# Grim Lessons of the Vinyl Chloride Coverup

*by Frank Goldsmith*

Over the past few years, "startling" discoveries of dangers in materials once thought to be harmless have been quite common. Thus, when the dangers of vinyl chloride were first widely publicized in 1974, there was little ripple within the engineering community—even though 5 billion pounds of the polymer, polyvinyl chloride, are produced in the United States each year, accounting for nearly 20 percent of all the plastic the nation uses.

But were the dangers of PVC—especially its ability to induce hemangiosarcoma, a previously rare cancer of the blood vessels of the liver—really unknown before 1974? Or were they simply ignored or even suppressed by companies within the plastics industry? Now that the dangers of PVC, asbestos, and numerous other substances have become known, what is being done to avoid similar experiences in the future? And what will be the outcome for engineers who design facilities in which potentially toxic or cancerous materials are used?

Sadly, the safeguards against potential occupational dangers are inadequate even now. The Occupational Safety and Health Administration is underfunded—scarcely able to check on the safety of existing industrial materials, let alone the 500 new ones that appear on the market each year. And

the agency insists on carrying out "economic impact" studies of its proposed major regulations, even though good data does not exist for calculating such costs (and as if, in any case, it is possible to quantify the value of a human life).

Nor is any remedy likely to be found outside the federal government. Engineers find it difficult to argue for strict protective measures in the face of weak federal standards. And the relatively few companies committed to keeping good medical records of their workers are often unaware of the types of subtle medical problems to look for.

The PVC affair highlights the weaknesses of worker and consumer protection against such substances. PVC was introduced commercially in this country in 1927 as a wall covering. It is one of the most versatile of all plastics—cheap, reasonably fire resistant, and easily molded at low temperatures. It has long been known that the monomer, vinyl chloride, can affect the central nervous system. In fact, it was once used as an anesthetic, but was discarded because it causes heart irritation.

The first technical article outlining occupational health problems with the chemical appeared in 1938 (see chronology). By the 1960s, the professional occupational health journals had carried numerous articles on bone and skin diseases among workers who had been exposed to high concentrations of VC. In 1961, researchers at Dow Chemical, a major producer of the monomer, reported that test animals exposed to 100 ppm during the equivalent of normal working hours for 4.5 to 6 months suffered slight liver damage. As a result of these findings, the company lowered the allowable level of worker exposure to VC in its own plants to 50 ppm.

At the time the most widely accepted standard was 500 ppm, which had been the level decided upon by the American Conference of Governmental Industrial Hygienists. In 1962, on the basis of research done at Yale by D. Lester, L.A. Greenberg, and W.K. Adams, which found no evidence of danger from VC exposure, the ACGIH decided not to follow Dow's lead and to modify its 500 ppm limit only slightly. It was not until 1971 that the ACGIH standard was significantly tightened—to 200 ppm.

The United States was clearly lagging behind Europe in strengthening

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its VC exposure standards. "Great Britain had lowered to a maximum level of 200 ppm, following cases of acroosteolysis [bone disease] in the sixties," says Dr. Irving Selikoff, cancer researcher at New York's Mt. Sinai School of Medicine. "West Germany had set a level of 100 ppm in 1970, based on Dow's 1961 results with animals." The Soviet Union's occupational exposure limit at this time was only 10 ppm.

In this country, however, industry seemed to be trying to ignore the problem. In 1964, B.F. Goodrich fought claims for compensation from a worker for injuries he claimed were due to exposure to VC. The worker late died from hemangiosarcoma; his was the second death to be firmly tied to VC exposure.

Harold Williams, who worked for nearly 30 years at a Monsanto facility in Springfield, Massachusetts, which pressed vinyl chloride resins into, among other things, phonograph records, is currently suffering from nerve problems that may have been caused by VC exposure. He recalls that Monsanto did inform its employees in the mid-1960s that there were "some problems" with the material, but it said that the workers should not worry.

