade against nuclear artillery shells — W82, W79, and so forth — is still uncertain. The answer lies in the political arena, not in the technical arena.

**SLN:** How would you summarize our weapon program for 1988?

**Jones:** It was a good year. But we had, and continue to have, a very heavy committed weapon work load. It's straining us.

**Welber:** Especially at Sandia Livermore.

**Jones:** They have the W82 development, SRAM [short-range attack missile] development, a heavy load.

**Welber:** So heavy, unfortunately, that they've had to cut drastically into their tech base activity, and that gives me grave concern because they have some very good work going on there.

**Jones:** But, again, that's the level-of-effort concept: When we have a heavy committed work load, then we have to cut back on some of the tech base work.

**SLN:** You said last year that you wanted to move things back and forth between Livermore and Albuquerque. Have you succeeded at that?

**Jones:** Yes, I think so. But it's easier to flow things this way [to Albuquerque] because we're so used to that — Livermore doesn't have an Organization 2000 so they must come to Albuquerque to get component development work done. And in other years, we were flowing some work out there. It goes back and forth.

But whether we can maintain two of almost everything in tight budget times is an issue we're going to have to grapple with. For example, can we afford two separate computing centers, both manned

**[Fundamental research] is remote only in time. —Bray**

with very expensive Class-7-or-greater supercomputers? That's a heavy-duty issue for the Computer Committee to grapple with.

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*(Continued from Preceding Page)***'Exceptional Service'**

**SLN:** *But don't we send computing work back and forth via cable and microwave?*

**Jones:** Yes, we're making some progress there, but still not nearly enough to allow full sharing of resources.

**SLN:** *One final weapon question — what about earth and/or water penetrators?*

**Jones:** They seem to be on hold for a year or two at this point. I think the slowdown is due to problems in the proposed military delivery vehicle, which we can't discuss here.

**SLN:** *Let's get into our research program now. How does it tie into the kind of weapon work we've already mentioned? Some of our research — for instance, superconductivity and parallel processing — seems pretty remote from, say, the Navy's problems.*

**Jones:** Are they? Well, consider the quartz oscillator that's going into a Trident II timer, which has to survive a very intense radiation environment. That oscillator is based on an understanding of the effects of radiation-generating color centers that cause frequency shifts, understanding we gained through fundamental research 15-20 years ago.

**Bray:** It's remote only in time.

**Welber:** That's the point, of course. You can ask yourself "What is superconductivity going to do for me a year from now?" Maybe nothing, but . . .

**Jones:** . . . But maybe something — we can now lay down good superconducting films in conjunction with new compound semiconductor devices. One of these days, we could have an amazing circuit in terms of speed-of-computation. The challenge — to get back to the underlying question — is that it really puts a heavy responsibility on both the research organization management and individual researchers to think about what they're working on and to let their minds expand, be visionary, and work in those areas that in some cases only *they* can see or dream are going to feed into our business in the future.

I clearly don't support research just for the sake

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**The research we do has to be germane to our mission . . . or at least has to be able to aspire to a role in that mission. —Welber**

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of research. Sandia's never been the kind of laboratory willing to ante up the bucks for somebody to work on something that's disconnected from its business.

**Welber:** That comes right from the Bell Labs heritage — the research we do has to be germane to

our mission, has to have a connection, or at least be able to aspire to a role in that mission.

**Jones:** All our research programs won't impact our mission, but they all start out headed in that direction.

**SLN:** *How about our parallel processing work?*

**Welber:** I asked Venky [Narayanamurti, VP of Research] the same question just the other day. He told me that we are now beginning to apply our parallel processing capability to problems in synthetic aperture radar. SARs need tremendous amounts of computation in order to take in information and process it to get an image out. So that is the next step — looking at real problems, not just problems designed to show the speedups possible.

**Jones:** But let's give some credit for the speedups too. It's really quite amazing what our computing/math groups, a new initiative just a few years ago, have accomplished in parallel processing — winning of the Gordon Bell prize, the Alan Karp Challenge, SUPERNET at Sandia Livermore (the Linda-related work with Yale). Again, this work shows how quickly Sandia's been able to make an imprint in a new area.

And this work is very high leverage to the kinds of things we need to be able to do in the future — target recognition, for example; that's one of the fun-

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**Trust, Faith — and Performance**

**SLN:** *Throughout this interview, the terms "customer" and "customer satisfaction" keep cropping up. In the context of a nonprofit R&D lab, what are the implications here?*

**Bray:** Each of us has a customer; some are outside the Labs, but, more often, they're inside — customers of our research people might be in advanced development; their customers might be in development; *their* customers might be in systems; and so on. And our job really is to maximize the success of our respective customers.

That means understanding how we can support our customers in whatever they're doing by doing our job in such a way that we're maximizing *their* success. If we're always mindful of what it takes to do that, we'll do a better job of supporting them — we'll be more attuned to their needs and, when we do that, they'll become more aware of what we're doing. That's also important; we'll want to come back to that.

But right now, if I could put one thought in the minds of all our people, it would be: Remember, your job — whatever it is — is to maximize the success of your customer.

If you're a secretary and you're typing for your boss, you're trying to maximize his or her success by getting the best memo out. Every one of us has that same obligation.

**Jones:** Another way of maximizing your customer's success is be sure that you're part of the customer's team, that you don't see yourself as standing off to the side doing a certain piece of something that you just hand off. You have to be a part of the customer's team in helping solve the customer's problems.

**Bray:** It all gets back to the concept of customer satisfaction. That's important all the way through the customer chain inside Sandia, but

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**Each of us has a value-added function for a customer. —Jones**

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it's absolutely essential at the end of the chain — the end customer outside the Labs.

**Jones:** As Lee pointed out at the management assembly last fall, each of us within the Labs has the responsibility to add value to whatever we're working on. Each of us has a value-added function for a customer that receives and adds more value till finally the product goes out-

side the Labs. And, as an R&D laboratory, we darn well better have added value for the end customer.

**SLN:** *But what do you do when end customers don't recognize that the value added has to be paid for in a tech base, that they're getting the benefit of things they don't see?*

**Bray:** That's where we have to do a better job of helping the customer understand what went into the product or how significant it is. More important than the technical significance of what we did is its significance to the customer. It can be a great technical achievement, but if it has only marginal additional value to the customer, it's seen as just marginal improvement.

**Welber:** But it's no simple problem. The connection of our tech base activity to a customer is tenuous — although as Orval pointed out [in the discussion of the role of research; see main story], our components today are built on the fundamental research of 20 years ago.

**Bray:** That says that the people who are part of the tech base — researchers, say — have to earn their stripes, not with the end customer,

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**The value of your contribution is assessed by the next link in the customer chain. —Bray**

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but with the advanced development people or the systems people. And to the degree those folks are satisfied with the researchers' efforts, they've succeeded.

Now, they're dealing with sophisticated customers — people who are smart enough to recognize that a coupling is weak or the time intervals are long and a lot of other things. The point is that the value of your contribution is assessed by the next link in the customer chain.

**Welber:** It's subtle, it's very subtle, because the further you are into research, the more time-removed you are from an application. And the memory gets hazy as to the value of that piece of research.

**Bray:** If you're asking, "Can you unbundle your cost structure for a customer?" the answer's no. And if you're trying to justify your cost structure to a customer, you've got problems. Now, all that says is that, at the end, we'd

better be delivering a great product!

**Jones:** It cycles around to performance. As long as you're not out of line on cost, and performance is excellent, there may be grumbling, but I think you can get your tech base supported. That doesn't happen automatically though — you've got to work at it.

**Welber:** You can say it over again: If our customers feel they're getting value from us for their money, and trust us to do what we do because we met their schedule, then they'll believe us when we say, "Look, you've got to trust us when we say we've got to spend X amount of your money on tech base, because it's the tech base that has permitted us to serve you."

Really, it comes down to trust and faith — and performance.

**Jones:** That's exactly the relationship we've developed with, for example, the Strategic Navy through our work on Poseidon, Trident I, Trident II, and other weapons. Frankly, it gives me a humble feeling to realize how much confidence they have in the Labs, but it also makes me proud.

**Sandia's Major Challenge**

**SLN:** *We've talked about the growing importance of our work for others if we're to*

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**The challenge [is] to retain our traditional values in an increasingly cost-conscious world. —Jones**

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*maintain a full-service laboratory. What are the implications of that work in terms of customer perception of the Labs?*

**Jones:** If you were to ask what, in one word supplemented by a sentence or two, is going to be Sandia's major challenge in the future, the one word would be "cost" — and the challenge would be to retain our traditional values — quality, reliability, innovation, quick turnaround, and so forth — in an increasingly cost-conscious world.

Remember, we still carry with us the "diamond-stamp/gold-plate everything" image that grew out of the nuclear weapon business, especially the nuclear weapon business of the past.

And when we get out into the world of

*(Continued from Page Four)*

## 'Exceptional Service'

damental problems in both the nuclear and conventional arms arenas, especially as you talk about identifying mobile targets. Remember that the Soviets are well ahead of the US in putting mobile missiles into the field. Both SARs and parallel processing are vital in solving that problem.

**SLN:** What about the energy business?

**Welber:** Well, it may be energy's turn to get some attention — again dictated by the environment, this whole issue of the greenhouse effect, the effect of CFCs [chlorofluorocarbons] on the ozone layer, acid rain. All of these issues directly affect the nation's views of solar energy and coal combustion, even of nuclear power. In fact, we're getting rumblings that some of the most severe critics of nuclear energy are beginning to have second thoughts because of the environmental impacts of other energy sources.

More to the point, the Japanese have asked us to consult with them because of our experience in nuclear safety analysis. They want to build a nuclear safety facility to emphasize the technology of nuclear safety in power plants, and they're taking a long-range view. If they can build a facility that allows them to gain some new understanding of nuclear

safety, then they may generate a new confidence on the part of the public. And then they could design these improved nuclear power plants, perhaps become the world supplier.

**SLN:** One of Sandia's goals is to assist American companies in becoming more competitive. How does this work with Japan fit in?

**Jones:** There's a long-standing relationship between the US and other countries, going back to the Atoms for Peace program, and we share a lot of nuclear technology in the safety area. So I would expect that, since nuclear power is stalled out in this country, our general view — and the DOE's — would be "if another country can increase world acceptance of nuclear power, we ought to support it." In the long run, I believe it's to the benefit of the American public.

**Welber:** I hope it's a direction we're going to see this country taking — greater acceptance of nuclear energy.

But I think that the nation's environmental problems — acid rain, greenhouse effect, and so on — are also going to mean more research in how to use the 300-to-400-year supply of coal we have in the ground in the cleanest possible manner.

**SLN:** Do you see anything in the new administration or the new Congress that suggests a will-

ingness to put more dollars into research on coal burning?

**Welber:** That's one of those chicken-and-egg questions. If, because of our research and advanced development, we come up with a great idea, we can generate support. But without an idea that looks like a sure winner, then we're asking people just to support research to generate the good idea.

**Jones:** And, of course, we don't know the new Congress yet. But I'm really pleased to see [former NM Representative] Manuel Lujan named the Secretary of Interior because he understands the coal program and appreciates the needs there.

**Welber:** We're also beginning to work with MIT and Harvard to gain a better understanding of global problems such as the greenhouse effect. We hope to use our expertise in instrumentation and systems engineering to see whether a partnership could begin to shed some quantitative light on these issues.

**Jones:** This MIT-Harvard-Sandia relationship represents another dimension of our responsibility to transfer our energy technologies. Getting our technologies outside the Labs will allow us to point to the success of our energy research. We have a lot of successes — from better blasting technologies, so our powder companies can be more competitive with the overseas powder companies, to record-breaking photovoltaic cells and systems. Good ideas abound in 6000.

**SLN:** What's happening in our work for the NRC [Nuclear Regulatory Commission] and in Bill Snyder's [6500] area?

**Jones:** Well, the Congress put the NRC on a reduced diet, and, in addition, we've shifted some resources out of the NRC program. But I think we're in good equilibrium there. We still have a very strong program.

In our magnetic fusion program, our limiters are sought after around the world. In fact, we have Sandians spending six months at a time in Europe and Japan, and concepts from around the world are brought here to be tested on our machines.

Bill Snyder and his group continue to push toward renewing existing nuclear power plants, improving the reliability of nuclear reactors and, ultimately, pressing for intrinsically safe nuclear power. I can't say that we've made big inroads yet, but Bill's very much respected in the business and I think we're doing the right thing.

The nuclear waste management program could probably grow a great deal more than we've allowed it to; but, like the SDIO program [see below], it's a question of balance. The Labs strategy here is to try to pick carefully the areas in which we work in terms of their leverage and whether we can make a really significant contribution.

**SLN:** We've talked here at some length about the implications of our energy program. What's its state of health in general?

**Jones:** We have a solid energy program. There are some 600 direct FTEs [full-time equivalents] working on it, and they in turn are able to draw upon the resources of our laboratory tech base. But the program is fragile. Some groups are really hurting because just a little downturn in their budgets, given small budgets to begin with, has a big effect. But we're still able to do good things. I would be discouraged if we see the new Congress and administration tightening down even more.

**SLN:** Do you think we can maintain 600 people?

**Jones:** Yes. We were moving down towards 500, and one of the challenges put to Dan [Hartley, Energy VP] was to stabilize that program, and in fact it's grown some. As a result, this year — in terms of budget — we're better off than we've been in the last three or four.

**SLN:** The tech transfer group was recently moved out of Legal and into the energy organization. Why?

**Welber:** Well, here is a line organization that's been extremely successful in transferring technology to the energy industry, and here is tech transfer, which has become so important to us. So it should be in an organization that has that experience. We hope

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## Customer

potential customers who don't really know us very well, that's one of the first things that comes up — "You know, we're not sure we can afford you. We've heard you gold-plate everything; we don't need any gold-plating."

I believe completely that we build reliability, we build quality, and all those things. But, in the broadest sense, quality is more than just reliability. It's something that . . .

**Bray:** It's at a cost the customer is willing to pay.

**Jones:** That's right. And, in the '90s, we're going to have to work very aggressively at that. I'm confident we can. We've got smart people and a strong engineering-based organization. If anybody can do it . . .

**Bray:** And it's not just the technical side of the house. We have to watch our costs everywhere . . . construction . . . all procurement . . . make sure we're spending all our funds wisely.

**SLN:** What should we be doing to increase our cost-consciousness?

**Welber:** Glen Cheney [2000] recently reviewed for Small Staff the effort now under way for standardized parts. If we could standardize the parts our designers use and work with our suppliers so that they will supply parts that meet our reliability requirements, then the production agency doesn't have to do incoming tests on all parts; that would be a major step toward reducing costs. That's one way.

**Jones:** Another is that we must carefully think through the high-leverage technical areas where a new component could make a big difference in function and cost.

**SLN:** Such as?

**Jones:** Let's say in an environmental sensing device. For example, we use rolamite now, big rolamites and small rolamites. We've had a lot of production difficulties with small rolamites, but there are applications where you need the kind of capability of a small rolamite.

A replacement technology may be a quartz-based digital accelerometer of some kind. And, this year or next year, we could go right into production with some kind of QDA. But, at this point, we do have the rolamite manufacturing process under control, and there's some question as to whether we could put the QDA concept into production without having to solve

production problems during manufacture.

So that's an example of an area where there's a leverage point. We ought to work to bring new technology along, and we ought to commit resources to have it ready. Then, when it's ready — and not before — send it to the manufacturer.

That requires discipline on our part. First, we have to recognize we can't do everything — we can't work the whole waterfront simultaneously. We have to pick some areas, peak them up, make real progress on them, get them ready, and then bring them into the next system so that they manufacture easily without scrap and rework, loss, nonconformance, SXR's [special exception releases], and so forth. These production problems may not cost us a lot of money, but they take a lot of money out of DP's [Defense Program's] pocket, and eventually that cycles back and comes out of our budget.

**Bray:** One further point here: As we work more and more on reimbursables where the deliverable comes in smaller packets and there's a tighter link to deliverable cost, I think our peo-

**The people doing reimbursables have it for real — it's a learning experience.**

—Welber

ple become more sensitized to that relationship. And then, with our post-and-bid movement of people, I think that cost sensitivity will diffuse throughout the Labs, and we'll be able to bring that same mentality into the MA side of the house.

**Welber:** That's really important — we can only talk about it, but you've got to be immersed in it and get rewarded for doing a good job — or get punished for not doing a good job.

The people doing reimbursables have it for real — they have a customer who's agreed to pay so much money for a deliverable, and there's a date, and there's a product. It's a learning experience.

**SLN:** Do you think there'll be a time, Irwin, when you can go home and say to your wife, "They think I'm cheap at the Laboratories"?

**Welber:** My wife knows that already.

**Jones:** How about "value-conscious"? We don't want to be cheap!

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## 'Exceptional Service'

it's going to pay off in its new home.

**Jones:** I'd like to make it clear to employees that putting the tech transfer function in Organization 6000 doesn't mean that our interest in tech transfer is now being focused on, or limited to, energy.

**Welber:** Exactly.

**Jones:** We felt that the connectivity in 6000 — an organization that's been heavily involved in tech transfer and knows how to do it — will serve the entire Laboratories.

**SLN:** Do you expect the tech transfer function to grow?

**Welber:** It depends on how successful we are in it. It could be a growth area.

**Bray:** We might see a few more people.

**SLN:** If our Defense Program budgets decline, we're going to be more dependent on our work for others, our reimbursable programs. Let's start with our work for SDIO [Strategic Defense Initiative Organization].

**Jones:** Our program with SDIO is strong. General Abrahamson [recently retired SDIO director] was here last fall and gave us a vote of confidence by continuing funding of several programs that we had worried might be cancelled because SDIO is facing tight budgets too. Delphi, for example, was one that we worried about, but that's now been funded for another year. [Delphi is a laser- and electron-beam concept for distinguishing incoming reentry bodies from decoys.]

I think we're in a good position in our SDI programs. As we planned early on, we're broadly diversified — our work covers the whole SDI cycle from threat studies to development of rocket hardware and instrumentation, from system studies to physics investigations. We're not concentrated in a single enormous piece of hardware development. I'm comfortable with how we've positioned ourselves.

**SLN:** Any particular successes in 1988?

**Welber:** How about the EPOCH experiment?

**Jones:** We've shown that, in the earth's magnetic field, we can transport a stable electron beam along a laser channel over rather substantial distances. Some of our best successes have to do with our rocket group and our ability to launch actual experiments into space.

**SLN:** How about the reconnection gun?

**Jones:** All of us continue to think it's a great technical idea. The group has had some marvelous success already in propelling projectiles to greater than 1 km/sec. — over very short distances. As I've said before, it's a great solution, and we believe we know a number of problems it could solve. Unfortunately, we have not been able to capture the interest of funding agencies, so we're in a taper-down mode right now. If the program is to remain healthy, we're going to have to find a customer in the next year.

We continue to make good progress on the FALCON [fission-activated laser concept], and the Hawk Experimental Facility has allowed us to explore the lasing physics.

**SLN:** You're encouraged by progress on FALCON?

**Jones:** Yes; it's a record of steady progress, but we still have major issues to explore involving beam energy extraction and beam quality — the divergence problem. And, in a separate area, we've made excellent progress in PBFA II [Particle Beam Fusion Accelerator II] in terms of beam focusing . . .

**Welber:** The plasma opening switch has given us a feeling of confidence.

**Jones:** And the lithium-ion beam source is coming along; these have all been difficult problems. But the really exciting events during the year in Area IV have been fabulous successes in bringing up Saturn and HERMES III. [Saturn simulates X-ray effects of nuclear weapons; HERMES III, their gamma-ray effects.] Literally, they've been operating from the

first shot forward. They're a real testament to our capabilities in these areas.

Another exciting development coming up this year in Area IV is the completion of the SDF [Strategic Defense Facility]. Both AGT [above-ground testing] and our UGT [underground testing] people will be brought together there. We're really looking forward to the synergisms that we think that proximity's going to produce. I think it'll be a guaranteed winner for us.

**SLN:** Speaking of AGT, any recent developments toward a Test Ban Treaty? How would one affect us?

**Jones:** Well, it's easier to answer the last part first. I think we're well positioned regardless of what happens, given our AGT facilities. They're essential now. Under any context of a test ban treaty, they'd be crucial. That's why Saturn and HERMES III are so important to us. As to what's going to happen on the international scene, my impression is that a test ban is pretty much at a standstill right now. We'll have to see what position the new administration takes.

**SLN:** Speaking of treaties, how about TOSI [Technical On-Site Inspection] and the treaty-verification efforts related to TOSI?

**Welber:** Before I answer that, let's mention a couple of Sandians who have been honored for their work in this internationally important field. One is Stan Fraley [9241], who won the Secretary of Defense Medal for Outstanding Public Service for his work as the US chair of the US-USSR Inspection Protocol Working Group during the INF [Intermediate-range Nuclear Force] negotiations in Geneva in 1987.

The other is Horace Poteet [DMTS, 9115], a recent winner of DOE's Certificate of Appreciation. He participated in the Joint Verification Experiment with the Russians in Nevada, and he was at Semipalatinsk for a month working with the Russians on the JVE there.

Back to your question — one big problem with verification is, "Will we agree with the Russians on whether we use teleseismic techniques, or will all nuclear tests have to be verified by CORTEX?" And that's an issue that we will participate in. [CORTEX, Continuous Reflective Radius Time Experiment, is a device that measures the yield of a nuclear device used in underground tests.]

But for TOSI itself, which provides verification that treaty-banned weapons are not manufactured, we created a concept and design of which many elements are now in use in the Soviet Union. The Russians apparently feel that TOSI technology can be used, as evidenced by their acceptance of it in their country. Whether they adopt it for their application in the US or not, we don't yet know, but I think it's been quite a success.

**Jones:** That's undoubtedly true. I think we remain preeminent in the verification area. A lot of our attention is turning at this point to the development of tags — unique identifiers for treaty-controlled missiles. It's a very challenging technical problem, creating a "fingerprint" that can't be removed, falsified, or replaced — and yet can be put on a missile easily and inexpensively. One of the characteristics of the verification control program is that the operations are very expensive. This calls for really good technical solutions with a real concern for cost.

