dent a U.S. early warning satellite was "blinded" for hours by a flare from a ruptured Siberian gas pipeline. The distant early warning radars are said to have been fooled by objects ranging from migrating Arctic geese to the rising moon. So it could be undesirable for a President to order the destruction of one country, and risk the destruction of his own, on the advice of such machines. Politically, a launch-on-warning policy would raise a storm of domestic controversy, not only from arms controllers, who would worry about the dangers of such hair-trigger launches, but from conservatives, who would complain that a President confronted with blinking machines and a horrendous choice might hesitate, do nothing for 25 minutes, and lose his land-based ICBM's without striking back in return.

Finally, a solution that is, on the face of it, cheap and stable would be for both sides to defend some fraction of their land-based ICBM's from ballistic missile attack. Richard Garwin, of the IBM Corporation, has proposed an array of ingenious devices—from gravel spewed in the air around a silo to a pole fence that would disable an attacking warhead so that it would fall to the ground a dud. Pentagon research into ballistic missile defense, which is allowed under international agreements, suggests other more conventional schemes.

The complication, however, is that under the landmark 1972 SALT I treaty on ABM, each side is permitted to build ballistic missile defenses at only one site. Deployment of any kind of ABM at the missile sites would require modification of the treaty.

But it is likely that any moves by the Administration to reopen the ABM treaty would rattle the foundations of arms control itself. The landmark document prohibited a twist in the arms race that was at least as destabilizing as the threat of absolute ICBM accuracy. As the State Department's SALT brochure says, the treaty prevented both sides from building themselves "bullet proof vests" that could tempt either to launch a first strike in the belief that it was invulnerable. Politically, U.S.-Soviet relations have been so strained recently that it is questionable whether a treaty signed in the mellower days of détente, if reopened for negotiation, would itself survive. So the proposal to move to ballistic missile defense, while appearing in some sense cheap, may have a heavy price.

Clearly, the military and political quandary posed by the inevitable improvements in U.S. and Soviet ICBM accuracy is generating a fertile field of solutions. But many of the solutions, whether they entail turning over an area the size of Connecticut for a new ICBM system or reopening a landmark treaty, will have important and independent consequences. So, as the policy-makers seek to avoid a world of absolute accuracy, they should give equal thought to what the alternative worlds would be like.—DEBORAH SHAPLEY

NRC Panel Renders Mixed Verdict on Rasmussen Reactor Safety Study

The old Atomic Energy Commission's Reactor Safety Study (RSS), intensely controversial ever since the first draft of it was issued in 1974, has now come under a severely critical but not entirely unfavorable judgment by a review panel appointed by the Nuclear Regulatory Commission (NRC), a successor agency to the AEC.

The panel, in its recent report to the NRC, concluded that the RSS—known as the Rasmussen study after MIT professor of nuclear engineering Norman C. Rasmussen who chaired it—failed to arrive at a convincing assessment of the probability of major nuclear accidents occurring. It also concluded, however, that the RSS was a useful pioneering effort to apply fault-tree/event-tree analysis* to the extraordinarily complex nuclear reactor systems.

The Rasmussen study was issued in final form about 3 years ago as the culmination of an effort commissioned by the AEC in 1972 to put to rest the then growing controversy over reactor safety. The Union of Concerned Scientists and other groups and individuals critical of nuclear power have denounced it as grossly misleading in its conclusion that the chances of a catastrophic nuclear accident are almost vanishingly small.

Last spring a year ago, the NRC, with encouragement from the House Subcommittee on Energy and the Environment chaired by Representative Morris Udall (D–Ariz.), established the RSS review panel and named Harold W. Lewis of the University of California at Santa Barbara to head it. Included among the seven panel members were some individuals who had been critical of the RSS and some who had defended it.

Lewis himself had chaired the American Physical Society (APS) study group which in 1975 issued a report that expressed no confidence in the "absolute values" as to risks set forth in the RSS draft report. Frank von Hippel of the Center for Environmental Studies at Princeton University, also a member of the APS study group, had been an outspoken critic of the RSS. On the other hand, the panel included persons such as Walter B. Lowenstein, director of nuclear safety analysis for the Electric Power Research Institute (an entity created and supported by the utility industry) and Herbert J. C. Kouts of the Brookhaven National Laboratory, who was director of the AEC's reactor safety research division at the time the Rasmussen study was under way (with one of Kouts's deputies serving as staff director).

In view of this diversity of attitudes and backgrounds represented on the Lewis panel when it began work in August 1977, the degree of consensus finally achieved is remarkable. The panel members were, in fact, unanimous in their principal conclusions, which were:

- The "absolute values" of risk set forth in the RSS are far less accurate than claimed and "should not be used uncritically either in the regulatory process or for public policy purposes." According to the panel, the estimates of risk might be either high or low (it could not determine which), for the error bounds are in general "greatly understated." This is true, the panel said, because of inadequacies in the data base, an inability to quantify "common cause failures" (a breakdown of several discrete systems as the result of an event such as a fire or earthquake), and "some questionable methodological and statistical procedures."
- The RSS has succeeded in providing a "logical framework for the discussion of reactor safety, information about the

*Event-tree analysis begins with a particular event and then traces forward in causal sequence along the paths that derive from it. Fault-tree analysis is similar, except that the analysis proceeds backward in time from an event to trace the connections and discover the circumstances which may have led to it.

