The 135,000 people evacuated from the 30-kilometer zone represent a population roughly equivalent in size to the survivors of the atomic bombs dropped on Nagasaki and Hiroshima, who have been followed for four decades. Data from the atomic bomb survivors provide much of the basis for current cancer risk estimates.

From a scientific point of view the most important group to study may be the 24,200 people evacuated from within 15 kilometers of the plant. According to Soviet data, they received radiation doses ranging from 35 to more than 50 rems, a level of exposure that is likely to result in a statistically significant increase in cancer mortality. According to rough calculations performed by Jablon, application of the range of risk factors in the BEIR report indicates that excess cancer deaths in this population will be between 130 and 625 (a range that says a lot about the uncertainties).

Any long-term follow-up will require accurate assessments of individual doses. Soviet scientists have already distributed cards to the evacuees asking them to describe where they were at the time of the accident, but accurate dose estimates will require a battery of complex and costly cytogenetic tests. These are aimed at detecting chromosome aberrations, which correlate with degree of exposure.

Several suggestions were put forward privately at the meeting for an international effort to conduct the cytogenetic analyses, and various mechanisms to provide international advice on conducting the follow-up studies were discussed. No formal agreements were reached, however.

One concrete development that has occurred since the accident is that Soviet officials have decided to modify some features of the type of reactor that exploded at Chernobyl. Valeri Legasov, the head of the Soviet delegation to the meeting, said that about half the 27 reactors of the Chernobyl design are currently shut down for temporary fixes. These will include the addition of controls that will make it impossible for operators to override safety systems.

In addition, the reactors will be equipped with a safeguard to ensure that control rods are partially inserted in the core at all times. One of the major contributing factors in the Chernobyl accident was that virtually all the control rods were withdrawn in an effort to stabilize the power output before the experiment. Finally, in order to reduce the possibility that the power output from the reactors can surge uncontrollably, Soviet reactors will eventually use more highly enriched fuel. ■

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EPA Proposal on Alachlor Nears

A 2-year investigation into the safety of the country's most widely used herbicide comes to a head

In 1984, the Monsanto Company received some unwelcome news about alachlor, one of its most profitable products and the most widely used herbicide in the country. In two Monsanto-sponsored studies, laboratory animals that were fed alachlor developed cancer. The findings raised serious questions about the herbicide's safety for farmers and other users. Only after careful study did the company conclude that the concern was unwarranted because the rodents in the studies were unsuitable for predicting cancer hazards to humans.

The Environmental Protection Agency (EPA) looked at the same studies and reached a different conclusion, however. It temporarily imposed tighter restrictions on alachlor's use. It also set in motion an intensive safety review that will come to a head in the next month. Whatever regulatory action EPA proposes—whether to tighten the temporary restrictions or merely to make them permanent—is likely to be controversial.

EPA is primarily worried about alachlor's potential hazards to the more than 1.3 million people in the farm community who handle it. Agency officials are also concerned that the general public might be at risk from drinking alachlor-contaminated water. The herbicide has now been detected in surface and ground water in several states, but mostly at low concentrations.

Alachlor effectively kills grassy and broadleaf weeds and has been marketed by Monsanto since 1969 under the trade name Lasso. According to EPA estimates, 90 to 95 million pounds are applied each year in the United States, primarily by corn and soybean farmers.

Monsanto is fighting to protect its product, whose sales for 1986 are expected to reach $320 million. The company submitted 20 volumes of documents to EPA, including detailed risk assessments and a lengthy analysis of alachlor's economic benefits. One of Monsanto's major arguments is that stringent alachlor regulations will severely disrupt the country's farm economy because the product boosts corn yields by as much as 4 bushels an acre more than other herbicides.

But environmental groups, including the National Audubon Society, and Charles Benbrook, executive director of the Board on Agriculture at the National Academy of Sciences, counter that reasonable alternatives to alachlor are available. They say that another herbicide, metolachlor, is less hazardous and equally effective. Maureen Hinkle of the Audubon Society also argues that alachlor is not needed because corn is already in vast surplus.

According to EPA scientists, one of the greatest challenges has been to make a reliable estimate of the cancer risk to alachlor users. In 1984, EPA categorized alachlor as a "probable human carcinogen" based on the Monsanto studies. Most agency scientists believe that alachlor is a potent carcinogen because the cancers appeared in separate animal species, rats and mice. In addition, the rats developed several different types of cancers, including a rare nasal tumor, and some cancers occurred at relatively low doses. One nasal tumor appeared in a rat fed a dose as low as 2.5 milligrams per kilogram.

But human exposure has been particularly difficult to calculate. In 1984, an EPA report on alachlor said that the increased cancer risk to applicators is as high as 1 in 1000 based on 30 days of exposure per year over a lifetime. Since then, new data have been collected, which, according to EPA staff, suggest that users face less of a hazard than previously believed.

Laboratory experiments sponsored by Monsanto indicate that alachlor is not absorbed through the skin as readily as EPA had earlier estimated, says Joseph Reinert, chief of the exposure assessment branch in EPA's office of pesticides. On the other hand, other studies published in the scientific literature show that applicators splash more pesticide on themselves when handling chemicals than calculated before. Exposure in these tests was estimated by measuring chemicals that soak into patches attached to workers' clothing.