**Welber:** Our tagging concepts are mainly still in development. We've reduced them to practice, but the question is, "How will they be applied to actual missile bodies in the field, and how will the tag be confirmed?"

**SLN:** Is treaty verification apt to be a growth industry?

**Jones:** I would never characterize verification as a growth industry. Funding always seems to be difficult. Yes, I think there's going to be some growth — and I think we're in an excellent position to participate — but my personal view is that it will have limits.

**SLN:** What about other reimbursables? They obviously have to take up the slack if we're going to maintain a certain size Laboratories if other areas decline.

**Jones:** Well, our NSAC [National Security Advisory Committee] has the basic responsibility for

reimbursables, although we have some reimbursable work in EAC [Energy Advisory Committee], such as the NRC program. NSAC has just reassessed its customers' needs and funding capabilities, and it's a positive view. I think we can look at that with some assurance — the advanced bomb program that we mentioned earlier is an example.

We're also now seeing a substantial renewal of interest in SWERVE [Sandia winged energetic reentry vehicle], which pleases me. NASA's [National Aeronautics and Space Administration] interested, DARPA's [Defense Advanced Research Project Agency] extremely interested, and so SWERVE seems to be rising phoenix-like as a test vehicle. We've always seen it as a Sandia test bed, but now it could become a national test vehicle; that's very exciting to me.

**Welber:** It's about the only existing technology that comes close to the kind of capability the NASA folks are looking forward to in their national space platform.

**SLN:** Because of the guidance system?

**Welber:** And its speed, maneuverability.

**Jones:** It operates in a regime where this country doesn't really have any other data. We almost have a lock on the aerodynamic data in those regimes.

Our satellite program has expanded too. That's an area that's difficult to talk about in detail, but it's been an area of Sandia excellence for a long time — our very high reliability, our special instrumentation, and so forth.

Command and Control is a reimbursable area that hasn't completely jelled for us yet, but we have a variety of elements in place — the modular building block technology, the POCET [proof-of-concept experimental test bed] facility that we delivered to SAC [Strategic Air Command] last year, which gives them a mobile communication capability.

I think we've made some real progress in the last year in the recoding of weapons. We've now been able to get enough of the new PAL controllers out into the field that the services can look forward to

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**Sandia is in a unique position to look at the whole issue of Command and Control from the very initiation of the command at the White House . . . to where it ends up inside the missile.**

—Welber

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not having to send recode teams out — recoding can be done at the unit level. That's really quite an advance, and will lead us into the next step — crypto-PAL units and the handling of coding information at the headquarters units overseas and the automation of message decoding and handling. These are areas where we're working hard — splendid activities for Sandia — ones we need to give every attention to.

**Welber:** Sandia is in a unique position to look at the whole issue of Command and Control from the very initiation of the command at the White House, through the chain of command, to where it ends up inside the missile. That's a very intricate and complex problem.

**Jones:** And there's a lot of national interest right now in Command and Control that did not exist in the '70s but picked up in the early '80s. It's opened a variety of vistas for us, and, along with the National Security Agency, we're really an important player. I think there are real opportunities for us.

**SLN:** You see growth here then?

**Jones:** Yes, but not without effort, of course.

**SLN:** One final question on reimbursables: Do we have a contract with the Treasury Department to foil counterfeiters by "tagging" bank notes and currency?

**Jones:** My impression is that 9000's concept was the only acceptable long-term approach. It's based on two-key encryption concepts and unique characteristics — "fingerprints," if you will, built into a bill — and it connects right into our weapon security work and our verification and control programs involving tagging.

**SLN:** Before we end this discussion of our 1988

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## 'Exceptional Service'

*accomplishments and their implications, let's mention both computing and construction. What can you say about our computing environment?*

**Jones:** Well, you have to decide which computing environment you're talking about. We have central computing, we have distributed computing, we have parallel processing work, we have the PCs, and so forth. We have a tremendous investment in computing, and we won't be able to follow every direction as fully as some might like.

The computing budget this year, including CAD/CAM, was \$104 million. That's 10 percent of our entire budget, so it's something that we have to manage very judiciously. We've got a Computer Committee, and I've challenged its members to broaden their horizons to include the CAD/CAM area as well as just central computing. In the past year, we've put together for the first time a plan for distributed computing. Frankly, I was shocked at the expenditures proposed — an increase of some 20 percent. Clearly, given the tight budget, we're going to have to husband our resources carefully. For \$100 million, we should be able to do an enormous amount with computing; we have to keep it bounded.

*SLN: Let's move from one big-ticket item, com-*

**[In terms of facilities], we're in the best shape we have been in for a long time. —Bray**

*puting, to another, construction. What was done this year?*

**Welber:** We've made progress toward a far-sighted plan put together by Bob Peurifoy [7000] and his folks in 7800 — and it's been done at Sandia Livermore as well. The LAB NEWS did a story on our construction program last fall [Nov. 4], so we won't try to list them all here. But one I do want to mention is the new Primary Standards Lab; it will be a cornerstone for measurement standards throughout the whole DOE production complex.

We're having a little problem in getting funding for the second phase of the CRF [Combustion Research Facility] at Sandia Livermore, but we're pursuing that. The CRF has been so successful that we think the funding's well deserved.

**Bray:** All in all, I think we're in the best shape we have been in for a long time, and we still have half a dozen facilities coming on stream in the next few years. I think the only thing that we've not been successful with is our lease-to-ownership plan [in which a third party would construct and own a building that Sandia would lease, with lease payments applied toward eventual purchase] for administrative facilities. But we've taken an aggressive look at other facilities we can move people out of, then modernize and convert into better administrative facilities for some of our folks. I think we're in good shape and have good prospects for the near-term future.

A major problem is what we talked about earlier — DOE's needing so much money to do cleanup over the next 20 years. But, as Paul Stanford [100]

**The whole issue of the environmental cleanup is an area where the Labs can . . . bring technology to bear in meeting the challenges.**

—Welber

reminds me, over the last half dozen years or so, Sandia has made substantial investment in facilities and equipment; that investment has positioned us well for the future. So I feel pretty good about where we are at this point.

**Jones:** And I'm not willing to declare our failure on the lease-to-ownership of buildings a defeat. It would have required spending our operating money, and operating money's really tight too. I agree with Lee completely: I think we have an excellent complement of buildings, and several that are in the funding cycle will be completed no matter what happens.

### Challenges for the Future

*SLN: We've looked at some of our 1988 accomplishments and their implications, but — given those accomplishments and the context we talked about*

*earlier — what do you see as our major challenges for the future?*

**Welber:** The whole issue of environmental cleanup is an area where the Labs can play a role by bringing technology to bear in meeting the challenges. It's definitely an area where the Labs can play a role in reducing the tremendous costs — perhaps \$81 billion DOE-wide; some people say it's higher — for cleanup.

**Bray:** But in addition to asking ourselves, "Can we do something to make the cleanup less costly?" we also need to ask, "Can we develop technologies and processes that don't continue to add to the problem and thus pile up debt for tomorrow?"

**Jones:** Irwin set the stage for this very well at the Large Staff Conference this past September; he laid down three future challenges for us to address. The first we've mentioned — how can Sandia contribute to solving some of these environmental, hazardous waste issues? In the broadest sense, that includes "How can we do our designs in such a way that the production complex generates less waste, or waste of lesser toxicity?" We've got scientists in Livermore's Combustion Research Facility and Albuquerque's energy and research groups who can deal with everything from nuclear waste to toxic waste. Can we be party to helping come up with new techniques for solving those?

Irwin's second challenge is, "Can we come up with better design metrics, better design quality, so that the production agencies don't end up dissipating so much money in scrap, rework, waste, destructive testing?" — that's money down the drain.

**Welber:** So we have less to spend. It's like conservation.

**Jones:** John Crawford [8000] is chairing a Sandia Oversight Committee on Design Quality; John, Glen Cheney [2000], Everet Beckner [5000], Herman Mauney [7200], Dick Schwoebel [2500], and I have been visiting the production agencies that we work most closely with — Allied Signal, Kansas City Division; GEND in Pinellas, Florida; EG&G Mound in Miamisburg, Ohio; and Rocky Flats in Colorado.

Sandia management's visiting the plants because we want to convey to them the fact that we're dead serious here and we want to hear it the way it really is, on their turf. We'll also review the results of the Claassen Committee some years back where we set up the new design review approaches — seeing how well these work, grading our report card, taking into account the current needs.

We've got to think more about the customer, and, in this context, that means design quality. We've got to give the production agencies a design that they

**Sandia is realizing it's not appropriate any longer to rush technology into production and then solve the problems on the production floor.**

—Jones

can build. If we don't do that well, they'll waste a lot of money. So the big change is that we are realizing more and more it's not appropriate to rush technology into production and then solve the problems on the production floor. We cannot afford to be complacent about how much material the manufacturers have to throw away or how many parts they have to scrap. We have a different kind of challenge now — how to make each part manufacturable and affordable. So we have to ask, "Is it ready? Does it go onto the manufacturing floor smoothly, without waste?"

Let me give you an example: A Phase 2 design concept allocates the space available for a component. So the component is really sized in many ways at the time of Phase 2, even though all that's said may be, "We're going to do it in this much space, and it's only going to weigh that much, and we've got a few ideas of how we might do it."

Well, maybe we need to be thinking earlier about whether we can effectively build the component before agreeing to provide the function in smaller volume with less weight. We're going to have to focus our attention not only on the challenge of just tech-

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## Nonpermanent Compensation: A Learning Experience

*SLN: We've now had a couple of years of experience with nonpermanent compensation — Individual Performance Awards [IPAs]. What's happening there?*

**Bray:** As I told the technical division supervisors who make up an ad hoc advisory committee recently, we have been working with nonpermanent moneys because Bell Labs and AT&T are doing it — that's the primary reason. I know there are many who think that we ought not to be doing it.

But let me give you some background here. To the degree we do not follow Bell Labs and AT&T practice, we significantly weaken our position for continuance of our unique contract. So the only reason I think we should deviate from Bell Labs and AT&T practice is when we can demonstrate and document that to follow their practice would be detrimental to our service to the federal government. When we can't do that, we ought to follow their lead. I understand that the reasons for us to have nonpermanent compensation are somewhat different from the reasons for Bell Labs, but that doesn't mean that there aren't good reasons for us as well.

We've tried to let each vice-president determine how to administer the IPA program. And we've run into the expected problems that grow out of the lack of universal understanding or agreement or acceptance. I think now we'll probably pull back and see what lessons we learned from all that, and we'll try to define the best way to use nonpermanent compensation.

Unless we learn something more negative than we've learned so far, I'm convinced that there is a way to use it, and that we need to do it to follow the practice of Bell Labs and AT&T and to demonstrate to the DOE that we're not trying to pick the best of all worlds.

**Jones:** As I see it, we face a different set of problems in using nonpermanent compensation than does Bell Labs. For example, we don't generate a bottom line profit. We started by providing our vice-presidents with a lot of flexibility in using nonpermanent compensation. And we've developed a wide range of options for using the combination of permanent and nonpermanent pay. That's been a learning experience for us. We agreed when we set it up that we were going to look at it as an experiment; it's gone off in several different directions, but now we expect to pull those back together, extract the best from the variety of experiments, and codify it in the coming year.

**Bray:** The supervisory/advisory committee I mentioned earlier will help us sift out the best approaches and decide how best to handle it this coming year.

**Jones:** That committee, incidentally, is a group of division supervisors who work with the Compensation Department and then brief Lee and me so we know what first-line supervisors are grappling with as they do the performance review. We've met periodically over the last three years, and they've been very helpful to us. We've learned; they've learned.

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nical innovation but also on the challenge of manufacturability and quality.

**Bray:** Let me suggest another way to think of that design quality/customer relationship. I wonder what would happen if the design engineer stayed with the project all the way through to the implementation in the field — if he or she were accountable, not only for the design, but for the production and cost and the recalls and the field retrofits and all of that.

**Jones:** We heard exactly the kind of thing Lee's talking about during our trips to production agencies: "You folks dissolve a design team before we really settle the problems in production, and then you have a terrible time reconstructing the team when we have problems."

**SLN:** *What's been your response?*

**Jones:** Well, it's yet to be decided. But I'm afraid we have enough pressure and enough demands

**Farewell, Irwin!****Welber Tenure Ending**

**SLN:** *Irwin, your three-year tenure at Sandia ends March 31. What are your reactions as you look back?*

**Welber:** It's gone very fast! And it's been a wonderful three-plus years. Each day is a new experience, wonderful people to work with, what more can you ask?

I'm very grateful to have had the opportunity to serve here. I feel that Sandia has given me much more than I've given it. The opportunity to serve Sandia and, hopefully, serve the country — it's a wonderful way to go out.

**SLN:** *Will you continue to live — here?*

**Welber:** Sure, I'll continue to live, I hope. I plan to live here, and Governor Carruthers has asked me to chair a Commission on Economic Development and Tourism, which is already proving to be a very challenging task. And when the new chief science advisor for the Ministry of Defence in Great Britain was here a couple of months ago, he suggested that, after I retire, it might be interesting to consult with them on some of the issues that they face as they look toward more technology transfer. Well, some of my experience might be valuable to them. I think there are a lot of things I can do.

**SLN:** *What do you, Orval and Lee, see as the Welber legacy?*

**Jones:** I think Irwin's done a great deal in opening the line of communication, keeping it clear from top to bottom — the management assemblies are just one example of the real openness he's fostered.

**Bray:** I second that. Irwin's done a very good job of team-building, founded principally on a management environment that encourages open communication.

**Jones:** He's also had a strong effect on revitalizing the views of our national leaders about the importance of nuclear safety. He's taken a strong stand.

**Welber:** I've also tried to push for a national energy policy. I think we have an excellent weapon program, and our national security is protected well. But we really don't have an energy policy in this country.

**Jones:** And, finally, he eats in the cafeteria whether invited to sit at your table or not.

**SLN:** *I think that's a kind of legacy that not many presidents in the past can point to.*

**Welber:** Or would want to continue in the future!

**Jones:** Seriously, I think that's a good way to be remembered.

on us that we can't keep a design team just sitting there on call; we have to apply team members to other programs. Nevertheless, I believe we should keep a string on design team members. If there's a problem, they'll have to regroup even if they're in a new organization.

**Welber:** That's got to become a discipline. It's going to be tough to enforce, but, if we're serious about this, we'll really have to do that.

**SLN:** *It not only would require the design team member to do certain things but would require the new boss to do certain things.*

**Welber:** That's right, and that's where it gets tough. The new boss may not have the same sympathy for that project.

**Jones:** But here's another reason to move in that direction. We have been, I think, very poor in completing the component development reports on some designs. Too often the bibliography lists them as "to be published." When the design team breaks up too quickly and goes off on new jobs, they just never get back to that writing. There are more "fun" things to do.

In the Trident II program, we're trying to implement a really new approach — the job isn't done until the paperwork's finished. I'm very encouraged by the way the team is reacting.

The third challenge that Irwin put to us is "How do we in Large Staff, and Small Staff in particular, come up with measures on how well we're doing as an R&D laboratory — more specifically, how well are we managing the Laboratories?" In many ways, that's probably the toughest of the three assignments.

**Welber:** And that's why I asked Lee to look at that.

**Bray:** The charge was R&D effectiveness and we have met once as a committee. We realized pretty quickly that what we're really grappling with is management effectiveness. We're fairly comfortable in the assurance that our staff is able to do what needs to be done, if properly directed. But we've got some questions about our abilities to most efficiently provide direction.

Essentially, we want to be convinced that we have an effective mechanism to understand the needs and directions of the Labs and that we're able to move the levers in such a way that we can shift direction

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**We need to ask ourselves, "What do other people really know about what we're doing?"**

—Bray

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as we need to. We're not trying to develop a formula or a set of metrics. We think that, if we succeed, we'll be able to talk convincingly to others about the effective utilization of our tech base.

**Welber:** I agree with Lee — measure our effectiveness by, if you will, how effective our management is in determining what should be done.

**SLN:** *Isn't this a case of the fox guarding the hen house? How can you, as a manager, be an impartial judge of how well you're doing as a manager?*

**Bray:** You're right if we were to take a completely in-house view in making that judgment. But I think the answer lies somewhere in our level of customer satisfaction. We're asking, "How well are we satisfying our customer?" and to the degree we're satisfying the customer well, we have an effective system [see "Maximize the Success of Your Customer"].

**SLN:** *What other challenges are out there?*

**Bray:** We lack a sufficient outward view. We have a little bit too much of an inward focus. We should always start with the customer's concern — how does the customer know he's getting the biggest bang for his buck?

We may have created a little bit more of an "arm's-length" relationship with DOE than we should have. It might have been better to bring their people here more often and show them how we're doing — and let them be singing our praises to others better than they have been.

**SLN:** *Isn't it a part of Sandia's corporate culture to do a good job and shut up about it?*

**Bray:** That's true, and we shouldn't toot our

own horns, turn on the neon lights, and so forth. But we need to ask ourselves, "What do other people really know about what we're doing?" We need to recognize that, in some cases, their perception may be more important than what we're really doing.

All we have to do is think about it — do the good job we do and be mindful of what the decision-makers know about what we're doing.

**Welber:** I agree; we're going to have to go a little more public. In the past, doing good and shutting up was appropriate. Well, in the new environment we have to be a little bit more open, make sure that our accomplishments are understood — even appreciated.

**SLN:** *And other challenges?*

**Jones:** A very important one that we've emphasized in the last year is a growing awareness of safety. Sandia has a real safety responsibility. Irwin issued a simple, direct policy statement, and we hope all our people have noticed that.

But policy statements are just words; they have to be translated into actions by all of us, right down to the people doing the designs. In thinking about the implications of the Challenger accident, the next round of stockpile modernization, and everything that goes with that, I believe we've done an exemplary job. But that safety concept has to be constantly reinforced. Sandia needs to stand very tall in that area.

**Welber:** I agree. As I leave this job, I think I owe it to the incoming leadership in Washington to alert them again and again about the importance of safety in the stockpile. One of their most important jobs is to be constantly alert in making sure that that stockpile continues to be as safe as we know how to make it. ●BH

**Guide to This Issue —**

**This LAB NEWS is really three issues in one. The inside eight pages are your "regular" LAB NEWS.**

**The middle eight pages contain major FY88 Labs Accomplishments, as selected by Sandia's nine vice-presidencies at Albuquerque and Livermore.**

**The outside eight pages contain the annual "State of the Labs" interview with President Welber and Executive Vice-Presidents Orval Jones and Lee Bray.**

# Laboratories Accomplishments FY88

Continuing a LAB NEWS feature begun eight years ago, *Laboratories Accomplishments FY88* sums up what we, Sandia National Laboratories, consider our principal achievements for the fiscal year that ended Sept. 30.

The work summarized here has been submitted by organizations in Albuquerque, Livermore, and Tonopah. No attempt has been made to rank items, but an attempt has been made to group project-related items. The responsible organizations are shown in parentheses after each item.

Requests for further information should be sent to Public Information Div. 3161, Sandia National Laboratories, Albuquerque, NM 87185.

## Nuclear Weapons

- We continued to participate in flight tests of the Navy's **Trident II missile** at Cape Canaveral; our components performed successfully in all flight tests. A joint ground-test program with Los Alamos and the Lockheed Missiles and Space Co. reached about 90 percent completion and demonstrated the capability of our mechanical and electronic systems to meet or exceed all technical objectives and requirements. The entire W88/Mk5 achieved First Production Unit status at Pantex in September — one month ahead of schedule. Production support of the Navy's Operational Capability requirements is on schedule. (5100)

- All the electronic subsystems for the **Trident II W88/Mk5 arming, fuzing, and firing system** successfully entered production this year. The major subsystems are the programmer, radar, force balance integrating accelerometer (FBIA), and the firing set. The radar is the first to incorporate both airburst and proximity fuzing options for a strategic reentry vehicle weapon system. The FBIA

is the first precision inertial measurement subsystem to be applied to a nuclear weapon system requiring strategic radiation-hardness levels. The firing set is the first to implement wireless energy-coupling to enhance nuclear safety. We completed radiation-hardness verification testing and analyses using a variety of radiation-effects simulation machines, as well as underground nuclear-effects tests. We established that the W88/Mk5 can survive the specified nuclear-threat environments. (2300)

- The Fuel-Ringed External Cavity version II (FREC-II) is a major modification to the Annular Core Research Reactor. FREC-II provides a 20-in.-diam. experiment cavity for exposing test items to neutron and gamma radiation. The facility was developed specifically for neutron vulnerability and hardness experiments for the **Trident-II W88 warhead**. It also provides a unique and flexible capability for testing an array of electronic components and weapon hardware in a variety of radiation environments. (6400)



SUBMARINE LAUNCH of a Trident II missile is depicted in this drawing. The missile achieved First Production Unit status at Pantex in September — one month ahead of schedule.



TWO-STAGE GENIE ROCKET SYSTEM was used for a full-scale structural test of a strategic earth penetrator. The first stage lifted the penetrator; the second drove it into the earth at 1460 mph (inset).