In the early 1970s, according to Williams, Monsanto ran additional tests on its workers in Springfield, but the tests' purpose went largely unexplained and individual test results were kept secret. (Whether Monsanto was performing these tests in response to new research that had surfaced in 1970 linking VC exposure to cancer in animals is uncertain, but the suspicion is strong.) Sweeping statements were issued by the company to the effect that the workers faced no danger and that they were in good shape. PVC operations at the plant are now closed, and Williams is fighting the company to prove that his health problems are work-related.

The circumstantial evidence suggests that many firms deliberately suppressed evidence of PVC dangers in order to avoid costly plant modifications. However, in the companies' defense, it should be pointed out that there was no great appreciation of industrial cancer problems in the early sixties (although aniline dyes have been causing recognized cancer problems since the 1880s) and no strong central agency, governmental or private, to coordinate and disseminate research findings. Thus, Dow Chemical could announce a possible danger and cut worker exposures in its own facilities. But there was no way of forcing the remainder of the industry to follow suit.

These shortcomings were supposed to have been corrected with the creation of the Occupational Safety and Health Administration (in the Labor Department) and the National Institute of Occupational Safety and Health (in HEW) in 1970. But OSHA and NIOSH have proved to be singularly slow-moving and incompetent with regard to many occupational safety problems. PVC was one of these. Even after the ACGIH lowered its exposure limit for VC to 200 ppm in 1971, OSHA, which had gotten its 500 ppm standard from the ACGIH in the first place, did not follow suit.

In January 1974, the general public

# In Search of a Standard

**1927:** Polyvinyl chloride first commercialized in United States.

**1938:** Acute animal toxicity to high doses of vinyl chloride first reported.

**1949:** Liver damage found in 15 of 48 workers exposed to VC in the Soviet Union.

**1961:** After numerous reports from around the world suggesting potential dangers in VC, Dow Chemical conducts sensitive experiments on the question; discloses animal data showing deleterious effects of VC concentrations as low as 100 ppm; decides to cut worker exposures in its own plants to 50 ppm.

**1963:** American Council of Governmental Industrial Hygienists modifies its 500 ppm time-weighted average VC exposure limit to 500 ppm maximum concentration.

**1964:** John L. Creech, B.F. Goodrich plant physician in Louisville, reports that an unusual hand problem has developed among a few employees who enter polymerization reactors to manually remove buildups of solid PVC from reactor walls.

**1965:** *Soviet Medicine* reports disorders of the liver and bile ducts in workers engaged in the production of some plastics.

**1970:** Preliminary results of animal experiments presented by P.L. Viola at Tenth International Cancer Congress in Houston, showing that high VC doses cause cancer.

**1971:** OSHA publishes list of "threshold limit values" for pollutants in the workplace; VC limit is set at 500 ppm.

**1972:** ACGIH revises VC limit downward to 200 ppm; OSHA standard remains at 500 ppm.

Cesare Maltoni finds first angiosarcomas in rats he is studying (August).

**1973:** In January, a team of three American chemical industry representatives visits Maltoni in Bologna to learn of his results and see his slides.

In spring, Creech at Goodrich recommends that liver function tests be initiated; they eventually involve 271 employees, of whom 55 show evidence of "slight liver abnormalities."

July 17, representatives of the Manufacturing Chemists Association and NIOSH meet in secret to discuss the VC matter.

December 18, Maurice Johnson, environmental health director of B.F. Goodrich, visits Louisville plant; Creech informs him that he has learned of an employee's death the previous March due to angiosarcoma of the liver. This prompted Creech to review medical records of another employee, who had died of liver cancer in 1971, and the review confirmed that the death was due to angiosarcoma.

By year's end, Maltoni's study shows that levels of VC as low as 250 ppm induce a variety of cancers in rats.

