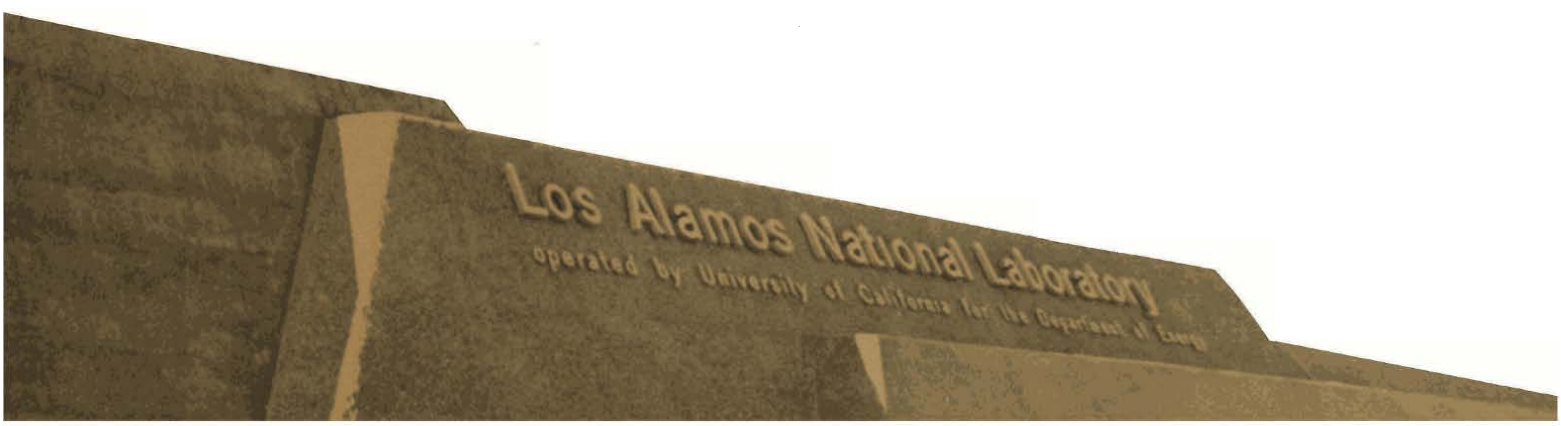
Q&A

THE FUTURE OF NUCLEAR WEAPONS

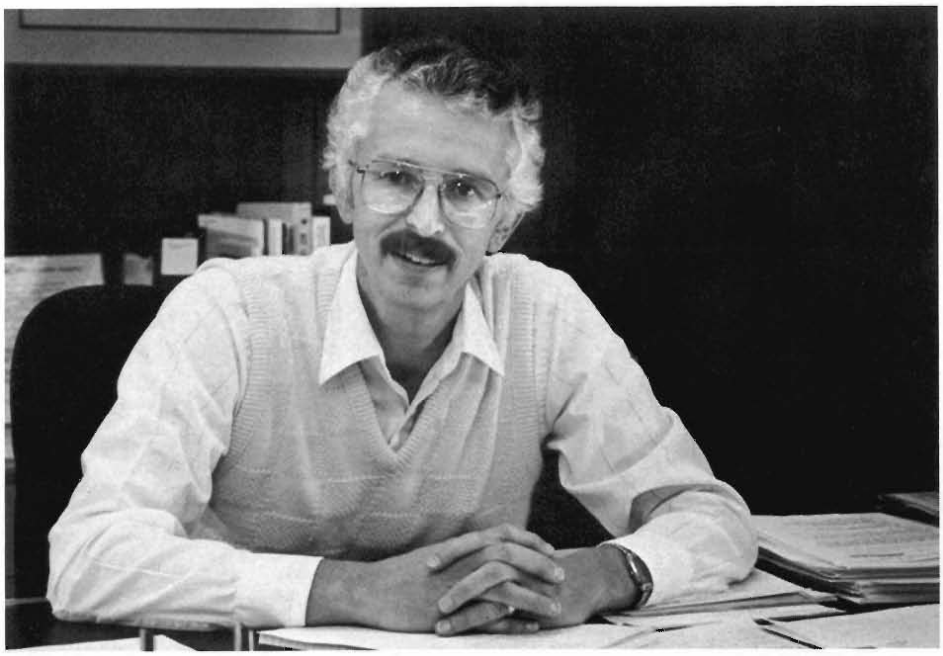
Q *How does a conference on the future of nuclear weapons, a conference that looks forward to potential changes in nuclear weapon requirements, affect your thinking and planning about the future of Los Alamos and the nation's nuclear weapons complex?*