- We conducted several tests in the Coyote Canyon test complex in support of the **W88/Mk5 development program**. Tests included temperature cycling proof tests of a war-reserve unit at the Climatic Facility and flight-qualification tests (between 120 and 150 g's) on one of the large centrifuges. We conducted a one-hour pool fire test of a unit containing live high explosives as part of the abnormal environment test and evaluation program. Impulse tests for validating structural models used the one-of-a-kind Light-Initiated High Explosive Facility to supplement Nevada Test Site experiments. We also conducted pyrotechnic shock separation tests at the Thunder Range and high-velocity, reverse ballistic tests (to evaluate fuzing and crush-up) on the 10,000-ft. rocket sled track. (7500)

- Under a new DOE/DoD Memorandum of Understanding, responsibility for production of all **nuclear weapon parachutes** was transferred from the DoD to DOE, with Sandia directing all parachute technology issues in support of Mason and Hanger (the procurement agency). During FY88, production activities began on the 24-ft.-diam. parachute for the B61-3,4 and the 46-ft.-diam. parachute for the B83. For the first time ever, Sandia trained and certified contractors to build and pack these weapon components. Parachutes of exceptional quality have been procured on schedule under the new arrangement. (1500/7200)

- The first Design and Materials Review of a stockpiled weapon — the **W56 Minuteman** — was conducted in

March at SNLL. (The Air Force plans to keep the W56 weapon system in stockpile well past the year 2000.) Many people originally involved in design and production of the W56 presented background information on design decisions and materials selections of 20+ years ago. The presentations showed the importance of an in-depth formal procedure when considering lifetime extension of older stockpile weapons; such a review determines required actions to prove a weapon's lifetime is extendable — with minimum risk to its functional reliability. (8100)

- We initiated and are continuing **Post-Initial Operational Capability (Post-IOC) Weapon Evaluations** — an effort to formally re-evaluate weapons and associated hardware three to four years after entry into the stockpile. This activity provides an opportunity to evaluate a weapon after several years of field experience, to assess authorized maintenance procedures, and to appraise weapon design and field-support and auxiliary equipment. Post-IOC evaluations of several weapons resulted in procedural changes in technical publications, design and fielding of some new equipment, and the solution of several field problems. (7200)

- A prototype of the **Integrated Optical Safety, Arming, and Firing System (IOSAFS)**, a joint effort between Sandia and General Electric Neutron Devices, Largo, Fla., was fabricated and tested. Goal of the IOSAFS program was to design and implement a firing-set prototype with potential nuclear safety enhance-

ments. Optical energy and information are transmitted through the barrier into the exclusion region, inside of which a gas dielectric capacitor conforms to the barrier wall and contains the high-voltage circuitry. This system was designed to be volume-compatible with existing weapon systems. (2300/2500/7200)

- Since the early '60s, the Soviet Union has continued a construction program to establish deep underground command-and-control facilities. A joint DoD/DOE Phase 2 study was initiated to examine the feasibility of **earth penetrating weapons** for putting these facilities at risk. Numerous payload/delivery system options are being studied to identify the most appropriate system for development. (5100)

- We conducted a full-scale test to show that a **strategic earth penetrator** could successfully penetrate medium-strength rock and survive. The test, conducted at Tonopah Test Range, used a two-stage Genie rocket to hurl a full-scale penetrator into rock at 1460 mph. Post-test recovery of the unit confirmed the structural survivability of the penetrator (including Lawrence Livermore National Laboratory warhead components), a key step in establishing the viability of this concept. (8400/8100/1500/7100/7500/9100/LLNL)

- We developed a data acquisition system that will measure the electromagnetic environment at aircraft-weapon locations. The **Electromagnetic Measurements System (EMMS)** consists of a B61 bomb shape equipped with surface current probes, a spectrum analyzer, a power meter, and other supporting hardware. The computer-controlled data recording equipment and other instruments are contained within a self-sufficient, air-transportable trailer. This system will be used to verify the electromagnetic compatibility of aircraft transmitters and nuclear gravity bombs. The EMMS was used on a test of NATO aircraft authorized to carry US

nuclear weapons. The data indicate that the EMMS operated as designed, and that it could successfully be used with NATO aircraft or at a NATO air base with minimal support. (5100)

- **Laser Diode Ignition (LDI)** of pyrotechnics and certain types of high explosives has been successfully demonstrated. The LDI component — a replacement candidate for hot-wire igniters in new and existing weapons — uses a high-power, solid-state laser diode coupled to a dielectric optical fiber that terminates in a pyrotechnic header assembly. The pyrotechnic is ignited by pulsing the laser diode, guiding the optical energy down the optical fiber, and focusing the light onto the pyrotechnic, which creates localized heating that leads to ignition. Using the high-reliability laser diode and replacing the existing conductive leads of the hot-wire igniter with the optical fiber results in improved component reliability, enhanced handling and use safety, and possible extended systems capabilities. Though developed primarily for nuclear weapon systems, the LDI component is generating interest among field-test groups, safeguards and security systems designers, and others working with pyrotechnic devices. (2500)

- Congress re-authorized development of the **W82 155mm nuclear artillery projectile** with the stipulation that design and production costs not exceed a specified ceiling. Because this is the first nuclear weapon to be completed under a "fixed price contract," new cost-control initiatives were needed for more effective cost management. With DOE/AL, we established a method to create a baseline cost for all the major components. In addition to this cost — based on the current design definition — we also estimated an allowance-for-change, based on design uncertainties and manufacturing unknowns. As the components matured, we refined the procedures to focus on the

parameters that we and our production-agency-counterpart engineers can control (materials, hours, tooling, etc.). With this method, we are now in a position to identify cost impacts as a function of design or manufacturing process change. The procedures established on the W82 are now included in a DOE Baseline Cost Management System Handbook and are being adapted to the W89 Short Range Attack Missile program. (8100)

- Several **W82 6-in. Artillery Fired Atomic Projectile** Weapon Electrical System (WES) tests were successfully completed using an air turbine-driven spinner recently put into service at SNLL. The spinner provides angular velocities up to 30,000 rpm for the WES units, and monitors and records their performance through a 100-channel slip-ring system. Development WES units fired from a cannon at the Tonopah Test Range were soft-recovered and subsequently tested on the spinner, where they functioned at in-flight conditions. (8200)

- We supported several Navy and Air Force programs using the **W80 Common Warhead**. The W80-0 is deployed in the Sea-Launched Cruise Missile; the W80-1, in the Air-Launched Cruise Missile (ALCM). Both launch-platform-compatibility tests and submarine-shock trials on the W80-0 were conducted. W80-1 integration activities continued for the ALCM/B-1B bomber program and the new Advanced Cruise Missile program. (5100)

- Advances in computational mechanics have made possible detailed analysis of the **structural response of electronics packages**. For example, a five-board component was represented using 82,000 computational elements. Stress distribution in this package was analyzed at 2600 instants in time as it was mathematically subjected to a high-G pulse. Accurate three-dimensional analyses of components and systems can now

be conducted as a routine part of the development process. (1500)

- In October 1987, the DoD requested that DOE develop and produce a nuclear warhead for the **Short Range Attack Missile II (SRAM II)**. This request culminated several years of effort by the DOE preliminary-design team and the Air Force and its SRAM II contractors. In January 1988, DOE notified the DoD that it would join with the Air Force in developing the SRAM II weapon system. This initiated full-scale engineering of the W89 warhead by Sandia and Lawrence Livermore National Laboratory (LLNL). The W89 program has developed a baseline system design that should allow the warhead to meet all its requirements. Interface control drawings have been signed with Boeing Aerospace Division, the Air Force missile contractor. Draft control drawings have been prepared for all Sandia components, and the test program plan has been developed and initiated. Sandia and LLNL have also developed an approach for ensuring that the W89 could be used — with minimum modification — to replace the W69 warhead in the SRAM A missile, thus providing it with modernized safety and security systems. (8100)

- We determined the thermal design requirements for all of the **Short Range Attack Missile II/W89** system components, beginning with the conditions external to the missile specified in the stockpile-to-target sequence. Analysis of heat transfer in the warhead led to added insulation to protect overheated areas. Similarly, structural stiffness of the missile system was examined, because the natural frequencies of the system must avoid resonances with the guidance and control dynamics. Particular attention was given to the stiffness of the warhead and its supports. Analytical techniques were modified and verified to ensure the correctness of the solutions. (8200)

## Components/Materials & Processes

- We developed an **airborne imaging radar** for precision navigation and guidance applications. The radar, a synthetic aperture radar, forms images similar to optical photographs, but the radar is impervious to weather and provides its own source of illumination. The radar forms the image by using sophisticated digital signal-processing techniques. Our efforts focused on processing the image in real time and on developing the miniature electronics needed for weapon applications. (2300/9100/7100)

- We developed a new method for

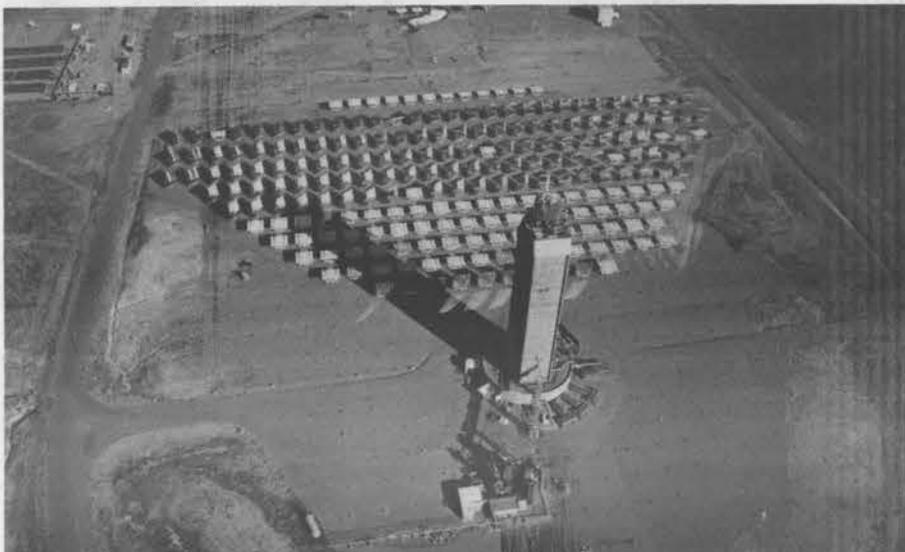
automatically correcting phase errors induced in **synthetic aperture radar (SAR) image data**. The algorithm is completely data-driven and differs significantly from previous methods used for this purpose. It is nonparametric, in that it requires no *a priori* assumptions about the particular form or order of the phase error function present. Further, it requires no human interaction to specify a number of subapertures to be used; in fact, the technique is not subaperture-based. The algorithm can be programmed into a 'black box' that could, with appropriate comput-

ing hardware, run at near real-time rates. The result is that phase errors — resulting, for example, from uncompensated aircraft motion — induced across the synthetic aperture in SAR imagery can be automatically mitigated, using only raw radar data. The technique has proved to be effective when applied to a number of real SAR data collections. (9100/1400)

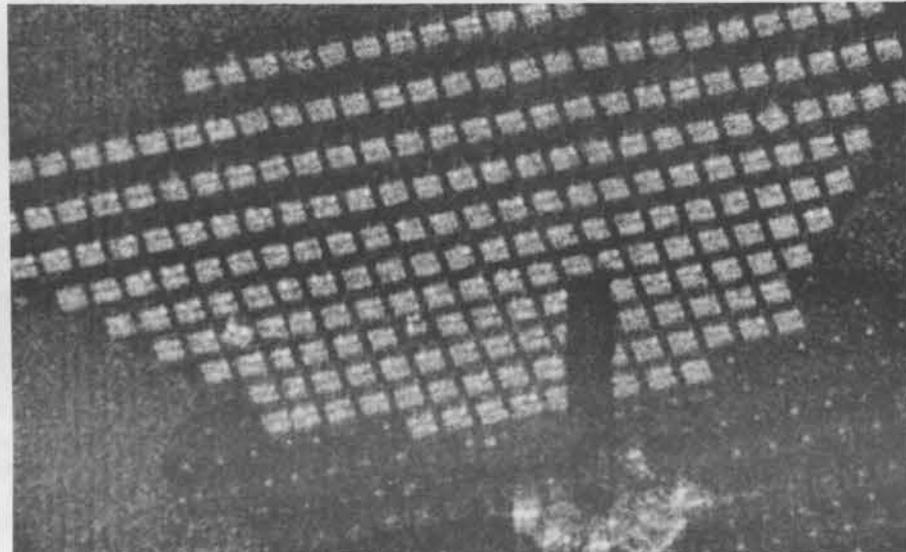
- We developed a fine-line, closer-tolerance **hybrid patterning capability** to support new radar designs that require gold circuit features as small as 25 microns (1 mil) and tighter tolerances (plus

or minus 2.5 microns) on all conductor features. The 25-micron patterning technique will supplement — and, in some instances, replace — the 125-micron patterning capability developed for previous hybridized radar circuits. The finer-line patterning was accomplished with improved hybrid circuit fabrication equipment and development technology that takes advantage of new photoresist products. (7400)

- SNL and AT&T Bell Laboratories completed the joint design of a radiation-hard **256K SRAM (Static Random-**



OPTICAL PHOTO of Sandia's solar "power tower" (left) and corresponding synthetic aperture radar (SAR) image. (The photo and image were obtained on differ-



ent days.) SAR was developed for navigation and guidance applications. Digital-signal processing equipment is used to form the radar image.

**Access Memory**), the most complex radiation-hard memory currently available. Sandia's expertise in the area of rad-hard design and fabrication was combined with Bell Labs' advanced 1.25 micron commercial technology capability to produce the 256K SRAM. Initial models of the jointly developed rad-hard 1.25 micron technology were fabricated at AT&T (Allentown, Pa.), and proved to be fully functional on the first pass. Preliminary characterization indicates that the memory can meet Defense Nuclear Agency requirements. The technology is radiation-hardened to well over a megarad(Si) total dose and is free from latch-up, has high levels for dose-rate upset, and can provide immunity to errors from high-energy particles. (2100)

• Stress-induced voiding of aluminum interconnects significantly affects the **reliability of integrated circuits (ICs)**. Numerous IC failures by this mechanism have been reported by most commercial manufacturers and by Sandia. We developed the first detailed, mechanistic understanding of this process through newly developed analysis tools and microstructural-based thermodynamic modeling. Cavities form in the aluminum because of large tensile stresses locked into the metal by a glass layer that covers the lines. Using a specially developed heating/cooling

stage for the scanning electron microscope and a high-voltage imaging technique, we were able to grow, close, and re-grow these voids and to observe the process as it occurs underneath the glass layer. The process of cavity growth has been modeled, using our understanding of the physical processes involved. The model predicts the growth rate of different forms of cavities and is in general agreement with available data. (1800/2100)

• Equipment installation was completed at the new **Microelectronics Development Laboratory** (formerly called RHIC II). The Laboratory's clean room functions at a cleanliness level better than Class 1 and displays exceptional temperature and humidity control. All clean-room employees are gowned in the Dryden MAXIMUM Particle Control Jumpsuit with full facial-enclosure headgear. The first lots of the 1.25 micron AT&T/SNL radiation-hardened integrated circuit technology (64K static random-access memory) have been started and are being used to characterize the equipment and processes. The clean room and its equipment provide Sandia with a flexible, state-of-the-art capability for microelectronic development. (2100)

• Demonstration of Sandia's next-generation, **16-bit microprocessor** (SA3300) was completed under contract

with National Semiconductor. Initial models were fabricated by AT&T Bell Laboratories in the 1.25-micron radiation-hard technology, and proved to be fully functional on first pass. Successful "first silicon" for an integrated circuit of this complexity (70,000 transistors) is an achievement comparable to that of the finest commercial semiconductor firms. The SA3300 functioned as expected in preliminary breadboard evaluations for two of our customers (Jet Propulsion Laboratory and Sandia's satellite organization). (2100)

• A lithium chloride-potassium chloride (LiCl-KCl) eutectic mixture has been used as the **electrolyte for thermal batteries** for more than 30 years. In recent studies, we have identified two new electrolytes that result in improved thermal-battery capabilities. An all-lithium electrolyte — lithium chloride-lithium bromide-lithium fluoride (LiCl-LiBr-LiF) eutectic — has a greater electrical conductivity than does LiCl-KCl, and its use results in improved performance of high-power batteries. Long-life thermal batteries have been improved by the use of a new low-melting electrolyte, lithium bromide-potassium bromide-lithium fluoride (LiBr-KBr-LiF) eutectic. Three thermal batteries currently being developed will use these new electrolytes. (2500)

## Supporting Technologies

• With inputs from the Nuclear Weapon Complex, the **robotic edge-finishing laboratory** is developing four areas required for deburring (brush-smoothing of edges) and chamfering (machining of bevels): (1) automatic robot programming from computer-aided-design data bases, (2) elimination of fixtures using machine vision coupled with force control to ensure proper tool contact, (3) robotic deburring and precision chamfering, and (4) automated inspection of edges. A precision chamfer of 0.012 (plus or minus 0.001 inch) has been machined on an aluminum test piece. (1400)

• We incorporated **Rapid Interface Prototyping (RIP)** into the process for developing nuclear weapon software. RIP facilitates communication between Sandia designers and their customers by allowing a simulation of an interface (computer interaction) proposed by the user to be rapidly built (sometimes in less than a day) and demonstrated. This interface is then iterated until it meets the customer's satisfaction. The software tool (called "Mirage") used to implement RIP was developed under contract at New Mexico State University. Mirage was used in the development of a product — Crypto Algorithm Message Processor (CAMP) — recently delivered to Pantex. CAMP is a portion of a system that enables weapons equipped with code-activated processors to be properly initialized before shipment to the military. Mirage is currently being used on three other products being designed in 2300 and also by designers in 5200. (2300/5100)

• The SUPERNET project developed a **new supercomputing capability** on Sandia's existing network of minicomputers. Using a collection of 14 VAX computers (3 in Livermore and 11 in Albuquerque) and a parallel-processing system called "Linda" (developed at Yale University), a rocket-plume simulation sensitivity analysis was run more than twice as fast as on a Cray-1S supercomputer. Another application, a charged-particle transport computation, achieved about half of Cray performance using 11 VAX computers. Not all applications can achieve such high performance using SUPERNET. However, the project demonstrated that some can use our existing network of smaller computers in a parallel-processing mode to solve supercomputer-class problems, thus freeing up resources on our overburdened Crays. (8200)

• We collated and indexed **crystallographic and compositional data for inorganic compounds** in a new way, making it easier to identify small particles (between 50 and 500 nanometres) with an analytical electron microscope. A

## Safeguards & Security

• We completed a **weapon storage vault demonstration program** under the sponsorship of the Defense Nuclear Agency. The program included the design, demonstration, preliminary testing, and documentation of two types of underground storage vaults for Army weapons. The Simplified Storage Vault provides basic survivability and security features for Army Artillery Fired Atomic Projectiles (AFAPs) at minimized installed cost. The Small Projectile Vault provides storage for AFAPs and missile warhead containers and incorporates many additional operational and security features that might be desirable in a fielded system. The program supports a NATO study of weapon storage vault applications and has been presented to the NATO High Level Group and Senior Level Weapons Protection Group. The new storage vaults currently are being considered for several weapon storage applications. (5200)

• In response to increased concern about potential insider threats, we developed a **system that monitors personnel and material movements** in special nuclear material facilities. The material-tracking-system portion uses radio-frequency (RF) reporting techniques to minimize system-installation costs. Recently developed software combines this RF tracking system with commercial barcode and proximity-badge systems to form a complete personnel and material tracking system. The system has been demonstrated in several DOE facilities and is being integrated with a Los Alamos National Laboratory material-accountancy system for installation in an operational facility. (5200)

• We have made several contributions to automated and reliable **detection of purposeful motion in video scenes**. Our custom implementation of the One-Dimensional Target Cueing and Tracking System (1-D TCATS) achieved an order-of-magnitude reduction in power, size, and cost, compared to commercially available systems. This design also reduced

system complexity and increased reliability while achieving a factor-of-two increase in image-frame process rates. The hardware design of a two-dimensional TCATS has been completed and, when fully integrated with its software, will provide a user-friendly environment and offer computational rates two orders of magnitude greater than its 1-D predecessor. (2300)

• We developed the design for a new **personnel security badge** for DOE's Office of Safeguards and Security. The badges contain a three-track magnetic strip compatible with the automated access-control system now being considered for DOE-wide application. Sample badges were obtained from several potential suppliers and are undergoing rigorous testing to determine suitability. The selected badge will be issued for use by all DOE federal employees in the summer of 1989 and will be a model for DOE contractor applications. (5200)

• We are developing a **portable physical security system** called the Modular Tactical Force Protection Package (MTFPP) for the US Army's Belvoir Research Development and Engineering Center, Ft. Belvoir, Va. MTFPP, a perimeter-surveillance and intrusion-detection system that requires only one operator, is easily transported (by helicopter or other military vehicles) and rapidly deployed (in 40 man-hours). It will provide worldwide protection for US forces in low-intensity conflict (LIC) situations. A number of field surveys and equipment demonstrations have been conducted to ensure that the design will fulfill major LIC needs. A demonstration of the initial system and several possible future enhancements was presented to representatives from some 20 government agencies in early December 1988. Mostly off-the-shelf components have been integrated into a modular system that accommodates most duration and size requirements of the various LIC missions. A number of agencies with temporary security requirements have also expressed interest in the system. (5200)

• Superglue-vandalized locks on gates, buildings, and cars pose a security problem because mechanical means of regaining access are often time-consuming, destructive, and expensive. We developed a technique in which **superglue is dissolved out of a lock** with hot solvent: A miniature immersion heater (a 1/16-in.-diam. probe) inserted into a lock heats injected acetone to near its boiling point of 56°C as it flows along the probe, freeing the lock in about 20 minutes. Sandia is currently working on transferring this method to the private sector; several companies have expressed interest, because superglued locks are a remarkably common form of vandalism — particularly at public schools and universities. (1800)

• We completed Phase I (basic capability) design of the **Tactical Engagement Simulation System (TESS)**, and 20 sets of prototype hardware were manufactured. The hardware was used in a demonstration before President Reagan and the National Security Council last October, then used in a force-on-force exercise in Europe for the Joint Theater Surety Management Group's annual conference. TESS is a more realistic laser-based tactical engagement system specifically designed for use in security/counter-terrorist training exercises. TESS is tailored to NATO and US security force weapons. (5200)



HIGH-VOLTAGE PULSE GENERATOR in Primary Standards Lab consists of three subsystems: the test tank (shown with top cover open), which contains the high-voltage pulse transformer and the voltage standards to be calibrated; the oil storage tank (right rear), where oil is stored between calibrations; and the instrumentation rack.

search through more than 71,000 entries can now be performed in less than half a minute, and can tell an analyst whether or not the "unknown" phase being examined matches any previously reported compounds. Developed at Sandia jointly with the NIST (National Institute of Standards and Technology, formerly the National Bureau of Standards) Crystal Data Center, the data base and search/match algorithm shorten the identification process from days to minutes, while at the same time ensuring that virtually all reported compounds are considered. This year, the Electron Diffraction Data Base (developed by NIST, Sandia, and the International Center for Diffraction Data) went into use at several national laboratories, universities, and industrial research laboratories. The technology has been transferred to instrument manufacturers, two of which now offer commercial versions to the general public. (1800)

