minutes

67

SPI

DEC 6 1976

R N WHEELER JR.

AD HOC COMBUSTIBILITY COMMITTEE

Sheraton-Hopkins Inn
Cleveland, Ohio

Wednesday, November 10, 1976
10:00 A.M.

ACTION SUMMARY

1. The group discussed the need for studies to identify the specific toxicology hazards of PVC combustion products.

2. They identified the need to communicate facts about PVC's unique characteristics as well as to develop hazards assistance with PVC combustibility products to the public and health officials.

3. The group recommended formation of a PVC Fire Safety committee to carry on its activities.

4. They considered the question as to whether the new committee should be under the sponsorship of the present VCM and PVC Producers Group or form as a separate operating group.

ATTENDEES -

Ray Abramowitz, Hooker Chemicals & Plastics, River Roadm Burlington, N.J. 08016
W. R. Axtell, Ethyl Corp. P. O. Box 341, Baton Rouge, La 70821
Joseph D. Banzer, Diamond Shamrock, P. O. Box 348, Painesville, Ohio 44077
O. Paul Cohen, Great American Chemical Co., 650 Water St. Fitchburg, Mass 01420
W. C. Douglas, General Tire & Rubber Co. One General Street, Akron, Ohio 44022
Larry K. Hunt, Goodyear Tire & Rubber Co. 142 Goodyear Blvd. Akron, Ohio 44316
D. H. Hunter, Tenneco, Turner Place, Piscataway, New Jersey 08854
D. L. Kent, B. F. Goodrich Chemical Co., 6100 Oak Tree Blvd. Cleveland, Ohio 44131
Bob Laundrie, General Tire & Rubber Co., One General St., Akron, Ohio 44329
John R. Lawrence, SPI, 355 Lexington Avenue, New York, New York 10017
G. J. Mantell, Air Products & Chemicals, P. O. Box 538, Allentown, Pa 18105
Gene McLoughlin, Hill & Knowlton, 633 Third Avenue, New York, N.Y. 10017
Michael M. O'Mara, B. F. Goodrich, P. O. Box 122, Avon Lake, Ohio 44012
Russell A. Park, Firestone Plastics Co., Box 699, Pottstown, Pa.
S. V. Parikh, Stauffer Chemical Co., 216 DuPont Avenue, Newburgh, N. Y. 12550
Dick Savage, Goodrich Chemical Co. 6100 Oak Tree Blvd. Cleveland, Ohio 44131
Eugene Skiest, Borden Chemical, 511 Lancaster Street, Leominster, Mass 01453
James Tanzilli, B. F. Goodrich Chemical Co. 6100 Oak Tree Blvd. Cleveland, Ohio
R. N. Wheeler, Union Carbide Corp., P. O. Box 8004, S. Charleston, WV 25303

THE SOCIETY OF THE PLASTICS INDUSTRY, INC.
355 Lexington Avenue • New York, N.Y. 10017
(212) 573-9400

1. Mr. Lawrence opened the meeting with a brief background leading to the call for this meeting to discuss appropriate action in the area of PVC combustibility. This was followed by self introductions by those in attendance.

2. Dick Savage gave additional background on the purpose of this meeting saying that the PVC combustibility problem was an industry-wide one that all responsible companies involved with PVC and its precussors should respond to. He indicated that unlike the VCM problems that initiated specific programs within government agencies, that there is an opportunity for the industry to take corrective action on the PVC combustibility issue before restrictive regulations may be placed upon PVC.

3. Dan Kent made a presentation to define the problems associated with the burning of PVC based on his activities in the area. The complete content of his presentation is included as Attachment "A" in the material up to and including "Legal Community".

4. Dr. O'Mara reviewed the status of PVC combustion toxicology, going into considerable detail as to the gasses that are known to be released, the results of animal toxicology, work by foreign researchers and the role of PVC combustion products in the studies being sponsored by SPI's CCCS committee at the Universities of Utah and Michigan. It was made clear that although considerable information is known about the hazards of PVC combustion products, there are as many unknown factors.

5. Mr. Kent then reviewed the Recommendations and Options that might be available for the industry to take on the PVC combustibility question. (see Attachment A).

6. After considerable discussion, it was generally agreed that there should be an ongoing program to investigate PVC combustibility matters. It was moved by Ray Abramowitz that:

   > A PVC Fire Safety Committee should be formed to pursue activities related to the technical and public relations aspects of the combustibility of PVC.

   The motion was seconded and passed unanimously.

7. A task force was appointed to develop a suggested program for this PVC Fire Safety Committee if its organization is approved by the VCM and PVC Producers Group or elsewhere within SPI. This task force was made up of the following:

   Messrs. Kent, Mantell, Wheeler
   Banzer, Axtell, Cohen

8. The meeting adjourned at 3 P.M.

Respectfully submitted,

John R. Lawrence

John R. Lawrence
Technical Director

Attachments

11/23/76

ATTACHMENT A

A G E N D A

PVC/VCM PRODUCERS GROUP

AD HOC COMMITTEE ON COMBUSTIBILITY

Sheraton Hopkins Inn
Toronto Room
Cleveland

Wednesday, Nov.10,1976
10:00 A.M.

Self Introductions

Introductory Comments ..... R. D. Savage
J. R. Lawrence

PVC Combustibility Problem ..... D. L. Kent
- Why we think the industry should be interested..
- What is the impact of the problem?.....
- Is it a problem an industry group can handle or should handle? .....

Review of PVC Combustion Toxicology ..... M. M. O'Mara

Recommendations on Problem Approach ..... D. L. Kent
M. M. O'Mara

Discussion ..... Group

Conclusions ..... Group

Adjournment

MEETING SPI

TO: VCM AND PVC PRODUCERS GROUP
AD HOC COMBUSTIBILITY COMMITTEE

SUBJECT: THE NEED FOR A PVC INDUSTRY GROUP TO RESPOND TO THE COMBUSTIBILITY ISSUE

Sheraton-Hopkins Inn
Toronto Room — Wednesday, Nov. 10, 1976
Cleveland — 10:00 A. M.

Introduction

This report will illustrate the kind of combustibility problems the PVC industry is facing. It will describe the concerns of the influentials, such as the fire community, code officials, etc., and how these impinge upon the problem. It will conclude with a recommendation that the PVC industry take concerted action.

Rationale

Plastics comprise a group of materials derived largely from petroleum--oil and natural gas. Because these man-made materials are organic in nature--as are wood, paper, cotton, etc.--they will burn if sufficient heat is applied.

Some organic materials ignite easily and burn quickly, others are more difficult to ignite, but all will generate smoke and all will emit toxic gases when either smoldering or burning. Some characteristics of burning, such as ignition, flame spread and smoke generation can be modified to a degree when dealing with man-made materials (plastics). However, this process is only a relative one for we have not been able to convert or modify "plastic"materials that are combustible into a non-combustible.

