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

ENVIRONMENTAL AND REGULATORY IMPACTS ON FUTURE PVC GROWTH

PRESENTATION FOR

THE VINYL CHLORIDE SAFETY ASSOCIATION MEETING
SAN FRANCISCO, CALIFORNIA
SEPTEMBER 22, 1988

BY ROY T. GOTTESMAN, EXECUTIVE DIRECTOR OF THE VINYL INSTITUTE

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Wayne Interchange Plaza II • 155 Route 46 West • Wayne, NJ 07470 • (201) 890-9299

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INTRODUCTION

It is probably no exaggeration to state that no other chemical or plastic has been subjected to as many regulatory and environmental assaults in the past few years as has been the case with polyvinyl chloride or PVC. The problems, some real and some the result of application of misinformation or unsupported allegations, have made people associated with the PVC industry justifiably feel that they are constantly under siege or attack. Once the product has been successfully defended against critics in one area, it is the rule, rather than the exception, for another threat to the industry to surface, generally one that has not been anticipated.

It is the purpose of this paper to review the more significant environmental and regulatory situations that the PVC industry has been confronted with, to discuss how the industry has organized and responded to these challenges, and to assess the near-term and future impacts that these issues have had on the industry.

The issues I will discuss are the following:

1. Health and Safety Effects of Vinyl Chloride.
2. Food and Drug Administration (FDA) Activity Related to the Use of PVC in Packaging Materials.
3. Fire Performance and Combustion Toxicity of PVC.
4. Alleged Environmental and Health Effects Caused by Permeation of and Leaching from PVC Pipe.
5. Management of PVC in Municipal Solid Waste.
6. Proposition 65 in California.

HEALTH AND SAFETY EFFECTS OF VINYL CHLORIDE

Early workers handling vinyl chloride monomer, the raw material used in the manufacture of polyvinyl chloride, recognized the potential explosion and fire hazards associated with this raw material. However, there was little work, if any, that suggested potential health hazards. In 1962, based on work carried out at Yale University, ACGIH concluded that a level of 500 ppm offered adequate safety for humans and published this as the recommended standard. In 1971, the same level (500 ppm) was accepted by the Occupational Health and Safety Administration (OSHA) as a national standard.

Since there were reports of finger abnormalities among workers involved in cleaning polymerization vessels, the Manufacturing Chemists Association (MCA) [now the Chemical Manufacturer's Association (CMA)] had earlier initiated a study at the University of Michigan on acroosteolysis. Although the results of that study failed to pinpoint a causal relationship between vinyl chloride exposure and the disease, a worker exposure limit of 50 ppm was recommended when this work was published in the Archives of Environmental Health in January 1971. In late 1971, several European producers initiated work at the Institute of Oncology in Bologna, Italy with Dr. Cesare Maltoni to follow-up on work at the Regina Elena Institute of Cancer Research in Rome by Dr. P.L. Viola which had shown that exposure of rats to very high levels of vinyl chloride led to cancers and tumors. The Maltoni work, which was widely reported early in 1973, indicated tumors in the ear canals, kidney and liver of rats at concentrations of 500 and 250 ppm, but not at 50 ppm.

The potential severity of the problem became apparent when the National Institute for Occupational Health and Safety (NIOSH) advised OSHA on January 22, 1974 that the BFGoodrich Company had reported to NIOSH that the death of three employees from a rare type of liver cancer, angiosarcoma, might have been occupationally related. These workers had exposure to vinyl chloride at unknown, but presumably high concentrations, for approximately 19 years. In subsequent OSHA hearings it was revealed some employees of Union Carbide, Firestone Tire and Rubber Company and Goodyear Tire and Rubber Company had also died as a result of angiosarcoma.

Having been advised by NIOSH, OSHA had a fact-finding hearing on February 15, 1974, announced an Emergency Temporary Standard permitting exposure to 50 ppm maximum, but shortly thereaft r announced a proposed permanent standard that included a "no detectable" level for employee exposure. After extensive public hearings in June and July 1974, OSHA promulgated the final standard, effective October 5, 1974, that required that no employee be exposed to vinyl chloride monomer concentrations

greater than 1.0 ppm averaged over an eight-hour period or 5.0 ppm averaged over any period not exceeding 15 minutes. Further, the regulation established an "action level" of 0.5 ppm over an 8-hour work day. In addition to the OSHA regulations which covered workplace exposure, the Environmental Protection Agency (EPA) issued regulations on October 21, 1976 covering emissions of vinyl chloride under the National Emission Standards for Hazardous Air Pollutants (NESHAPS) as required under the Clean Air Act. These regulations set forth the following requirements:

1. The concentration of vinyl chloride in exhaust gases discharged to the atmosphere from each reactor or stripper, from mixing, weighing, or holding vessels or from the monomer recovery system cannot exceed 10 ppm.

2. Residual vinyl chloride after using stripping technology may not exceed:

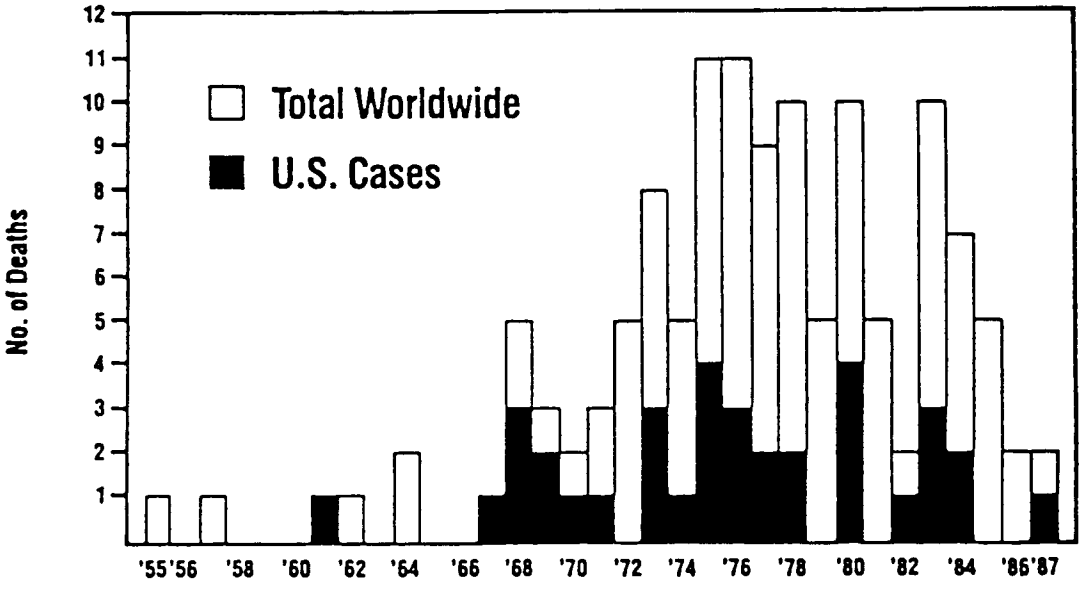
   (i) 2000 ppm for PVC dispersion resins, excluding latex resin, or

   (ii) 400 ppm for all other PVC resins, including latex resins, averaged separately for each type of resin.

Industry had two years to come into compliance with these EPA regulations.

At the time of the recognition of vinyl chloride occupational exposure as being responsible for angiosarcoma, there were dire predictions as to the number of cancer cases that would be reported in subsequent years. A Registry of Angiosarcoma Cases was started by Dr. John Stafford of ICI Chemicals and Polymers in England and is now maintained by Dr. Brian Bennett. The 1988 update of this Registry indicates that there have been 138 cases of angiosarcoma worldwide and 129 of th se individuals have died. Included in these figures are 38 U.S. cases involving 35 deaths. The graph on th following page shows the number of deaths occurring each year.