• Often it is desirable that some sensitive or irreversible action — such as launching a missile, arming a warhead, or self-destructing an aberrant space shot — cannot be initiated without the concurrence of more than one person. The concurrence required can be very simple (two of the controllers must agree, for example) or very complex (as might be the case when several national interests are involved, each of which must be accommodated before the controls are acceptable to participants). A general means of solving the **problem of shared capability** has been devised for cases in which initiation of the controlled event depends on the availability of a piece of information that can be recovered only by the cooperative effort (concurrence) of certain designated persons. The need for such control schemes arises in the command and control of nuclear weapons, the devolution of command (national), various treaty-controlled actions, access control in secure computing networks, and other areas. One interesting technical feature of the new shared-capability schemes is that they are unconditionally secure, because their security against misuse is independent of the computing capability and of any effort that unauthorized persons might use against them. (200)

• We demonstrated the first IR (infrared) detectors based on indium-arsenide-antimonide **strained-layer superlattices (SLs)**. The detectors have high sensitivities in the atmospherically transparent 8-to-12-micron wavelength range that is important for military applications. The SLs give these devices the largest operating wavelength ever achieved in III-V compound semiconductor photovoltaic detectors. These devices are being developed to replace the complex and costly mercury-cadmium-telluride detectors used for IR detector array applications. (1100)

• A **new scientific instrument** developed cooperatively by researchers at SNLL, Lawrence Livermore National Laboratory, and the University of Dortmund (West Germany) won an R&D 100 Award as one of the 100 most innovative new products/concepts of the year. Need for high-resolution chemical characterization of subsurface portions of materials used in several laboratory programs prompted development of the instrument, which allows three-dimensional imaging of composition, crystallographic phases, and densities of materials at resolutions to five microns (a human hair is about 100 microns in diameter). While similar to the conventional CAT-scanning technology

used in the medical community, the new instrument has a resolution about 100 times better and can provide three-dimensional visualization of chemical information nondestructively in opaque samples. (8300)

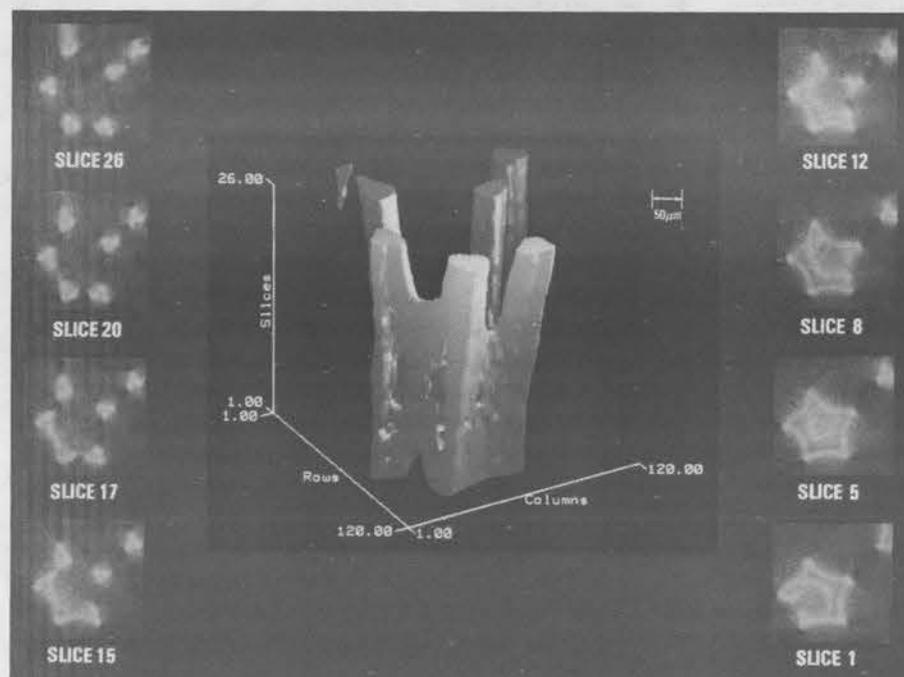
• We developed **parallel, high-performance solutions for full-scale scientific problems** and have achieved unprecedented speedups — in excess of 1000 times — on a 1024-processor hypercube computer. We showed that the fraction of sequential (serial) computing need not be small to achieve high performance and that there appear to be no major limitations to the efficiency of parallelism in achieving speedup of computations. These new findings depart significantly from those of previous models such as Amdahl's Law. Sandia was awarded the inaugural Bell Prize for the most outstanding contribution to parallel processing for this work, and also won the Karp Challenge for demonstrating a 200 times or better speedup on three full-scale scientific applications. (1400)

• The discovery of supernova SN1987A in early 1987 triggered a worldwide flurry of activity among astrophysicists. Investigators scrambled to prepare instruments for measuring radiation from the supernova while it was still in its interesting evolutionary phases. Because of our previous involvement in space science and our fast-reaction capability, we were asked to provide support to three of these endeavors: a rocket launch of a Columbia University/SNL X-ray (imaging) telescope from Woomera, Australia, in November 1987; and expeditions to Australia in May and October 1988 to launch the balloon-borne **Gamma Ray Imaging Spectrometer (GRIS)**. GRIS is a 3500-lb., shielded, high-resolution germanium spectrometer/telescope developed jointly by AT&T Bell Labs, Sandia, and the Goddard Space Flight Center of NASA. (9200)

• We developed and demonstrated a **real-time optical correlator** for two-dimensional pattern recognition. The instrument can correlate a 32 x 32 pixel input image with a 256 x 256 input scene at video rates, and uses one-dimensional acousto-optic and charge-coupled technology to implement the desired two-dimensional processing. Sandia is the first organization to overcome the inherent light-efficiency problems (low light throughput) in this architecture to demonstrate real-time tracking of a moving object. Applications of the correlator technology include landmark and target recognition as well as real-time robotic vision. (1400)

• Our study, with French scientists, of the **new piezoelectric polymer PVDF (polyvinylidene fluoride)** has shown that PVDF can serve as the pressure-sensing element in a shock-pressure gauge with revolutionary new characteristics. Its upper operating limit of 450 kilobars extends the range of previous piezoelectrics by an order of magnitude. Further, the ability to directly measure stress rate with nanosecond resolution is unprecedented. The thin-film character of the gauge allows gauge measurements with a minimum of perturbation. All features considered, the gauge has capabilities that are expected to make it the principal diagnostic tool for shock-pressure measurements. (1100/7100)

• We successfully developed and demonstrated a new **automatic target recognition concept** based on neural network paradigms that can classify targets in sensor images (TV, infrared, laser, or radar)



**THREE-DIMENSIONAL CHEMICAL MICROSCOPE**, which won an R&D 100 Award as one of the 100 most innovative new products of the year, shows image of palladium catalyst (center). Smaller side photos show 8 of the 16 tomographic sections (slices) used to produce the center image. The microscope provides 3-D visualization of chemical data nondestructively in opaque samples.

independent of target orientation or perspective. The processing hardware architecture design demonstrated a throughput of 2.5 billion connections per second. This is several orders of magnitude faster than existing commercial simulators. Neural network technology is applicable to both weapon and security work. (9100)

• In a combined effort between experimentalists and computer analysts, we made the first step toward quantitatively modeling the **residual stress distributions in actual welds**. Using a newly developed finite-element code, PASTA, we were able to simultaneously solve for the temperature and stress distributions in an actual traveling gas tungsten arc weld on 304L stainless steel. Advances in neutron diffraction allowed us to experimentally determine residual elastic stress in the as-welded plate without having to section or perturb the specimen; this provided an excellent basis for comparison with

computer predictions. A combination of high-speed thermocouple measurements and infrared spectroscopy was used to verify temperature predictions. (8300/8200)

• The Primary Standards Laboratory developed a **high-voltage pulse generator** that provides microsecond voltage pulses up to 300 kilovolts. The system is used to calibrate high-voltage standards for contractor standards laboratories throughout the Nuclear Weapon Complex. The generator — computer-controlled and fully automatic — includes a voice enunciator that allows the operator to perform other tasks while the system is operating. Transient waveform digitizers record the wave shapes, which are then stored in a computer for analysis and comparison with previous pulse records. Analysis of historical data helps to identify measurement uncertainties associated with each standard. (7200)

## Testing

• We developed a new test capability called SWAT (Sum of Weighted Accelerations Technique) for **measuring dynamic forces** that drive the structural response of everything from weapon components to shipping casks. Accurate measurements of these forces are crucial to designing for surface impacts, earth penetration, and various accidents — as well as for environmental shock/vibration testing of weapon components. SWAT is quantified and calibrated in the laboratory by modal analysis and has been proved in both lab and field. The technique was successfully used for the first time in 1988 to measure slap-down forces on a spent-fuel shipping cask during drop tests. (7500)

• We developed an **airborne digital signal processor** for computing real-time power spectral density for in-flight vibration measurements. A flight demonstration test was conducted at Tonopah Test Range in which the power spectral density from three accelerometers was computed in the air, converted to digital format, and transmitted to the ground. The analog signal from the accelerometers was concurrently transmitted, also for display on the ground. On-board computation permits many more on-board measurements to be made within the same signal bandwidth. (5100)

• We conducted **three rocket launch-**

es from Sandia's Kauai Test Facility in support of Strategic Defense Initiative program objectives. In one launch, a Strypi XI three-stage solid rocket system was used to provide atmospheric and exoatmospheric thrusting rocket targets for observation by satellite instrumentation. Critical guidance and control functions were accomplished by a Sandia-designed on-board SANDAC flight computer and a MINI-RIMS inertial measurement unit. Concurrent with launch activities, \$6 million worth of construction was completed on schedule at the Kauai facility to provide a new capability to fly fully guided, vertically launched rockets. (7500)

• Tonopah Test Range (TTR) people conducted **293 tests during FY88**. A highlight was the launch of a Navy-sponsored Tomahawk Land Attack Missile from a new INF-Treaty-approved permanent test launch pad at TTR. A NATO-sponsored series of Multiple Launch Rocket System tests used live spotting charges to verify the performance of the European-built M455 fuze system. TTR also played an active role in the earth-penetrator program; tests included Davis Gun-launched earth penetrators and helicopter and aircraft drop tests. A new C-band radar system was delivered to TTR in September. The computer-based radar

(Continued on Page Five)

**(Continued from Page Four)**

has automatic calibration features, on-axis tracking, and a processor with coherent data recording. This highly mobile system can be transported by aircraft, ship, or truck. (7100)

- Work in 7100 and 1500 resulted in a significant **reduction in closure time** of devices — the Modified Auxiliary Closure (MAC) and the Gas Seal Auxiliary Closure (GSAC) — used in underground tests. Faster closure times were achieved by replacing the high-pressure nitrogen gas used to close the MAC and GSAC gates

with high-pressure helium gas — an alternative to redesigning the closure devices' gas storage systems to accommodate a higher gas storage pressure. Using data from Sandia Livermore's Tritium Research Center, we developed accurate equations of state for the gases and used them to predict closure time for the devices. Helium delivers 40 percent more energy to the closure devices' gates than does nitrogen; its use enables the design of closures that respond up to 20 per cent faster or that have up to 40-per-cent-stronger gates, depending on test-bed require-

ments. (7100/1500)

- We developed **diagnostic measurement techniques** fielded during the Los Alamos National Laboratory (LANL) underground nuclear event, "Laredo." Despite the harsh radiation environment of all measurement locations, each experiment yielded useful data. Two experiments — a self-generating piezoelectric polymer stress sensor and a coaxial ablation probe — were new to underground testing. Joint experiments with LANL included a flash X-ray machine for which we designed the tube, power supply, and

control circuitry, and a laser beam-interrupt experiment using fiber optics. We also fielded experiments on the "Misty Echo" event, an underground simulation of a surface-burst nuclear detonation to measure the amount of energy coupled into the ground, gamma-ray and X-ray outputs from the explosion, ground shock produced, and seismic disturbance created. Energy coupling data appear to validate the theoretical models and computer codes that are employed in fuzing studies to evaluate the effectiveness of strategic weapon systems. (7100)

## Other Defense-Related Work

- We developed a teleoperated vehicle (called "Dixie") on an ATV (all-terrain vehicle) chassis to investigate mobility, navigation, human interfaces, and other issues related to unmanned combat vehicles. Dixie is a continuation of the "Fire Ant" concept and currently operates as a **mobile reconnaissance vehicle**, with a TV camera mounted on an extendable mast. (5200)

- We developed a compact **digital video electronics system** in a flight-test configuration that will allow unmanned flights to "see" experiments performed in a space environment. In many cases, the details of these experiments are classified; consequently, the video data telemetered back to earth is encrypted. Because relatively high-resolution pictures are required, this video system uses data compression and sends video frames at a rate ensuring a clear picture of the experiments. This technology is useful when visual observation is required from a hostile environment. (8400)

- A Sandia-led effort produced the **Phase One Threat Specification (POTS)** for the Phase One Program Office in the Strategic Defense Initiative Organization (SDIO). The POTS is SDIO's first system-level threat definition that serves system and subsystem design purposes for both the Army and Air Force, as well as for SDIO's system engineering contractor team. It includes specification both of threat elements and their collection into attack scenarios. The work was part of Sandia's participation in the SDIO-sponsored Phase One Engineering Team (POET).

POET is a collection of staff from selected DoD and DOE laboratories who provide independent technical support to the Phase One Program Office. In developing the POTS, Sandia provided overall leadership of the multi-laboratory POET team, coordinated the offensive threat description and analyses, and developed the defense suppression threat definition. (8100/9000)

- We studied the **sensitivity of predicted infrared signatures of rocket plumes** to uncertainties in input and model parameters. Formal sensitivity analysis techniques, including the Fourier Amplitude Sensitivity Test and Latin Hypercube Sampling, have been applied in this program funded by SDIO through the Air Force Astronautics Laboratory (Edwards AFB, Calif.). Variables such as altitude and aspect angle, rocket-engine parameters, particle optical properties, and reaction rates have been evaluated. This work resulted in a greater understanding of the uncertainties and sensitivities of complex physical models used to predict plume signatures for SDI platform and sensor designs. In particular, we studied proposed sensor algorithms in the face of model parameter uncertainties and provided guidance to code-upgrade and experiment-design efforts. (8400)

- Sandia developed and recently delivered major elements of a **Mobile Command and Control (C<sup>2</sup>) Center** for use by the Commander-in-Chief, US Pacific Command (USCINCPAC), as an austere survivable alternative to the current fixed Command Center. The air- or ground-transportable C<sup>2</sup> suite (five shel-



"DIXIE," a mobile reconnaissance vehicle that's operated remotely from a base station some distance away, is displayed by Connie Vanderburg of Nuclear Security Systems 5200. TV camera is mounted on the extendable mast.

ters, auxiliary generators, transmitters, and other equipment that cover between one and two acres when deployed) is called USCINCPAC Enhanced Crisis Management Capability (ECMC). Through ECMC, the USCINCPAC will be able to exercise command and control over the entire scope of mission responsibility. The program was funded by the Defense Communication Agency, the Defense Nuclear Agency, and Pacific Command. (5200)

- We developed a **polyvinylidene difluoride accelerometer** capable of measuring and surviving shock environments in the 100,000-to-200,000-G range. A basic part of the work was to design for very-low-cost production. Potential

applications are in "smart" ship-seeking missiles and automotive safety systems such as air bags. (2500)

- Applying Sandia's many years of experience in development of use-control technologies and systems for nuclear weapons, we developed a **prototype use-control device** for the Army's Stinger portable surface-to-air missile system that is adaptable to many other conventional weapon systems. Integrating a use-control device into a conventional weapon system prevents successful operation of the weapon in any other than the intended mode, thus forestalling unauthorized use of the weapon. (9100)

## Arms Control Verification

- Sandia provided significant support to the **negotiation and implementation of the Intermediate-Range Nuclear Forces (INF) Treaty**. Support included providing people (from 9200, 9100, and 5200) who directly participated in the negotiations and implementation discussions, as well as backup support. In addition, Sandia furnished inspectors (from 5200) at the USSR's Votkinsk site, which is being monitored by equipment developed at Sandia. (9200/9100/5200)

- We developed, designed, constructed, and initiated the preparations for shipment of the **continuous monitoring system for the Votkinsk facility** in the USSR. The monitoring system, also known as a portal monitoring system, was developed to meet the requirements of the INF Treaty signed on Dec. 8, 1987. (The Votkinsk facility was used to assemble SS-20 missiles, the production of which is prohibited by the INF Treaty. It is still in use by the Soviet Union to assemble the larger, strategic SS-25 missiles.) The

monitoring system includes modular portable buildings, data-processing equipment, exit sensors for monitoring road and rail vehicles leaving the Votkinsk facility, and surveillance equipment. This project involved coordinated efforts — under demanding schedules — by a number of Sandia organizations to construct a prototype at the Labs, as well as to design and test the system later sent to Votkinsk. The project was funded by the DoD through the Air Force Electronics Systems Division. (9200/5200/7400/9100/7100/3700/7800)

- We organized and documented several **on-site inspection exercises** at DOE and DoD facilities. The videotapes and reports of these exercises have been widely disseminated, and have had a significant impact on US INF inspections and on deliberations concerning potential Strategic Arms Reduction Talks (START) inspection regimes. (9200)

- We developed a **system for positive identification of specific items** such as

missiles or other military equipment that would be limited by an arms control treaty. A mixture of a transparent plastic material and crystalline reflective particles would be painted onto a small area of each treaty-limited item when it is declared by the inspected party; the procedure creates a tag composed of a unique multi-dimensional pattern of reflective surfaces. The tag would be read with a special reader (a still video camera and an array of 24 lights). An image — recorded with each of the 24 lights illuminated in sequence — would create a description of the unique random pattern that results from reflective-particle location and reflective-surface angle. In subsequent on-site inspections, the tags on any treaty-limited items would be read and recorded in the same manner. A computer would be used to compare the images with those recorded when the items were declared, thus determining whether they are the same — and, therefore, legal. (9200)

- **Experimental and theoretical**

**shock-compression studies** identified the importance of physical-chemical phase transitions occurring at high pressures and loading rates in geophysical materials. This work resulted in unique data that provided scientific leverage to US negotiators in discussions with Soviet counterparts on recent results from Joint Verification Experiments that used ground-shock measurements to determine nuclear yields in underground tests. (1500)

- We completed prototype testing of a recently designed **large-scale integrated electronics device for satellite applications**. The device was designed jointly by Sandia's Space Systems Dept. and the Center for Radiation-Hardened Microelectronics to time-tag the arrival of various signals received by Global Positioning System satellites. It will replace approximately 100 small-scale integrated circuit chips currently used and will reduce the power needed by more than 90 percent. This device — and two others now being designed — will help reduce total power

and volume requirements while improving performance of our satellite instrumentation systems. Minimizing the number of components (and lowering weight, volume, and power requirements) translates to significant cost savings and reliability improvements for satellite systems of the future. (9200/2100)

- We deployed two satellite ground

station data-acquisition and display systems. Each system consists of multiple, geographically separated nodes of local-area-network interconnected workstations. Communication between nodes is provided by the Defense Data Network. Software developed for these systems to date includes over 50,000 lines of Ada code. (9200)

## Pulsed-Power Development

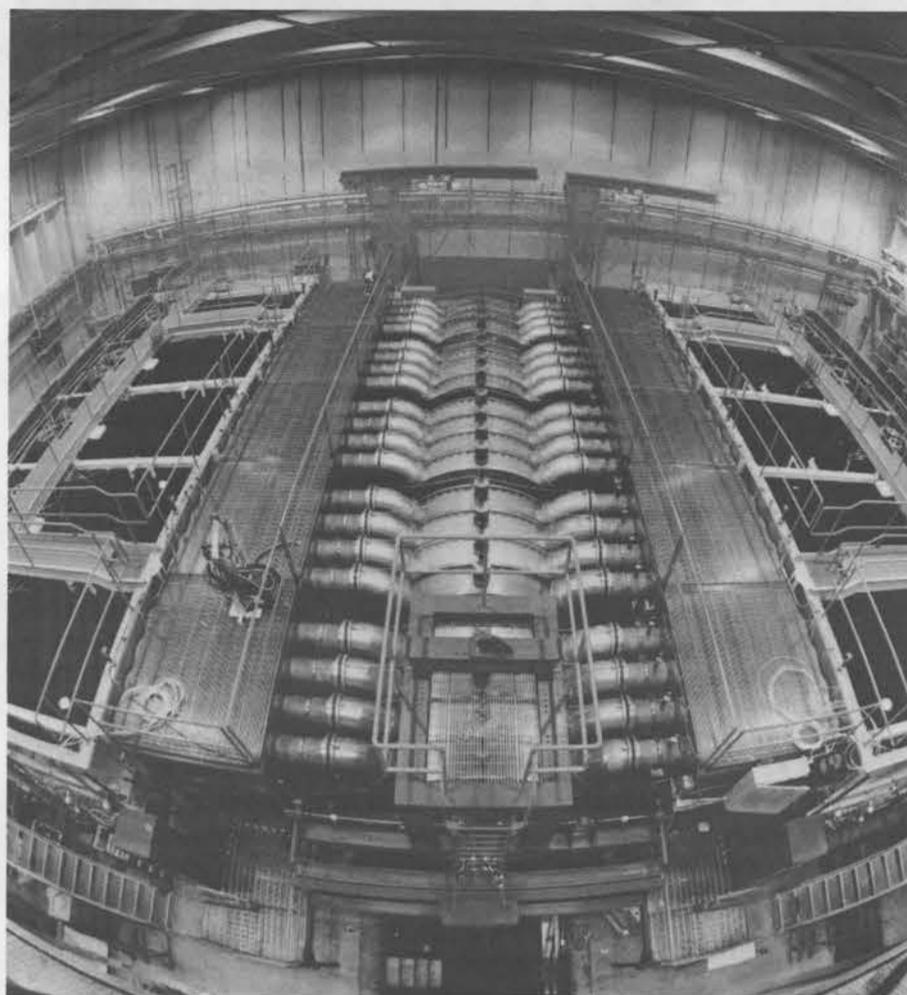
- Construction and testing of **HERMES III**, a new gamma-ray simulator, was successfully completed. HERMES III simulates the gamma-ray exposure that a weapon system might encounter more accurately than has ever been possible in aboveground testing. The failure rate of the devices tested depends largely on the rate at which radiation energy is deposited (dose rate) in these components; HERMES III produces 10 times the dose rate of its predecessor. The radiation is produced by stopping 730,000 amps of 20-million-volt electrons in a tantalum target. The high-energy electron beam is produced with an entirely new pulsed-power-accelerator technology, which combines high-power linear induction accelerator cavities and a vacuum transmission line to generate the 20-million volt output pulse. The vacuum transmission line uses the magnetic field generated by the large currents it transmits to prevent loss of large amounts of energy along its length. HERMES III satisfies all of its performance requirements and came on-line one year ahead of schedule. (1200)