The role of plastics in the built environment has increased enormously in the past 25 years and they are increasingly involved in fires. Concurrently, the role of plastics as a fire hazard to occupants and to fire fighters has now become an issue of national importance.

The above, which can be expressed in many different ways, is the rationale for the current industry endeavor in this area and for the work which is going on by various agencies, universities, and even by the National Fire Prevention and Control Administration.

Industry Programs

It is appropriate, therefore, for the industry to review the effort it has made, examine ongoing programs, determine what industry goals should be, and establish long-range programs to meet these goals.

This is being done in meetings with the SPI Combustibility Issue Coordinator, with the Coordinating Committee on Consumer Safety (CCCS), with the National Bureau of Standards (NBS), with the National Fire Prevention and Control Administration (NFPCA), with federal agencies such as FAA, DOT and HUD, and with various universities where specific and special programs are in progress.

Certain plastic materials have come under special scrutiny and have been identified as presenting special problems. Foremost, has been the foamed polyurethanes and polyvinyl chloride. By force of the FTC consent agreement, the polyurethane manufacturers formed the "Urethane Safety Group". This group in the last four years has done a remarkable job of technical investigation and public relations to turn a serious negative position into one of credibility and positiveness with the result that rigid polyurethanes last year had an upbeat performance of a 15 percent increase in sales in a year when most materials sales declined, or at best showed only a minor or modest increase.

It now appears appropriate for the PVC industry to review its position in the combustibility area when there is still time for it to anticipate and initiate on its own a positive endeavor. To wait longer may invite a "forced" program or result in a position vastly more difficult than that which we face today. It isn't necessary to belabor the point that PVC is already under a black cloud as presenting a health hazard, but it does seem appropriate to list some of the negative views that exist as to how its combustibility characteristics are viewed.

Fire Community

The opinion research conducted by Research Strategies Corporation for SPI has one section called "Plastics as a Fire Hazard". Most of the opinions in this section were solicited from fire chiefs. Toxic fumes given off when plastics burn are by far the most frequently mentioned fire hazard other than the combustibility of plastic. Most of the applications considered as presenting problems involved PVC--(wiring, furniture, ducts, pipe and flooring). One chief phrased their concern succinctly when he said:

"The plastics industries should be doing much more testing to make plastics more resistant to fire. They should be slower burning and less toxic. This research may be expensive, but in the long run, it would be a better, safer world because plastics are our biggest concern and worry when we fight fires. It is unpredictable. It is deadly. It is unreliable. Most people in a fire do not burn to death. Toxic gases kill them. There is enough plastic in the room we are in now to give enough toxic fumes, if we had a fire, to kill every person in this eight-story building. That is how deadly the toxic fumes are!"

If this is what the firemen believe, this is what we must cope with whether we believe it or not!

Fire chiefs may be considered activists on the subject of the fire hazards of plastics; most of them selected four items they felt w re needed to help control the problem:

- legislation prohibiting hazardous materials in public buildings
- complete prohibition of hazardous construction materials in any building
- stricter enforcement of building codes
- improved education on combustibility of plastics

Research Toxicologists

Research physiologists and toxicologists worldwide have included PVC in most of their biological studies. As a result, PVC has been identified as a material emitting unusual combustion products with unusual toxicity characteristics. Until recently we maintained the position that HCl was the major combustion product of PVC, and thus we were dealing with a situation simply involving a primary irritant. The more recent work alluded to above has now developed data which indicates that the combustion products from PVC

-- will cause lung edema

-- will cause lung hemorrhage

-- will cause a change in blood ph - acidosis

-- will cause a change in behaviour patterns (neurotic)

-- will cause gross pathological changes

-- there is some evidence of epithelial or tissue changes (carcinogenic)

Medical Community

As a result of these animal studies, the medical profession has now become concerned and is investigating the effect of combustion products, especially of plastics and specifically of PVC, on fire fighters. Recently, the National Fire Prevention and Control Administration distributed a new study titled Fire Fighter Mortality Report done by the International Association of Fire Fighters under the sponsorship of the National Bureau of Standards. The 15-month study investigated the death of 101 fire fighters in the line of duty. The following is excerpted from a section where combustion products of plastics are implicated in heart attacks.

> "In recent years the medical community has shown that there is a relationship between smoke inhalation and heart disease. Carbon monoxide has been the most commonly thought of toxic fume affecting the heart; however, in recent years with the increased use of plastic-based materials in construction and household products, fire fighters have been faced with even more deadly fumes given off by burning plastic. The most common of these plastics is polyvinyl chloride, which with its thermal degradation results in the formation of at least 75 identifiably potential toxic compounds. The inhalation of carbon monoxide and other toxic fumes contribute to the development, and irritation in existing conditions, of arteriosclerosis."

> "It is assumed that during their careers as fire fighters, most of the victims were exposed to and inhaled toxic fumes other than carbon monoxide. There are two cases in which there is a direct relationship between the inhalation of fumes, given off by burning plastic and the fatal heart attack. In Case 14 the fire fighter was subjected to fumes from a burning bean bag chair (vinyl

bag stuffed with bits of styrofoam) and in Case 56 the fire fighter inhaled fumes from a burning plastic curtain. Both fire fighters showed delayed reactions - of several hours - to the fumes. Shortly after these incidents, both men developed respiratory problems followed by heart disease."

"A special hazard that occurs during overhaul is that concrete retains a great amount of heat and releases fumes throughout the operations. Recent tests showed "highly toxic concentrations of hydrogen-chloride to be present in concrete for as long as one hour after the fire has been extinguished." There were three heart attack cases (Case 12, 19 and 81) in which the fire fighter either took off his mask during overhaul or entered the building for the first time, and without a mask, during overhaul operations."

The concern of the medical profession regarding PVC combustion products has also been communicated to the general public through medical columns and syndicated articles in daily newspapers, with special reference to the article by Victor Esch, M.D., and Robert Dyer, M.D., entitled "Polyvinyl Chloride Toxicity in Fires", JOURNAL OF AMERICAN MEDICAL ASSOCIATION, January 26, 1976.

Legal Community

All of this negative information is beginning to build pressure in the legal area and it is here where the industry will find itself forced to take action if it wants to protect and develop its markets. Without going into detail, it is sufficient to simply point out that certain federal agencies that specify materials, such as HUD, DOT and FAA, and other agencies representing and protecting consumer rights such as FTC and CPSC are all considering restrictions on the use of PVC because of smoke, toxic gases, and its possible adverse effect on life safety. Of specific impact is the action being taken by regional and local codes wherein a material can be unequivocally banned from use. It is also important to be aware that the threat of civil suits is now more possible, and that an abstract of the Esch-Dyer article has already been published in TRIAL MAGAZINE, a publication for lawyers.

