



A Division of The Society of The Plastics Industry, Inc.

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Executive Director

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TO: VI Executive Board

RE: Presentation to PVC '93

The attached paper was presented by Roy Gottesman to the PVC '93 conference in Brighton, England. This piece was actually written in late 1992 for inclusion in the proceedings book and an updated version was given on April 27th to the 500+ attendees at the meeting.

This is an excellent history of the industry over the past twenty years, plus a very accurate summary of the current status and outlook. We suggest appropriate circulation within your organization and again thank Roy for this contribution to the Vinyl Institute.

RHB/pmb

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ISSUES AFFECTING THE PVC INDUSTRY IN THE UNITED STATES

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An overview of U.S. PVC production capacity, consumption, exports and use patterns is provided. Two early industry issues dealing with health and safety related to vinyl chloride exposure and fire/combustion toxicity and the successful means used countering them are reviewed. Current issues dealing with disposal of PVC including recycling, incineration and tertiary recovery and recent anti-chlorine initiative of Greenpeace are discussed. Finally, two uniquely U.S. issues: FDA action on PVC in food packaging and the California Environmental Impact Report on Plastic Pipe are reviewed.

INTRODUCTION

In recent years, the PVC industry has been subjected to many regulatory and environmental assaults that, if allowed to go unchallenged, could impede the use of this versatile material and reduce its continued market growth. Because the PVC business is global in nature, vigilance is required by the industry in the United States, so that it is aware of such activity in Europe and elsewhere in the world. While such attacks may be based on an emotional bias rather than on sound scientific grounds or technical accuracy, they must be dealt with seriously. With modern worldwide communications, the transfer of information or misinformation by environmental activist groups occurs with increasing frequency and must be addressed expeditiously. The purpose of this paper is to review the major issues that currently face the vinyl industry in the United States, what action is being taken and how industry cooperation on a global basis is needed to respond to these challenges.

THE U.S. PVC INDUSTRY TODAY

Before discussing the issues affecting the PVC industry in the United States, a brief overview of the industry is in order.

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Production capacity and the domestic consumption of PVC in the United States for the period from 1972 through 1991 was one of steady growth. Production capacity more than doubled from some 4.3 billion pounds in 1972 to almost 9.7 billion pounds twenty years later. Consumption over the decade from 1981-1991 showed a compound average growth rate of 4.9%. During the past twenty years, the only significant downturn in consumption occurred in 1975, the year that followed the disclosure of the occurrence of angiosarcoma, a rare liver cancer, in PVC plant workers as a result of repeated high level exposures to vinyl chloride monomer in occupational settings. Domestic consumption dropped 21.8% (from 4.414 billion pounds to 3.452 billion pounds) that year and the utilization of production capacity dropped from 90.3% to 65.8%.

Since 1975, a shake-out has taken place in the United States and a number of companies shut down plants with a multiplicity of small capacity reactors as a consequence of more stringent regulations coupled with the emergence of large-scale reactor technology. Two foreign-based companies Formosa Plastics and Shintech entered the U.S. market with domestic-producing facilities and a third, Westlake Polymers, acquired facilities formerly operated by Air Products Company. Information published by the Society of the Plastics Industry in its annual "Facts and Figures of the U.S. Plastics Industry" shows that the number of producers dropped from a high of 23 in 1976 to 12 in 1992 (1).

In addition to an increase in domestic consumption of PVC in recent years, there has also been a marked increase in exports abroad by United States producers as shown in Table 1 (1).

TABLE 1 - United States Domestic Consumption and Exports of PVC

Millions of Pounds Per Year				Percent Export
Year	Domestic	Export	Total	
1987	7,650	430	8,808	5.3
1988	7,770	517	8,287	6.2
1989	7,575	918	8,493	10.8
1990	8,051	945	8,996	10.5
1991	7,593	1,493	9,086	16.4

PVC exports from the United States were expected to drop in 1992 to about 1.2 billion pounds or about 12% of the production. The reasons for the increased exports are manifold including the following - United States producers are the world's lowest cost manufacturers as a consequence of plentiful ethylene supplies assuring cheaper feedstocks; the cheaper dollar based on recent currency exchange rates; large foreign markets unable to be satisfied by local suppliers and the dramatic increase in United States production capacity as noted above.