ANNUAL INCIDENCE OF ANGIOSARCOMA DEATHS



Source: Angiosarcoma Registry, Dr. B. Bennett, ICI (1988)

In the case of U.S. fatalities, it is of interest to note that in most cases the workers affected were first exposed to vinyl chloride in the mid-1940's and their exposures were generally repetitive and at high levels. All of the U.S. fatalities occurred in older plants, i.e. plants that started operations in 1960 or earlier and 30 deaths occurred at three of the oldest plants.

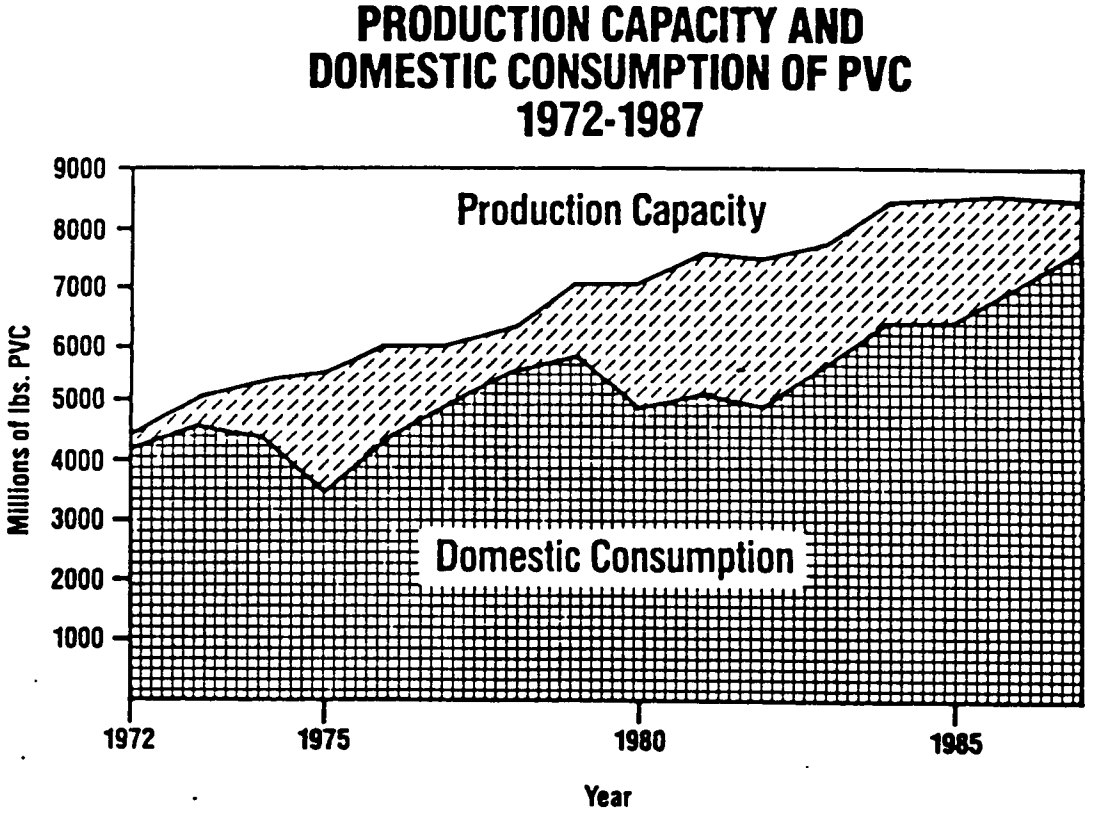
What Were the Impacts of These New OSHA and EPA Regulations?

The immediate impact was that industry spent considerable time, manpower effort and money to comply with these regulations. This included plant and equipment modifications, installation of vinyl chloride monitoring and alarm systems, stripping columns to remove unreacted vinyl chloride and incinerators for eliminating vinyl chloride from vent gases or non-emergency discharges. Economically, these changes were felt most acutely in older PVC facilities that had to modify and retrofit their processes with new controls. At the time of introduction of these regulations, EPA estimated the annual cost (including amortization of the estimated $198 million in capital) to maintain the required emissions levels would be $70 million per year.

The cost of industry's compliance with these regulations for the ten-year period from 1977 through 1986 was estimated to be $765.7 million (in 1977 dollars/by TRW, Inc., Research Triangle Park, N.C.) in its February 1982 report to EPA "Vinyl Chloride - A Review of National Emission Standards". This includes investments, capital, operating and maintenance costs for new and existing plants.

EPA subsequently issued revised figures showing total air pollution control costs of $1.2 billion during the 1981-1990 period for industry compliance with the vinyl chloride standard.

Another immediate impact was a sharp drop-off in the production of PVC in 1975, the year that followed the first disclosure of angiosarcoma cases. Domestic consumption of PVC dropped 21.8 percent in that year (from 4.414 billion pounds to 3.452 billion pounds) and capacity utilization dropped from 90.3 percent to 65.8 percent. The following graph shows the production capacity and domestic consumption of PVC over the period from 1972 to 1987.

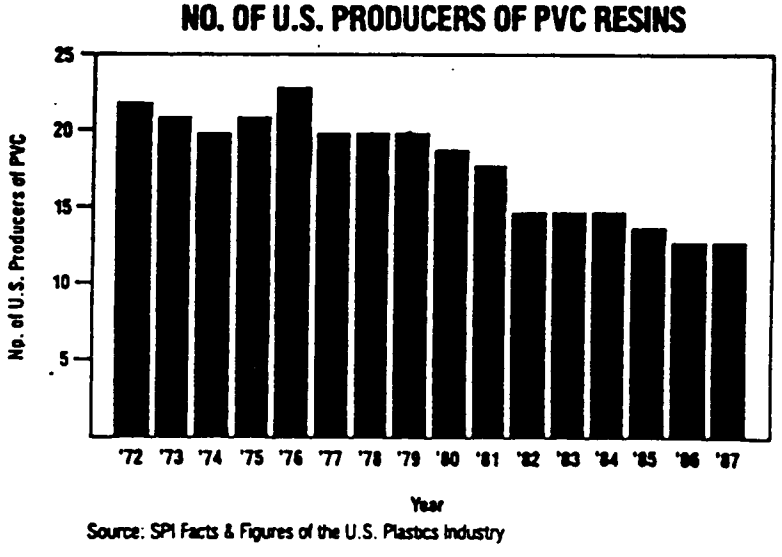


While the average growth rate for PVC consumption was 3.22% from 1972 through 1977, it has averaged 3.66% over the past decade. This would suggest little change in apparent growth as a result of these regulations. Average growth rates can be misleading, however. In actual pounds, domestic consumption increased very significantly.

Period	Pound Increase (in billion pounds)	Increase Average/Year (million pounds)
1972-1977	0.809	134.83
1978-1987	2.040	204.00

These figures strongly suggest that once the initial shock of the angiosarcoma cases was overcome and the resulting OSHA and EPA regulations were responded to, the long term effect on poundage of PVC produced and consumed was minimal. Production costs were, of course, increased by an average of approximately 1.35 cents/pound solely for EPA compliance.

