

# PHYSICS and SOCIETY

THE NEWSLETTER OF THE FORUM ON PHYSICS AND SOCIETY, PUBLISHED BY  
THE AMERICAN PHYSICAL SOCIETY, 335 EAST 45th ST., NEW YORK, NY 10017  
PRINTED BY THE PAPER EATER PRINT SHOP, LANSING, MI 48933

Volume 14, Number 3

July 1985

## TABLE OF CONTENTS

<b>Executive Committee Members</b> .....	<b>2</b>
<b>Star Wars: The Price of All that Money by Peter J. Gollon</b> .....	<b>3</b>
<b>Star Wars: Successor to MAD by Paul Craig</b> .....	<b>4</b>
<b>Estimating Vulnerability to EMP Effects by John H. Richardson</b> .....	<b>5</b>
<b>EMP From High-Altitude Nuclear Explosions by Conrad Longmire</b> .....	<b>7</b>
<b>Acid Rain: What Science Tells Us by Michael Oppenheimer</b> .....	<b>7</b>
<b>Acid Rain: Present and Proposed Laws by Leonard Weiss</b> .....	<b>8</b>
<b>Nuclear Winter: Recent Results from Climate Models by Michael C. Mac Cracken</b> .....	<b>9</b>
<b>CIFS Report by T.H. Stix</b> .....	<b>9</b>
<b>COPS Report by I.S. Jacobs</b> .....	<b>10</b>
<b>News of the Forum</b> .....	<b>11</b>
<b>Nuclear War Education Conference</b> .....	<b>12</b>

PHYSICS AND SOCIETY is a quarterly newsletter of the Forum on Physics and Society, a division of the American Physical Society. The newsletter is distributed free to members of the Forum and also to physics libraries upon request. It presents news of the Forum and of the American Physical Society and provides a medium for Forum members to exchange ideas. PHYSICS AND SOCIETY also presents articles and letters on the scientific and economic health of the physics community; on the relations of physics and the physics community to government and to society, and the social responsibilities of scientists. Contributions should be sent to the Editor: John Dowling, Department of Physics and Astronomy, Michigan State University, E. Lansing, MI 48824-1116, 517-355-6537.

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Please write Peter Zimmerman at the above indicated address.

**SLIDE SHOW ON STAR WARS** "The Dream of an Impenetrable Shield: Ballistic Missile Defense in the Nuclear Age" describes the Strategic Defense Initiative and provides a guide to understanding the debate. 80 slides, 26 min. audiocassette. \$30 from Nuclear War Graphics Project, 100 Nevada St., Northfield, MN 55057; 507-645-7736.

**STAR WARS: THE PRICE OF ALL THAT MONEY** by Peter J. Gollon, Safety & Environmental Protection Division, Bldg 525A, Brookhaven National Lab., Upton, NY 11973.

Most of us are aware of the deep split in the scientific community over President Reagan's Strategic Defense Initiative (SDI) or "Star Wars" proposals. That split is focused on the desirability and feasibility of the President's two year old plan to create an effective defense against ICBMs.

There is much less disagreement among academics and researchers over the desirability of accepting the Pentagon's Star Wars research contracts. Indeed, one might conclude from watching the scramble to help the Pentagon spend its money, that Star Wars money might be the only research money around.

However, little consideration appears to have been given to the price that might have to be paid for accepting that money. I will focus on some of the effects that accepting such Star Wars contracts by a laboratory or university could have on its present unclassified scientific research program, on the scientists asked to work on those contracts, and on the integrity and credibility of the institution itself.

These concerns are relevant to the entire national physics community. Many of the examples given relate to Brookhaven National Laboratory (BNL) because of my direct knowledge of events here. However, I have no reason to believe that trends here are atypical of those at other institutions which have previously been involved only in open, unclassified scientific research. The opinions expressed here are of course my own and not those of the BNL management.

**1. EFFECTS ON SCIENTIFIC PROGRAM IN OTHER AREAS:** An obvious initial cause for concern is the sensitive nature of the Star Wars technology. Much of this is classified. In addition, the Department of Defense (DoD) is attempting to control the dissemination of unclassified technical information via export control regulations.<sup>1</sup> Under these circumstances it is fair to expect that a Star Wars contract would require imposition of restrictions on hiring, on foreign visitors, and on possible opportunities for publishing the results of the work. This could result in the end, at those laboratories and universities which presently have an "open" environment, of the very condition which is crucial to their productivity in basic science.

A special cause for concern is the possibility of a "creeping" extension of the security requirements from the Star Wars project itself to groups and support services which are only peripherally related to it. It is reasonable to expect that any experimental project will eventually require the occasional services of laboratory electricians, machinists, programmers, safety experts, etc. Coordinating and supervising

the work of these people would be far easier if they too had the appropriate security clearance; thus there will be a definite institutional pressure for individuals only peripherally involved in the Star Wars project to obtain clearance.

Even though construction has not yet started on BNL's first Star Wars project (an irradiation facility), we clearly see the beginning of this trend at BNL, an "open" national laboratory devoted to peaceful aspects of nuclear and related sciences. A senior project official has stated that because of the sensitive nature of some of the planned irradiation experiments, all those reviewing experiments for safety will be required to have security clearance. Normally such reviews would involve some safety experts not on the staff of the project itself.

In the second example, the security implications extend beyond the confines of the Star Wars project itself to the unclassified, basic research facility (Alternating Gradient Synchrotron Linac) which provides its proton beam. It has been suggested that, in order to facilitate coordination between the Star Wars project and the AGS Linac, the AGS Liaison Physicists (a rotating position) have security clearance. This trend—the extension of security clearance requirements to those only peripherally involved in the project—can be expected to proceed here and elsewhere when Star Wars projects are undertaken by laboratories and universities not currently involved in sensitive military work.

Even projects that do not start out as classified may, during their course, be made classified if their results progress beyond a certain threshold (as has happened elsewhere), or if current perceptions regarding the need for classification change. This can and does occur despite the opposition of the principal investigators and others on the project.

Whether coincidentally or not, BNL has just increased its supervision of visiting scientists from communist countries. In addition to the previously required prior permission from the Department of Energy (DoE), the visitor's host must now complete a "Report of Soviet Bloc Visit or Participation at BNL" after the visit.<sup>2</sup> Among other detailed questions, this form asks for the host's "personal observations of participant, special skills or interest, familiarity with English, sociability, frankness, reactions expressed by participant to his work or to the U.S. in general." [Emphasis added.] The political nature of this question suggests that its purpose is related to something other than the promotion of scientific cooperation and progress.

Although security concerns will have some adverse impact on scientific productivity, the sheer magnitude of the Star Wars project may well have a greater effect. In the present situation with limited available financial resources, Star Wars research may "squeeze out" the more traditional and open basic research that has brought scientific preeminence to this country.

What will become of the careers of the foreign or foreign-born graduate student or assistant professor at a university whose well-funded research now requires security clearance? Will the brightest researchers migrate away from their financially strapped fields to where the money flows freely? Will the price for short-term prosperity of our scientific institutions courtesy of Star Wars money turn out to be their long-term decline in quality? The time to ask these questions is now.

**2. "CONSCIENTIOUS OBJECTION" TO STAR WARS RESEARCH:** Star Wars research has a definite and necessary military orientation, while the majority of research institutions (mostly universities) in the U.S. do not. Much of the Star Wars money which is starting to flow to these institutions represents either their first involvement with military work or a large increase in the scope of such work over a previously small base. It thus stands to reason that most of the researchers at such institutions were hired at a time when weapons work was either nonexistent or at a minimal level. They can now be faced with a situation in which their institutions change direction toward weapons work, about which they may have serious moral reservations. What are, and what should be, their rights regarding reassignment when they are asked to work on Star Wars, but find that they must refuse for reasons of conscience? (This has already happened at BNL.)

This issue ought to be considered in the broadest context by the physics community—it is really one of scientific and intellectual freedom and independence. We should be as concerned about the rights to continued employment (especially at academic and nonprofit institutions) of those who refuse for reasons of conscience to be transferred from nonmilitary to weapons work, as we are about the rights of scientists in totalitarian societies. If this issue is not addressed directly and forcefully in the near future, we may find that part of the price for an institution's accepting Star Wars contracts will be paid by these scientists who are forced to choose between their jobs and their consciences.

**3. CONCEALMENT OF THE NATURE OF STAR WARS RESEARCH ("TRUTH IN ADVERTISING"):** Independent of the scientist's right to refuse to work on a weapons project and still retain his job is his right to examine the underlying purpose of his assigned or potential work. In order for any decision to be meaningful, one must know the nature of that work. Yet I find it a most disturbing tendency for the true nature of this work to be concealed. This is especially critical when it occurs at universities and other organizations not traditionally involved in weapons development, for then scientists have every expectation that the nature of their work will be non-military.

