ous forms of possibly inappropriate prescribing would thus be detected: excessive quantities, dubious efficacy, incompatible multiple drugs, and risk of adverse reactions. A firm assessment might require the difficult process of individual case analysis; therefore, utilization review might be limited to selected problem drugs. Following disclosures, attempts would be made to influence physician behavior by remedial education, disallowance of claims, prior approval for certain drugs, and other administrative controls.

These and related strategies attempt to enlist the professional pride and economic interest of physicians on the side of rational prescribing. Other possible approaches affect as well the other participants in the medical care market. Some examples of less familiar courses of action follow.

If prepayment were extended to services of ancillary health workers in the doctor's office or group center (nutrition, counseling, physical therapy, and so on), the emphasis on prescribing a drug as the finale of the doctor-patient contact would be reduced. Necessary manpower would have to be developed. Increasing patients' knowledge about drugs is a familiar specific suggestion, but increasing their voice in the design and management of health programs might have spillover effects on their readiness to seek or accept medication, particularly where therapeutic indications are least clearly defined, as is the case with analgesic and sedative drugs. Even more broadly, drug-taking may be affected by improvement in the lifetime distribution of paid leisure as a preventive against time lost from work through illness, a change that calls for major social planning.

The pharmacist's role can be influenced by the development of a compensation base that is independent of the volume of medications sold and that encourages detection of excess prescribing and conflicting medication plans. In the hospital system, explicit controls over prescribing and dispensing to individual patients could be included in accreditation and reimbursement standards. Finally, one should note that requiring drug companies to establish superior efficacy as well as safety and competitive efficacy, in the premarketing approval process would reduce the flow of new medications into the medical care system—if such a law could be enforced.

The vigor with which each such course should be pursued depends on the investment relative to the probable benefits. These may be hard to quantify, but the demonstrated responsiveness of actual prescribing practices to economic and social influences, rather than to medical necessity, suggests that welfare may be served by a trial of other consumption patterns.

References and Notes

1. *New Engl. J. Med.* **285**, No. 5, 293 (1971).
2. A. Smith, E. Traganza, G. Harrison, *Psychopharmacol. Bull.* (March 1969), p. 1.
3. U.S. Senate, Select Committee on Small Business, Subcommittee on Monopoly, *Present Status of Competition in the Pharmaceutical Industry* (91st Congr., 1st sess., 1969).
4. C. Muller, *J. Chronic Dis.* **18**, 689 (1965).
5. *Prescription Drug Data Summary, 1971* (Social Security Administration, Washington, D.C., 1971).
6. U.S. Senate, Select Committee on Small Business, Subcommittee on Monopoly, *Hearings on Effect of Promotion and Advertising of Over-the-Counter Drugs on Competition, Small Business, and the Health and Welfare of the Public* (92nd Congr., 1st sess., 1971).
7. W. O'Brien, *Bull. At. Sci.* **25** (1), 8 (1969).
8. American Medical Association, *Reference Data on The Profile of Medical Practice* (Center for Health Services Research and Development, Chicago, 1971), pp. 26, 48, 51, 53, and 54.
9. S. Albert, unpublished manuscript.
10. P. D. Stolley, M. H. Becker, L. C. Lasagna, J. D. McEuilla, L. M. Sloane, *Med. Care* **10** (1), 17 (January–February 1972).
11. R. A. Bauer and M. G. Field, quoted in B. Barber, *Drugs and Society* (Russell Sage Foundation, New York, 1967), pp. 56–58.
12. H. F. Dowling, report presented at the Conference on Continuing Education for Physicians on the Use of Drugs, 5 February 1969.
13. D. N. Price, *Soc. Sec. Bull.* **34** (1), 19 (1971).
14. U.S. Department of Health, Education, and Welfare, Task Force on Prescription Drugs, *Final Report* (Government Printing Office, Washington, D.C., 1969), p. 15.
15. T. D. Rucker, *J. Drug Issues* **1**, 326 (October 1971).
16. Senate bill 3, section 25, pp. 13–16. This bill, introduced on 25 January 1971 by Senator Edward Kennedy (D–Mass.), aims to create a national system of health security.

NEWS AND COMMENT

Nuclear Reactor Safety: At the AEC the Way of the Dissenter Is Hard

A number of disquieting indications have turned up in the past 2 years to suggest that a vital safety feature of nuclear power reactors may be far less capable of preventing a catastrophic accident than has long been assumed. As this disturbing information trickled into the Atomic Energy Commission from the nuclear industry, and from the AEC's own national laboratories, it carried with it the gravest of implications for public safety. For the feature in question—the emergency core cooling system (ECCS)—is a last-resort device meant to guard against what is thought to be the "maximum credible accident" that a reactor can possibly sustain, a major loss of cooling water through a broken pipe or valve.