The export of over one billion pounds per year, principally to the Far East, is expected to continue. Together, the Far East and

Japan account for almost one-third (32%) of the world demand for PVC.

Use patterns are significantly different in the United States as compared with the rest of the world as shown in Table 2 (2).

TABLE 2 - PVC Demand By Market, 1991

	<u>United States</u>	<u>Rest of World</u>	<u>Total</u>
Pounds (Billions)	7.6	32.4	40.0
	<u>Demand By Use Market, Percent (%)</u>		
<u>Durable Applications</u>			
Pipe and Fittings	44	30	33
Rigid Profiles	18	9	11
Rigid Film and Sheet	4	12	11
Flooring	4	4	4
Wire and Cable	<u>5</u>	<u>9</u>	<u>8</u>
Sub-Total	76	64	67
<u>Disposable Applications</u>			
Bottles	3	6	5
Flexible Film	<u>9</u>	<u>13</u>	<u>12</u>
Sub-Total	12	19	17
<u>Other Applications</u>	<u>12</u>	<u>17</u>	<u>16</u>
TOTAL	100	100	100

PVC usage in long-lived durable applications such as in building and construction is some 18% higher in the United States than elsewhere in the world. This is largely due to the much higher consumption in the manufacture of pipes and fittings and in rigid profiles used in vinyl windows, doors and siding.

On the other hand, the use of PVC in short-lived disposable applications is almost 37% higher outside of the United States. This higher level of disposables becomes of importance when considering plastics waste disposal options, particularly recycling and incineration.

Issues affecting the United States PVC industry will next be discussed in the following order:

1. Earlier issues and the response to them.
2. Current issues of a global nature and actions underway.
3. Issues unique to the United States.

EARLIER ISSUES AND THE RESPONSE TO THEM

Health and Safety Aspects

On January 22, 1974, the National Institute for Occupational Safety and Health (NIOSH) reported to the U.S. Occupational Health and Safety Administration (OSHA) that the BFGoodrich Company had informed NIOSH that the deaths of three employees from a rare form

of liver cancer, angiosarcoma, might have been occupationally related. In subsequent OSHA hearings it was revealed that employee deaths due to angiosarcoma had been discovered at other companies including Union Carbide, Firestone Tire and Rubber Company and Goodyear Tire and Rubber Company. The most recent compilation (3) of the "World Register of Angiosarcoma of the Liver (ASL) due to VCM" published in February 1991 reported a worldwide total of 161 cases. Of these, 39 cases occurred in the United States in which the dates of the first exposure of affected employees to vinyl chloride occurred between 1942 and 1968. The average latency period, that is the time between first exposure and onset of the disease, was 25.67 years. All of these cases occurred before the installation of the vinyl chloride controls and automatic polymerization reactor cleaning.

As a result of hearings held by OSHA, its final standard was promulgated, effective October 5, 1974 and was followed thereafter by regulations adopted by the U.S. Environmental Protection Agency (EPA). These stringent emissions regulations along with other environmental regulations including the Clean Air Act, the Water Pollution Control Act, the Resource Conservation and Recovery Act (RCRA) the Emergency Planning and Community Right-To-Know Act of the Superfund Amendment and Reauthorization Act (SARA) have resulted in such a reduction of toxic emissions (industry can trace a 95% reduction in vinyl chloride emissions since monitoring began in the 1970's) that there is today no real concern about the health and safety of workers in U.S. PVC plants. Because of the minimal emissions at plant sites and the rapid dispersion in air, community health effects are negligible. Indeed a number of monitoring programs have substantiated low levels of vinyl chloride in plant site communities and there is no evidence of chronic health effects in residents of such communities.

Fire Performance and Combustion Toxicity of PVC

Rigid PVC accounts for approximately 40% of all plastics used in construction and is, by far, the leading plastic used for pipes, fittings, conduit, window and door frames and siding. In these uses, PVC has replaced traditional materials such as metals, concrete, ductile iron and wood because of the many advantages that it provides including longer service life, higher corrosion resistance, fire retardance, lower cost and ease of installation.

