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cc: H. A. Hall - Conoco
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September 16, 1983

Maury N. Johnson, M.D.
The B. F. Goodrich Co.
500 South Main Street
Akron, OH 44318

Dear Dr. Johnson:

The following is intended to be a point-by-point criticism of R. F. Dyer and V. H. Esch's "Polyvinyl Chloride Toxicity in Fires - Hydrogen Chloride Toxicity in Firefighters," JAMA 235, 393-397, 1976. I have categorized the technical criticisms according to the subheadings used in the original paper. I submit these points for review as a first stage in the preparation of a formal document to be used as a reference when this paper is cited in the future.

See my comments on the copy I left with staff

- o The Fire
  - The fire is not well described and the materials from which the copy machine was constructed are not detailed. — may not have been PVC.
  - What is "non-chemical smoke"?
- o Effect of Fumes
  - Symptoms of exposed firefighters and pathology of the victim who died are consistent with exposure to irritant gases, but HCl is not proven to be the cause.
  - Microscopic findings, symptoms, and lesions cannot confirm exposure to a given toxicant. This is not proof of HCl exposure.
- o Animal Experiments
  - Kishitani Paper (ref. 4) - Because this paper is the major reference used by Dyer and Esch, it deserves detailed attention.

A. The paper is out of the Engineering Faculty at the University of Tokyo.

B. In pure gas exposures, a great deal of work is reported on the effects of CO on ECG's, but these results are not interpreted or related to exposure to combustion products. In fact, the last line of the paper reveals that the authors by their own admission are laymen and are not qualified to interpret the ECG changes either for pure gas or combustion product exposures. Why were the data collected if they weren't going to be interpreted? ECG's are extremely sensitive to irritant exposure of any kind, low O_2, fear, and many other neurological disturbances.

C. Chlorine gas is implicated as the cause of ocular irritation although neither it nor $COCl_2$ has been observed to form during the combustion of PVC (Wooley [1971], Br. Polym. J. 3, 186).

D. Analytically, only CO concentrations were determined in the exposure chamber. However, O_2 depletion during combustion of test material could explain why some mice died at relatively low COHb concentrations.

E. The ECG responses reported are not specific for direct effects of a chemical on the myocardium and it cannot be concluded from this work that one material is different from another in this regard.

F. There is no evidence in the Kishitani paper to suggest that CO and HCl are synergistic. In fact, work by Alarie and Barrow in mice would suggest that in the presence of an irritating concentration of HCl, the LC50 of CO would be increased, due to decreased breathing rates.

o Effect of Smoke

- The respirability of toxicants cannot be strictly subclassified in terms of particles and gases. The respirability of particles is dependent on their aerodynamic characteristics. The nose, mouth and throat are not good filters for particles <5um in aerodynamic diameter. In contrast, the regional deposition of gases and vapors in the respiratory tract is largely dependent on their water solubility. Highly

water soluble gases such as HCl tend to deposit in the upper respiratory tract, while gases such as ozone easily reach the pulmonary regions. Dyer and Esch get the particulate part straight on p. 395, but they can't have it both ways.

- Again, there is no evidence to suggest that phosgene and Cl_2 are formed when PVC is decomposed.

o Fuel Loading

- Generic comparisons of 'plastics' to other materials are not meaningful (e.g., "plastics possess a heat of combustion 2.5 times that of other combustibles").

o Smoke Inhalation

- The statement that "CO is not noxious" reinforces the theme of the paper that to be intoxicated by CO is acceptable, but other toxic species provide an unsual hazard.

- The amount of CO in a patient's blood is only a good indicator of CO exposure; it is not an indicator of the presence of other gases.

o COHb Levels and Circulation

- There is no evidence to suggest that irritating vapors would potentiate cardiovascular disease. However, a lot of data on the deleterious effects of low level CO for short exposure times on the circulatory system is in the literature.

- Kishitani did not demonstrate any specific effect of chlorine (sic), HCl or CO on the myocardium. HCl at concentrations at or below those which cause lung effects is not likely to be a direct acting myocardial irritant since it will rapidly dissociate to H_3O^+ and Cl^- in the blood, becoming physiologically indistinguishable from H_3O^+ and Cl^- which are present normally. In order to increase blood Cl^- by 10%, a person would have to breathe 16,000 ppm of HCl for about 20 minutes, an unlikely situation. However, even if the myocardial irritancy theory of HCl toxicity was tenable, Kishitani's paper shows that the ECG changes during exposure to cedar, wood-wool cement board, fire

retarded plywood, polyurethane foam and phenol foam all occurred earlier than or at the same time as the changes observed during PVC exposures. In short, there is nothing to suggest that any of the ECG changes observed were due to anything but CO or anoxia brought about by the combustion of the materials in question under oxygen-limited conditions. Earlier studies on rabbits have shown that myocardial damage occurs after only 4 hr. exposure to 180 ppm of CO with resultant COHb levels of 8-12% (Thomsen and Kjeldsen, 1974). The well documented cardiovascular effects of CO are completely ignored by Dyer and Esch.

- o Clinical Study
  - There is no discussion of how PVC combustion product exposure was confirmed.
  - There is no control group to which these subjects can be compared. Therefore, there is no way to determine whether the effects observed are specific for this group or common to many comparably exposed populations.
  - No data, especially clinical chemistry and COHb levels in the exposed firefighters, are presented.
- o Conclusions
  - How will the "mandatory use of self-contained breathing apparatus by all who will be vulnerable to toxic smoke" aid in the prevention of plastics fires?