Now, after pondering this unseemly problem for 2 years, the AEC is engaged in a showdown public hearing on it with environmentalists, utilities, and reactor manufacturers. From the testimony so far, it has begun to look as if the AEC's own administrative safeguards are in as questionable shape as the reactors it licenses. For a large amount of evidence has accumulated suggesting that AEC policy-makers have been studiously ignoring, rejecting, and even discouraging dissenting views from within the agency in the matter of emergency core cooling.

The argument over ECCS is neither academic nor trivial. Should a reactor's searingly hot core run dry, the ECCS is supposed to reflood it with water within seconds after the leak occurs. Should the ECCS fail—or even hesitate for long—the core could melt and ensuing steam explosions could scatter its radioactive contents over a wide area. The indications are that existing designs of backup cooling systems might not adequately reflood a reactor after a major leak.

For more than a year, the AEC kept its growing apprehensions largely to itself, sharing them with the four companies that manufacture reactors but telling the public essentially nothing. Late in 1970, to its credit, the AEC appointed a "task force" of four senior members of the regulatory staff to take a look at the problem and suggest some answers.

In an offhand sort of way, the task

force acknowledged that the AEC indeed had a serious problem when, on 19 June 1971, it issued a set of special instructions for operating and evaluating reactors. These "interim criteria," the task force said, would compensate for any unforeseen shortcomings in backup cooling systems. Happily for the multibillion dollar nuclear industry, the "interim criteria" imposed no serious hardships on utilities that were then operating some 20 power reactors. Nonetheless, an AEC press release said, these special regulations were "clearly conservative."

That, however, may not be quite the case. And issuance of the "interim criteria" turns out to have merely been the beginning, not the end, of the ECCS affair.

Last January the new AEC chairman, James R. Schlesinger, ordered a hearing in the matter of ECCS to allow the public to comment on the "interim criteria." This is not an unusual procedure in itself, but what it has produced certainly is.

The hearing, which may continue through the summer, has already uncovered an extraordinary welter of dissent inside the AEC over the way that the agency handled the problem of emergency core cooling. In recent weeks, half-a-dozen foremost specialists in nuclear reactor safety from two national laboratories and from within the AEC's regulatory structure have testified that the interim criteria are—in many respects—anything but conservative. More than 20 others within the AEC appear to share these misgivings. And at least two technical experts—the very ones who recognized the problem in the first place—have said that questions still surrounding the adequacy of this safeguard device are so serious, and are so far from being resolved, that they warrant an immediate and indefinite moratorium on reactor design changes and on increases in reactor power levels, pending further research.

But more than this, compelling evidence has come to light of several instances in which AEC officials apparently have tried to prevent more conservative, dissenting opinions from percolating up from the AEC's national laboratories and out into public view.

Utilities and reactor manufacturers are yet to be heard from, and they are expected to testify that the ECCS regulations are in some ways *too* conservative. Though the balance of testimony may yet shift, it seems at this point inescapable that the AEC has badly bungled one of the most serious safety issues ever to arise—and did so for reasons that are not at all clear—by ignoring or rejecting the more conservative judgments of a large portion of the expertise at its disposal.

The hearing that has aired all this dirty laundry is taking place on the first floor of a rented office building in suburban Bethesda, Maryland, near one of the AEC's three headquarters buildings in the Washington area. Technically, it is known as a "rule-making" hearing, one meant to gather information to assist the five AEC commissioners in deciding whether to change a proposed or existing regulation.

The hearing is being held now partly because the AEC considered its ECCS regulations so urgent last year that it put them into force without providing the usual 30- to 60-day comment period. What's more, environmental groups had learned of the AEC's concerns, and since last summer have been interjecting the core cooling issue into more and more reactor licensing hearings. In an apparent effort to settle the issue once and for all, Schlesinger ordered the hearing.

Although it has now raised broad questions about freedom of dissent and about relations between the national laboratories and the commission, the specific issue at hand is the adequacy of the interim criteria worked out by the senior task force, under the direction of Stephen H. Hanauer, the chief technical adviser to the AEC's regulatory staff.