As PVC usage grew and it replaced traditional materials, it became the victim of an unprecedented attack relating to its fire performance. A major producer of steel conduit used in electrical applications had seen its market share from some 50% to 32% due to the in-roads made by PVC conduit. It initiated a campaign aimed at consumers, contractors, legislators and building officials to publicize the hazards that it claimed were associated with the use of PVC conduit. It alleged that toxic gases were evolved from burning plastics, particularly PVC, and they were stated to be responsible for a so-called "intoxication syndrome", which resulted in disorientation of fire victims thereby resulting in their inability to escape from the fire scene. Though never proven to be valid scientifically, this campaign gained momentum as a result of

a series of spectacular hotel fires in which multiple deaths occurred.

Recognizing the need to counter this attack, it was apparent that scientifically valid information was necessary to refute these spurious allegations and little such information existed. It was further recognized that attempts to counter these emotional attacks with emotional counter-arguments was not productive. The Vinyl Institute initiated a two-pronged program involving research and education. It funded research studies at Southwest Research Institute in San Antonio, Texas dealing with both the toxicity of hydrogen chloride and authentic smoke from PVC fires as well as studies on the transport of fire gases from the site of the fire. These studies and others conducted on behalf of the Federal Aviation Administration showed that baboons, which are primates and have respiratory systems similar to humans, were not incapacitated after exposure to hydrogen chloride at exposure levels up to 10,000 ppm for 15 minutes and did not suffer any chronic health effects. This is particularly significant because hydrogen chloride levels in a typical fire rarely exceed 300 ppm. Further, these studies demonstrated that, unlike other gases evolved in fires, hydrogen chloride does not remain in the atmosphere because it is largely absorbed on the surface of common building materials such as cinder blocks, concrete and wallboard.(4) Armed with this information, a coordinated communications program was initiated to publicize these findings.

Separately, liaison was established with a number of firefighter organizations and an educational program established with the International Society of Fire Service Instructors to educate firemen on fighting fires involving plastics. A key element of this program was the recognition that carbon monoxide, a known toxicant generated when any material that contains carbon burns, whether that material is of synthetic or natural origin, represents the most significant fire hazard. The solution to minimizing fire deaths is not in the banning or regulation of useful products, but rather in appropriate fire prevention measures including sprinkler systems and fire/smoke detectors. In addition, firefighters needed to be educated to use proper protective equipment, including self-contained breathing apparatus when battling fires.

The net result of this combined research and education program was the defusing of the fire/gas toxicity issues as ones of lasting impact. Although there appeared to be a potential threat of legislation in various states, only one - New York State - enacted regulations that required the filing of combustion toxicity data for certain building materials and finishes.(5) This data was to be determined by use of a modification of a test developed at the University of Pittsburgh, but it has been shown that this test does not provide an accurate indication of the hazards that may result when such building materials are involved in a real fire. While the New York State Toxicity Data Bank filing is required, there are no limits or ranges that are set on toxicity values for what constitutes an acceptable product as the State recognized that this test could not be used for regulatory purposes. Other factors are more important in a fire scenario including rate of heat release,

smoke generation, ease of ignition and rate of flame spread. These factors are in computer programs developed by the National Institute for Science and Technology (NIST) used for fire modeling to develop a total hazard assessment.

The successful approaches used to counter these earlier attacks on PVC are useful as background because they show that a unified and concerted effort by industry must be brought to bear on significant challenges that threaten the industry's survival. Such efforts will continue to be needed to counter the current industry challenges.

CURRENT ISSUES

Disposal of PVC in Municipal Solid Waste

The safe and effective disposal of municipal solid waste is one of the major societal problems facing most communities in the United States. The lack of suitable available land spaces, community resistance to siting of new waste disposal facilities and the contamination of underground aquifers, often the sole source of a community's water supply, by leakage from older unlined landfills have resulted in an accelerated search for suitable management approaches. It is now recognized that the only real hope for solving this problem is to apply an integrated management approach that includes four basic methods:

1. Source reduction
2. Recycling
3. Waste incineration with energy recovery
4. Landfilling

Even though PVC discards in the municipal waste stream (MSW) are generally less than 0.5%, all plastics have been targeted for elimination from waste being landfilled.

