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Standard Support-Environmental Impact Document

An Investigation of Health Effects and Emission Reduction of Vinyl Chloride in the Vinyl Chloride Monomer and Polyvinyl Chloride Industries

Volume II

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March 1975

Acknowledgements

Many persons from the Environmental Protection Agency have contributed to this document. While the following list is not complete, the principal investigators wish to thank these individuals for their input and assistance.

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The Standard Support Environmental Impact Document for vinyl chloride is divided into two volumes. Volume I (containing chapter 2) deals with the scientific nature of the pollutant in terms of health effects. Volume II (containing all other chapters) evaluates control techniques and costs, alternative control levels, and environmental impact of a proposed standard. The document is divided to facilitate handling and distribution.

PREFACE

A. PURPOSE OF THIS DOCUMENT

This report summarizes the information obtained so far during the development of national emission standards for vinyl chloride under the authority of section 112 of the Clean Air Act. It is being distributed for review internally within EPA at this time, and also to the EPA Working Group and the National Air Pollution Control Techniques Advisory Committee to explain the background and basis for the proposed standards which have been developed up to this point. Before standards for vinyl chloride are proposed in the Federal Register considerable revisions in the policy and standards recommended in this document may take place as new information on vinyl chloride is acquired and as the document is reviewed within EPA.

Contained in this document is information on the health effects of vinyl chloride, the rationale for selecting section 112 as the regulatory route, the rationale for selection of certain source categories for regulation, information on other standards applicable to the industry, an industry characterization in terms of sizes and locations of plants, information on applicable control technology, the alternative control strategies and their impacts, and the proposed standards and the rationale for their selection. For additional information or for copies of documents (other than published literature) cited in the background information document, or to comment on the proposed standards, contact Mr. Don R. Goodwin, Director, Emission Standards and Engineering Division, United States Environmental Protection Agency, Research Triangle Park, North Carolina 27711, [(919) 688-8146].

B. AUTHORITY FOR THE STANDARDS

National emission standards for hazardous air pollutants are promulgated in accordance with section 112 of the Clean Air Act (42 U.S.C. 1857c-6), as amended in 1970. "Hazardous air pollutant" is defined in the Act as "an air pollutant to which no ambient air quality standard is applicable and which in the judgment of the Administrator may cause or contribute to an increase in mortality or an increase in irreversible, or incapacitating reversible, illness." Emission standards established under the authority of section 112 are to be set at a level which in the Administrator's judgment "provides an ample margin of safety to protect the public health from such air pollutants."

To set a standard under section 112 of the Act, a pollutant must be listed in the Federal Register as a hazardous air pollutant. Within 180 days of listing, the Administrator must propose a national emission standard which, in his judgment, adequately protects public health. Within 30 days of proposal of the standard, the Administrator must give notice of a public hearing. The Administrator can withdraw a pollutant from the hazardous list only if he finds, on the basis of information presented at the public hearing, that the pollutant clearly is not hazardous. Otherwise the Administrator must promulgate a standard within 180 days of the proposal. The Act does not require that the Administrator consider available control technology or economic impact in establishing the level of the standard. However, EPA must, from time to time, issue information on control technology.

C. CONSIDERATION OF ENVIRONMENTAL IMPACTS

Section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969 (Pl-91-190) requires Federal agencies to prepare detailed environmental statements on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment. The objective of NEPA is to build into the decision-making process of Federal agencies a careful consideration of all environmental aspects of proposed actions. The Energy Supply and Environmental Coordination Act (ESECA) of 1974 (PL-93-319) specifically exempted proposed actions under the Clean Air Act from NEPA requirements. According to section 7(c)(1), "No action taken under the Clean Air Act shall be deemed a major Federal action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act of 1969."

EPA has concluded, however, that the preparation of environmental impact statements could have beneficial effects on certain regulatory actions. Consequently, while not legally required to do so as a result of section 102(2)(c) of NEPA, environmental impact statements will be prepared for various regulatory actions, including proposed actions under section 112 of the Clean Air Act. This voluntary preparation of environmental impact statements, however, in no way legally subjects EPA to NEPA requirements.

To implement this EPA policy decision, therefore, a separate section is included in this document which is devoted solely to an analysis of the potential environmental impacts associated with the proposed standards. Both adverse and beneficial impacts associated with the proposed standards in such areas as air and water pollution, increased solid waste disposal and increased energy consumption are identified and discussed. Generally, standards proposed under section 112 will most likely have beneficial impacts on ambient air quality and potential adverse impacts in other areas.

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ABSTRACT

National emission standards for vinyl chloride emissions from vinyl chloride and polyvinyl chloride plants are being proposed under the authority of section 112 of the Clean Air Act. Section 112 is intended for the regulation of hazardous air pollutants. "Hazardous air pollutant" is defined in section 112 as "an air pollutant to which no ambient air quality standard is applicable and which in the judgment of the Administrator may cause, or contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible; illness." Under the authority of section 112 an emission standard is set at a level which in the Administrator's judgment "provides an ample margin of safety to protect the public health from such hazardous air pollutant."

Vinyl chloride has been implicated as the causal agent of angiosarcoma (a rare form of liver cancer) and other disorders, both carcinogenic and noncarcinogenic, in people with occupational exposure and in animals with experimental exposure to vinyl chloride. Reasonable extrapolations from these findings suggest that vinyl chloride may cause or contribute to the same or similar disorders at present ambient air levels. Therefore, vinyl chloride meets the specifications of a "hazardous air pollutant" as defined in the Clean Air Act.

Although there is sufficient evidence to indicate that vinyl chloride poses a serious health risk to the public, there is insufficient evidence at this time to determine a numerical threshold ambient exposure level for vinyl chloride. This is because at the present time, there are no dose-

response data available for concentrations of vinyl chloride below 50 ppm; consequently, there are no dose-response data for the concentrations of vinyl chloride found in the ambient air. In fact, since vinyl chloride is a carcinogen there may be no exposure level which represents absolutely no risk to public health. Because a numerical threshold ambient exposure level cannot be determined at this time, the regulation of vinyl chloride will consist of two or more phases. The first phase, which is represented by the proposed standards, is to minimize risk to public health by establishing emission standards which will reduce emissions to the lowest level practicable with available control systems. The second phase consists of gathering additional data on health effects, ambient air levels, and control technology which will be used to determine if further regulatory actions are needed at a later date.

There are three known source categories of vinyl chloride emissions: polyvinyl chloride plants (47) which are responsible for approximately 90 percent of the total nationwide emissions, vinyl chloride monomer plants (15) which are responsible for less than 10 percent of the total emissions, and fabrication plants (approximately 8,000) which are responsible for the remaining emissions. The proposed standards are applicable to only vinyl chloride and polyvinyl chloride plants because they are the largest sources of emissions both on a nationwide basis and on a per plant basis, and also because, at the time of initial standards development, EPA had available almost no information on the numerous fabrication plants. During standards development for vinyl chloride and polyvinyl chloride plants, EPA initiated data gathering on fabrication plants, including process operation, emissions, applicable control equipment, and ambient concentrations. Based on this information, it is indicated that regulation of these plants is (is not) needed. [This study is not complete at this time, but will be before the standards are proposed].

In order to minimize vinyl chloride emissions to the atmosphere, the proposed standards cover all process and fugitive emission sources in both vinyl chloride and polyvinyl chloride plants. The process emission points in vinyl chloride plants include the ethylene dichloride and vinyl chloride distillation vents and the oxychlorination vent. The process emission points in polyvinyl chloride plants include the reactor purge, reactor safety relief valves, monomer recovery vent, slurry blend tanks, centrifuges, dryers, and storage silos. Fugitive emission sources in both kinds of plants include transfer points, pressure relief valves, pumps, opening of equipment, etc. The proposed standards, which are based on best available control systems for each of these emission points, will reduce emissions from a typical vinyl chloride plant by approximately 96 percent and from a typical polyvinyl chloride plant by approximately 95 percent. (These emission reductions are based on emission levels which were reported to exist in the spring of 1974).

The costs of control to meet the proposed standards are not deemed to be sufficient, of and by themselves, to cause an adverse economic impact to accrue to any producer of vinyl chloride or polyvinyl chloride, since it is assumed that improved stripping techniques can be utilized by polyvinyl chloride plants to comply with the proposed standard. If it is not possible to employ improved stripping techniques and incineration must be used instead to meet the standard for polyvinyl chloride plants, then the possibility of adverse economic impact exists. In this case the economic viability of new dispersion process polyvinyl chloride plants would be questionable and the possibility also exists of some closure of existing plants.