Recommendations & Options (See Appendix)

This discussion of concerns only hits the top of the waves, but it does serve to show that major influentials are critical of PVC. As this kind of information develops, it gets disseminated in ever-widening circles--it is sensational--it is news--and it is excellent material for competitive industries. In the meantime, the PVC industry has done only a very little to counteract it. Furthermore, almost all efforts have been defensive and most of the response has been fragmented.

We can do one of three things. One, do nothing and hope the problem will go away (this is less than we are doing now). Two, continue our present approach, react in a defensive way when a problem emerges, i.e., react as individual companies or through certain groups within SPI. Or, three, have the PVC industry take a leading role in anticipating and in developing a positive public relations and technical program.

Summary

The PVC industry must be made aware of all the facts. A complete assessment should be made of the problems and problem areas. This should then be followed up by an assessment of what is being done and ask the question does this relate to the problems? At the same time, recommendations of what should be done must also be developed.

The PVC combustibility issue should be approached as an industry problem. While the industry literally sits still, it is constantly being attacked. The attack is straightforward. It goes like this:

> "PVC is a good material for its intended use, but in a fire situation it is BAD NEWS! Therefore, let's get rid of it and replace it with something else."

The overriding problem is that PVC is developing a bad name and is being identified as a material detrimental to life, health and safety.

Unless there is a concerted industry program (both technical and public relations), there will be no chance to effectively promote a positive image to important influentials like the fire community, regulators, specifiers, medical and legal community, news media, the general public and ultimately our customers. Further, there is no other way to effectively counteract the efforts of competitive interests such as iron and steel, cast iron and wood.

General Objectives of a PVC Industry Group Re: Combustibility

1.) Identify critical aspects of the combustibility problem and their significance.

2.) Design of a program to find solutions to these problems.

3.) Ultimately communicate positive results and findings to various audiences.

D. L. Kent

DLK/em

OPTIONS

ACTIVITY	RATIONALE	HOW AND WHAT?
DO NOTHING EXTRA.	ALL MATERIALS ARE THE SAME. PVC IS NO WORSE THAN OTHER MATERIALS. OTHER INDUSTRY ACTIVITIES WILL SOLVE THE PROBLEM. PROBLEM WILL GO AWAY.	CONTINUE CURRENT SPI EFFORTS (CCCS) AND INDIVIDUAL COMPANY EFFORTS.
SHOW, TELL & SELL (A) FIRE COMMUNITY (B) PUBLIC (C) MEDICAL-LEGAL	ENOUGH INFORMATION ALREADY AVAILABLE BUT NEED TO GET IT OUT.	PAC-PR FOR PVC. FUND OUTSIDE PR GROUP. INDIVIDUAL COMPANIES MUST MAKE SAME COMMITTMENT. MEDICAL - P.R. - LEGAL. ADDED EFFORT AT H & K.
CCCS - PVC SUB COMMITTEE	CCCS ALREADY ORGANIZED TO FIRE PROBLEM. HAS A BROAD BASE OF EXPERIENCE AND KNOWLEDGE ALREADY THERE.	PVC INDUSTRY ALLOCATE ADDITIONAL $ AND ADDITIONAL MANPOWER.

ACTIVITY	RATIONALE	HOW AND WHAT?
NON CCCS-PVC COMMITTEE	CURRENT CCCS EFFORT TOO DIFFUSE. PROBLEM ORIENTED NOT MATERIAL ORIENTED. CCCS MANDATE REQUIRES A GENERAL APPROACH TO PROBLEMS. PVC NEEDS ARE SPECIFIC.	PVC INDUSTRY ALLOCATE $ AND MANPOWER.
PVC-COMBUSTIBILITY SUB COMMITTEE OF PVC/VCM PRODUCERS	IF PVC/VCM PRODUCERS GROUP ACCEPTS STEWARTSHIP CONCEPT-THEN COMBUSTIBILITY SUB-COMMITTEE IS A NATURAL FUNCTION.	$ AND MANPOWER

Nov-10

Operating Unit Profile

USG: Concerned For Consumer Safety And Meaningful Standards

Concern for consumer safety was the prime motivation in forming SPI's Urethane Safety Group in June of 1972. The by'aws of the USG clearly state its objectives as follows: "(a) To constitute a group within the Society representing the urethane industry, to foster intelligent regulations, meaningful standards, and truthful communication looking toward safety for the consumer; (b) To assure that the urethane industry is represented on matters before governmental agencies, industry and other concerned groups as regards questions of urethane flammibility and the safe use of urethane products; (c) To collect statistics and other data concerning the safe use of urethane; (d) To support and conduct research and testing programs related to the safe use of urethane."

Forty Members

For the past four years, the USG has been composed of approximately forty member companies and operates under the direction of a fifteen-member Steering Committee. Day-to-day operations are conducted by a full time SPI staff director, Arthur B. Chivvis.

"In the past four years, USG has done considerable large-scale fire testing of both rigid and flexible urethane foams," reports Richard H. Davis, newly elected Chairman of the group. "These testing programs, which are continuing, have assisted greatly in the development of building code provisions and guidelines on the safe and proper uses of our products." Mr. Davis is manager, Urethane Chemicals, the Dow Chemical Company, U.S.A.

Noting that the principal emphasis of the group has been in the area of combustibility, Mr. Davis points out that USG has sponsored sixteen fire tests of various configurations of polyurethane foam assemblies and control assemblies to determine their combustibility behavior in simulated industrial constructions.

These tests have been conducted in the large-scale corner wall facility of the Factory Mutual Research Corporation, Norwood, Mass. Specifically, what the test includes is a facility 25 feet high with a 40-foot fall and a 50-foot wall, roofed over. The ignition source is a 750-pound crib of wood, ignited in the corner, producing temperatures of over 1000 degrees Fahrenheit. This makes it a very severe test.

Results Published

The tests have been conducted with various types flame barriers, both metal and spray-on, and under sprinklered and non-sprinklered conditions. Results of each series of tests have been published and widely distributed to foam contractors, general contractors, architects, building owners, building inspectors and the fire services.

Results of these corner wall tests have been instrumental in development of new provisions on foam insulation that have been written into the national model building codes. These provisions have been translated into many local and state building codes.

The Factory Mutual test results were also an important factor in the deliberations of the Federal Trade Commission, in which twenty-five industry members and SPI signed a consent agreement in 1974. Under the agreement, a Product Research Committee was established to coordinate and manage a scientific research program on the combustibility of cellular plastics for a period of five years. It is financed by a $5,000,000 program fund provided by the assessment of the respondents to the agreement.

