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August 23, 1974

Mr. James Kallenborn
Acting Director of Planning, Evaluation and Research
OSHA
MNSA Building
Room 110
1726 M Street, N.W.
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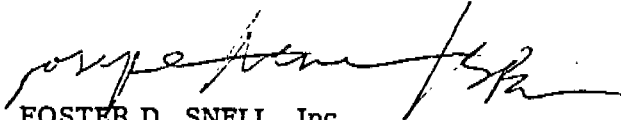
Re: Contract No. L/A 74-167

Dear Mr. Kallenborn:

The following is the preliminary report being submitted by August 23, 1974, for insertion into the Vinyl Chloride Hearing Transcripts. As agreed, the report presents the findings gathered by the study team during the seven weeks begun on July 1, 1974. The conclusions developed and presented in this report are preliminary, in that they will be subjected to further analyses in the remaining period of the contract.

Please do not hesitate to call should you have any questions about this report.

Sincerely,


FOSTER D. SNELL, Inc.

Joseph Nemec, Jr., Ph.D.
Vice President

mjs

A Subsidiary of
BOOZ • ALLEN & HAMILTON Inc.

DOW 1492

PRELIMINARY REPORT

ECONOMIC IMPACT STUDIES OF THE EFFECTS OF PROPOSED
OSHA STANDARDS FOR VINYL CHLORIDE

Contract No. L/A 74-167

Mr. James Kallenborn
Acting Director of Planning, Evaluation and Research
OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

U. S. DEPARTMENT OF LABOR

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August 23, 1974

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I. INTRODUCTION

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I. INTRODUCTION

This chapter presents the background of the economic impact study of the proposed OSHA standards for vinyl chloride, the study methodology, and the organization of the report.

1. SNELL'S ASSIGNMENT WAS TO ASSESS THE ECONOMIC IMPACTS RESULTING FROM THE COST TO INDUSTRY FOR MEETING ALTERNATE STANDARDS FOR WORKER EXPOSURE TO VINYL CHLORIDE MONOMER (VCM) IN THE VCM AND POLYVINYL CHLORIDE (PVC) MANUFACTURING INDUSTRIES

On January 22, 1974 the Occupational Safety and Health Administration (OSHA) was informed by the National Institute for Occupational Safety and Health (NIOSH) that the B.F. Goodrich Chemical Company reported that deaths of several of its employees from a rare liver cancer (angiosarcoma) may have been occupationally related. As a result of this information, subsequent epidemiological studies and a fact finding hearing, an Emergency Temporary Standard (ETS) was promulgated by OSHA on April 5, 1974 detailing preliminary regulations on worker exposure to VCM (50 ppm ceiling exposure limit).

As required by law, six months after the issuance of an ETS a permanent standard must be formulated and approved. Therefore, on May 10, 1974 OSHA published a proposed permanent standard which included "no-detectable limit".

To aid OSHA in carrying out its standard setting mandate Snell was assigned to prepare this report dealing with assessing the economic impacts of alternate standards for worker exposure to VCM in the VCM and PVC manufacturing industries. The alternate standards investigated are:

- . 50 ppm ceiling
- . 25 ppm ceiling
- . 25 ppm 8-hour time weighted average (TWA) with a 40 ppm ceiling
- . lower TWA(s) with a ceiling
- . "no-detectable" proposed permanent standard

The study is limited to U.S. production of VCM and PVC.

Exhibit I-1, on the following page, is a self-explanatory summary of the scope of the Snell study.

EXHIBIT I-1
U. S. Department of Labor/Occupational Safety
and Health Administration
THE SCOPE OF THE SNELL STUDY

Primary Emphasis

- Assess the economic impact of VCM regulation on VCM and PVC manufacturing
- Concentrate on PVC manufacture (approximately 80% of level of effort)
- Investigate the following alternate standards
 - 50 ppm ceiling
 - 25 ppm ceiling
 - 25 ppm TWA⁽²⁾ with 40 ppm ceiling
 - lower TWA(s) with ceiling
 - "no detectable" level
- Emphasize key regulatory considerations
 - engineering and work practices
 - use of personal protective equipment
 - environmental and personal monitoring
 - assembling of exposure data
 - residual monomer levels in PVC

Secondary Requirements

- Include a study of VCM manufacture (approximately 20% of level of effort)
- Include secondary regulatory considerations⁽¹⁾
 - medical surveillance costs
 - record keeping costs
 - covered workers
 - regulated areas

Deliverables

- Deliver preliminary report on the 50 ppm, 25 ppm and "no detectable" cases in 7 weeks starting on July 11, 1974 on 23 August 1974
- Present draft final report in 11 weeks (13 September 1974)
- Key deliverables are
 - estimates of the time table required in each of these evaluations for effective implementation
 - .. in the near-term, 6 months to one year
 - .. in the longer-term, 2 years or more
 - estimates of the costs of achieving the various levels of VCM controls evaluated
 - assessment of economic impact on the basis of technical feasibility, timing and costs

(1) Other regulatory considerations include, for example, emergency situations and signs and labels, but were not included in the scope of Snell's work. All the regulatory considerations assigned for study are listed in the Exhibit.

(2) TWA = Time weighted average

2. THE REPORT IS ORGANIZED INTO TWO PARTS

The report conclusions and recommendations are presented first supported by detailed appendices.

(1) The First Part Of The Report Presents The Findings Of Economic Impact Together With Recommendations

Part One includes the following outputs:

- . Chapter I - Introduction. This chapter summarizes the problem, the scope of the study and the organization of the study.
- . Chapter II - Methodology. This chapter presents the Snell study methodology.
- . Chapter III - Industry Structure. This chapter presents data on
 - members of the VCM and PVC producing industries
 - location of plants
 - marketing and base-line economic data.
- . Chapter IV - The Technology of the Industry. This chapter describes the processes of VCM and PVC and includes
 - process description and flow diagrams for each major process
 - representative operating procedures
- . Chapter V - Findings. This chapter details the major findings related to economic impact emphasizing technical feasibility, timing and costs based on aggregating individual company data to the industry level.

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Chapter VI - Conclusions. The conclusions are presented as a function of various VCM levels and include

- technical feasibility particularly in relation to the emphasized regulatory considerations studied, including
 - .. engineering controls
 - .. work practice
 - .. personal protective equipment
 - .. monitoring
- timing
- costs

Chapter VII - Recommendations. The recommendations presented in this chapter give heavy emphasis to technical feasibility and timing.

(2) The Second Part Of The Report Presents Detailed Study Documentation (Appendices)

This part of the report is comprised of seven self-explanatory appendices and supports the material in Part One.

- . Appendix A - Detailed Process Description and Procedures
- . Appendix B - Exposure Data
- . Appendix C - Cost Details
- . Appendix D - Personal Protective Equipment and Hygiene
- . Appendix E - Monitoring Equipment
- . Appendix F - Medical Surveillance
- . Appendix G - NIOSH Recommendations to OSHA

* * * * *

This chapter presented the scope of the study and the organization of this report. The following chapter details the methodology used by Snell to carry out the study.

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II. METHODOLOGY

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II. METHODOLOGY

This project was carried out as a rapid response study. The timing of the report was such that on August 23, 1974, seven weeks from the start of the study, this preliminary report was submitted to USDOL/OSHA for inclusion into the public record. The preliminary report features

- . Fact finding, such as field visits and telephone interviews including recontacting of parties for data clarification.
- . Preliminary analysis of regulatory scenarios including
 - "no-detectable" vinyl chloride monomer (VCM) levels
 - 25 ppm levels

A final report draft is to be submitted by the end of the 11th week of the study (September 13, 1974).

The methodology used by Snell in fulfilling the work requirement was to perform the study in several major tasks described below. All exhibits are presented at the conclusion of the text of this chapter.

1. PLANT AND INDUSTRY VISITS WERE A PRINCIPAL MEANS OF INFORMATION GATHERING

- . During the course of the investigation, Snell team members made 29 industry visits. The vinyl chloride and polyvinyl chloride industries consist of 30 producers and 53 plants. These visits involved either day long technical discussions in their engineering and production offices or detailed plant tours.
- . Exhibit II-1 presents the plants, location and purposes of these trips. These trips were comprised of
 - 22 plant visits
 - 8 visits to corporate engineering offices.

2. INDUSTRY RELATED ORGANIZATIONS, GOVERNMENTAL AGENCIES, EQUIPMENT MANUFACTURERS, AND SPECIALISTS WERE VISITED TO SUPPLEMENT INFORMATION OBTAINED FROM PLANT VISITS

In order to gain a broader view of the technical feasibility and necessary costs, personal visits were made to recognized experts in the areas covered by the study.

Exhibit II-2 details the organizations, governmental agencies, and equipment manufacturers visited and the types of information obtained. These visits included

- 4 visits to government agencies
- 3 visits to industry organizations
- 4 visits to equipment manufacturers or technical specialists

3. A TELEPHONE SURVEY WAS CONDUCTED OF MANUFACTURERS OF MONITORING EQUIPMENT, RESPIRATORY DEVICES, PERSONAL PROTECTIVE EQUIPMENT AND PROCESS EQUIPMENT

The purpose of this task was to obtain detailed information covering costs, availability, and technology. Information was obtained both directly through the telephone survey and the brochures and catalogues sent to Snell as a result of the conversations.

Exhibit II-3 details the manufacturers interviewed during the telephone survey. Calls were made to

- 13 monitoring equipment manufacturers
- 7 manufacturers of respiratory equipment
- 6 producers of protective clothing
- 8 processing equipment manufacturers or designers

4. THE SNELL INFORMATION CENTER STAFF CONDUCTED A LITERATURE SURVEY TO IDENTIFY AND OBTAIN BACKGROUND INFORMATION ON AREAS RELEVANT TO THIS STUDY

- . To obtain an overview of manufacturing processes, pollution problems, marketing, end-use products, and possible protective devices, etc., a survey of the following journals was performed:
 - Hydrocarbon Processing - 15 years
 - Modern Plastics - 5 years
 - Chemical Marketing Reporter - 3 years
 - Chemical and Engineering News - 3 years
 - Chemical Engineering - 5 years
 - European Chemical News - 3 years
- . Standard chemical reference texts such as the Encyclopedia of Polymer Science and Technology and the Kirk-Othmer Encyclopedia of Chemical Technology were also researched to obtain more general information.
- . Chemical Marketing Abstracts and Chemical Economics Handbook were used for basic industrial facts.