Essentially, the Hanauer group did two things: It laid down some new operating rules for power reactors which are aimed at reducing the already small chance of a major "loss-of-coolant accident," or LOCA. (One such rule set a maximum operating temperature of 2300°F, or 1200°C.) Second, the task force issued special instructions for evaluating the performance of ECCS in the event of a major leak. These instructions applied to all 20 or so reactors then operating, as well as to more than 100 being designed or built, and they called for using one of several computer models of LOCA phenomena previously developed by the AEC and industry.

The Hanauer group recognized that computer models of ECCS performance have never been adequately verified by experimental work, nor, indeed, has a backup cooling system ever been tested under realistic operating conditions in a working reactor (*Science*, 9 July 1971). Nevertheless, the task force felt confident that a lengthy set of "suitably conservative" assumptions and conditions it prescribed for plugging into the models would fully but-

Kennedy Asks NSF Budget Boost

Senator Edward M. Kennedy (D–Mass.) has introduced a bill that would authorize $740 million for the National Science Foundation for fiscal 1973. This is $94 million above the Administration request.

The largest increase in the Senate bill is included in the $131,200 asked for science education programs. The Administration wants $75 million. For Research Applied to National Needs (RANN), the Kennedy bill asks for $96.5 million, which is $16.5 million above the Administration request. The higher amount includes a near-doubling of the sum requested for energy research—or $26 million. This money, says Kennedy, would go for research in solar, geothermal, and other nonconventional sources of energy.

The special subcommittee on the NSF, which Kennedy heads, planned to hold hearings on the bill at the end of this week.

Meanwhile, the House last week passed a bill authorizing $673.8 million for NSF for the next fiscal year. The major increase over Administration demands is contained in the $109.8 million the bill asks for science education in the categories of science education improvement, graduate student support, and institutional aid. For RANN, the House bill endorses the Administration's $80 million request.

The Administration plans to release $21 million in education funds that it impounded for fiscal 1972, which would bring its total projected 1973 budget to $667.7 million. The NSF 1972 appropriation was $619 million.—C.H.

tress the model's weaknesses. These evaluations-by-computer would then be used as a basis for licensing reactors until those initial "disturbing questions" about core cooling could be cleared up. (It might be noted at this point that the question first arose when inconsistencies between computer models of reactor accidents suggested that engineering design assumptions once thought to be conservative really were not.)

The hearing on these instructions has been under way for 15 weeks and has produced, so far, more than 8000 pages of oral testimony and thousands of pages more of written documents. The thrust of testimony to this point has been to substantially discredit the asserted conservatism in the Hanauer group's handiwork. And one report, in the trade newsletter, *Nucleonics Week*, indicates that chairman Schlesinger has been "upset" to find so many doubts raised about safety measures that he had been led to believe were thoroughly defensible.

Had the hearing been confined to utilities, reactor "vendors," and the AEC, it might have been a far swifter and less mortifying affair. What made the difference was the participation of some 60 environmental groups in a coalition calling itself the National Intervenors. (The Intervenors are receiving some technical support from half-a-dozen members of the Union of Concerned Scientists, the Boston affiliate of the Federation of American Scientists.) At the hearing, the Intervenors are represented by Daniel Ford, a 23-year-old Harvard economics graduate and a member of the union who has devoted himself for the past year in reactor technology, and by Myron M. Cherry, an aggressive Chicago attorney who has become something of a bête noire to midwestern utilities through his involvement in several reactor licensing hearings.

Cherry is the hearing's most striking personality. Lean, wiry-haired, exceedingly intense, he evinces a Naderesque energy and ardor. A sometimes flamboyant courtroom tactician, he pops up frequently with discursive objections, and he's not above delivering a verbal shin kick to a hostile witness on occasion. (He once accused Stephen Hanauer of sleeping during the hearing.) "From a parliamentary standpoint," Cherry said in a recent interview, "this isn't a judicial proceeding, it's a circus. So I don't necessarily feel like being judicial."

On the other hand, his cross-examinations have revealed a facet of the ECCS affair that otherwise might never have seen the light of day.

The environmentalists scored their first points early in February, when members of the AEC regulatory staff presented the agency's technical justification for the interim criteria. It soon evolved that the Hanauer group had intended to write a detailed "white paper" on its findings, but never got around to doing so. Hanauer conceded that, to his knowledge, the five commissioners never were furnished with technical documents supporting the criteria—and thus, by implication, had accepted them on faith.

In time, the regulatory staff did write a post facto justification and this became the AEC's official hearing testimony. Cherry then inquired as to whether any of the staff who were present, and who had prepared the testimony, disagreed with it. Seemingly with great reluctance, one nuclear engineer, G. Norman Lauben, raised his

Sierra Club Foiled in High Court

A recent decision by the Supreme Court could be a setback for conservation and other groups in their attempts to establish a beachhead in the courts in the growing number of public interest law suits.