BACKGROUND SUPPORT AND ENVIRONMENTAL IMPACT DOCUMENT
FOR THE PROPOSED NATIONAL EMISSION STANDARDS
FOR VINYL CHLORIDE EMISSIONS FROM THE
VINYL CHLORIDE MONOMER AND
POLYVINYL CHLORIDE INDUSTRIES

DRAFT ENVIRONMENTAL IMPACT STATEMENT
FOR THE PROPOSED STANDARDS FOR VINYL
CHLORIDE

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CHAPTER 1

SUMMARY

CHAPTER 1 - SUMMARY

1.1 SUMMARY OF THE PROPOSED STANDARD

The standards which are being considered for proposal under the authority of section 112 of the Clean Air Act for vinyl chloride and polyvinyl chloride plants are stated below. The purpose of these standards is to minimize risk to public health by establishing emission standards which will reduce emissions to the lowest level practicable with available control systems.

Polyvinyl Chloride Plants

The standard for polyvinyl chloride plants would apply to the suspension, dispersion, bulk, and solution processes and includes the production of all homopolymers, copolymers, and latexes. The specific emission limits would be as follows:

A. Control fugitive emissions by using the following techniques.

1. Control transfer operations by purging unloading hoses to the controlled monomer recovery device described below in D or other device capable of control to 10 ppm vinyl chloride. This standard can be met by using nitrogen to blow the vinyl chloride remaining in the hoses to a controlled recovery system as described in D or to an incinerator or other control device. Control loss from slip gauges by using magnetic or sonic liquid detectors and by venting the slip gauge to the controlled monomer recovery device described below in D or other device capable of control to 10 ppm vinyl chloride. This procedure is in commercial use.

2. Install canned pumps, double mechanical seals, or equivalent on all pumps in vinyl chloride service. This standard can be met by

using canned pumps, pumps with double mechanical seals with a pressurized purge fluid between the seals, or pumps equipped with equivalent no leak seals. Canned pumps and double seal pumps are in common use in the chemical industry.

3. Install rupture disks and pressure gauges on equipment in vinyl chloride service to reduce safety valve leakage. This standard can be met by fitting a rupture disk between the vessel and the safety valve and using a pressure gauge to measure any pressure build-up between the disk and the valve. If the pressure gauge indicates a leak, the disk can be changed before the safety valve unseats.

4. All pressure relief valves in vinyl chloride service should be tied into a flare, recovery system or other control device capable of reducing the vinyl chloride content of the gas that is discharged to the atmosphere to less than 10 ppm.

5. Before maintenance or inspection of equipment displace all vinyl chloride in equipment to the controlled monomer recovery system as described below in D or to a control device capable of maintaining 10 ppm vinyl chloride in the exit stream. This standard can be met by providing a vinyl chloride venting system in the plant designed to vent all equipment before the equipment is opened for maintenance or entered for inspection. The vented gas would be recovered or sent to a control device capable of maintaining 10 ppm vinyl chloride in the exit stream. At least one plant now has a recovery system which controls purging losses from all major pieces of equipment.

6. Prevent loss during vinyl chloride sampling by purging the sample flask back to the process. This standard can be met by placing sample connections so that the vinyl chloride purge flows from the process back into the process at a second point which is at a lower pressure. This method of sampling is in use in at least one vinyl chloride plant which has sampling conditions similar to polyvinyl chloride plants.

7. Detect fugitive emissions by installing a multipoint vinyl chloride detector and making routine checks of possible leak points by using portable sensing devices. Repair leaks promptly. The plant can meet the above standard by installing the necessary equipment and putting into practice a formal and detailed program of leak detection and reduction. A part of this program would be a record of the vinyl chloride (or hydrocarbon) concentrations measured near all possible leak points and the action taken to correct any leaks found.

8. Vacuum pump and steam jet exhausts are to be vented to an incinerator, carbon adsorber or other control device capable of reducing the vinyl chloride content of the atmospheric discharge to 10 ppm or less.

9. The amount of vinyl chloride in the process water that is to be exposed to the atmosphere is to be reduced to 0.0013 kg VCM/100 kg PVC produced. The vinyl chloride removed from the water shall be transferred to a controlled monomer recovery system or to a control device capable of control to 10 ppm vinyl chloride.

B. Control all emissions from the reactor and stripper by using a purge water system or equivalent. The use of a reactor purge water system reduces emissions to 0.001 kg VCM/100 kg (lb VCM/100 lb) PVC produced. The standard can be met by installing a purge water system or demonstrating that another system is equivalent. The purge water system is in operation at one polyvinyl chloride plant.

C. Eliminate all polymerization reactor relief discharges by injecting chemicals to stop the reaction (short stop), properly instrumenting the reactor to detect upset conditions or by venting the reactor contents to a gasholder.

D. Control emissions from the monomer recovery system to an exit concentration of less than 10 ppm. This standard can be met with a refrigerated vent condenser and an add-on control device such as a carbon adsorber, solvent absorber or incinerator. A carbon adsorber is in use in one plant and solvent absorbers are in use in several locations in the United States.

E. Control emissions from the slurry blend tanks and the centrifuge to an exit concentration of less than 10 ppm. This source can be controlled by carbon adsorption, solvent absorption, or other device. One producer uses a carbon adsorption unit to control this stream.

F. Control the total vinyl chloride emitted from all sources downstream of the stripper to less than 0.04 kg VCM/100 kg (lb VCM/100 lb) PVC produced. The specific sources controlled would include any slurry blend tank, centrifuge vent, filter, dryer, conveyor air discharge or storage silo discharge and from all other in-plant sources. The standard can be met by using add-on control systems, stripping the resin to a residual vinyl chloride content of 400 ppm (dry basis), or stripping the resin to a residual vinyl chloride content such that the difference between the residual vinyl chloride in the resin coming out of the stripper and the resin which is shipped out of the plant is equal to 400 ppm.

Ethylene dichloride - Vinyl chloride plants

The emission standard for vinyl chloride plants would apply to plants that produce vinyl chloride by cracking ethylene dichloride (EDC) or by hydrochlorinating acetylene. Vinyl chloride emissions from ethylene dichloride plants are also regulated. The specific emission limits would be as follows:

A. Control fugitive emissions by using the following techniques.

1. Control transfer operations by purging loading hoses to a controlled monomer recovery device or other device capable of control to 10 ppm vinyl chloride. This standard can be met by using nitrogen to blow the vinyl chloride remaining in the hoses to a controlled recovery system or to an incinerator or other control device. This procedure is in commercial use.

2. Install canned pumps, double mechanical seals, or equivalent on all pumps in vinyl chloride service. This standard can be met by using canned pumps, pumps with double mechanical seals with a pressurized purge fluid between the seals, or pumps equipped with equivalent no leak seals. Canned pumps and double seal pumps are in common use in the chemical industry.

3. Install rupture disks and pressure gauges on equipment in vinyl chloride service to reduce safety valve leakage. This standard can be met by fitting a rupture disk between the vessel and the safety valve and using a pressure gauge to measure any pressure build-up between the disk and the valve. If the pressure gauge indicates a leak the disk can be changed before the safety valve unseats.

4. All pressure relief valves in vinyl chloride service should be tied into a flare, recovery system or other control device capable of reducing the vinyl chloride content of the gas that is discharged to the atmosphere to a concentration of less than 10 ppm.

5. Before maintenance or inspection of equipment displace all vinyl chloride in equipment to the controlled monomer recovery system or to a control device capable of maintaining 10 ppm vinyl chloride in the exit stream. This standard can be met by providing a vinyl chloride venting system in the plant designed to vent all equipment before the equipment is opened for maintenance or entered for inspection. The vented gas would be recovered or sent to a control device capable of maintaining 10 ppm vinyl chloride in the exit stream. A few plants now have recovery systems which control purging losses from all major pieces of equipment.

6. Prevent loss during vinyl chloride sampling by purging the sample flask back to the process. This standard can be met by placing sample connections so that the vinyl chloride purge flows from the process into one end of the sample flask and from the other end of the sample flask back into the process at a second point which is at a lower pressure. This method of sampling is in use at several vinyl chloride plants.