A recent *Science* article suggests a pattern of concealment of the true direction of Star Wars

from the lower level scientists who will actually perform it: "[James] Ionson [Director of SDI's Innovative Science and Technology Office] said although principle investigators will be expected to obtain a 'secret' clearance so that they can 'steer their students.' the research itself will be mostly unclassified..."<sup>3</sup> How, then, is one to make any informed decision about one's work if its true goals are deliberately concealed by the institution or principal investigators?

As specific examples, I will cite two instances which have occurred at BNL. The first involved the only article on a BNL Star Wars project in the Laboratory's *Brookhaven Bulletin*.<sup>4</sup> The article, which did not state the full nature of the radiation effects project, referred only to measuring "the effects of proton beams on electronic circuitry"... for the space shuttle [or] voyages to Mars." This was at best disingenuous, as the various proposals talk about "radiation damage experiments" to "assess the real [weapons] potential of energetic particle beams" on targets such as warhead components and assemblies up to a meter in size, some of which will be classified and guarded for reasons of national security.<sup>5</sup>

The second example is the help wanted ad for the Star Wars beam neutralization project that appeared in the April 24, 1985 *New York Times*. After a bold heading, "ACCELERATOR BEAM TECHNOLOGY/OUR REPUTATION IN HIGH ENERGY RESEARCH GENERATED EXCITING NEW OPPORTUNITIES", the ad lists a whole host of technologies present at high energy machines, but contains not a word about weapons, SDI, DoD funding, or possible security considerations. The eager job hunter seeing this ad would imagine an opportunity in high energy accelerator development, and might never even learn the weapons nature of the work until an actual interview.

These examples suggest that part of the price to be paid by institutions accepting Star Wars research money will be an increase in secrecy and dissimulation—hardly what we have come to expect at our best scientific institutions, and not the qualities which have contributed to their present excellence.

Because of their relevance to the national physics community, these questions have been referred to the Council of the American Physical Society, which was requested to consider (a) cautioning against the weakening of our basic research efforts by the intrusion of Star Wars projects into non-military institutions; (b) defining the scientist's right to refuse without penalty to work on weapons projects for reasons of conscience; (c) deploring the tendency to conceal the nature of these projects from those directly involved in them; and (d) affirming the scientist's right of free discussion of the above points without reprisal.

Those readers with opinions on the subject

might wish to make those opinions known to their colleagues, officials at their laboratories and universities, and officers and members of the APS Council. It would also facilitate a broad discussion if scientists who know of similar instances at other institutions would also communicate them to their colleagues elsewhere via this journal.

#### REFERENCES:

1. See, for example, *Science* 26 April 1985, p. 471.
2. The "Soviet Bloc" is defined to include Czechoslovakia, Cambodia, East Germany, Hungary, Laos, Mongolia, North Korea, People's Republic of China, Poland, Romania, USSR, and Vietnam, but not Yugoslavia.
3. *Science*, vol 223, p. 304, April 19, 1985.
4. *Brookhaven Bulletin*, Nov. 30, 1984.
5. Proposal for Design Construction of a Dedicated Irradiation Facility at the 200 MeV H<sup>-</sup> Linac. BNL/NPB-103. Pierre Grand. July 1984.

#### STAR WARS—SUCCESSOR TO MAD AN OPTIMISTIC VIEW FROM A CONFIRMED CYNIC by Paul P. Craig, Department of Applied Science, University of California, Davis, CA 95616.

The Strategic Defense Initiative—star wars—appeared on the world scene two years ago in a dramatic ending to a Presidential speech. The dream of making ICBM's "impotent and obsolete" regained for President Reagan the "moral high ground," and captured the imagination of many Americans—particularly the technical community which saw a lot of exciting research, plus prospects for a cornucopia of funding.

The history of the evolution of US strategic nuclear doctrine has only a few entries. In 1945 we were the only nuclear power. In 1949 the USSR joined the nuclear club, but the US was so powerful that during the Bay of Pigs in 1962 President Kennedy knew the US could destroy the liquid fueled Soviet ICBM's before they could be launched. This knowledge—which the Soviets obviously also had—almost certainly played a role in the decision by Premier Khrushchev to back down. By the mid 1960's the Soviets had built up a strong ICBM capability. The US shifted to a policy of **massive retaliation**—the legacy of John Foster Dulles.

Under Secretaries of Defense Robert McNamara and Harold Brown the options were broadened, and we moved to the concept of maintaining an ability to fight nuclear war at all levels. Under the present **controlled response** doctrine as embodied in the **SIOP** (the Single Integrated Operational Plan for waging nuclear war), there is no end in sight to the number of

weapons that we "need." Thus our strategic arsenal has escalated to 10,000 or so warheads, and there are an estimated 50,000 warhead in the combined arsenals of the US and the SU.

Our capability for destroying civilization is clear, and our ability to destroy humanity is probable—as the recent discoveries on nuclear winter have made all too clear.

Thus President Reagan's dream of making nuclear weapons impotent has enormous appeal. It has a special appeal to physicists. There is a long history of guilt feelings among some of the physicists who worked on nuclear weapons—the best known of these are Robert Oppenheimer and Andrei Sakharov. There is also an appeal to the technical community to seek a **technical fix** for the problems that they have in part produced.

Now that we have nuclear weapons, there is no way to make them go away. The knowledge is too widespread. Further, there are many ways in which nuclear weapons might be delivered. The ICBM is just one. There are also cruise missiles, bombers, coastal submarines, and suitcase bombs.

On technical grounds there are very severe problems with a "star wars" defense—and "star wars" defends only against ICBM's with high orbits. This has led to a divergence between what President Reagan proposed, and at least a part of what the DoD appears to be in the process of doing. There are two major aspects to the DoD thinking.

One aspect is R&D. To the extent that R&D is defensive in character—that it prevents surprises—it is probably a good thing. There has been R&D on defensive systems operating for several years at a level estimated at about \$1B. If the R&D budget goes way up, the situation changes. Then the R&D is likely to prove threatening to the SU, and to lead to escalation.

The second aspect of thinking about "SDI" is to try to understand what such a system is used for. One answer is clear—even a partially effective system could be used to protect high value vulnerable targets—like the MX. If used in such a mode the SDI offers a limited shield, and like all shields it conveys a dual message to a prospective enemy. On the one hand it can be perceived as a defense against a Soviet first strike. But on the other hand it may equally well be perceived as a device which will protect US capability from retaliatory attack by a much weakened SU force after a first US strike. No matter how much we assert that our new forces are not a part of a preemptive (first strike) capability, the SU will be very unlikely to believe us.

I don't have the time to address the many technical questions about the effectiveness and likely vulnerability of SDI technologies. I will only observe that the SU is not a fixed target—the SU will certainly move vigorously to

defeat any SDI systems we may install. This means they are likely to target our satellites, which are much more vulnerable than our missiles. They are likely to use all manner of decoys. And more. As Herbert York has remarked, the problem of a military system is very different from landing on the moon. It is sort of like trying to land on the moon with the expectation that as you get close, someone jerks the moon out of the way.

Thus the idea of a **star wars defense** makes sense only if there is some limitation on what the other side does. This is a point clearly made by the Deputy Secretary of Defense for R&D Richard DeLauer in testimony before the Congress. He said that in the presence of unlimited escalation, no SDI defense is possible.

This is the nub of the matter. A transition from the present strategic defense based on the capabilities of the two superpowers to destroy each other—MAD—described not so much as a strategy but as an existential fact—is a wonderful dream. If we are to move toward making this dream a reality we must approach with care.

Most importantly, we must act so as not to inadvertently increase the risk of nuclear war. This means that **we should not even want** a totally defensive system, if the SU does not also have one. It means we should not endeavor to outrun the SU, for there is no doubt that they will work hard to defeat our systems—and in the process we may enter a new and very expensive round of escalation which may well succeed in making the world a much less secure place than it is today. We should not repeat the error that we made in deploying MIRV—an effort which only led to SU MIRVing, and a reduction in everyone's security.

If we are to move into new strategic directions we can do so only in **collaboration** with the SU. The nub of the process will involve a great deal of science. It will involve even more statesmanship. We should by this time have learned that the search for **technological fixes** which ignore human institutions and human drives are a delusion.

A successful SDI will require:

- that the SU develops technologies in parallel with the US. This does not mean that we need to give our technologies to the SU—this is impossible on bureaucratic grounds. But rather parallel development, by not trying too hard to hide our capabilities, and by policies of not attempting to outrun the S.U. In this instance parallel programs are more stabilizing than technical end runs.

