

Rasmussen Issues Revised Odds on a Nuclear Catastrophe

In the summer of 1974, the Atomic Energy Commission (AEC) made public a draft of the most comprehensive study ever undertaken to assess the risks of an accident in commercial nuclear power plants. The study, which was directed by Norman C. Rasmussen, professor of nuclear engineering at the Massachusetts Institute of Technology, concluded that the risks inherent in reactor operation are comparatively small (*Science*, 6 September 1974).

Subsequently, some 90 organizations and individuals submitted comments on the draft—about 1800 pages worth in all. Many of the comments, including some of the most extensive and most carefully formulated, were highly critical of the study's risk estimates and methodology.

Those criticisms have now been digested by the study group and by the Nuclear Regulatory Commission (NRC), which took over the regulatory functions of the AEC when the latter agency was abolished early this year. At a press conference at NRC headquarters on 30 October, Rasmussen presented the final version of the report* and explained some of the revisions made as a result of the criticisms. The upshot is that, while the study group has yielded to the critics on a number of details, it insists that such changes "do not change the basic conclusion of the draft report that reactor risks are relatively small compared to other societal risks."

The chances that an individual would be killed in a nuclear reactor accident if there were 100 plants in operation—the number anticipated for the United States by about 1980—are described as 1 to 5 billion. By comparison, an individual is given a 1 in 2.5 million chance of being killed by a hurricane and a 1 in 2 million chance of dying by lightning. Death by air travel is rated a 1 in 100,000 risk, while the chance of dying in a motor vehicle accident is 1 in 4000.

The study report stresses that it "made no judgment on the acceptability of nuclear risks." But William A. Anders, chairman of the regulatory commission, drew the lesson the nuclear advocates were hoping for. "The report reinforces the commission's belief that a nuclear power plant designed, constructed and operated in accordance with NRC's comprehensive regulatory requirements provides adequate protection to public health and safety and environment," he said.

How well that conclusion will sit with the nuclear critics remains to be seen. Few, if any, have thus far had a chance to read even the main report, let alone the 11 technical appendices which discuss the methodology and assumptions in detail. The appendices have not yet been widely distributed.

The way in which the report was released has already miffed some of the critics. As Thomas B. Cochran, of the Natural Resources Defense Council, put it: "Rasmussen has done it again. He did the same thing with his draft document. He's published the results before he tells you what his assumptions were. I have very little regard for this kind of operation. The assumptions won't be available until they've had time to hawk the results around."

John Abbotts, of the Public Interest Research Group, one of Ralph Nader's enterprises, said that, to judge from a quick reading of the main report and a peek at one of the appen-

dices, it looks as though the Rasmussen group has not specifically rebutted estimates by an American Physical Society study that the number of fatalities in a major accident would be much higher than Rasmussen originally estimated.

A press release issued with the final report says that it differs from the draft version in only "minor respects" in its estimates of the probability that various accidents will occur. But the sections on the likely consequences of those accidents have been "substantially revised," generally in the direction of increasing the estimates of the damage that would ensue.

Thus the final report estimates that the worst case accident would cause 3300 early fatalities, up from 2300 in the original draft; 45,000 cases of early illness, up from 5600; and \$14 billion in property damage (due to contamination), up from \$6.2 billion. Long-term health effects from that same accident are estimated as 1500 latent cancer fatalities per year, up from 110 in the first draft; 8000 thyroid nodules per year, up from 2800; and 170 genetic effects per year, up from 106.

Despite these upward revisions of the consequences, the odds against a major catastrophe remain—almost literally—astronomical, according to the study. Thus it is predicted that a group of 100 nuclear plants would experience an accident involving 1000 or more fatalities only once in every 1 million years—the same probability that a meteorite impact would kill that same number. For the worst case accident to occur, there would have to be a meltdown of the fuel in the reactor core (with 100 reactors operating, the odds of such a meltdown are 1 in 200 per year), followed by a major release of radioactivity with the wind blowing in the direction of a dense population concentration.

Although a large electrical fire at the Brown's Ferry Nuclear Power Plant has recently attracted considerable attention as an example of equipment unreliability at nuclear plants, the Rasmussen group concludes that the odds that such a fire would lead to a core melt (it did not in this case) were too low to affect their results significantly.

The methodology used by the study, involving "event tree" and "fault tree" analysis developed for predicting the reliability of space and military systems, has been challenged by some critics. But Rasmussen told the press conference that estimates developed with the methodology match well with actual experience in those cases where operating data exist. He also said that the National Aeronautics and Space Administration and British atomic energy officials, who have pioneered the use of this type of analysis, have reviewed his approach and have concluded it is a valid use of the methodology. That may be overstating the case. The space agency, for example, called the methodology "an effective technique" but said it was "not in a position to validate the numerical assessments in the Rasmussen study because of the extensive efforts such a validation process would require."

The Rasmussen study took 3 years to complete, involved 100 or more people, and cost some \$4 million. Many of the key personnel worked for the Atomic Energy Commission or the national laboratories associated with it, leading some critics to challenge the study's independence. The study focused on water cooled reactors of the present generation. It did not analyze the risks of breeder reactors, the likelihood of catastrophes from sabotage or acts of war, or the risks involved in other elements of the fuel cycle, such as transportation and waste disposal. —PHILIP M. BOFFEY

**Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants. Main Report* (WASH-1400, Nuclear Regulatory Commission, October 1975). Single copies of the executive summary may be obtained from Saul Levine, Nuclear Regulatory Commission, Washington, D.C. 20555. Copies will be available for purchase about 1 December from the National Technical Information Service, Springfield, Virginia 22161.