5. THE STUDY METHODOLOGY EMPHASIZED THE PARAMETERS DEFINED IN EXHIBIT I-1, IN THE INTRODUCTION CHAPTER

The methodology described in the above points was employed to determine and define the scope of the following parameters:

- . Profiling of industry structure and processes

- . Definition of the number of workers potentially exposed to VCM considering
 - job description
 - unit operation
 - potential exposure to VCM levels
- . Determination of costs and means of controlling exposure levels through engineering controls and improved work practices with particular attention to:
 - "buttoning-up" of plants
 - ventilation
 - operation
 - maintenance
 - monomer levels in the polymer
- . Investigation of further methods and costs of protection through the use of personal protective equipment beyond controlling exposure through engineering and work practices.
- . Development of a technical and economic information base for personal, and area monitoring and leak determination equipment.
- . Isolation of information regarding:
 - medical surveillance costs
 - record keeping costs
 - covered workers
 - regulated areas

Detailed methodology is presented as footnotes to exhibits, textual reference or material in the appendices.

6. AS DIRECTED BY OSHA THE STUDY DEALT PRIMARILY WITH PVC PRODUCTION

Approximately 80% of the level of effort was devoted to PVC production. Discussion emphasis in subsequent chapters reflects this.

7. FURTHER WORK AFTER THE PRELIMINARY REPORT WILL ADDRESS THE EVALUATION OF EXPOSURE LIMITATIONS BETWEEN THE "NO DETECTABLE" AND 25 PPM CASES, GENERAL DATA REFINEMENT AND FURTHER EVALUATION OF DEVELOPMENTAL TECHNOLOGY

This section indicates the topics to be further expanded on in the final report. These topics include:

- . An analysis of case(s) representing potential exposure limit(s) between "no detectable" and 25 ppm. (The preliminary report deals with the 50 ppm, 25 ppm and "no detectable" cases).
- . Data refinement where indicated in the body of the preliminary report
- . The 35,000 gal. reactor technology
- . Polymerization cycles and reactor cleaning
- . Monomer stripping
- . Carbon absorption
- . General R&D

8. WHERE THERE WAS A QUESTION AS TO THE POSSIBLE PROPRIETARY NATURE OF INFORMATION,
DATA SOURCES WERE CODED

The elements of each coded plant designation are as follows

- . Random leading number only for VCM plants
- . Random leading number - PVC plant capacity - PVC plant age - PVC plant siting
for PVC plant
 - S = small, less than 100 million lbs.
 - M = medium, 100 to 200 million lbs.
 - L = large, over 200 million lbs.
 - New = to 10 yrs.
 - Int. = 11 to 20 yrs.
 - Old = over 20 yrs.
 - C = cold climate
 - W = warm climate

- . Exhibits featuring the code refer back to this page for meaning of the elements of the code.

* * * * *

This chapter detailed study methodology. The chapter that follows presents the preliminary findings and conclusions.

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EXHIBIT II-1(1)
 USDOL/OSHA
 VINYL CHLORIDE/POLYVINYL CHLORIDE
 PRODUCERS VISITED AND INTERVIEWED
 BY PHONE BY SNEIL STAFF FOR DATA
 COLLECTION

Firm or Organization Visited

Air Products, Inc.
 Valley Forge, Pennsylvania

Allied Chemicals, Inc.
 Corporate H.Q.
 Morristown, New Jersey

American Chemical Co.
 Long Beach, California

Conoco
 . Corporate H.Q. Saddlebrook, New Jersey
 . Oklahoma City, Oklahoma

Diamond Shamrock
 . Corporate H.Q. Cleveland, Ohio
 . Delaware City, Delaware
 . Deer Park, Texas

Dow Chemicals, Inc.
 . Oyster Creek, Louisiana
 . Freeport, Texas

Ethyl Corporation
 Baton Rouge, Louisiana

Firestone Tire & Rubber Co.
 Akron, Ohio

General Tire & Rubber Co.
 Ashtabula, Ohio

Purpose of Visit

Technical and engineering data collection on PVC

Technical and engineering data collection on VCM

Plant visit on VCM and PVC

Technical and engineering data collection
 Plant visit on PVC

Technical and engineering data collection on PVC

Plant visit
 Plant visit

Plant visit on VCM
 Plant visit on VCM

Plant visit on VCM

Phone interview on PVC

Plant visit on PVC

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Firm or Organization Visited

Purpose of Visit

B. F. Goodrich Co.
• Corporate H. Q. Cleveland, Ohio
• Calvert City, Kentucky
• Long Beach, California
• Louisville, Kentucky
• Pedricktown, New Jersey

Technical and engineering data collection
Plant visit on VCM
Plant visit on PVC
Plant visit on PVC
Plant visit on PVC

Goodyear Tire & Rubber Co.
Niagara Falls, New York

Plant visit on PVC

Great American Chemical Co.
Fitchburg, Massachusetts

Plant visit on PVC

Hooker Chemical Corp.
Florence, New Jersey

Plant visit on PVC

Monsanto
Springfield, Massachusetts

Phone interview on PVC

National Starch & Chemical Co.
Corporate H. Q. Plainfield, New Jersey

Technical and engineering data collection on PVC

Olin-Thompson Plastics
Assonet, Massachusetts

Plant visit on PVC

Pantasote
Passaic, New Jersey

Plant visit on PVC

Robintech, Inc.
Painesville, Ohio

Plant visit on PVC

Shell Oil Co.
• Corporate H. Q. Houston, Texas
• Deer Park, Texas

Technical and engineering data collection on VCM
Plant visit on VCM

Stauffer Chemicals
Delaware City, Del.

Plant visit on PVC

Tenneco
Burlington, New Jersey

Plant visit on PVC

EXHIBIT II-1(3)
USDOL/OSHA

Firm or Organization Visited

Union Carbide, Inc.
So. Charleston, West Virginia

Uniroyal Chemical Co.
Akron, Ohio

Source: Snell

Purpose of Visit

Technical and engineering data collection on PVC

Plant visit on PVC

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EXHIBIT II-2
USDOL/OSHA
GOVERNMENT AGENCIES, INDUSTRY ORGANIZATIONS,
AND EQUIPMENT MANUFACTURERS VISITED BY SNELL
STAFF FOR DATA COLLECTION

I. Government Agencies

U. S. Department of Labor
Washington, D. C.

General data collection and attend hearings

National Institute for Occupational Safety and Health
Cincinnati, Ohio

Discussion on medical, monitoring, and protective equipment

Environmental Protection Agency
Washington, D. C. and Research Triangle Park, N. C.

General data collection

U. S. Department of Commerce
Washington, D. C.

Industry marketing data collection

II. Industry Organizations

Manufacturing Chemists Association
New York, New York

Discussions on technical feasibility and marketing data

Organizational Resources Council, Inc.
Washington, D. C.

General discussion

Society of the Plastics Industry
New York, New York

Discussions on technical feasibility

III. Equipment Manufacturers, Medical Laboratories, Industrial Consultants, Etc.

The Pfaudler Co. - Div. Sybrou Corp.
Rochester, New York

Discussions on polymerizers and other technical questions
(sole U. S. suppliers of glass lined equipment)

Diagnostic Sciences, Inc. - Ivan K. Smith
Morris Plains, New Jersey

Medical surveillance data collection

Tec-Air, Inc. - David Metal
East Northport, New York

Protective equipment data collection

Human Motivation Resources - Joel D. Schaffer
Morris Plains, New Jersey

Safety program data collection

Source: Snell

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FIRMS CONTACTED DURING THE SNELL TELEPHONE
SURVEY OF EQUIPMENT MANUFACTURERS

I. Monitoring Equipment Manufacturers

AID
West Chester, Pennsylvania

Bacharach Instrument Co.
Pittsburgh, Pennsylvania

Beckmann Instrument
Fullerton, California

Bendix Corporation
Environmental Science Division
Baltimore, Maryland

Byron Instruments, Inc.
Raleigh, N.C.

Carle Instruments
Fullerton, California

Century Systems Corp.
Arkansas City, Kansas

Hewlett-Packard Co.
Avondale, Pennsylvania

Microchemical Specialties Co.
Berkeley, California

Perkin-Elmer
Norwalk, Connecticut

Anatole J. Sipin Co.
386 Park Avenue, S.
New York, New York

Varian Association
Palo Alto, California

Wilks Scientific
Norwalk, Connecticut

II. Respiratory Equipment Manufacturers

Bausch & Lomb
Rochester, New York

Mine Safety Appliances
Pittsburgh, Pennsylvania

Minnesota Mining & Manufacturing, Inc.
Minneapolis, Minnesota

Scott Aviation
South Haven, Michigan

Survive-Air
Santa Ana, California

Welsh Scientific, Inc.
Providence, Rhode Island

Willson Products
Pennsylvania

III. Protective Clothing Manufacturers

Arrow Disposables, Inc.
Cincinnati, Ohio

E. I. Dupont de Nemours
Wilmington, Delaware

Durafab
Cleburne, Texas

Edmont-Wilson
Coshocton, Ohio

Mars, Inc.
Ashville, North Carolina

Uniroyal, Inc.
New York, New York

IV. Processing Equipment Manufacturers

Crawford and Russel, Inc.
(Design Engineers)
Stamford, Connecticut

Dresser Industries
(Compressors and Vacuum Pumps)
Connersville, Indiana

Durion Company, Inc.
(Valves and Pumps)
New York, New York

Fluid Handling System
(Viking Pumps)
Secaucus, New Jersey

GAF
(Cleaning Systems)
New York, New York

Nash Engineering Co.
(Compressors and Vacuum Pumps)
Norwalk, Connecticut

Process Pumps, Inc.
(Pumps)
Kenilworth, New Jersey

Stauffer Inc.
(Cleaning Systems)
Westport, Connecticut

Source: Snell

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III. INDUSTRY STRUCTURE

III. INDUSTRY STRUCTURE

This chapter presents an overview of the structure of the U.S. vinyl chloride monomer (VCM) and polyvinyl chloride (PVC) industries. Key elements of production, prices and markets are delineated to provide a background and comparative criteria to judge the economic impact of proposed regulations on VCM and PVC manufacturing.

The chapter is divided into three sections:

- . . . Section IIIA - Vinyl Chloride Monomer Production
- . . . Section IIIB - Polyvinyl Chloride Production
- . . . Section IIIC - Key Polyvinyl Chloride Markets

IIIA. VINYL CHLORIDE MONOMER

This section defines the structure of the vinyl chloride monomer (VCM) manufacturing industry.