In a 4 to 3 decision, the court ruled that the Sierra Club did not have the standing to sue for a halt in plans for a vast $35 million recreation complex that Walt Disney Enterprises wants to develop at Mineral King Valley, a wilderness area in Sequoia National Forest in California. The ruling affirmed a ruling by the California court of appeals, which reversed a San Francisco district court injunction against the project. The majority opinion maintained that the club did not have standing because it did not allege in its suit that the project would be detrimental to a specific individual.

The decision was not all bad for conservationists, though, because the court firmly stated that an individual has as much right to go to court when his esthetic and environmental well-being is threatened as when he faces economic damage. The decision was a clear encouragement to the Sierra Club to start over again with its suit, this time in the name of one or more persons whose enjoyment of the wilderness was at stake in Mineral King Valley.

The minority justices, William Douglas, William Brennan, and Harry Blackmun, argued for a more flexible interpretation of standing, pointing out that a group as large and experienced as the Sierra Club could legitimately speak for a significant portion of the population. Blackmun, in an uncharacteristic difference of opinion with Chief Justice Warren Burger, wrote: "Must our law be so rigid and our procedural concepts so inflexible that we render ourselves helpless when the existing methods and the traditional concepts do not quite fit and do not prove to be entirely adequate for new issues?"

Douglas suggested that the entire problem could be sidestepped if environmental issues could be litigated in the name of the inanimate objects about to be despoiled. Nonpersons such as ships and corporations enjoy this status, he said, so why not trees, rivers, and so forth?

Friends of the Earth, which filed an amicus curiae brief in the case, said the court's decision "shows that a new law is needed to give citizens groups their day in court." Such a law (S. 1032), sponsored by senators Philip Hart (D–Mich.) and George McGovern (D–S.D.), is under study in the Senate environment subcommittee. It would broaden the definition of standing as far as the Constitution allows, which means any person (or group) would be allowed to sue on an environmental issue as long as an adversary relationship exists.

While the Sierra Club will probably reinstigate its suit, prospects for stopping the Disney juggernaut are dim. Planning has been going on since 1964 on the project, which features a huge array of motels, parking lots, power lines, a railway, and a 20-mile highway designed to accommodate 14,000 visitors daily.—C.H.

hand. He conceded, "There were certain portions of the testimony that I would have to consider personally as not being sufficient." He went on to explain that, if an assumed value involving a heat transfer coefficient—as specified by the criteria—were inaccurate by the relatively small amount of 20 percent, then emergency core cooling systems in a number of reactors might not be able to prevent melting of the core in the event of a major water leak.

Lauben had raised what was to become a central question in the hearing: AEC doctrine holds that unknowns in reactor behavior can be offset by conservative engineering assumptions. But can one always be sure what "conservative" means?

Cyril G. Lawson, an authority in core cooling problems from Oak Ridge National Laboratory, elaborated the point:

> The assertion is that conservative assumptions are made where possible, and this is true. But there are some areas where, in my opinion, we don't know whether the assumption we are making is conservative or not because we don't know what is occurring physically.

As to whether backup cooling systems would or would not perform as they were supposed to, Lawson said that both possibilities were equally speculative. No one, he said, had ever tabulated the "conservatisms" and "unconservatisms" presumed to exist in ECCS design, "so the net conservatism is unknown."

On 9 March, Phillip L. Rittenhouse, another safety researcher from Oak Ridge, pointed to what he felt were serious technical deficiencies in the interim criteria. Then he startled the hearing by asserting that a great many of his colleagues in the national laboratories and the AEC headquarters staff shared his reservations about the reliability of backup cooling equipment. Cherry asked who these colleagues were. Rittenhouse read into the record the names of 28 persons, including Lauben, Lawson, William B. Cottrell, the director of nuclear safety programs at Oak Ridge, his assistant David O. Hobson, and ten top officials of the Aerojet Nuclear Corporation, which manages the safety research program at the National Reactor Testing Station in Idaho. Significantly, Aerojet Nuclear is responsible for running most of the AEC's emergency core cooling research, much of which has yet to be completed.

Doom Spelled for Vampires

There was bad news for the vampire bat at a press conference called last week by John A. Hannah, administrator of the Agency for International Development (AID).