7. Detect fugitive emissions by installing a multipoint vinyl chloride detector and making routine checks of possible leak points by using portable sensing devices. Repair leaks promptly. The plant can meet the above standard by installing the necessary equipment and putting into practice a formal and detailed program of leak detection and

reduction. A part of this program would be a record of the vinyl chloride (or hydrocarbon) concentration measured near all possible leak points and the action taken to correct any leaks found.

8. Vacuum pump and steam jet exhausts are to be vented to an incinerator, carbon adsorber or other control device capable of reducing the vinyl chloride content of the atmospheric discharge to 10 ppm or less.

9. The amount of vinyl chloride in the process water that is to be exposed to the atmosphere is to be reduced to 0.00057 kg per 100 kilograms (lb/100 lb) of vinyl chloride produced. The vinyl chloride removed from the water shall be transferred to a controlled monomer recovery system or to a control device capable of control to 10 ppm vinyl chloride.

B. Control all emissions from the ethylene dichloride distillation columns by incineration, carbon adsorption or other method to give the equivalent of 10 ppm vinyl chloride in the stream that is discharged to the atmosphere.

C. Control all emissions from the vinyl chloride distillation columns by incineration, carbon adsorption or other method to give the equivalent of 10 ppm vinyl chloride in the stream that is discharged to the atmosphere.

D. Control all emissions from the oxychlorination vent by incineration or other method to give the equivalent of 10 ppm vinyl chloride in the steam that is discharged to the atmosphere.

1.2 ENVIRONMENTAL IMPACT SUMMARY SHEET

(✓) Draft Environmental Impact Statement

( ) Final Environmental Impact Statement

Environmental Protection Agency
Emissions Standards and Engineering Division
Office of Air Quality Planning and Standards

1. Name of action.

    (✓) Administrative action

    ( ) Legislative action

2. Brief description of action indicating what States are particularly affected.

The proposed standards for vinyl chloride and polyvinyl chloride plants, which are described in section 1.1, will impact primarily on southwestern Texas, southern Louisiana, and the Northeastern States, where most of the plants are located. Twelve of the 15 vinyl chloride plants are located in southwestern Texas and southern Louisiana. Other states in which vinyl chloride or polyvinyl chloride plants are located include Kentucky, California, Illinois, Massachusetts, Mississippi, Oklahoma, Delaware, Maryland, Pennsylvania, Ohio, New Jersy, New York, West Virginia, Rhode Island, Alabama, and Michigan. There is also a vinyl chloride plant in Puerto Rico. Additional States may be affected by the proposed standards as new plants are constructed. The proposed standards are national emission standards which will be enforced by the Federal EPA, unless a State requests delegation of authority to enforce the standards.

3. Summary of Adverse Health, Environmental, and Socio-Economic Impacts of the Proposed Standards

The primary impact of the proposed standards would be 95 or greater percent reductions in vinyl chloride emissions from vinyl chloride and polyvinyl chloride plants, and consequently corresponding reductions in ambient air concentrations of vinyl chloride in the vicinity of these sources.

There are several potential health, environmental, and socio-economic secondary impacts of the proposed standards. These include increased atmospheric emissions of hydrogen chloride, lowered pH of plant effluent due to hydrogen chloride, increased water consumption, small increases in the quantity of vinyl chloride in the plant effluent, increased solid waste disposal due to carbon used for adsorption, increased energy consumption, possible closure of some of the small polyvinyl chloride plants, and increased cost of polyvinyl chloride consumer products.

As discussed in detail in Chapter 11, section 11.5.2, the types and degree of adverse impacts will vary from plant to plant depending on the type of control selected to meet the standards. Methods are readily available for minimizing most of the potential adverse impacts. Hydrogen chloride emissions to the atmosphere, which would result from control with incineration and are most likely to be a potential problem at vinyl chloride plants, can be minimized by absorption control, which is typically installed without regulatory requirements because of corrosion problems that would result both on plant property and in the community without such control. Plants at which hydrogen chloride is released into the plant effluent from the absorption system would have to adjust the pH to meet EPA's effluent guideline regulations. Increased water consumption, though insignificant, could be further minimized by recycling. Any incremental increases in the vinyl chloride content of plant effluent due to control systems would be minimized by the proposed standards, which requires stripping vinyl chloride out of the water before it is discharged (because it would eventually be emitted to the atmosphere). Carbon used in adsorption systems can be regenerated to some extent; if it must be discarded, it would probably not be discarded more than once every 1 to 3 years, and therefore would not be expected to add significantly to solid waste problems. Increased energy consumption rates would vary greatly depending on the type of control equipment selected to meet the standards. Incineration, the control system with the greatest energy consumption rate because of the supplemental fuel required for combustion, would cause a 3 percent increase in energy consumption at a "typical" vinyl chloride plant; however, the value of the fuel and the hydrocarbon emissions could probably be recovered. If incineration were used at polyvinyl chloride plants, the increase in energy consumption would be very significant and the heat value probably could not be recovered. However, improved stripping, which is the most likely type of control technology to be adopted by polyvinyl chloride plants, requires minimal energy consumption compared with other forms of control which could be used by polyvinyl chloride plants. In regard to socio-economic impacts, if any small polyvinyl chloride plants close in response to the standards, it is expected that they would have been in the same situation with less stringent controls. Increases in prices of consumer products made of polyvinyl chloride would depend on the type and quantity of resin in the product, but could be as high as 3 to 6 percent.

In summary, all of the potential adverse impacts of the proposed standards are either insignificant or will be minimized without additional action, except for two. These are the increased energy consumption which would result in the rare situation of a polyvinyl chloride plant using incineration, or to a lesser extent, carbon adsorption rather than improved stripping to control dryers, storage, and transfer operations. The other adverse impact which cannot be minimized is the probable price increase in polyvinyl chloride consumer products. Price increases are of considerable concern to the public at this time and polyvinyl chloride is used in a wide variety of consumer goods.

4. List alternatives considered.

The several categories of alternatives which were considered are listed below:

A. Alternative regulatory actions.

1. No action.
2. Delayed action.
3. Banning (through zero emission limits).
4. Section 115 of the Clean Air Act (Abatement Conferences).
5. Section 303 of the Clean Air Act (Emergency Powers).

6. Section 109 of the Clean Air Act (National Ambient Air Quality Standards for Vinyl Chloride or National Ambient Air Quality Standards for Non-Methane Hydrocarbons).

7. Section 111 of the Clean Air Act (Standards of Performance for New Sources).

8. Section 112 of the Clean Air Act (National Emission Standards for Hazardous Air Pollutants).

B. Alternative Degrees of Stringency.

1. Less stringent standards.

2. The proposed standards.

3. More stringent standards.

C. Alternative Technical Approaches.

1. Alternative units for the standard (e.g., POM or kg/unit production).

2. Alternative enforcement procedures.

3. Alternative source categories for standards setting.

4. Alternative emission points for standards setting.

5. Alternative pollutants for regulation.

6. Alternative control technologies.

7. Alternative formats for Test Method 106.

5. List all Federal, State, and local agencies from which comments have been requested.

A. Federal Agencies

1. Department of Health, Education, and Welfare.

2. Department of Transportation.

3. Department of Labor.

4. Department of Commerce.

5. Department of Defense.

6. Department of Interior.

7. Federal Energy Office.

8.

9.

B. All State and local agenices either through the State and Terrirorial Air Pollution Programs Administration (STAPPA), the EPA regional offices, or the formal comment period.

6. Dates draft statement made available to the Council on Environmental Quality (CEQ) and public and where copies can be obtained or reviewed.

The draft statement will be made available to CEQ and the public on June 20, 1975, and copies can be obtained from:

Mr. Don R. Goodwin, Director

Emissions Standards and Engineering Division

Environmental Protection Agency

Research Triangle Park, North Carolina 27711

CHAPTER 3

RATIONALE FOR REGULATION OF VINYL CHLORIDE UNDER THE AUTHORITY OF SECTION 112 OF THE CLEAN AIR ACT

3. RATIONALE FOR REGULATION OF VINYL CHLORIDE UNDER THE AUTHORITY OF SECTION 112 OF THE CLEAN AIR ACT

In January 1974, B. F. Goodrich Chemical Company reported to the National Institute of Occupational Safety and Health that several of its employees had died from angiosarcoma of the liver (a rare form of cancer) and that these deaths may have been related to occupational exposure to vinyl chloride gas. This report resulted in growing concern over the potential health effects of vinyl chloride emissions and spurred efforts by both government and industry to reduce vinyl chloride emissions while at the same time obtaining the data needed to better assess the impact of vinyl chloride on human health.