A The primary job of the Laboratory is to provide the technological foundation for a credible nuclear deterrent. Deterrence is a broad and dynamic concept—for one thing, an effective deterrent must be technically viable *and* politically credible.

Experience shows us that maintaining such a deterrent requires frequent technical revisions and adaptations of the nuclear stockpile. These changes meet shifting challenges, including new nuclear weapon missions mandated from time to time by the national leaders. In other words, the Laboratory must not just maintain today's stockpiled weapons but must provide what I call nuclear competence. Competence implies a readiness to meet new challenges, a flexibility to respond in new technical directions, and a far-reaching technological vision that assures the nation won't be caught unprepared by technological surprise. To do this, we must maintain the highest level of scientific and technological excellence in our weapons and basic research programs. Only then can our leaders be confident of our ability to meet our nation's requirements.



But we also know that future nuclear weapons requirements—the requirements that provide technical direction for the weapons program—will depend greatly on developments in national security policy and the politics that surround that policy. The Conference helped us examine that technology-policy interface. It focused attention on the emergence of a world with multiple power centers and brought to the fore many questions about the role of nuclear weapons. We can't predict the future, but the Laboratory must be prepared to face any changes that might occur. Technological developments require long-term planning, a difficult task in the context of a changing political climate. Understanding the important but complex links between the weapons technology on the one hand and the security policy on the other helps our long-term planning for the Laboratory.



Q *Is nuclear testing an important part of nuclear competence?*

A Nuclear weapons testing is one of the *critical* elements of maintaining a credible nuclear deterrent. Such testing is current U.S. policy, and the reasoning behind it is well known. For example, testing is required if we are to ensure nuclear deterrence in a changing strategic environment. Also, testing assures us of the reliability of the stockpile and allows us to improve the safety and security of nuclear weapons with confidence.

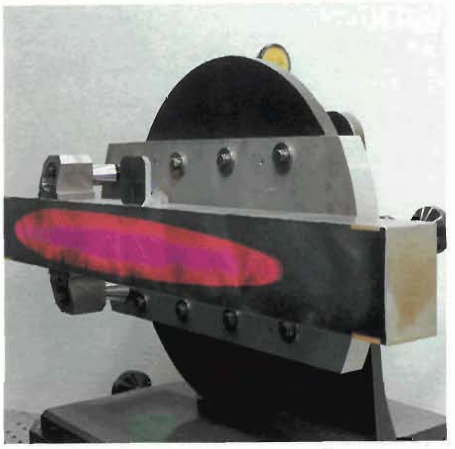
What's sometimes missed in our position regarding the need for testing of nuclear weapons is that it's no different than the position taken by any other high-technology activity—that is, component and product testing are universally considered indispensable. In the auto industry car frames are shaken through millions of cycles of simulated road tests; in the aviation industry wind tunnel tests help shape new designs; in the aerospace industry almost every component is thoroughly tested before being accepted for flight use. The Government, taxpayers, and consumers alike consider it a crime, or, at the very least, a breach of professional ethics, to place untested consumer and industrial products on the market. And although nuclear weapons have important differences from other complex technical systems, the need for testing is fundamentally the same and the impact of error is considerably greater. From a technical perspective it makes sense to depend on nuclear testing for as long as we continue to rely upon our nuclear deterrent for security—especially if nuclear arms are reduced as a result of arms control.

