Nuclear Safety: Calculating the Odds of Disaster

So remote was the chance of a nuclear power plant suffering a catastrophic accident and endangering nearby populations, the former chairman of the Atomic Energy Commission (AEC), Glenn Seaborg, wrote several years ago, that "it is not possible to make a sensible estimate" of the risk of living near a nuclear plant.

Seaborg's opinion reflected the prevailing wisdom of the time, but times have changed. To be sure, the AEC still thinks the risks inherent in reactors are vanishingly small. But amid continuing public unrest over the safety of nuclear generating plants—an unrest fed partly by the strident opposition of consumer advocate Ralph Nader—the AEC has invested 2 years and roughly $3 million attempting to calculate once and for all the probability of a catastrophe that has never happened and, the AEC believes, almost certainly never will.

The result of this effort strongly reinforces the official view that nuclear power plants make safe neighbors. In a news conference on 20 August, the AEC released a draft version of its 11-volume risk analysis,* and in the report, as commission chairman Dixy Lee Ray expressed it, the nuclear industry "comes off pretty well."

The study concludes that, even with 100 nuclear power plants in operation (as is expected in the early 1980's), the chance of an accident severe enough to kill 100 persons is far less than the chance of an airplane crash of similar magnitude. A nuclear disaster large enough to kill 1000 persons is said to be about as likely as the same number of deaths caused by a large meteor—an annual chance of about one in a million.

In its most general terms, the report's main conclusion is that potential hazards of nuclear power plants do exist but that they are "smaller than many other man-made and natural risks." From fires and explosions to hurricanes and toxic gas releases, all of the nonnuclear accidents examined are said to be "much more likely to occur and can have consequences comparable to or larger than nuclear accidents."

Apart from its sheer weight and cost, the risk report is noteworthy for several reasons. It is the first major attempt by the AEC to substitute hard and fast numbers for engineering intuition—to give substance to airy assertions that the hazards of nuclear power were "acceptably low" or "negligible," in the official language. This is also the most direct effort the AEC has made to answer critics who contend that the chances of a nuclear plant running out of control and dispersing lethal radioactivity over wide areas are not negligible at all. Thus the study's technical merit and the objectivity of its authors will come under close scrutiny by the critics in the next few months.

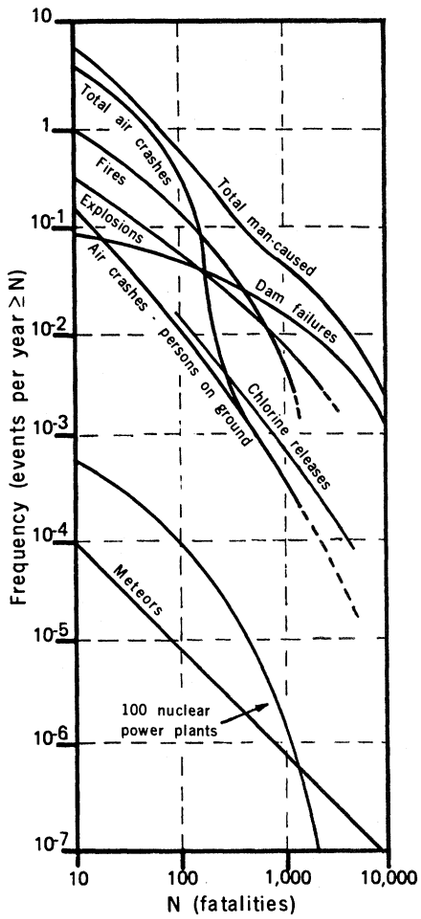

Chart adapted from AEC report compares the probability of accidents in nuclear plants with natural and other man-made disasters.

Norman C. Rasmussen, a professor of nuclear engineering at the Massachusetts Institute of Technology, directed the study, although most of the work was done at the AEC's headquarters near Germantown, Maryland. Sixty persons contributed to it, including staff director Saul Levine and nine other AEC employees, and an unspecified number of researchers at the AEC's national laboratories.

An AEC news release described the efforts as an "independent study," a characterization that was quickly challenged by nuclear critics. "I don't know how anyone could call this an independent report in any ordinary sense of the word," said Henry Kendall, a nuclear physicist at Massachusetts Institute of Technology and a leader of the Union of Concerned Scientists (UCS), a small, Cambridge-based group that has been among the AEC's most trenchant critics and which also provides technical advice to Nader. Kendall said that the UCS was trying to organize a group of five to eight professionals to review the Rasmussen study, but that any such effort by a small, outside group would be severely hampered by a lack of money.

In past years there have been numerous instances in which AEC officials appeared to go beyond the bounds of normal editing and pressured employees or contractors to tone down or otherwise modify sensitive reports on matters of nuclear safety. No such instances have come to light during Ray's 2 years as chairman, however. And during the news conference she and Rasmussen adamantly denied that any attempt had been made to force predetermined results from the new safety study.

"We were not told in any way how the conclusions should come out," Rasmussen said. And Ray said it would be a "serious charge" to suggest that "just because the commission paid for it, it can't be objective."