Objectives of the program are: "(a) To determine the most effective manner for employing cellular plastics and systems containing such products to minimize fire hazards in the final intended uses; (b) to develop guidelines for the effective use of such cellular plastics; (c) To develop tests or the basis for standards, including large-scale tests as well as methods by which the results of small-scale tests can be correlated to provide an index of the behavior of cellular plastics in various burning conditions, which tests accurately relate in real fires."

Mini-Corner Tests

One aspect of fire testing criticized by the FTC was the use of small-scale tests. As a result of research work done by a USG member, The Upjohn Co., Factory Mutual has reported achieving a high degree of correlation to large-scale burns with a mini-corner at one-twelfth scale. Further experimental work is now being done, and if it proves successful, the mini-corner will permit the speeding-up of fire testing of solid and cellular plastics and other building materials at less cost than large-scale methods.

Similar important test work has been performed on flexible polyurethane foam, which is used for bedding and furniture, at the Rubber and Plastics Research Association in the United Kingdom under the auspices of an intercompany panel and the International Isocyanate Institute, and at Southwest Research Institute in the United States under the sponsorship of the Urethane Safety Group. Generally speaking, these tests studied ignition of cushioning materials using cigarettes, methanamine pills, newspaper and a multiple flame gas burner as ignition sources. Ignition, flame spread and heat and smoke development data were compiled and analyzed and gaseous combusion products of burning materials identified.

More recently, USG has been conducting discussions with the Oil Industry Association on the feasibility of conducting tests on rigid spray-on polyurethane foam used to insulate huge tanks and pipelines. As test information is developed, it is disseminated for industry use.

Status Report

Basic to the USG informational effort has been a "Status Report" providing an overview of flexible and rigid polyurethane foams and safety considerations. The first companion to this document was a two-page bulletin titled "Fire Safety Guidelines for Rigid Polyurethane Foam Insulation", containing information on building code provisions and additional guidance from the Urethane Safety Group. This bulletin has been republished and quoted broadly in insurance publications, building code magazines, construction media and elsewhere. USG now has under development a set of fire safety guidelines for furniture manufacturers and reupholsterers that pertain specifically to flexible polyurethane foam.

Results of the Factory Mutual corner wall tests have been published in two bulletins, one on fire testing involving metal facings and the other involving spray-on thermal coatings.

USG has also produced a sound and slide presentation based on the fire safety guidelines and building code provisions and has made it available to professional groups on a sale or lease basis. Seventy-five of the sets have been in circulation and it is estimated to date that close to 20,000 professionals in the safety and combustibility fields have seen the presentation.

More recently, USG has developed a second slide presentation which speaks directly to the concerns of firemen, and this is being made available to the fire services throughout the country.

USG's most recent publication is a report prepared by the Stanford Research Institute summarizing the results of the flexible foam fire testing done at Southwest Research Institute and in the United Kingdom.

Using the slide presentations and other materials as the basis for a speaking tour, Mr. Chivvis has carried the story of urethane safety to meetings of urethane contractors, firemen, insurance industry personnel, agricultural builders, and industrial tank engineers. In recent months, industry representatives have been meeting with various state and federal officials concerned with a series of mattress fires started by prisoners in their cells or in prison storage areas.

There is no doubt that since its inception, SPI's Urethane Safety Group has become an effective industry vehicle for promoting the safe use of urethane in the construction industry and educating governmental agencies, the fire community and urethane markets in regards to questions of flammibility. At the recent annual meeting, it was pointed out that during 1975, polyurethanes had done comparatively well for an off year, particularly in building insulation, where there was a 15 percent increase in use despite a drop in construction as a whole.

FIRE RESEARCH:

A Progress Report from the Plastics Industry

JOHN A. BLAIR

Chairman, Coordinating Committee on Consumer Safety
The Society of the Plastics Industry

Based upon suggestions from inside and outside the industry, and in order to attack more directly mutual problems relating to fires and consumer safety, the technical programs of The Society of the Plastics Industry (SPI) have been altered to deal in a more direct manner with actual fire hazards that can be adequately defined. These programs are discussed in this article.

About a year ago, Ralph Harding, President of The Society of the Plastics Industry, in his address to the International Association of Fire Chiefs, cast out a challenge to the fire community. That challenge, in essence, stated:

> Tell us the needs, as you see them, and let us, in SPI, see how we might alter our present programs and/or establish new programs to find answers to those needs.

The response has been rapid and thoughtful. Individual members of many groups have contributed: the National Fire Protection Association (NFPA), the National Fire Prevention and Control Administration (NFPCA), the International Association of Fire Chiefs (IAFC), the International Association of Fire Fighters (IAFF), the Fire Marshals Association of North America (FMANA), the International Society of Fire Service Instructors (ISFSI), Underwriters Laboratories (UL), the Consumer Product Safety Commission (CPSC), International Conference of Building Officials (ICBO), the Factory Mutual Research Corporation (FM), the American Society for Testing and Materials (ASTM), the American Institute of Architects (AIA), the University of Utah, the National Bureau of Standards (NBS), the University of Michigan, Harvard University, and many others.

Based upon the responses, we in the plastics industry are placing increased emphasis, in our programs, on dealing with hazards of actual fire situations. To do so effectively, we are concentrating on known hazards and/or hazards that can reasonably be expected. Hazard analyses provide the guidance for our programs — for only when the problem has been adequately defined can we develop the proper solution.

The responses have been so meaningful, and so much interest has been shown, that we have asked for and received the help of representatives from various organizations to direct some of our programs. In fact, three of our newest and most important programs are being developed and administered by members of nonindustry groups, including the NFPA, NFPCA, IAFC, IAFF, FMANA, ISFSI, the California Fire Marshals and Fire Chiefs, and ICBO, with the SPI mainly supplying part or all of the funds.

Our own analysis and evaluation to date indicates that we must develop proper scale tests that will lead to controls for proven fire hazards in given product applications. This is also a principal concern of the Federal Trade Commission, as evidenced by the work of its Product Research Committee. Therefore, we are putting our greatest efforts into large-scale testing and trying to produce correlative results in smaller scale, rather than simply trying to improve such existing small-scale tests as ASTM D 635 and D 1692 and/or adding "let-the-user-beware" caveats. While caveats are required and may be appropriate in some cases, they really should be used only as a backstop until proper solutions are found.

Mr. Blair is Senior Consultant for The Du Pont Company.

Our method of operation is to work on a mutual basis with all interested groups, reviewing all programs underway in the United States and Canada, and then to provide financial and/or technical support to those that have the most pertinent programs underway. If we determine that there is a need for additional effort in a specific area, we then consider initiating a specific SPI program. We have found this overall cooperative approach to be the most effective in producing the best results toward consumer safety in the shortest period of time. This approach minimizes duplication of effort and provides communications and discussions from the start, tending to reduce the time span between the end of experimentation and adoption of an adequate standard.

