Nuclear Safety: A Federal Adviser's Warnings Provoke Ire of Colleagues

A Berkeley mathematician serving on a federal advisory panel has publicly questioned the safety of nuclear reactors only to be slapped down by fellow panelists for allegedly misusing the committee's name and time.

The fracas broke into the open on 12 May when Keith Miller, professor of mathematics at the University of California at Berkeley, charged in a nationally televised interview that computer codes used to predict what will happen in the course of nuclear accidents are "totally inadequate to the complexity of the problem." Miller called the codes "just as reliable as tomorrow's prediction of the weather, and I wouldn't trust my life on tomorrow's prediction of the weather."

His comments drew national attention largely because of his position as a consultant to the Nuclear Regulatory Commission's Advanced Code Review Group, which is monitoring efforts by contractors to develop new digital computer codes with greater predictive power than the current generation of codes. That group became irritated at Miller's actions. In a meeting held 2 days later, the other members and consultants blistered him with a variety of criticisms ranging from naiveté to ignorance to failure to understand the mission of the review group.

The reliability of the codes is a matter of considerable importance since the safety systems in nuclear reactors have never been subjected to a full-scale integrated test. Instead, there have been tests of separate components and of small-scale integrated systems, and computer codes have then been used to predict what would happen at full scale. Some of the most widely quoted estimates of the alleged safety of nuclear reactors are based in part on the assumption that the codes do predict accurately what would happen in certain kinds of accidents.

None of the alarms raised by Miller is new. The adequacy of the codes was challenged in marathon hearings on the emergency core cooling systems for reactors held in 1971–1973 and in a number of weighty analytical reports, including one issued in 1975 by a distinguished panel assembled by the American Physical Society. These onslaughts led the Nuclear Regulatory Commission (NRC) to take some steps to tighten up its licensing requirements for reactors. But Miller's outburst reveals that the issue is by no means resolved—the fears have not been allayed.

The episode also raises questions about the appropriate attitude and conduct of members of federal advisory groups. Should they become involved in issues that lie outside the narrow scope of the work assigned to their particular committee? The group on which Miller serves, for example, is supposed to deal only with advanced codes that do not yet exist, not with the current codes or current licensing procedures for reactors. And even in the field of advanced codes, they are supposedly advising only on the development of such codes; another review group is supposed to monitor the verification studies that seek to determine how well those advanced codes correspond with what happens in reality. But what is a concerned scientist to do—put on blinders and ignore problems that lie just outside the boundaries of his advisory task? And when should he take his case to the public?

"Appalled" at Safety Claims

Miller said he decided to carry the argument beyond the confines of the review group partly because the issue had been raised for years within the NRC but was still unresolved, and partly because he was "appalled" at misrepresentations that are being spread in California during the current statewide debate there over the future of nuclear power. He was particularly disturbed by claims that an individual is "more likely to be killed by a falling meteor than by a nuclear accident" because such statements are based on computer codes that he considers unreliable.

But other consultants to the code review group, while acknowledging Miller's right to act according to his conscience, contend that he should have done so as a private individual and scrupulously refrained from dragging the name of the review group into it. Novack Zuber, the NRC official who chairs the review group, accused Miller of using the group as "a platform to voice a personal judgment." And Richard T. Lahey, Jr., chairman of nuclear engineering at Rensselaer Polytechnic Institute and a former General Electric employee, suggested that Miller was not primarily concerned about the codes but was really "bearing witness" on the broad issue of reactor safety, with one eye on the nuclear initiative scheduled for a vote in California on 8 June. "It comes through as a completely orchestrated thing," he said. "We're being used—you're using my bod." Still, once Miller had decided to go public, it is hard to see how the name of the committee could have been suppressed. Miller never claimed to speak for the committee, but press reports inevitably identified him as a member of the group since that was a major source of his expertise.

Miller first began voicing serious reservations about reactor safety at the January meeting of the Advanced Code Review Group. This is one of the newest of the NRC's 40 or so review groups; it has been in operation roughly 18 months. Four NRC officials are "members" of the group, while ten outsiders, mostly academics, are "consultants."

At the request of the group's chairman, Miller amplified his concerns in a 25 March letter. Subsequently he stumbled onto the American Physical Society's report on reactor safety and found that it voiced many of the same reservations. He also began talking with concerned experts—including individuals who had participated in the American Physical Society study group or in the Union of Concerned Scientists, the Massachusetts-based organization that had sparked the hearings on emergency core cooling systems. By early May Miller had decided to carry his concerns to a higher level. He prepared a memorandum—dated 6 May—to the commissioners of the NRC and a long letter—dated 7 May—elaborating on these concerns.

He directed his fire chiefly at the emergency core cooling systems, which are supposed to flood the reactor core in the event of an accident, thereby preventing excessive temperature rise, a meltdown of the core, and possible escape of radioactive gases on a catastrophic scale. In part, he attacked the design of the system for pressurized water reactors, asserting that it "has basic flaws which promise to make its operation only mar-

ginally effective, if effective at all." And in part he attacked the computer codes.

Miller cited a number of examples where computer codes failed to predict problems that arose in partial-scale tests, and he called it a "risky business" to rely on codes that have not been verified by full-scale tests. He urged the NRC to consider requiring "a very wide margin of safety, enough to overwhelm all aspects of our ignorance." He also urged consideration of alternate designs for emergency cooling and of full-scale or nearly full-scale testing. In his most dramatic move, he called for public hearings on the issues and for a moratorium on licensing new nuclear plants until the issues are resolved.