1. NINE COMPANIES OPERATE 14 VCM PLANTS

- . Exhibit III-1, on the following page, presents a profile of the VCM producers in terms of plant locations, capacities and manufacturing process. Process related factors are discussed in Chapter IV.
- . Shell, Dow and Goodrich are the leading 1974-1975 producers, accounting for approximately 58% of nameplate capacity.
- . Approximately 5,225 million pounds VCM are estimated to be available for conversion into PVC in 1974-1975, assuming no major economic impact from OSHA regulations.
- . With the exception of the Goodrich plant in Calvert City, Kentucky, the U.S. VCM plants are located in warm climate areas -- Texas, Louisiana, Puerto Rico, and California. In general, the plants are open except for weather screening.
- . VCM plants are generally located in or near petroleum rich areas to minimize the cost of feedstock (ethylene) transfer.

2. U.S. VCM PRODUCTION HAS INCREASED APPROXIMATELY 370% TO 6,000 MILLION POUNDS IN 1974 SINCE 1964, WHILE THE MID-1974 PRICE IS 7 TO 10 CENTS PER POUND OR ALMOST DOUBLE THE 1972 PRICE

- . Exhibit III-2, on the following page, presents production, sales and price data for the years 1962 through 1978-1980 (estimated). Sales and unit cost information are also presented.
- . Since 1964 production of VCM has increased from 1,615 million pounds to an estimated 6,025 million pounds in 1974, for an increase of 373%.
- . For the years 1962 to 1972, production of VCM increased from 1,311 million pounds to 5,089 million pounds or 388%, while merchant sales increased from 516 million pounds to 3,343 million pounds or 647%. Merchant uses were 39% of production in 1962 and 66% of production in 1972. This indicates a decreased forward integration in the industry with growth.
- . The doubling of price from 1972 to mid-1974 is attributed to the great escalation in feedstock costs due to the "energy crisis".

3. THE VCM MANUFACTURING INDUSTRY HAS APPROXIMATELY 940 PRODUCTION WORKERS

- . Based on a Snell survey of VCM producers, representing approximately 65% of 1974-1975 nameplate capacity (see Exhibit III-1), estimates were developed of the number of production and related personnel in the industry.

EXHIBIT III-1

USDOL/OSHA

PROFILE OF VINYL CHLORIDE PRODUCERS

<u>Major Producer/Location</u>	<u>1974-1975 Nameplate Capacity⁽¹⁾ (Million Lbs.)</u>	<u>Process⁽²⁾</u>
Allied, Geismar, La.	300	Oxychlorination
American Chemical, Watson, Calif.	170	Stauffer Oxychlorination
Conoco, Lake Charles, La.	625	Stauffer Oxychlorination
Dow, Freeport, Tex.	*180	Dow Oxychlorination
Dow, Oyster Creek, Tex.	1,400 { *700	Dow Oxychlorination
Dow, Plaquemine, La.	{ *450	Dow Direct Chlorination
Ethyl, Baton Rouge, La.	450 { *270	Direct Chlorination
Ethyl, Houston, Tex.	{ *150	Direct Chlorination
Goodrich, Calvert City, Ky.	1,000	Goodrich Oxychlorination
Monochem, Geismar, La.	350	Acetylene
PPG, Guayanilla, P. R.	900 { *500	Oxychlorination
PPG, Lake Charles, La.	{ *300	Oxychlorination
Shell, Deer Park, Tex.	1,500 { *800	Stauffer Oxychlorination
Shell, Norco, La.	{ *700	Stauffer Oxychlorination
Total	<u>6,695</u>	
Correcting for 90% operating level	670	
Subtotal	<u>6,025</u>	
5% lost in polymerization	300	
Subtotal	<u>5,725</u>	
Estimated 1974 exports	300	
Estimated 1974 imports	Negligible	
Subtotal	<u>5,425</u>	
Other uses of VCM	200	
Total available for PVC conversion	<u>5,225</u>	

*Order of magnitude values

- Sources:
- (1) Company and industry totals based on Modern Plastics, May, 1974 and plant site estimates based on Chemical Marketing Reporter, 17 September, 1973, and industry interviews.
 - (2) Industry interviews.
 - (3) Snell assessment

EXHIBIT III-2

USDOL/OSHA

VINYL CHLORIDE MARKET TRENDS

<u>Year</u>	<u>Production⁽¹⁾</u> <u>(MM Lbs.)</u>	<u>Sales⁽¹⁾</u> <u>(MM Lbs.)</u>	<u>Unit Value</u> <u>(\$/Lb.)</u>
1962	1,311	516	7.5
1963	1,435	501	7.0
1964	1,615	597	6.4
1965	2,000	688	6.1
1966	2,500	836	5.9
1967	2,424	952	5.3
1968	2,969	1,463	4.6
1969	3,736	2,359	4.4
1970	4,040	2,720	3.9
1971	4,336	3,003	4.2
1972	5,089	3,343	4.0
1973	5,348	NA	5 ⁽²⁾
1974	6,025 ⁽³⁾	NA	7-10 ⁽²⁾
1978-- (Unimpacted by OSHA Standards)	6,800 ⁽⁴⁾	NA	NA

- Sources:
- (1) "Synthetic Organic Chemicals", U. S. Tariff Commission, Annual Reports 1960-1973.
 - (2) Posted price in tanks (works, freight equalized), Chemical Marketing Reporter, December 31, 1973 and June 24, 1974.
 - (3) Estimate based on 1974 capacity 6,695 MM Lbs. in Exhibit III-1 at 90% utilization.
 - (4) 7,500 MM Lbs. capacity at 90% utilization per Hydrocarbon Processing, May, 1974, p. 83.

NA=Not Available

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Exhibit III-3, on the following page, summarizes employment data for 1974

- production, maintenance and laboratory personnel have responsibilities with likelihood of VCM exposure; these represent 720 workers or 77% of manufacturing employment
- there are approximately 220 management and support personnel

* * * * *

This section defined the structure of the VCM industry. The section that follows similarly profiles PVC manufacture.

IV. TECHNOLOGY OVERVIEW

IV. TECHNOLOGY OVERVIEW

The previous chapter defined the economic infrastructure of the vinyl chloride (VCM) and polyvinyl chloride (PVC) industries. This chapter presents a technological overview of VCM and PVC manufacture to provide broad engineering and operational perspective to the information of Section V, which presents findings and conclusions.

This chapter is divided into two sections:

- . Section IVA, Vinyl Chloride
- . Section IVB, Polyvinyl Chloride

PVC is given significantly greater discussion emphasis than VCM since the study is of PVC.

IVA. VINYL CHLORIDE

This section discusses the technology of vinyl chloride (VCM) manufacture. Exhibits appear sequentially at the end of the text.

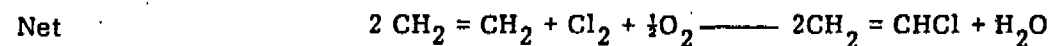
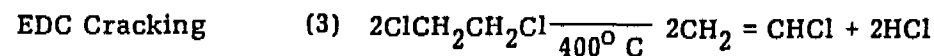
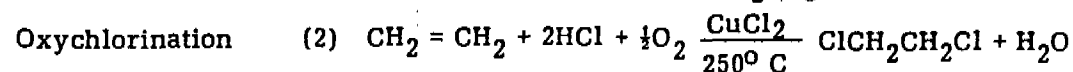
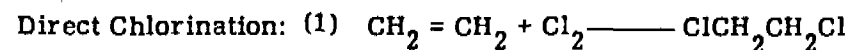
1. THE OXYCHLORINATION PROCESS ACCOUNTS FOR APPROXIMATELY 80% OF VCM CAPACITY

The table below summarizes estimated U.S. VCM capacity in 1974 as a function of the manufacturing process.

<u>VCM Process</u>	<u>Estimated 1974 Nameplate Capacity (Million Lbs.)</u>	<u>Percent of Total</u>
Oxychlorination	5,450	81%
Direct Chlorination Only	900	14
Acetylene	<u>350</u>	<u>5</u>
Total	<u>6,700</u>	<u>100%</u>

Source: Exhibit III - 1

The balanced oxychlorination process is described by the following equations:



Source: Brownstein, A. M., U. S. Petrochemicals. Tulsa, Oklahoma;
The Petroleum Publishing Co., 1971, p. 250.

Exhibits IV-1 and IV-2 provide representative flow diagrams for the balanced oxychlorination process based on the Stauffer Chemical and B. F. Goodrich Chemical designs, respectively. Unit operations are similar in balanced oxychlorination plants, although design details can vary appreciably regarding mass and heat balances, particularly in fractionation steps.

Exhibit IV-3 provides a general process description related to the Stauffer design. The Exhibit also provides a more detailed description of unit operations involving VCM.

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. The American Chemical plant is believed to feature unbalanced oxychlorination, using only reactions (2) and (3) in the preceding table.

. The Ethyl plants and Dow's Plaquamine plant are believed to feature direct chlorination and cracking only, using reactions (1) and (3) in the preceding table.

. The Monomchem plant, the only substantial acetylene-based process still operating, is believed to be balanced type employing both ethylene and acetylene. The HCl produced by pyrolysis of ethylene dichloride is added to acetylene for further VCM production, instead of oxychlorination.

. The newest process is the Transcat process (Lummus Co., and Armstrong Cork Co.) with the potential to compete strongly with the ethylene process. It is one step synthesis of VCM by oxychlorination of ethane. VCM is produced by passing ethane, HCl and air (1 to 1 to 2.5 vol) through a molten catalyst of KCl and CuCl/CuCl₂ at 875°F.

. Exhibit IV-4 summarizes estimated 1974 VCM economics.

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2. GENERALLY, VCM PRODUCTION CAN PRESENT RELATIVELY LIMITED CHANGES OF EXPOSURE TO THE OPERATING PERSONNEL DUE TO AUTOMATION AND REMOTE CONTROL AND OUTDOOR CONSTRUCTION SIMILAR TO REFINERIES

However, localized hazard areas are associated on a routine basis with the loading of tank cars, the cleaning of tank cars and of other equipment. Maintenance operations may be also a source of personnel exposure.

(1) The VCM Production Plants Are Highly Automated

- . A typical VCM production plant consists of an island of process units, principally fractionation and similar towers, cracking furnaces, and sometimes compressors. Day tanks, providing storage space during testing, are also included.
- . Long-term storage is provided by Hortonspheres which are located in tank farms and connected to the loading racks where the tank cars are filled.
- . The flow of material through the production train (or trains) is controlled from control rooms, which, especially in newer installations, are fairly removed from the actual production units.
- . The operators spend much of their time in the control room, mostly monitoring the operation of automatic controllers and from time to time making necessary set point adjustments. Normally there is little need for the operating personnel to be physically present in the production area.