Recycling

In the past few years, numerous communities have established plastics recycling programs in the aftermath of either state or local legislation. Most of the collected plastics from such programs are either polyethylene terephthalate (PET) beverage bottles or high density polyethylene (HDPE) milk jugs. However, a survey conducted by R. W. Beck and Co., for the former Council for Solid Waste Solutions (now the American Plastics Council) identified some 1,200 communities with access to vinyl plastics recycling through curbside, drop-off or buyback programs. As mixed plastics have limited utility, the separation for individual plastics from such mixtures for reclaim and reuse has been the focus of recent activity.

Vinyl plastics are almost always collected as part of an overall plastic collection program and manual sortation is largely used to separate the PVC away from other materials. However, automatic sortation devices are gradually being introduced and are gaining acceptance. (6)

The Vinyl Institute was one of the sponsors, along with the United States Environmental Protection Agency (EPA), of a project that led to the development of the first automatic sortation device to separate PVC bottles from other plastics. That device, which is based on the principle of electromagnetic radiation absorption due to the presence of the chlorine atom in the PVC molecule, have been trademarked Vinyl Cycle™ by its developer National Recovery Technologies, Inc. (NRT) of Nashville, Tennessee. Since the announcement of this development in October 1990, over 16 Vinyl Cycle™ devices have been placed in operation worldwide. At present, one such unit is in operation at Clearvue Plastics, Amsterdam, New York and a second NRT device is to be installed at Envirothene in Chino, California early in 1993 under Vinyl Institute sponsorship.

A second sortation system has been developed by Magnetic Separation Systems (MSS) also of Nashville, Tennessee and utilizes an x-ray fluorescence detector developed by ASOMA Instruments, Austin, Texas. The MSS system, called Bottlesort™ was first installed at Eaglebrook Plastics Inc., Chicago, Illinois in 1991 and at Environmental Recycling, Inc., Raleigh, North Carolina in 1992. MSS PVC bottle separation system was also installed under Vinyl Institute sponsorship as a demonstration project at Waste Alternatives in Ocala, Florida in January 1993.

It is believed that these programs have been invaluable in thwarting legislation that might have restricted the use of vinyl in packaging based on erroneous allegations that it was not recyclable.

Incineration

Another option for disposal of PVC in MSW is incineration. However, because of concerns regarding acid gas (HCl) generation during incineration processes and the potential projection of dioxins, the Vinyl Institute was one of the sponsors of a test program carried out by the New York State Energy Research and Development Authority (NYSERDA) at a full scale incinerator in Pittsfield, Massachusetts under the auspices of the American Society of Mechanical Engineers (ASME). Those tests, completed in 1987, revealed that the presence or absence of PVC had no statistically significant effect on the formation of dioxins or furans (PCCDs and PCDFs).(7) The test program showed that incinerator operating conditions was the most important factor in minimizing dioxin formation.

With regard to acid gas generation, research has shown that properly designed scrubbing systems can remove approximately 99% of the hydrogen chloride generated from the incineration of PVC. Ambient air quality standards established by the EPA make such scrubbers mandatory on all incinerator installations. A leading manufacturer of incinerators, Ogden Martin Systems, has advised the EPA that its equipment can "tolerate reasonable increases in acid-producing waste components" without any adverse effects. Such incinerators do not require the use of any exotic metals in their fabrication.

Despite the development of this information in the United States, because of continuing concerns in Europe on this matter, the Vinyl Institute is participating in incineration research projects being managed by the European Council of Vinyl Manufacturers (ECVM) which are being carried out at the University of Umea in Sweden and at a Norwegian Scientific Institute.

Tertiary Recovery

Work is now underway under the sponsorship of the American Plastics Council to investigate the feasibility of obtaining useful chemical feedstocks by pyrolysis of mixed plastics feedstocks, including PVC, followed by recovery in a refinery as part of the crude petroleum feedstock. It is understood that similar work is underway in Europe.

While it is too early to know if this option will be successful, it could represent a low-cost alternative for recovering the value of plastics disposed of in MSW.