Perhaps the biggest effect of these regulations was the shake-out that occurred in companies that elected to stay and participate in this business. In many cases, the companies leaving were producers with plants that had a multiplicity of small capacity reactors and the new environmental regulations, coupled with emerging large-scale reactor technology, made such facilities uneconomic. While a number of domestic-based companies elected to exit the business including Diamond Shamrock, Ethyl Corporation, Firestone, General Tire and Rubber Company, Goodyear Tire and Rubber Company, Olin Corporation, Stauffer Chemical, Tenneco Chemicals, and Uniroyal; two foreign-based companies, Formosa and Shin-Etsu entered the U.S. market with domestic-producing facilities. The following chart, developed from information published by the Society of the Plastics Industry in its annual Facts and Figures of the U.S. Plastics Industry, shows how the number of domestic producers had dropped from a high of 23 in 1976 to 13 in 1987.



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The Vinyl Chloride Emission Standard requires reporting excursions from the standard occasioned by such incidents as relief valve discharges, manual venting and reactor dumping. These are required to be submitted within 10 days of the incident. It basically amounts to industry "blowing the whistle" on itself. It is ironic that enforcement of the standard by EPA using this information has resulted in some 17 settlements with penalties totaling $4,328,500 since 1982. Companies have settled rather than incur significant legal costs to defend against the agency actions. The most recent settlement by Borden Chemical on February 1, 1988 was for a total of $1.25 million of which $250,000 will be for an endowment for the Louisiana State University Foundation for a program to support research on air emissions in the New Orleans to Baton Rouge industrial corridor. It involved alleged discharges of vinyl chloride dating back to 1977 and at issue were emergency relief releases of short duration from incinerators in excess of the stringent 10 ppm standard.

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FOOD AND DRUG ADMINISTRATION (FDA) ACTIVITY RELATED TO THE USE OF PVC IN PACKAGING

On November 21, 1968, the Bureau of Alcohol Tobacco and Firearms (BATF) authorized the use of PVC liquor bottles on an experimental basis. This temporary authorization was reviewed annually. In 1971, BATF required the preparation of an environmental impact statement, and on March 9, 1973, a favorable one was issued by the Treasury Department. However, shortly thereafter, representatives of Schenley Distillers, in a meeting with Food and Drug Administration officials, reported that alcoholic beverages stored in PVC bottles for periods up to nine months had vinyl chloride monomer contents as high as 20 ppm. These bottles had been made from PVC resin produced prior to the stringent 1974 OSHA AND 1976 EPA requirements which necessitated stripping to remove unreacted vinyl chloride monomer. The vinyl chloride found was presumably extracted from the PVC bottles produced from such "high VCM" resin.

In May of 1973, BATF announced that it would not renew the authorization for the experimental use of PVC liquor bottles.

On September 3, 1975, FDA proposed a rule that would have restricted the use of rigid and semi-rigid PVC in food contact applications. That proposal was not adopted but subsequent to its publication, a number of significant developments bearing on it occurred including:

1. Improved technology prompted by compliance with the OSHA and EPA regulations made it possible to obtain PVC with significantly reduced levels of vinyl chloride by a factor of almost one million.

2. FDA developed a policy concerning regulation of food and color additives that might contain carcinogenic impurities.

3. Developments in scientific technology and risk assessment procedures permitted FDA to determine whether additives containing known carcinogenic impurities were safe.

In a submission to FDA on November 12, 1982, the Society of the Plastics Industry (SPI) advised the agency that industry could provide products with RVCM levels not exceeding 10 ppb. this quantity of RVCM was so law that even after an exaggerated shelf life at moderately elevated temperatures, the concentration of vinyl chloride in the contents would not exceed the safe (0.073 ppb) level.

On February 3, 1986, FDA withdrew its 1975 proposal and proposed a new regulation to "provide for the safe use of certain vinyl chloride polymers by establishing limits on the amount of residual vinyl chloride monomer (RVCM) they may contain".

Specifically, FDA proposed:

1. A 5 part per billion (ppb) limit on RVCM for plasticized films and coatings.

2. A 10 ppb limit on RVCM for rigid and semi-rigid food containers.

3. A 50 ppb limit on RVCM for pipe used to carry water inside a food processing plant.

4. A 50 ppb limit on RVCM in vinyl chloride - vinylidene chloride copolymer films and coatings.

5. A recognition of prior sanctioned status of both homopolymer and copolymer PVC resins used as films, coatings, water pipe, flexible tubing, gaskets, bottle or jar liners and rigid sheet.

The proposal contained FDA's analysis of migration from bottles used for food contact use and estimated that individual exposure to vinyl chloride from PVC packaging would not exceed 25 nanograms per day. FDA calculated an individual lifetime risk of less than 1 in 10 million.

Based on these considerations, FDA concluded that the use of PVC as food-contact materials, with the RVCM limits as established, was safe.

Further and most significantly, the agency carefully considered the potential environmental effects of its proposed action and concluded that it would not have a significant impact on the human environment and that an "environmental impact statement is not required". This finding of no significant impact or FONSI was considered under FDA's final rule implementing the National Environmental Policy Act (NEPA).

Nevertheless FDA welcomed the submission of any data bearing on its FONSI and particularly requested information on the environmental fate of certain plasticizers such as phthalates and adipates and whether PVC contributed to the emission of polychlorinated dioxins or furans from solid waste incinerators.

FDA initially had a 60-day comment deadline which was extend d an additional 60-days until June 5, 1986. By that date, not a single public interest group had submitted any comments. At virtually the last minute, however, the Environmental Protection Agency submitted comments which, while endorsing the basic FDA proposal, questioned the thoroughness of the reasoning underlying the FDA FONSI. These EPA comments prompted FDA to solicit comments and views from state solid waste officials and from environmental groups. An initial trickle of comments

developed into a deluge and by the end of 1986, well over 900 comments were received at FDA, all submitted after the "official" comment deadline. Virtually all suggested that the FDA proposal would have a significant impact on human environment and called upon FDA to prepare an environment impact statement.

Because the comments on the proposal by both EPA and the EIS proponents were based on inaccurate assumptions and factual errors regarding the current regulatory status of PVC, they seriously overestimated the likely impact of the proposal on markets and, thereby, on the environment. In an attempt to correct this, the Vinyl Institute filed a document with FDA early in January 1987 providing factual information to refute allegations concerning the dioxin/furan problem, exposure to phthalate, adipate or epoxidized soybean oil plasticizers, and potential impact on overall waste recycling. In a meeting in late February 1987 with high ranking FDA officials in the Center for Food Safety and Nutrition, Vinyl Institute representatives were advised that the Agency did not require any further information concerning environmental matters, but it requested an updated market analysis on the potential impact of the proposal. This information was provided in a filing on April 20, 1987, Institute counsel met with EPA officials in July to brief them on newly-developed information regarding incineration, recycling and other environmentally-related matters, but no action was forthcoming.

On December 23, 1987 FDA Commissioner Frank Young was briefed on the issue and, at that time, decided to ask EPA to review this entire matter and the more recent submissions and to advise FDA whether it believed an EIS was needed. A letter to EPA formally making this request was sent by FDA on February 2, 1988 - this two years after the original proposal!

On May 23, 1988, EPA responded and recommended "that FDA perform a comprehensive EIS". They indicated that "the range of issues" that now needed to be addressed had "grown to include: (1) the effect of PVC incineration on municipal incineration plant compliance with state emissions requirements for hydrogen chloride; (2) complications created in recycling programs as a result of the presence of PVC; and (3) the possibility that increasing use of PVC will exacerbate existing solid waste management crises associated with diminishing landfill capacity".

