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PVC: How Toxic Is the Smoke?

by Sharon Lynn Campbell

THE SMOKE FROM BURNING POLYVINYL CHLORIDE (PVC) CONDUIT IS LITTLE, if any, more toxic than ordinary wood smoke. Yet a manufacturer of metal conduit has launched a campaign to scare consumers into buying its more expensive product by raising exaggerated concerns about the safety of PVC.

Metal vs. PVC

PVC conduit is a superior product for many uses. Metal conduit and piping corrode, are expensive to produce, and require costly trained labor to install. They must be painted or protected from the elements in some other way, and they can sometimes cause fires via short circuits, although they cannot burn. In contrast, PVC does not corrode, costs one-third as much as metal conduit to produce, and can be installed cheaply and easily even by do-it-yourselfers. PVC cannot start fires, and although it can burn, it does so only so long as a flame is held directly to it.

PVC's virtues are reflected in the growth of its market share, from a mere 9 percent in the late 1960s to 31 percent in 1980, with projections of 49 percent by 1995. Steel, which accounted for 68 percent of the conduit market in the 1960s, is expected to drop to 43 percent by 1995.

In an effort to combat this trend, Allied Tube and Conduit has placed a series of advertisements in trade journals, the *Washington Post*, and other publications, discussing "Why you might not escape from a high-rise fire" and describing the so-called Intoxication Syndrome, supposedly caused by the presence of burning plastics. The advertisements describe in detail the frightening symptoms suffered by victims of fires



in which burning plastics are involved. What they do not mention is that the reactions they describe will occur when people are exposed to *any* kind of smoke. They are not specific to PVC.

Other Charges Against PVC

Other angles to the Allied fear campaign have included charges that PVC pipe contaminates water, and that burning plastics are responsible for firefighters' cancer deaths.

The claim that PVC pipe contaminates water with vinyl chloride monomer and other carcinogens has long since been disproven. Full regulatory and standards approval have been granted for the use of PVC conduit for water.

The issue of firefighters' cancer rates is less clear-cut. It is true that firefighters have a higher cancer rate than people in many other occupations. However, the reasons for this are complex and incompletely understood. There is a total lack of evidence that burning plastics are responsible for firefighters' increased cancer risk.

Electrical Code Controversy

Allied's campaign against PVC has not been limited to misleading publicity. Another action by the company has led to a lawsuit by Carlon, a manufacturer of thin-walled PVC electrical conduit, for extreme irregularities in the way PVC was kept off of

the list of approved materials in the National Electrical Code (NEC).

The NEC, which is created by the National Fire Protection Association (NFPA), is a set of standards which do not by themselves carry the force of law, but which are almost always adopted by local governments by reference. This then gives them the force of law, and they become part of local building codes. Products not permitted by the NEC thus suffer a serious marketing setback.

The NFPA periodically updates the NEC. Unfortunately, the way this is done is by having the NFPA membership vote on proposed changes. This method invites abuse, since NFPA membership is not limited to experts in fire protection. A voting membership can be purchased by anyone, including you, for \$50.

As reported in the February 7, 1983 issue of *Fortune*, in 1980 Allied Tube and Conduit took advantage of this system by buying memberships for its salespeople and other employees, and using that voting power to prevent the Carlon product from being approved. Carlon promptly brought suit against both Allied and the NFPA. The NFPA has since been dismissed from the suit, which will go to court later this year.

No Good Tests Available

What makes this whole situation almost ludicrous is that no validated, well-accepted method of rating the relative toxicity of various burning materials has yet been developed. There are at least six different tests used for this purpose, but each has shortcomings and none of them approximates a real fire situation. Each fire is a unique set of circumstances, which makes the development of good tests very difficult. Although efforts to develop better tests are currently underway, experts in the field generally agree that the current tests are of value primarily as scientific tools. They are inadequate as a basis for regulations.

That hasn't stopped the regulators. In Oklahoma, the city of Tulsa has denied approval of PVC conduit, stating that the dangers of PVC "particularly under fire conditions, are well known because of the hazardous, disastrous, death dealing products of combustion." The lack of a valid method of determining whether these combustion products are unusually hazardous does not seem to have deterred city officials.

In New Mexico, a panel headed by the Director of the state's Construction Industries Division has recommended severe limitations on the use of PVC conduit.