Anti-Chlorine Initiatives and its Linkage to PVC

While initially not as well focused as the activity of Greenpeace in Europe, recently Greenpeace, U.S.A. has accelerated its anti-chlorine activity. In the summers of 1990 and 1991, its campaign involved a boat that made stops at various cities along the Great Lakes where it largely staged media events aimed at promoting the phase-out of the use of chlorine and chlorine-based chemicals. In 1991, industry through an aggressive communications and outreach program led by the United States Chlorine Institute was effective in blunting this Greenpeace effort by meetings with the media in various cities in advance of the arrival of the Greenpeace ship and by providing technically-sound and accurate information. This Greenpeace tour ended at Traverse City, MI where the biennial meeting of the International Joint Commission (IJC) on the Great Lakes took place. Greenpeace concerns raised at this meeting included incinerators and dioxins, nuclear reactors, use of chlorine in pulp and paper mills, toxic waste disposal, potable water and landfill pollution. A Greenpeace sponsored conference in December 1992 at Monroe, MI served to highlight these issues and openly called for elimination of PVC due to its derivation from chlorine.

That the linkage of PVC to alleged hazards of chlorine being emphasized by Greenpeace has gained some regulatory attention was highlighted by Sixth Biennial Report on Great Lakes Water Quality issued by the IJC on April 15, 1992.(8) This report contains recommendations concerning many chemicals which, if adopted, would have a detrimental effect not only on the economy of the Great Lakes but could result in restricting industrial activity elsewhere based on information provided by Greenpeace which has no scientific validity. Recommendation 7 of this report is "that the parties, in consultation with industry and other affected interests, develop timetables to sunset the use of chlorine and chlorine-containing compounds as industrial feedstocks and that means of reducing or eliminating other uses be examined". If enacted, this would affect

both vinyl chloride (VCM) and PVC. As the specific risks of both VCM and PVC have not been demonstrated, the Vinyl Institute in coordination and cooperation with the Chlorine Institute has organized opposition to Recommendation 7 by a campaign aimed at governors, regulators and legislators in states that border the Great Lakes. This campaign calls for rescinding Recommendation 7 until there is a full review of all scientific data and an evaluation completed on its economic impact. The Chlorine Institute has contracted for a complete review of the toxicology of chlorine and its derivatives and this review, expected to be available early in 1993, should be useful in countering the Greenpeace anti-chlorine campaign.

Recognizing the global nature of the Greenpeace activity and the need for a coordinated industry effort worldwide, representatives of the European Council of Vinyl Manufacturers, the Japan PVC Association and the Vinyl Institute met in Washington, D.C. in early December 1992 to plan strategy for such an effort. A follow-up meeting scheduled to be held in Brussels in February 1993 should result in a definitive program.

ISSUES UNIQUE TO THE UNITED STATES

Two issues, unique to the United States, will be briefly discussed below. These issues have both been active for several years and serve to show the impact that governmental bureaucracy has on the PVC industry in the United States.

The Food and Drug Administration (FDA) Action on PVC in Food Packaging

In 1973, the Bureau of Alcohol Tobacco and Firearms (BATF), which has jurisdiction over containers used for alcoholic beverages, did not renew the authorization for the experimental use of PVC liquor bottles due to the finding of vinyl chloride monomer (VCM) levels as high as 20 ppm in alcoholic beverages stored for periods of up to nine months. These bottles had been manufactured from PVC resin produced prior to enactment of the stringent OSHA and EPA regulations that resulted in a dramatic reduction of VCM levels in PVC. A rule proposed by FDA in February 1975 that would have restricted the use of rigid and semi-rigid PVC in food contact applications was never adopted.

In late 1982, the Society of the Plastics Industry advised FDA that industry could provide food containers with residual VCM levels (RVCM) not exceeding 10 ppb, assuring that products stored in such containers, even after exaggerated shelf life at moderately elevated temperatures would not exceed 0.073 ppb VCM.