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However, inspection trips may be necessary from time to time and are usually motivated by some abnormality in the operation. While most of the abnormalities are usually traceable to instruments or control malfunction, significant leaks could be occurring and result in appreciable exposure risk.

(2) The VCM Plants Are Usually Completely Outdoor Operations

All production equipment is generally installed out-of-doors. There is limited chance of VCM accumulation and area concentrations may remain low even in the presence of significant leaks, particularly when atmospheric conditions are not stagnant.

However, significant exposure may be encountered by the greaser. Since his function is to fill up the lubricating devices of pumps and compressors, which in some instances may have to be done daily, he comes into close proximity of seals which may be leaking, and his own personal exposure may be in considerable excess to what would be surmised from the general background.

(3) Tank Car Loading And Tank Car Cleaning Present The Most Critical Areas Of Exposure In Monomer Plants

While there are some "over-the-fence" pipeline deliveries and some marine shipments, the bulk of the VCM is moved in railroad tank cars. Significant VCM exposure risk can result from disconnecting transfer lines and from the historical practice to use "dip tubes" to determine the level in the tank car.

The "dip tube" method consists in allowing a minute amount of VCM gas continuously to escape through an adjustable tube dipping into the tank. When the level of the liquid in the car reaches the bottom of the tube liquid VCM is discharged resulting in a visible "plume" from the tube. Usual practice has been to raise further the dip tube at this point and to complete the filling carefully at a lower rate until the permissible level was reached. Under certain atmospheric conditions this method is known to have given significant VCM concentrations even at some distance from the tank car dome. A solution to this problem has been to re-equip larger fleets of tank cars with more elaborate, non-emitting gauging devices.

Tank car cleaning operation put men in close contact with cars which may contain residual amounts of monomer. But thorough venting and incineration can be installed and personal protection used. Thus, exposure hazard to personnel can be minimized.

(4) Maintenance Operations, While Serious Potential Sources Of Personnel Exposure, Can Be Controlled By Appropriate Depressurization And Venting Procedures

Catastrophic failures involving rupture of large volume containers or massive leaks upstream of the main control device are rare.

Other situations requiring maintenance action (such as pulling a unit off the line for repair) divide into two categories: scheduled and unscheduled, with the former more easily accomplished using proper procedures to minimize VCM exposure risks.

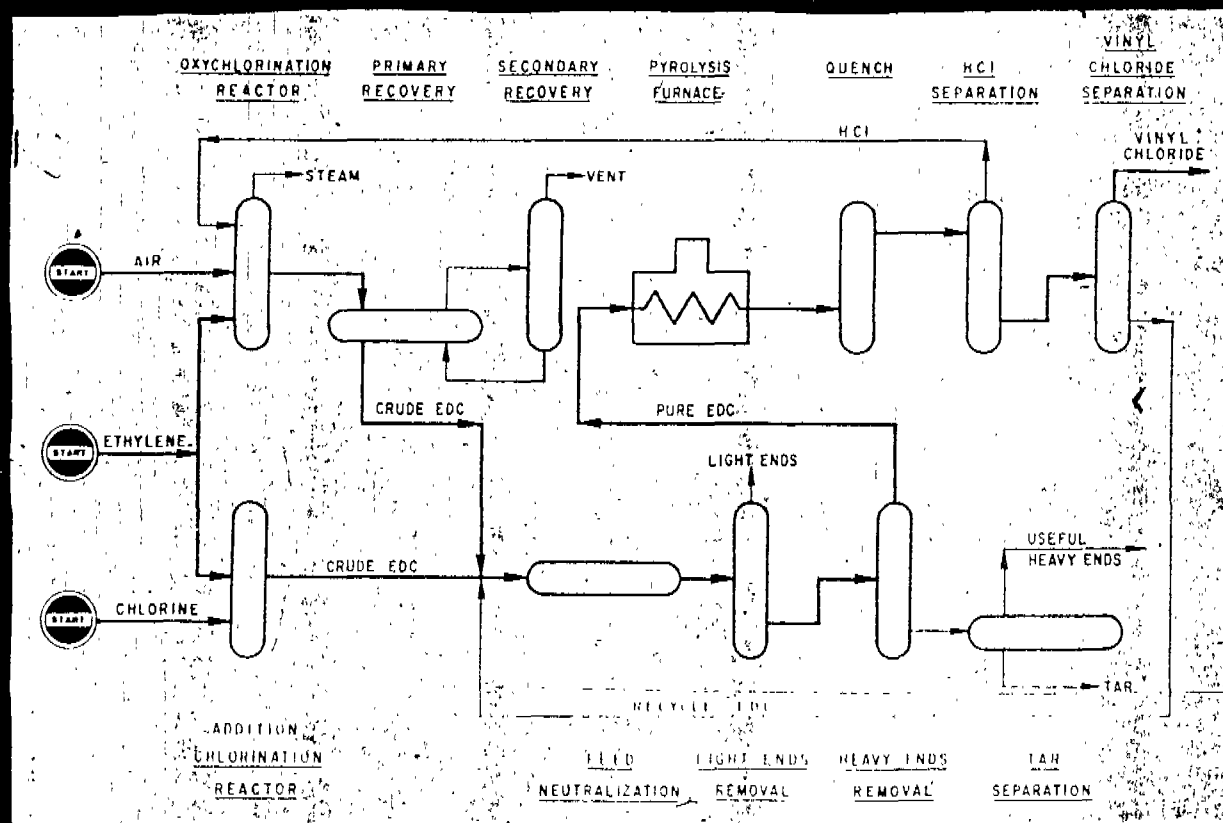
Appropriate operating procedures and additional venting equipment can be used to reduce or to virtually eliminate the risk of exposure. Exhibit IV-5 shows an example of current operating procedure for maintenance action of the Dow Chemical Company

* * * * *

Section IVB, following, provides a similar overview of polyvinyl chloride technology.

USDOL/OSHA

THE STAUFFER PROCESS FOR VINYL CHLORIDE



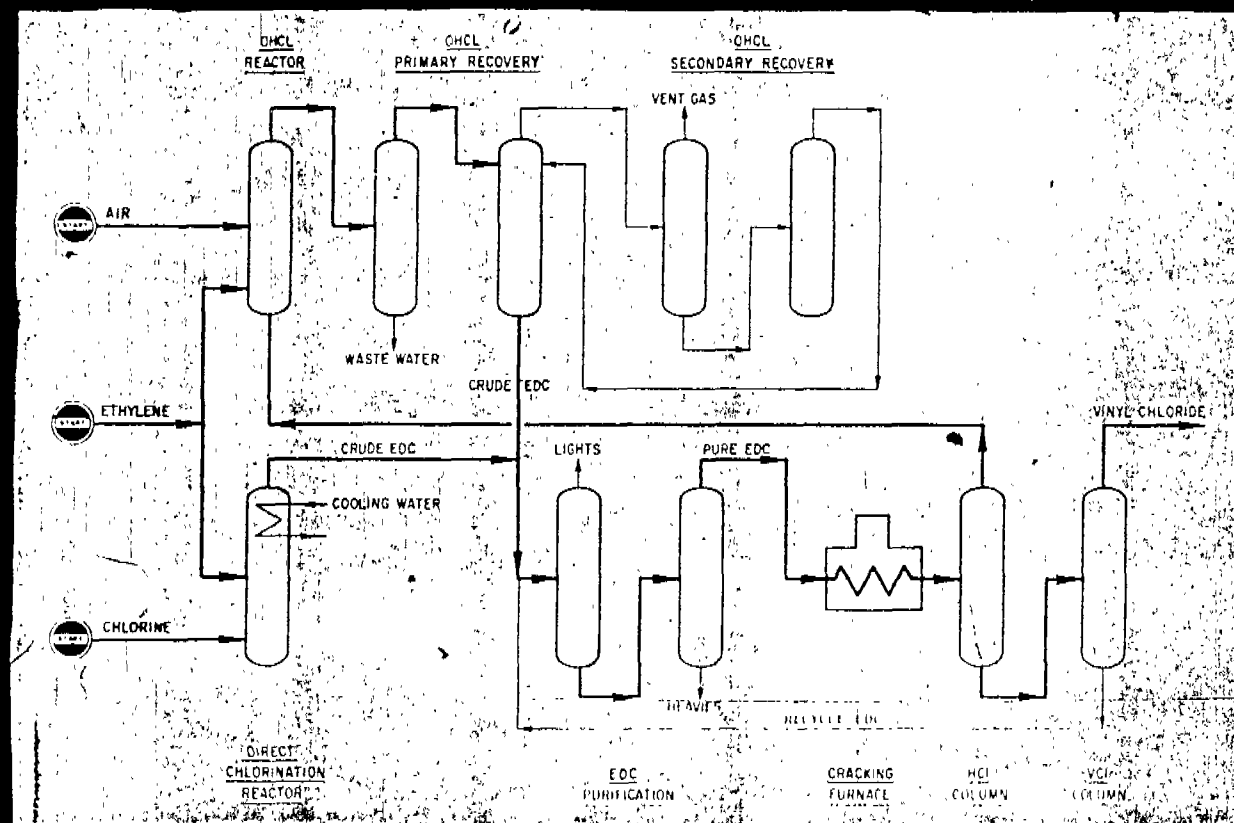
Source: Stauffer Chemical Co.: Vinyl Chloride. Hydrocarbon Processing 52: 194, November 1973.

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EXHIBIT IV-2

USDOL/OSHA

THE B. F. GOODRICH PROCESS FOR VINYL CHLORIDE



Source: B. F. Goodrich Chemical Co.: Vinyl Chloride. Hydrocarbon Processing 52: 191, November 1973.

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EXHIBIT IV-3 (1)

USDOL/OSHA

VINYL CHLORIDE PROCESS DESCRIPTION

General Description⁽¹⁾

Ethylene dichloride (EDC) is produced in both addition (direct) chlorination and oxychlorination units. In the addition chlorination unit ethylene and chlorine are combined to produce EDC in a liquid phase reactor. In the oxychlorination unit ethylene, air and byproduct HCl from the EDC cracking unit are reacted to produce EDC. An efficient catalyst in the vapor phase oxychlorination reactor is used to promote high yields. High pressure steam generated in the oxy reactor removes reaction heat and is used as heat medium in other points in the process. EDC is separated from vent gas by condensation in two recovery units. There are no moving parts in the entire oxy process except in the air compressor and refrigeration units.