- The **Saturn X-ray simulator** attained record radiation levels that enabled testing of larger military components at higher radiation levels than have ever been

possible aboveground. Saturn either met or exceeded its radiation output goals in fluence, pulse width, pulse rise-time, and radiation dose rate-area product (the product of bremsstrahlung dose rate in silicon multiplied by the area over which the dose rate produced drops to half its peak value). Sandia nuclear-weapon hardware, as well as other military hardware from various DoD programs, is routinely tested at the Saturn facility. (1200)

- An intense source of soft X-rays is required for vulnerability and lethality studies, and as a driver for laboratory X-ray laser physics experiments. On **Saturn**, Sandia's 30-TW (trillion watt) pulsed-power accelerator, we recently exceeded an important program milestone by using a gas-puff Z-pinch to generate more than 500 kilojoules (equivalent to 14 TW) of X-rays — larger by a factor of two than any other laboratory source in the US. We also have generated 5 TW and 3 TW in narrow X-ray energy bands around 1 and 3 keV (kilo-electron volt), respectively. These high intensities increase our capability to test military hardware and extend existing laboratory X-ray laser experiments. (1200)

- We made major strides in the development and application of intense



VIEW FROM THE TOP of house-sized HERMES III, new gamma-ray simulator that produces 10 times the dose rate of its predecessor. HERMES III came on-line one year ahead of schedule.

ion-beam diagnostics. **Particle Beam Fusion Accelerator II** produced an ion beam with more than 10 trillion watts of power and 400 thousand joules of energy. An analytic theory of the beam-generation process in ion diodes was tested against experimental data and computer simulations, and excellent agreement was found. The improvements in these areas allowed

us to develop an ion-beam diode with 80-percent conversion efficiency from electrical energy to ions, and to focus a proton beam to a 6-mm-diam. spot. Our work on generating a pure lithium ion beam led to an increase (from 20 percent to 70 percent) in beam purity from one lithium source. (1200)

## Energy/Environment

- We demonstrated the feasibility of using **computer-aided molecular design (CAMD)** to guide the synthesis of catalysts for the direct (i.e., more efficient) conversion of natural gas to liquid fuels. This work represents a significant advance over state-of-the-art techniques to tailor-make novel catalysts for specific end-use applications. Laboratory test data have validated the technical merit of our approach. Additional applications of CAMD to coal structure, the chemistry of large molecules, and pillared clay catalysts are currently under investigation. (6200)

- We formulated a mathematical theory in which the hydraulic and electrical conductivities of a fracture in rock generally depend on surface roughness, sample size, and shear and normal displacements. This theory simplifies previous finite-difference calculations by using a small number of well-defined free parameters. The theory for the **transport properties of fractures** is important to predicting rock-mass response under dynamic loading conditions. It is also of primary importance to oil and gas production from fractured reservoirs, to reservoir stimulation by hydrofracturing, and to hazardous waste isolation. (6200)

- The Geoscience Research Drilling Office at Sandia is responsible for implementing **scientific drilling activities** sponsored by DOE. Recently, the Drilling Office completed a 5780-ft.-deep hole in the Valles Caldera in northern New Mexico. Nearly 100-percent core recovery was achieved, using the largest wireline coring rig available in the world. Special

modifications were made to the Australian-built rig for convenience, safety, and blow-out prevention. Downhole temperatures exceeded 570°F; the hole differs from other wireline-cored holes in that it is designed for producing steam. Coring techniques developed on this project are applicable to geothermal and hydrocarbon exploration, and the analysis of both productive and barren core specimens allows a more efficient utilization of these resources. (6200)

- We successfully installed a **pump limiter experiment** on the Tore Supra Tokamak at Cadarache (France). The Tore Supra Tokamak is a large fusion-energy experiment that is investigating the technology and physics of magnetically confining high-temperature plasmas. The Sandia experiment, funded by the DOE Office of Fusion Energy, will investigate plasma density control and impurity removal in a large, long-pulse tokamak. Installation in France followed a year-long Sandia effort to design, analyze, and construct the pump-limiter module. A unique feature of the limiter module is its graphite head, which was machined at Sandia using computer-aided design and manufacturing techniques. Sandians will participate in module experiments scheduled for 1989. (6500)

- In the Tl-Ca-Ba-Cu-O (thallium-calcium-barium-copper-oxygen) system, we demonstrated the first **high-temperature superconductors** with transition temperatures above 120 kelvin. We also fabricated the first thin films in this system and made the first polycrystalline

films with very high critical currents (above 200,000 amps/cm<sup>2</sup>). These results demonstrate that the thallium-based superconducting system has good potential for high-critical-current and high-magnetic-field applications. (1100)

- At the Combustion Research Facility, we established a collaborative program with Cummins Engine Co. to take advantage of our unique in-cylinder laser diagnostic expertise and knowledge of soot particulate formation/destruction processes. The goal is to understand the sources of **heavy-duty diesel particulate emissions**, the most pressing issue facing diesel-engine manufacturers today. Cummins sent a staff member to Sandia for the three-year duration of the project, along with a complete optically accessible diesel-engine test facility that is now installed and operating. Measurements of particle sizes and velocities have been obtained and published to validate multidimensional modeling calculations. (8300)

- As part of our program on research and development of terrestrial photovoltaic solar energy, we developed a **mechanically stacked, multijunction (MSMJ) solar cell** that achieved an efficiency of 31 percent at high solar intensities. This was the highest efficiency reported to date for any solar cell, and the first solar cell ever to exceed 30 percent. The cell consisted of a GaAs (gallium-arsenide) solar cell mechanically stacked on top of a silicon solar cell. The GaAs and silicon component cells were developed in cooperation with Varian Research Center and Stanford University, respectively. The

GaAs cell converts the visible portion of the solar spectrum into electrical energy, while the infrared light is transmitted through the GaAs cell for conversion by the underlying silicon cell. The GaAs cell was specifically designed for a stacked-cell application, including use of a low-doped substrate (to minimize free-carrier absorption losses), optimized anti-reflection coatings, and a polished back surface with gridded contacts. Our analysis indicates that efficiencies approaching 35 percent are possible with a fully optimized GaAs/silicon MSMJ cell. (6200)

- The dedication in May 1988 of the DOE/Sandia **Vertical Axis Wind Turbine (VAWT) Test Bed** at Bushland, Tex., marked the successful completion, within cost, of the design and construction phases of the program. The 165-ft.-tall, 110-ft.-diam. VAWT, rated to produce 500 kilowatts of power while rotating at 37.5 rpm in a 28-mph wind, will provide electricity to the local utility grid. Now under way is the testing phase, which may provide performance data leading to a truly cost-competitive renewable energy source for electric grid applications. Transfer of these improvements to US industry could spread wind power into vast areas of the country with moderate winds — including the Great Plains. (6200)

- After completion of the pressure test of a 1:6-scale reinforced concrete nuclear power plant containment building, postmortem examinations of the model and additional analyses of the tear in the liner of the building were conducted. Other activities for the Nuclear

Regulatory Commission-funded **containment integrity program** were analysis and testing of a full-size personnel air lock under pressure and thermal loading, and testing of inflatable seals. As a result of this work, Sandia is now recognized as the world leader in evaluating the integrity of nuclear power plant containment systems under severe accident conditions. (6400/1500)

- We made substantial progress on our program to obtain additional productive years of nuclear power plant operation beyond the licensed 40-year period. Sandia, playing the lead role for DOE, is working with the nuclear power industry and the Electric Power Research Institute on this effort. In FY88, Sandia developed a method to identify and evaluate plant equipment for license-renewal review. The method, officially adopted by the nuclear industry, is the cornerstone of a systematic and efficient evaluation process to ensure **continued safety of nuclear plants during extended-life operation**. The approach will be used by the first two utilities that apply to the NRC for a renewal license. (6500)

- We are completing a landmark study for the Nuclear Regulatory Commission that sets new **standards for assessing the risk from nuclear power plants**. This study updates the 1975 Reactor Safety Study, and is based on comprehensive methods that deal with all phases of a reactor accident — initiator, system response, core-melt progression, containment response, and off-site consequences. The study explicitly addresses the large uncertainties inherent in these processes; its methods and results are having a major impact on the regulation of nuclear power plants and on planning future severe-accident research. This technology is now also being applied to the assessment of risk from operation of DOE production reactors. (6400)

- We completed the current series of **Source Term experiments** in the Annular Core Research Reactor as part of the Nuclear Regulatory Commission's joint international Severe Accident Research Program. During experiments, the time-dependent releases of fission products from previously irradiated reactor fuels are measured as fuel rods are subjected to excessive, high-temperature (2500 kelvin) environments characteristic of severe light-water-reactor accidents. Results from these unique experiments are essential to the development and assessment of sophisticated fission-product release models used for detailed severe-reactor-accident analyses. (6400)

- We accomplished three major tasks required for beginning construction of two exploratory shafts at Yucca Mountain, a site in Nevada being studied for a **civilian nuclear waste repository**; the shafts are essential for underground testing of the site. We prepared technical responses to extensive comments made by the Nuclear Regulatory Commission (NRC) when it reviewed DOE's draft plan for studying the site. Among these responses are analyses, requested by the NRC, that examine potential effects of the shafts. The analyses show that the shafts and tests carried out in them will not make the site unsuitable for a repository; they also show that the tests themselves will not interfere with one another and invalidate results. We completed two key studies required for design of the shafts; they establish repository-system requirements and the set of reference information to be used in its

design. Our third major effort set up the elaborate quality-assurance program that must be in place before the NRC can approve the design process; this program is modeled after programs required for civilian power reactors. (6300)

- We made a unique set of measurements at the Waste Isolation Pilot Plant within a shaft now under construction. To understand the **time-dependent structural response (creep) of salt**, a precise determination is needed of the closure history of the shafts to the underground rooms. Obtaining closure measurements immediately is important, because early creep closure is pronounced. This history is used in performance assessment of the repository as required by Environmental Protection Agency regulations. The shaft-construction method — upreaming with a 20-ft.-diam. rotating cutting head pulled upward from the 2150-ft. depth by means of a drill stem running in a pilot hole — would have precluded human access for 6 to 12 months (an unacceptable delay). Therefore, a special closure-point emplacement device was built that could be remotely pulled up by cable under the cutting head. When activated, the device emplaced opposing closure-measurement points into protected holes drilled into the shaft wall and remotely measured, with a linear potentiometer, the distance between the opposing points to establish a closure station. Later, when human access is possible, these points will again be measured to give the closure history. Using this method, closures beginning within 36 hours of shaft excavation can be obtained. (6300)

- We completed the last scheduled round of **Waste Isolation Pilot Plant (WIPP) site-characterization documentation**, focusing on studies conducted from 1983 through 1987. Documentation included stable-isotope characterization of both "old" and "new" groundwaters in the vicinity of the WIPP site, estimation of groundwater residence times by radiocarbon and uranium-disequilibrium techniques, detailed interpretation of both single-hole and regional-scale hydrologic testing, determination of relevant flow and transport mechanisms in the Rustler Formation, and examination of the degree of consistency between interpretations based on modern physical hydrology and those based on geochemistry. Major conclusions are that (1) because modern flow directions and those indicated by geochemical studies are not consistent, the geologic and hydrologic flow direction and flow rate of the WIPP site are transient (time-dependent) on the 10,000-year time scale of regulatory interest; and (2) because of the effects of fracturing in the Rustler Formation, both groundwater and radionuclide travel-times may be significantly less than previously expected under some conditions. Future emphasis in ongoing geotechnical studies at the WIPP will be on the Salado Formation, which contains the underground workings of the WIPP facility. (6300)

- We completed a 10-year **study of the naturally occurring surface radiation** at the Waste Isolation Pilot Plant (WIPP); results and measurement-techniques information were distributed to interested groups. These radiation-dosimetry data establish pre-construction reference points that could be valuable in documenting changes of the surface radiation environment at the WIPP site. (3200)

- We completed several tasks related to commercial development of the TRU-

**PACT-II packaging** that will be used for transporting the major volume of nuclear wastes to the Waste Isolation Pilot Plant. When it became apparent that continuing to pursue TRUPACT-I could lead to overall programmatic delays, we developed a concept for alternative cylindrical packaging. During ensuing development activities on a cylindrical transport container (TRUPACT-II), we worked out an approach — acceptable to the Nuclear Regulatory Commission — for characterizing the package contents, and conducted a number of engineering tests on a full-scale prototype unit. The tests included multiple structural tests at our cable test facilities and a 30-minute pool fire test in Lurance Canyon that used jet fuel. Because initial temperature control of the prototype was important to creating the proper test conditions, we used the environmental facilities in Area III for condi-

tioning TRUPACT-II. (6300)

- We combined the Embedded Atom Method (EAM) with Monte Carlo simulations to study the **structure and order-disorder transformation of one specific surface of Au (gold)** — the (110) surface. Previously, we showed that the EAM predicts that the Au (110) surface (a naturally occurring facet of gold) forms a "missing-row" structure, in agreement with experiment. Recently, we found that the missing-row structure disorders at 570 K (kelvin), in close agreement with the experimental value of 650 K. Relaxations and vibrations are essential for accurate calculation of the critical temperature. This is the first time that a surface order-disorder phase transition has been predicted accurately. This new method promises to provide a realistic means of simulating structural order in other metals as well. (8300)

## Technology Transfer

- Technology (drawings, software, test methods, etc.) for the **manufacture of crypto device adaptor modules (CDAMs)** has been successfully transferred to an industrial source. CDAMs are microprocessor-based modules for the remote control and monitoring of communications security devices. These modules facilitate automated-equipment troubleshooting and allow common pooling and appropriate reduction in the number of devices required in survivable command/control systems. Funding for this reimbursable program was provided by the Defense Communications Agency. (5200)

- Recovery of oil and gas from hard-to-tap reservoirs is more efficient as the result of a Sandia-developed **anelastic strain recovery technique** that determines direction and magnitude of stresses occurring deep beneath the earth's surface by measuring the stress relaxation of core samples. Using this technique, engineers can determine the direction and distance that man-made fractures are expected to travel from a wellbore, thus permitting them to properly position wells for optimum (up to 30 percent better) oil and gas recovery. British Petroleum and AMOCO

have used this technique in their North Sea operations, and several oil service companies — including Terra Tek, Rock Mechanics A/S, Halliburton, and Litton Core Laboratory — plan to offer the method as a service to oil and gas companies. (6200)

- A program recently initiated by DOE's Energy Research Office has assisted four companies in sending employees as interns — in the fields of robotics, polymers, combustion research, and metallurgy — to Sandia Albuquerque and Livermore during the past year. It provides funding of approximately \$35,000 for **enabling industry scientists to spend time at DOE laboratories** and to acquire expertise for application in American industry. (6000)

- **Technology transfer consulting** helps promote the transfer of previously developed Sandia technologies and offers additional support to the tech-transfer process. In 1988, 22 employees received approval to consult — on weekends and vacations — for 15 US companies, six of which are located in New Mexico. (6000)

## Laboratories Support

- We implemented the IBM 3090-120E as the **Laboratories Information Systems** node for the Administrative Network (ADNET). This processor complex will serve as the UNISYS replacement. ADNET will use IBM's new data-base management system and related application development tools to assist with timely changeover of administrative systems from UNISYS to IBM. The first major accomplishment of the changeover effort was the evaluation, selection, and acceptance of a Human Resources Information System commercial software package. We plan to implement the Payroll portion of the package at the end of FY89. The Personnel and Benefits portions, which require substantial modifications to meet Sandia's needs, will follow over the next several years. (100/2600/3500)

- We accomplished a major step in the implementation (scheduled for late 1990) of a new SNLA supercomputer: the creation of a **Prototype Secure Network (PSN)**. The PSN is a test bed for software functions required to support a new supercomputer, Local Area Networks (LANs), and individual terminals and work-

stations in a UNIX-based environment. The PSN also will be used to evaluate production implementation of network services and hardware for a new Secure Supercomputing Network. The PSN consists of an Alliant FX/8 worker computer, 3 VAX service nodes, and extensive networking facilities that use the new data PBX, as well as local Ethernets. The network now serves a LAN containing some 80 workstations and is currently used in four directorates. (2600)

- As part of a continuing effort to **automate design definition**, all of our mechanical design definition is now being done on Computer-Aided Design (CAD) workstations. VAXcluster technology combines more than 150 workstations into a highly integrated, multiprocessor environment with centralized system management. Software is controlled on 12 host servers (VAX 3600), and design data and resources are shared across all mechanical-design workstations. Specifications, design guides, and D-standards — until recently prepared manually — are now prepared and transmitted to other Nuclear Weapon Complex (NWC) agencies using

a CAD/text-integration system implemented at Sandia. The new system cuts transmission time for a specification from days to hours. A recently acquired and installed Image Management System (IMS) maintains and displays design definition more efficiently than the traditional process of creating and storing aperture cards. The IMS, composed of a network of workstations connected to optical disk storage, will store several years' data. The system is now being used to capture all engineering releases generated by SNL and other NWC agencies; it also provides on-line access and display of releases at several locations within the Labs. (2800)

- We developed a point-to-point **numerical control (NC) software assistant** (Program P2P) to simplify preparation of point-to-point NC machining programs. P2P, implemented as a set of process rules executed under control of an expert system, contains tables of tooling information, material parameters, and process-sequence rules. Its output is a "ready-to-run" program that contains all tooling, documentation, cycle sequences, and suggested machining parameters. Program users have realized significant reductions in program-preparation time. (7400)

- Plating-process quality depends to a large extent on maintaining control of the plating bath's chemistry and on determining the bath's desired composition. We developed **linear programming models** that describe required bath adjustments, and that can be mechanically applied to control the composition of a wide variety of chemical solutions. We also developed a computer program that automatically — in a matter of minutes — creates the linear programming models, making them especially useful for correcting chemically complex baths. The linear programming method minimizes chemical quantities used and waste generated, thus providing a more economical and environmentally sound procedure. (7400)

- Sandia Livermore's new LDAS (Livermore Document Accountability System), an on-line, **centralized document accountability system**, tracks all controlled documents at SNLL from birth to death. The system uses double-line barcode labels to identify each document and imposes a time limit on the completion of any interstation movement to prevent incomplete transactions. Failure to complete a transaction within the allotted time results in warnings to the originating and receiving organizations, to document-control people, and, subsequently, to the security organization. Among its features, LDAS contains authorization tables that identify employees in terms of user groups, authorized organizations, and special-access categories to ensure that documents are distributed only on a need-to-know basis. LDAS captures bibliographic data to facilitate identification and retrieval of any document at SNLL; another feature is central destruction. Major benefits include improved control of documents and a reduction in time spent on accountability functions. (8500)

- The WhiteStar project — a cooperative effort among the electronic sub-systems, components, design engineering, microelectronics, weapon development, and monitoring systems directorates — supplies data on parts selection and design to weapon and space-systems design engineers. WhiteStar encourages the use of standard parts through its **engineering parts data base** containing quality-design

data and technical characteristics for standard electronic parts. User evaluation of the demonstration prototype has led to standardization of data-base interface requirements. WhiteStar supports design standardization and design engineers by supplying data on standard parts, thus reducing time spent in part selection. (2800)

- We developed **master safeguards and security agreements** for both SNLA and Tonopah Test Range. These documents outline security requirements and strategies for protecting classified information and materials, computer and communications systems, special nuclear materials, and other DOE property; the agreements also define accepted levels of risk for protecting Sandia's classified and nuclear material assets. The agreements state formal procedures that will be used by DOE's Albuquerque and Nevada Operations offices, DOE's Assistant Secretary for Defense Programs, and DOE's Deputy Assistant Secretary for Military Application. (3400)

- We **helped generate information** and provided services that are useful to various line organizations and their customers. Video documentation of the test-to-failure of a scale-model nuclear power plant containment building provided valuable data to the nuclear industry and its regulators. The library's Translation Project assisted in several programs: the Soviet visit to NTS for the Joint Verification Experiment, documentation and packaging of monitoring equipment to be shipped to the USSR in support of the INF Treaty, and Sandia's International Training Course on Physical Protection of Nuclear Facilities. Classification guidelines were developed for nuclear weapon use-control systems, a secure cryptographic unit, and strategic earth penetrator technology. Internal and external publicity on Labs technical accomplishments helped make Sandia capabilities better known to potential users. (3100)

- Sandia received two **awards from the US Small Business Administration (SBA)**: (1) Superior Program Performance Award (the highest national award for federal government prime contractors that meet criteria of their subcontracting plans and demonstrate creative ways to offer maximum business opportunities to small, small-disadvantaged, and women-owned firms); and (2) Distinguished Prime Contractor of the Year Award for Region VI (N.M., Ark., La., Okla., and Tex.) for achievements that support SBA's primary missions — raising the percentage of total dollars subcontracted to small-disadvantaged businesses and managing programs designed to assist socially disadvantaged small businesses. (3700)

- A new **Code of Conduct & Corporate and Personal Integrity Program** booklet was distributed in August. The booklet, expanding on the previous Code of Conduct, emphasizes quality of products and services, standards for maintaining existing corporate ethics, and maintenance of a safe environment at the Labs. Other sections of the previous Code — specifically, expectations for both on- and off-the-job personal conduct, as well as for work time — were strengthened. (3500)

- We led a **Labs-wide program focusing on quality** as a vital ingredient of all Sandia activities. Quality, a specific responsibility of all line organizations, is defined as conforming to all specifications — technical, scheduling, and cost; the primary goal is performing the job right the



LIBRARY'S TRANSLATION PROJECT assisted in several programs, including a visit of several USSR officials involved in INF Treaty verification. Here, translator Patricia Newman works with an International Training Course participant.

first time, every time. Program activities included establishing a group of 92 Quality Coordinators who assist line organizations with day-to-day quality issues and organizational quality plans; adding quality assurance procedures to existing electronic assembly, mechanical assembly, and test equipment activities; drafting new Quality Plans encompassing nonweapon, as well as weapon- and software-related, quality issues within the Labs; revising Engineering Procedures to reflect the shift toward early quality-team involvement with hardware, software, and other products; and revamping the in-hours technical education series of courses on quality and related issues. (7200)

- For the first time, Sandia served as one of 150 host sites across the nation for the **National Quality Forum**. This forum is the highlight of National Quality Month, which is designated by the President and Congress. Speakers were the chief officers of several major US corporations. The local presentation was jointly sponsored by Org. 2600 and the Albuquerque Section of the American Society for Quality Control, and was attended in the Technology Transfer Center by more than 200 people — including representatives of 57 local businesses. (2600)

- We developed a **"Total Quality System"** for shop-overflow procurements of special-design products. The system involves teams of people from 3700 and 7400 who have responsibility for reviewing all purchasing procedures to ensure on-schedule procurement for Sandia line organizations of high-quality products from contractors. A vendor rating system that provides a quality and delivery performance rating for each contractor further emphasizes to contractors the importance of quality in Labs procurements. (3700/7400)

- We upgraded a **standby generator system** to meet emergency power requirements in Areas I and II. The upgrade included installation of a 2400-kilowatt closed-transition system that allows the system to automatically synchronize with utility power during generator operational tests — an advantage, in that connected users do not realize a power outage. Two computers, for sensing load demand and generator demand, allow for an energy-efficient match of generated power to load demand. (7800)

- We designed and installed a **coaxial high-purity piping system** in the Compound Semiconductor Research Laboratory. The system provides a second "containment" tube that surrounds tubing carrying any toxic or pyrophoric gas.

