

Toxic fumes from fire-retarded foam

Because many plastics and polymers are extremely flammable, Federal regulations require that they pass various ignition and fire propagation tests before marketing. Usually the addition of some fire-retardant material during the manufacturing process provides the required flame protection, but little attention has been given to the possible toxicity of fumes given off by smoldering retardant-polymer combinations, heated by a surrounding fire. Initial results of such testing have revealed frightening possibilities.

A group of scientists at the Flammability Research Center of the University of Utah report in Feb. 28 *SCIENCE* on experiments exposing rats to the fumes of a polyurethane foam treated with a common phosphate fire retardant and heated until it begins to chemically decompose. After 20 minutes exposure to the smoke the rats all exhibited severely impaired ability to perform normal movements. Within an hour they developed grand mal, epileptic-like seizures. Depending on the concentration of retardant in the foam, some rats progressed to continuous major seizures and death.

Studies of blood samples from the dead rats indicated that when heated, the urethane had decomposed into chemicals that could react with the flame retardant to form toxic "bicyclic phosphate" compounds. Such compounds can cause seizures in concentrations lower than one part per million—small enough to escape notice by conventional smoke-analysis techniques.

In an interview, three of the scientists involved in the experiment, K. J. Voorhees, S. C. Packham and I. N. Einhorn, talked about the implications of their work. At first, says Einhorn, the results were viewed as "laboratory curiosities" since the polyurethane foam used in the experiments was not a commercial sample, but when subsequent Government and industry tests produced the same effects in flame-retarded foam already on the market, "all of a sudden we got a very quick response." Some products have already been withdrawn from public consumption and the National Bureau of Standards is accepting new sample materials from chemical companies, and sending them to the Flammability Research Center for toxicity testing.

But the problem is greater than just one class of retardants and products. "The results," says Packham, "point to a need for a new approach in toxicity testing." First, the discovery of toxic fumes from heated materials points to the need for direct biological testing of flame-retarded products—just finding out how much the ignition point is

raised no longer appears sufficient. But more subtle effects are also involved: Such fumes may also impair judgment, their toxic effects may not appear until some time after exposure, and other kinds of poisoning—such as skin toxicity—may be involved.

When, for example, rats had been exposed to fumes from polyurethane foam that had not received flame-retarding treatment, they were able to "escape" from a plate-sized circle in less than six seconds. But rats exposed to the smoke from flame-retarded foam were so disoriented or convulsive that

they could not move out of the circle in less than a minute—if at all. The apparent danger is that humans caught in a burning building containing similar materials might also become too disoriented to escape. The authors conclude that this effect might become evident well before otherwise "lethal" concentrations of smoke were present.

Despite initial skepticism, chemical companies are now cooperating with the Flammability Research Center, including some financial support, according to Einhorn. The new methodology developing out of this effort, he concludes, may lead to improved pre-market screening of many kinds of flame-retarded materials. □

The ethics of human experimentation

Increasing attention has been given in recent months to ethical problems surrounding medical treatment and medical research. At the moment, concern is largely directed toward experiments on fetuses, prisoners and the poor.

The Congressionally mandated Commission for the Protection of Human Subjects, for example, is drawing up recommendations for Health, Education and Welfare on how to continue all forms of research while protecting basic human rights. Its first recommendations, on fetal research, will be announced on May 1.

Last week the National Academy of Sciences held a two-day symposium on the ethical problems of experimenting on fetuses, prisoners and the poor. Some 500 physicians, researchers, lawyers, philosophers and concerned citizens attended.

The subject that is receiving top priority by the commission and that drew much attention at the symposium is research on live fetuses. Since abortions have been legalized, fetuses have become widely available for research. And researchers have apparently been making wide use of these fetuses. Maurice J. Mahoney, a fetal researcher at Yale University, looked into the extent of live fetus experimentation for the commission. He reports that some thousand studies on live fetuses have been carried out, at least a third of them in the United States and Canada. Those conducted in the United States have largely dwindled, however, since the National Institutes of Health stopped funding research on live fetuses (SN: 4/21/73, p. 253).

Those who favor research on live fetuses argue that an aborted fetus is like a removed organ. The mother's decision or whatever caused the abortion, they say, has already doomed the undeveloped child. In such instances it

seems more acceptable to these researchers to use the fetus for valid research than to dispose of it. During the few hours the fetus might live, for instance, the effects of drugs can be tested much better on it than on single organs or cell cultures. Such research, these investigators argue, will benefit fetuses destined to be born.

Experimenting on live fetuses, however, raises knotty ethical questions. At what stage does the fetus have human rights? At what stage does it feel pain? Scientists at the NAS symposium confessed that no one yet knows. But assuming that fetuses can feel pain, some of the experiments being conducted on them sound "like a horror story," in the view of Nobel laureate Frederick C. Robbins of Case Western Reserve University, one of the NAS symposium speakers. In one study, for instance, the heads of eight live fetuses (less than 12 weeks old) were cut off and then injected with radioactive compounds to study brain metabolism.

Speakers at the NAS symposium largely agreed that fetal research should be limited to dead fetuses. Such research presents no ethical problem, in the view of symposium participant Joseph Bellanti of the Georgetown University Medical School. He uses naturally aborted fetuses to study immunodeficiency diseases.

When the Commission for the Protection of Human Subjects makes its recommendations on fetal research on May 1, the NIH ban on funding live fetus research will be continued or rescinded.

As for experiments on prisoners, there is little doubt that they advance vaccine and drug research. Scientists at the NAS symposium underscored this point. Albert B. Sabin, creator of the Sabin polio vaccine, cited his own studies on "hundreds of prisoners" at a former Federal reformatory at Chilli-