- that effective negotiations lead to lowering of the total number of nuclear warheads. Just how far this should go is not clear. I think the two decade old **McNamara criterion** is not a bad place to start—a few hundred warheads. This number is not zero—but I don't see zero war-

heads as a possibility for a long, long time if ever. We should plan on having enough that if there are a few errors in counting (verification errors), it doesn't matter. At a level of a few hundred warheads there is a possibility that defensive systems can work. These defensive systems would also protect both ourselves and the SU against accidental launches.

- that defensive systems be developed against other forms of delivery system than ICBM's.

- that reliable inspection and verification systems be developed which will give both nations confidence about the numbers of warheads that remain.

- that we recognize that the kind of shifts in strategy we are talking about will take many years; we must be patient. We will need to educate our own nation, and the SU, that these changes will ultimately make our lives more secure, and allow us to develop our best resources and our best minds to more constructive undertakings.

These challenges are extraordinarily demanding. They will require the best of our scientific minds, and of our political capabilities. Scientists and engineers have important roles to play in this process. These roles include not only doing the science and engineering, but also include communicating to the public and to the political community what science can do, and what it cannot do.

I do not believe it is proper for scientists to stay out of the political debate. Nor do I believe it proper for scientists to refrain from working on these technical projects. This area is critical to our nation's future. Not all of our best minds should be devoted to it—there are many challenges the nation needs to face. But **some** of the best minds should be encouraged to move in this direction. And to do so without need for apology.

If we can move in these directions, then President Reagan's dream may represent the birth of a new view of the nuclear arms race. With a combination of carefully constructed agreements with the Soviet Union, and vigorous development of carefully selected technologies, the Strategic Defense Initiative could grow into a new national strategy, one embodying the principles which Freeman Dyson developed so convincingly in his wonderful book **Weapons and Hope**. This is the philosophy of **Live and Let Live**—where we and the Soviet Union accept and agree to rejoice in the idea that a live citizen is far more valuable than a dead foreigner.

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**Estimating Vulnerability to Electromagnetic Pulse Effects\***, by John M. Richardson, Energy Engineering Board, National Academy of Sciences-National Research Council, Washington, DC 20418

\*A study by the Committee on Electromagnetic Pulse

Environment, National Research Council, supported by the Defense Nuclear Agency (National Academy Press, Washington, 1984).

In the first talk of this session Conrad Longmire characterized the physical phenomenon of high altitude electromagnetic pulse (EMP).<sup>1,2</sup> John Mattox's paper described some effects of an actual EMP event. Joseph Mileta will describe hardening of telecommunications systems. I would like to discuss the question of estimating the vulnerability of systems, in the general sense, after protection has been provided.

I am reporting on a study conducted by a committee of the National Academy of Sciences-National Research Council, chaired by John R. Pierce. The study was a survey of past work on the subject rather than new research. Emphasis was less on physics and engineering and more on the problems of making estimates that would be useful to those who make decisions about procurement, deployment, and military operations.

The question put to the committee was: Can we accurately estimate the vulnerability of electronic systems to EMP effects?

Our answer is that assessability depends greatly on the system. For systems well controlled as to the electrical stress from EMP, the strength of the individual components, and the configuration of their conductors, it should be possible to use deterministic analysis and testing based on known physical laws and data. However, most systems are not well controlled because they are large, complex, and subject to change over time. The main problem in assessing EMP protection arises from the many uncertainties about the electromagnetic stress that reaches susceptible semiconductor devices and the ability of these devices to withstand the stress. The uncertainties include the randomly distributed failure thresholds of individual components, incomplete knowledge about the coupling of EMP stress to and among circuits, and the absence of experience with actual EMP phenomena. So all available methods, including statistical ones, are used to systematize the estimates of vulnerability.

The principal conclusion of the study was that one really has to rely on testing to validate the estimates of vulnerability. Therefore, one wants to engineer the system beforehand so that meaningful tests can be conducted on it; and one wants to make full use of statistics to get the greatest information from the tests and their data.

### The Threat

Electromagnetic pulse is only one of many effects of nuclear weapons. This study did not try to compare the relative severity of the EMP threat with nuclear blast, heat, and radiation.

Recall that the electric field of EMP rises to several tens of kilovolts per meter in about 10 nanoseconds and decays in a few microseconds. Thus the energy is spread over a spectral range from about 100 kilohertz to 100 megahertz. The pulse occurs virtually undiminished almost simultaneously over an area of continental extent (see Figure 1). The field can induce open-circuit currents of thousands of amperes in circuits that extend over very many meters. Energy of the order of a kilojoule can be coupled to such circuits.

Thus EMP is a serious threat to power lines, communication lines, command posts, radio stations, satellite ground stations, radar systems, aircraft and missile electronics, vehicular electronics, computers, and so forth. Some of the malfunctions and damage

that can occur are given in Table 1. Obviously one must protect such systems and form some idea of the degree of protection attained. Such estimates are important to strategic and tactical decisions that affect national security.

**Protection and Assessment**

For achieving product reliability against ordinary electrical stresses, one relies on a cycle of analysis, design, prototype testing under actual conditions, redesign, deployment of the entire product population to the actual environment, and retrofit if necessary. For EMP protection the prototype and final product can be exposed only to a simulated environment; and, of course, retrofit after actual exposure will be too late--to say nothing of too little.

The EMP protection process starts with system design based on promising principles and easy testability in available simulators. The stresses coupled by the threat are analyzed with respect to the strengths of the circuits set by the failure thresholds of their components. If the analysis points to a soft system, more protection is designed and the result is reanalyzed. If analysis says the system is hard, one proceeds to testing. If the system fails the test, the cycle is repeated. If the system passes at some acceptable level, it is deployed.

The most vulnerable elements of a complex electronic system are usually its semiconductor components and "chips." It is not feasible to increase the electrical strengths of these devices enough to resist the incident EMP. Nor is it usually reliable to infer the chances of system failure by estimating individual failures at the semiconductor device level in response to some partially screened level of EMP stress. Rather, the goal is to reduce the voltages and currents caused by EMP in the entire system to values comparable to or less than the voltages and currents normally present in the absence of EMP. Such a result is attempted by shielding and filtering. Suitable isolation between shielded system modules must be achieved. Antenna, by their very nature, must be exposed to EMP; thus their lead-in transmission lines require specialized protection measures.

There are basically two kinds of simulation: (1) the generation of a field similar in its temporal and spectral properties to the actual EMP and (2) the application to circuit terminals of currents and voltages that are similar to those that would be produced by the actual EMP. Field simulators may accommodate a small volume, in which subsystems have to be tested separately, or a large volume, in which entire systems such as a missile or aircraft may be tested. The fields may be at low level, requiring linear extrapolation to actual EMP levels; or they may approach the level of the actual EMP threat, providing the opportunity to detect nonlinear electrical responses. Lightning, although both impulsive and energetic, is not really a good simulator for EMP for reasons beyond the scope of this talk.

Two protection approaches are often distinguished--integral shielding and tailored hardening--although any mixture of the two may occur. Some salient features of each are listed in Table 2. By and large, integral shielding tries to protect at the system level so that detailed stresses and strengths inside the system need not be addressed. Tailored hardening, as its name suggests, applies protection at many specific locations within the system that are found by analysis and test to need it. For example, the protection of one type of military aircraft required consideration of some 3,000 penetrations of the aircraft hull and some 60,000 interface pins, although not all these locations were hardened.

**Table 1 - EFFECTS ON ELECTRONICS**

**UPSET**

1. Bit-Changes In Digital Circuits
2. Memory Changes
3. Erroneous Data
4. Loss Of Sync
5. Computer Scramble
6. Latchup
7. Erroneous Clock
8. Message Errors
9. Coding/Decoding Errors

**BURNOUT**

1. Transistors
2. Diodes
3. Integrated Circuits
  - A. Semiconductors
  - B. Metallization
  - C. Insulators (Oxides)
  - D. Resistors
4. Resistors
5. Electromechanical Devices
6. Electro Explosive Devices
7. Capacitors
8. Inductors

Source: Autonetics Division, Rockwell International

**Table 2 - TWO PROTECTION APPROACHES**

Feature	Integral Shielding	Tailored Hardening
Protection At EMP Attenuation Interfaces	System Level Below Signal	System and "Box" Levels Below Thresholds
Internal Coupling	Few (Penetrations)	Many (Pins)
Configuration Control	Need Not Know	Must Know
Protection Against Upset	Not Required	Required
Testability	Yes	Don't Know
Ease	Good	Poor
Initial Cost	Easy	Hard
	High	Low

Integral shielding has a number of advantages, provided that it can be done without unacceptable weight and cost penalties. The idea is to create a known and measurable attenuation with the shield while controlling leakage via any conductors or apertures that penetrate the shield. Optical fiber interconnections for signal paths will obviously help.

