Recalculating the Cost of Chernobyl

A new DOE study anticipates 39,000 extra cancer deaths because of the accident, most of them outside the Soviet Union

EUROPE, not the Soviet Union, is likely to be most affected by the medical consequences of Chernobyl's fallout, according to a new study sponsored by the Department of Energy (DOE). Twenty-one thousand Europeans may die of cancer in the next 50 years because they were exposed to radiation from the accident. That is nearly twice the number of victims projected in the U.S.S.R.

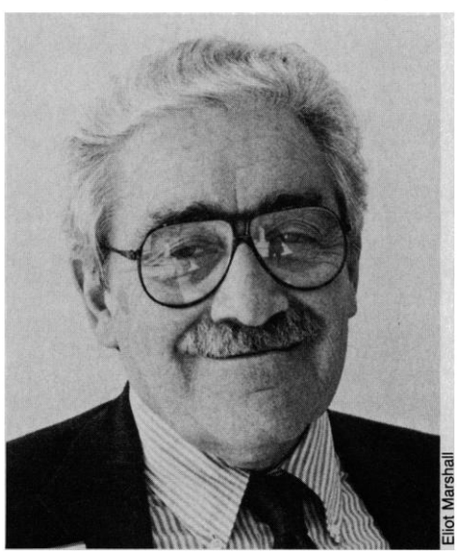
The estimated cancer deaths for Europe are five times greater than the number given in a U.S. interagency report released in February and considerably higher than the figure used by European governments. There is no significant change in the expected impact on the United States, which remains virtually nil.

The new numbers, reported on 29 April at a meeting of the American Occupational Medical Association in Philadelphia, have already been criticized as too high. Oddly, the criticism comes from an agency that is often accused of inflating risks itself: the Nuclear Regulatory Commission. In this case, the roles are reversed. The safety enforcer is playing down the hazards, and DOE, the friend of nuclear power, is playing them up.

The sponsor of this report, DOE's office of health and environment research, has set no date for its release. But the chief author, Marvin Goldman of the University of California at Davis, gave a preview to nuclear industry physicians in April. His coauthors are Lynn Anspaugh of the Lawrence Livermore National Laboratory and Robert Catlin of the Electric Power Research Institute.

Goldman says that all earlier reports have a key weakness: they rely heavily on radiation data provided last summer by the Soviets. The information was good, he says, but limited. The Soviets halted their analysis at the border and apparently did not report on debris that went high into the atmosphere. It was obvious, however, that fallout went aloft, crossed the border, and spread around the Northern Hemisphere. The question is, how much? To get a full picture of the radioactive cloud and its impact, Goldman and his colleagues combined the Soviet data with a meticulous collection of readings from outside the U.S.S.R. and then matched them with a computer model.

The global perspective is what sets the DOE report apart, according to Goldman. He thinks its account of fallout beyond the U.S.S.R. is the most complete and sophisticated so far. It incorporates surface radiation measurements from 15 nations, including fortuitous ones, such as a reading from the Arabian Peninsula taken by a former student of Harvard physicist Richard Wilson. It uses atmospheric measurements from five sources, including some from 10 kilometers aloft taken by the Polish air force. These measurements were used to test a global model of the fallout cloud created by a computer model known as PATRIC, based at the Lawrence Livermore National Laboratory.



Marvin Goldman. *Chernobyl's fallout was a bit less than from all weapons tests.*

PATRIC uses U.S. Air Force weather data to produce a three-dimensional image of radioactive debris moving in space and time. Its results were compared to those from two European models, one based at Bilthoven in the Netherlands (GRID) and the other at the Imperial College, London (MESOS). PATRIC performed brilliantly, according to Goldman. It came close—within a factor of 2 or 3—to predicting most of the measurements collected at distant locations and at various altitudes.

The most significant result is that fallout containing cesium-137, which has a half-life of 30 years, is estimated to be three times greater than others have assumed. Goldman says that roughly 1 million curies fell within Soviet borders, another 1 million curies fell on the rest of Europe, and a final 1 million curies spread throughout the Northern Hemisphere. The total amount ejected is comparable to, but slightly less than, the fallout from all atmospheric weapons tests.

The higher numbers for cesium increase the radiation dose estimates. Another aspect of DOE's analysis increases the expectation of cancer deaths. This is the choice of a "risk factor" to convert radiation doses to deaths. The process by which radiation causes cancer is not fully understood, and data on low-dose effects are sketchy. The choice of a risk factor is based in part on science but also on intuition. Debates on this subject, as Goldman says, are intense because they are conjectural—like medieval disputes on the number of angels that can fit on the head of a pin.

The Soviet Union used a risk factor of 1 fatal cancer per 10,000 person-rem of radiation exposure, a United Nations benchmark set in 1977. (The figure for person-rem represents the level of exposure—0.1 rem per year being the natural background level—multiplied by the number of exposed individuals.) The U.S. Environmental Protection Agency, author of the relevant chapter in the U.S. interagency report earlier this year, used a factor of 2 fatal cancers per 10,000 person-rem. DOE went further. It used the latest epidemiological data assembled in a study by the National Institutes of Health in 1985. According to one of the editors, Seymour Jablon of the National Academy of Sciences staff, this study represents "the state of the art." From these data, DOE derived a risk factor of 2.3 fatal cancers per 10,000 person-rem. Arthur Upton of New York University, chairman of the newest National Academy of Sciences radiation study panel, says 2.3 is a reasonable number to use and that this coefficient will continue to "creep upward" because late-appearing cancers from the bomb blasts in Hiroshima and Nagasaki are sending risk estimates upward.