The Environmental Protection Agency (EPA) established a Task Force on vinyl chloride in February, 1974, to identify the environmental problems resulting from the manufacture and use of vinyl chloride and polyvinyl chloride. While air, water, and solid waste disposal are all possible routes for entry of vinyl chloride into the environment, the Task Force concluded that, based upon current information, the air route poses the most significant environmental problem.

In May, 1974, EPA initiated a study to determine whether Federal regulation of atmospheric emissions of vinyl chloride is needed, and if so, which of the regulatory alternatives under the Clean Air Act would be most appropriate for reducing vinyl chloride emissions. For the purpose of the analysis, data were gathered on health effects, air quality concentrations, control techniques, and costs. The alternative control strategies considered in that analysis and the reasons for selecting Section 112 of the Act as the regulatory strategy are summarized below.

3.1. Alternative Control Strategies Considered

In the analysis, EPA first considered the alternatives of no standards and delayed standards, i.e., whether Federal regulation of vinyl chloride is needed and if so, whether it is needed at this time, and the "banning alternative", i.e., whether a zero emission limit should be established for vinyl chloride. The analysis next considered the wide range of regulatory alternatives available under the Clean Air Act. These include:

Regulatory action under:

Section 115--Abatement Conferences

Section 303--Emergency Powers

Standards setting under:

Section 109--National Ambient Air Quality Standards (NAAQS)
National Ambient Air Quality Standard for Nonmethane Hydrocarbons

Section 111--Standards of Performance for New Stationary Sources (SPNSS)

Section 112--National Emission Standards for Hazardous Air Pollutants (NESHAP)

This section provides a discussion of the alternatives listed above and an assessment of their appropriateness for controlling (or not controlling) vinyl chloride at this time. The selection of a regulatory alternative was based primarily on consideration of the health effects, sources and pollutant characteristics of vinyl chloride; however, the required times to accomplish control, State and EPA resources needed, and social and economic impact of the decision were also included in the evaluation.

3.1.1. No Standards or Delayed Standards--Need for Federal Action

Factors considered in determining whether Federal regulatory action is needed for vinyl chloride emissions, and if so, whether it is needed at this time, included the health effects of vinyl chloride, the extent of public exposure to vinyl chloride, and the degree to which other regulations are reducing vinyl chloride emissions.

3.1.1.1. Health Effects

As described in detail in Chapter 2, the results of animal experiments coupled with epidemiological data strongly imply that vinyl chloride gas in the atmosphere is a potential health hazard in the vicinity of vinyl chloride plants, polyvinyl chloride plants, and possibly fabricating plants. This health hazard includes a strongly suggested increased risk of developing angiosarcoma, other cancers, and various types of nonmalignant damage to the liver and other organs.

3.1.1.2 Extent of Public Exposure

There are approximately 15 vinyl chloride plants, 47 polyvinyl chloride plants, and 8,000 fabricating plants. Based on results from a preliminary ambient monitoring program conducted by EPA in the Spring of 1974, persons living in the immediate vicinity of industrial sources of vinyl chloride are generally exposed to daily concentrations of less than 1 ppm with some 24 hour excursions to 1 to 3 ppm and with occasional peak (one-hour) exposures of as high as 33 ppm. (These figures may be revised at a later date as a result of the current ambient monitoring program.) Data are not conclusive as to the degree of risk these levels represent.

If vinyl chloride industries are not regulated, community exposure to vinyl chloride may increase as the industry expands. Production growth between 1961 and 1971 for polyvinyl chloride averaged 13.4 percent per year. Forecasted growth in polyvinyl chloride production is approximately 6 percent per year. At this rate, current capacity would double by about 1986.

3.1.1.3. Degree to Which Existing Regualtions are Reducing Vinyl Chloride

At least some reduction of vinyl chloride emissions may be expected as the result of the standard promulgated by the Occupational Safety and Health Administration (OSHA) on October 4, 1974, and some State regulations for new construction and hydrocarbons. These regulations are described in Chapter 13.

In response to the OSHA regualation which was scheduled to go into effect January 1, 1975, and delayed by Court order until April 1, 1975, the vinyl chloride and polyvinyl chloride industries have adopted some measures which not only reduce employee exposure, but also reduce emissions to the atmosphere. Other methods of reducing employee exposure to vinyl chloride, however, such as respiratory protection, ventilation of the workplace, opening sides of buildings and installing tall stacks do not reduce the emissions to the atmosphere. Even though the OSHA standard requires all employers to institute feasible controls to the fullest extent possible and to continue to improve and apply engineering controls until full compliance is achieved, it does not establish any deadlines for compliance through engineering controls. Written plans demonstrating how plants will achieve this goal must be drawn up and be made available, upon request, to representatives of OSHA and NIOSH; however, there is no deadline for submittal of formal plants. For these reasons, it is difficult at this time to evaluate the degree to which the OSHA regulation will reduce vinyl chloride emissions to the atmosphere. It is assumed, however, that the plants will respond to the OSHA regulation with a combination of ventilation techniques, emission reduction, and respiratory protection, and that this response will not be uniform.

Some newly constructed polyvinyl chloride plants and some oxychlorination vents at existing vinyl chloride plants are required to be controlled as the result of State regulations for new sources and for hydrocarbons. The State regulations, however, do not necessarily cover all emission points or require the same degree of emission reduction as the proposed standards, and they are not expected to be uniform in the degree of control they require.

3.1.1.4 Conclusions

The data presented in Chapter 2 indicate that vinyl chloride is a potential health hazard at ambient concentrations. The role of other regulations in reducing vinyl chloride emissions is uncertain at this time, but these regulations are not expected to impose uniform controls or to necessarily reduce ambient concentrations of vinyl chloride to the same degree as could regulatory actions taken by EPA. Therefore, it seems appropriate, that EPA initiate regulatory action to reduce the atmospheric concentration of vinyl chloride in order to minimize any potential risk to health posed by such exposure. A delay in tandards setting would allow time for acquiring additional information on vinyl chloride to fill in the gaps which currently exist. However, sufficient evidence is available to indicate that ambient concentrations of vinyl chloride do pose a serious health risk to the public and should not be allowed to persist until all information gaps.are filled.

3.1.2. The Banning Alternative--Zero Emission Limits

EPA could establish zero emission limits for vinyl chloride under the authority of Section 112 of the Act. (The provisions of Section 112 are discussed in a later section.) Establishing zero emission limits would in effect ban domestic vinyl chloride production, because vinyl chloride and polyvinyl chloride plants could not comply with zero emission limits using currently feasible control technology.

3.1.2.1. Direct Impact

The direct impact of banning vinyl chloride and polyvinyl chloride production would be upon the producing firms, the employees of these firms, and the regions where these firms are located.

Thirty-four firms would be directly impacted. However, the lack of detailed financial information for privately held corporations and profit data by vinyl chloride and polyvinyl chloride output for publically held firms make an assessment of probable firm (not just plant) failure difficult. But for 30 firms, dependency on vinyl chloride and polyvinyl chloride production can be approximated by relating estimated vinyl chloride and polyvinyl chloride sales to total sales. See Table 3-I. It should be recognized, however, that the estimated percentage of vinyl chloride and polyvinyl chloride sales is not necessarily the same as the estimated percentage of profits. Based on the information on sales, three of the 30 firms are judged to be highly dependent upon vinyl chloride and polyvinyl chloride production, [Pantasote (16 percent), Great American Chemical Corporation (36 percent) and Robintech (59 percent)], and are also polyvinyl chloride fabricators. With a ban on vinyl chloride and polyvinyl chloride production, all three would probably fail. For the other four firms, sufficient data is not available for estimating probable firm failure.

The direct employment impacts by plant of a vinyl chloride and polyvinyl chloride ban are not known. However, estimates of total vinyl chloride and polyvinyl chloride plant employment are available, and indicate that 1000 people are employed in vinyl chloride production. Banning vinyl chloride production would delete the need for the services of these people. Although many skills used in vinyl chloride production are readily transferrable to other industries, the extent of this transfer availability is not known, but, it would not be immediate.