After you and the other members of the committee have had a chance to review these points, we should set up a conference call to discuss additional points which may have been overlooked, as well as format and style for final presentation.

Very truly yours,

Stephen J. Williams, Ph.D.
Research Toxicologist

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THE ATTACK ON PLASTICS: AN ECONOMIC BATTLE

Because plastics perform so well and at such low costs, the petrochemical industry has been able to penetrate many markets previously dominated by traditional materials, i.e., copper, aluminum, steel, wood. In an effort to maintain market share in the face of technological advances made by plastics, a producer of competitive materials (joined on occasion by special interest groups) is attempting to arouse public alarm about plastics and manipulate this fear as a weapon in their battle to save their products and trade.

By funding with front organizations that prey upon the public's health concerns, competitive interests such as Allied Tube & Conduit Corporation, a steel fabricator headquartered in Harvey, Illinois, are waging a well orchestrated and cleverly disguised smear campaign against plastics to combat a dramatic loss in market share. Despite decades of safe performance, they are charging that plastics are a unique fire hazard. Their tactic has been to manipulate the public by misleading the media and several well intentioned legislators.

They state with great alarm the fact that a high percentage of fire deaths are caused by toxic gasses, not flames.

The facts are: The principal killers in fires are smoke and gases. They always have been. They probably always will be.

The question today is whether the smoke in gases produced by burning synthetic materials are any more hazardous than the smoke and gases produced by burning natural materials in the era before man-made materials.

Smoke and gases had been recognized as the prime killers in accidental fires long before the age of synthetics. Carbon monoxide has been, and still is, identified as the prime toxic gas.

There are those who will have you believe that the introduction of plastics in our living environment exposes us to exotic gases from accidental fires and that somehow places us at greater risk. Not only is such a statement without foundation, but it contradicts the basic fact that the fire death rate is falling in the United States and has been for years.

The National Fire Protection Association (NFPA), as reported in the September 1983 Fire Journal, released the 1982 Fire Experience Survey which stated that the fire death rate in 1982 decreased 10.1% from the previous year.

Fire, and the hazards it presents, is a complex problem. It involves ease and type of ignition, the rate of fire growth, and the rate, amounts and types of smoke and gases generated.

In laboratory scale testing, fire conditions can be controlled and certain phenomena can be observed and measured. But real fires are extremely complicated. Each real fire is different from every other fire. Reliance on small scale combustion toxicity tests alone, without accessing other factors such as ignitability, flame spread, rate of heat release, and relevance to actual fire scenarios, to predict real fire characteristics of materials can be misleading and can channel us to undesirable results.

Most of those familiar with the subject of combustion toxicity believe that the technical merits of the National Bureau of Standards (NBS) protocol on combustion toxicity represent the state of the art and are far superior to others that have been developed. The NBS protocol was an endeavor mandated by Congress and utilized considerable research and input from academia, industry and government and involved inter-laboratory comparisons.

Further developments are forthcoming as the science of combustion toxicology progresses. However, use of the NBS protocol alone, or misuse of the protocol in specifying materials can lead to at the least, the misleading of consumers, and at the worst, advocating more hazardous products.

The National Bureau of Standards Center for Fire Research, the National Institute of Building Sciences, and the National Fire Protection Association have all concluded that toxicity protocols must not be incorporated into building standards at this time. They believe that science and technology have not been developed to the degree that toxicity protocols can be used as a regulatory tool.

The combustion toxicity protocol has been completed by NBS. What is now being conducted is a study of how the NBS combustion toxicity protocol can be used in association with flame spread tests and smoke development studies to determine a Material Hazards Index.

Substantial amounts of research and millions of dollars have been spent by the petrochemical industry on combustibility. The United States Government has funded and is continuing to fund research at Southwest Research Association on the development of the Material Hazards Index and mathematical modeling relevant to actual fire scenarios.

The fact is that many plastic materials play an important role in the effort to reduce the number of injuries and deaths caused by fires each year. Resistance to ignition, low levels of flame spread and inability to sustain combustion have made many plastics a preferred material for conduit, flooring, wire and cable insulation and in other products which must meet the most stringent requirements for fire safety. In addition, plastic materials do not conduct electricity and therefore cannot start a fire the way metal can. Plastic materials provide an extra margin of protection in electrical uses

because it can't corrode, rust or cause electrical shorts. Short-circuiting and electrical arcing can occur with metal conduit systems and lead to the kind of tragic fire death that occurred in 1980 at the MJM Grand Hotel in Las Vegas.

The destruction caused by fire poses a serious problem without one simple solution. The effort to minimize the potential for fires is one that demands a commitment of industry, the fire protection community, building officials and the public. The following seven-point program for fire prevention offers methods to help reduce the occurrence of fires:

1. The use of safe building materials with good fire-resistant characteristics and the employment of the best construction and installation methods for those materials.

2. The development and enforcement of effective safety standards, codes and regulations.

3. The widespread use of smoke detectors and sprinkler systems.

4. The adoption of reasonable testing protocols, standards and guidelines for the safe and effective use of products.

5. The continued study of fire prevention characteristics of materials in the investigation of what happens to materials when they burn.

6. The best education and protection programs for fire fighters, including mandatory use of self-contained breathing apparatuses.

7. The promotion of consumer awareness of fire safety methods for prevention, control and survival.

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