The major approach to combustibility research by the plastics industry is comprised of three steps:

1) Hazard analysis to attempt to determine all possible fire hazards;

2) Evaluation of the data to determine which hazards may be "unreasonable hazards" that warrant major action; and

3) Research to develop effective measurement and control methods for the defined major hazards.

Based on the results of this three-step approach, the plastics industry may modify its products, work for changes in standards or codes, or provide safe-use instructions and other information for consumers. Sometimes a combination of all three measures is required.

HAZARD ANALYSIS

A complete and technically sound analysis of the hazard is essential for any program aimed at true consumer protection. The problems must be properly defined first, if adequate solutions are ever to be found. For example, a slab of low-density foamed material lying in the center of a playing field cannot be envisioned as a hazard, except perhaps as a minor tripping hazard. On the other hand, that same low-density foam applied exposed to the ceiling of a nightclub (to make it look like a cave) where the occupancy may be high, the possible ignition sources numerous, and exits limited, can truly present an "unreasonable hazard."

Analysis of hazards must first be based upon a technically sound compilation of data, including case histories. The NFPA has always been first and foremost with fire statistics. Not only does it issue statistics on 30,000 fires, but it also makes compilations to indicate important trends.

The IAFF and the NBS published an excellent and comprehensive report on fire-fighter mortality in May 1976. And of course, one of the most comprehensive programs of data collection is the National Electronic Injury Surveillance Systems (NEISS) used by the Consumer Product Safety Commission (CPSC). Data relating to fabrics are included in the Flammable Fabrics Accident Case and Testing Systems (FFACTS), developed at NBS and now maintained by the CPSC.

The SPI wholeheartedly supports these efforts on data accumulation and encourages additional work now underway to improve the overall quality of detailed reporting.

Work within the SPI program that specifically relates to this area of data collection includes the following:

1) A proposed program conducted jointly by the Harvard University School of Public Health, the NFPCA, the Boston Fire Department, and the SPI that will analyze combustion gases at more than 100 actual fires to determine what products of combustion are being produced and whether they may present major hazards to either fire fighters or occupants. This excellent program, developed by Dr. William Burgess of Harvard, would be financed by the NFPCA and the SPI. The fire gas samples would be obtained at the fire location by members of the Boston Fire Department and subsequently analyzed at Harvard. Gases would be collected by instruments worn by the fire fighters during their first entry at the fire scene and also during cleanup operations. These would be analyzed for carbon monoxide, carbon dioxide, oxygen, nitrogen dioxide, hydrogen cyanide, hydrogen chloride, aldehydes (acrolein), etc., and their concentrations determined. In addition, the major combustible materials involved in each fire would be reported. A formal proposal has been submitted by Harvard to NFPCA and SPI for funding this program.

2) An independent "toxicity review" conducted with top personnel of key government, code, fire protection, and medical organizations, etc., through personal interviews. The objective of the review is to obtain a better "definition of the problem" and to adjust our programs accordingly. The review is expected to be completed during the last quarter of 1976, with any necessary changes in SPI programs coming by the summer of 1977.

3) The loan of an SPI scientist to the NBS as a research associate assigned by the NBS to the group whose responsibility is hazard analysis (analyzing fire statistics and causes).

4) The investigation of fires by independent consultants who have had many years of investigative experi-

ence. Such investigations sometimes become necessary when news reports implicate plastics. The investigations often show that plastics were not involved, or that the material used was not installed in accordance with codes or good standard practice.

5) The funding of a fire injury incidence study being conducted by Professor Irving Einhorn's group at the University of Utah. A detailed initial report presented in July 1975 at the University of Utah Polymer Conference series[1] analyzed 103 fires in Salt Lake City. The data obtained were similar to national data on causes of fires.

EVALUATION OF HAZARDS

Programs should be aimed at the elimination of defined "unreasonable hazards." Materials themselves cannot be correctly and technically defined as "hazardous," but must be evaluated in their specific end use. They can become hazardous only in respect to the degree of risk involved in the use of a material in a specific application. Many of the most hazardous situations result from the misuse of a material — that is, a use that is outside the original intent of the material supplier or fabricator. For example, common unmodified cellular foams are not intended to be used as a sprayed-on decoration, applied to and left exposed on the ceilings of a nightclub.

The plastics industry usually finds it difficult to obtain true findings of "unreasonable hazards" regarding its specific products. While data lead us to believe that misuse of cigarettes, alcohol, matches, gasoline, firecrackers, guns, etc., creates at least a severe degree of hazard, what is the true extent of hazards for items such as furniture stuffed with foam, and occasional furniture or kitchen cabinets made of plastics?

It is confusing at times to our SPI technical groups when they observe that relatively weak action is being taken against known hazards such as ignition sources (cigarettes, matches, cigarette lighters) or extremely flammable materials such as gasoline, etc. Yet there are a few who would indiscriminately ban the use of polyvinylchloride (PVC) in electrical conduit — "due to the hydrogen chloride toxicity problems." To date, there has not been one substantiated reported death, proven by autopsy, related to hydrogen chloride produced by combustion of PVC. Leading toxicologists tell us that hydrogen chloride is so irritating that a human cannot physically remain in a room in which it exists in the 50 ppm range, and the dangerous levels for hydrogen chloride are generally above 2000 ppm.[2] While data obtained to date indicate that hydrogen chloride is not an "unreasonable hazard" in ordinary fire situations, we are aware that special care should be taken if an unusually heavy concentration of PVC is involved in a fire – for example, in a telephone exchange or computer room. In this case, hydrogen chloride, being acidic, can contribute to irritation of the lungs, leading in severe cases to pulmonary edema generally one to three days following exposure.

The same precautions should be taken in any situation where large quantities of a single material are present, such as a storeroom full of wool clothing that can produce large amounts of hydrogen cyanide when it burns. This is particularly important when the space is totally enclosed. This is the situation as we see it to date; however, we are continually looking for and would appreciate any additional input based upon sound technical data.

Five recent programs on the evaluation of fire hazards appear to be extremely helpful. First is the excellent *Fire Fighter Mortality Report*[3] that was done by the IAFF for the NBS. This in-depth, 165-page investigation of the in-line-of-duty deaths of 101 fire fighters is an excellent example of hazard analysis. Forty-five of the 101 cases were related to heart attacks (which were brought on by: a) exposure to smoke/toxic fume inhalation, b) stress, and c) overexertion). The *Report* concluded that: "The case investigations have uncovered numerous problems of fire fighter's health and safety which require immediate attention. Solutions to several of the problems are evident. . . ." Because of the pertinent information presented, this *Report* should be "must reading" for each of us in the fire community. But the *Report* itself is only the beginning. While the *Report* lists only two deaths directly related to toxic fume inhalation, toxic fumes — particularly carbon monoxide, with its effect on the oxygen-carrying capability of the blood — must be considered as a factor in many of the 45 heart attack cases and in the nine cases attributed to smoke inhalation. The *Report* emphasizes that fire fighters should wear self-contained breathing apparatus "in all fire situations."