In New York City, PVC conduit made headlines in 1982, when the Metropolitan Transit Authority (MTA) was censured by public interest groups for installing it in subway stations. As a result of the highly publicized allegations that the use of this conduit would increase the risk of toxic smoke inhalation during a fire, the installation of PVC tubing in the subways was discontinued, at a high cost to taxpayers. Existing PVC conduit is currently being removed by the MTA, at an additional cost.

The state of New York has also taken steps toward limiting the use of PVC, despite warnings from the consultant who selected a toxicity test for the state's use that such tests should not be used for regulatory purposes. New York Secretary of State Gail S. Schaffer has called the current codes and regulations inadequate, stating that "neither building codes nor fire regulations seem to have taken much account of the dangerous aspects of plastics." New York State Senator Israel Ruiz, Jr. has proposed a bill to ban PVC in wire insulation.

After that bill's introduction, Dr. Roy T. Gottesman, Executive Director of the Vinyl Institute, commented that "the bill claims that PVC emits toxic smoke when it burns but fails to point out that anything that burns, including such natural products as cotton, wool rugs and wood, emits toxic smoke. A press release on the bill is filled with exaggerations and errors of fact and could not stand up under any reasonable level of scientific scrutiny."

The "Evidence" Against PVC

ACSH took a close look at the scientific evidence which allegedly shows the extreme toxicity of PVC smoke. Most of this evidence comes from three organizations: Dr. Yves Alarie's research group at the University of Pittsburgh School of Public Health, the Washington-based Foundation for Fire



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(Photo by J. Jones)

Safety, and the New York-based Public Interest Scientific Consulting Service, Inc. None of these were able to show us any convincing evidence supporting their contentions.

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A review of the papers produced by the Alarie group showed severe shortcomings in many cases, particularly in the work published from 1977 to 1979. The work from 1979 on was somewhat better, but the researchers still made some odd assumptions and failed to include some comparisons that could easily have been done (and would probably have shown that PVC isn't quite as bad as they say). The best paper pro-

duced by this group was published in 1983. Significantly, it refrains from labeling PVC as deadly, as the earlier publications had done. In fact, it is merely a measure of how good a particular test is. Overall, the Alarie group's research fails to support claims that PVC smoke is unusually toxic.

The research performed by the Foundation for Fire Safety is weak, and some other actions by the Foundation suggest that its work is not to be trusted on any level.

Two of the Foundation's papers illustrate the problems with its research. In one, an unpublished report on an investigation of the Westchase Hilton fire, the introduction states that the investigation was needed to "establish the role of synthetics in toxic insult," an unusual statement, since an unbiased investigation might have revealed that they played no role at all. The paper itself was full of vague impressions, speculations and unexplained contradictions, all of which "supported" the thesis that plastics killed the victims.

Another paper, "Inhalation of Toxic Products from Fires," by Merritt M. Birky and Frederic B. Clarke, includes many assumptions which are unsupported by evi-

dence. It presents a table purporting to show a correlation between increased plastics use and the levels of hydrogen cyanide in fire victims' blood. There is no mention of the quantity or type of plastic used (which is important, since some plastics, including PVC, do not give off cyanide when burned), and the table doesn't even show a steady rise in the levels of both substances from year to

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year. The paper also fails to include the necessary statistical analysis which would tell if the numbers were really related.

Scientific Deficiencies

Other actions by the Foundation have also been scientifically questionable. It brought together a group of experts to develop a priority list of fire problems to be solved, and then proceeded to subject that list to a popular vote of its not-necessarily-expert dues-paying members. It proposed an autopsy study that has been characterized by a forensic toxicologist at a major university as needing much work to make it useful in the real world.

The Foundation's Dr. Birky advocates having data on fire victims, living and dead, collected via studies done by firefighters with gas chromatographs in fire stations—a method that is unlikely to produce meaningful results. Gas chromatographs are exceedingly touchy machines, requiring careful and complicated preparation of both the samples and the instrument. Accredited medical laboratories can do this, but it is doubtful that firefighters would be able to do so without expensive training and equipment and without hindering the firefighting part of their jobs.

The public information published in the Foundation's newsletter sometimes contains major factual errors. For instance, in one issue, Dr. Birky stated that “the major products of polyvinyl chloride (PVC) combustion are hydrogen chloride (HCl) and benzene. . . . Furthermore, exposure to benzene can lead to aplastic anemia which is believed

to result in the development of leukemia.” This is very frightening to the reader. It is also very wrong. The major products of PVC combustion are carbon monoxide (CO) and HCl, with benzene being only a very tiny fraction of the total gases given off. The doses of benzene that can lead to aplastic anemia are very large, and aplastic anemia seldom if ever causes leukemia.