In the polyvinyl chloride industry, approximately 5,000 workers are employed. As in the vinyl chloride industry, many workers' skills are transferable. But, again, the degree to which these transfers are available or will occur is not known.

For vinyl chloride plants, the immediate regional impacts of a production ban would be primarily upon the areas of southeastern Texas and southern Louisiana where 12 out of the 15 vinyl chloride plants are located. In certain instances, vinyl chloride output goes to other regions. In these cases, multiplier impacts in terms of decreased output, unemployment, and lower income could be expected.

For polyvinyl chloride plants, the immediate impact of a production ban would be more dispersed geographically. Although some polyvinyl chloride plants are located in the southeast Texas-southern Louisiana area, most are located in the eastern part of Delaware, New Jersey, New York, and Massachusetts. As in the vinyl chloride case, multiplier impacts would occur.

3.1.2.2. Indirect Impacts

The indirect impacts of a ban on vinyl chloride and polyvinyl chloride production would be primarily upon the raw material suppliers (ethylene dichloride producers send about 80 percent of their output to vinyl chloride and polyvinyl chloride markets) and product output receivers (fabricators). These impacts would be in terms of firm viability, job loss, and geographic location.

There are 11 firms producing ethylene dichloride at 16 plants. With one exception (Vulcan Materials), all firms also produce either vinyl chloride or polyvinyl chloride or both. Because much ethylene dichloride output appears captive, the impact of lost ethylene dichloride revenues has probably been counted in terms of lost vinyl chloride and polyvinyl chloride sales (See Table 3-1). Vulcan Materials, even though it does not also produce vinyl chloride or polyvinyl chloride, would not be expected to fail in the event of a ban on vinyl chloride and polyvinyl chloride production because it does not rely heavily on ethylene dichloride sales.

For the vinyl chloride and polyvinyl chloride fabricating business, the Chemical Economics Handbook estimates the number of fabricators to be 8,000.[1] It is not known how many of the 8,000 are independent or how many are affiliated with larger firms. The viability of the fabricator has not been analyzed. To the extent that those firms are solely dependent on vinyl chloride and polyvinyl chloride input, the possibility of failure with a vinyl chloride and polyvinyl chloride ban is likely.

There are no estimates of domestic ethylene dichloride employment. Hence, no indirect employment impact can be determined for that industry. For the fabrication end, total direct and indirect (e.g., no pipe for construction; no seat covers and coated wire for cars) employment loss with no transfer of jobs or raw material substitutes is estimated by Arthur D. Little, Inc., to be 1.7 to 2.2 million jobs.[2] This amounts to over 1 percent of the 1972 labor force. (This figure includes not only persons employed by fabricating companies, but also persons employed in utilization of the fabricated products, such as construction workers).

Nearly all ethylene dichloride manufacture takes place in southeastern Texas and southern Louisiana, as does most vinyl chloride production and some polyvinyl chloride manufacture. Consequently, this area could conceivably be hard hit, if resources required in ethylene dichloride, vinyl chloride and polyvinyl chloride output could not be transferred to other needs in the area.

No location maps of fabricators have been developed. However, the wide variety of outputs from polyvinyl chloride fabricators and the number of fabricators suggests no geographic concentration area. The fabricators are probably dispersed through the country. If there are any clusters, they are probably around metropolitan areas.

3.1.2.3. User Impact

3.1.2.3.1. Substitution

It is estimated that substitutes exist for approximately 85 percent (by weight) of present PVC uses. It is believed that the prices of the substitutes would be generally higher than polyvinyl chloride and would result in higher consumer prices for finished goods.

As an alternative to complete substitution, there exists the possibility of importing polyvinyl chloride resins for final fabrication by United States industry. Although the United States has imported very little polyvinyl chloride in the past (4 million pounds in 1972), imports in 1973 increased significantly from 4 million to 64 million pounds.[1] However, excess foreign polyvinyl chloride capacity remained. At the end of 1973, outside of the United States, excess polyvinyl chloride resin capacity was about 2750 million pounds per year. But there is no assurance that feedstocks would be available to foreign producers to operate at a 100 percent capacity in the future. Nor would there be any assurance that United States polyvinyl chloride resin users would receive the additional supplies.

Industry representatives have indicated that although known substitutes exist for most polyvinyl chloride uses, they do not feel that the substitutes exist in sufficient quantities to immediately fill the void which would be created by a product ban. In effect, they say that there would not be sufficient substitutes for polyvinyl chloride products for approximately two years.

Industry representatives have also pointed out that one of the desirable properties of polyvinyl chloride fabricated products is nonflammability. Most of the proposed substitutes do not have this property, and would require additional processing costs to eliminate potential fire hazards in the end products.

3.1.2.4. Conclusions

A ban on the manufacture of vinyl chloride and polyvinyl chloride could have a severe impact on the economy, particularly upon the fabricators and users of polyvinyl chloride. The manufacturers of vinyl chloride and polyvinyl chloride would also be adversely affected, but since these plants tend to be part of larger conglomerates the adverse impacts would be mitigated. In view of the beneficial uses of vinyl chloride products for which desirable substitutes are not readily available, the number of employees in fabrication industries who would become unemployed, and the lack of dose response data for concentrations of vinyl chloride which exist in the ambient air, banning vinyl chloride and polyvinyl chloride production does not appear to be justifiable, warranted, or desirable. Unless future health data indicate otherwise, a minimal risk of exposure to vinyl chloride appears to be acceptable due to the economic impact of banning vinyl chloride and vinyl chloride's wide range of beneficial uses.

3.13. Section 115--Abatement Conferences

Section 115 of the Clean Air Act provides EPA with the authority to call abatement conferences in instances where an air pollutant endangers the health or welfare of persons. Such conferences may be requested by a State or city when the pollutant problem originates within their jurisdiction or when the problem originates elsewhere but is a problem in their area. EPA may initiate conferences if the problem exceeds State boundary lines. Subjects to be covered at an abatement conference include information on occurrence of the air pollutant, adequacy of abatement actions, and the nature of delays that may be encountered in abating the pollution.

In the case of vinyl chloride, abatement conferences would have to be initiated by at least 16 States and Puerto Rico where all of the vinyl chloride and polyvinyl chloride plants are located, and possibly the remaining States because of fabricating plants. Generally, EPA could not call abatement conferences since vinyl chloride problems are localized and not interstate, but EPA could encourage the States to call such conferences. Once appropriate abatement actions were determined during the conferences, the States involved would have to initiate such actions. If abatement actions were not initiated by the States, EPA would have six months to hold hearings and request that abatement action be taken within a reasonable time, but in no less than six months. If States or industry chose not to take abatement actions, EPA would have to file suit in the appropriate U. S. district court to secure abatement. In general, this procedure is somewhat unwieldy, requires a significant amount of manpower, and based on past experience, may not bring about the required abatement measures. Therefore, the use of abatement conferences is not considered an effective approach to controlling vinyl chloride.

3.1.4. Section 303--Emergency Powers

Section 303 allows the Administrator to bring suit, in the appropriate U. S. district court, to immediately restrain any person from contributing to air pollution that presents an "imminent and substantial endangerment to the health of persons." Under these powers, the Administrator may request a full range of actions from emission reductions to plant shutdown. This measure is intended for use during short-term pollution episodes whenever air pollution concentrations reach levels that are associated with significant health effects, incapacitating reversible illness, or mortality. Section 303 is clearly intended as an interim control measure to reduce pollutant emissions for a limited time or in a limited space during an emergency situation. This mechanism has only been initiated once by the Agency. In 1971, court injunctions were obtained for plants in Birmingham during an air pollution episode to reduce concentrations of particulate matter below dangerous levels.

Since Section 303 is not intended as a mechanism for permanent control, it is not considered an appropriate alternative for controlling vinyl chloride. In addition, using Section 303 for the control of vinyl chloride could be cumbersome since injunctions would have to be obtained in each U. S. District Court which has a source of vinyl chloride in its jurisdiction.

3.1.5. Section 109--National Ambient Air Quality Standards (NAAQS)

Air quality standards are aimed at controlling air pollutants which have an adverse effect on public health and welfare and whose presence in the ambient air results from numerous or diverse stationary or mobile sources. Primary standards are set at levels requisite to protect the public health, allowing an adequate margin of safety. Secondary standards are set at levels requisite to protect the public welfare from any known or anticipated adverse effects. Section 109 is usually used to control pollutants whose presence in the ambient air is ubiquitous. Vinyl chloride is emitted from vinyl chloride plants, polyvinyl chloride plants, and polyvinyl chloride fabricating plants. Detectable concentrations of vinyl chloride have not yet been found in the ambient air except in the vicinity of these sources.