Tailored hardening introduces greater variability and uncertainty into the protection assessment. Nevertheless, the approach has its uses where weight, configuration, cost, or criticality dictate that selected portions of a system be protected.

Integral shielding should give greater assurance of protection than tailored hardening.

- It is easier to accomplish.
- It is less dependent on system details.
- Its relevant parameters are knowable with greater certainty.
- Its continued effectiveness may be more easily monitored.

The committee made several recommendations on the engineering aspects of EMP protection. These recommendations reflect the belief that there is no one route to protection. If the threat can be more narrowly characterized and if the mission-critical systems can be isolated, the task becomes somewhat easier. Although system-level shielding seems most reliable, there is also room for improvement at the component and "box" levels. Tests are needed to confirm that hardness is maintained. Also, the methods of predicting stresses need improvement and can possibly be validated by the big simulation experiments themselves.

**The Role of Statistics**

Given the uncertainties inherent in the problem of EMP protection, we have to make an early appeal to statistics. The uncertainties are roughly of three sorts: random variation, such as failure

thresholds of components; variability in phenomena, such as electromagnetic coupling, that are deterministic in principle but are too complex to characterize in practice; and incomplete knowledge of other phenomena, such as nonlinear responses to high fields.

Therefore, statistical methods have several important roles in EMP-protection. Statistics is well suited to characterize failure thresholds of large populations of semiconductor components and, hence, to establish design criteria for required protection and even point the way toward achieving increased component strength. Statistics can improve the design of tests and the evaluation of results at both the subsystem and system level. As a result the most efficient acquisition and use of test information is achieved for vulnerability assessment and for redesign of protective measures. Techniques of statistical quality control can be used to detect deterioration of protection quality for systems in service. Statistical methods employed in fault tree analysis allow for compounding estimates of failure for basic levels of the system into estimates of failure for a whole system. For huge systems, such as a telephone network or a bomber aircraft, which cannot be tested as a whole, there is little recourse other than disciplined and systematic statistical inference from incomplete information.

A very practical issue in EMP vulnerability assessment is the particular interpretation of probability that underlies the statistical methods used. If probability is interpreted strictly as the long-run, relative frequency of occurrence of a random event, it can have little application to situations where repeated sampling has no operational meaning. However, a subjective interpretation of probability can be consistent with the same axioms and the same mathematical theory that pertain to the frequentist interpretation. In the subjective approach, the statistician expresses his uncertainty in terms of prior probability distributions on the unknown. These distributions are estimated from the best

available sources, including expert judgement. After observing the results of whatever experiments may be possible, one applies Bayes' theorem to compute posterior probabilities given the data. The role played by data, however sparse, is to revise previously held opinions.

The different interpretations of probability are useful at different levels of vulnerability assessment. The frequentist view is well matched to the study of "piece parts" and perhaps to the characterization of hundreds of terminals at the "box" level. However, in the application of statistical methods to the estimate of vulnerability of large systems and huge systems one rapidly exhausts the frequentist interpretation of probability. In these cases the experimental setup is not easily replicated and the mathematics appropriate for large numbers of repeated trials does not provide useful answers. In such cases, one may be forced to the subjective interpretation.

The committee also made several recommendations on the statistical aspects of EMP protection. There is room for the use of more advanced statistical concepts than the EMP community usually uses. Where statisticians, engineers, and physicists have worked closely as a team, valuable results have been forthcoming; and such collaboration ought to be encouraged. Contracts ought not specify 100 percent or almost 100 percent certain survival, but should call for objective tests by which probable survival can be inferred. Fault tree analysis should be further developed to handle the complicated relationships in EMP work. Finally, valuable interdisciplinary collaboration ought to be encouraged by supporting postdoctoral fellowships in this subject matter.

Two final points ought to be made.

First, the application of statistics to EMP problems cannot give results as certain as those in statistical mechanics nor as trustworthy as those of thoroughly controlled and randomized experiments. Rather, the results may be more like the application of statistics to large scale phenomena like weather. In such problems important relationships of dependence, both on the average and in deviations, are easy to miss. Thus it is essential that the recipients of the numbers from an EMP analysis understand the uncertainties and liabilities that surround them. For a misinterpretation of meaning may give rise to a much greater (or possibly lesser) trust in some number

than that number deserves.

Second, there is no reliable way to base an analytical estimate of EMP vulnerability on first principles. Thus there can be no substitute for the best physical simulations possible as a route to adjust and improve the results of analytical and statistical studies.

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**The EMP From High-Altitude Nuclear Explosions by Conrad L. Longmire, Mission Research Corporation, Santa Barbara, CA 93102**

A nuclear explosion at high-altitude leads to the production of an electromagnetic pulse (EMP) that can be observed anywhere on the ground within line of sight from the explosion. Thus the EMP from an explosion at altitude 300 km or higher could be observed over the entire U.S.

The EMP is produced by gamma rays emitted in the explosion. The gamma rays eject electrons from air atoms in the altitude range of 20 to 40 km. The electrons from an electric current pulse which, after deflection by the geomagnetic field, radiates the EMP in the direction the gammas were traveling. Effectively, the pulse of gamma rays is converted by this mechanism into an EMP with an efficiency that can be as much as a few percent.

The amplitude of the EMP is the order of 1 statavolt/cm, or 30,000 volts/meter. Its duration is of the order of 100 nanoseconds. Theoretical calculations of the EMP are in substantial agreement with experimental data obtained in the 1962 test series Operation Fishbowl.

The predicted EMP depends on nuclear weapon characteristics, explosion altitude, and location of observer relative to the explosion. It would be a gross oversimplification to describe it in terms of just one amplitude and one pulse length. However, the generation mechanism does contain its own limiting process. Thus the amplitude cannot greatly exceed the value stated above, and in general large amplitudes come with shorter pulse durations.

When the EMP impinges on a wire, such as radio antenna, telephone and power lines, currents of the order of 1000 Amperes are induced in the wire. The duration of the current depends on the length of the wire and other factors. Energy from the EMP can be collected over a substantial length of wire, much longer than the ~ 30 meter wavelength of the EMP.

EMP is a serious threat to electrical and electronic systems. It need not be disastrous if sensible steps are taken to protect the systems. Hardening to EMP is similar to, but not identical with, hardening to lightning. A major difference is that the EMP could arrive over the entire U.S. within one hundredth of a second. A difficulty in hardening complex systems is in predicting the coupling of the EMP into such systems. In the author's view, present coupling

predictions depend too much on guessing, too little on valid scientific or engineering methods. Another difficulty is the lack of opportunity, under the nuclear test ban, to test systems to realistic EMP threats.

**ACID RAIN: WHAT SCIENCE TELLS US (AND WHAT IT DOES NOT TELL US) by Michael Oppenheimer, Environmental Defense Fund, 444 Park Avenue South, New York, NY 10016.**

Our rapidly expanding knowledge of acid deposition over the past ten years has created a firm basis for the development of public policy. The following general characteristics describe acid deposition and its interaction with the environment in Eastern North America.

1. More than 90% of acid sulfur and nitrogen deposition is anthropogenic in origin. Seventy percent of sulfur emissions originate in electric power plants. Both nearby and distant sources can significantly affect deposition at a given receptor.