Hannah announced the development of a new means—economical, lethal, species-specific, and ecologically unassailable—of doing away with droves of the tiny flying mammals, which have harassed generations of Latin American livestock and caused countless cattle deaths from rabies. Rabies carried by these bats has also killed some people, and there is evidence that the bats carry the virus of Venezuelan equine encephalomyelitis, which killed thousands of horses last year.

The bats in question are *Desmodus rotundus*, one of three major types of bats. Unlike the other species, which are, respectively, insectivorous and frugivorous, and unlike the vampire bats that prey on birds, the *Desmodus rotundus* like mammalian blood, particularly that of docile and easy-to-locate cattle. The territory of these bats stretches from central Mexico to northern Argentina, and they are responsible for 1 million cattle deaths, amounting to $250 million worth of meat and milk, each year.

Various quite unsuccessful methods have been used to combat their oft-diseased bite. These include vaccination of cattle, which is expensive and of limited effectiveness; electric night lighting or netting around corrals; fumigation or destruction of roosts (a practice that can result in the destruction of multitudes of good bats sharing the same cave or abandoned well); and the application of a strychnine and honey syrup to bites to poison those bats returning to the scene of an earlier meal.

Intensive research on the problem by AID, the Department of the Interior, and the Mexican department of agriculture began in 1968. Scientists carried out detailed observations of the vampire bats' flight, feeding, and domestic habits and their reactions to various drugs. Basic research was done at the Interior Department's Fish and Wildlife Research Center in Denver, and field studies were carried out in Mexico and Brazil.

Scientists finally located two circumstances that fit together to spell doom for the vampires. One is that this species has an extremely low tolerance for anticoagulant drugs of the kind used to treat heart disease in human beings. The other is that bats are constantly grooming and licking themselves and their neighbors in the roost. So a mixture of petroleum jelly and anticoagulant was made and spread on the backs of captured bats.

The results were startling. In test populations of cattle, there was a 96 to 100 percent reduction in bat bites in 2 weeks. Every bat applied with the deadly mixture was responsible for the deaths of perhaps 2 or 3 dozen of the bats he roosted and preened with. The results were equally effective when an anticoagulant was injected in the stomachs of cattle. For several days, the cattle's blood contained enough anticoagulant to kill their predators. The drug has no adverse effects on cattle because of their bulk, but the vampire bat, which is 3 inches long and weighs 1 ounce, experiences a lingering death from hematomas, internal hemorrhaging, failure of the circulatory system, or, if he survives the initial impact, insufficient strength to go out for food.

Nelson Kverno, a biologist at the Denver Research Center, said Latin American cattle breeders are already tooling up for the new treatment and that it has such an immediate and devastating effect on bat populations that it will only have to be used once every 3 to 8 years, at a cost of 1 or 2 cents per bat killed. Officials disavowed any intention (or capability) of wholesale eradication of the vampire, "a very exciting little animal," as Kverno called it, merely of reducing the population in cattle-raising areas. AID is touting the $800,000 project as an extraordinary example of efficient, economical applied research—the total cost is about 0.3 percent of the annual damages caused by the bats.—C.H.

"These people have too many reservations . . . shared too generally, for me to pass off," Rittenhouse said. "These reservations [concern] portions of the LOCA. Maybe they're just not sure what's going on."

Some of the most damaging criticism of the way the AEC handled the core cooling question has found its way into the hearing record in the form of internal AEC correspondence and memoranda. The commission itself released a large number of such documents after Cherry threatened to sue for them under the Freedom of Information Act. Other revealing letters, reports, and memos have arrived in unmarked envelopes in Cherry's morning mail. "The AEC leaks like a sieve," he says.

One document which the AEC released during this period was a "Dear Jim" letter, which Alvin M. Weinberg, the director of Oak Ridge National Laboratory, wrote to AEC chairman James Schlesinger on 9 February. In it, Weinberg expresses a "basic distrust" of the sort of computer calculations that the Hanauer group advocated for evaluating ECCS performance, "especially where the calculations have not been checked by full-scale experiments . . . and the consequences of failure are serious."

Weinberg makes a second point worth quoting at length, for it hints at one major cause of the AEC's present embarrassment:

> I have one other point, I believe ORNL and the other National Laboratories should have been as intimately involved in the preparation of the interim criteria as we have since been in the preparation of AEC testimony for the hearings. That we were not so involved reflects a deficiency in the relation between Laboratory and Commission that troubles me. I continue to believe that the rather independent expertise of the national laboratories—an expertise which can only be maintained through complete access to information—must be called upon fully by the Commission even when this may uncover differences of opinion between the laboratories and the staff of the commission.