Because the Vinyl Institute was concerned that the EPA response could impact adversely on PVC and particularly on the activity of the EPA Municipal Solid Waste Task Force that was developing a strategy document for the Agency, Vinyl Institute representativeS met with members of this Task Force on June 21st in Washington. At that time, we also met with the EPA Office of Federal Affairs and on July 6, 1988 officials in the EPA Office of Air Programs were briefed. Information was provided to all of these groups responding to the issues raised in EPA's response to FDA.

Finally, on August 12, 1988, Vinyl Institute representatives met with FDA officials at the Center For Food Safety. At that time, it was learned that a decision on an EIS had not been made, although FDA officials had been reported as leaning that way. If the Commissioner of the Food and Drug Administration decides that such an EIS is needed, it was indicated that a Notice of Intent would be published "relatively soon" in the Federal Register.

At that time, discussion was held on interim measures that would clarify the status of PVC in food contact applications and reaffirm its safety while an EIS is in preparation. Vinyl Institute Counsel is to cooperate with FDA legal counsel in establishing the best approach to achieve this clarification. Should FDA decided that an EIS is needed, an action the author considers inappropriate and unnecessary in view of available information - it could delay any final action by as much as 3 to 4 years.

What has been the effect of this delay? Any analysis is complicated by the fact that data reported on packaging materials is not broken down by categories involving uses where FDA approval is a prerequisite. Further, it must be recognized that the proposed "new" FDA rule will not authorize any major "new" uses of PVC in packaging nor will it significantly increase the number of PVC articles in the marketplace. The fact is that PVC food packaging materials have been widely and continuously used since the early 1950's in a variety of applications such as baby oil and shampoo, cooking oils, and the like. The market for such materials, meat wrap, can coatings will likely not be greatly affected should this FDA proposal be promulgated. The only real change which finalization of the FDA proposed rule could occasion would be the use of PVC for bottling distilled spirits - assuming the liquor industry continues to have interest in such a bottle.

There is no question that the uncertainty raised by FDA inaction has adversely impacted on the PVC packaging market. As shown in the table below, total pounds consumed in packaging applications was less in 1986 and 1987 than it was 5 years ago. PVC consumption in bottle manufacture declined by 10 million pounds in 1987 as compared with the prior year and this is almost entirely due to the unresolved FDA situation.

PVC Consumption in Packaging (millions of pounds)

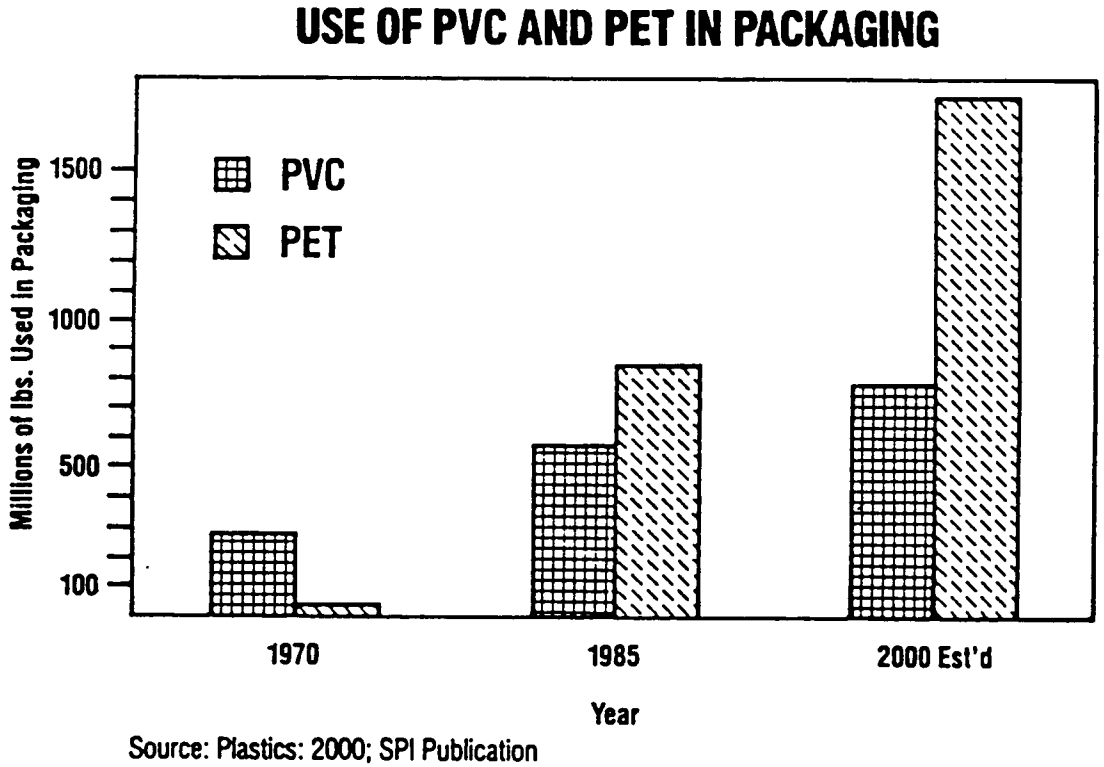
	1983	1984	1985	1986	1987	Growth Rate 1983-1987
Bottles	165	186	163	188	175	+ 1.2%
Film/Sheet	385	430	304	340	367	- 0.9%
Other Pkging.	33	32	34	36	36	+ 1.8%
Total	583	648	501	564	578	- 0.2%

Essentially, the PVC market in packaging has been static for the past five years.

Since 1987, other plastic materials have had a major impact on the packaging industry. In November of 1982, one of these, polyethylene terephthalate (PET) received FDA and BATF approval for use in liquor bottles. So in reality, the only niche for PVC liquor bottles is in the half-gallon liquor bottle with a molded-in handle on the jug. No other plastic material can provide this feature.

The best projection of the Vinyl Institute was that promulgation of the FDA proposal by 1987 could lead to a 12 million pound per year additional consumption of PVC in 1991, directly attributable to the liquor bottle.

What is troublesome is that the FDA's continued delay in promulgating a final regulation and the attendant uncertainty about the status of PVC in food contact applications that this delay has caused, has resulted in certain potential users in seeking out alternative materials. While PVC has many unique qualities which make it very desirable such as the ability to mold a handle into a bottle, the clarity of bottles, lower mold costs, etc. as the following graph shows, PET has overtaken and will dominate the liquor bottle market. Final FDA approval, if and when it occurs, may indeed be a hollow victory.



Source: Plastics: 2000; SPI Publication

FIRE PERFORMANCE AND COMBUSTION TOXICITY OF PVC

Rigid PVC was the first plastic to be used in the construction industry. It accounts for approximately 40% of all plastics used in construction, and is by far, the leading plastic used in this industry. Phenolic resins, which are the second largest family of plastics used, only have a 19.4% share of the construction market. The largest uses for PVC are in pipe, fittings, and conduit which constitute approximately 70% of PVC construction sales. In these uses, PVC has replaced such materials as copper in small diameter pipes, and concrete and ductile iron in large diameter pipes. PVC provides many advantages such as longer life, lower sedimentation rate, higher corrosion resistance, lower cost and ease of installation.

PVC is also finding substantial use in panel and siding products used in home siding and in window and door frames. In these applications, vinyl has replaced metals, largely aluminum, and to a lesser extent wood. Here vinyl materials are used because they are easier to install, do not chip or peel, are very energy-efficient, and are lower cost than conventional materials.