On February 3, 1986, FDA withdrew its 1975 proposal and proposed a new regulation that established limits on RVCM to "provide for safe use" of certain PVC products. Included were limits of 5 ppb RVCM for plasticized film and coatings and 10 ppb for rigid and semi-rigid containers. FDA's analysis of migration estimated that an individual's exposure to RVCM would not exceed 25 nanograms per day and represented a lifetime risk of cancer of less than 1 in 10

million. Most significantly, FDA, after careful consideration of potential environmental effects of its proposed action, concluded that it would not have a significant effect on the human environment and that an environmental impact statement was not required.

In the ensuing extended comment period, several non-issues were raised including allegations about dioxin/furan formation in incineration, exposure to plasticizers (some of which are not used in food grade films) and the effect on waste management and recycling.

On November 22, 1988 FDA issued a notice (9) in the Federal Register that stated "The comments on the proposed rule have not provided any basis for FDA to alter its tentative conclusion about the human health risk (from residual vinyl chloride monomer in PVC food contact articles). Consequently, the agency has no concern about the safety of food that comes in contact with articles that comply with the monomer limits stated in the proposed rule. Therefore, pending development of an EIS and review of the environmental effects of the proposed rule, the agency advises that it will not take action against current uses of vinyl chloride polymers that are in compliance with these limits."

The Environmental Impact Statement that FDA indicated it would prepare has now been over four years in preparation, this despite its 1986 determination that one was not required!

There is no question that the uncertainty raised by FDA's actions have adversely impacted the PVC packaging market in the United States and the market for PVC bottles has been virtually static over the past 5 years. FDA's continued delay in promulgating a final regulation has caused confusion in potential users and, in many cases, they have sought alternative materials. Final FDA approval, when the Environmental Impact Statement is completed, may indeed prove to be a hollow victory.

California Environmental Impact Report (EIR) on Expanded Uses of Plastic Pipe

A review of the chronology of the California Environmental Impact Report shows this to be a classic example of delay, linger and wait rivaled only by the FDA failure to give final approval for its packaging regulation. In the fall of 1979, the California Commission on Housing and Community Development, later renamed the Department of Housing and Community Development (HCD), issued a proposal that would have resulted in expanded uses of plastic pipe in drain, waste and vent (DWV) applications and in potable water distribution in residential structures. Among the piping materials covered were PVC, polyethylene, polybutylene, ABS and chlorinated PVC (CPVC). Almost immediately, members of the plumbers' union, the California Pipe Trades Council, raised allegations concerning flammability of plastic pipe and adverse health effects in plumbers due to exposure to solvent cement vapors. When these were apparently resolved, the union attorneys in late 1980 filed a petition with HCD entitled "Leaching of Toxic Chemicals into Drinking Water Requires Preparation of an Environmental Impact

Report". In the aftermath, the State of California received plastics industry funding form completion of such a report.

By the summer of 1982, SRI International was selected as the contractor to prepare the EIR. A full recitation of all of the delays occasioned by either deliberate actions on the part of the plumbers' union or those caused by the contractors in carrying out and completing leaching tests and worker health and exposure studies is beyond the scope of this paper. Suffice it to say that by August 1989, SRI issued a draft EIR document (10) which concluded that "no significant environmental impacts are associated with more widespread use of plastic plumbing pipe". Further, the report noted that "the various environmental implications of the two types of plumbing systems, although differing, indicate no clear environmental preference for plastic or for metal pipe."

Public hearings were held in September and October 1989 to receive comments on the draft EIR. Organized union opposition raised objections to the use of ABS and polybutylene based on allegations of failures in use and not on the basis of health and safety issues which the EIR is meant to address. Response to the comments made at these hearings was drafted by SRI and completed in December 1990 but the response document was never formally issued due to questions raised concerning the legal conformity of the document with the requirements of the California Environmental Quality Act (CEQA).

Plastic industry representatives have had continued contact with HCD over the past two years aimed at resolving the impasse and a December 1992 meeting offers hope that a final EIR may be issued in 1993.

Despite the fact that a final California EIR has not yet been issued, questions concerning the health and safety of PVC pipe have not surfaced in any other state and its use has continued to expand. However, without any question, the delay in issuance of the final EIR has been detrimental to the expansion of CPVC pipe in the California market.

ACKNOWLEDGEMENT

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