So far, dissent has been concentrated in the laboratories, but it is by no means limited to them. The most severe and detailed criticism of the AEC's handling of the ECCS affair has come from two members of the commission's own regulatory staff, Morris Rosen and Robert J. Colmar. Until the staff was reorganized earlier this year, Rosen headed the systems performance branch of the Division of Reactor Standards and Colmar was his deputy. Together they were directly responsible for day-to-day evaluation of backup cooling systems.

The hearing record shows that last 1 June, Rosen and Colmar fired off a strongly worded memo to the Hanauer task force urgently protesting that the criteria it was about to issue were not conservative enough and would not prove "technically defensible" as a basis for reactor licensing. They contended that the computer models that figured so prominently in the criteria were crude and arbitrary, and rested on only a thin foundation of experi-

APS Challenged on Bulletin Censorship, Charter Changes,

At last week's American Physical Society meeting in Washington, D.C., the society's liberal wing acted less flamboyant than in the past but, nonetheless, gave APS leaders a run for their money. If the APS is any index, protest in scientific societies is alive and well.

Despite the provocations of the Indochina bombing, the physics activists last week focused on APS internal affairs: Censorship by the *Bulletin* of publication of the abstracts for the Forum on Physics and Society, and a proposed broadening of APS's constitutional statement of goals that would legitimize and extend the society's nontechnical activities.

The militant actions of the past, such as the 1969 march on the White House, have been known to leave crusty APS leaders howling—but these internal business dealings seem to have succeeded in aggravating some ulcers, too.

The censorship fight was a first test of the forum, the safety valve, quasi-division of APS organized in January for talking about physicists, instead of physics. At issue were the abstracts of a forum session, with Jay Orear of Cornell as chairman, on "Some recent case histories" relating physicists and public affairs. Raphael Littauer of Cornell would present the final edition of his much-publicized study of the air war in Indochina; William C. Davidon, of Haverford, who was at one time named a coconspirator in the plot to kidnap Henry Kissinger, would talk on the war and scientific workers; Leonard Rodberg of the Institute of Policy Studies would talk about the Pentagon Papers, and Pierre Noyes of the Stanford Linear Accelerator (SLAC) would discuss the legal—or rather the illegal—aspects of the Vietnam war. It was all to be very topical and newsworthy. But when W. W. Havens, executive secretary of APS, received the abstracts of these talks in February, as he said later, "I did not think the abstracts advanced the objectives of the society," which according to the APS constitution, article II, are "the advancement and diffusion of the knowledge of physics."

The real sticker, it turned out, was Davidon's abstract, which mentioned "inactivating equipment intended for killing or harming people" as a "needed" activity. (Davidon's actual talk was about a real incident, an alleged wrecking of 300 bomb casings at the American Machine and Foundry plant at York, Pennsylvania, for which 2000 people, by signing a statement, took responsibility.) Bomb sabotage, it should be noted, is not a subject that crosses the desks of executive directors of the APS every day, and Havens naturally referred it, with the whole package of forum abstracts, to the APS executive committee, which vetoed their publication.

The censorship of the abstracts looks like a form of sabotage of the new forum, but forum spokesmen prefer to call APS leaders "confused" as to how to react to the challenge it poses. In recent years, a group of left-liberal activists, including Brian Schwartz of the Massachusetts Institute of Technology, Martin Perl of SLAC, Seymour Koenig of IBM, and others, have been urging APS to take more responsibility for social issues where physicists

mental verification of questionable relevance to the huge power reactors currently being built.

They argued that uncertainties of ECCS performance appeared so great, and the sophistication of present computer models so poor, that a more prudent course of action would be to institute a moratorium on reactor design changes and power-level increases. At the same time, they urged a rapid acceleration of core cooling research.

Hanauer has acknowledged that the task force received and discussed the memo. But its advice is not reflected in the regulations the task force issued 18 days later.

It appeared at one point that the AEC would not allow Rosen and Colmar to testify at the hearing. A lower-level decision to this effect is said to have been reversed by L. Manning Muntzing, the new director of regulation.

The two engineers testified on 12 and 13 April, and from all appearances the passage of 10 months had only heightened their qualms. Rosen presented an 80-page critique of the interim criteria in which he charged that "undeniably serious gaps" exist in knowledge of ECCS reliability. He said that he found it "disturbing and discouraging" to see the dissenting views of what he believed to be a large majority of experts available to the regulatory staff "still being basically ignored."

"Margins of safety once thought to exist do not," Rosen warned, "and yet reactor power levels continue to increase, resulting in an even more tenuous situation."