Rasmussen and his staff relied heavily on a methodology called "fault-tree analysis" developed primarily by the aerospace industry for predicting the effects of failures of small components

* *An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants*, WASH-1400 (U.S. Atomic Energy Commission, August 1974). Copies available from the National Technical Information Service, Springfield, Va. 22151

on large, complex systems. Thousands of possible sequences of reactor failures were assessed by computer for their probability and for their ultimate effects stated in terms of radioactivity released, casualties caused, and property damaged.

A major focus of the study was the much discussed loss-of-coolant accident or LOCA. A LOCA begins with a sudden break in a main pipe carrying cooling water to a reactor's hot core of uranium fuel. Critics of the AEC have contended that the commission has never adequately tested the backup safety systems—especially the emergency cooling systems of power plants—to ensure that a LOCA would not lead to melting of a reactor core, penetration of the massive containment dome surrounding the reactor, and dispersion of lethal fission products over a wide area.

The Rasmussen study found that, as the hypothetical severity of such an accident increased, its probability decreased. At one extreme, the annual chance of a core meltdown could reach 1 in 17,000 but would involve no more than one death and $100,000 in property damage beyond the nuclear plant site (the reactor itself might be a multimillion dollar loss and casualties could occur to workers on the site). At the other extreme—the "bottom line," as Rasmussen put it—would be a core meltdown, followed by failure of all backup safety systems: all during the worst possible weather conditions. This, Rasmussen said, could lead to some 2300 fatalities, $6 billion in property damage, and the permanent contamination of 31 square miles of land around the reactor. But this accident's probability is rated at only 1 in 10 million.

The study has its limitations, as Ray and Rasmussen readily acknowledged. It applies only to present designs of light water reactors and not to other elements of the nuclear fuel cycle. It does not take into account the possibility of sabotage, although Rasmussen said a saboteur could not cause an accident more severe than the ones considered in the study. The possibilities of human error in operating a nuclear plant were factored into the calculations, but the possible presence of fundamental design errors in safety systems could not be predicted, Rasmussen said.

He nonetheless declared the study to be "the most careful and definitive assessment" of risks associated with nuclear plants that had ever been done, and Ray agreed. Early next year, after reviewers' comments have been studied, the commission will issue a final report representing "the definitive position of the AEC," she said. The report avoids directly answering a central policy question—how safe is safe enough? But Ray left the clear impression that accident probabilities put forward in the Rasmussen report mean that nuclear power is indeed safe enough.

—ROBERT GILLETTE

Dalkon Shield Affair: A Bad Lesson in Science and Decision-Making

Months of confusion and doubt about the Dalkon shield intrauterine device (IUD) are winding down to an unsettling end. Throughout a summer of uncertainty about the safety of the shield, people were anticipating a full-dress public hearing on the evidence. That hearing, which drew about 200 persons, was held during the third week of August at Food and Drug Administration (FDA) headquarters in the Parklawn building in Rockville, Maryland. By the conclusion, a special FDA panel was persuaded that sales of the shield continue to be temporarily suspended. From information gathered since the voluntary suspension of sales and distribution by the manufacturer in late June, the FDA disclosed at the recent hearings that the original number of serious problems presumably associated with the shield had about doubled, the total now being 11 deaths and 209 infected abortions.

But ambiguities still color a respectable scientific appraisal of the safety of the shield by the Center for Disease Control in Atlanta, in spite of the panel's action. Whether the shield is any worse than other devices has yet to be firmly established. Further clouding the issue is the indisputable fact that both the pill and pregnancy are more dangerous than IUD's in general, including the Dalkon shield. Unsubstantiated doubts and rumors guided public officials and other influential people who made public statements during recent months about the shield, producing a fragmented, often contradictory running commentary in the press.

Between the morning news and the usual string of local advertisements, radio stations early this summer were broadcasting a public service announcement of sorts, a recall for Planned Parenthood patients. The family planning organization whose nationwide clinics provide women with various types of contraceptives was asking that all its patients who had been fitted with the Dalkon shield turn themselves in for a checkup, and possibly a new contraceptive.

On 23 May, on the orders of Dr. Celso-Ramon Garcia, then chairman of its national medical committee, all Planned Parenthood centers stopped prescribing the shield. On 29 May, after a full meeting of that committee in Washington, D.C., the antishield directive was reissued with a recall clause. It said not only that no new shields should be inserted but that women wearing them should be advised to have them removed because of a "serious risk to their health in the event that they should become pregnant with the IUD in place and choose to continue that pregnancy."

The Planned Parenthood recall was apparently inspired by a "Dear Doctor" letter that A. H. Robins Company of Richmond, Virginia, had sent to some 120,000 physicians. That letter, dated 8 May, was not mailed until the middle of the month and not announced publicly until the end of the month. As far back as last February, Robins officially acknowledged reports that its product might be hazardous. Specifically, the company's advisory panel on family planning and birth control met to discuss reports that there was an unusually high incidence of midtrimester