Crude EDC from the addition and the oxychlorination units is combined with recycle EDC from the cracking unit and purified by removal of small quantities of light and heavy materials. Aqueous effluents separated from the crude EDC are steam stripped and are suitable for biological treatment. Both light and heavy ends may be treated for further use as feed to other chlorination processes.

Vinyl chloride monomer (VCM) is produced by cracking purified EDC in the pyrolysis furnace.

Description of Unit Operations Involving VCM⁽²⁾

Dry EDC is dehydrochlorinated to vinyl chloride as it passes through the packed tubes of a cracking furnace.

The tubes are normally packed with pumice, charcoal or some other "contact" type catalyst. At 900 to 950° F and 50 PSIG, EDC conversion is about 50% and yield to vinyl chloride is 94 to 97 mole%. The hot effluent gases are then quenched, and partially condensed, by direct contact with cold EDC in a quench tower.

Effluent fractionation and product purification are generally accomplished in three additional towers, where each producer of VCM has its own modification of this process.

Hydrogen chloride and light chlorinated hydrocarbons are rejected overhead in the "HCL" and "Light Ends" towers. The hydrogen chloride is normally recovered by water scrubbing and recycled to the EDC plant. Trichloroethane, chlorinated C₄'s and other heavy ends are rejected from the bottom of either the "quench tower" or the "vinyl tower". Contained EDC is recovered by fractionation and recycled to both the quench tower and the feed storage tank. The light and heavy ends are either further processed or disposed of by, for example, incineration. Vinyl chloride monomer is taken overhead in the "vinyl" column, generally caustic washed, and then sent to the product storage facilities.

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EXHIBIT IV-3 (2)

USDOL/OSHA

VINYL CHLORIDE PROCESS DESCRIPTION

General Description⁽¹⁾

After quenching, the furnace products are separated into HCl, which is recycled to the oxy unit, and high purity VCM. Unreacted EDC is recycled through the EDC purification system.

The overall process is balanced so that only VCM is produced without byproduct HCl. Design is easily adapted to produce HCl for other uses, to use HCl from other sources, or to make EDC as a separate product.

The process is highly automated for stable, fail-safe operation at high yields over a wide turn-down range. Startup is easy and rapid. Units combine simplicity of operation with low manpower, capital, operating and maintenance costs.

- Notes:
- (1) Related to the Stauffer process, Exhibit IV-1
 - (2) Reflects generalized practice

- Sources:
- (1) Stauffer Chemical Co.: Vinyl Chloride. Hydrocarbon Processing 52: 194, November 1973.
 - (2) Air Products & Chemicals, Inc. Houdry Division, Survey Report on Vinyl Chloride Monomer Production Via Dichlorethane Pyrolysis. Prepared for Environmental Protection Agency; Durham, North Carolina; 1972.

EXHIBIT IV - 4(1)

USDOL/OSHA

ESTIMATED VINYL CHLORIDE MONOMER
ECONOMICS - 1974

Unit Production Costs For A 500 Million Lb. Ethylene Oxychlorination Plant of 1974
Construction With Total Fixed Capital of \$20.4 Million (¢/lb.)

Plant Investment	4.08	
<u>Cost of Manufacture</u>		
Raw Materials		
Ethylene (0.49 lb/lb @ 6.0¢/lb)	2.94	
Chlorine (0.67 lb/lb @ 3.0¢/lb)	<u>2.01</u>	
Subtotal		<u>4.95</u>
Labor	0.12	
Utilities	0.25	
Maintenance	0.20	
Overhead	0.15	
Taxes & Insurance	0.06	
Depreciation	<u>0.40</u>	
Total cost of manufacture		<u><u>6.13</u></u>

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EXHIBIT IV - 4(2)

USDOL/OSHA

ESTIMATED VINYL CHLORIDE MONOMER
ECONOMICS - 1974

Unit Production Costs For A 500 Million Lb. Ethylene Oxychlorination Plant of 1974
Construction With Total Fixed Capital of \$20.4 Million (\$/lb.)

Profitability

Net selling price (FOB plant)	7.41
Cost of manufacture	(6.13)
Selling, general and administrative expenses	~ (0.30)
Pretax profit	0.98
Pretax return on total investment (@ 1.2 plant investment)	20%

- Sources:
- (1) Snell estimates based on Brownstein, A. M., U. S. Petrochemicals, Tulsa, Oklahoma, The Petroleum Publishing Co., 1971, p. 25
 - (2) Snell estimates based on mid-1974 Chemical Marketing Reporter posted prices

EXHIBIT IV-5 (1)

USDOL/OSHA

EXAMPLE OF A STANDARD OPERATING PROCEDURE FOR
MAINTENANCE AT DOW CHEMICAL CO. VINYL CHLORIDE WORKS

SAFETY PROCEDURE

Subject: BLEED-DOWN OF VINYL CHLORIDE CONTAINING EQUIPMENT

Problem: At present, pumps, sections of piping, and some equipment is partially or otherwise bled down to atmosphere. This exposes personnel to vinyl vapors if care is not taken.

Situation: Obviously, there are numerous situations that occur in the plant, where exposure to vinyl vapors is possible when preparing equipment for repair or entry. Most equipment is either already tied into the vent recovery system for bleed-down, or can be, with limited temporary piping. Almost all bleed-downs can be done through the vent recovery system and all personnel exposures to vinyl vapors must be eliminated. Elimination of exposure to the vapors should extend to any final low pressure bleed-down of equipment that has already been relieved through the vent recovery system. Also, preventative measures should be taken when opening equipment with stagnated vapors in it. In these two cases, proper respirators should be used to prevent exposures due to change of wind direction or otherwise.

Solution:

1. All seal repair work done on vinyl furnace pumps should utilize the vent recovery system for the primary bleed-down. Any small final bleed-down should involve personal respirator protection. In some cases, it may be necessary to use a full face mask, rather than a mouth-bite respirator.
2. Temporary piping to the vent recovery system should be run when necessary to vent an isolated piece of equipment, or run of piping.
3. When breaking into a vessel or piping system containing vinyl that has been depressured, use a respirator. (Hose-Line Mask). In the case of breaking vinyl containing system, the use of respirators should parallel the policy of using monogoggles.

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EXHIBIT IV- 5 (2)

USDOL/OSHA

EXAMPLES OF A STANDARD OPERATING PROCEDURE FOR
MAINTENANCE AT DOW CHEMICAL CO, VINYL CHLORIDE WORKS

4. All vessels will be purged to D-234 vent recovery system before opening. Considerable exposure to vinyl vapors is possible working around these openings due to trapped liquid vaporization inside the vessel. Therefore, fresh air-supplied masks should be used around such openings for exposures of any length.
5. When breaking into vinyl containing equipment, the immediate supervisor of that area should advise the type of respiratory equipment to be used, and issue a safe work permit in some cases.

Source: Dow Chemical Corporation

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V. FINDINGS AND CONCLUSIONS

This chapter of the preliminary report presents the findings and conclusions drawn from the detailed data appearing in Chapters II and III, dealing with industry structure and technology respectively, as well as from the appendices.

Information is presented in individual sections topically addressing each of the key regulatory considerations of primary concern to the study. See Exhibit II-1. Secondary considerations are discussed in a general category. Then, an overview is provided in a preliminary economic impact assessment. Sections follow as shown

- VA - Preliminary Economic Impact Assessment, Including Timing of Engineered VCM Controls
- VB - Personal Protective Equipment
- VC - Monitoring Equipment
- VD - Medical Surveillance Costs

Each of these sections will indicate the analysis, refinements, or new information to be developed during the remaining three weeks of the study between this preliminary report and the draft final report.

VA. PRELIMINARY ECONOMIC IMPACT ASSESSMENT

This section presents the preliminary estimated economic impact of various regulatory standards on the vinyl chloride monomer (VCM) and polyvinyl chloride (PVC) industries. For this study, economic impact is defined only as the direct cost impact on the VCM and PVC industries resulting from compliance with proposed OSHA levels of VCM exposure. Economic impacts in other sectors were not included in the scope of work. The timing required to achieve engineered controls of VCM at various compliance levels is also discussed.

1. THE METHODOLOGY FOR ASSESSING THE ECONOMIC IMPACT IS BASED ON SNELL AUDITS OF INDUSTRY ASSESSMENTS OF REQUIRED ENGINEERING, PERSONAL PROTECTIVE AND MONITORING EQUIPMENT

- . Information for assessing the economic impact under various VCM regulatory levels was collected through an industry survey conducted by Snell.
- . The cost estimates are developed for various compliance levels.
 - plant-by-plant costs reported by industry for various VCM exposure levels provided the data base
 - individual plant information was aggregated to provide the estimated economic impact per pound of VCM or PVC produced for the industry.
- . Cost estimates of specified equipment were checked by Snell for order of magnitude validity.
 - monitoring and personal protective equipment information were compared with equipment supplier quotations
 - specific items such as compressors, pumps, etc. were validated with supplier quotations

- in addition, process designers were contacted
- selected extraneous industry claimed improvements, such as water treatment systems, were not included in the cost summary

2. THE ESTIMATED ECONOMIC IMPACT OF STANDARDS ON THE VINYL CHLORIDE MONOMER INDUSTRY RANGES FROM 0.073¢ PER POUND TO MEET A 50 PPM CEILING VCM LEVEL TO 0.42¢ PER POUND TO MEET A LESS THAN 10 PPM CEILING VCM LEVEL AND 1 TO 5 PPM TWA AND SUSTAIN 1974 CAPACITY

Snell assessed industry costs of reducing VCM levels in VCM plants were separated into five categories which include:

- engineering costs, including:
 - .. ventilation
 - .. vapor recovery
 - .. stripping
 - .. loading for shipping
 - .. other (pumps, piping, etc.)
- personal protective equipment costs, including:
 - .. shower and eating facilities
 - .. breathing equipment (respirators, air lines and bottled air)
 - .. clothing (uniforms and protective clothing)
- monitoring costs, including:
 - .. personal monitoring equipment
 - .. area and leak monitoring equipment
 - .. medical testing
 - .. recordkeeping

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- productivity loss
 - ... the cost of keeping at the levels unimpacted by OSHA capacity otherwise derated as a result of regulation
 - .. the cost includes equipment, personnel, etc.
- expensed items
 - .. these include consultant costs, management time, etc.
 - .. out-of-pocket expenses of 0.01¢/lb are not included in the cost summaries

Summarized estimates of VCM industry cost impacts and timing to meet selected VCM compliance levels follow in Exhibits V-1 through V-5.