A classic example of what happened as PVC's use grew, is the now well-documented case of the activities of a major producer of rigid metal pipe used in conduit. Plastic conduit, mainly composed of PVC, made heavy in-roads into this market. The PVC share of the conduit market grew from an estimated 9% in the late 1960's to 54% in 1980. Over this same period, the marketshare of steel conduit fell from nearly 50% to 32%. In the late 1970's, this major rigid metal pipe producer stung by its loss of market share, initiated a campaign to publicize hazards of PVC. This was aimed at consumers, contractors, legislators and building code officials. It even went to the extent of establishing a not-for-profit organization, The Foundation For Fire Safety, and enlisted the aid of certain firefighter's organizations publicizing supposedly unusual fire hazards of PVC and particularly those associated with evolution of hydrogen chloride (HCl) from burning PVC. A full recitation of the unethical business practices employed has been effectively documented in an article in Fortune magazine in February 1983 entitled "The Dubious War on Plastic Pipe". Unfortunately, the spectacular hotel fire at the MGM Grand and a later fire at the Westchase Hilton, added fuel to this fire. It was alleged that toxic gases from burning plastics, and in particular PVC, were responsible for a so-called "intoxication syndrome" which resulted in an inability on the part of fire victims to escape. A horrible fire just last New Year's Eve at

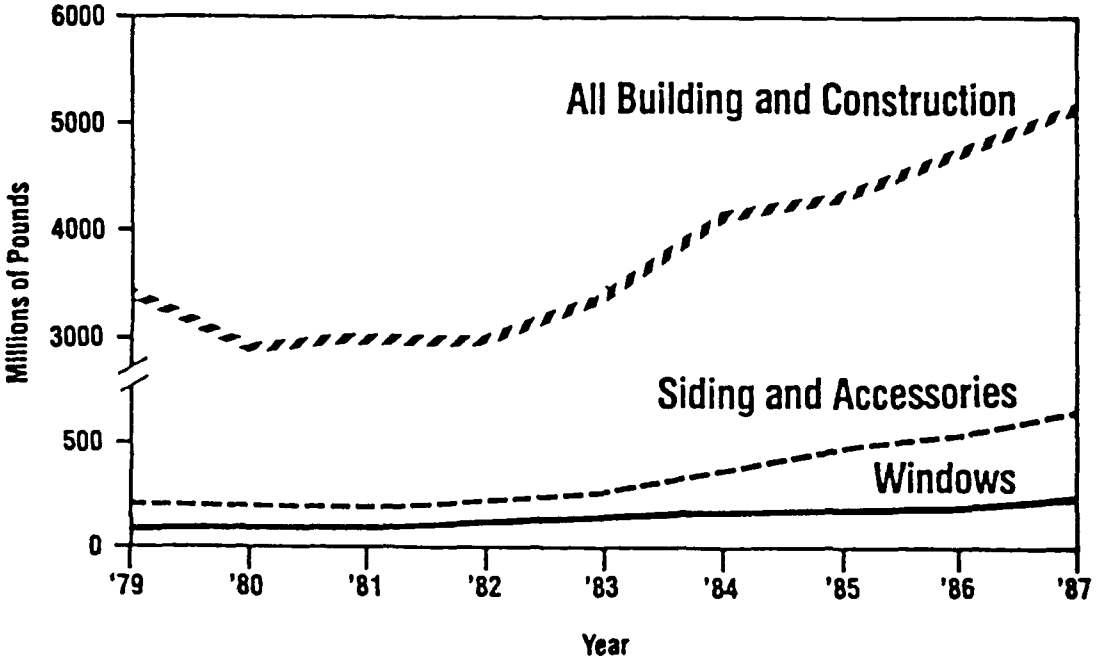
the Dupont Plaza Hotel in San Juan, Puerto Rico, dramatically brought this issue to the forefront again. In all of these, allegations were made that furnishings were highly flammable, that they produce toxic gases during the fire and, in a number of cases, PVC was cited as a source of particularly hazardous fumes.

During the past few years, the Vinyl Institute has funded research studies at the Southwest Research Institute in San Antonio, Texas which have shown that, unlike many other gases evolved during a fire, hydrogen chloride does not remain in the atmosphere because it is largely absorbed by common construction materials. Recent studies conducted separately by the Federal Aviation Administration and the Vinyl Institute have also shown that primates were not incapacitated after exposure to as much as 30,000 ppm of hydrogen chloride for 5 minutes. Neither did they suffer any long term lung effects. All of this is particularly significant, considering that that HCl concentration in real fires is generally less than 300 ppm. No fire death has ever been linked, with any scientific credibility, to hydrogen chloride exposure. Vinyl is no more dangerous than any other materials used in construction and is probably safer than many.

Despite these scientific facts, which are slow to be accepted by the public, one state, New York, has already instituted a databank filing regulation, which requires that the combustion toxicity data be determined using a small-scale laboratory test, the so-called "University of Pittsburgh Test" for establishing the combustion toxicity of certain building products. In addition to adding to the cost of these products, such testing programs do not provide an adequate indication of the hazard that may be presented by building materials in a real fire. Toxicity data alone, particularly those from a questionable test, can only lead to an inappropriate choice of building materials. Other facts are more important than toxicity, including smoke generation, ease of ignition and rate of flame spread. Unfortunately, the use of the New York State Toxicity Databank information may lead to improper material choice. It is for this reason that the Vinyl Institute and the Society of the Plastics Industry actively support the development of a total hazard assessment.

In order to put this issue completely into perspective however, one needs to look at the construction market to see that despite the furor that all of this has raised, and the considerable expenditure of resources to counter inaccurate information, it has <u>not</u> had a major impact on the market.

PVC USE IN BUILDING AND CONSTRUCTION 1979-1987



Over all construction uses, PVC consumption grew from 3,365,000,000 pounds in 1979 to 5,154,000,000 in 1987. This is an average growth rate of 5.9% per year. Most spectacular have been the 19.1% per year growth rate in vinyl windows and door frames and 16.1% per year growth rate in vinyl siding and accessories. During this period however, the consumption of PVC in wire and cable has been relatively static, possibly a result of the fire toxicity issue.

ALLEGED ENVIRONMENTAL AND HEALTH EFFECTS CAUSED BY PERMEATION OF AND LEACHING FROM PVC PIPE

The market for PVC pipe and fittings has grown from 2.451 billion pounds in 1979, to 3.529 billion pounds in 1987 representing a growth rate of 4.7%. Consumption in 1987 amounted to 46.4% of the domestic PVC produced. As mentioned earlier, in most of these applications, PVC pipe has replaced metal materials, largely as a result of ease of installation, lower cost and desirable physical properties.

As in the case with other building materials, this product has also been subjected to attack by interests who feel that further encroachment on the metal pipe usage will result in fewer jobs for members of the plumbers unions. The issues here are largely permeation, i.e., intrusion of solvents through the pipe wall and into a water supply system, and questions concerning leaching of low molecular weight organic materials from either the pipe or the solvent cements used in joining the pipe. These allegations concerning health and safety have effectively stopped the use of PVC for potable water distribution in residential structures in the State of California. PVC has a long history of successful and environmentally safe use drain, waste and vent applications, but even today, it is still not allowed in as large a city as Chicago, again due to opposition from labor unions.

As regards permeation, work carried out by the Vinyl Institute at Battelle Columbus Laboratories has conclusively shown that in highly contaminated environments, all piping systems that were tested, including asbestos cement and ductile iron, demonstrate the same qualitative permeation problems. Unjointed pipe generally showed slower or no permeation as compared to jointed pipe. The pipe material is an important factor in permeation and the transport of organic solvents through PVC is strongly dependent on solvent activity. Under normal contamination conditions, the predicted break-through times for typical PVC pipe would be "many centuries". This work has been confirmed in studies both in Holland and at the University of California.