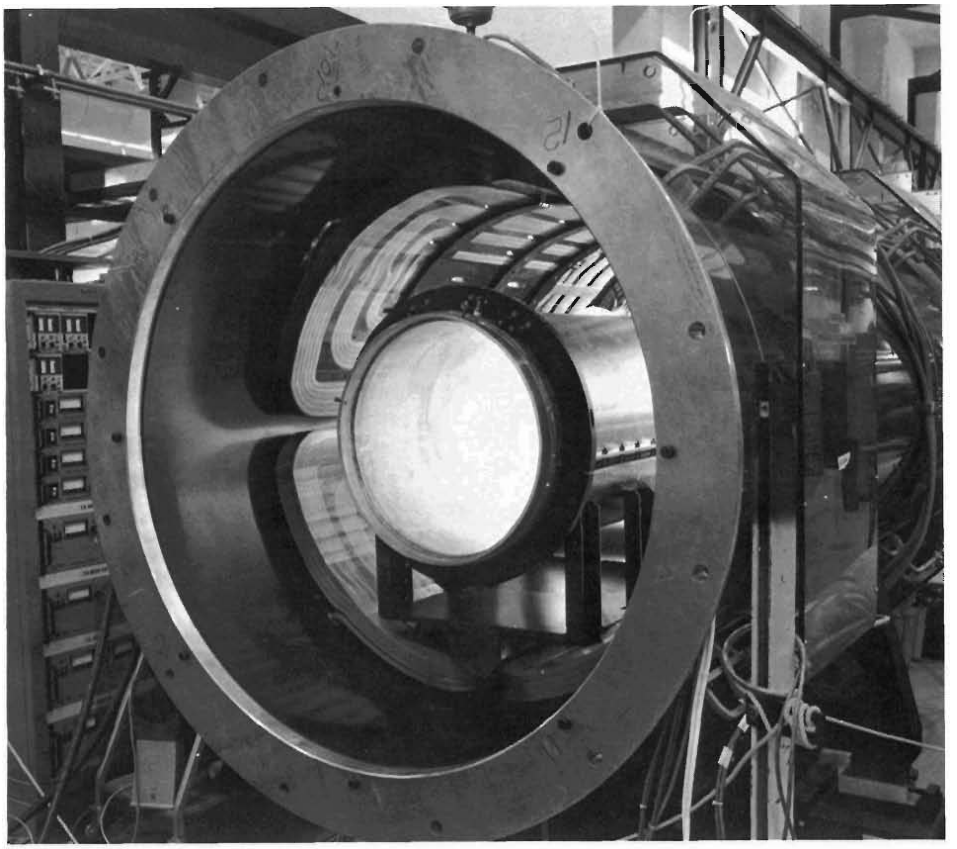
Q *Can't nuclear weapons be developed simply by using our current knowledge of the physics involved? Why do we need to carry out explosive nuclear tests?*

The Nevada Test Site is the location of all U.S. underground nuclear weapons tests. Here, a ring of dust rises as the underground cavity formed by a nuclear explosion collapses. Inset: in preparation for another underground test, this diagnostics rack will be lowered into a bore hole, giving instruments attached to it a line of sight to "ground zero," the location of the nuclear device.

A The events that occur in a nuclear explosion are so complex and insufficiently understood that even today we still cannot design weapons from first principles of physics or from computer simulations alone. Further, nuclear explosions produce temperatures and pressures like those inside a star and cannot be simulated in a laboratory. Thus, we must use an iterative design process involving theory, computer modeling and calculation, non-nuclear laboratory tests, and underground nuclear tests. Ultimately, nuclear tests are essential in calibrating our theoretical design models, which undergo continuous development.

The same holds true for the engineering problems. Nuclear tests provide the





Two research efforts at Los Alamos that could have an impact on directed-energy weapons technology are the neutral particle beam and the free-electron laser. Right: the objective lens of the Laboratory's large-bore magnetic telescope for a neutral particle beam was tested recently at Argonne National Laboratory. Left: grazing reflections, which spread out a beam's "footprint," allow the intense light of a free-electron laser to be redirected without damaging the optic surface of the mirror. The technique, simulated here using the red light of a helium-neon laser, also reduces the effects of mirror aberration and scatter.

final proof of warhead engineering and the packaging of components. The subtle effects of many engineering changes on warhead performance are often more difficult to predict than changes in the physics design.