The containment tube, open at one end to clean-room air, terminates at the other end in the gas cabinets located in a bunker outside the clean room. A highly sensitive gas-detection system monitors clean-room air as it is drawn into the gas cabinets; the system can detect a leak within a matter of seconds and sounds an alarm to alert clean-room workers of any potential problem. Thus, the system provides a safe, well-monitored environment for clean-room occupants. (7800)

- **Simulation Technology Laboratory (STL) project activity** continued throughout the year. A major accomplishment was completing construction of HERMES III; this gamma-ray simulator has been in continuous operation since it was fired for the first time in February 1988. To prepare for the move of Proto II (an X-ray simulation machine) from Area V to the STL in Area IV, we completed two construction activities — a new accelerator tank and the pit beneath it. (7800)

- Sandia served as the lead laboratory in the **Science and Technology Alliance**. The Alliance, established last year, is a consortium including Sandia, Los Alamos and Oak Ridge national laboratories, the Ana G. Mendez Educational Foundation, N.M. Highlands University, and North Carolina A&T University. The Alliance's purposes are to increase the US pool of minority scientists and engineers and to increase the quality of educational programs and research on campuses of predominantly minority universities. (3500)

- A statewide task group (headed by Sandia and the University of New Mexico) completed a year-long effort to design an **instructional television network (ITV)** that will enhance educational opportunities in New Mexico and enrich the state's economic potential. Sandia contributions included (1) implementation of an educational-needs assessment method that provided a foundation for the original network design and (2) sharing expertise and resources in delivery-system technologies, instructional design techniques for TV, and project management skills. ITV supports the DOE-Sandia mission by improving the available work force and enhancing productivity (on-roll employees are able to attend job- and career-related courses without leaving the workplace). Sandia currently receives more than 30 live courses from UNM, New Mexico State University, and New Mexico Institute of Mining and Technology; that number will expand considerably as the network develops. (3500)



## 'HealthSmart' Designed to Encourage Cost-Effective Health-Care Utilization

### Changes in Medical Care Plan Are Effective April 1

By B. J. Jones (3545)



Sandia remains committed to providing you and your family with a sound health-care package to protect you against unexpected, chronic, and catastrophic medical expenses.

However, Sandia's medical care costs continue to escalate faster than general inflation and faster than the Labs' budget. These escalating medical costs have prompted some changes in the Medical Care Plan (MCP) — changes that should help the Labs better manage MCP costs and continue to provide a quality health-care plan (see "It Works, So Why Change It?").

Effective April 1, the plan will include a new supplement — "HealthSmart." The supplement will apply to most employees (including eligible dependents) and some retirees, with several exceptions. HealthSmart will not apply to covered individuals with primary Medicare coverage or those receiving care outside the United States.

HealthSmart also will not apply to most individuals covered by the optional Health Maintenance Organization (HMO) plan at Sandia Livermore; the only way it could apply to these HMO participants is in the case of the chemical-dependency supplement (see information under "Highlights" subheading below).

The Labs is holding a series of voluntary meetings to explain the changes and answer questions (see times/places at end of article) and is mailing information packets in mid-March to the homes of all Sandia employees, retirees, and surviving spouses.

#### Highlights of Changes/Additions

HealthSmart includes some new benefits, some improved benefits, and a medical treatment review program. It will mean no change in claim administrators (Provident) or the way claims are filed.

However, it will mean a change in what you are asked to do before entering the hospital, having surgery, or receiving psychiatric or chemical-dependency treatment. Patients needing these services will be asked to call Health Risk Management (HRM) before nonemergency treatment and after emergency treatment. HRM is an independent health-care review firm that will administer the medical treatment review part of HealthSmart. The firm, reached through a toll-free telephone number, will provide medical information to you and will work directly with your doctor to review details of your medical treatment.

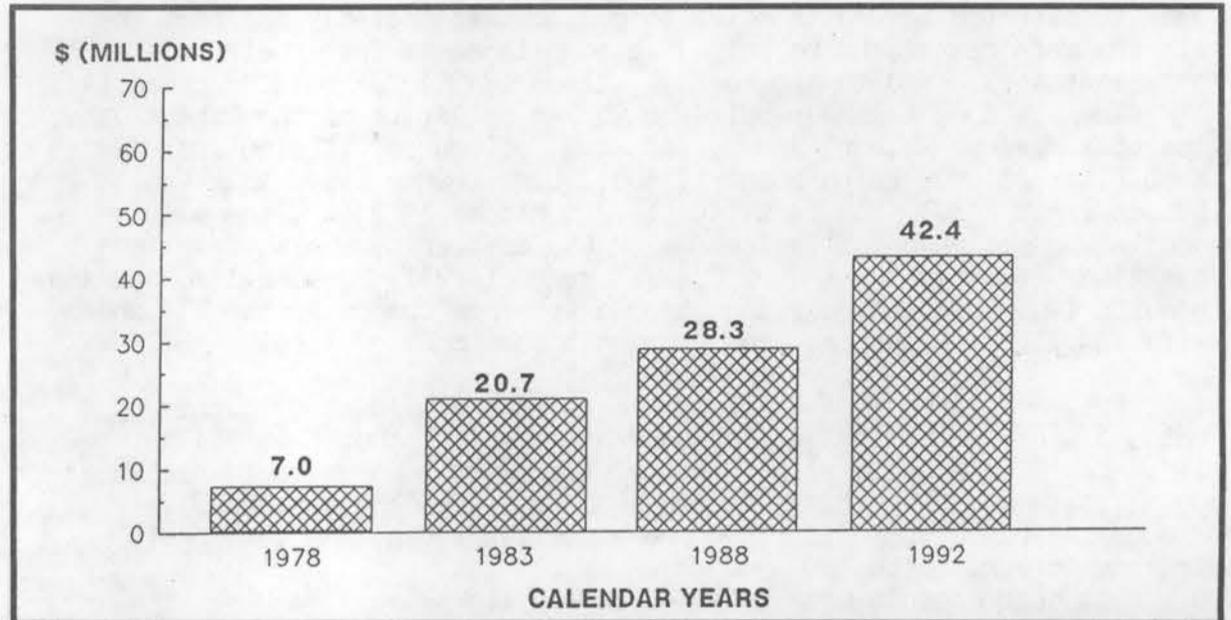
By calling HRM, you will ensure that you receive maximum allowable benefits under the MCP. However, if you do not call HRM, any benefits allowable under MCP will be reduced by \$300.

It is not necessary to call HRM before or after routine appointments, procedures, or tests at a doctor's office. However, patients may call HRM if they desire general medical information about routine matters.

#### HRM Services

The new benefits include payment for some alternatives to hospital stays — home health care, birthing centers, skilled-nursing facilities, and hospices — when arranged by HRM. (In 1987, the average cost of a private hospital room in the US was \$702/day, an increase of \$114/day from 1985.)

(Continued on Page Four)



DRAMATIC RISE in Sandia's medical care program costs since 1978 is evident. The 1988 cost of \$28.3 million averages out to \$2294 for each Sandia employee and retiree — about 12,330 total. Medical program costs are projected to continue to rise faster than general inflation and faster than the Labs' budget. All costs, including the 1992 projection, are figured in 1988 dollars.

#### Up to the Challenge!

### Sandia Wins 'Don't Drive' Challenge

Sandians responded in a big way to Albuquerque's "Don't Drive One in Five" Challenge Week Jan. 23-27, "outdistancing" KAFB and DOE/AL employees in the three-way competition to reduce the number of people driving to work. Challenge Week was part of this winter's Better Air Campaign, sponsored by Ridepool, Sun Tran, and the city's Environmental Health Department.

Officially, 1662 Sandia employees and on-site contractors — about 24 percent of the usual work force — indicated their participation by completing and mailing in DDOIF coupons, says Sandia's commuter assistance coordinator, Linda Stefoin (3543). The coupons stated that the employee refrained from driving to work — by carpooling, walking, biking, or riding the bus — at least once during the week.

"Actually, even more Sandians participated, but we received some coupons late and couldn't count them as part of the competition," says Linda. "Even so, the 24 percent figure is excellent. Many organizations get fewer than 10 percent of their employees

to participate in this type of program."

Challenge Week also included an internal competition among Sandia's Albuquerque organizations. The 4000 group (combined for convenience with several smaller groups — 400, 100, 20/30, and 1) took the honors, with 39 percent participation, five percent better than the second-place group.

Because the Labs won the three-way competition with KAFB and DOE, five Sandia participants were selected in a drawing to receive 10 free gallons of gasoline each. The winners are Edward Clark (1554), Bill Marshall (6210), Mark Powell (2545), Mary Sanchez (3152), and Daniel Abeyta (contractor).

Linda hopes the competition stimulates continuing interest in carpooling and other alternatives to single-occupant vehicles. "Some people find it hard to start ridesharing, but easy to continue once they begin," she says. "Any Sandia employee or contractor can call me [on 4-7433], and I'll try to match them with others interested in ridesharing."



SANDIA WINS! — Linda Stefoin (3543), Sandia's commuter assistance coordinator, displays the trophy awarded to the Labs for winning the "Don't Drive One in Five" Challenge Week competition Jan. 23-27. About 24 percent of the Sandia Albuquerque work force participated by carpooling, walking, biking, or riding the bus to work at least once during the week. Sandia won the three-way competition by having a higher participation percentage than KAFB and DOE/AL.

# Antojitos

This Is Sandia -- Well, here it is -- the one issue all year that comes closest to providing a wide-angle snapshot of the entire Labs today. It includes, in the Labs Accomps section, the major accomplishments of last year from each of our nine vice-presidencies (as selected by the organizations themselves). It includes, in the "State of the Labs" section, the views by our top three executives of those accomplishments of Labs-wide importance, the environment (and they do mean "the environment") currently shaping Sandia, and the challenges they predict we'll face soon. And it includes a "regular issue," which, for obvious (we hope) reasons, is a bit anemic this time.

Our thanks go to all the people who contributed to the Labs Accomplishments section, whether or not their accomplishment actually made it over the several hurdles to publication (notably the fact that all VPs were restricted to only 15 accomplishments from their organizations). And thanks to Phyl Wilson (3162) for editing those LAs.

Thanks, too, to the people who worked on "State of the Labs." That includes Messrs. Welber, Jones, and Bray, of course; it also includes Herb Pitts (3100), Ralph Bonner (3500), Dick Craner and Wright Van Deusen (both 3180), Bob Park (4010), Jim Mitchell (3160), the many people who got phone calls from me or LAB NEWS writers with frantic questions (such as "What does CORRTEX stand for?"), Personnel's Rose Ann Schultz (who typed the original transcript from our audio tapes), and my wife and little daughter, whom I haven't seen much of lately.

\* \* \*

Hail and Farewell -- I always sorta assumed I'd stay in this job until I wrote something, or let something get printed, that I'd get fired for. It's comforting to be leaving under honorable circumstances.

Yes, I'm moving on, as of March 1, to Video Services and Film Processing Div. 3153. It'll be a new challenge, and I'm definitely looking forward to the new job.

But that doesn't mean this one is easy to leave. Working with creative people on an exhilarating task is part of it. But there's more: I've seen lots of "revolutionary new developments" across the full spectrum of Sandia technologies since I came to the LAB NEWS as a fledgling newspaper writer in 1972. Every tech story is, one way or another, "state-of-the-art" or it wouldn't be a story. Which means that every one of them is an intellectual challenge to an English major. You'd think I'd know better than to crawl into that bed, much less stay in it, at Albuquerque and Livermore, almost 15 of my last 17 years.

Guess I'm a little like the guy who was charged with drunkenness and, more seriously, with setting his bed on fire and damaging a hotel. The man pleaded guilty to being drunk, but he insisted he was innocent to the charge of setting his bed on fire: "The bed was on fire when I crawled into it."

\* \* \*

Past LAB NEWS Editors -- Bob Gillespie (ret.): 1951-65; Bob Colgan (retiring today): 1965-67; Tom Heaphy (dec.): 1967-68; John Shunny (ret.): 1968-82.

\* \* \*

What I've Learned at the LAB NEWS -- How can I know what I think until I read what I write? --James Reston

By the time you figure out how far you can go, you've gone too far.

--Hieronymus Anonymous

Life is too serious to take seriously.

●BH

## Supervisory Appointment



VERN BYFIELD to supervisor of Design Definition Div. 8272, effective Feb. 1.

Vern joined Sandia Livermore in June 1962 as a design drafter and later became a project leader in drafting. In 1979, he became involved in procurement and installation of the Computer-Aided Design System (CADS). After that, he trained drafters to use CADS and did software testing and tailoring of CADS for Sandia's unique needs.

Vern has an Associate of Arts degree in drafting technology from Modesto Junior College. He enjoys tennis and skiing.

Vern lives in Livermore with two daughters.

## Deaths



Bill Gordon of Phase I and Phase II Studies Div. 8171 died Feb. 10. He was 54 years old.

Bill, a Distinguished Member of Technical Staff, was an electrical engineer at Sandia for 33 years.

Survivors include his wife, a son, and a daughter.



Henry "Whitey" Sorensen of Telemetry Systems Div. II 8452 died Feb. 13 after an extended illness. He was 59 years old.

Whitey was an electrical engineer and had worked at Sandia for 31 years.

Survivors include his wife, a daughter, and a son.

## Sympathy

To Chuck Comroe (8243) on the death of his mother in Los Angeles, Dec. 5.

To Lorena Schneider (8523) on the death of her brother in Lake Worth, Fla., Jan. 10.

To David Hutton (8442) on the death of his father in Chattanooga, Tenn., Jan. 14.

To Robert Schefer (8351) on the death of his mother in Larkspur, Calif., Jan. 17.

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SURROUNDED BY SYMBOLS of his Sandia career is Bob Colgan, who retires today after exactly 30 years of Sandia service. Most recently, he's been the supervisor of Tech Art 3155, but he's best known for the 21 years he spent as supervisor of Video Services and Film Processing (nee Motion Picture) Div. 3153.

# Sandian Solves Mystery About Revolutionary War Statue

A Sandia metallurgist is tackling the unsightly white crust that keeps forming on the mouth of a statue honoring a Revolutionary War heroine. With the help of high technology — and some Brown University researchers — Terry Lowe (8314) hopes to remedy the problem permanently.

The bronze sculpture, in a county park near Carmel, N.Y., depicts 16-year-old Sybil Ludington on a famous midnight ride of April 26, 1777. Sybil alerted the Colonial militia that the British were raiding and burning nearby Danbury, Conn. (see "Teenage, Female Paul Revere").

For several years, a white crusty substance has exuded from the statue's mouth, making it appear that the girl was foaming at the mouth. The DAR, which owns the statue, and county officials have had the problem investigated and the sculpture cleaned, but the condition still recurs.

And it has drawn attention. A recent *Philadelphia Bulletin* story, titled "In Search of Paranormal," began, "In another time and place, the physical manifestations exhibited by the statue of Sybil Ludington could have made it an object of religious devotion."

## Tour With Uncle

Terry learned about the statue's condition while he was at Brown University on assignment for Sandia last fall. He visited his uncle, Nobles Lowe, who took him on a tour of the area. As they passed the statue on Route 52 in Carmel, Nobles mentioned the unfortunate appearance of the landmark.

Terry wanted to know more. With the permission of county authorities, he took scrapings of the crusted material and analyzed them at Brown, where he was working with the staff of the Center for Advanced Materials Research.

"At the time I thought it might be a corrosion problem, which would be an interesting challenge for a metallurgist," explains Terry. "I also figured it would be a community service, using our scientific and analytical tools to solve a problem of public interest."

"A close-up look at the material showed it was calcium sulphate — commonly known as gypsum. By doing some research in the Brown University library, I found that sculptors and foundries have commonly used this material for the molds with which castings are made. Apparently the material was never removed from inside the head of the statue when it was completed in 1959."

Terry thought that gypsum might be seeping through thin, porous areas of the bronze. Because

the inside of the mouth was protected from rain, the gypsum there would not be rinsed away before it hardened.

To test his theory, Terry contacted county authorities again, this time obtaining permission to check for possible leaks through the bronze. He encapsulated the statue's head in a plastic hood, infused gaseous Freon 112 into the head, and used equipment borrowed from the university to determine whether and where the gas leaked out. This procedure would reveal whether the pores in the mouth were large enough for gypsum to seep through.

In an hour or so one weekend, Terry's hypothesis proved valid — he found the expected leaks.

Although the statue had earlier been coated with an acrylic lacquer to protect it, the acrylic had worn away and did not keep the bronze sealed.

## Volunteer Help

So much for the problem. Now for a solution.

Terry has enlisted the aid of other Sandians. Included in lunchtime brainstorming are Howard

*(Continued on Page Four)*



SYBIL LUDINGTON's face, as portrayed on statue — note encrusted area around the mouth.



SANDIA METALLURGIST Terry Lowe (8314) and his uncle Nobles Lowe stand in front of the Revolutionary War heroine's statue near Carmel, N.Y.

## Prelude to Victory

# A Teenage, Female Paul Revere

Sybil Ludington was the daughter of Col. Henry Ludington, commander of an American militia unit during the Revolution.

One night in April 1777, a militiaman came to the colonel's home near Fredericksburg, N.Y., and told him that 2000 British troops were raiding and burning Danbury, Conn. The Danbury militia had only 150 men, not enough to stop the plundering.

The messenger was too fatigued to go any further, and Colonel Ludington would need to stay and organize his troops as they arrived. The colonel found another messenger to alert the militiamen in the immediate vicinity, but someone would have to go to neighboring villages and the countryside.

The best choice was 16-year-old Sybil, an excellent horsewoman who knew the surrounding territory.

So, like the more famous (thanks to Longfellow's 1863 poem) Paul Revere, Sybil volunteered to make a midnight ride, raising the alarm for her father's men to muster and repel the Redcoats.

She rode some 25 miles through six hamlets. When she returned home, she was exhausted but had reached most of the regiment. After responding in the middle of the night, they routed the British the next day in a major battle at Ridgefield, Conn.

Three bronze statues commemorate Sybil's ride. The largest is on the shore of Lake Gleneida, near Carmel, N.Y.; the others are in Washington, D.C., and Danbury.

The lifesize bronze at Carmel was created in 1959 by sculptor Anna Hyatt Huntington and donated to the DAR. It was dedicated in 1961 at the Carmel park. Sybil is also commemorated on a US postage stamp issued on the 200th anniversary of her ride.



# SANDIA LIVERMORE NEWS

VOL. 41, NO. 4

SANDIA NATIONAL LABORATORIES

FEBRUARY 24, 1989

LIVERMORE RETIREES this month are Billy Pontsler (DMTS, 8162, left) and Dick Cook (8272). Others retiring but not pictured are Dick Feil (8454), Ruby Bell (8534), and Clay Mavis (DMTS, 8165).



(Continued from Page One)

## Medical Plan

Benefits are being improved for outpatient psychiatric care, increasing to 80 percent of usual and customary costs, up from 50 percent.

Health Risk Management, one of the nation's most advanced health-care cost management companies, is staffed by experienced nurses 12 hours a day, 6 a.m. to 6 p.m. (Mountain Time) Mon.-Fri. These nurses are supported by consulting, practicing physicians.

HRM will provide health-care information, inform patients when surgery can be performed without an overnight hospital stay, arrange for second opinions when appropriate, and review a patient's medical treatment plans by comparing the recommended treatment to established medical guidelines. All information is kept strictly confidential. HRM's services are free to the caller; Sandia pays all HRM costs via a fixed-fee contract.

*The final decision about the medical treatment you receive is made by you and your physician.*

The Health\$mart information packet will include a booklet giving precise information, new MCP identification cards, a summary card of the review process, and a form to give to your doctor. The packet also contains the toll-free telephone number for HRM, a number for the Sandia Benefits information desk, and a telephone sticker with the phone numbers.

### Schedule of Health\$mart Meetings

Organizations are assigned a specific meeting time to ensure adequate space for everyone. If you cannot attend with your organization, you may attend an alternate meeting.

The "special" designation in the schedule below indicates meetings outside of normal working hours. These meetings are for swing-shift employees, retirees, and employees who want to bring their spouse. Please call 844-4608 to make a reservation if you plan to attend one of these "special" meetings in Albuquerque. Reservations are not required to attend the "special" meeting at SNLL.