Considering leaching, a review the chronology of the California Environmental Impact Report, a classic example of delay, ling r and wait rivaled only by the FDA activity in approving a PVC liquor bottle. In the fall of 1979, the California Commission on Housing and Community Development, later renamed the Department of Housing and Community Development, issued a proposal that would have expanded the use of plastic pipe for drain/waste/vent applications and potable water distribution in residential structures. Among the piping materials covered, were PVC, polyethylene, polybutylene, ABS, and chlorinated

polyvinyl chloride (CPVC). Public hearings were held, and at that time, members of the California Pipe Trades Council and its union locals raised allegations about the flammability of plastic pipe and about health effects on plumbers exposed to solvent cements. At the request of the legislature, approvals were delayed until further testing was completed.

In January of 1980, the Housing and Community Development Department requested a study of worker health from the Department of Health Services and a report on the flammability from the State Fire Marshall. Five months later, the State Fire Marshall issued a report concluding that plastic pipe did not present an unusual fire risk. In October of 1980, the Department of Health Services filed a study on solvent cements and plastic pipe, in which it concluded that no adverse worker health effects existed and that flushing new piping systems would reduce the risk that any chemicals might leach into the water. With the flammability and worker health allegations apparently resolved, union attorneys in November 1980 filed a petition with the Department of Housing Community Development entitled "Leaching of Toxic Chemicals into Drinking Water Requires Preparation of an Environmental Impact Report" (EIR). Normally, EIR's are required for matters such as plant siting requests, but the Housing and Community Development Department sought and received plastic industry funding for the completion of an Environmental Impact Report.

In May of 1981, the Housing and Community Development Department hired a contractor to oversee the hiring of outside consultants for the development of an EIR. By the summer of 1982, SRI International had been selected to carry out an Environmental Impact Report. The SRI environmental review document, which was completed in March 1983, found no need for additional flammability work, but did recommend further studies on the worker health issue, and leaching studies on polybutylene and chlorinated polyvinyl chloride. In July 1984, the National Institute for Occupational Safety and Health (NIOSH) issued a report of its investigation into worker health issues related to plastic pipe installation. Observed exposure levels were only 20-30% of the permissible levels. Safe work practices, such as wearing gloves when using pipe cement, were recommended. This confirmed a 1982 NIOSH study.

In August of 1984, the Department of Housing and Community Development issued a protocol for these leaching studies. Its initial contractor, Versar Laboratories, selected in March of 1985, was terminated in May of 1985, because it had not followed mandated testing procedures.

In the spring of 1986, the University of California at Berkeley was hired to conduct leaching tests. Frustrated by this inaction, the Vinyl Institute initiated its own testing using

the agreed-upon protocol in October 1985. This work, completed in July of 1986, was submitted to the Housing and Community Development Department in July of 1987, approximately one year before the State of California tests actually began. By August of 1987, a risk assessment sponsored by the Vinyl Institute, based on the leaching data from the McKesson studies was completed by CH_2M Hill, a respected consulting firm.

On December 17, 1987, the Department of Housing and Community Development released the results of the University of California at Berkeley leaching tests, which effectively confirmed the testing that had been carried out earlier at McKesson Environmental Sciences by the Vinyl Institute. But even at this point, the Environmental Impact Report is still months away. We have recently submitted the independent health risk assessment from CH_2M Hill to SRI for their review in connection with the Environmental Impact Report. This study compared the potential health risks of plastic and metal piping and concluded that plastic pipe poses no greater risk to health than conventional materials, and in some cases, may be the preferred material due to the potential for leaching of lead. In our judgment, this study represents a definitive affirmation of PVC's appropriateness for plumbing systems and the alleged health hazards that had been linked to PVC, and particularly those that promoted the EIR process, clearly do not exist.

In January 1988, after the University of California leaching tests confirmed the results of the earlier Vinyl Institute-sponsored tests, the Plumber's Union demanded a health assessment study on worker health and safety in the installation of PVC pipe using solvent cements. Political pressure was applied to both the Department of Housing and Community Development and the Department of Health Services. The Department of Health Services, in a reversal, "caved in" to these pressures and indicated they supported the need for additional health assessment information.

During this period, the Vinyl Institute submitted data to the State of California on potential carcinogenic risks from inhalation of organic vapors released during the soldering of metal pipe.

On February 3, 1988 the Housing and Community Development Department advised SRI to begin Phase II of its Draft Environmental Impact Report (EIR). Negotiations, meanwhile continued on a "60-day worker health study" which Union representatives indicated could be carried out and would satisfy their request for a worker health assessment.

As negotiations continued, it became obvious that public funding for the worker health and exposure study would not be available due to an estimated $1 billion California budget shortfall. Further, the Plumber's Union indicated that it

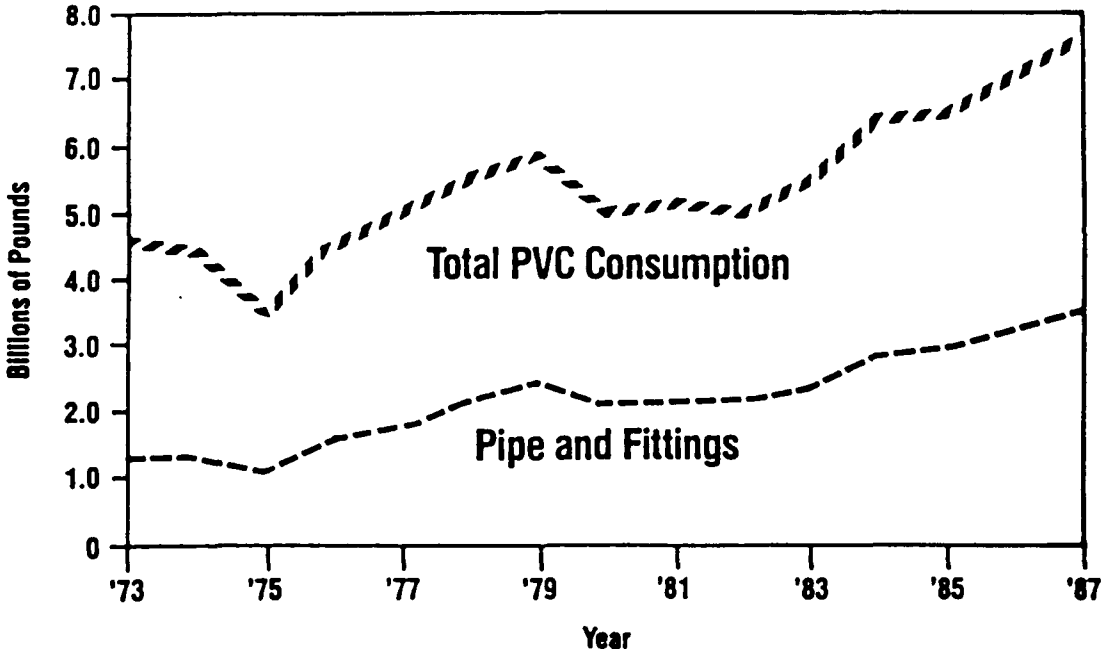
would oppose the use of public funds for this study. It further insisted that such an exposure study be carried out during "hot weather" conditions.

Rather than lose another year, the Vinyl Institute and its member companies agreed to fund a 5-phase program at a total cost of $253,700. Based on the current schedule, sampling should be completed by October 15, 1988 and analysis and reporting by February 28, 1989. A final report is expected by May 31, 1989. The "60-day" study will be more like a 1 year study! At that time, SRI should be able to complete the full EIR.