Ambient air quality standards must be based on published criteria information, which relates adverse effects to exposure at a specific concentration of the pollutant in the ambient air. At this time, data on the relation between health effects of vinyl chloride and air concentrations as exist in the ambient atmosphere are almost nonexistent. Effects in animals have been observed at

50 ppm and above; however, a "threshold" level, below which there is no effect on health, cannot be specified at this time. (In fact, there is possibly some small risk associated with a finite level of any carcinogen, teratogen, or mutagen.) Research to establish the lower end of the dose response curve is just now beginning. Until this research is complete (at least 2-4 years), the level of an NAAQS would be difficult or impossible to set and defend.

Establishing an air quality standard for vinyl chloride would set into motion preparation of State implementation plans for each of the 247 air quality control regions (AQCRs) to demonstrate attainment and maintenance of the standard. This is a complex process and is not generally considered the optimum regulatory approach for situations involving a limited number of source categories. The time to implement the air quality standard/State implementation plan process is estimated to be 6 months for setting a standard and 13 months to develop and approve the State plans. Compliance with the standards must be within 3-5 years after the State plans are approved.

Section 109 is not the most suitable alternative for controlling vinyl chloride because vinyl chloride is a localized problem, the health data cannot establish a threshold of effects, and because the NAAQS/State implementation plan process is time-consuming, complex, and requires considerable State and Federal resources.

3.1.6. Section 109 - National Ambient Air Quality Standard for Nonmethane Hydrocarbons

There exists a national ambient air quality standard for nonmethane hydrocarbons, which possibly could be used as a regulatory mechanism for control of vinyl chloride. However, the hydrocarbon standard (NAAQS) is clearly intended as a guide to achieving the NAAQS for photochemical oxidants. The Code of Federal Regulations states that the degree of total hydrocarbon emission reduction necessary for attainment and maintenance of the national standard for photochemical oxidants will also be adequate for the attainment of the national standard for hydrocarbons. States now have approved control strategies for oxidants and are progressing toward fulfilling the requirements of their respective strategies. To change the State implementation plans, EPA would have to present findings that the plans are inadequate and require resubmittal of the plans. This would reopen a full review of the hydrocarbon control strategies, including the transportation control plans. Hydrocarbon/oxidant strategies have focused on area-wide emissions and it would be difficult to justify singling out vinyl chloride sources for control. Vinyl chloride is less photochemically reactive than many other petrochemicals and does not contribute significantly to total urban hydrocarbon emissions. Moreover, the hydrocarbon standard regulates only the 6-9 a.m. concentrations of nonmethane hydrocarbons. During the remaining 21 hours of the day, control of vinyl chloride emissions could not be required under existing State implementation plans. For the above reasons, control of vinyl chloride under the existing NAAQS for hydrocarbons would not be appropriate or effective.

3.1.7. Section 111--Standards of Performance for New Stationary Sources (SPNSS)

New source emission standards apply to categories of sources that emit pollutants which may cause or contribute to the endangerment of public health and welfare. New sources are controlled under

Section 111(b) and existing sources under Section 111(d). [Section 111(b) standards can be established for pollutants already regulated under the authority of Section 109 or 112, whereas Section 111(d) standards cannot]. Such standards reflect the use of the best system of emission reduction (considering cost) which has been adequately demonstrated for the affected source. The level of control need not be related directly to adverse effects.

The standard setting process begins by listing categories of sources in the Federal Register for which the Agency intends to set standards of performance. Within 120 days after listing, standards for these sources must be proposed and public comments solicited. Within the next 90 days the Administrator must consider the public comments and promulgate the standards. Any new source which commences construction after the proposal of the standard must comply.

To control existing sources under Section 111(d), the Agency proposes and promulgates guidelines that describe emission limits achievable with best demonstrated control systems. These guidelines represent the level of control that must be required by the States for their plans to be acceptable to EPA. The guidelines also specify times within which EPA believes that compliance with such emission limitations can be achieved . Within 9 months after promulgation of the guidelines, the individual States must submit a plan for implementing emission regulations for existing sources of the pollutant (in this case, vinyl chloride). After the plans are received, EPA has 4 months to approve or disapprove the plans and 2 months more to promulgate EPA regulations if the State plan is unacceptable. In cases where existing sources would incur severe economic hardship or risk closure if forced to comply with State standards, the State could issue a variance allowing the source to continue operations without full compliance.

The use of Section 111 would require the use of best demonstrated control technology, taking cost into account. The best available systems for controlling vinyl chloride emissions have been used within the petrochemical industry or have been shown achievable in laboratory or pilot scale tests. Since these control systems appear to be economically feasible, emission standards reflecting the use of best available control technology would be required under Section 111 and would achieve considerable emission reduction at both vinyl chloride and polyvinyl chloride plants. However, consideration of cost could result in lower levels of emission reduction required at some individual existing plants. Also, if States allowed variances, application of best available control technology would not be assured at all plants.

3.1.8. Section 112--National Emission Standards for Hazardous Air Pollutants (NESHAP)

Section 112 was incorporated into the Clean Air Act to control pollutants which in the Administrator's judgement may cause, or contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness. Emission standards should be set at levels that provide an ample margin of safety to protect the public health from the atmospheric emissions of the pollutant. Hazardous emission standards apply to all new and existing sources of the pollutant.

To set a hazardous standard, vinyl chloride must be listed in the Federal Register as a hazardous air pollutant. Within 180 days of listing, the Administrator must propose a national emission standard, which, in his judgment, adequately protects public health. Within 30 days the Administrator must give notice of a public hearing to be held to publicly examine the Administrator's judgment of whether the pollutant is hazardous. Allowance must also be made for comments on the proposed standard from the public, scientific, and industrial communities. The Administrator can withdraw a pollutant from the hazardous list only if he finds, on the basis of information presented at the public hearing, that the pollutant clearly is not hazardous. Otherwise the Administrator must promulgate a standard within 180 days of the proposal. The Act does not require that the Administrator consider available control technology or economic impact in establishing the level of the standard. However, EPA must, from time to time, issue information on control technology.

Several issues, which are reviewed below, were evaluated in determining whether Section 112 would be an appropriate regulatory route for vinyl chloride.

(1). Does vinyl chloride meet the specifications of the definition of hazardous air pollutant in the Act?

Vinyl chloride appears to be a "hazardous" air pollutant as defined in Section 112 of the Clean Air Act. However, most of the human health effects associated with exposure to vinyl chloride have been observed in occupational situations where exposures were much higher and for a less continuous time than exposures in the ambient air. In deciding whether to control vinyl chloride under Section 112, a primary issue was whether hazardous effects of vinyl chloride have resulted or may result from continued exposure to vinyl chloride at ambient air concentrations.

In response to a request by the Deputy Assistant Secretary for Health and Scientific Affairs on October 24, 1969, the Ad Hoc Committee on the Evaluation of Low Levels of Environmental Chemical Carcinogens was formed "to review the problems relating to the evaluation of low levels of environmental chemical carcinogens, to consider the scientific bases on which such evaluations can be made, and to advise the Department of HEW (Health, Education and Welfare) on the implications of such evaluations." The <u>Evaluation of Environmental Carcinogens</u>, which was prepared by the Ad Hoc Committee and published by HEW, includes the following conclusions and recommendations:

(1) "Any substance which is shown conclusively to cause tumors in animals should be considered carcinogenic and therefore a potential cancer hazard for man."

(2) "Because the latent period in human carcinogenesis is so long, epidemiologic evidence develops only over periods of 15 to 20 years. Timely decisions to exclude materials from uses involving exposure to man, therefore, must be based solely on adequately conducted animal bioassays. Retrospective human evidence of risk must not be allowed to show itself before controlling action is taken. Chemicals should be subjected to scientific scrutiny rather

than given individual "rights"; they must be considered potentially guilty unless and until proven innocent."

(3) "No chemical substance should be assumed safe for human consumption without proper negative lifetime biological assays of adequate size. The minimum requirements for carcinogenesis biossays should provide for adequate numbers of animals of at least two species and both sexes with adequate controls, subjected for their lifetime to the administration of a suitable dose range, including the highest tolerated dose, of the test material by routes of administration that include those by which man is exposed."