#### Albuquerque

*Solar Power Tower & Coyote Test Field Employees* — March 13, 8-9:30 a.m.; Bldg. 9981, Rm. 146.

*Org. 5000* — March 13, 10:30 a.m.-12 noon; Tech. Transfer Center (Bldg. 825).

*Org. 6000* (except 6420, 6450; see below) — March 13, 1-2:30 p.m.; Tech. Transfer Center (Bldg. 825).

*Orgs. 3700, 7100, & 7200* — March 13, 3-4:30 p.m.; Tech. Transfer Center (Bldg. 825).

*Orgs. 1220, 1230, & 1240* — March 14, 9-10:30 a.m.; Bldg. 960, Rms. 112-113.

*Orgs. 6420 & 6450* — March 15, 9-10:30 a.m.; Bldg. 6582.

*Special* — March 15, 6-7:30 p.m.; Coronado Club, Zia Rm.

*Orgs. 1250, 1260, & 1270* — March 16, 1:30-3 p.m.; Bldg. 960, Rms. 112-113.

*Special* — March 16, 6-7:30 p.m.; Coronado Club, Zia Rm.

*Orgs. 7500 & 7800* — March 17, 8:30-10 a.m.; Tech. Transfer Center (Bldg. 825).

*Orgs. 7400 & 7500* — March 17, 10:30 a.m.-12 noon; Tech. Transfer Center (Bldg. 825).

*Orgs. 2300, 2500, 2601, 2610, & 2620* — March 17, 1:30-3 p.m.; Tech. Transfer Center (Bldg. 825).

*Orgs. 400, 1100, 3500, & 4000* — March 20, 9-10:30 a.m.; Bldg. 815.

*Org. 1500* — March 20, 1-2:30 p.m.; Bldg. 822, Rms. A-B.

*Special* — March 20, 6-7:30 p.m.; Coronado Club, Zia Rm.

*Orgs. 100 & 1400* — March 21, 9-10:30 a.m.; Bldg. 815.

*Orgs. 1400 & 1800* — March 22, 9-10:30 a.m.; Bldg. 815.

*Orgs. 3100 & 3300* — March 22, 1:30-3 p.m.; Bldg. 815.

*Special* — March 22, 6-7:30 p.m.; Coronado Club, Zia Rm.

*Org. 9100* — March 23, 9-10:30 a.m.; Bldg. 815.

*Org. 9200* — March 23, 1:30-3 p.m.; Bldg. 815.

*Special* — March 23, 6-7:30 p.m.; Coronado Club, Zia Rm.

*Org. 3400* — March 24, 9-10:30 a.m.; Bldg. 815.

## Sandia's Medical Care Program

### It Works, So Why Change It?

Sandia's medical care program cost the Labs \$28.3 million in 1988, more than four times the \$7 million (figured in 1988 dollars) that it cost just 10 years ago. Sandia benefits specialists believe that by 1992, costs could go up another 50 percent to \$42.4 million (also in 1988 dollars). The program includes the Medical Care Plan (MCP), which covers most Sandians, and the Health Maintenance Organization option available at Sandia Livermore.

The costs are increasing much faster than general inflation and much faster than Sandia's total budget, which is essentially flat when inflation is considered.

"That's why it's very important that we keep our medical care costs under control," says Sandia Personnel Director Ralph Bonner (3500). "The program is funded out of our general budget and is taking an increasingly larger 'bite' every year. If the trend continues unabated, some of the Labs' other programs will begin to suffer."

The "Health\$mart" supplement to the MCP (see article by B. J. Jones) is designed to help control MCP costs, but Charles Mika, manager of Benefits Dept. 3540, emphasizes that's not the whole reason.

"Our goal is not simply to control our MCP costs, but to continue to provide a high-quality health-care program for employees, dependents, retirees, and surviving spouses," says Charles. "We think Health\$mart will help us do that."

Ralph acknowledges that it may take employees and retirees a while to get used to one of the new features. People planning hospital stays, surgery, or treatment for psychiatric or chemical-dependency problems will need to consult (via a toll-free telephone number) with Health Risk Management (HRM), a health-care utilization review firm, before nonemergency treatment or after emergency treatment.

"This new service should help all of us use our available health-care services more efficiently," says Ralph. "It's a tool that can help us find out precisely what the diagnosis means and what alternatives may be available."

"The service is *not* intended to restrict anyone's treatment. The final decision about medical treatment remains strictly between patients and their doctors."

Charles thinks Sandians will find HRM's professional advisers helpful and courteous. "We selected HRM from a list of 11 companies that submitted bids to provide this service," he says. "We looked very carefully at six of them, especially looking for quality of service and the ease of accessing that service. We checked with many of their client firms and even monitored calls of patients consulting with HRM."

"We were impressed," concludes Charles. "We think this is a 'class' firm that can deliver."

Although consulting with a health-care utilization firm will be a new experience for most Sandians, it's becoming common for employees of many large firms. HRM alone works with more than 90 clients — several much larger than Sandia — and overall handles the review process for more than a million and a half covered participants.

"Many companies are going to this type of system to help control their health-care costs," says Ralph. "Rapidly rising medical costs aren't just a Sandia problem — they are a national problem."

Sandians, retirees, and surviving spouses covered by the Sandia MCP are encouraged to attend one of the scheduled meetings at which MCP changes will be detailed and questions will be answered (see schedule at end of B. J. Jones' article).

*Orgs. 2100, 2630, 2640, & 2800* — March 24, 1-2:30 p.m.; Tech. Transfer Center (Bldg. 825).

*Make-up Session* — April 3, 9-10:30 a.m.; Tech. Transfer Center (Bldg. 825).

#### Livermore

*Active Employees* — March 14, 1-2:30 p.m.; Bldg. 904, Aud.

*Special* — March 14, 5:30-7 p.m.; Bldg. 904, Aud. (If you or your spouse are uncleared and need a pass to get into the auditorium, please contact Dottie Wiemken on 294-2252.)

*Active Employees* — March 15, 9-10:30 a.m.; Bldg. 904, Aud.

#### Pantex

*All Active Employees* — March 16, morning, exact time and meeting place to be announced at Pantex later.

#### Nevada

*All Active Employees Assigned to NTS* — March 23, morning, exact time and meeting place to be announced later.

*All Active TTR Employees* — March 23, afternoon, exact time and meeting place to be announced at TTR later.



PLASTIC BAG over statue's head was part of Terry's setup for checking whether gypsum could seep out through pores in the bronze.

(Continued from Page Three)

## Statue

Johnsen (8313), Bert Brown (8314), Cal Feemster (8313), and Tim McCabe (8316). At Brown University, research help is coming from the Materials Center director, Professor Bob Asaro, plus professors David Paine and Don Avery, and staff members Mike Sosnowski and Herb Stanton.

"We're thinking about several options to counter the encrusting," says Terry. "One is brush plating, in which the pores are filled with metal in an electroplating process. Another possibility is a chemical exchange in which the white deposit is transformed to seal the pores."

Terry's efforts so far have received front-page attention from two local New York newspapers as well as the *Philadelphia Bulletin* item. Terry hopes to return later this spring (on his own time and at his own expense) to complete the project.

Meanwhile, Putnam County officials are pleased that the visiting Sandia researcher has shown so much interest. The county executive, commissioner of highways, county historian, and DAR regent from the local chapter are all enthusiastic about his plans to restore Sybil Ludington to her intended glory.

# Supervisory Appointments



**GEORGE ALLSHOUSE (DMTS)** to supervisor of Radiation and Hydrodynamics Theory Div. 1261, effective Dec. 16.

George joined the Labs in June 1979 as a member of the Target Interaction Theory Division. He's worked in that division through its various name changes. His work has been primarily in ICF (inertial confinement fusion) target design.

Before joining Sandia, George worked at LLNL and LANL in thermonuclear weapon research. He has a BS in physics from the University of Washington. He's a member of the American Physical Society.

In his spare time, George likes to backpack, fly-fish, hunt, and work with computers. He and his wife Bea have one child and live in the NE Heights.

**JOAN WOODARD** to manager of Materials Characterization Dept. 1820, effective Dec. 16.

Joan joined Sandia Livermore in 1974 as a member of the Systems Studies Division, where she helped to analyze solar thermal systems. She continued that work in the Solar Energy Technology Division, and also worked on technical management and design evaluation for the Barstow Solar Central Receiver pilot plant. Later, she contributed to the systems analysis of solar hybrid and repowered plants.

She joined the Combustion Applications Division, where she did research on auto-ignition properties of synthetic fuels, and was promoted to supervisor of the Solar Programs Division in 1982. Her work there was in long-range planning and assessment for the DOE Solar Thermal Technologies Division.

In 1984, Joan transferred to the Materials and Processes Division, which provided material support to the weapon systems program. The division also conducted research in modeling of metal-forming processes, and Joan established an organic composite materials program that offered a new technology for advanced engineering applications. Recently the division became the Chemistry and Advanced Materials Division with an active role in SRAM II and SDI materials support.

Joan earned a BS in applied mathematics from the University of Missouri at Rolla, an MS in engineering economic systems from Stanford through Sandia's OYOC (One-Year-On-Campus) program, and a PhD in mechanical engineering from the University of California at Berkeley through Sandia's Doctoral Study Program (DSP). She's a member of the ad hoc MTS Performance Evaluation committee.

Her spare-time activities include skiing, camping, and hiking. Joan and her husband Jim (2140) have two children and recently moved into a home



**JIM (2140) and JOAN (1820) WOODARD** in the NE Heights.

\* \* \*

**JAMES WOODARD** to manager of Integrated Circuit Technology Dept. 2140, effective Jan. 1.

Jim joined Sandia Livermore in 1974 as a member of the Systems Studies Division, where he studied transportation requirements for an NRC project. He also did evaluations of the Barstow Solar Central Receiver pilot plant and other solar programs.

In 1979, he transferred to the Exploratory Systems Division to work on the Permissive Action Link (PAL) controller program. He was promoted to supervisor of the Electronic Systems Division in 1982. There he worked with microprocessor-based systems for command and control applications. He also headed the Weapon Subsystems Development and Advanced Electronics divisions. He returned to the Exploratory Systems Division in 1986, and supervised the SRAM II Electrical Systems Division from August 1987 until his promotion.

Jim's education was at MIT, where he received all his degrees, through PhD, in electrical engineering. He served in the US Army before joining the Labs. He is a member of IEEE.

He and his wife Joan (1820) enjoy outdoor activities in their spare time. They have two children.



**WAYNE COOK** to supervisor of Special Project Development and Fielding Div. 7126, effective Jan. 1.

Wayne joined Sandia in June 1959 as a member of the Environmental Test Division. In 1961, he transferred to the Electromagnetic Testing Division. He joined the Field Measurements Division in 1967, where he worked on instrumentation development.

He has a BS from the University of Missouri and an MS from UNM (through Sandia's Technical Development Program), both in EE.

Wayne's spare-time activities include downhill skiing, camping, and hunting. He and his wife Marsha have three children and live in the NE Heights.

## Retiring



**Jim Porter (2648)**



**Don Williams (DMTS, 2811)** 37



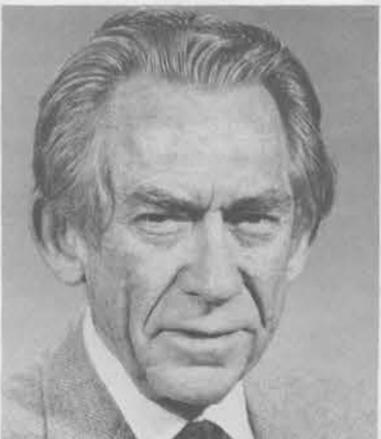
**Gene Harling (7100)** 30



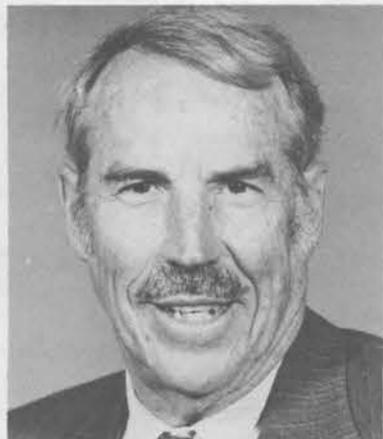
**Bob Adams (5256)** 33



**Harold Goddard (7222)** 39



**Stan Howard (DMTS, 5233)** 37



**Harold Barnett (2363)** 37



**Vernon Easley (7850)** 31

# Southwestern Plants in the Wild and in the Garden



It's easy to dismiss "native landscaping" as variations on cactus and gravel, with perhaps a few yuccas thrown in. But in the past few years, local horticulturists

have gone far beyond that limited palette.

Many species of plants that are pleasant in the wild have been adapted for landscaping. Learn more about this subject at the next Community Focus lecture at 12 noon, Thursday, March 9, in the Technology Transfer Center.

Judith Phillips, author of *Southwestern Landscaping With Native Plants*, will present "Southwestern Landscape Ecology: Native Plants in the Wild and in the Garden." She is co-owner/operator (with her husband) of Bernardo Beach Native Plant Farm in Veguita and of a retail outlet in Albuquerque.

Phillips will discuss local ecosystems such as arroyos, canyons, and foothills, showing slides of plants one might see in each and how these plants can fit into a home landscape.

"The best hiking areas are often the best areas to look for garden subjects," says Phillips. "You can see the diversity. If you're hiking and see a plant in a canyon, it will be in a relatively wet area. In the foothills, drainage is rapid and exposure more open. You may see the same plant, but it will be smaller and sparser looking."

For those who prefer not to hike, she says, road-

sides are good places to look, because runoff of water encourages many species.

## Don't Dig — Buy

However, Phillips cautions, gardeners who admire a wild-growing plant should obtain their own from a nursery — partly to preserve the wild ones, but also because wild-collected plants are likely to die.

"People generally try to dig up wild plants that are too old," says Phillips. "A small one may be 12 or 15 years old, with a root system too big to take completely. A similar-sized plant from a nursery will be young and more likely to survive transplanting."

"There's good availability of native plants for homeowners at local nurseries — at least 200 species have been adapted."

Native plants can form a low-maintenance garden or lawn — even lower, once they are established, than cactus-and-gravel. "Cactus landscaping isn't truly low-maintenance," says Phillips, "because maintenance is more than watering. Papers and leaves blow in, and cleaning them out of cactus can be a thorny problem."

Phillips has worked in ornamental horticulture since 1970, specializing in dry-land native plants for the past eight years. She has participated in projects of Albuquerque City Parks and the Bosque del Apache Wildlife Refuge, has contributed to several publications on naturalized landscaping, and regularly presents slide programs and workshops.



JUDITH PHILLIPS

## Take Note

Sandia is again participating in the Albuquerque YWCA's annual Women on the Move Achievement Awards. Final nominees from Sandia will be determined through a highly selective process. Nominees exemplify the YWCA's philosophy and goals: the development of "full realization of individual potential and betterment of the community . . . meeting the changing needs of persons of all ages, economic, ethnic or racial groups." In the past four years, Sandia has nominated 63 women for contributions to their own organizations, the company, and the Albuquerque community. The YWCA gives the awards in the following categories: Arts, Trades, Communications, Education, Health, Government/Politics/Military, Social Services, Business, Religion, Science/Engineering/High Technology, and Other Professions. Past winners from Sandia are Carol Ashby (1126), Frances Cheek-Martin (2601), Nancy Freshour (7825), Judith Mead (7213), Jennie Negin (3140), Yolanda Padilla-Vigil (3551), and Shirley Wallace (132). "We're proud of the many talented women who work at the Labs, and we expect many good nominations again this year," says Dennis Roth, VP of Administration 3000.

\* \* \*

The American Society of Mechanical Engineers (ASME) New Mexico Section February meeting is scheduled tonight at 7:15 p.m. in the lobby of the UNM Mechanical Engineering Bldg. (SW corner of the main campus). An open house is being held for ASME members, families, friends, and students. Refreshments will be served. The meeting is free and no reservations are required. Call Verne Romesberg (6322) on 4-2187 or Joe Koski (6514) on 6-0138 for information.

\* \* \*

Allison Davis (1813), George Novotny (7222), Dick Schwoebel (2500), and Dick's wife Jennie are treading the boards again in an Albuquerque Academy Parents' Assn. production of "Patience," a musical satire on the affectations and fickleness of the aesthetic craze that swept Great Britain in the late 19th century (updated to the 1960s era of "flower children" and their quest for ideal love and beauty). Allison is the director, Dick plays the role of Grosvenor, Jennie plays Patience, and George is a member of the dragoon chorus. Performances are March 9-11 at 8 p.m. in the Academy's Simms Fine Arts

Center auditorium. Tickets may be purchased at the door or in advance by calling 294-1975 or 888-5101.

### Sandia Colloquium

Tom Westenberg of the US Olympic Committee Sports Science Dept. will talk about "Using New Technology to Improve Olympic Performances" at the Technology Transfer Center (Bldg. 825) on March 10 at 9 a.m. Call host Henry Dodd (6225) on 4-5253 for information.

The ethnic arts and crafts exhibit (announced in the LAB NEWS, Jan. 27), held in conjunction with Sandia's International Day, has been expanded to include collections of ethnic art as well as original art. If you have a modest collection of arts and crafts from other countries that you'd be willing to put on display in one of Sandia's exhibit areas, contact Joe Laval (3163) on 4-6531. Deadline for submissions has been extended to March 15. Exhibits will be on display from April 3 to May 12.

### Retirement Seminar

Guy Trujillo of Financial Network Investment Corp. will present "Asset Allocation," an approach to portfolio development designed specifically for IRA rollovers and other qualified retirement plans, March 1 at 5 p.m. at the Coronado Club, Eldorado Rm. RSVP to Guy on 291-8585.

The Rio Grande Chapter of the Special Libraries Assn. and the UNM General Library are sponsoring a seminar, "Patents and the Successful Inventor," March 13 from 8:30 a.m. to 4 p.m. at UNM Woodard Hall, Rm. 147. Registration is \$25; deadline is March 6. Information and agendas are available from Cathy Pasterczyk (3144) on 4-1080 or 255-2066.

\* \* \*

Members of Albuquerque-area singles groups will gather for a "Combo — Singles Open House" on Sunday, Feb. 26, from 2 to 5 p.m. at St. Aidan's

Episcopal Church (1500 Chelwood Park Blvd. NE). The informal get-together for snacks and conversation is sponsored by the Living Single group, started a year and a half ago at Sandia by Kathleen Hovorka (7523). All singles are invited to attend. A \$1 donation is requested. For more information, contact Kathleen on 6-8384.

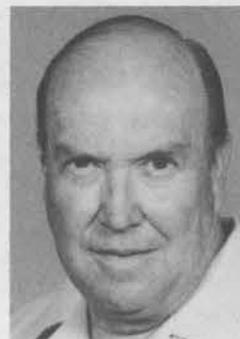
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All Faiths Receiving Home (a United Way agency) is looking for volunteers interested in enhancing the lives of abused and abandoned children. A membership meeting is scheduled March 1 at 9:30 a.m. Tour the Home, meet other volunteers and staff members, and find out where you can best volunteer your talents. Refreshments will be served. For information, call 345-8938.

\* \* \*

The Friends of the Albuquerque/Bernalillo County Public Library need scientific and technical books and journals for the organization's 20th annual book sale March 15-18 at the Main Library (6th and Copper NW). Drop off donations at any Albuquerque Public Library branch. Tax donation forms will be available. For more information, contact Duane Arlowe (5261) on 298-1770.

## Death



Kenneth Hankins of Project Design Definition Div. II 2852 died Feb. 5 after a lengthy illness. He was 54 years old.

He was a technical staff associate and had been with Sandia since 1952.

Survivors include his wife, three daughters, and one son.

**Biking** — Balmy days and nights aren't far off, so bikers might think about joining the Tour de Taos Bike 150 tour from Albuquerque to Taos set for June 3 and 4. The tour will be fully catered: rest stops, water, juices, fruit, high-energy snacks every 8-10 miles, professional bike mechanics, overnight-gear transportation, communications support, medical vans, and sag wagons.

The tour leaves Albuquerque Saturday morning and heads through the Sandias. Camp will be set up Saturday night at Tesuque's Camel Rock Camp Ground with a catered dinner and refreshments, entertainment, swimming, dancing, and jacuzzi facilities. At the end of the ride in Taos, bikers and bikes will be transported back to Albuquerque.

Proceeds from the tour will benefit the Multiple Sclerosis Society. Prizes for most pledges collected will be awarded; grand prize is a trip to London. Each rider must obtain at least \$1 per mile in pledges, for a total of \$150. Registration deadline is May 26. Contact Fred Hansen (ret.) on 869-2716 for information.

\* \* \*

**Boating** — The Coast Guard Auxiliary is again offering boating safety courses in both power- and sailboating. Classes began Feb. 22 at the Armed Forces Reserve Center (400 Wyoming NE). Both

courses are held on Wednesdays at 7 p.m. for approximately 13 weeks. Instruction is free, but there's a \$10 charge for material for the first member of a family for the course text; additional family members are charged \$3 for course worksheets. To preregister, call Ben Gardiner (7411) on 298-0116, Earl Livingston on 298-5926, or Ed Williams on 821-2060.

\* \* \*

**Softball** — Interested players and coaches are invited to an organizational meeting of the Sandia Softball Assn. on March 8 at 4:45 p.m. at the Coronado Club. Information packets to sign up teams will be available. Season starts April 24. Completed rosters and money are due by March 31. Contact Charles Ringler (5249) on 4-1789 for more information.

**Move Over, Punxsutawney Phill!**



For the 30th year running, apparently, the hedgehogs in Ontario, Canada, have predicted the weather and got it right (according to the British Hedgehog Preservation Society's newsletter). The guidelines are simple: If a hedgehog looks out of its nest on Candlemas Day (2 February), and the sky is so clear that it sees its shadow, this means six more weeks of winter. So it returns to hibernation and humans know what to expect.

We are assured that the local mayor has been checking on hedgehog habits for the past 30 years and has collected statistics which show that the little fellows' weather forecasts are 90 percent accurate.