Looking for a Fight

What is this foundation? Why was it founded? Its newsletter states that “the Foundation for Fire Safety was founded in part to help fill the vacuum left by the federal government when they opted to discontinue many of the ongoing fire research and study programs.”

An interview published in the December 12, 1983 issue of *Consumer Newsweekly* offers a different view. In it, Gordon F. Vickery, founder and president of the Foundation, comments that “a Democrat who's out of work in Washington, DC, and has a year's lease on a condominium becomes very innovative. I went down and incorporated this foundation, and then looked for sponsors. When you look for money in Washington, you have to look for a fight. Nobody gives money for love. The fight between the plastics industry and the steel industry was a natural—Thank God they're fighting!”

The bulk of the Foundation's funding comes from the metals industry, including

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large contributions from Allied Tube and Conduit.

The third source of “evidence” condemning PVC, the Public Interest Scientific Consulting Service, Inc., has not produced any high-quality scientific work. The President, Dr. Deborah N. Wallace, claims to have several active research programs underway, but refused to talk with ACSH about them or anything else. Dr. Wallace is new to the field of PVC toxicity (her background is in environmental biology) and some of her testimony on PVC issues seems to reflect an

incomplete knowledge of the subject. Many of her conclusions about causes of death have been based on superficial evidence. The National Institute for Occupational Safety and Health (NIOSH) has described her study of firefighters' cancer as “not epidemiologically sound, and the conclusions could not be supported by the data.”*

Unfortunately for the consumer, a naive press has given heavy publicity to the scare stories about PVC smoke without looking closely at the likely motivations of those generating the stories, or at the results of research on PVC by other scientists. Let's take a look at what these other sources have to say about the safety of PVC.

Other Evidence Neutral on PVC Hazard

There have been few papers published in the scientific literature on PVC toxicity. What information there is indicates that while PVC smoke is toxic, no one has been able to show that it is more dangerous than wood smoke, or that in a fire situation, PVC smoke is a significant factor in the death rate.

Would restricting the use of plastics in general or PVC in particular have an effect on the fire death rate? International comparisons indicate that this is unlikely. *Modern Plastics* reported in its March 1982 issue that “vinyl and other plastics account for about 70 percent of electrical pipe and tubing (including electrical conduit) used in construction in Sweden compared with only eight percent in the U.S., yet official Swedish fire statistics show that the death rate attributable to fires is far lower than it is in the U.S. In Japan, which used more plastics in its buildings and where fire hazards generally are much greater, the seeming paradox is that per capita fire losses are a fraction of ours.”

All in all, the evidence fails to show that PVC is any extraordinary hazard in fire situations. The U.S. has one of the highest fire death rates among the industrialized nations, and research and prevention efforts should be concentrating on the factors which will help to prevent fire deaths. Yet it appears that Allied Tube and Conduit, in protecting its own economic interests, has diverted us from the really key factors in fire death prevention by drawing unwarranted attention to the toxicity of PVC smoke. 

*NIOSH Health Hazard Evaluation Report #80-155-776.

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FACTS

ABOUT
VINYL CHLORIDE
MONOMER

VCM

SPI-26665

VCM CHARACTERISTICS AND APPLICATIONS

Vinyl Chloride Monomer (VCM) is the basic building block for producing the most versatile plastic yet developed — polyvinyl chloride (PVC). Today, thousands of products used in the home and in industry are made of PVC — products which are extruded, molded or calendered from PVC resins into diverse shapes, sizes and colors. Mechanical characteristics can be controlled to produce forms that are rigid, flexible, or in a liquid form such as latexes, pastes and adhesives.

Most of the seven billion pounds of VCM produced annually in the United States is converted into PVC resin. The remainder is used as a chemical intermediate in various manufacturing processes. Over 60% of VCM is ultimately used to manufacture permanent construction materials such as pipe, siding, and flooring.

VCM is a colorless gas made mostly by the pyrolysis of ethylene dichloride and is one of the purest organic compounds produced commercially; analyses of typical production material show

less than 100 parts per million (ppm) of total organic impurities. VCM has a faintly sweet odor at high concentrations.

The product is sold, shipped, and stored in the form of a liquefied gas under pressure. This is similar to how propane is handled, for example. VCM is converted to PVC by suspension, emulsion, bulk or solution polymerization methods. The primary method used in U.S. production is suspension polymerization. Most PVC is fabricated into end products by melt processing in extrusion, molding and calendaring equipment.