Despite the aggressive lobbying by plumbers against PVC piping, we believe that vinyl will continue to make heavy in-roads into water piping because of its proven safety for potable water. Plumber associations have discouraged its use, probably due to the fear of a potential loss of jobs to the do-it-yourself market, since PVC piping is easy to install. However, environmental concerns of lead leaching from galvanized and lead soldered copper pipe, which was demonstrated in the McKesson leaching studies, should facilitate the substitution of PVC for metal piping. The congressional ban on lead solder, starting in 1989, will certainly expand the use of PVC in water piping.

The graph below shows the dramatic growth in PVC pipe and fittings over the period from 1973 to 1987, as compared with the total growth in all construction uses. The growth rate has been 4.7% per year over the past 9 years, and it is anticipated that a growth rate of at least 4% will be achieved over the next 5 years and this will be accomplished largely through marketshare gains from metal pipe and concrete.

PVC USE IN PIPE AND FITTINGS
1973-1987



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MANAGEMENT OF PVC IN MUNICIPAL SOLID WASTE

The critical need for appropriate facilities for the disposal of municipal solid waste was put graphically into focus last summer when a bargeload of trash from Islip, Long Island went on a well-publicized Caribbean cruise. The problem is not only the lack of land space for garbage dumps or landfills, but as has become apparent in recent years, improperly constructed landfills lead to the contamination of underground water sources, aquifers, as a result of leaching toxic materials that had been deposited in the landfills. In a rush to try to find quick solutions to a problem that has been many years in the making, there recently have been a rash of well-intentioned but ill-conceived solutions. Many of these focus on the regulation of packaging and the role that plastics play in the municipal garbage stream. A disproportionate amount of that effort is being directed at PVC or vinyl plastics, including legislative proposals recently in New York State and Minnesota to ban PVC products. There is a widespread belief that vinyl packaging is a significant contributor to municipal solid waste. In fact, plastics represent somewhere between 7 and 8% of the municipal solid waste, and PVC represents less than 10% of that amount. The following chart shows that most trash consists of such non-synthetic, traditional materials, such as durable goods, food and yard wastes.

THE MUNICIPAL SOLID WASTE STREAM*
(Percent By Weight of Total Discards)

Durable Goods (appliances, furniture, etc.)	14.0
Non-Durable Goods (clothing, newspapers, etc.)	25.6
Containers and Packaging**	32.6
Food Wastes	8.1
Yard Wastes	17.9
Miscellaneous Wastes	1.8
	100.0%

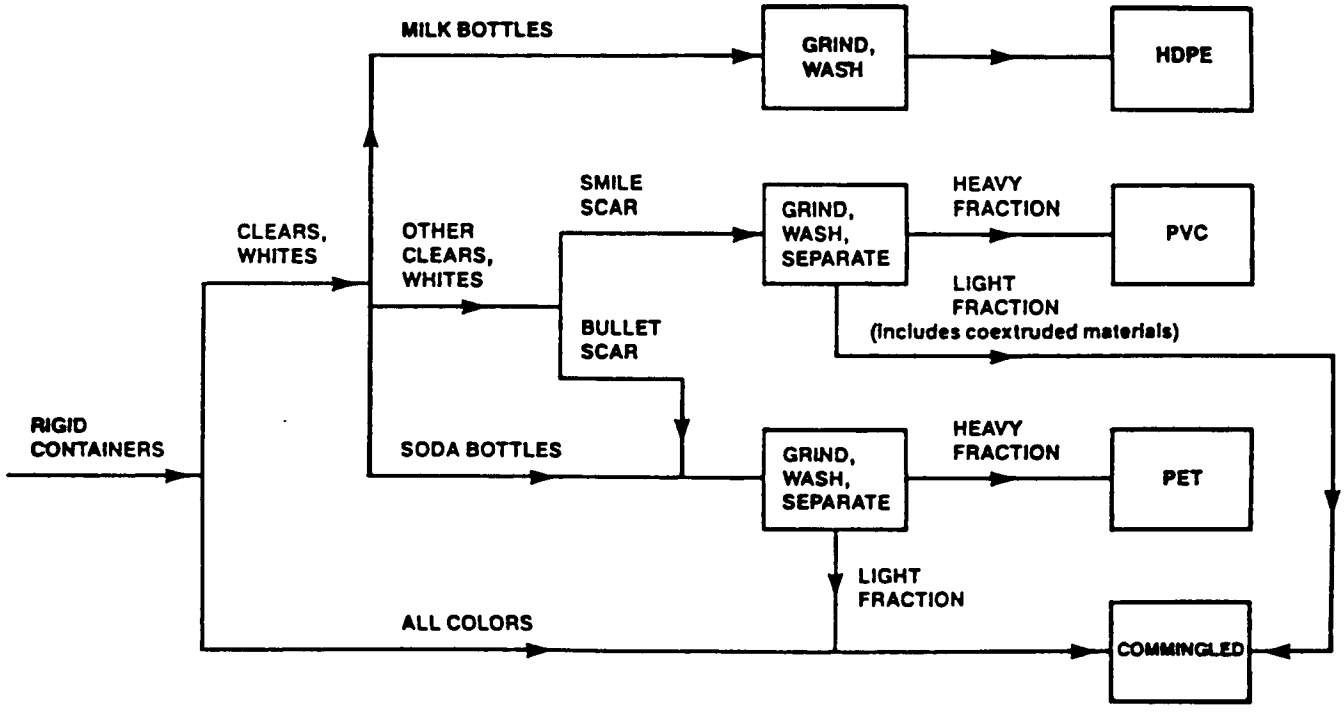
**Glass	8.9
Steel	2.1
Aluminum	0.7
Paper	15.6
Plastics	3.7
Wood	1.5
Miscellaneous	0.1
	32.0%

*Characterization of Municipal Solid Waste in the United States, 1960 to 2000, Final Report, Franklin Associates, Ltd., July 1986.

It has therefore been necessary to develop information on alternative methods of safe disposal of vinyl plastics in the waste stream, in order to answer the concerns of legislators at all levels. Basically, this approach has involved investigation of recycling either as a separated material or commingled plastics and incineration with resource recovery.

A full discussion of each of these is beyond the scope of this paper. Nevertheless, this paper will briefly highlight some of the work that either is in progress, or has been carried out. Recycling of certain materials is well-established. For example, the separation of newspapers and magazines from trash which initially had been set-up as a voluntary activity in many communities, is now mandated in certain localities. Even though recycling of aluminum beverage cans has been carried out for many years, less than 50% of these are actually coll cted for recycling. Recycling appears to work best in the 12 states that now have deposit laws, and in some of these, the recycling of glass and aluminum containers have actually become profitable. With such materials, the recycling products are returned to the manufacturing process to produce new containers in which a portion of the recycled raw material is used. Recycling of newspapers is also being carried out to manufacture newsprint or cardboard and egg cartons.

Although the situation with plastics is much more complex, PVC is one of the more recyclable plastics, as it can be converted into a variety of materials such as pipe, fittings, sheeting and other containers. The basic problem is to separate it away from other plastic materials contained in the waste stream. A schematic flow sheet to accomplish this is shown below, but at the present time, this requires hand sorting.



Should a suitable code system that can be read by a scanner ultimately be developed, a system like this separation scheme could be carried out mechanically. Separated PVC is ground, cleaned and washed and the resulting material can be used in the manufacture of drain or sewer pipes. As bottle-grade PVC compound has exceptional impact strength and good flow characteristics, it can be molded in pipe, fittings or extruded thermo-formable sheet. From many points of view, these are ideal recycling uses because not only has a product been removed from the waste stream, it has been converted into a material having a fairly long life.