**1974:** January 22, B.F. Goodrich announces that the two deaths, plus a third one were due to angiosarcoma.

January 24, Goodrich's announcement carried by *Louisville Courier-Journal* and *Wall Street Journal*.

February 15, informal fact-finding

hearing is convened by the Labor Department "to give interested persons or organizations an opportunity to present oral or written data, views, and/or positions regarding the possible hazards associated with the manufacture and/or use of vinyl chloride."

March 11, NIOSH director Marcus Key notifies OSHA that "in view of . . . our inability to describe a safe exposure level as required in Section 20 (a) (3) of the Occupational Safety and Health Act, we rejected the concept of a threshold limit for vinyl chloride gas in the atmosphere."

April 5, OSHA sets Emergency Temporary Standard for exposure to VC at 50 ppm.

May 3, OSHA releases proposed draft Environmental Impact Statement on its proposed VC standard for comments. That same date, Tabershaw/Cooper Associates, Inc., submits its report, *Epidemiological Study of Vinyl Chloride Workers*, to the Manufacturing Chemists Association; it concludes that "cancers of the liver (primarily angiosarcoma), respiratory system, brain, and cancers of unknown primary site, as well as lymphosarcoma, occurred more often than expected in those members of the study population with the greatest exposure. Even though the excesses were not statistically significant, the findings warrant further study."

May 9, OSHA proposes that the permanent VC job health standard be set at "no detectable level."

May 10 and 11, New York Academy of Sciences holds first public international meeting on the toxicity of VC.

In June, Maltoni reports angiosarcomas in test animals exposed to only 50 ppm VC during simulated work periods.

June 12, final draft Environmental Impact Statement on proposed VC standard is released by OSHA.

June 25, OSHA holds public hearing on proposed standard for occupational exposure to VC.

August 26, economic study on proposed standard, done by Foster D. Snell, Inc., calls "no detectable level" standard on VC "not feasible." Study is criticized by Health Research Group on September 6 as emphasizing "the failure of the industry to produce detailed and relevant economic data to support any of its claims."

October 1, OSHA releases final VC regulations, to become effective October 4; maximum permissible level is to remain at 50 ppm through December 31, then drop to 1 ppm averaged over an eight-hour period, and 5 ppm for 15-minute periods. The industry goes to court, seeking a stay in the standards due to take effect January 1; U.S. Court of Appeals grants the stay.

1975: January 31, OSHA regulations on VC upheld by U.S. Court of Appeals for Second Circuit; industry files appeal.

U.S. Supreme Court agrees to hear case, but refuses to order a stay of the regulations in the meantime; regulations go into effect April 28.

May 8, General Tire and Rubber Company's Ashtabula, Ohio, plant says it was in full compliance by April 1, and had been in a position to be in compliance as of the original January 1 date.

May 23, Georgia-Pacific announces that its plant VC levels meet new OSHA curbs.

May 28, U.S. Supreme Court upholds the 1 ppm limit on VC.

finally learned about the dangers of VC exposure. Three workers at a B.F. Goodrich plant in Louisville, Kentucky, were judged to have died from hemangiosarcoma caused by exposure to vinyl chloride. Numerous other workers at the plant displayed nerve disorders that appeared to be VC-related.

Hearings were quickly called by OSHA to gather information on the scope of the danger and to set new occupational standards. At the February 1974 hearings, several industry executives refused to acknowledge any previous awareness of the VC problem. Tony Mazzocchi, legislative director of the Oil, Chemical, and Atomic Workers Union, asked Goodrich president Anton Vittone, for example, why his firm's operations in Holland had more information on the VC problem than the parent company. Vittone dodged the question: "We've been trying throughout these many years to keep abreast of any developments in Europe with respect to this area and we will continue to do so."