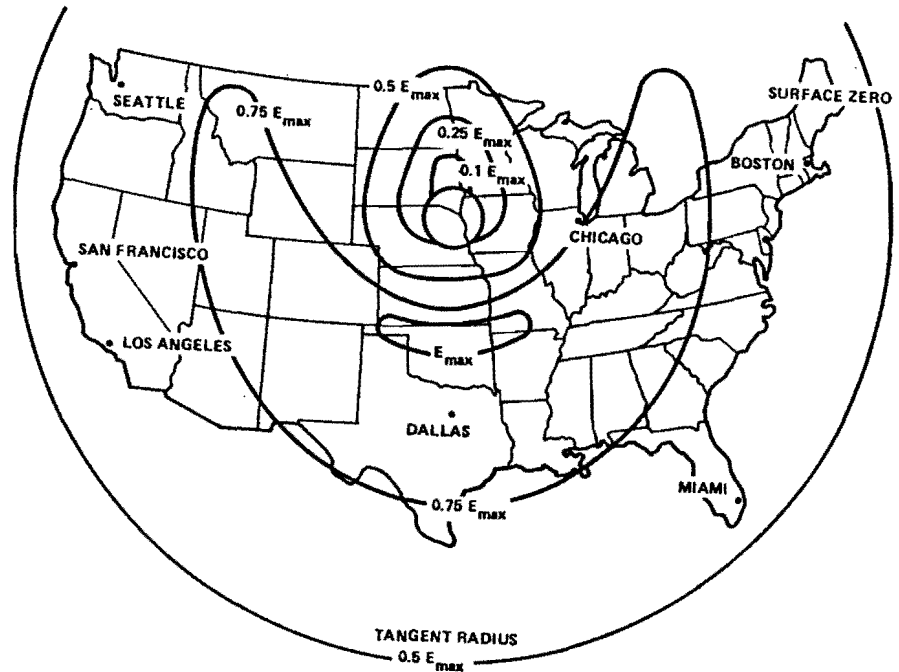


Figure 1 EMP Ground coverage of High Altitude Bursts (500 KM HOB)

2. The chemistry of thousands of lakes and streams spread over a large fraction of the land area of Eastern North America has been altered by acid deposition, and sulfur (and its associated acid) is the major water pollutant over extended remote areas. These chemical changes lead to large biological changes in sensitive waters. In the case of several thousand lakes and streams, fish and other biota have been eliminated. The chemistry of some waters appears to be changing currently even where deposition was stabilized.

3. The primary cause of these chemical changes is sulfur deposition since nitrogen is lower in emitted acid potential, and, on an annual average basis, is taken up by biota.

4. Long-term wet sulfate deposition levels exceeding 17 kg/ha.yr. are associated with acidification of lakes and streams. Lower values may cause alteration over long time periods. Current deposition is generally 30-40 kg/ha.yr. Therefore, a decrease in sulfur dioxide emissions in excess of 50% is needed to protect waters from acidification.

5. Regional scale sulfur dioxide emissions reductions will produce proportional reduction in deposited sulfur and acidity.

6. Other systems affected by acid pollutants include forest, soils, materials, drinking water and human respiratory systems. Recent experience in Europe suggests that acid pollutants, in combination with other air pollutant stresses, can cause rapid forest decline, in the course of only 3 or 4 years. Symptoms of forest decline are now observed in North America. Ozone and nitrogen may be important stresses on forests in addition to sulfur. Evidence also exists for the gradual impoverishment of soils.

7. High altitude areas of the western U.S. are sensitive to acid deposition and are receiving sulfate concentrations close to damage thresholds.

Some areas of uncertainty include:

1. The specific fraction of damage to forests attributable to each air pollutant;
2. The long term changes to soils, forests and surface waters due to many decades of acid deposition;
3. Point-to-point pollutant source-receptor relationships, dry deposition and atmospheric concentration monitoring and modeling;
4. The quantitative inventory of resources at risk;
5. The refined definition of threshold values (if any) for long term surface water acidification;
6. Quantitative dose-response functions for human health impacts;
7. Effects on extended aquatic systems, such as Chesapeake Bay.

We conclude that science provides an adequate basis for policy formation, but that fertile ground for further research exists and can contribute to the refinement of policy. In particular the exact amount of sulfur emissions reduction in excess of 50% and the amount of nitrogen reduction need better definition. Current research support for research on long term atmospheric-biosphere interactions is not adequate for this task.

**ACID RAIN: Present and Proposed Laws by Dr. Leonard Weiss, Minority Staff Director, Subcommittee on Energy, Nuclear Proliferation, and Government Processes, U. S. Senate, Washington, DC 20510**

With no pun intended, the climate for passage of acid rain legislation in the 99th Congress appears to have deteriorated markedly from that existing in the previous Congress, just one year ago.

By mid-year, 1984, there were about two dozen pieces of legislation on acid rain pending before Congress. These included: three bills to expand research into causes and effects; three bills to accelerate research and development on clear coal utilization technologies; two bills to amend the Clean Water Act and provide for study and/or mitigation of acid rain effects; and 16 bills to reduce acid rain precursor emissions.

These bills were accompanied by a barrage of supporting research material from the Congressional Research Service, the Office of Technology Assessment, the Congressional Budget Office, and private sources. Lobbying was intense, and the amount of printed material on the subject distributed by environmental organizations on one side and industrial groups on the other presented a formidable challenge to even the most conscientious legislator. In the end, no legislation passed either the House or the Senate that would have required substantive action toward reducing acid rain precursors.

There were many reasons for the failure to enact an acid rain reduction program. Among them were:

#### 1) Uncertainties over costs and who would pay them

Annual costs for a ten million ton/year reduction in utility SO<sub>2</sub> emissions have been estimated at \$3-6 billion or more, depending upon assumptions of cleanup methodology. These numbers frightened midwestern legislators who were facing proposed acid rain remedies that would have placed the financial burden mainly on their constituents. Specific attempts in legislation to share the cost burden through imposition of region-wide or nationwide fees were viewed as being either insufficient by midwestern interests or as being inequitable by other regional interests who did not view themselves as contributors to the problem.

#### 2. Uncertainties over employment impacts

It was widely assumed that given a choice, utilities would opt for fuel switching as the favored mechanism for reducing SO<sub>2</sub> emissions. The projected economic dislocations in the high sulfur coal industry cemented a potent political alliance between that industry, electrical utilities, and the United Mine Workers to fight acid rain legislation. Proposals which included strong provisions for technology-based controls in order to avoid coal industry dislocations were nonetheless, not given support because of fears that such legislation might undergo substantial amendment prior to passage to remove or mitigate the requirement of technological controls.

#### 3. Uncertainties as to the scientific facts

The evidence linking aquatic body and other resource damage to acid deposition arising from precursors produced by emissions of SO<sub>2</sub> and NO<sub>x</sub> from utilities and motor vehicles was made stronger in the minds of legislators following the reports of the Acid Precipitation Task Force, the National Academy, and OTA. However, ongoing uncertainties and controversies about the relative importance of SO<sub>2</sub> versus NO<sub>x</sub>, the long range transport of precursors and therefore the relative roles of local versus distant sources in producing acid deposition at specific locales made the political problem of who should pay more difficult to resolve.

In addition, some claims of forestry damage due to acid rain or fog began to seem somewhat more tenuous in light of research indicating that multiple pollutants may be responsible. While such information did not imply that acid rain should be neglected, it raised the question of whether \$40-60 billion ought to be invested in SO<sub>2</sub> reductions alone.

#### 4. Opposition by the Executive Branch

Despite an endorsement of some control measures even in the face of uncertainty by an advisory panel to OSTP, the Administration maintained that there was an inadequate scientific base from which to launch what then EPA Administrator William Ruckelshaus called "an expensive and potentially divisive control program." Without leadership from the White House, the regional division over the acid rain issue could not be overcome.

#### Prospects in the 99th Congress

Regardless of the precise reasons for failure in the 98th Congress, it is evident to observers on Capitol Hill that the momentum for action on acid rain that produced so many legislative proposals in 1983 and 1984 has abated, at least temporarily.

Nonetheless, a few of these proposals have been dusted off and, with minor revision, reintroduced. In the first four months of this session of the 99th congress, two bills on acid rain have been introduced in the House, and three bills introduced on the Senate side.

The Senate bills, introduced by Senators Stafford (S. 52), Mitchell (S. 283), and Proxmire (S. 503), require substantial reductions of SO<sub>2</sub> (and, in one case, NO<sub>x</sub>) emissions in a 31-state region of the Eastern U.S. and have no cost-sharing provisions.

The House bills, introduced by Representative Conte (H.R. 1030) and Green (H.R. 1162), require emission reductions in a 48-state region, with H.R. 1030 containing a cost-sharing provision.

While it is still too early to be entirely certain of the attitude of the 99th Congress toward acid rain legislation, it does not appear likely that legislation mandating substantial reductions of SO<sub>2</sub> and NO<sub>x</sub> will be enacted. The same factors that frustrated efforts in the 98th Congress are still present, and progress toward congressional consensus on the issue will depend on the receipt of new information. Further research confirming the urgency of the problem or printing toward earlier introduction of new, more efficient technologies for the clean combustion of coal could act as a legislative catalyst in this regard.

Failing the emergence of such a catalyst, it may be that a strategy of incremental reductions of SO<sub>2</sub> emission through such methods as expanded coal cleaning could have brighter chances for success than attempts to pass a full scale long-term reduction program in the teeth of still-formidable regional and Executive Branch opposition.

#### State Programs

While the federal government has been essentially paralyzed on the acid rain issue except for research efforts, some states have moved forward with programs of their own to deal with local sources of acid rain precursors.