Since, as specified by the Ad Hoc Committee, animal data are available which show conclusively that vinyl chloride causes tumors in animals, vinyl chloride "should be considered carcinogenic and therefore a potential cancer hazard for man." As specified by the Committee, vinyl chloride has been shown to cause cancer in two or more animal species of both sexes by the inhalation route, the route by which man is exposed. Angiosarcoma of the liver has been observed in rats, hamsters, and mice exposed to vinyl chloride. In two of these, rats and mice, liver angiosarcoma has been produced in one experiment by exposures as low as 50 ppm for four hours per day, five days per week for over a 12 month period. In a second experiment, angiosarcoma in mice has been produced by exposures as low as 50 ppm for a six month period. Furthermore, these animal studies showed a multiple cancer risk from vinyl chloride; i.e. tumors in organs other than the liver such as the brain, lungs, kidneys, and mammary glands.

The points expressed by the Ad Hoc Committee with regard to the importance of animal data were reinforced to some extent by the appeals panel of the U. S. Court of Appeals for the Second Circuit, in their January 31, 1975, ruling against the industrial challenge to the October 4, 1974, Occupational Safety and Health Administration (OSHA) regulations for vinyl chloride. (The regulation and industrial challenge are described in Chapter 13, section 13.1). The Court noted that much of OSHA's evidence for the regulation was based on animal exposure to the chemical, with only indirect human evidence,but that "nevertheless, it remains the duty of OSHA to protect the working man, and to act even in circumstances where existing methodology or research is deficient." The panel also stated that the evidence against vinyl chloride's dangers was "quite sufficient" to merit OSHA's regulations.[4]

In addition to data from animal studies, epidemiological data are available which establish that vinyl chloride is a real cancer hazard for man in occupational situations. These data strongly imply that vinyl chloride in ambient air poses a risk to health for the general population, though less of a risk than in the occupational situation where exposures have been greater. To date 15 cases of liver angiosarcoma have been reported among workers with a history of exposure to vinyl chloride in the United States and 10 such cases have been reported from Europe. Most, but not all, of these reported cases have been among workers involved directly in polyvinyl chloride production. Cases of liver angiosarcoma have been reported in one U. S. and three European workers exposed to vinyl chloride, but not directly involved in polyvinyl chloride production. These cases suggest that exposure to vinyl chloride at lower levels than usually encountered in polyvinyl chloride production plants may be capable of causing liver angiosarcoma. At least one of those workers, (the one from the United States), who was involved in fabricating polyvinyl chloride products, was probably exposed to levels of vinyl chloride well within an order of magnitude of those observed in the ambient air,

Cases of angiosarcoma of the liver have also been reported in two persons residing in the vicinity of industrial sources of vinyl chloride. Historical exposure data do not exist, but it is estimated that these persons were exposed to levels of vinyl chloride much lower than in direct occupational situations although possibly higher than present ambient levels. It is likely that the full impact of community exposure to vinyl chloride has not been realized; it is indicated that there is a latent period of 20 or more years between initial exposure to vinyl chloride and occurrence of disease, and the vinyl chloride industry did not begin to operate on a large scale until relatively recently. Only about eight of the 47 polyvinyl chloride plants are 20 years or older, and the oldest one is 40 years old. As pointed out by the Ad Hoc Committee on the Evaluation of Environmental Chemical Carcinogens, due to the long latent period for human carcinogenesis, timely decisions to exclude materials from uses involving exposure to man should be made before retrospective human evidence of risk is allowed to show itself.

Dose response data are currently not available for vinyl chloride at concentrations found in the ambient air. Also, workers in the vinyl chloride industry and persons residing near sources of vinyl chloride are exposed to a variety of chemicals, in addition to vinyl chloride, some of which may also be carcinogens and/or liver toxins. This makes it difficult to draw final conclusions regarding the specific role played by vinyl chloride in the development of liver cancer and other maladies. However, consideration of the conclusions and recommendations made by the Ad Hoc Committee on the Evaluation of Low Levels of Environmental Chemical Carcinogens, results from animal experiments (which meet the specifications defined by the Ad Hoc Committee for identifying a carcinogenic substance), and available epidemiological data strongly imply that vinyl chloride poses a serious health risk to the public. These available data implicate vinyl chloride as the causal agent of angiosarcoma, other cancers, and non-carcinogenic disorders in people with occupational exposure and in animals with experimental exposure to vinyl chloride. Reasonable extrapolations from these findings indicate that vinyl chloride may cause or contribute to the same or similar disorders at present ambient air levels. Therefore vinyl chloride appears to meet the specifications of a "hazardous air pollutant" as defined in Section 112 of the Clean Air Act, i.e. it may cause or contribute to an increase in mortality, or an increase in serious irreversible, or incapacitating reversible illness.

(2) Can an emission level which provides an ample margin of safety to protect public health be specified?

Section 112 specifies that an emission standard is to be set at a level which in the Administrator's judgment "provides an ample margin of safety to protect the public health from such hazardous air pollutant." At the present time there are no dose-response data for vinyl chloride below 50 ppm; consequently there are no dose-response data for the concentrations of vinyl chloride found in the ambient air. For this reason, there is insufficient evidence to determine a numerical safe ambient exposure level or a numerical safe emission level for vinyl chloride. In fact, according to the Surgeon General's Ad Hoc Committee on the Evaluation of Low Levels of Chemical Carcinogens cited before,

> "No level of exposure to a chemical carcinogen should be considered toxicologically insignificant for man. For carcinogenic agents a safe level for man cannot be established by application of our present knowledge. The concept of 'socially acceptable risk' represents a more realistic notion."

Thus, there may be no exposure level to vinyl chloride which represents absolutely no risk to public health. The lack of dose-response data for concentrations of vinyl chloride below 50 ppm make any calculations of risk at ambient air levels less precise than they would be otherwise.

Thus, it was concluded that the major problem involved in setting the level of a hazardous standard is that the dose response relationship from either animal data or occupational exposure is unknown at levels of exposure which are believed to occur in the ambient air.

3.1.9 Conclusions

Based on the discussion in sections 3.1.1-3.1.8 it was decided that federal regulatory action is needed for vinyl chloride, but that, based on present data, banning vinyl chloride would constitute too drastic an action. Furthermore, it was decided that the use of national ambient air quality standards (Section 109), abatement conferences (Section 115), or emergency powers (Section 303) would not be effective regulatory alternatives for controlling vinyl chloride. The two alternatives which appeared to be most applicable were National Emission Standards for Hazardous Air Pollutants (Section 112) and Standards of Performance for New Stationary Sources (Section 111), which would also include a provision [Section 111(d)] for the control of existing sources. After analyzing Sections 111 and 112 in detail, Section 112 was selected as the preferred regulatory route because vinyl chloride, even based on the limited available data, can be considered a hazardous pollutant and therefore should be regulated under the section of the Clean Air Act intended for control of such pollutants.

The primary reason for considering Section 111 is that there is insufficient evidence to determine a numerical threshold emission level in using Section 112 to regulate vinyl chloride, and setting standards under the authority of Section 111 based on best control technology (considering cost) would achieve substantial emission reduction. However, Congress included several provisions in Section 112 which make it more appropriate than Section 111 for regulating hazardous air pollutants such as vinyl chloride.

(1) Section 112, unlike Section 111, does not require consideration of costs in setting the level of the standard.

(2) Under Section 112, both new and existing sources are regulated by uniform national standards. Under Section 111, existing sources are regulated by States under Section 111(d). Since States could grant variances for non-compliance, there would be no assurance of application of best control technology at all plants.

(3) Since Section 112 standards apply to both new and existing sources, regulations for existing sources can be promulgated a year earlier than under Section 111(d).

3.2 Implementation Strategy Under Section 112

3.2.1. List as a Hazardous Air Pollutant

Under the authority of Section 112, the first step in the regulatory process is to list vinyl chloride as a "hazardous air pollutant." This can be done based on the information found in section 3.1.8.

3.2.2. Level of Standard

The second step is to set an emission standard based on a level which will "provide an ample margin of safety to protect the public health." Since, as explained in section 3.1.8, a numerical threshold emission level for vinyl chloride cannot be designated, the strategy for regulation of vinyl chloride will consist of two or more phases.