- Exhibit V-1 presents the case of the 50 ppm VCM ceiling
- Exhibit V-2 presents the case of the 25 ppm ceiling
- Exhibit V-3 presents the case of the 15 ppm ceiling and 5 to 10 ppm TWA (time weighted average)
- Exhibit V-4 presents the case of the 10 ppm ceiling and 1 to 5 ppm TWA
- Exhibit V-5 presents the industry claimed time requirements for compliance

Exhibit V-6, following Exhibit V-5, serves as a summary discussion of findings.

EXHIBIT V-1

USDOL/CSHA

ESTIMATED INDUSTRY COSTS OF ACHIEVING A 50 PPM VCM
CEILING LEVEL IN VCM PLANTS AS CLAIMED BY INDUSTRY
AND ASSESSED BY SNELLSnell assessment of VCM level potentially achieved⁽¹⁾

Total plants in sample: 9

Processes represented⁽²⁾: O STO, DO, DC, GLocation of plants in sample⁽³⁾: 8W, 1C

Capacity in Sample - Millions lbs. per year (Percent 1974 U.S. nameplate capacity): 5,125 (77%)

Percent industry claimed capacity from sample subject to shutdown at a

50 ppm ceiling VCM level: 0%

Snell estimate of percent capacity from sample subject to shutdown at a

50 ppm ceiling VCM level: 0%

	<u>Direct Costs</u>	<u>Capital</u> <u>(\$/1,000 lb.)</u>	<u>Annual</u> <u>(\$/1,000 lb.)</u>	<u>Percent of Total Annual Cost</u>
I. Engineering Costs ⁽⁴⁾		\$1.14	\$0.41 ⁽⁵⁾	56%
II. Personal Equipment Costs ⁽⁶⁾		0.05	0.03 ⁽⁷⁾	4
III. Monitoring		0.11 ⁽⁸⁾	0.19 ^(7,8,9)	28
Total Direct Costs ⁽¹⁰⁾		<u>\$1.30</u>	<u>\$0.63</u>	<u>88%</u>
Productivity Loss		<u>\$0.18</u>	<u>\$0.10</u>	<u>14%</u>
Total Costs		<u>\$1.48</u>	<u>\$0.73</u>	<u>100%</u>

Note: (1) Snell estimate of VCM levels achieved in plants incorporating the level of control effort represented in the Exhibit. Monitoring data is detailed in Appendix B.

(2) O = Oxychlorination, STO = Stauffer Oxychlorination, DO = Dow Oxychlorination, DC = Direct Chlorination, G = Goodrich Oxychlorination.

(3) W = Sited in warm climate, C = Sited in cold climate.

(4) Includes ventilation, vapor recovery, stripping, loading and other (piping, general pumps, maintenance, etc.)

(5) Includes capital amortized @ 12% - 10 yrs. and O&M charges.

(6) Includes breathing equipment and clothing.

(7) Includes capital amortized @ 12% - 5 yrs. and O&M charges.

(8) Includes area and personal monitoring equipment.

(9) Includes medical and recordkeeping costs.

(10) Productivity loss = the industry average cost of additional capacity, personnel, etc. to maintain industry capacity level unaffected by OSHA regulations.

Source: Industry interviews and Snell estimates.

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EXHIBIT V-2

USDOL/OSHA

ESTIMATED INDUSTRY COSTS IN ACHIEVING A 25 PPM VCM
CEILING LEVEL IN VCM PLANTS AS CLAIMED BY INDUSTRY
AND ASSESSED BY SNELLSnell assessment of VCM level potentially achieved⁽¹⁾

Total plants in sample: 9

Processes represented⁽²⁾: O, STO, DO, DC, GLocation of plants in sample⁽³⁾: 8W, 1C

Capacity in Sample - Millions lbs. per year (Percent 1974 U.S. nameplate capacity): 5,125 (77%)

Percent industry claimed capacity from sample subject to shutdown at a

25 ppm ceiling VCM level: 0%

Snell estimate of percent capacity from sample subject to shutdown at a

25 ppm ceiling VCM level: 0%

	<u>Direct Costs</u>	<u>Capital (\$/1,000 lb.)</u>	<u>Annual (\$/1,000 lb.)</u>	<u>Percent of Total Annual Cost</u>
I. Engineering Costs ⁽⁴⁾		\$2.13	\$0.71 ⁽⁵⁾	59%
II. Personal Equipment Costs ⁽⁶⁾		0.07	0.04 ⁽⁷⁾	3
III. Monitoring		0.17 ⁽⁸⁾	0.25 ^(7,8,9)	21
Total Direct Costs ⁽¹⁰⁾		<u>\$2.37</u>	<u>\$1.00</u>	<u>83%</u>
Productivity Loss		\$0.36	\$0.21	17%
Total Costs		<u>\$2.73</u>	<u>\$1.21</u>	<u>100%</u>

Notes: (1) Snell estimate of VCM levels achievable in plants incorporating the level of control effort represented in the Exhibit.
Monitoring data is detailed in Appendix B.

(2) O = Oxychlorination, STO = Stauffer Oxychlorination, DO = Dow Oxychlorination, DC = Direct Chlorination, G = Goodrich Oxychlorination.

(3) W = Sited in warm climate, C = Sited in cold climate.

(4) Includes ventilation, vapor recovery, stripping, loading and other (piping, general pumps, maintenance, etc.).

(5) Includes capital amortized @ 12% - 10 yrs. and O&M charges.

(6) Includes breathing equipment and clothing.

(7) Includes capital amortized @ 12% - 5 yrs. and O&M charges.

(8) Includes area and personal monitoring equipment.

(9) Includes medical and recordkeeping costs.

(10) Productivity loss is the industry average cost of additional capacity, personnel, etc. to maintain industry capacity levels unimpacted by OSHA regulations.

Source: Industry interviews and Snell estimates.

EXHIBIT V-8

USDOL/OSHA

ESTIMATED INDUSTRY COSTS OF ACHIEVING A 15 PPM VCM
CEILING AND 5-10 PPM TWA LEVELS IN VCM PLANTS AS CLAIMED
BY INDUSTRY AND ASSESSED BY SNELL

Snell assessment of VCM level potentially achieved⁽¹⁾
Total plants in samples: 9
Processes represented⁽²⁾: O, STO, DO, DC, G
Location of plants in sample⁽³⁾: 8W, 1C

Capacity in Sample - Millions lbs. per year (Percent 1974 U. S. nameplate capacity): 5, 125 (77%)
Percent Industry claimed capacity from sample subject to shutdown at a
10 ppm ceiling and 5-10 ppm TWA VCM level: 0%
Snell estimate of percent capacity from sample subject to shutdown at a
10 ppm ceiling and 5-10 ppm TWA VCM level: 0%

<u>Direct Costs</u>	<u>Capital (\$/1,000 lb.)</u>	<u>Annual (\$/1,000 lb.)</u>	<u>Percent of Total Annual Cost</u>
I. Engineering Costs ⁽⁴⁾	\$3.59	\$1.21 ⁽⁵⁾	61%
II. Personal Equipment Costs ⁽⁶⁾	0.11	0.08 ⁽⁷⁾	4
III. Monitoring	0.24 ⁽⁸⁾	0.29 ^(7, 8, 9)	15
Total Direct Costs	\$3.94	\$1.58	79%
Productivity Loss ⁽¹⁰⁾	\$0.64	\$0.41	21%
Total Costs	\$4.58	\$1.99	100%

- Notes: (1) Snell estimate of VCM levels achievable in plants incorporating the level of control effort represented in the Exhibit. Monitoring data is detailed in Appendix B.
(2) O = Oxylchlorination, STO = Stauffer Oxylchlorination, DO = Dow Oxylchlorination, DC = Direct chlorination, G = Goodrich Oxylchlorination.
(3) W = Sited in warm climate, C = Sited in cold climate.
(4) Includes ventilation, vapor recovery, stripping, loading and other (piping, general pumps, maintenance, etc.).
(5) Includes capital amortized @ 12% - 10 yrs. and O&M charges.
(6) Includes breathing equipment and clothing.
(7) Includes capital amortized @ 12% - 5 yrs. and O&M charges.
(8) Includes area and personal monitoring equipment.
(9) Includes medical and recordkeeping costs.
(10) Productivity loss is the industry average annual cost of additional capacity, personnel, etc. to maintain capacity levels unimpacted by OSHA regulations.

Source: Industry interviews and Snell estimates.

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EXHIBIT V-4

USDOL/OSHA

ESTIMATED INDUSTRY COSTS OF ACHIEVING A LESS THAN 10 PPM VCM CEILING AND
1-5 TWA LEVELS IN VCM PLANTS AS CLAIMED BY INDUSTRY AND ASSESSED BY SNELLSnell assessment of VCM level potentially achieved⁽¹⁾

Total plants in sample: 5

Processes represented⁽²⁾: O, DO, STOLocation of plants in sample⁽³⁾: 5W

Capacity of sample: Millions lbs. per year (percent 1974 U.S. nameplate capacity) 2,950 (44%)

Percent industry claimed capacity from sample subject to shutdown at a 10 ppm
ceiling and 1-5 ppm TWA VCM level 42%Snell estimate at percent capacity from sample subject to shutdown at a 10 ppm
ceiling and 1-5 ppm TWA VCM level

	<u>Direct Costs</u>	<u>Capital</u> <u>(\$/1,000 Lb.)</u>	<u>Annual</u> <u>(\$/1,000 lb.)</u>	<u>Percent of Total Annual Cost</u>
I. Engineering Costs ⁽⁴⁾		\$4.56	\$2.18 ⁽⁵⁾	51%
II. Personal Equipment Costs ⁽⁶⁾		0.63	0.24 ⁽⁷⁾	6
III. Monitoring		0.24 ⁽⁸⁾	0.31 ^(7,8,9)	7
Total Direct Costs		\$5.43	\$2.73	64%
Productivity Loss ⁽¹⁰⁾		\$1.88	\$1.51	36%
Total Costs		\$7.31	\$4.24	100%

Notes: (1) Snell estimate of VCM levels achievable in plants incorporating the level of control effort represented in the Exhibit.
Monitoring data is detailed in Appendix B.

(2) O = Oxylchlorination, STO = Stauffer Oxylchlorination, DO = DOW Oxylchlorination, DG = Direct Chlorination, G = Goodrich Oxylchlorination.

(3) W = Sited in warm climate, C = Sited in cold climate.

(4) Includes ventilation, vapor recovery, stripping, loading and other (piping, general pumps, maintenance, etc.)