Miller's letter and memorandum were received at the NRC on 11 May. Copies had also been sent to other members of the review group in preparation for discussion at the group's next meeting on 13 and 14 May. But even before that group assembled, Miller arranged to be interviewed by a CBS-TV reporter for Walter Cronkite's 12 May evening news show, where he made his concerns public. The reporter buttressed the significance of Miller's warning by adding that "Five other government consultants have told CBS News they agree with Dr. Miller that the computer predictions are inadequate, but none went so far as he did in his conclusions."

Committee Repudiates Miller

When members of the Advanced Code Review Group assembled in Germantown, Maryland, the next morning, some were irritated at Miller's public crusade. Garrett Birkhoff, professor of mathematics at Harvard, who had previously written a letter suggesting that Miller's concerns should be looked into and who was one of the five consultants questioned by CBS, arrived with a written five-point explanation of what he had told CBS about where he stood on the issue. Among other things, he said he had told CBS that the committee was not ready to take a position on the issues raised by Miller, and that one mission of the Advanced Code Review Group was actually to *reduce* the safety factor required in reactor design.

That last point reflects the view of some experts in industry and the NRC who believe that current reactor licensing requirements are too restrictive and that better understanding through advanced codes will allow for some loosening. This is the exact opposite of what Miller is urging—namely, that safety margins be increased to offset possible errors in computer code predictions. By a 9 to 1 vote, with Miller the sole dissenter, the group endorsed Birkhoff's five points.

Secure in the knowledge that they had the review group's backing, NRC officials promptly scheduled a press conference the next morning—14 May—to rebut Miller's charges. Four top officials—Lee V. Gossick, executive director for operations; Herbert J. C. Kouts, director of the Office of Nuclear Regulatory Research; Bernard C. Rusche, director of the Office of Nuclear Reactor Regulation; and Stephen Hanauer, a technical adviser—told reporters that the issues raised by Miller have been considered in depth over the past decade (over 20,000 pages of testimony were taken in the 1971–1973 hearings) and that there is no reason to take the immediate, draconian steps he recommended. They also implied that Miller did not really know what he was talking about since he is a mathematician commenting on matters that, in their opinion, require engineering judgment. A prepared statement distributed by NRC even called Miller's position "unscientific."

Much to the NRC's surprise, Miller, who had learned of the press conference when he was contacted by a reporter, played hookey from the morning session of the code review group to attend the affair. He interjected a few comments during the proceedings, then, at the request of the reporters, held his own press conference immediately afterward.

That afternoon Miller returned to the final session of the code review group and, with a reporter from *Science* looking on, was barraged with criticisms and put-downs from his fellow panelists. Birkhoff, a white-haired elder of the mathematics community, and a longtime consultant to Westinghouse on reactor design, was one of the first to open fire on his 39-year-old colleague. He noted that this was only the fourth meeting of the review group and that he personally tends to be slow to take a position on subjects in which he has no background. He acknowledged that computer codes "can be treacherous if they are misused," but suggested that they can play a role if interpreted with "engineering judgment." He also decried attitudes that the reactor manufacturers are "corporate monsters trying to put something over on the rest of the nation." A nuclear disaster would put them out of business, he said, so it is in their interest to develop good codes. "I think we just have to be confident that we are working with other groups who are just as concerned as you are," he told Miller. "You can't take it on as an individual yourself. . . . It's too big a job. . . . These are very subtle things."

There was considerable debate over the alleged conservatism of the codes. NRC officials said it is important to distinguish between the so-called "realistic" or "best estimate" codes which seek to describe the actual functioning of reactors and the more conservative evaluation codes which are used in licensing reactors. In cases where there is uncertainty about the reliability of the best estimate codes, they said, the licensing codes add an element of conservatism by assuming that the safety systems will not work as well as predicted. But Miller expressed doubt about the safety margins in the licensing codes as well as about the accuracy of the realistic codes. The American Physical Society report also concluded that "in the absence of a credible description of the predicted course of an accident there is no unique way to assess whether a calculation really is conservative or not."

Argument over Testing

There was considerable opposition to Miller's call for full-scale testing, not just on the grounds that it would be very expensive, but also on the grounds that such tests are not particularly useful because they can only make a few measurements at a time. Thus, if one wants to test the system to destruction, one can do so for one postulated set of malfunctions, but one is then faced with the need to run similar destructive tests for other reactor types and other postulated malfunctions. Lahey, of RPI, said he is convinced that an integral test is "absolutely the worst test to run to get data." Miller agreed that such tests are not needed when one is obtaining data to develop a code, but he claimed that once the code is put together large-scale tests are needed to verify its accuracy.

Several panelists expressed confidence in the codes and in the safety of reactors; not one spoke up on Miller's side of the debate. The upshot of the confrontation was that Miller was asked to write yet another letter, for consideration at the group's next meeting, concerning issues that are relevant to advanced codes. His other safety worries will have to be pursued through other channels at the NRC. Miller said he hopes to "stay in the club" and continue to work with the committee. But he noted that the episode had imposed "a great deal of strain on my collegial relations." Still, he added, there comes a time when "you have to speak out on an issue like this."—PHILIP M. BOFFEY