The State of New York passed the State Acid Deposition Control Act on August 6, 1984. It



established a program run by the Department of Environmental Conservation to reduce, by 1991, sulfur dioxide emissions by approximately 245,000 tons per year or 30% below total state emissions in 1980. Interim control targets will be established for sensitive receptor areas to minimize damage from state sources. There is no provision for a cap on future emissions after the final control target is reached.

The State of Wisconsin passed the Air Pollution Sulfur Dioxide Emission Limitations bill on May 15, 1984 providing for a cap on total annual emissions of SO<sub>2</sub> by major utilities of 500,000 tons, beginning with calendar 1985. Other sources of SO<sub>2</sub> are not covered by this legislation.

Finally, on July 1, 1982, the Minnesota legislature adopted legislation providing for establishment of a plan for controlling acid deposition. The first step in the plan was to be establishment of an acid deposition standard by January 1, 1985. This has now been extended to January 1, 1986. Establishing a standard has been difficult because the state is having trouble delineating depositions emanating from state sources from those emanating from outside.

### **Nuclear Winter: Recent Results from Climate Models**

by **Michael C. MacCracken**

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A major nuclear exchange involving a large number of nuclear explosions in urban and suburban areas could ignite fires that might loft large amounts of highly-absorbing aerosol particles into the upper troposphere (5-10 km) and possibly higher. Because these particles are primarily submicron and may contain a substantial component of soot, this smoke could significantly change how the sun's energy is absorbed by the earth's surface and atmosphere.

The most recent results from global models of the atmospheric circulation indicate that extensive post-war fires could cause summer temperatures in mid-latitude continental regions to cool substantially, but not to levels as cold as normal mid-winter conditions. A wintertime nuclear war would reduce temperatures only a few degrees below normal if the smoke did not persist into spring.

For summer injections of massive amounts of smoke (100 Tg; 1 Tg = one million metric tonnes), transport of the smoke to equatorial and southern latitudes is likely. At latitudes near the equator, smoke could cause temperatures to drop below their normal cool season values, but the temperatures would still be well above freezing. At these lower latitudes the effect is probably very dependent on the amount of smoke injected and the time of year.

The most critical factor in estimating the intensity and duration of the potential cooling is the amount of smoke that is created and then survives scavenging in the fire plume. It

is very difficult to reduce uncertainties concerning the early-time scavenging, but progress could be made by a coordinated theoretical, laboratory, and experimental program.

The recent studies of potential global climatic effects have both confirmed and altered aspects of our knowledge of what may happen. Initial studies of the potential climatic effects of massive smoke injections by Turco et al. (1983) used a one-dimensional model considering only the vertical structure of the atmosphere. This first generation of model studies made a number of important simplifying assumptions, including not considering the latitudinal distribution of the smoke, neglecting the effect of differences in land-ocean thermal capacity, and having to use global annual average temperature instead of seasonally varying, mid-latitude land temperatures.

Second generation simulations have treated the global atmosphere and land-sea differences more realistically but kept smoke fixed in location. Third generation studies are now allowing the smoke to move and to perturb the temperature and circulation. Such modeling efforts are now being undertaken by the National Center for Atmospheric Research, Los Alamos National Laboratory. These models indicate that smoke injection of more than about 100 Tg could lower land surface temperature by a few to tens of degrees (°C). The local temperature drop would, however, depend on the time of year, continental size, proximity to the coast, distribution of the smoke, amount and characteristics of the smoke, and relative location of a site to the areas that burn.

Although recent studies have greatly improved our understanding of the potential short-term (few week) intense cooling, a critical issue is how the smoke may be removed over longer time periods. The models indicate that the smoke, once heated, may move to higher levels of the atmosphere (into what was the lower and middle stratosphere) where it could remain for months to years. Estimating the duration of potential climatic changes will require study of potential chemical and transport processes that may remove the smoke that reaches the upper atmosphere.

Further aspects deserving intense inquiry are the potential synergistic effects among dust, nitrogen oxides, perturbation of stratospheric ozone, and other materials and processes affected by a nuclear conflict.

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**Report from Committee on the International Freedom of Scientists by T.H. Stix, Plasma Physics Lab, Princeton University, Princeton, NJ 08544 (609-683-2488)**

#### **AAPT Cooperation:**

A request for help for Soviet refusenik Zachar Zunshain was placed before the committee in late February by the Committee of Concerned Scientists. Zunshain is from Riga, received a B.A. in physics

from the University of Gorki in Sverdlovsk, and taught high-school physics until 1980, when he declared his desire to emigrate to Israel. He was able to teach night school after that, but his pursuit of the right to emigrate led on June 28, 1984, to a three-year sentence in a labor camp. In the camp he was beaten by fellow prisoners, was twice placed in solitary confinement, and then sentenced to six months in prison in another labor camp.

The suggestion that signatures for a petition for Zunshain be solicited at the Baltimore APS Meeting in March, similar to the action for Paritsky taken at last year's Detroit APS meeting was turned down, in favor of presenting a petition to attendees of the Washington Meeting, in April, and provided that -- in the interim -- CIFS could obtain a) independent verification of the details of the case and b) the co-sponsorship of the American Association of Physics Teachers.

CIFS Vice-Chairman Peshkin pursued this case with diligence. Verification of Zunshain's academic background and present plight came from an independent group in the U.S. familiar with his case, and also from a direct telephone conversation between Peshkin and Mrs. Zunshain. And while AAPT heretofore has not addressed human rights cases, Anthony French, AAPT President, polled his Executive Board and received their unanimous approval for co-sponsorship to the Zunshain petition.

CIFS looks forward to continued cooperation with AAPT in the human rights area, and it would seem appropriate to suggest to the two Councils (see first item above) that AAPT have a representative on CIFS.

#### **CIFS: Informal Review of First Quarter 1985**

**Poland A:** Letters of deep appreciation have been received by APS thus far from two Polish physicists who are beneficiaries of donated APS memberships and journal subscriptions. Donor for these reduced-price memberships was the Mark Kac Memorial Fund of the Committee of Concerned Scientists. And a similar letter of thanks was recently received from an atmospheric physicist in Leningrad.

**Poland B:** Responding to a CIFS initiative, a letter sent on 11 December 1984 by APS President Dresselhaus to the Polish leader, General Jaruzelski, expressed the deep concern of APS members with respect to physicists reported to have been dismissed from the Polish Institute of Nuclear Research (Instytut Badaw Jadrowych). The letter listed names of twenty physicists. A letter from one of those named, Ernest Piasecki, was sent on 23 February 1985 to President Dresselhaus, and is worth quoting in full:

Dear Prof. Dresselhaus,

On behalf of all scientists dismissed from the Institute of Nuclear Research, I should like to express our gratitude for your letter to General Jaruzelski.

Concerning our present situation: although almost everybody have found a new job, none of us, however, can really be satisfied with what he found; majority of us had to change the profession or were forced to the early retirement. Nevertheless we are strongly convinced that the fight against the attempts to deprive us our own opinion was our duty, which we fulfilled.

Your kind interests as well as letters written by other physicists from various countries make us feel a part of the international scientific community. This consciousness of the partnership we appreciate very much. You intervention is important because it makes aware the authors and executors of destruction of our Institute that their action is not going to pass unnoticed by the scientific community.

Thanking you once more for your letter.

Sincerely yours,  
E. Piasecki

**Poland C:** The full story of the dismemberment of the Polish Institute of Nuclear Research was suggested to *Physics Today* and received favorably by Editor Gloria Lubkin. The reporter assigned for the story is, however, currently on a five-week tour of duty in Germany for another organization.

**Argentina:** A reception for Argentina President Raul Alfonsin was held at the American Museum of Natural History on 21 March 1985, given by the American Association for the Advancement of Science. CIFS was represented at the reception by Myriam Sarachik. It was the Argentine National Commission on Disappeared Persons, you recall, which last year requested a five-person forensic group sponsored by the AAAS Committee on Scientific Freedom and Responsibility, to visit the mass grave sites at some 340 formerly secret detention centers and to investigate the fate of some of the more than 9600 "desaparecidos".

**Chile:** CIFS was asked by Chandler Davis, Chairman of the Human Rights Committee of the American Mathematical Society, to support the proposal by Lipman Bers to the National Academy of Sciences, that the Academy send a committee of inquiry to Chile. Several mathematicians had recently been arbitrarily arrested, interrogated, dismissed from their university positions and, in at least one case, sent to internal exile.

CIFS Vice-Chairman Peshkin found and confirmed the names of two physicists who also had been recently fired from their universities and a letter, supporting the sending of the inquiry group, was sent by APS President Robert R. Wilson to the NAS.