At the same time, other industry spokesmen admitted that they had been privy to research indicating the danger at least since 1970. That was the year Italian researcher Publio L. Viola announced at the Tenth International Cancer Congress in Houston that VC had caused cancer in animals in preliminary tests at extremely high exposure levels (30,000 ppm). The Manufacturing Chemists Association, in public statements, admitted that it had been following Viola's work with experimental animals and had "carefully" studied his findings. Yet the trade group testified at the February hearings that it had had no direct contact with NIOSH specifically concerning the VC problem until July 17, 1973, when an industry delegation, including a European representative, met with Dr. Marcus Key, then NIOSH director, and his staff.

Commenting on MCA's slowness in contacting federal officials, Dr. Selikoff said, "If their statements mean what they seem to mean, then we're nearly four years behind where we should be. You don't automatically assume that animal studies are conclusive, but the industry should have at least notified its own doctors."

Dr. Sidney Wolfe of the Nader Health Research Group offered the same opinion. "It's inexcusable that they didn't tell the government [before mid-1973]," he said. A NIOSH scientist also criticized MCA: "it would have been appropriate for them to tell us about the European studies as soon as they knew," he said.

NIOSH, however, is not absolved from blame. Why did the institute have to wait for industry to tell it about the danger in the first place? Why didn't it have its own information? And why, even after receiving the evidence from the MCA, did NIOSH delay taking any action until after public disclosure of VC-related deaths in 1974?

In its own defense, the MCA claims that it did notify industry medical personnel—and that this notification is what led to identification of the first hemangiosarcoma death (at the Goodrich plant in Louisville in December 1973). When asked why a general public notification was not made, an

industry spokesman noted that the research was still in a preliminary stage. Companies, he said, fear that the release of inconclusive data will provoke public hysteria, governmental regulation, or private lawsuits before enough information is available to make rational decisions.

But the MCA appears to have been reluctant to pursue the information that *was* available. According to Cesare Maltoni, director of the Bologna Center for Prevention and Detection of Tumors and Oncological Research, it was not Viola's 1970 findings that prodded the MCA into action, but rather Maltoni's notification of the MCA directly, in late 1972. Maltoni added, in an article in *Ambio*, a Swedish journal, that even before 1972 "our data [had been] periodically transmitted to the European companies which have supported our research, and are available to all interested parties." Finally, a few months after Maltoni's formal notice to the MCA, and, according to *Chemical & Engineering News*, after "some months of negotiation" with the European companies involved (Montedison, Imperial Chemical Industries, Solvay, and Rhone-Progil), "a team of three U.S. chemical industry scientists visited Prof. Maltoni . . . to learn of his results and to see his slides."

More than 7,000 people in the United States alone work in plants where the potential for exposure to VC gas is particularly high—either in the production of the monomer from feedstocks or the plastic from the monomer. Tens of thousands more—one widely quoted estimate is 170,000—are involved in the fabrication of products containing PVC, and more than 1 million Americans work with such products after fabrication. Millions more may be in potential danger because they live near facilities handling PVC. One June 1, 1974, the *New York Times* reported that "a woman who for nearly 30 years lived four blocks downwind from a polyvinyl chloride manufacturing plant died of hemangiosarcoma." Despite the wording of the *Times* article, the women's death is still not confirmed as having been hemangiosarcoma, although the likelihood is strong.

NIOSH, with the help of major medical laboratories, has begun a "body count," using death certificate data, in an attempt to discover just how widespread the problem has become. However, it is difficult to obtain an accurate estimate. Death certificates do not contain much of the information necessary to determine the cause of a death; especially for occupational cancers, which generally take at least 15 to 20 years to develop, the person's occupational history is necessary. And numerous cases of hemangiosarcoma have no doubt been misdiagnosed, because, until recently, the disease was so rare.

Well over 100 deaths have been at-

# A Landmark Conference

**Toxicity of Vinyl Chloride-Polyvinyl Chloride** edited by Irving J. Selikoff and E. Cuyler Hammond (New York Academy of Sciences, 2 East 63 St., New York, N.Y. 10021, 337 pp., $35 paperbound).