(5) Includes capital amortized @ 12% - 10 yrs. and O&M charges.

(6) Includes breathing equipment and clothing.

(7) Includes capital amortized @ 12% - 5 yrs. and O&M charges.

(8) Includes area and personal monitoring equipment.

(9) Includes medical and recordkeeping costs.

(10) Productivity loss is the industry average annual cost of additional capacity, personnel, etc. to maintain industry capacity levels unimpacted by OSHA regulations. This is based on those plants that expected ability to meet the claimed levels shown in the Exhibit.

Source: Industry interviews and Snell estimates.

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EXHIBIT V - 5

USDOL/OSHA

U.S. INDUSTRY CLAIMED TIME TO REACH
SELECTED VCM LEVELS IN VCM PLANTS THROUGH
ENGINEERED CONTROLS

VCM Standard	Sample Total		End of Year									
			1974		1975		1976		1977		1978	
	Number of Plants	Capacity (million lbs)	Number of Plants	Percent ⁽¹⁾ Capacity	Number of Plants	Percent Capacity	Number of Plants	Percent Capacity	Number of Plants	Percent Capacity	Number of Plants	Percent Capacity
50 ppm ceiling	9	5125	9	100%								
25 ppm ceiling	9	5125	1	5%			8	95%				
15 ppm ceiling & 5-10 ppm TWA	9	5125					3	49%	5	46%	1	5%
<10 ppm ceiling & 1-5 ppm TWA	5	2950					2	51%	3	49%		

Notes: (1) Percent of sample 1974 capacity

Source: Industry interviews by Snell

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EXHIBIT V - 6

USDOL/OSHA

SUMMARY OF THE COST IMPACTS AND TIME
COMPLIANCE CLAIMED BY VCM INDUSTRY

VCM Level Claimed By Industry	Unit Costs, ¢/lb.			Compliance Period Required For Engineered Controls	Percent of Industry "Endangered" ⁽³⁾ Based On Sample
	Direct Costs of Compliance	Costs to Make Up for Loss of Productivity	Total Costs ⁽¹⁾		
50 ppm ceiling	0.06	0.01	0.07 ± 10%	in compliance now	0%
25 ppm ceiling	0.10	0.02	0.12 ± 20%	2 years	0%
15 ppm ceiling with 5-10 ppm TWA	0.16	0.04	0.20 ± 35%	2.5 years	0%
<10 ppm ceiling with 1-5 ppm TWA ⁽²⁾	0.27	0.15	0.42 ± 50%	3 years	42%

Notes:

- (1) The percentage ranges of total costs represent Snell's estimates based on partial statistical analysis of data
 (2) Two of the plants in the sample representing 1150 million pounds per year (22% of the 9 plant sample) estimated the ability to reach a 1 ppm VCM ceiling and 1 ppm TWA
 (3) Endangered = management will seriously consider plant shutdown

Source:

Exhibits V - 1 through V - 5

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3. THE ESTIMATED ECONOMIC IMPACT OF STANDARDS ON THE POLYVINYL CHLORIDE INDUSTRY RANGE FROM 0.72¢ PER POUND TO MEET A 50 PPM VCM CEILING TO 2.73¢ PER POUND TO MEET A 25 PPM VCM CEILING AND 10 TO 15 PPM TWA AND SUSTAIN 1974 CAPACITY

Snell assessed industry costs of reducing VCM levels in PVC plants were separated into five categories which include:

- engineering costs, including:
 - .. VCM unloading
 - .. ventilation
 - .. reactor cleaning
 - .. stripping and VCM recovery
 - .. other (pumps, piping, etc.)
- personal protective equipment costs, including:
 - .. showers and eating facilities
 - .. breathing equipment (respirators, air lines and bottled air)
 - .. clothing (uniforms and protective clothing)
- monitoring costs, including:
 - .. personnel monitoring equipment
 - .. area and leak monitoring equipment
 - .. medical testing
 - .. recordkeeping
- productivity loss
 - .. the cost of keeping at the levels unimpacted by OSHA capacity otherwise derated as a result of regulation
 - .. the cost includes equipment, personnel, etc.

- expensed items
 - .. these include consultant costs, management time, etc.
 - .. out-of-pocket expenses of 0.033¢/lb are not included in the cost summaries

Summarized estimates of PVC industry cost impacts and timing to meet selected VCM concentration levels are presented in Exhibits V-7 through V-1 after page V-8:

- Exhibit V-7 presents the case of the 50 ppm VCM ceiling
- Exhibit V-8 presents the case of the 25 to 40 ppm ceiling and 15 to 25 ppm TWA
- Exhibit V-9 presents the case of the 25 ppm ceiling and 10 to 15 ppm TWA
- Exhibit V-10 presents the case of the "no detectable" VCM level based on data provided by the Firestone Tire and Rubber Company

- .. Firestone was the only PVC producer reporting the ability to meet a "no detectable" VCM standard primarily using engineering controls.

- .. Exhibit V-10 presents the Firestone information for the two Firestone plants. These plants were not included in the industry summaries since the Firestone recommended measures to meet the 50 ppm standard were not estimated to be complete for two years. In addition, the Firestone estimates were inconsistently high with estimates provided by the remainder of the industry at higher VCM levels, for example 50 ppm, and included environmental protection measures, such as incineration and water pollution control, not directly determining OSHA compliance at the higher levels.

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- .. Exhibit V-10 also presents the Firestone economic impact data as a weighted average over the Firestone capacity of 507 million lbs. per year.
- Exhibit V-11 presents the PVC industry claimed time requirements for compliance.
- Exhibit V-12, following Exhibit V-11, serves as a summary discussion of findings.

4. INCREASINGLY STRICT VCM COMPLIANCE REQUIREMENTS ARE EXPECTED TO RESULT IN SIGNIFICANTLY GREATER PRICE ESCALATIONS FOR PVC THAN FOR VCM

- . Exhibit V-13, following Exhibit V-12, presents the estimated impact of selected VCM standards on VCM prices.
- . VCM prices are estimated to be reasonable through a 15 ppm ceiling and 5 to 10 ppm TWA since supplies are not expected to be affected.
- . The 8.0¢/lb price at the less than 10 ppm VCM ceiling and 1 to 5 ppm TWA is viewed as being on the low side since the effect of the claimed 42% of industry capacity possibly lost as a result of this standard should cause additional price increases due to supply and demand factors.
- . Exhibit V-14, following Exhibit V-13, presents the estimated impact of selected VCM standards on PVC prices.
- . PVC prices are estimated to be reasonable through a 25 ppm ceiling and 15 to 25 ppm TWA, since only 9% of supplies may be affected. That is, a 9% expected reduction in supply was claimed in the industry sample.

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The 22.9¢/lb through 30.5¢/lb prices at less than a 25 ppm ceiling and less than a 10 to 15 ppm TWA are viewed as being on the low side, since the effect of the claimed 31% to 100% of industry capacity possibly lost as a result of the lower standards should cause additional price increases due to supply and demand factors.

* * * * *

This section presented economic impact details. The next section discusses personal protective equipment.

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VB. PERSONAL PROTECTIVE EQUIPMENT AND HYGIENE RELATED FINDINGS AND CONCLUSIONS

Preliminary discussion follows.

1. TWO OF THE FOUR TYPES OF RESPIRATORS LISTED UNDER THE PROPOSED PERMANENT STANDARD (PPS) ARE READILY AVAILABLE FROM AT LEAST ONE EQUIPMENT MANUFACTURER

As presented in Appendix Exhibit D-8, two of the types of OSHA listed respirators are available from the manufacturer in approximately two to four weeks from the placement of the order. These types are:

- pressure demand full-facepiece self-contained breathing apparatus (PD)
- combination pressure demand full-facepiece respirator and pressure demand self-contained breathing apparatus (CPD)

The two other types of breathing apparatus listed in the PPS are not currently produced. Interviews with manufacturers indicate that these devices are considered wasteful of compressed air. These types are:

- positive pressure full-facepiece self-contained breathing apparatus
- combination continuous flow respirators and a pressure demand self-contained breathing apparatus.

2. THE REQUIRED TYPES OF RESPIRATORS PURCHASED UNDER THE 50 PPM TEMPORARY STANDARD MAY BE USED UNDER LOW VCM CEILING CONCENTRATIONS

The purchase costs for types PD and CPD from Exhibit D-8 are \$515 and \$615, respectively.

. The operating and maintenance costs from Exhibit D-10 range between \$500 to \$1,000 per man per year, with an average of data estimated at \$900.

. The cost of grade D or better breathable air is \$15 per 310 SCF cylinders. With an air flow of 4 CFM, this amounts to a cost of \$0.20/minute.

3. INDUSTRY AND THE EMPLOYEES PREFER HALF-MASK AIR LINES CANISTER OR CARTRIDGE TYPE RESPIRATORS OVER THOSE REQUIRED BY OSHA IN THE PPS

. Industry and worker preferences and human factors are detailed in Exhibits D-1 through D-4.

. Self-contained devices are heavy, bulky, and require highly trained individuals.

. Air line respirators are much lighter than self-contained, but they require a long hose for the air supply and a complicated air distribution system.

. Cartridge and canister types are the lightest and least expensive of the three, but lifetime has not yet been fully established for atmospheres containing VCM.

. Users of cartridge or canister type masks have no way of knowing when their air purifier is no longer effective.

. Half-face mask types are more comfortable to wear than those with full-facepieces, however, they do not provide complete facial protection.

4. THE NUMBER OF COVERED WORKERS NEEDING RESPIRATORY PROTECTION INCREASES WITH A DECREASE IN PERMISSIBLE VCM CONCENTRATION LEVELS OR REQUIRE HIGHER RESPIRATORY WEARING TIMES

The following table summarizes case studies of the percentage of workers needing respiratory protection as a function of VCM permissible levels, climate of plant location, and plant type (VCM or PVC). Further data will be provided in the final report.