(In an interview, Rosen and Colmar attached an important caveat to this statement. They said that, in their opinions, the probability of an individual reactor suffering an uncontrollable accident is low enough—and the present number of reactors is small enough—so as not to pose an undue risk to public safety. "We're not saying reactors working today are going to blow up," Colmar emphasized. "What concerns us is the future situation, when 100 reactors are running in the mid-1970's and a thousand by the end of the century.")

For his part, Colmar traced the history of the AEC's apprehensions and the genesis of his own dissent. On the strength of his story, he and Rosen would seem to rank in the major league of government whistle-blowers.

Colmar testified that in February 1970 he was assigned to evaluate a new and relatively sophisticated computer model of a loss-of-coolant accident which Westinghouse had developed for its reactors. Colmar said Westinghouse was highly enthusiastic about the model, which it called SATAN, partly because the company thought it demonstrated more-than-adequate capacity in backup cooling systems and perhaps even enough to permit a simpler, less costly design.

Colmar soon came to precisely the opposite conclusion. Westinghouse was reading its own model incorrectly, and far from showing excess cooling capac-

by Activists Concerned about War, Physicists' Role

are involved. Last January, the APS approved the forum, largely as an institutionalization of some informal sessions that Schwartz has been organizing at APS meetings for the last several years. Then, in February, the executive committee vetoed publication of the abstracts. At a Sunday meeting, the APS Council turned around and set up some appeal procedures for what to do when this happens again.

The real issue underlying the censorship, and one faced by other science societies, is whether and how APS should respond to pressure to include political and social material in its publications, meetings, and structure. Some in APS officialdom believe, as do many professional society leaders, that the antiwar movement and employment crisis, both of which have sparked these pressures, will just go away; hence, APS can get away with inaction. However, the activists want to broaden APS permanently, and this is what the second major issue at the meeting, the March amendment, was all about.

Sponsored by Robert March of the University of Wisconsin, the amendment would add to the APS's constitutional statement of goals (which is now only the advancement of physics) "the enhancement of the quality of life for all people," and assisting the membership in "pursuing these humane goals" and that APS will "shun those activities which are judged to contribute harmfully to the welfare of mankind." Such an addition, March says, would strengthen the hand of the forum and, in effect, justify its existence in APS. The proposed amendment is worded so blandly that one physicist termed it a "motherhood statement." Yet for something as American as apple pie, it has managed to find enemies in the APS, and it is given slight chance of winning the two-thirds vote it needs to pass.

Like their counterparts in one wing of the student antiwar movement, the APS activists have, in the more recent, so-called quiet years, turned to educational reform as the best way to reform the system. The forum held another session on physics education, where March, along with Earl Callen, of American University, and Leonard Eisenbud of the State University of New York, Stony Brook, talked about their attempts to reach out to the nonscience student, the antiscience student, and even the technically immersed graduate student in physics who has no overall scheme or philosophy of what he is doing and is unable to communicate with laymen. The session drew a fair amount of interest and attention, despite the fact that it was more about education than physics, and therefore outside the current purview of APS.

The APS reformers may think themselves an isolated fringe of the physics community but they may not be. As it happened, the establishment at the meeting, in the form of the Center for the History of Physics, was passing out copies of an old speech by J. Robert Oppenheimer, who, in a 1962 speech, spoke warmly of the "hardly paralleled dedication and responsibility of physicists to the great, dark, tangled and ununderstood cause of a peaceful world."—DEBORAH SHAPLEY

ity it strongly suggested that design assumptions once thought to be conservative were in fact overly generous.

Rosen began working with Colmar on SATAN and together they communicated their dismaying findings up the chain of command. By May, worried memos were circulating through the regulatory staff. One, from Edson G. Case, head of the reactor standards division, spoke of "serious implications" for Westinghouse and the other manufacturers. A memo dated 2 June 1970 from Richard C. DeYoung, one of Colmar's supervisors, to Peter A. Morris, head of reactor licensing, reported that "Westinghouse has admitted in private conversations that they erred in their initial claims. . . . [and] The general consensus of those who have reviewed the situation is that a serious problem has been uncovered for all PWR [pressurized water reactor] plants. . . ."

As the summer wore on, doubts about backup cooling broadened to include reactors made by Babcock & Wilcox. At the same time, reports filtering in from the National Reactor Testing Station described experimental evidence, raising a "serious question regarding safety margins in ECC systems"—evidence that was substantiated late in 1970 by some dramatic failures of a small mock-up of an ECCS at Idaho (*Science*, 28 May 1971).