In May 1974, less than four months after the first public disclosure of human deaths associated with vinyl chloride, the New York Academy of Sciences held a conference on the subject. The program was extraordinary, partly because of the speed with which it was organized (a speed that no governmental agency could ever hope to match, although several such agencies helped support the academy's effort), and partly because of the quality of the program's participants. Virtually every researcher doing significant work in the field—industrial hygienists, regulators, and physicians—attended, attacking the problem from all points of view.

This extraordinary meeting could have produced an extraordinarily dull book of proceedings—useful at best to a few workers doing esoteric work in the field, and perhaps not even very well understood by most of them. Instead, the proceedings—papers presented, discussions held, and a remarkable collection of 389 references on VC and health, going back as far as 1930—together form a definitive, landmark work. Of the numerous studies on the health affects of various technologies that have crossed our desks over the past few years, we have reviewed only the ones that could explain a health problem in terms a non-doctor can understand—those that a plant engineer, for instance, could use to justify increased worker protection to his or her management, or that a product designer could use to check on the safety of the materials he is planning to shove into the paths of commerce. This is one of those rare books. While one will need a medical dictionary or occupational health encyclopedia to get through the roughest papers, the pattern should be clear to any technically educated person of good will.

In part, this is due to the quality of the conference participants. But the book owes a debt to its two editors as well—they resisted the temptation to save space (and money) by eliminating each researcher's reasons for doing what he or she did. Thus, the editors have preserved methodologies that guide all health researchers. They have also preserved some of the groping the various authors went through, inching toward discovery of a terrible health problem by degrees, often in ignorance of data that could have been used to better define their experiments.

For this reviewer, reasonably skilled in the arcane art of measuring small amounts of pollutants in air, the sheer complexity of some of the animal experiments is especially startling. Is it necessary? The answer is provided by Cesare Maltoni and Giuseppe Lefemine, in their introduction to a paper presenting some of their findings: "What is now happening with vinyl chloride and the story of vinyl chloride carcinogenicity should bring about greater consideration of experimental bioassays and finally induce a new turn in the field of occupational and environmental carcinogenesis. In other words, experimental prediction on the pathogenetic potential of occupational and environmental agents before they are produced and released on a large scale into the human environment should preclude the need for later epidemiological evidence."

Remember the 389 references, which were compiled only after deaths were recognized and hundreds of future deaths were made unavoidable. Was it a failure of technology, or a failure of all professionals to be responsible for that technology—and their fellow human beings?

—S.S.R.

tributed to this disease (including several at PVC fabricating facilities, where much lower levels of exposure occur than in VC manufacture and polymerization). But, due to the paucity of data and incomplete employer medical files, the link between the disease and VC has not been confirmed in some of these cases.

Even so, it is clear that the problem is a national one—in fact, an international one. If a highly visible national disaster, such as a flood or earthquake, had caused as many deaths, it would have been accompanied by a massive federal aid program. Nothing like that has happened with VC.

OSHA has only recently begun to take effective action to deal with the problem. In April 1974 it set an interim worker exposure limit of 50 ppm, and proposed a limit of "no detectable VC" in plant atmospheres. The final standard, as promulgated by OSHA in October 1974, set a limit of 1 ppm per eight-hour day, with a 5 ppm limit for exposure times of no more than 15 minutes. The new limits did not go into effect until the following April, however, due to industry court action. At least four companies had announced compliance with the OSHA standard at press time, and another claims to be producing PVC with especially low residual VC for use in packaging.

Use of VC as a propellant in aerosol cans was banned by the Consumer Product Safety Commission in 1974, but the commission refused to order a recall of such aerosol cans already in the hands of consumers. The federal Environmental Protection Administration has set machinery in motion to establish a "hazardous air pollutant" standard for VC plants under the Clean Air Act; the standard was pending at press time. And the Food and Drug Administration has proposed to ban the use of rigid PVC in food packaging because of the potential (though comparatively slight) danger of VC leaching into the food.