The second good example of hazard analysis is the report "Fire Death Scenarios and Firesafety Planning,"[4] developed by the NBS and the NFPA. This report discusses the use of fire scenarios and lists the 14 top fire

[1] I. N. Einhorn and Newman, Polymer Conference Series, Flammability Research Center, University of Utah, July 1975.

[2] Y. Henderson and H. W. Haggard, *Noxious Gases*, Second Edition (American Chemical Society, Monograph Series No. 85, 1943)

[3] Thomas Balanoff, *Fire Fighter Mortality Report*, produced by the International Association of Fire Fighters for the National Bureau of Standards, May 1976.

[4] F. B. Clarke, III and John Ottoson, "Fire Death Scenarios and Firesafety Planning," FIRE JOURNAL, Vol. 70, No. 3 (May 1976), p. 20

scenarios that account for 66 percent of the fire deaths in the United States. Key conclusions of the report include the facts that: a) 27 percent of all fire deaths are related to fires in residential furnishings caused by cigarettes and other smoking materials; b) 54 percent of all residential fires involved the ignition of furnishings (one-half of them in mattresses and/or bedclothes; one-half in upholstered furniture); and c) *all* scenarios involving 2 percent or more of the fire deaths occur in the home. This report provides us with many important points.

A third example of good hazard analysis is the study conducted by Dr. Radford and others at the Johns Hopkins University Applied Physics Laboratory,[5] where the survey of 206 fire deaths in Maryland (from 1971 to 1974) showed definite carbon monoxide poisoning in 50 percent of the deaths. In 52 percent of the deaths, the cause of the fire was a cigarette or other smoking material. Dr. Radford further explains the extreme hazards of carbon monoxide. If an adult is exposed to a 5 percent concentration of carbon monoxide, which may frequently be encountered in fire situations, it will take only ½ to 1½ minutes to reach a 50 percent carboxyhemoglobin concentration in the blood. Compared to carbon monoxide, hydrogen cyanide is very soluble and will be taken up by body fluids. Dr. Radford indicates that for that reason, it is "probably relatively rare" to have a concentration of hydrogen cyanide in a fire sufficiently large to cause significant injury. Irritant gases such as aldehydes, on the other hand, will have an immediate effect because they become concentrated in the lungs, instead of being distributed throughout the body.

As a fourth example, Dr. Zikria of the Columbia-Presbyterian Medical Center of New York City has done some excellent studies[6] relating to the cause of death after arrival of the fire victim at the hospital. This work provides information on how gases and heat cause respiratory burns, and on injuries caused by inhalation of smoke and fumes — including carbon monoxide, aldehydes, and acidic and basic gases. Dr. Zikria's work has also involved studies with the irritating aldehydes in wood, specifically acrolein. Dr. Zikria has previously stated that: "It is likely that the agents causing tracheobronchial and pulmonary parenchymal damage of smoke poisoning in man are also the aldehydes which are found in large quantities in smoke and combustion of wood, cotton, furniture, and nonsynthetic structural materials." This type of investigation is important in regard to the possible damage caused by the more unusual aspect of gases produced during fire situations.

Professor Einhorn's group at the University of Utah[7] is evaluating additional independent data based upon the Fire Injury Surveys. This program is placing its major emphasis on the physiological and toxicological effects of combustion products.

All five of these studies provide us with some items on which to take immediate action. It is evident that toxicity is a major problem. There are so many unknown factors relating to toxicity, whereas the characteristics of ignition, heat release, and flame spread are defined more easily. All combustible materials (cotton, wool, wood, etc., as well as synthetics) present a hazard in regard to the toxicity of combustion products when involved in a fire situation. All of these materials produce carbon monoxide, which is the major cause of fire deaths. Furthermore, additional gases such as acrolein (wood), hydrogen cyanide (wool and urethanes), and hydrogen chloride (polyvinylchloride) may be produced. It is essential, therefore, that we determine whether these or any other materials may present an "unreasonable hazard." For this reason, a major part of the research effort being conducted by many groups, as well as by the SPI, is at present aimed at developing a testing method for evaluating materials and the toxicity of their combustion products in order to determine which, if any, of them may present an "unreasonable hazard."

Within the SPI: 1) the principal job of hazard evaluation is conducted by the Coordinating Committee on Consumer Safety (CCCS), which is comprised of representatives of 20 operating divisions concerned with various categories of plastics products. This Committee, which meets quarterly, assembles information on hazard analysis, searches out potential problems, reviews ongoing research, and determines directions for new research. Research programs may be conducted directly under the supervision of the Committee or by one of the operating divisions.

2) At the request of the National Bureau of Standards, the SPI has been supplying it with commercially significant materials for toxicity review and bioscreening of combustion products. This program, funded by the NBS, has to date evaluated at the Flammability Research Center of the University of Utah nearly 140 samples of materials with and without flame-retardant additives. Included are polyurethane foam (rigid and flexible), polyvinylchloride, polystyrene (expandable and rigid), polyolefins, and polyesters. Thus far, there has been no reported indication that any of these commercially significant materials presents an "unreasonable hazard" when subjected to heat or combustion.

[5] Edward P. Radford, "CO Is Still Worst of Lethal Gases. Fire Casualties Seminar Learns," *Fire Engineering*, Vol. 128, No. 9 (September 1975), p. 31.

[6] B. A. Zikria, et al., "A Clinical View of 'Smoke Poisoning,'" a paper given at Physiological and Toxicological Aspects of Combustion Products an International Symposium held March 18–20, 1974, at the University of Utah. (Published by the National Academy of Sciences, Washington, D.C. in 1976).

[7] See page 59 of this article.

RESEARCH EFFORTS

Technical development efforts on combustibility are continuing at several locations, where many groups are now conducting full-scale testing. These include the NBS, Underwriters Laboratories Inc., Factory Mutual, the Federal Aviation Administration (FAA), the National Aeronautics and Space Administration (NASA), the Rubber and Plastics Research Association (RAPRA) of England, the National Research Council (NRC) of Canada, the Southwest Research Institute (SWRI), the University of California, etc. A key effort on fire research by the Product Research Committee is now underway. This Committee, set up as a result of the 1974 Consent Agreement between the Federal Trade Commission, 25 plastics manufacturers, and the SPI, is spending $5 million over a five-year period on fire research relating to cellular products. Recent reports of large-scale testing include such reports as *Fire Hazards of Plastics in Furniture and Furnishings Fires in Furnished Rooms* (Palmer, Taylor, and Paul, RAPRA, February 1976); and *Flammability Studies of Cellular Plastics and Other Building Materials Used for Interior Finishes* (Underwriters Laboratories, 1975).