VCM HAZARDS AND THEIR CONTROL

While PVC resins and finished products are quite inert from a toxicity standpoint, there is concern about possible cancer and other adverse health effects related to VCM exposure. Therefore, VCM producers and the Occupational Safety and Health Administration (OSHA) require strict procedures for limiting potential exposure of personnel to VCM. Anyone using VCM must be

familiar with all applicable federal, state and local laws and regulations dealing with health and safety, and should be aware of current Material Safety Data Sheet information as supplied by VCM producers.

When vinyl chloride monomer is present in sufficiently high vapor concentrations (about 10,000 ppm), the vapor has a slight anesthetic action. Repeated exposure of employees to high levels of vapor has been linked to liver injury, acroosteolysis (a bone disease), and angiosarcoma (a cancer) of the liver. Other injuries, including mutagenic (chromosomal) changes, have also been reported but their relationship to vinyl chloride is not as well established. Available epidemiological data indicate that employees exposed to low levels even for long periods of time have suffered no adverse effect.

Federal (OSHA) standards currently limit occupational exposure to an eight-hour Time Weighted Average (TWA) of 1 ppm with a maximum average value of 5 ppm for any 15-minute period. Manufacturing, handling and use of VCM must be conducted within

equipment designed to minimize potential exposures to and emissions of VCM in the workplace environment. Conforming with federal regulations provides a margin of safety for employees working with the chemical.

VCM FIRE AND EXPLOSION HAZARD

Vinyl chloride must always be handled with an awareness of its volatility and flammability. Its vapors can form highly flammable mixtures with air at all normal ambient temperatures. In general, precautions should be taken to:

- 1) keep the material enclosed; and
- 2) eliminate all ignition sources.

In the laboratory, samples of vinyl chloride should always be handled in a well ventilated hood and away from all ignition sources so that accidental releases of small quantities of vinyl chloride will not create a hazard.

Most small fires can be extinguished with carbon dioxide or dry chemical agents properly applied. Adequate fire extinguishing equipment, fixed or portable, should be provided. Check

Material Safety Data Sheets for current recommendations.

Precautions must be taken to guard against vinyl chloride entering closed drainage or general sewer systems because of the possibility of explosive mixtures being formed.

VCM SPILLS AND LEAKAGE

Because of flammability and toxicity problems, spills and leaks of vinyl chloride must be prevented or, at least, held to a minimum by proper design, maintenance and operating procedures. Current governmental standards specify methods of sampling, loading and handling aimed at minimizing emissions of vinyl chloride. The standards also require the installation of approved monitoring devices and vinyl chloride detectors.

If spills or leaks occur, all sources of ignition must be removed from the area immediately and only properly protected personnel should remain in the area. Small spills usually evaporate rapidly but ample ventilation must be provid-

ed. For large spills, the recommended action is to cover the surface with protein-based foam to retard vaporization. If the spill has been confined in a pit or diked area it should be transferred into closed vessels or disposed of as soon as possible.

Precautions must be taken to prevent personnel contact with liquid VCM. In case of accidental contact with the liquid, immediate decontamination must be undertaken, while preventing inhalation. There is a danger of frostbite due to rapid evaporation of VCM.

VCM TRANSPORTATION OF

Vinyl chloride monomer is shipped in tank cars, barges and ships. These are specially designed and built to prevent contact of the VCM with copper, aluminum or their alloys which could cause formation of explosive or flammable compounds — copper acetylides or aluminum chloralkyls.

Vinyl chloride monomer is classified for transportation as a Flammable Compressed Gas. Requirements for packing, marking, labeling, placarding and prepara-

tion of shipping papers are well defined by federal transportation agencies.

VENTS AND WASTE DISPOSAL

Disposal of liquid or vapor streams that contain vinyl chloride must be carried out so that fire and health hazards are controlled.

The allowable concentration of vinyl chloride in process vents is set by EPA regulations. When the vinyl chloride in a waste vapor stream exceeds this level, the stream must be conducted through a suitable control device to remove vinyl chloride before the stream is released to the atmosphere. Procedures for clearing and venting vinyl chloride-containing equipment prior to personnel entry are also covered in the EPA standard.

When liquid vinyl chloride must be disposed of, it should be salvaged, if at all possible, by reprocessing through a vinyl chloride purification system. Otherwise, it must be burned in accordance with all applicable regulations in a suitable incinerator system under conditions that will adequately control potential vinyl chloride or hydrochloric acid emissions to the air.

**FOR FURTHER INFORMATION
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