Using the new risk factor boosts the extra cancer deaths in the European U.S.S.R. from 10,000 to 12,000. In global terms, it boosts the extra in cancer deaths from 14,000 to 39,000. The epidemic will be invisible, however, for it will be lost in a sea of 630 million cancer deaths. Furthermore, Goldman points out, the data do not rule out the possibility that the cancer increase will be zero.

One critical comment comes from the staff of the Nuclear Regulatory Commission, which was responsible for estimating global cesium pollution in the U.S. interagency report. Harold Denton, director of the office of nuclear reactor regulation, wrote on 14 April that the new DOE report is "substantially different from" earlier ones and could "create more confusion" if published as it stands. Denton recommended that it be withheld for a peer review lasting "at least 60 days."

Goldman is impatient to have the study see daylight, however, and he says that government officials including Denton have had months to study and criticize the findings. So far, he claims, they have not raised any substantive objections.

Another recent development annoys Goldman. Robert Gale, the U.S. bone marrow specialist who treated victims of the reactor accident last year, has been quoting data from this new report in TV appearances before its release and without naming DOE as a source. Goldman wishes Gale would share the limelight, and grumbles that he "got a lot of exposure at Chernobyl—but not from radiation."

Gale, who has said the accident will cause between 2,500 and 75,000 new cancers, claims that his estimate rests on a "review of several sources," including the DOE report and unpublished data in the hands of Soviet scientists. However, he adds, "If I had to pick one study as the best researched," it would be DOE's.

Both Gale and Goldman say that a unique opportunity to test the estimated radiation doses and cancer risks will present itself in the next year. It is important, they say, to set up a system to monitor the health of the evacuees from Chernobyl. The records from Hiroshima and Nagasaki show that exposure to a well-defined amount of radiation leads within 48 months to an increase in specific types of leukemia and chromosome abnormalities. In the U.S.S.R., a careful reading of the early leukemias will tell a great deal about what is likely to happen over the next 50 years. According to Gale, the Soviets have begun to organize a monitoring program that will include U.S. participants. The details have not been worked out. ■ ELIOT MARSHALL

Soviets Disinvited to Join Drilling Program

An invitation to join the international Ocean Drilling Program has been withdrawn because of objections by DOD

In December 1985, the Reagan Administration appeared ready to reestablish an important scientific link with the Soviet Union. Erich Bloch, the director of the National Science Foundation, wrote to the head of the Academy of Sciences of the U.S.S.R. to ask whether the Soviet Union would care to join the Ocean Drilling Program (ODP), a major international research effort to probe the geology of the earth's oceanic crust.

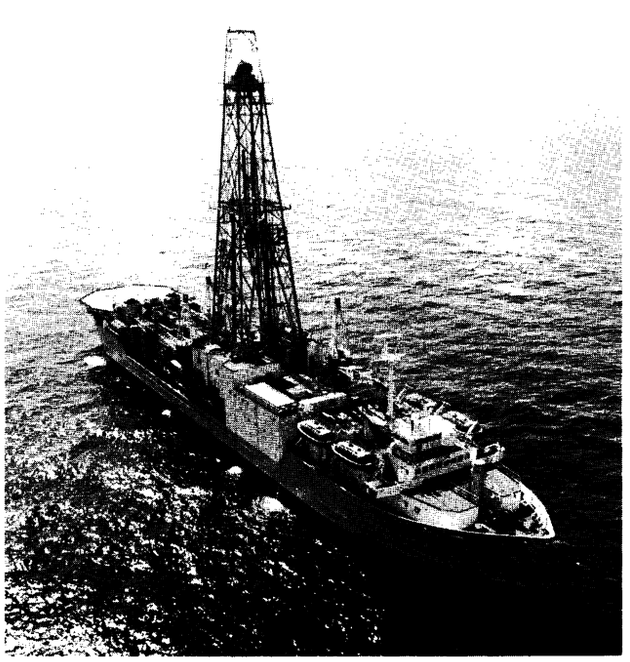
The Soviet academy had participated in the previous Deep Sea Drilling Program, but was frozen out when political relations between Washington and Moscow chilled in the early 1980s. The Soviets were evidently eager to get back in. The invitation to join the ODP was accepted last October, and a formal agreement was quickly drawn up.

On 29 April, however, Bloch was forced to notify the Soviets that the agreement could not be signed and that the invitation has been withdrawn. In a cable to Gury Marchuk, the new president of the Soviet academy, Bloch said: "I regret to inform you that we will not be able to conclude the agreement on cooperation in the Ocean Drilling Program." No reason was given. The cable stated only that "The Administration has determined that we should not go forward with this program at the present time."

Bloch was placed in the embarrassing position of withdrawing an accepted invitation because officials in the Department of Defense opposed it late in the game and mashalled heavy forces to shoot the agreement down.

The Ocean Drilling Program is a multinational endeavor involving the United States, France, West Germany, Canada, Japan, the United Kingdom, and several smaller European countries that participate through the European Science Foundation. The United States provides about $20 million a year through NSF and the other members each pay annual dues of $2.5 million. The program is headquartered at Texas A&M University and it is centered around a sophisticated drilling vessel, the JOIDES *Resolution*.

Bloch was given a green light to open discussions with the Soviet academy after an interagency committee reviewed the idea and raised no objections. Soviet member-



JOIDES *Resolution*

The Defense Department objects to Soviet participation in the ODP because the drill ship is equipped with advanced technologies, but the Administration refuses to say what it is specifically concerned about. Others say there is nothing on the ship the Soviets do not already have.