Much of the concern in this area focuses on toxicity of combustion products, and one example of an important pertinent report is *The Physiological and Toxicological Aspects of Combustion Products* (International Symposium of the National Academy of Sciences, 1976).

Technical efforts of the SPI include the following:

1) A committee on *Fire Services Full-Scale Testing* has been developed that includes members of the California fire fraternity and the SPI. The purpose of this committee is to develop guidelines, rationale, procedures, etc., for future full-scale testing — including full-scale building burns. This committee is being directed by members of the California Fire Chiefs Association, the International Association of Fire Chiefs, the California State Fire Marshals, and the International Conference of Building Officials. Its concept, although ambitious, has the potential to help identify the many dynamic variables in actual fire situations in multistory buildings.

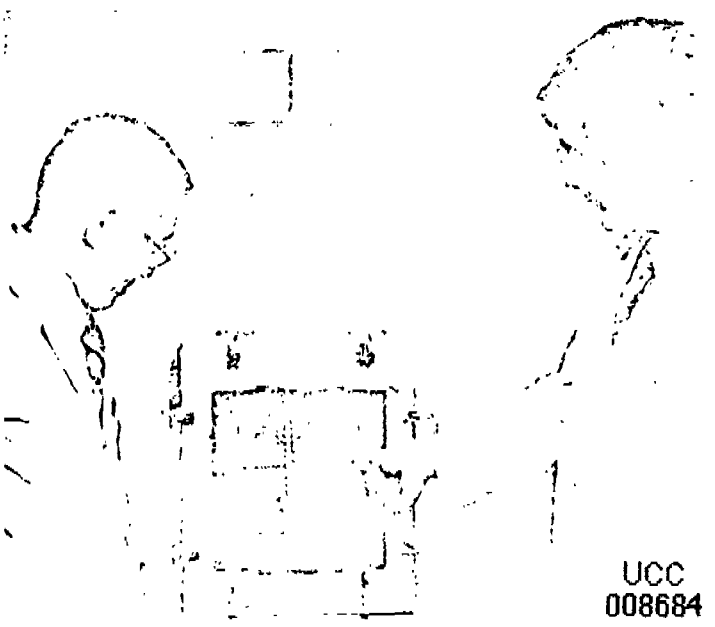
2) The second two-year period of the cooperative *SPI-NBS Research Associate Program* has been initiated. Six more scientists have been assigned to the Bureau to help develop firesafety technology. The group contributes to investigation of such areas as ignition toxicity of combustion products, flame spread, rate of heat release, and analysis of real fires. During the previous two years, the SPI's first six Research Associates, who have now returned to their respective companies, contributed to the NBS development of a radiant panel test for flooring and carpets, the extensive review of the furniture markets with a view toward establishing firesafety guidelines for furniture manufacturing and material suppliers, the development of the modified smoke density measurement chamber, the refinement of a method to measure the rate of heat release from materials, and the establishment of a rationale and technique for the analysis of combustion gases.

3) The NBS has stated that there is "no standard test method" available for adequate evaluation of hazards relating to combustion products from burning materials. At the same time, however, the NBS announced -- as a projected target — the development of a standard method for evaluating materials as an "unreasonable hazard" with respect to toxicity of combustion products. Following development of such a method, a second phase will attempt to develop a more refined and definitive test for evaluations. The SPI now has two Research Associates at the NBS assisting in this important project.

4) One SPI Research Associate is assisting in an aggressive NBS program aimed at designing and building a new calorimeter for *measurement of rate of heat release* (BTU/min) — a parameter considered by many to be important with respect to "flashover." The NBS reports that the design has been completed. Installation and demonstration of the equipment is scheduled for 1977.

5) At the University of Michigan, the SPI is conducting a joint program with the Manufacturing Chemists Association (MCA) to develop a system to evaluate the toxicity of combustion gases using a biosereening technique (rats) response to death and/or incapacitation. The

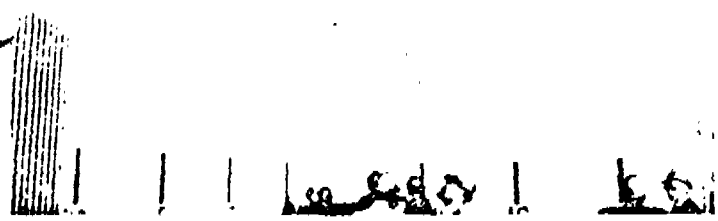
At Du Pont's Haskell Laboratory for Toxicology, Dr. J. B. Terrill (right) discusses with Dr. K. P. Lee, DVM, the loss of hind leg function in exercised rat resulting from carbon monoxide-induced anoxia. Experimentation of this type is being conducted in many laboratories to determine the effects of products of combustion in fires.



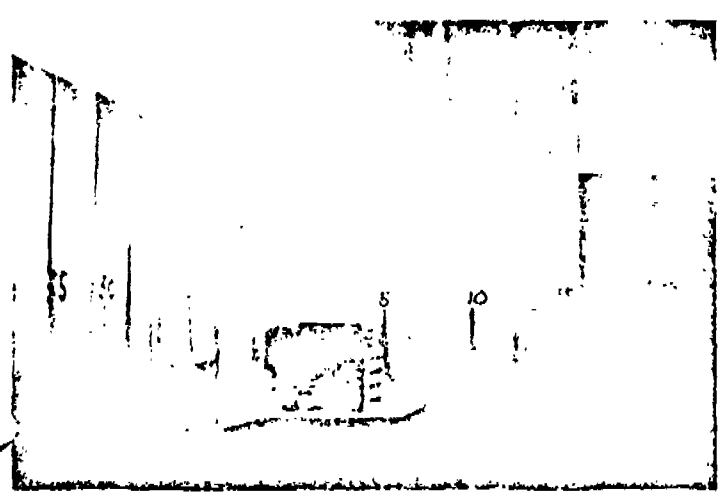
ultimate aim is a system to determine which, if any, materials might present an unusual hazard. Considerable progress toward this objective has been made. At present, the work is concentrating on improving the techniques used in the past for determination of "incapacitation." Many of the old techniques (such as the tumble cage) require prior training of the rats and/or make it difficult to determine the point of incapacitation (falling versus sliding, etc.). A roto-rod technique shows good potential as being less subjective.