New Scientist

## Welcome

**Albuquerque**

- Jeffery Adams (3426)
- Donald Flores (131)
- Michael Garcia (3426)
- John Larson (3142)
- Donald Wagy (3155)
- Gail Willette (3730)
- Brenda Zepper (131)

**Arizona**

- Tammy Henson (9225)

**California**

- Howard Hudson (7555)
- Richard Nygren (6514)
- Carl Peterson (7844)

**Florida**

- Tania Hake (6412)

**New Mexico**

- Daniel Taylor (1823)
- James Wiseman (2342)

**Texas**

- Clay Fulcher (5115)
- Daniel Moreno (2174)
- John Red-Horse (1524)

UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS • UNCLASSIFIED ADVERTISEMENTS

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

**Ad Rules**

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

**MISCELLANEOUS**

- FLOOR LOOM, 28", \$200. Jakowatz, 299-9271.
- '87 PALOMINO COLT CAMPING TRAILER, sleeps 6, \$2100. Sanchez, 292-1982.
- SINGLE CONTOUR CHAIR, orbital massage, power slide, thermionic heat, 3 yrs. old, \$750 OBO. Owens, 294-6470.
- FOUR ALL-TERRAIN TIRES, H78-15LT, nylon 6-ply, 10K miles, \$100/all. Brown, 884-6848.
- '85 KOFF TILT-BED TRAILER, has rail for motorcycle, \$475. Kayser, 877-0234.
- UNIVERSAL CAL GYM, w/pec deck, free-standing w/4 stations, 1 yr. old, \$1800. Furman, 298-9264.
- '83 KOMFORT 5th WHEEL, 20", dual axle, w/hitch, \$6500 OBO. Molina, 299-8718.
- FULL-SIZE MATTRESS SET and frame, \$50; Sharp 19" color TV, 2 yrs. old, \$150. Herr, 281-8275.
- SMITH-CORONA ELEMENT ELECTRIC TYPEWRITER, \$25; Dokorder reel-to-reel recorder, w/speakers, \$15; Roberts reel-to-reel plus 8-track recorder, \$15. Guilford, 255-6294.
- IBM PC JR., Zenith monitor, thermal printer, software, \$250; Ross 19" mountain-bike frame, fork, and brakes, \$75. Kovacic, 256-9867.
- H-P 41CX PROGRAMMABLE CALCULATOR, math applications pack, EE solutions book, additional programs, \$200. Hueller, 296-0976.
- CHROME REAR BUMPER, from '85 Dodge pickup, removed when new, \$75; Testors paints, unopened, 35¢/ea. Shaw, 296-2531.
- GARAGE REFRIGERATOR, \$30; dou-

- ble-bookcase bedstead, \$50; stereo cabinet w/speakers (12" x 100"), \$100; woman's golf club set, \$20. Rightley, 822-0383.
- SHELTIE-CROSS DOG, 1-to-2-yr.-old male, tri-color, 10 lbs., free to good home. Rex, 344-6552.
- ITHACA 16-GA. FEATHERWEIGHT PUMP SHOTGUN, bluing fair, no pitting, includes 2 boxes of shells, \$175. Szklarz, 291-0037.
- NAVY-BLUE LEATHER COUCH, cost \$1200, sell for \$550; antique oak table, \$600; oak coffee table w/glass top, \$350. Peterson, 296-7733.
- BLUE VELVET SOFA HIDE-A-BED, accent pillows, used as decoration (not as everyday furniture), \$400. Bennett, 889-0929.
- LIME-GREEN DRAPES, 10-1/2' long, w/sheers, double-track pull-type rods, 2 sets 9' x 6' widths. Randall, 821-0388.
- ANGEL FIRE SKI TICKETS, good through end of ski season, \$16/ea. Palmquist, 281-5951.
- '69 FORD SHOP MANUAL, 5 vols. plus schematics, all models — Falcon to Lincoln, free; '71-'84 Fiat manual, \$6. Underhill, 294-5774 after 6.
- SOFTWARE: dBASE 4, 3-1/2" disks, new in unopened package, \$175. Dionne, 262-0160.
- STEREO CABINET, oiled walnut, 2 horizontal sections w/supports that attach to wall, adjustable shelving, \$250. Greenwood, 298-5268.
- WHITE DINETTE w/4 blue chairs; concrete splash blocks, 16" x 145"; wrought-iron railing; broiler oven; hair dryer. Phipps, 299-8490.
- WOMAN'S SKI BOOTS, Munari alpine, size 7, w/carrier, \$10; man's bike shoes, Bata, size 12, \$3. Dippold, 821-5750.
- WESER BROS. PIANO, upright practice, \$150. Risse, 869-2037.
- CENTURY INFANT CAR SEAT/CARRIAGE, for baby up to 20 lbs., \$25. Baca, 299-4875.
- IBM ELECTRIC TYPEWRITER, w/carbon ribbon and 16" carriage; metal typing stand w/drop leaves; \$35/ea. Reno, 296-6290.
- MINK COAT, autumn haze, appraised at \$4500, sell for \$900. Allen, 263-2737.
- '86 US GOLD BULLION PROOF INVESTMENT COIN, 1 oz., sealed in case as issued by the US Mint. Wilson, 821-5442.
- DOUBLE BED, w/teak headboard, box spring, and mattress; twin-size box spring and bed frame. Drotning, 294-4807.
- WORDPERFECT 4.2 SOFTWARE & DOCUMENTATION, registered owner, \$60; PC/terminal stand, single-pedestal, casters, \$30. Schubeck, 821-3133.
- H-P 41CX CALCULATOR, w/petroleum engineering module, \$150 OBO. Hogan, 292-8879.

- CARPET: cream or brown plush carpet and brown tweed sculptured shag, \$1.50/yd. Freshour, 256-9168 after 6.
- TWO JUNE MUSIC FESTIVAL SERIES TICKETS, Guarneri String Quartet (June 3, 4, 6, 9 & 11), UNM Woodward Hall, \$100/pr. Feibelman, 242-1946.
- KAWAI GRAND PIANO, 5', ebony finish, locking keyboard, \$4000. Esterly, 296-9759.
- MADAME ALEXANDER DOLL, 8", "Red Boy," 1987 MIB, \$30. Van Deusen, 291-8196.
- MOTORCYCLE TRAILER, hauls 3 motorcycles, red, \$300. Hesch, 268-6122.
- REFRIGERATOR/FREEZER, almond, 19 cu. ft., \$50; building materials: Celotex, waterwood, joist hangers, joist bracing for 16" spacing. Kersch, 821-2848.
- LAB/SHEPHERD PUPS, 7 weeks old, free. Finch, 384-5272 after 6.
- PC/XT CLONE, 8-MHz, 10MB disk, color display, \$450; math coprocessor, 8-MHz, \$75; Intel Aboveboard, \$75. Ray, 294-7720.
- LONG-HAIRED CAT, neutered, likes kids but not other cats, free. Patterson, 822-1196.

**TRANSPORTATION**

- '86 MERCURY LYNX LNL SW, 16K miles, AC, FWD, cruise, Michelins. Morton, 296-6108.
- '79 HONDA MOTORCYCLE, CB 750F, new tires and battery, 11K miles, \$675. Britt, 299-1366.
- '85 PONTIAC, fully loaded; '86 Plymouth Caravel, extras, \$7900. Campbell, 888-3135 or 275-1143.
- '87 NISSAN PICKUP, AC, 28K miles, AM/FM cassette. Egan, 299-7487.
- '75 TOYOTA COROLLA, 5-spd., \$650. Ferguson, 292-3824.
- '82 YAMAHA 125 IT DIRT MOTORCYCLE, 1 hour on completely overhauled engine. Bercaw, 275-1691.
- '85 FORD T-BIRD, 2-dr. coupe, V-6, cruise, AM/FM, tilt, AC, AT, PS, PB, PW, 51K miles, \$6950. Sutherland, 345-1183.
- '83 AUDI 4000S, AT, PS, PB, AC, AM/FM cassette, 42K miles. Heimer, 821-9550.
- '86 MOTO-GUZZI LE MANS 1000, added performance parts, new tires, 13K miles, \$3000. Szklarz, 291-0037.
- '81 OLDS. CUTLASS SUPREME, AT, PS, AC, PB, 67.7K miles, \$2500. DeReu, 275-2336.
- '87 FORD F-150 PICKUP, transferable warranty, 351 engine, AT, AC, cruise, AM/FM cassette, tilt, 14K miles, \$8900. Malin, 299-6199.
- '85 FORD F-150 SUPERCAB XLT PICKUP, 4-spd. w/O, 6-cyl., fiberglass shell, AM/FM cassette, AC, PS,

- \$7400 blue book, asking \$7000. Kyger, 299-6398.
- '83 OLDS. CUTLASS CIERA BROUGHAM, V-6, 4-dr., loaded, new vinyl top and tires, shop manuals included, \$4400. Floyd, 293-5789.
- '84 GMC SIERRA CLASSIC PICKUP, 3/4-ton, 4-WD, 6.2L diesel, AT, AC, AM/FM, PS, PB, 61K miles, \$7300. Habbit, 293-7216.
- '65 MUSTANG, 3-spd., 289 V-8, needs work (some restoration done), \$2200 negotiable. Hunt, 255-7879.
- '86 SUNSTREAM MOTORHOME, 30', all extras, 6K miles. Jacobs, 821-2403.
- '88 HONDA ACCORD, 2-dr. coupe, 3.3K miles, no AC. Smith, 275-8185.
- '80 OLDS. CUTLASS SUPREME BROUGHAM, 2-dr., AM/FM, PB, PS, PW, AC, cruise, \$2495. Luther, 293-4462.
- '80 OLDS. OMEGA, 4-cyl., AT, AC, 71K miles, \$1500. Foltz, 291-0051.
- '84 BUICK REGAL, T-type, turbo, all power options, leather seats, sunroof, AM/FM cassette, \$5500. Bonahoom, 296-4450.
- '81 HONDA ACCORD, hatchback, 5-spd., new clutch and carburetor, \$2200. Ostensen, 296-4227.
- GIRL'S BICYCLE, for girl age 11 or younger, pink, w/basket, adjustable seat, \$50. Weiss, 821-8256.
- '68 APACHE MOTORHOME, 23', 440 Dodge engine, PB, PS, cruise, AC. Marsh, 865-4174.
- '86 FORD RANGER SUPERCAB, 4-cyl., 5-spd., AC, PS, AM/FM, camper shell, \$6800. Chambers, 898-6419.
- '71 VW SUPERBEETLE, not running, body needs work, new pistons, rebuilt block, heads, and carburetor, \$300. Brogan, 293-3282.
- '88 CHEV. 4x4, 11K miles, 5-spd., block heater, AM/FM cassette, custom paint, tow package, 2-ton jack, extras, \$13,700. Brantley, 294-1169.
- '79 MAZDA RX7, 76K miles, \$2100. Silva, 265-5523.

**REAL ESTATE**

- FOUR-PLEX, SE near Louisiana, assume FHA balance (80K) and pay closing costs. Cook, 255-7396.
- 1729-SQ.-FT HOME, 2 baths, hot-tub room, remodeled kitchen, new carpets, separate 522-sq.-ft. guest house, all on 2 lots. Baca, 877-0625.
- 3-BDR. HOME, 2-1/2 baths, \$99,500. Martin, 294-6792.
- 2-BDR. MOBILE HOME, '78 Flamingo, 14' x 70', 2 full baths, \$15,500 firm. Hill, 275-7415 or 836-2752.
- 2-BDR. HOME, near Ladera Golf Course, 2 baths, FP, landscaped, no qualifying, \$5000 down, terms negotiable, \$65,000. Gabaldon, 836-5154.
- FOUR-HILLS LOT. Padilla, 345-7660 or

- 242-8763.
- 3-BDR. HOME, Nob Hill/Monte Vista area, 2 full baths, 1600 sq. ft., 10% FHA assumable, \$96,000. Foly, 268-0412.
- 3-BDR. MOBILE HOME, in Four Hills mobile home park, 2 baths, LR, DR, shop, take over payments at credit union. Allen, 263-2737.
- 2-BDR. 2-STORY TOWNHOME, 2 baths, 2-car garage, Comanche/Tramway, mountain and city views, security system, skylights, FP, assume 9-1/2% loan, FHA payments \$870. Darnell, 294-5665.
- 3-BDR. HOME, 2 baths, 2-car garage, 1-acre lot, Bosque Farms/Los Lunas area. Roybal, 865-1090.
- 2 to 3-BDR. HOME, new kitchen & bath, hardwood floors, utility storage, garage, 400-sq.-ft. workshop, NE, \$67,500. Fessler, 294-8175.
- 2-BDR. MOBILE HOME, '86 Fleetwood, 14' x 80', vaulted ceilings, \$16,000 or \$500 down and \$185.66/mo. payments. Zamora, 898-8571.
- 4-BDR. HOME, Heritage East, 2 yrs. old, LR, DR, FR w/FP, 2 baths, kitchen w/nook, 2-car garage, landscaped, sprinklers in front, 1915 sq. ft., \$145,000. Dobias, 822-0013.

**WANTED**

- HOUSEMATE, woman to share home in NE Heights, nonsmoker. Piatt, 293-1204.
- PORTABLE DOG RUN or 25-in.-ft. of 6' fence w/gate. Snowdon, 344-4637.
- DUPLICATE BRIDGE PARTNER, Thurs. evenings at C-Club, not too serious, just for fun. Honnell, 291-9258.
- BASS GUITAR AMPLIFIER. Cronin, 265-5229.
- HIKERS: people interested in hiking in the Tarahmara country of Mexico over Easter, trip dates are March 18-29. Mattox, 292-7763.
- HOUSEMATE, nonsmoker, 3-bdr. furnished home in NE Heights, swimming pool, \$225/mo., utilities included. Smith, 291-9241 after Feb. 26.
- HOUSEMATE, nonsmoker, share 2-bdr. furnished home near Menaul and Morris, \$250/mo. + 1/2 utilities. Guidotti, 298-8818.
- BEDROOM SETS, full- and queen-size, no water beds. Hole, 255-1444.
- AMATEUR RADIO TRANSMITTER OR TRANSCEIVER, will consider tube, solid-state, crystal, or variable frequency, even non-working. Snyder, 293-3611 leave message.
- BABYSITTER, next year for kindergarten child when not in school (Hubert Humphrey area), prefer mother with another kindergartener. Patterson, 822-1196.
- TABLE-TENNIS TABLE; basketball and football bloopers video to view and return. Gallegos, 294-0233.

## Prime-Time Prancing, Shrimp-Time Shuffling — Take Your Choice Tonight

PRIME RIB OR FRIED SHRIMP are the menu selections tonight at the two-for-one special; take your choice of entree, and get two dinners for the low, low price of \$19.95. Afterward, exciting entertainment from the Cloggin' Express (7:30-8 p.m.) sets your toes tapping. And *that* gets you in the mood to dance the night away, accompanied by the tunes of Trio Grande. Help out the prime movers and shrimp shuckers in the kitchen by calling in your reservation ASAP (265-6791).

THE BRUNCH BANDWAGON rolls back into town this Sunday (Feb. 26). Served from 10 a.m. to 2 p.m., the fantastic food includes baked ham, roast turkey, mashed potatoes and gravy, omelets, pancakes, and all kinds of salads and desserts. Here's a great way to cap off the weekend, and you can also smile all the way to the bank: The price is just \$6.95 for adults and \$3.50 for children ages 4 to 11.

EVERYBODY KNOWS that C-Club membership has its privileges — and benefits. And membership dues have remained the same (\$5/month) for the last 10 years — even in the face of rising insurance and overhead costs, and plain old inflation increases. Now, however, because of those rising costs, the Board has effected a dues increase (as of March 1) to \$8/month — still a small price to pay for the finest of facilities, outstanding events for every member of the family, and special-interest groups

for like-minded folks such as skiers, dart-throwers, and Lobo followers.

BINGO BUFFS can play their cards right every Thursday night, starting in March. Check out prizes in the lobby showcase for the upcoming week. Card sales start at 5:30 p.m., and the early-bird game blasts off at 6:45 each evening (March 2, 9, 16, 23, and 30).

SPEAKING OF CARD-PLAYING, the T-Bird card sharks go back to the tables on March 2, beginning at 10 a.m. Come out for all kinds of gaming, free refreshments, and door prizes. Note: In honor of St. Patrick's Day — coming up later in the month — honcho Jim McCutcheon will undoubtedly wear his green eyeshade.

NEXT FRIDAY NIGHT (March 3), enjoy prime rib or crab legs at the two-for-one special dinner. Afterward, shuffle the night away (8 p.m. to midnight) as those ever-popular Isleta Poor Boys strum their sagebrush specialties.

LITTLE DEARS can watch their favorite little deer at Family/Variety Night on Saturday, March 4. The Disney classic, "Bambi," lights up the big screen at 6 p.m. Beforehand, a low-cost buffet featuring all kinds of kid-pleasing food is served from 5 to 6. As usual, movie admission is free.



NEW QUARTERS FOR SERP — Recreation manager Stan Ford and recreation assistant Suzan Baldonado invite Sandia Employee Recreation Program members to come by and take a look at their new office space in the C-Club basement. They're displaying some of the equipment available for loan to SERP participants.

### Congratulations

To Mary and Ronald (2857) McIntosh, a son, Jeron Martell, Jan. 15.

To Laura and Steven (1266) Chaba, a son, Kevin Mark, Jan. 18.

To Julie and Mark (2858) Pilcher, a daughter, Nicole Alyse, Jan. 31.

To Wendy (2523) and Michael (1833) Cieslak, a daughter, Jacqueline Elizabeth, Feb. 3.

To Kim (3142) Denton-Hill and Roger (6311) Hill, a son, Zachary Denton Hill, Feb. 10.

To Elaine and Kevin (3532) McMahan, a son,

Alexander Thomas, Feb. 14.

To Anne (2315) and Luis Chavez, a son, Joshua Edward, Feb. 14.

To Ginny Hill (3152) and Tom Graham (ret.), married in Albuquerque, Feb. 18.

### Sympathy

To Frank Nutt (3426) on the death of his father in Albuquerque, Feb. 4.

## Events Calendar

Feb. 24 — Crownpoint Rug Auction: 3-6:45 rug viewing, 7 p.m. auction; Crownpoint Elementary School, 786-5302.

Feb. 24-25 — "Quilters," musical about frontier women; 8 p.m., Rodey Theatre, 277-4402.

Feb. 24-25 — "Ubu Roi," farce about a nobleman who takes over the Polish throne and terrorizes the natives, presented by Theatre-in-the-Making; 8 p.m. Fri.-Sat.; Centerstage (formerly Rep East, 3211 Central NE), 260-0331.

Feb. 24-March 4 — "A Raisin in the Sun," play by Lorraine Hansberry about divergent dreams of — and conflicts within — three generations of a black family living on Chicago's South Side; 8 p.m. Fri.-Sat., 6 p.m. Sun.; Vortex Theatre, 247-8600.

Feb. 24-March 19 — Exhibit, "Houses by Bart Prince," drawings and architectural models; 9 a.m.-4 p.m. Tues.-Fri., 5-9 p.m. Tues. evenings, 1-4 p.m. Sun.; UNM Art Museum, 277-4001.

Feb. 24-April 30 — "High Country," photography/video exhibit detailing plants and animals in the harsh environment above 11,000 feet in New Mexico's Sangre de Cristo Mountains; 9 a.m.-5 p.m. daily, New Mexico Museum of Natural History, 841-8837.

Feb. 25 — "Genre'-ly Speaking: Baroque & Classical," works of Bach, Schultz, and Haydn presented by Quintessence Choral Artists of the Southwest; 8:15 p.m. (preceded by string quartet at 7:30), St. Paul Lutheran Church (1100 Indian School Rd. NE), 836-6775.

Feb. 25 — Keller Hall Series: Joanna de Keyser on cello and George Robert on piano, performing works by Beethoven, Mozart, Mendelssohn, and Shostakovich; 8:15 p.m., Keller Hall, 277-4402.

Feb. 26 — "Burgundy and the Flowering of the Renaissance," Musica Antigua de Albuquerque performs music by composers influenced by Philip the Bold, John the Fearless, Philip the Good, and Charles the Bold — rich and powerful Dukes of Burgundy in the 15th century; 4 p.m., St. Thomas of Canterbury Episcopal Church (425 University NE), 842-9613.

Feb. 26 — "Messiah Sing-and-Play-Along," singers and instrumentalists of all types are welcome, scores available at the door, entire "Messiah" will be done; 7 p.m., St. Thomas of Canterbury Episcopal Church (425 University NE), 247-2515 or 836-6775.

Feb. 26 — Odetta, folk songs; 8 p.m., KiMo Theatre, 243-4500.

Feb. 27-28 — Liz Lerman and Dance Exchange, dance theatre blending political satire and poignant concern; 8 p.m., KiMo Theatre, 243-4500.

March 4 — Pops Concert #3: "2000 and Fun"; New Mexico Symphony Orchestra performs themes from "Star Trek," "Star Wars," "Superman," "Close Encounters of the Third Kind," and "2001: A Space Odyssey"; 8:15 p.m., Popejoy Hall, 842-8565.

March 4 — Famous People Players present funny version of "Swan Lake," with fish and mermaids floating in a sea of black, and life-size images of Liberace, Elvis, Liza Minelli, and other pop idols; 8 p.m., KiMo Theatre, 243-4500.

March 7-24 — Exhibit, "Whistler Etchings," selection of 10 etchings from the Thames Suite by James Abbott McNeill Whistler; 9 a.m.-4 p.m. Tues.-Fri., 5-9 p.m. Tues. evenings, 1-4 p.m. Sun.; Study Gallery, UNM Art Museum, 277-4001.

March 10 — "Beethoven + Goode = Great," New Mexico Symphony Orchestra with pianist Richard Goode, performing Beethoven's Piano Concerto No. 5 in E-flat Major, Op. 73 (Emperor); 8:15 p.m., Popejoy Hall, 842-8565.

March 10-12 — "Premieres and Encores," Southwest Ballet Company performance of works by choreographers George Balanchine, Eleanor King, and Rodney Griffin; 8:15 p.m. Fri. & Sat., 2:15 p.m. Sun.; KiMo Theatre, 294-1423.