Another new company study might also lead to a lower cancer risk estimate. Specifically, Monsanto developed a new direct assay to determine a worker's exposure to alachlor in which it measures a certain metabolite in a urine sample. If these data were

incorporated in the calculations, the cancer risk would be lowered by an order of magnitude, because the apparent exposure is much lower than predicted, according to Curt Lunchick, a scientist in EPA's exposure assessment branch.

EPA scientists say the Monsanto assay method is valid, but they are uncertain about the significance of the results because the company tested only a handful of people. No one else has tried to duplicate the study, Reinert says.

The cancer risk posed by alachlor in drinking water is even less certain because there are scant data on the extent of contamination, agency officials say. New, but incomplete, information suggests that alachlor pollution is not as widespread as previously believed, they say. "We still don't have enough [monitoring] data to tell what the risk is from water," remarks Lois Rossi, who heads EPA's special review of alachlor. Last year, the agency did go so far as to propose that, as a goal, the maximum contaminant level for alachlor in drinking water should be set at zero.

In 1984, the agency estimated conservatively that the increased cancer risk to a child who drinks a liter of water containing 2 parts per billion (ppb) of alachlor over a lifetime is 1 in 100,000, an amount that is generally considered worrisome. EPA also speculated that surface water in the corn-belt region commonly contains 2 to 5 ppb of alachlor. New preliminary data indicate that "these levels can be reached, but it is still not clear how widespread the contamination is within and beyond the corn belt," says Carolyn Offutt of EPA's pesticide office, who has been tracking alachlor levels in surface water. In northwestern Ohio, where surface water is a main source of drinking water, peak concentrations in three rivers climbed to values as high as 17 ppb during 1985, according to studies by David Baker of Heidelberg College in Tiffin, Ohio.

The findings on ground water contamination are puzzling. EPA scientist Stuart Cohen notes, for example, that "there are a lot of negative [findings] in Kansas. I don't know what to make of it." So far, alachlor has been detected in ground water in five states: Iowa, Pennsylvania, Maryland, Nebraska, and Minnesota. According to Iowa state surveys, alachlor has been detected in only 10% of 150 public drinking water supplies. The range of concentrations ranged from 0.1 to 11 ppb. The mean concentration was 0.8 ppb.

But even this contamination is troubling to Richard Kelley of the Iowa Department of Natural Resources, who monitors public water supplies in the state. He says that alachlor, for the most part, is not eliminated by purification at conventional city water treatment plants or even activated charcoal filters. And, in Iowa, alachlor is leaching through not only limestone formations called karsts, but also alluvial areas, which are common in the Midwest.

Larry Lefever/Grant Heilman

Herbicide *application to corn field to forestall weed growth.*

Kelley and Benbrook of the Academy predict that, based on the behavior of other herbicides, alachlor concentrations in ground water will increase the longer it is used. Atrazine, which has been sold since 1959, is commonly found in ground water because it has been used long enough to reach ground water, they say. Kelley warns, "By the time we discover alachlor in ground water, we've exposed the whole population" in the area.

EPA officials say that the contamination issue will not be resolved any time soon because some important studies by Monsanto that were ordered by the agency will not be completed until next year. Monsanto submitted data on alachlor concentrations in both surface and ground water to the agency earlier this year, but agency scientists say the protocols were seriously flawed. EPA has ordered Monsanto to conduct monitoring again, this time with agency approved protocols.

A factor that has complicated EPA's analysis of alachlor's benefits is that metolachlor has strong assets as an alternative herbicide, says Jan Auerbach, head of EPA's special review branch. Animal studies indicate that it is a much weaker carcinogen than alachlor, according to EPA. Ciba-Geigy, the manufacturer of metolachlor, asserts that the two herbicides are equal in boosting corn yield. Metolachlor is already widely used, although its market is smaller than alachlor's.

EPA can propose a variety of regulatory options, which will then be circulated for public comment and made final within the next year. Interviews with agency officials indicate that it is highly unlikely that the agency will ban alachlor but it could propose to continue the restrictions that were imposed in 1984. These rules focused primarily on reducing applicator exposure. EPA ordered Monsanto to start an intensive training program for farmers and required product labels to warn users to wear protective clothing. Farmers commonly do not wear gloves when pouring the herbicide, use their bare hands to handle a dripping nozzle on herbicide spray equipment, and blow out clogged nozzles with their mouths.

To cut exposure even more, EPA could require Monsanto to market alachlor only in a closed pump system. In 1984, the company argued strongly that applicator exposure could be significantly reduced by encapsulating the chemical in small beads, but studies showed that this formulation provides little additional protection. To stem water pollution, Benbrook says, EPA should limit the amount of herbicide applied per acre and restrict its use to certain geographic areas.

Hinkle and Kelley hope that EPA will follow Canada's example and suspend alachlor's use. Since the beginning of this year, alachlor has been off the market in Canada. Wayne Ormrod, director of the pesticide division within the Canadian agriculture department, says the decision to suspend alachlor was based on the Monsanto cancer studies and the detection of the herbicide in Canadian water supplies. Monsanto is currently appealing the suspension.

Leslie Ravitz, an analyst at Salomon Brothers, notes that EPA's special review has provided Monsanto with a potentially important, hidden benefit. The U.S. patent on alachlor expires in December 1987. But because the regulatory fate of the herbicide has been uncertain, no major manufacturer of generic pesticides has geared up to produce alachlor, Ravitz says. So if EPA does not tighten the regulations, Monsanto could maintain its position as the exclusive manufacturer for a while longer. ■

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