The first phase is to minimize risk to public health by establishing emission standards for vinyl chloride and polyvinyl chloride plants which will reduce emissions to the lowest level practicable with available control systems. Emission standards based on best available control technology will result in different total emission levels and different ambient air concentrations at different plants, due to variations in plant sizes, ages, and process types employed,

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The second phase, which was initiated at the same time as standards were being developed, involves a program to gather additional data on health effects at the lower end of the dose-response curve which can be used to more precisely calculate the health risk associated with the proposed standards. Data are also being collected on ambient air concentrations in the vicinity of the sources, emission levels from source categories not covered in the original standards setting effort, and control technology. As more precise data and improved control technology become available, further control actions will be initiated as necessary. These actions may include expanding the Section 112 standards to include more sources, revising the standards based on achieving and maintaining a precise ambient air concentration, or setting standards of performance for new sources (under the authority of Section 111 or 112) to more tightly control the expected growth in the vinyl chloride industries.

3.2.3. Selection of Source Categories

There are three known sources of vinyl chloride emissions: vinyl chloride plants, polyvinyl chloride plants, and polyvinyl chloride fabrication plants. There are 15 vinyl chloride plants, 47 polyvinyl chloride plants, and approximately 8,000 fabrication plants. At the time of initial standards development, more data were available on emissions, ambient air concentrations, locations, and control technology for vinyl chloride and polyvinyl chloride plants than for fabricating plants. Polyvinyl chloride plants are responsible for approximately 90 percent of the total vinyl chloride emissions, vinyl chloride less than 10 percent of the total vinyl chloride and fabricating plants the rest. Due to the general lack of data for fabricating plants, their relatively low emissions, and the need to reduce vinyl chloride emissions as soon as possible, it was decided to develop standards for vinyl chloride and polyvinyl chloride plants, while gathering additional data on fabricating plants to determine whether regulations are needef for them.

As a result of this study on fabrication plants, ________.

1. Data on the plants.
2. Effect of improved stripping on the plants.
3. Future action on fabricating plants.

[The study on fabrication plants is incomplete at this time. Results from this study will be available in the near future and will be added to this document before standards for vinyl chloride are proposed.]

Table 3-1
Estimated Dependence on PVC

Firm	Capacities[1] (Millions of Pounds Per Year)			Revenues Dependent on PVC[2] (Millions of 1973 Dollars)					
	Ethylene Dichloride	Vinyl Chloride	Polyvinyl-Chloride	Ethylene Dichloride	Vinyl Chloride	Polyvinyl-Chloride	Total	Total 1973 Sales Revenues	% Sales Dependent on PVC[3]
Air Products and Chemical	0	0	210	-	-	31.50	31.50	398.9	8
Allied Chemical Corporation	600	342	0	3.00	-	17.10	20.10	1501.0	1
American Chemical Corporation	235	170	150	-	1.00	22.50	23.50	N.A.	N.A.
Atlantic Turbing[4]	0	0	100	-	-	20.00	20.00	N.A.	N.A.
BASF Wyandotte[5]	0	0	150	-	-	22.50	22.50	2338.5	1
Borden, Inc.[4]	0	0	320	-	-	64.00	64.00	2554.0	3
Certain-Teed[6]	0	0	300	-	-	45.00	45.00	476.2	0
Continental Oil	1200	730	480	2.35	12.5	72.00	86.85	4510.0	2
Diamond Shamrock	110	0	370	-	-	55.50	55.50	667.1	8
Dow Chemical[5]	3560	1220	150	81.62	53.50	22.50	157.62	3067.9	5
Ethyl Corporation	750	420	180	4.32	12.0	27.00	43.32	713.7	6
Firestone Tire Company	0	0	500	-	-	75.00	75.00	3154.9	2
General Tire	0	0	173	-	-	25.88	25.88	1380.0	2
Georgia Pacific[5]	0	0	220	-	-	33.00	33.00	2228.7	1

Table 3-1 (continued)
Estimated Dependence on PVC

Firm	Capacities[1] (Millions of Pounds Per Year)			Revenues Dependent on PVC[2] (Millions of 1973 Dollars)					
	Ethylene Dichloride	Vinyl Chloride	Polyvinyl-Chloride	Ethylene Dichloride	Vinyl Chloride	Polyvinyl-Chloride	Total	Total 1973 Sales Revenues	% Sales Dependent on PVC[3]
B. F. Goodrich Company	900	1000	880	-	6.00	132.00	138.00	1661.0	8
Goodyear Tire Company	-	-	205	-	-	30.75	30.75	4675.3	1
W. R. Grace[5]	-	-	300	-	-	45.00	45.00	2807.8	2
Great American Chemical Corp.	-	-	40	-	-	6.00	6.00	14.04	43
Keysor-Century	-	-	35	-	-	5.25	5.25	NA	NA
Monochem, Inc.	-	300	-	-	15.00	-	15.00	NA	NA
Monsanto	-	-	70	-	-	10.50	10.50	2648	negligible
Morton and Norwich[5]	-	-	150	-	-	22.50	22.50	407	6
National Starch and Chemical[7]	-	-	10	-	-	2.60	2.60	211.6	1
Occidental Petroleum	-	-	183	-	-	26.45	26.45	1080.4	3
Olin Chemical Company	-	-	150	-	-	22.50	22.50	1252.0	2
Pantasote	-	-	108	-	-	16.20	16.20	86.79	19
PPG Industries	1700	800	-	21.80	40.0	-	61.80	1512.6	4
Robintech	-	-	250	-	-	250	37.50	55.51	68

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Table 3-1 (continued)
Estimated Dependence on PVC

Firm	Capacities[1] (Millions of Pounds Per Year)			Revenues Dependent on PVC[2] (Millions of 1973 Dollars)				Total 1973 Sales Revenues	% Sales Dependent on PVC[3]
	Ethylene Dichloride	Vinyl Chloride	Polyvinyl-Chloride	Ethylene Dichloride	Vinyl Chloride	Polyvinyl-Chloride	Total		
SCM[5]	-	-	150	-	-	22.50	22.50	980.3	2
Shell Oil Company	1400	1400	-	-	70.0	-	70.00	5749.6	1
Stauffer Chemical Company	-	-	175	-	-	26.25	26.25	621.3	4
Tenneco Chemical Inc.	-	255	235	-	1.00	35.25	36.25	3940.0	1
Union Carbide	300	-	460	-	-	60.00	69.00	3938.8	2
Uniroyal Inc.	-	-	108	-	-	16.20	16.20	2090.0	1
Vulcan Materials	270	-	-	13.50	-	-	13.50	325.3	4

1. End of 1973.
2. Estimated on the following assumptions: \$.05/lb for EDC and VC; \$.15/lb for general purpose PVC; it takes 1.58 lbs of EDC to make a lb of VC; it takes 1 lb of VC to make a lb of PVC; operating rate 100 percent; and intra company transfer of EDC and for VC revealed in the price of end product. ex. Allied Chemical Corp. $[600-(342 \times 1.58)] \times \$.05 + 342 \times \$.05 = 3.00 + 17.10 = 20.10$
3. Total Revenues Dependent on PVC ÷ Total 1973 Sales Revenues.
4. Revenues were adjusted to reflect the price of the copolymer (vinyl acetate) produced here. Price of that PVC copolymer was \$.20/lb.
5. Plant capacity was not known. For each plant a 150 million pound/year capacity was assumed.
6. In 1973, this firm had no PVC capacity. The capacity given here was brought on in 1974.
7. This firm produced emulsion resins only. Revenues were adjusted to reflect the 1973 price: \$.26/lb.

References

1. "Polyvinyl Chloride Resins, "Chemical Economics Handbook, Stanford Research Institute, September, 1973,

2. Cited from "Economic Impact of a Shutdown of the Polyvinyl Chloride Industry," a study done for the Society of the Plastics Industry by Arthur D. Little, Inc., May, 1974.

3. Ad Hoc Committee on the Evaluation of Low Levels of Environmental Chemical Carcinogens, Evaluation of Environmental Carcinogens, Report to the Surgeon General, USPHS, HEW, Washington, D. C., April 22, 1970, pp. 1, 8.

4. U.S. Court of Appeals for the Second Circuit, The Society of the Plastics Industry, Inc., v. Occupational Safety and Health Administration, 2 OSHC 1496-1504.