An inquiry group, which included two Nobel winners, was authorized, left for Chile in mid-March and is now returned. A preliminary report is that the group was openly received and given a frank discussion of the problems, which have now been resolved. The mission was felt to be of considerable value not only with respect to the resolution of existing cases but also as an indication to Chile of the intensity of U.S. concern in the area of human rights.

**Turkey:** CIFS was given the names of three Turkish physicists who were among the 1188 faculty members (as of April 1984) either removed from their posts or forced to resign. One is now in Germany, one in East Germany, and one has another position in Turkey. For starters, their names were given to Heicklen, who is seeking further guidance, from the original informant, on a course of action before starting Small Committee work. Stix will look for advice, too, from Prof. Bernard Lewis, who will be back at Princeton shortly.

**West Bank:** Pershan has placed inquiries with regard to Sami Kilani, a dissident West Banker who taught physics at An Najah University, Nablus, and is now in internal exile.

**East Germany:** The case of East German Dipolphysiker Rolf Schalike was brought to the attention of CIFS in September 1984. A nuclear physicist, Schalike lost his job for political reasons in the early seventies, worked as a technical interpreter until 1980, when even this work was forbidden to him, and was jailed in 1984 under paragraphs of East German law that clearly denote political causes. This story has a happy ending -- Schalike and his family have now been allowed to emigrate to West Germany.

**India:** Rutgers Associate Professor of Physics Natan Andrei was an invited speaker to the Winter School and International Colloquium on Exactly Solvable Problems in Condensed Matter and Relativistic Field Theory, sponsored by the Tata Institute of Fundamental Research, Bombay. The colloquium took place 30 January - 12 February 1985, but despite earnest efforts in this behalf by the conference organizers, the government of India refused to issue a visa to Professor Andrei on the grounds that he carries an Israeli passport. A travel grant for the American attendees was given by the U.S. National Science Foundation (INT-8415163).

A 13 March 1985 letter from B. Bartocha, Director of the NSF Division of International Programs, explained that a "landing permit" for Andrei could very likely have been obtained had the NSF been alerted earlier to the possible problem. Bartocha continued "It does take advance warning and a certain amount of time, however, to process such applications since the consular officer at the embassy must have time to get instructions from the home office and the Indian co-sponsor of the event. The fact that Dr. Andrei was unable to get a visa, I believe, was due less to an expression of policy on the part of the Government of India than to a bureaucratic failure in that the responsible consular officer in the embassy most likely had not received any instructions regarding this application and therefore turned it down."

A preliminary canvas of CIFS members find this explanation satisfactory for NSF but not for India, and a letter to Indian leaders will be drafted and offered to APS President Wilson.

**Helsinki Accords:** There will be a convening in Ottawa of Human Rights Experts from the Helsinki Accords (Conference on Security and Cooperation in Europe) countries, for six weeks starting 8 May 1985. CIFS brought this opportunity to the attention of both AAAS Clearinghouse on Science and Human Rights and the Committee of Concerned Scientists. The Clearinghouse convened a session, attended by APS Washington representative Robert Parks, on 13 March 1985, to discuss the Ottawa meeting. The U.S. delegation to Ottawa will be headed by Ambassador Robert Schifter, U.S. Representative to the UN Human Rights Commission and Deputy U.S. Representative to the UN for Security Council Affairs.

The U.S. State Department held a meeting on 4 April 1985, for non-governmental organizations, to review the U.S. position for the forthcoming conference. CIFS, specifically invited to the meeting, was

represented by past-Chairman Gerjuoy. Worth mentioning also is the position paper submitted to this meeting by the Committee of Concerned Scientists, detailing human rights abuses of scientists in the USSR, Turkey, Yugoslavia and Poland. This 18-page paper is a first-rate piece of work, well organized, detailed and citing a large number of specific violations. Copies are available from CCS.

**1986 APS in Washington:** CIFS will propose that a Session on Human Rights be added to next year's Washington meeting. The occasion is an auspicious one, since Physical Societies from foreign countries will be invited to participate in this meeting.

**VELIKHOV** - Evgenii Velikhov, Vice President of the Academy of Sciences of the USSR, was scheduled to be in Princeton in mid-February for a half-day visit. Velikhov, a plasma physicist by trade, accompanied Gorbachev on his recent visit to London. At the February 1985 New York City meeting of CIFS, the Committee urged Stix to express to Velikhov the deep concern which many APS members feel concerning human rights problems in the USSR. In the end, Velikhov did not come, but Stix gave a letter to Boris Kadomtsev for hand-delivery to Velikhov.

A recent USSR exchange visitor has told us that Velikhov is now on many government commissions and is the recipient of the Hero of Socialist Labor award. (Sakharov, whose contributions were in the field of national defense, was a Hero of the Soviet Union.)

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#### REPORT OF THE COMMITTEE ON OPPORTUNITIES IN PHYSICS (COP) MEETING OF APRIL 23, 1985, by I.S. Jacobs, General Electric Co., Bldg K-W, Schenectady, NY 12301.

The new chairman Roland Good called on Joe Budnick, the 1984 Chairman, for an update. His review embraced the full agenda of the past year, from the COP symposia on the University-Industry Interface and on the Small Business Innovation Research Program to the ongoing-but-low-profile Ombudsman role of the Committee. The COP makes its own agenda through frequent meetings and interactions with the membership, the APS staff, and other APS committees. The decision to publish selections of the APS Washington Office "What's New" in a recent bulletin is an indirect consequence of COP discussions in December 1984. Joe cited a continuing need for better interactions with academic departments and their (often invisible) Employment Information Offices. The renewed consultations with Beverly Porter of the AIP Manpower Statistics Division is relevant to this. COP also favors restoration of the dormant Visiting Physicist Program, he said.

New COP member Mike Casper raised the question of the impacts on the physics profession which may result from the Strategic Defense Initiative (SDI-"Star Wars"). If only a few percent of the projected SDI budget goes to the academic community, it would be comparable to the NSF budget! This program has significant impact potential for research opportunities and staffing in industry as well as for personnel and physical resources in universities. Questions of security

classification and technology transfer might also arise. COP is planning a symposium on this topic for the 1986 Washington meeting. It is not intended to be a political discussion, nor will it try to compete with APS Directed Energy Weapon (DEW) Study getting started under the leadership of N. Bloembergen, K. Patel and L.C. Hebel.

The forthcoming wave of retirements in academic physics departments and the accompanying creation of opportunities has become a focus for COP member Linwood Lee, picking up where his Stony Brook colleague Peter Kahn left off. Several studies of early or staged academic retirement programs have recently appeared, and a multi-foundation-supported "Commission on College Retirements" is getting started. An interesting question is whether physics is "special" among the full family of academic disciplines. Lee will research this with Beverly Porter. Discussion also returned to an older COP theme, that is post-retirement opportunities for physicists.

Bill Havens, APS Exec. Sec'y, participated in much of the meeting and was invited to describe his views on the COP activity. He retraced its history, deriving from the earlier Committee on Professional Concerns which ran afoul of the APS Council and of (misguided) threats from an IRS examiner. Havens commended the quiet Ombudsman role of COP as a good outlet for last-resort appeals. He said that this activity (and others of the committee) showed that the Society does have a concern for the welfare of physicists, even if the number of ombudsman cases is small. He supported the developing interactions with the AIP Placement Center. In each of these COP could bring the viewpoint of the practicing physicist. In Havens' opinion, Council views COP as a sensitive link to the membership. In subsequent discussion it was noted that direct liaison with Council effected through appointments in earlier years has not been maintained, to the possible detriment of relations between COP and Council.

The "Honor in Science" topic initiated recently in Sigma Xi-American Scientist editorials was reported for discussion. "Jake" Jacobs urged members to regard the Sigma Xi pamphlet on the subject before the next meeting. Is it suitable for distribution to all Physics Ph.D. candidates? Tony Arrott's letter in *Physics Today* (12/84) seeking data on malicious or irresponsible peer reviews was noted for follow-up.

Future meetings of the committee are scheduled for July 17, September 10 and December 10, all at APS in New York City.

## NEWS OF THE FORUM

### Request for Nominations: Forum Awards

Since 1974, the Forum has annually given awards to individuals and groups who have

worked in the interface between physics and society. We are now requesting nominations for the awards to be presented in the spring of 1986. The criteria for the two awards are as follows:

### Leo Szilard Awards for Physics in the Public Interest

To recognize outstanding accomplishment by a physicist in promoting the use of physics for the benefit in such areas as the environment, arms control and science policy.

### Forum Award for Promoting Public Understanding

To recognize outstanding accomplishment in the endeavor to promote understanding of issues involving the interface between physics and society.