6) Eight full-scale tests have been conducted to determine what type of fire protection is needed for warehousing of short life-cycle plastics (e.g., polyethylene bottles, foam trays and cartons, and polystyrene cups) commonly stored in commercial warehouses. Results of those tests, conducted at Factory Mutual, have demonstrated sound methods of storage configurations and sprinkler protection for plastics commodities. Additional tests are planned to further refine the information that is being provided to insurers, the fire service, and standards-making groups.

Engineers at Factory Mutual Research Corp. study installation of foam plastic insulation in preparation for a fire test on large-scale corner wall. Such tests have been conducted for the plastics industry since 1972.



Factory Mutual's large-scale corner wall is 25 feet high with 50-foot and 40-foot-long walls. Wall materials are tested in conditions simulating a factory installation. The fire source is a 750-pound crib of wood generating temperatures of over 1000°F.



7) The Urethane Safety Group has just published a new bulletin on four large-scale corner wall tests, conducted at Factory Mutual, that involved spray-on thermal coatings over spray-on polyurethane foams. Those tests followed 12 corner wall tests that involved exposed and metal-clad polyurethane foam panels and control materials. Some of the test materials were rated acceptable by Factory Mutual and some failed, providing a great deal of guidance on sound applications.

8) The Plastics Pipe Institute of SPI has sponsored a number of tests at the research facilities of Ohio State University and the University of California at Berkeley. These tests, based on ASTM test method E 119, are designed to determine the effect of penetration with plastics pipe on fire-rated walls and floors. The data gathered thus far indicate that, when properly installed, plastics pipe will not reduce the endurance rating of fire-resistant construction, nor will it serve as a vehicle for the spread of fire through a structure.

9) All Research Applied to National Needs (RANN) programs related to firesafety have been transferred to the National Fire Prevention and Control Administration by the National Science Foundation. One ongoing, significant, sophisticated program at the University of Utah involved bioscreening analysis of traditional materials (wood-cellulosic) and synthetics (PVC, urethane). The SPI funds all six graduate students who are working on this program.

10) Recently, the Expanded Polystyrene Block Molders Committee has been conducting fire tests of its products in a dwelling-size corner at Underwriters Laboratories Inc. They also are conducting, at Factory Mutual, large-scale warehousing tests on materials used as packaging insulation for appliances.

11) A fellowship has been awarded to Johns Hopkins University for the development of methodology on toxicity, in conjunction with the NBS.

12) Our work at the Southwest Research Institute (SWRI) has shifted to determination of the effects of density on the rate and quantity of off-gas evolution. This program is nearing conclusion. Although the program

Representatives of the fire services at a working session with the Society of the Plastics Industry to devise a training program for fire fighters on plastics and combustibility. First phase of the program has been completed and development of training materials is underway.

was originally intended to be of relatively short duration, the complexity of analyzing products to determine the toxicity of their combustion off-gases presented a number of technical difficulties that were not easily solved.

13) The Polystyrene Safety Group has work underway at SWRI relating to methodology that, while specific to their products, will add to the overall technology.

14) In cooperation with the State Fire Marshal of Ohio and Patton Life Safety Systems, the SPI sponsored a series of burns in which sprinkler systems were tested for possible residential use. Work in this area, and on smoke detectors, is expected to be continued and expanded under the direction of the NFPCA.

CONTROL OF FIRE

The results of all this analysis, evaluation, and research obviously would be meaningless if the steps ended there. But they do not.

Members of the plastics industry are constantly analyzing results obtained from these programs and field experience in order to modify their products and develop new ones.

In addition, SPI members are and have been participating for many years, with many others in the fire community, in developing proper standards and building code provisions in recognition of the fact that fire is an enemy to all of us.

It is becoming increasingly obvious that our abilities to control unwanted fires through design of materials and assemblies, while improving all the time, will never provide the total answer because combustibles will always be with us in the built environment. Therefore, it is essential that adequate systems for rapid detection and suppression also be used — for true life safety.

One of the best examples of this type of system is Disney World in Florida, where a planned combined system of detection / alarm / suppression / smoke venting, coupled with compartmentalization, permits widespread uses of combustible materials (treated wood and plastics) in an area of greatest concern — one of the most densely populated (with children) areas in the world.

Another very important step involves education and communication. Specific efforts within the SPI include:

1) Distribution by the SPI and its member companies of many safe-use bulletins describing proper methods for handling and installing their products, and encouraging adherence to building code provisions that prescribe proper uses.

2) A project now underway at the NFPA to develop a training program concerning plastics for fire fighters. The project is being developed by the NFPA staff with guidance from members of the IAFC, IAFF, FMANA, ISFSI, and SPI, who meet regularly. The first phase, involving research and design, has been completed and the program should be ready for distribution and use by early 1977.

The use of plastics in the built environment has grown very rapidly in the past quarter century, and projections indicate that it will continue to grow. The SPI is concerned that this be a proper growth, not accomplished at the expense of firesafety. In 1977, we should begin to see results from many of the programs described in this article, and these will be passed along to the fire community. We believe that, with the help of the fire community, we are on the right track with our programs, but obviously a great deal of additional work needs to be done. The SPI welcomes constructive criticism and suggestions on how changes can be made in its constant reevaluation of its programs. △

POLYMERS AND FIRE

Our initial objective in producing our film entitled "Polymers and Fire" was to put into proper perspective the flammability characteristics of synthetic materials, especially PVC. We felt there was need to communicate with the fire community, architects, building trades, code officials and the public in general. We wanted to illustrate how the positive flammability characteristics of PVC were being used to advantage in wire insulation, furniture covering, building components and the like.

As the project developed, and as we reviewed our progress with various groups in the building trades, and with members of the fire community, one thing of special significance emerged. It became apparent that the fire community did not have a clear understanding of the compositional relationship between synthetic polymers and natural polymers and how this relates to flammability. We also found that in most cases, the firemen viewed with alarm the toxicity of the combustion products of the little understood man-made polymers. In contrast, they seemed to believe that exposure to combustion products from natural polymers or traditional materials were less hazardous and there was less need to rely on self-contained breathing apparatus.

As a result, we abandoned our original idea to produce a film on PVC alone and used this opportunity to make a film that would have a broader educational message of all "Polymers and Fire" aimed especially at firemen.

The main message is that all polymers, natural and man-made, produce toxic gases when burned and the best protection for firefighters against this hazard is the self-contained breathing apparatus.

The film illustrates:

- That polymers are the most common class of materials to be involved in fires and include both natural and man-made materials such as wood, wool, cotton and synthetics.
- That polymers are long chain molecules containing carbon.
- When carbon-containing materials burn, carbon monoxide is usually generated. This is the main threat to life safety. In addition, other toxic gases are also produced--depending upon the polymer's composition. PVC is one of the polymers included.
- The firefighter must assume that the atmosphere around all working fires is hostile and his best defense against toxic combustion products is the self-contained breathing apparatus.