Where the separation of plastic materials is either not feasible or exceeds the needs of the marketplace, commingled plastics can represent a recycling alternative. Work on this is currently underway at the Center for Plastic Packaging Recycling at Rutgers University in New Brunswick, New Jersey and is being financially supported by the Vinyl Institute. In each case, efforts are aimed at optimizing the operation of a recycled plastics processing machine, ET1, which was developed by Advanced Recycling Technology Limited in Brackel, Belgium. In the extruder, which has a short l/d ratio, the commingled mixed plastic feed is moved from a hopper into the extruder from whence it flows into a long mold contained in the turret. After the mold is filled, the turret rotates, so that a new and empty mold is made available to receive extrudate while the filled mold is first cooled in air and subsequently, as the turret rotates, the mold and its contents are cooled in a circulating cold water bath. After the turret completes a revolution of the cooled lineal plastic member, the plastic part is expelled by a blast of air and is manually placed on a rack. It can be cooled further to assure that it does not bend or distort, and the molds themselves can give rise to a variety of shapes in products. The major challenge of this work will be to develop suitable markets for products made from such recycled materials.

Because there had been allegations that PVC led to the production of polychlorodibenzodioxins and polychlorodibenzofurans when municipal solid waste containing PVC was incinerated, the Vinyl Institute participated in a product managed by the New York State Energy Research and Development Authority (NYSERDA) located in Albany, New York. In this project, a series of runs were carried out both with normal municipal solid waste and PVC-free waste. The objective of this work was to evaluate the effect on formation of dioxins and furans that are caused by changes in incinerator operating conditions, PVC content of the waste, moisture content of the waste and combustion gas variables. The following chart shows a matrix of the experimental design of the final phase of this program.

Type of Waste	Temperature of Primary Chamber °F			
	1300	1400	1550	1800
MSW	●	●*	●	●
MSW + H_2O			●	
MSW + PVC**				●
MSW (low O_2)				●
PVC-Free				●
PVC-Free + PVC***				●
PVC-Free + H_2O				●

* Only one run was carried out under this conditions; duplicate runs in all other cases.

** Sufficient PVC was added to MSW to bring the total chlorine content to 1.3% from ca. 0.3%.

*** PVC was added to bring the chlorine content to 0.3% (as in normal MSW).

The major conclusions of this study were that all levels of dioxins and furans were relatively low and that the incinerator operating temperatures significantly affected the levels of these materials that were formed.

The highest levels of polychlorinateddibenzodioxins were found at the lower operating temperatures (1300°F) and there were no significant differences in the levels of dioxins using runs that had variations in composition. The conclusion of this work was that there was no evidence that the amount of PVC in the waste stream affected the levels of PCDD's and PCDF's found in this study.

As would be expected, the amount of PVC in the waste did increase the amount of HCl in the combustion gases. What about hydrogen chloride? First, incinerators being designed today are equipped with scrubbing equipment that remove greater than 90% of the hydrogen chloride generated, to say nothing of the remaining 99.9% of dioxins in the incineration process. Such equipment is needed to meet EPA ambient air standards.

Having established that both recycling and incineration are viable and environmentally safe options for handling PVC in the waste stream, it is not anticipated that the solid waste crisis which this country faces, should lead to legislative bans on PVC. The major task in the next months will be to see that this information reaches those legislators who consider PVC to be a problem in the waste stream.

PROPOSITION 65 - CALIFORNIA

No paper about environmental and regulatory impacts on the PVC industry would be complete without a brief discussion on the most recent regulation, commonly known as Proposition 65. This far-reaching new California law puts the burden on companies to prove that their products and emissions are safe, or to give public warnings. It establishes a "bounty hunter" provision, where citizens who sue violators can keep 25% of any fines that are levied. Under the law, which is titled "The Safe Drinking Water and Toxic Enforcement Act", no business may expose people to chemicals that cause cancer or birth defects, without giving a "clear and reasonable warning". Exceptions are made when there is "no significant risk of human cancer" or "no observable effect at 1,000 times the level of exposure when it comes to birth defects". Failure to give warning can result in fines of up to $2,500 a day for each exposure.

On February 17, 1988, California's Health and Welfare Agency issued a set of emergency regulations covering the implementation of Proposition 65. These emergency regulations were issued shortly before the act's warning requirements went into effect for some 29 listed chemicals. The emergency regulations temporarily adopt compliance with state and federal food safety laws as a basis for concluding that a product poses "no significant risk" under the law. This provision is an interim standard and it is intended to be superseded by "no significant risk levels" that will be adopted at a future date. Thirty-one "no significant risk levels" are included in the emergency regulations. Of greatest interest in relation to PVC is that it includes a level of vinyl chloride at 0.3 micrograms per day, which is consistent with the FDA risk assessment that formed the basis for the Agency's pending rulemaking, discussed earlier. These emergency regulations were intended to remain in effect initially for 120 days.

In June, the California Health and Welfare Agency issued a proposal to adopt the emergency regulations, which are now due to expire in October, as permanent regulations. The Agency invited comments on its proposals.

On June 26, 1988, comments were submitted by SPI's Food, Drug and Cosmetic Packaging Materials Committee endorsing this proposal and stressing the need to maintain the exemption for packaging materials established under the emergency implementing regulations issued on February 17, 1988.

Proposition 65 has already shown evidence of becoming lawyer's bonanza. On May 31, 1988, a coalition of environmental and labor groups including the Natural Resources Defense Council, the Environmental Defense Fund, the Sierra Club, AFL-CIO and Public Citizen filed suit against the State of California in

Superior Court seeking to overturn the temporary exemption from the warning requirements of Proposition 65 for food, drugs and cosmetics which comply with existing state and federal standards. The Grocery Manufacturers of America, the Proprietary Association, the Pharmaceutical Manufacturers Association, the Cosmetic Toiletry and Fragrance Association and the Health Industry Manufacturers Association moved to intervene to help the state defend the exemption. At a hearing on August 11, 1988, these five motions to intervene were granted.

Another equally controversial part of this law prohibits any business from knowingly discharging listed chemicals into drinking water. This provision, which carries criminal penalties, goes into effect on October 27th.

At this time, it is difficult to assess the impact that Proposition 65 will have on PVC packaging and piping. But the PVC industry is not alone, most chemical and plastics manufacturers have expressed concerns and are deeply worried about the "bounty hunter provisions". This may well turn out to be the California lawyers equal opportunity act, and as a matter of fact, seminars have already been held to train lawyers in bringing suits against companies for the 25% bounty.

Although imitation has often been termed the highest form of flattery, imitation of Proposition 65 is the highest form of idiocy. In April and May of this year, legislation modeled after California's Proposition 65 was introduced in the Massachusetts, New York, Illinois and Louisiana legislatures. While none of these bills made it to the floor for a vote, it can be expected that such measures could well resurface when these and other legislatures reconvene this fall.

Where is the Federal Government while all of this is going on? Largely through the efforts of the Council For Labeling Uniformity, on June 27th, the President's Domestic Policy Council considered whether FDA should preempt Proposition 65, but rejected this idea as it would be inconsistent with the White House well-established commitment to states rights. Instead, the Council directed its staff to prepare a study as to whether or not Proposition 65 duplicates or conflicts with the Federal Food, Drug and Cosmetic Act. That study is due in December. Dependent on the conclusion of that study, we could see Federal intervention here. That would be a welcome relief!

Although the backers of Proposition 65 call it the dawn of a new environmental age that will sweep east across the country, many people in the industry have expressed a belief that Proposition 65 is a nightmare and that the chemical and plastics industry will never be the same.