Please send nominations to Dr. Barbara G. Levi, Center for Energy and Environmental Studies, Princeton University, Princeton, NJ 08544. Other committee members are Peter Zimmerman (U.S. ACDA), Chris Hohenrmer (Clark University), and Paul Zitzewitz (U. of Michigan - Dearborn). Be sure to identify the award for which you are nominating a person (or persons) and include supporting biographical material. Thanks for your help.

### Nominations For Forum Offices:

The Nominations Committee of the Forum would be happy to receive your ideas and names for candidates for the offices of Vice-Chairperson, Secretary-Treasurer, and two members of the Executive Committee. Please send your nominations to Dr. Henry Kelly, Office of Technology Assessment, Washington, DC 20510. Other members of the Committee are John Dowling, Ken Ford, Irene Engle, and Allan Hoffman.

### Letters to the Editor

In the April 1985 issue of *Physics and Society* there is an interesting table titled "WHERE THE DOLLARS GO" by Evans M. Harrell. In this table Swiss civil defense is listed as costing \$33 per person per year, and a national blast shelter program (U.S., I presume) is estimated to cost \$500 per person, in total. The Swiss civil defense program is probably the best in the world and provides blast shelter protection for about 90 percent of the Swiss population. If Harrell's estimate for national blast shelter program were spread out over 15 years, the annual cost per capita would be the same as the Swiss program. What fraction of the U.S. population is to be provided blast protection in Harrell's estimation?

Carsten M. Haaland  
Engineering Physics and Math Div.  
P.O. Box X  
Oak Ridge Nat'l Lab  
Oak Ridge, TN 37831  
14 May 1985

Reply by Evans Harrell, School of Mathematics, Georgia Institute of Technology, Atlanta, GA 30332.

Carsten Haaland's clarification of the cost of the national blast-shelter program is quite right.

The data available to me did not include the construction time of certain programs, such as blast shelters, Kings Bay, and the Strategic Defense Initiative (Star Wars), so I gave total figures, which would be spread over some number of years. These figures cannot be directly compared with the annual budget figures. The blast-shelter program referred to is that advocated by Haaland for the U.S. There is actually a wide range of possible figures, depending on various options, but this is a typical figure of \$1000.00 per space times 50% of population protected. Other civil defense expenditures would have to be added on, but at levels comparable to what we have today they are so small that they would be less than the uncertainties in an annual budget for blast-shelter construction. By the way, there is no indication that the government hopes to enact the blast-shelter program in the near future.

The Swiss civil defense program includes such things as compulsory service, mandatory shelter construction in every dwelling, and underground hospitals. The government shares construction costs with property owners, and about 80% of the \$33.00 figure goes toward these costs. The shelters typically provide protection against 1 atmosphere of overpressure, which represents significant blast protection, but would not save people close to ground zero. The latest figures I have (as part of a Forum study) are that so far about 80% of the populace has access to such shelters, and most of the rest have access to "makeshift spaces." In their major legal document on civil defense in 1971, the Swiss completely rejected crisis relocation as an option, in favor of sheltering.

### REPORT OF THE FORUM COUNCILOR by Kenneth W. Ford, Molecular Biophysics Technology, Inc., 3508 Market St., Philadelphia, PA 19104.

Items of interest to Forum members from the April 24 Council meeting:

**1. Freedom of information.** The recent wave of restrictions on the free flow of unclassified (but so-called "sensitive") information is affecting many individual researchers and some scientific societies--although not yet APS. President Robert Wilson agreed to re-affirm publicly and forcefully the APS policy on open meetings.

**2. POPA study on directed-energy weapons.** As of late April, this important study was poised to move forward. A 15-member study group, chaired by N. Bloembergen and K. Patel, had been briefed once by the Strategic Defense Initiative Office (a second briefing occurred in May); L. C. Hebel had agreed to serve as executive director of the study; a review committee, chaired by G. Pake, had been appointed; and \$200,000 in funding (out of a needed \$660,000) had been secured. If enough additional funding can be found (which the Council agreed must come from outside the Defense Department), the study will undoubtedly proceed. However, some Council members questioned the balance of the study group, and others argued that policy considerations--which cannot be neatly segregated from technical considerations--should be included in the study. The Council recommended that two or three more members be added to the study group in the interest

"What's New"

of balance, and asked the Executive Committee to review the status of the study and take any needed actions in June.

3. Proposed special projects fund. Council tabled a proposal brought by Treasurer Joe Burton that a \$1 million fund be set aside, the income from which could be used for special projects in the Society, such as projects related to physics education and societal issues. The proposal will be reviewed by the Executive Committee.

4. US-USSR scientific interaction. Council members had mixed reactions to a proposed new protocol on scientific exchange between the Soviet Academy of Science and the U.S. National Academy of Science. Some applauded a step toward greater scientific cooperation. Some feared that Soviet dissidents and refuseniks would see the protocol as a signal of decreased concern for human rights. Perhaps most Council members felt both ways. President Robert Wilson said he would plan to communicate to the President of the Soviet Academy the continued grave concern of American scientists for the welfare of Sakharov and other persecuted Soviet scientists, at the same time welcoming increased scientific cooperation between the two countries.

5. UNESCO substitution. Past President Mildred Dresselhaus drew the attention of Council to the fact that the Federal Government has not yet made good on its promise to redeploy the money saved by withdrawing from UNESCO into other international educational and scientific activities.

6. New APS staff. Harry Lustig, now Provost at City College in New York, was named Treasurer of APS, to succeed Joe Burton. Miriam Farman, an astrophysicist at SUNY Stony Brook, was named Deputy Executive Secretary. These are excellent appointments indeed.

It is thirteen years since the Forum was founded. The deep concern for the issues joining science and society that brought the Forum into being is now evident in every part of the Society. It can be seen in the work of the officers, the Council, the Panel on Public Affairs, the Office of Public Affairs, a variety of committees-and of course, the Forum. In my half-year as a Councilor, every one of the following issues has made an appearance as business of the Council: energy and the environment, arms control and nuclear war, equal opportunity, human rights, international cooperation, freedom of communication, and education. The Society, whose main business remains meetings and publications, is made stronger by the breadth of its present concerns.

Every week, Bob Park, Executive Director of the APS Office of Public Affairs in Washington, issues a brief, timely, informative report entitled "What's New". At 5:00 p.m. each Friday, it is fed to Telemail. For anyone having access to a terminal or computer with a modem, "What's New" provides an excellent (and very convenient) way to keep abreast of public policy developments related to physics. This service is subsidized by APS, and is intended for APS members on a free trial basis. Forum members should find it of special interest.

To obtain access instructions and password, write to "What's New", c/o APS, 335 E. 45th Street, New York, NY 10017.

As a faithful reader of "What's New," I recommend it to Forum members.

Kenneth W. Ford

1985 Carnahan Conference on Harmonizing Technology with Society

The purpose of this conference is to address the crisis in ethics and values and to discuss the future organization of society in light of the developments in robotics, automation, and artificial intelligence. The conference is August 22-23 in the Carnahan House, U. of Kentucky. Contact: John Jackson, Electrical Engineering Dept., 565 Anderson Hall, U. of Kentucky, Lexington, KY 40506, 606-257-3926.

NUCLEAR WAR EDUCATION CONFERENCE

George Mason University April 11-12, 1986

This is a preliminary announcement of a two day national conference on nuclear war/peace courses and their context in the general education of college students. This conference is intended for faculty that have taught or are considering offering courses on nuclear war and peace. This preliminary notice is a call for papers in the following areas:

- A. Motivations. Why should nuclear war courses be offered? How do they fit within the context of a student's education? Why do students take them? Why are some institutions more or less receptive? How can obstacles be overcome in less receptive institutions? How can objectivity be assured?
B. Model courses. Examples of courses now being offered and their context within the university program, including a discussion of the practical considerations of exams and assignments.
C. Surveys. What nuclear war education is being offered in your country, state or region?
D. Resources. What resources exist for use in nuclear war courses, including books, files, guest speakers, and computer software?
E. Other. Other issues of relevance to nuclear war education.

PLEASE TEAR OFF AND RETURN

I am very interested and hope to attend this conference. Please send me the final program announcement.

I would like to present a paper on the following topic:

NAME

ADDRESS

City State Zip code

PHONE (area code)

Please return to

Robert Ehrlich Physics Department George Mason University Fairfax, VA 22030

"Your Career and Nuclear Weapons," is a guide for young scientists and engineers on the arms race, the role their fields play in it, and how it may affect their work. It analyzes military programs in industry and universities. Prepared by post-doctoral research scientists at the Institute for Theoretical Physics, U.C. Santa Barbara. Order at \$2/copy from Peace Resource Center of Santa Barbara, 331 N. Milpas St. #F, Santa Barbara, CA 93103.