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relative probabilities of various accident sequences, and the beginning of an effort to provide absolute probabilities." The panel concluded that much greater use could be made of the RSS methodology in identifying critical safety hazards and hence in readjusting regulatory priorities. For instance, it said that whereas the RSS had identified human error (among other things) as an important contributor to overall risk, this was not yet adequately reflected in the priorities of the NRC's research and regulatory groups.

But the panel cautioned against trying to apply the RSS methodology where adequate data are lacking, and, in briefing the NRC on its findings on 7 September, Lewis and the other panel members indicated that to attempt to redo the RSS now would be a bad idea.

The panel characterized the RSS as sorely lacking in "scrutability," by which it meant that to try to follow any of the particular fault-tree/event-tree analyses from beginning to end tends to be a baffling and frustrating experience. This inscrutability had interfered with peer review of the RSS and lessened confidence in it by the technical community, the panel indicated.

But the panel suggested that controversy surrounding nuclear power is such that peer review of an AEC or NRC report on reactor safety would have been a troubled process at best. " . . . [In] the area of reactor safety, a peer comment has come to mean anything written by anybody asserting anything about anything," the panel said. In addition, part of the NRC staff was said to have drifted into a stance which can at best be described as defensive, and at worst as a "seige mentality."

The only dissent voiced by a member of the Lewis panel had to do with a section of the panel's report addressing an accusation by the Union of Concerned Scientists (UCS) that the RSS was intellectually dishonest. It discussed in some detail a specific complaint by the UCS that the Rasmussen study group had "suppressed" or omitted from its report an entire section on quality control showing "either the unreliability of reactor safety systems or the indeterminacy of that question."

The panel found the accusation to be without merit. But von Hippel dissociated himself from this part of the report because, as he explained to *Science*, he felt that if the panel was going to go into the question of intellectual honesty at all, its finding in this respect should deal with the RSS as a whole. Von Hippel said there were a number of things about the executive summary and main body of the study that troubled him.

For instance, he said, there was the fact that, despite criticism on this point from peer reviewers, graphs in the final report's executive summary still failed to note that the few deaths shown for reactor accidents did not include the hundred times larger number of cancer deaths which had also been calculated in the study. (The panel itself characterized the summary as a "poor description" of the report and as lending itself to misuse.)

Nevertheless, von Hippel did go along with other panel members in accepting a summary prepared by Lewis which commended the RSS as a "conscientious and honest effort" to apply fault-tree/event-tree analysis to reactor safety. Von Hippel told *Science* that he suggested using a term such as "monumental effort" instead, but, when Lewis insisted on his choice of words, "I went along with it because I did not want to be put in the position of saying the report was dishonest."

All five members of the NRC were present to hear Lewis and other panel members discuss their findings and recommendations, and, to all appearances, their report was well received. The kind of uncritical acceptance the Rasmussen study once enjoyed may be a thing of the past. Certainly it would be awkward for any of the commissioners to do as Marcus Rowden (a former NRC chairman) did in a speech 2 years ago and confidently state that "the risks from potential nuclear accidents would be comparable to those from meteorites."

—LUTHER J. CARTER

Califano Reviews New DNA Rules

Significant changes in the administrative parts of the NIH's revised recombinant DNA guidelines may be made as a result of a hearing held on 15 September by HEW general counsel Peter Libassi.

The revised guidelines have already been publicly reviewed by NIH director Donald Fredrickson (*Science*, 6 January), but a second review was ordered by HEW Secretary Joseph Califano. Libassi said Califano had asked that special attention be paid to the procedures for administering and revising the guidelines, to the mechanism for creating exemptions, and to the membership of the NIH and local committees that supervise the research.

The hearing took place at a juncture when the steam finally seemed to have escaped from Congress's effort to legislate, leaving the initiative with the Administration. A sign of the Administration's strength was a letter sent on 12 September by Califano to Senator Edward Kennedy, in reply to a suggestion that Section 361 of the Public Health Service Act be invoked as the basis for regulating recombinant DNA. Regulation under Section 361 is now the least preferred of the NIH's options, and Califano told Kennedy he did not intend to use it. Since Congress now seems unlikely to pass a bill, the way is clear for a continuation of the NIH's semivoluntary approach, an outcome that few would have predicted a year ago.

The witnesses before Libassi fell into two main groups. Scientific representatives, such as Harlyn Halvorson of the American Society for Microbiology and W. J. Whelan of the International Council of Scientific Unions, stated that the proposed revisions were amply justified by new assessments of the risk. Representatives of public interest groups, such as Leslie Dach of the Environmental Defense Fund and Pam Lippe of Friends of the Earth, focused on the regulatory aspects of the revised guidelines. "EDF is concerned that the poor quality of the drafting of the guidelines will result in confusion and compliance failure," Dach said.

The regulatory quality of the guidelines is also criticized in the long-awaited report by Senator Adlai Stevenson's science and space subcommittee. A perceptive analysis of the various issues, the report endorses the main thrust of the guidelines. Yet, it says, "The NIH's lack of experience in regulation is indicated by the ambiguity of the guidelines' procedural provisions, by the guidelines' failure to establish clearly the responsibilities of institutions, institutional biohazards committees and investigators, and by the absence of any mention of procedures to investigate and correct violations."

Although the report was referring to the existing guidelines, its chief author, committee staff member Steven Merrill, says the revised version is little better. Stevenson is likely to offer Califano suggestions for improvement, such as clarifying the responsibilities of institutional committees and specifying who should do what in the case of violations.—N.W.

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