Q *Then are you opposed to a comprehensive test ban treaty?*

A I have already stated that nuclear testing is critical to maintaining a credible nuclear deterrent. We believe that under a comprehensive test ban our nuclear design and engineering expertise could erode, and erosion could undermine the nation's nuclear competence.

Yet I recognize that there are other considerations in the debate about nuclear weapons. Nuclear testing has taken on great symbolic significance, and some people believe that curtailing testing will end, or at least slow down, the arms race.

In the end the nation's policymakers must look at the trade-offs between potential benefits of increased restraints on nuclear testing and the technical risks and consequent military penalties. Our job is to objectively evaluate the technical risks of further testing restraints.

Q *In most projections nuclear weapons are expected to remain the centerpiece of U.S. deterrent forces, although some experts foresee fewer of them and some narrowing of their role. In that case, how can Los Alamos prevent a decline in the quality of the nuclear weapons science and technology base?*

photo by Jerry Halladay

Advanced techniques and diagnostic capabilities developed for nuclear weapons programs have frequently been adapted for use in a number of other applied technologies, including the design and testing of conventional weapons. Here a warhead developed by Physics International is being dynamically tested using the Laboratory's high-speed, monorail rocket sled. After having been accelerated along the track from left to right, the warhead detonates at the target, which, in this case, is "projected 1995 Soviet armor." Surrounding the target area are a variety of diagnostic instruments, including intense x-ray machines that record the interaction of the warhead with the target (see "ATAC and the Armor/Anti-Armor Program" and "Studying Ceramic Armor with PHERMEX").

A First, I think we have to keep in mind that even in the midst of the current enthusiasm for reducing nuclear weaponry, nuclear deterrence remains a critical element of our defense posture. Even if the number of U.S. nuclear warheads were substantially reduced, there would still be a continued need for significant research and development at the nuclear weapons laboratories. Smaller nuclear stockpiles that continue to support deterrence would likely require changes in the *kinds* of weapons as well as changes in nuclear designs.

Furthermore, the size and the diversity of the current stockpile provide some insurance against both surprise attack and the sudden emergence of unforeseen technologies by another nation. If large numbers of nuclear weapons are eliminated, the weapons laboratories will be continually called upon to assure the survivability and technical robustness of the remaining stockpile. We must also continue to inform the nation of technological possibilities on the horizon that we may be forced to defend against.

We seek to complement our direct nuclear weapons programs with other kinds of scientific and engineering research that will help us remain at the cutting edge of scientific knowledge. We strive to maintain a world-class scientific institution staffed with some of the best professionals in the nation. In this way we will continue to serve a vital national function by retaining our ability to solve large, complex scientific and engineering problems. In the past the base of nuclear weapons science and technology at Los Alamos has given rise to numerous nonweapon technologies; in the future we will count on challenging programs at the forefront of research and development to help maintain the knowledge and personnel base required to assure nuclear competence.

Along these lines I would point out that about one-fourth of the current Laboratory budget is spent on research for imaginative and powerful non-nuclear defense concepts, including the neutral particle beam and the free-electron laser. Another one-fourth of our effort is directed toward fundamental research in areas such as high-temperature superconductors, supercomputing, mapping the human genome, and in energy and other civilian technologies. These scientific programs may not only have tremendous long-term payoffs to the nation, but they contribute to the Lab's expanding scientific and technical base and form a natural part of the Laboratory's mission—to offer creative solutions to problems of national urgency. These ef-

The Soviet and U.S. flags flying from a derrick at the Soviet's underground test site at Semipalatinsk symbolize the milestone reached when scientists of both countries participated in joint verification experiments at their respective underground nuclear test sites. These experiments allowed both groups to calibrate their detection techniques against controlled, baseline events. The effort does much to ensure that either country can verify compliance with nuclear test treaties by the other.

forts are in support of our attempts to broaden our concept of national security to include economic strength and energy security.