In short, it took at least five years from publication of evidence linking VC to cancer—and more than a quarter of a century after VC was linked to other occupational diseases—for reasonable protection standards to be instituted. Even now, there is a question as to how strongly those standards are being enforced. OSHA, for example, has yet to inspect those plants that claim to have cleaned up.

The vinyl chloride case, as well as recent experience with asbestos and mercury, highlights the need for independent research on occupational and environmental hazards. That is why NIOSH was created in the first place, and why it received the support of organized labor and large sections of the scientific community. But, as far as labor is concerned, OSHA and NIOSH were not diligent enough about getting the facts of the PVC case to the public. Jacob Clayman, secretary-treasurer of the Industrial Union Department of the AFL-CIO addressed the issue at a 1974 symposium on PVC at the New York Academy of Sciences. "Multicorporate studies of cancer from vinyl chloride were initiated secretly in this country and in Europe," he said. "They were discussed with the [U.S.] government in secret, and their results would probably still be secret without the presence of mass media [interest] . . . Even after the Louisville cases were announced, the government attempted to conduct key meetings without the presence of [labor] representatives. In at least one case . . . the government sought to substitute a medical survey of employees by an independent researcher . . . with a study of their own to be conducted—by a secret prearrangement—in collaboration with the company.

"Seemingly to slow down the development of new information, NIOSH is being ordered to request no increases in staff and funds to cope with the additional burden of the vinyl chloride investigation. Because of resources already stretched to the breaking point, in effect NIOSH is being asked to diminish its total effort. Research means information and information means regulation. Regulation means corporate expenditures. The equation is rather simple."

Hard evidence to support Clayman's charges is difficult to come by, but there is no doubt that such monetary and political equations have governed OSHA thinking in the past. A memo from former OSHA director George Gunther surfaced during the Watergate affair, in which Gunther suggested that selective OSHA enforcement (and nonenforcement) of the Occupational Safety and Health Act could yield large amounts of money for President Nixon's reelection campaign.

Although management of OSHA and NIOSH has taken a turn for the better recently, the only way to insure relative independence for occupational safety enforcers is to split OSHA off from the Labor Department. Such independence would also increase the possibility that "no strings" research money would be available for health investigations by scientists and engineers.

Labor must also put its own house in order. With few exceptions, American unions are cut off from international research and advances in occupational safety and health—in part because AFL-CIO head George Meany refuses to sit at the same table with trade unionists and scientists from socialist countries such as the Soviet Union, or even officials from social democratic countries such as Sweden. Thus, U.S. unions, a key force in safety and health policy-setting in the United States, are often unaware of important data presented at meetings of the International Labor Organization and the World Health Organization. Fortunately, some unions, even within the AFL-CIO, are not heeding Meany on this issue, and have begun to participate.

Despite dire industry predictions that the PVC industry could disappear under tough new standards, no plant has closed because of them, at least four new ones have opened, and prices are below 1974 highs. On October 1, Uniroyal threatened to close a 29-year-old PVC plant unless the standards were loosened. But even if there are dislocations in the industry, should that be the main consideration? In the past, labor has tended to be protective of jobs, and to bargain on occupational safety. But Peter Bommartio, president of the United Rubber Workers Union, the union with the most to lose if the PVC industry closes, told the Labor Department, "This country survived for nearly 200 years without polyvinyl chloride, and we can survive in the future without it. If PVC cannot be made and used safely, then the proposed standard must be replaced by an orderly procedure to phase out vinyl chloride production and find substitutes for its products, or to phase out the products themselves."

That attitude may be disturbing to some engineers. But it is a warning that continuation of past mistakes should not be tolerated, and that the chance for new mistakes should be minimized, even if the development of new products is slowed in the process. To do otherwise is to reduce the value of human life to that of the rats used in the experiments of Viola and Maltoni. □