Licensing Continued

Yet in the face of all this information, the AEC refrained from holding up any reactor licensing activities until early 1971, nearly a year after the problem first came to light. Indeed, over the protest of Rosen and Colmar, the AEC certified one B & W reactor plant as safe in August 1970. (The name of the plant was not divulged.)

Toward the end of 1970, the commission appointed its senior task force, a commendable gesture at least. Glenn Seaborg, then chairman, said the Hanauer group would "provide overall management review of important safety issues," which was about as close as the AEC ever came to openly admitting that it had a problem on its hands.

Up to now, the AEC had reacted laudably, if slowly, to a difficult situation. But pressures apparently came to bear on the task force to produce an answer that was both technically sound and expedient. As time passed, the task force is said to have turned a deaf ear to the worried experts at its disposal and put aside its ambition to write a definitive "white paper." At one point, the task force commissioned a state-of-the-art report on ECCS from Aerojet Nuclear. The draft that Aerojet delivered in the first week of April 1971 was replete with pessimistic talk of experimental work yet undone, the crudeness of computer models, and the difficulties of "patching" them up with conservative assumptions that no one could be sure were conservative. The Aerojet report received only cursory attention, and the task force finally did what so many advised against: It issued its interim criteria based on essentially the same computer models that had triggered the whole affair, and it buttressed them with what it hoped was a solid dose of conservatism. The final product was, in Colmar's phrase, "a triumph of hope over reason."

Early this January, Morris Rosen was removed from his job and Colmar requested a transfer. An AEC spokesman said Rosen had been promoted to a higher position—as technical adviser to the director of regulation—with added responsibility. While that may be true, he also has less to do with emergency core cooling. "It's the sort of thing," he says philosophically, "that, if it happened very often in an organization, you'd have to wonder."

Other, related events may also give one pause to wonder whether the expression of dissent is not a difficult and sometimes risky practice in the AEC. For example, there is the letter that William Cottrell and several others at Oak Ridge wrote to AEC headquarters on 6 December 1971, criticizing the interim criteria and speaking of "wide gaps in our knowledge." A week later, one of Cottrell's superiors, Donald Trauger, got wind of the letter and took the unusual step of calling L. Nanning Muntzing about it. He told the director of regulation that the letter was only a draft, that it didn't represent Oak Ridge's views, and would he please send it back? Muntzing complied. Testimony at the hearing later established that the letter was not a draft and that it certainly reflected the views of a number of qualified people at Oak Ridge.

A month or so later, Schlesinger found it necessary to call Weinberg and ask him to assure Cottrell, Trauger, and others that anyone called to testify should feel free to express his views even if they conflicted with official policy.

Then there's the matter of the Advisory Committee on Reactor Safeguards, the semiautonomous, 15-man "watchdog" of reactor safety. Participants in the hearing are allowed to submit written questions to the safeguard group but the AEC will not allow individual members of the committee to testify, as they are said to be very busy and their appearance would serve no useful purpose. Actually it might, but not the AEC's. Several members of the ACRS are thought to be sympathetic to Rosen and Colmar's proposed moratorium.

Reports Blue-Penciled

Finally, at one point in the hearing, it was brought out that AEC headquarters regularly blue-pencils reports on reactor safety research emanating from Aerojet Nuclear to remove what authorities in Washington consider to be "speculative" material. J. C. Haire, an Aerojet official, testified that he thought this practice was "rather an inhibition of free and open discussion," and he surmised that it was done by the Division of Reactor Development and Technology, under Milton Shaw, "to avoid the problem, or burden if you will, of having to spend a lot of time answering public inquiries [on safety matters] that are addressed to Congress and referred to them."

The whole sorry story of emergency core cooling generates a natural compulsion to seek out guilty parties and assign some measure of blame. Rosen and Colmar, who are perhaps in the best position to do that sort of thing, are unwilling. They tend to ascribe the affair to human nature, to call it a product of groupthink and the bureaucrat's instinct to keep programs running no matter what the cost. "It's the sort of thing that can happen in any regulatory agency," Rosen says.

That's probably part of the problem. Certainly there have also been barriers in communication between the nuclear safety program and the AEC's regulatory arm; perhaps safety programs belong under the aegis of regulatory authority, not the development side of the AEC.

In any event, given that emergency cooling is only a small part of nuclear safety technology, it would seem worth the while of Congress to take a penetrating look at the health of reactor safety research and the use of expert opinion by the AEC.

—ROBERT GILLETTE