Q *Some policy and technology development trends seem to be going in different directions. Is there any conflict here? For example, why is Los Alamos developing technologies such as the earth-penetrating warhead when we are trying to negotiate reductions in nuclear arms?*

A The long-term trend appears to be toward reduced nuclear arms. But in the short term there are well-recognized deficiencies developing in our deterrent posture that may require new technologies or concepts. For example, our military planners are becoming increasingly concerned about our ability to hold at risk a number of high-value Soviet targets, such as mobile missiles and deeply buried or super-hard structures. The earth-penetrating warhead and other Laboratory weapons concepts provide technical options to U.S. military planners.

But the issue is more general than that specific example. Long-term trends in nuclear weaponry may very well result in different technical requirements in the future, and we must be able to meet them. For instance, improvements in the safety and security of nuclear weapons are clearly desirable, regardless of the size of the nuclear arsenal. Improvements of this kind are made possible by research and development. Finally, we need to build a technology hedge—a hedge against breakthroughs in weapons technology that could place the nation's deterrent at risk. Such breakthroughs would have a greater impact in an environment of significantly fewer weapons.

Q *There was a suggestion at the Conference that over time advanced conventional weapons may play an increasing role in the U.S. deterrent. What would be the implications for Los Alamos?*

A The Laboratory is already contributing very significantly to conventional weapons. This year we are conducting over $200 million in research on non-nuclear technologies that include concepts that may be truly revolutionary, such as particle beams, lasers, and

high-powered microwaves. We are also involved in more evolutionary technologies, such as those pertinent to the armor/anti-armor balance of tank warfare. In this case we are using diagnostic capabilities and other advanced techniques developed in the nuclear weapons program to assess the effectiveness of a broad variety of applied technologies.

Although the Lab plans a vigorous program of activities in conventional weapons, we are not assuming that these technologies will replace nuclear weapons. Rather it is our view that they will be used to augment and complement nuclear deterrent forces. There is considerable controversy whether even extremely accurate conventional weapons, including the so-called zero-CEP weapons, can *ever* serve as an effective deterrent by themselves. Not only are there some military missions that can only be accomplished with nuclear weapons, but non-nuclear strategic weapons lack the psychological impact, and thus the full deterrent effect, of nuclear weapons. Accurate conventional weapons can serve as effective complements to nuclear weapons, providing a greater range of conventional alternatives before nuclear use must be contemplated.

Q *The nation faces a major problem in cleaning up and modernizing the nuclear weapons production complex. Can we do that and still maintain the technology base at the Laboratory?*

A The cleanup and modernization of the Department of Energy weapons production complex is one of the exceptionally difficult problems facing the new administration. Everyone recognizes that the situation is unacceptable now and that we must single out the worst problems and attack them head-on. This effort is going to require the commitment of new financial and technical resources if it's to succeed. We think the Laboratory can play a significant role in the development and application of advanced technologies that may efficiently, and at reduced overall cost, assist with the cleanup. In other words, the bulldozer-and-asphalt approach won't work, and it's too costly. We have to do "smart" cleanup with advanced technologies.

The Laboratory can also help design a modern production complex that will be both more reliable and environmentally benign. Many of the applicable technologies are spinoffs from the Lab's weapons technology base. The important considerations of environment, health, safety, security, safeguards, and materials accountability have to be integrated into process and plant design, not added sequentially in layers. The laboratories can help.

Q *What is the single most important contribution that Los Alamos can make to the nation's security in the future?*

A Los Alamos and the other weapons laboratories are themselves a critical part of this nation's ability to deter war. A policy of mutual deterrence depends upon the belief of national leaders, beyond a reasonable doubt, that their own and their adversaries' nuclear forces are survivable, are deliverable, and will function as intended. This belief does not rest upon the technical knowledge of our national leaders but upon assurances those leaders receive from scientists and engineers and upon the credibility that the scientists and engineers have with their leaders. Unlike non-nuclear weapons—which have a technical base of a thousand or so defense contractors, almost one hundred service laboratories and many universities—the nuclear weapons technology base and the resulting competence rests principally with the three Department of Energy weapons labs. Their combined technical expertise forms the backbone of nuclear deterrence as it evolves over time, regardless of the specific policies or technical directions the nation might choose. ■