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<u>Plant Type</u>	<u>Climate of Plant Location</u>	<u>Ceiling VCM Level (ppm)</u>	<u>Percent Of Workers Needing Respiratory Protection</u>	<u>Percent Of Time Respiratory Protection Needed</u>	<u>Comments</u>
VCM	Warm	50	15%	50%	With Engineering Controls
		25	15	50	With Engineering Controls
		10	30	75	Without Engineering Controls
		10	74	50	With Engineering Controls
		1	100	100	With Engineering Controls
PVC	Warm	50	75	1	With Engineering Controls
		25	100	3	With Engineering Controls
		10 ppm TWA	100	25	With Engineering Controls
		+25 ppm ceiling			
		1	NA	NA	With Engineering Controls
	Cold	50	100	10	Without Engineering Controls
		25	100	25	Without Engineering Controls
		1	100	100	Without Engineering Controls

Source: Exhibit D-11 and Snell Assessment

5. MOST OF THE TYPES OF PROTECTIVE CLOTHING ARE AVAILABLE WITHIN FOUR WEEKS FROM ORDER PLACEMENT

Disposable clothing, hoods, shoe covers, gloves and overalls are available within one week from the manufacturers including one piece pressurized suits, as shown in Exhibit D-9.

Permanent (reusable) work clothing is also available within one month of order.

Full impervious pressurized suits however, have a procurement lead time of at least two months.

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6. COSTS FOR PROTECTIVE CLOTHING VARY WITH TYPE, WITH A LOW OF \$3.50 FOR DISPOSABLE CLOTHING TO A HIGH OF \$178 FOR A PERMANENT, IMPERVIOUS FULL PRESSURIZED SUIT

- . A full suit of disposable clothing including coveralls, hoods, shoe covering, and gloves costs approximately \$3.50.
- . Permanent work clothing costs in the neighborhood of \$40.00 per worker for a full suit of clothing including coveralls, gloves and boots.
- . A permanent impervious full pressurized work suit which can be worn with an air mask costs \$178. Industry believes that routine use of these is not feasible on grounds of human factors, indicated in Exhibit D-5 and concluded from the Snell industry interviews.
- . The cost of cleaning a suit of permanent work clothes is in the range of \$1.00 to \$1.50 per suit, per worker, per day.

* * * * *

The next section deals with monitoring equipment.

VC. MONITORING EQUIPMENT, RELATED FINDINGS AND CONCLUSIONS

Preliminary discussion follows.

1. THE THREE MAJOR CLASSES OF VCM MONITORING DEVICES: PERSONAL, AREA, AND LEAK, ARE ALL AVAILABLE TO THE VCM AND PVC PRODUCING INDUSTRIES

- Personal monitoring, which is the technique recommended to OSHA by NIOSH (see Exhibit E-3), is available to industry from the manufacturer within two months from time of order. The gas chromatograph needed for the analysis of their samples can be received from the manufacturer in two to three months time.
- Area monitoring systems of the automatic sequential or continuous type can be obtained for installation within six months from time of order. Installation could take upwards of two months.
- Manual area monitoring systems comprising a gas chromatograph with a flame ionization detector (FID) and Mylar or Tedlar bags for sample collection can be obtained from the manufacturer within three months. These devices require little or no set-up time.
- Leak detection devices such as portable gas chromatographs or infrared spectrophotometers can be received from suppliers within two months.

2. THE COSTS OF MONITORING EQUIPMENT RANGE WIDELY DEPENDING ON TYPE, HOWEVER, MOST EQUIPMENT PURCHASED UNDER THE TEMPORARY 50 PPM STANDARD MAY BE USED AT LEVELS DOWN TO AND BELOW ONE PPM VCM

- Personnel monitoring equipment vary in cost from \$300 for automated charcoal tube/pump system to \$70 for colorimetric tube devices. For the automated system, a back-up gas chromatograph is required at a cost upwards of \$7,000 including basic chromatograph, columns, recorder, and mechanical integrator as shown in Appendix Exhibit D-5.
- Area monitoring systems of the sequential gas chromatograph type cost in the neighborhood of \$12,000 per 10 point instrument system without installation. Those operating under the FID total hydrocarbon principle can be purchased for \$8,000, again without installation charges.
- Leak detection equipment, which are either of the portable gas chromatograph, total hydrocarbon FID, and infrared types cost from \$3,000 to \$5,000. No installation is required for these devices.

3. EXPENDITURES FOR MONITORING EQUIPMENT FOR A TYPICAL VCM OR PVC PLANT AVERAGE \$100,000 IN CAPITAL WITH ANNUAL OPERATING EXPENSES OF \$30,000

- Personal monitoring equipment of the colorimetric types do not require a chemist for back-up due to their instantaneous reading capability. The charcoal tube types, however, require a trained chemical technologist for analysis of samples due to the necessity of using a gas chromatograph. At least one chemist per plant is needed at an annual cost of \$15,000 to \$20,000.

5. AUTOMATIC SEQUENTIAL MONITORING SYSTEMS (ASMS) CAN SERVE AS A LONG TERM DATA COLLECTION SYSTEM FOR AN ENTIRE PLANT

- . The ASMS can analyze an air sample from a particular point in the plant in 1 to 3 minutes with potential for at least 10 point monitoring.
- . A system installed in the polymerization building can provide warning to work personnel in that area if VCM levels have gone above ceiling levels.
- . Personal monitoring data can provide the statistical basis for locating sampling points for the ASMS.
 - TWAs can be determined by the personnel monitors for critical areas
 - these values can provide a calibration for the ASMS and determine the points within an area where the greatest VCM exposures are most likely to occur.
- . The ASMS can be used to provide correlation with personnel monitoring data of actual worker exposure. In addition, it can be used to provide a permanent record of VCM levels, provide alarms in case of exceeding ceiling values, serve as a means to initially identify the general sources of VCM releases, and to monitor progress in complying with OSHA requirements.

6. THE AUTOMATIC SEQUENTIAL MONITORING SYSTEM CAN PROTECT WORKERS AND ALERT MAINTENANCE PERSONNEL WHEN EXCESSIVE VCM CONCENTRATIONS OCCUR

VCM emissions can occur from two sources:

- slowly developing minor continuous leakage, such as a worn pump seal

The cost of installation for automated sequential or continuous area monitoring systems is approximately \$15,000 per 10 point unit with operating and maintenance costs of about \$30,000 per year with an operator. A mini-computer can be interfaced with the system for alarming and recordkeeping for an additional \$10,000 to \$15,000 and O&M costs of \$4,000 per year.

Leak detection devices cost in the area of \$2,000 to \$3,000 for O&M including a part-time operator for each instrument.

4. THE INDUSTRY AS A WHOLE SHOWS NO PREFERENCE FOR PARTICULAR TYPES OF MONITORING EQUIPMENT, ALTHOUGH THE CONCEPT OF AREA MONITORING APPEARS WELL ACCEPTED.

The VCM and PVC producing industries employ a variety of different types of monitoring equipment in each classification.

In personal monitoring, both the colorimetric and charcoal tube system are employed. However, the charcoal tube type are sensitive to lower VCM concentrations than colorimetric devices.

For area monitoring, both gas chromatographs (GC) and total hydrocarbon analyzers are used.

- gas chromatographs provide concentration values which are specific for vinyl chloride monomer
- total hydrocarbon analyzers, as their name suggests, are not specific for VCM but give the total hydrocarbon concentration in the sample air.

- serious leakage, such as resulting from an operating error (e.g. valve left fully or partially open) or a serious sudden leak (e.g. blown gasket, sight glass breakage, etc.)

In both cases, the system can prove useful in alarming the potentially affected people.

- . In the case of a minor leak however, (with localized effects) the sample point nearest the leak will register the localized concentration and alarm on the next sampling indicating localized concentration above the limit.
- . Response to either type of alarm can be standardized. These steps could include donning of personal protective equipment, investigation using leak detectors; isolating the point of VCM release and corrective maintenance.

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The next section deals with medical surveillance costs.

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VD. MEDICAL SURVEILLANCE COSTS, RELATED FINDINGS AND CONCLUSIONS

Preliminary discussion follows:

1. THE AVERAGE TIME REQUIRED PER EMPLOYEE FOR THE REQUIRED MEDICAL EXAMINATION IS FOUR HOURS WHEN PERFORMED OUTSIDE THE PLANT

From the information presented in the Appendix Exhibit F-2, the time allowance per employee is itemized as follows:

- . Travel to and from examination facility -- 2.5 hours
- . Examination and laboratory tests - 1.5 hours
- . Maximum time required - 4 hours or 1/2 working day

2. THE SNELL ESTIMATE FOR TOTAL EXAMINATION COST PER EMPLOYEE IS \$160

- . The cost estimate developed by Snell is based primarily on the tests and examination procedures recommended to OSHA by NIOSH as detailed in Exhibit F-3.
- . The costs were estimated for examination and tests completed outside the plant for a manufacturing facility with 500 covered workers. The total cost for such a plant would be approximately \$82,000/year.

3. INDUSTRY ESTIMATES OF THEIR PRESENT MEDICAL SURVEILLANCE COSTS AVERAGE
\$140 PER WORKER PER YEAR

It was assumed by Snell that the examinations performed by the reporting plants were based on the NIOSH recommendations to OSHA. This will be confirmed prior to the submission of the final report.

* * * * *

The chapter that follows presents next steps in the study.

APPENDIX D

PERSONAL PROTECTIVE EQUIPMENT AND HYGIENE

Don 1558

APPENDIX D

PERSONAL PROTECTIVE EQUIPMENT AND HYGIENE

This appendix presents the elements of personal protective equipment and hygiene as related to their purpose, costs, and availabilities. The appendix summarizes the relevant portions of the testimony at the public hearings and details which types of equipment have been purchased by the industry. All exhibits follow the text of the appendix sequentially.

1. REVIEW OF THE REGULATORY REQUIREMENTS PRESENTED BY THE OSHA VINYL CHLORIDE TEMPORARY AND PROPOSED PERMANENT EXPOSURE STANDARDS IN RELATION TO PERSONAL PROTECTIVE EQUIPMENT AND HYGIENE ARE SUMMARIZED BELOW

This section summarizes the requirements of employers in the vinyl chloride monomer (VCM) and polyvinyl chloride (PVC) producing industries concerning breathing equipment, protective clothing and personal hygiene as they relate to both the temporary and proposed permanent exposure standards.

(1) The Emergency Temporary Standard (ETS) For Exposure To VCM⁽¹⁾

The ETS applies to any area or operation in which VCM is:

- manufactured
- reacted
- handled
- processed
- released
- repacked
- stored

(1) 29 CFR 1910, Occupational Safety and Health Standards Emergency Temporary Standard for Exposure to VCM

Wherever any monitoring sample reveals VCM at a concentration in excess of 50 ppm, or whenever any accident, such as rupture of equipment or spillage, indicates the likelihood of a greater than usual release of VCM into the ambient air

- all employees exposed to such concentrations should be withdrawn to a safe area
- the employees should not be permitted to re-enter the work area unless they wear either
 - .. type C continuous flow or pressure demand air-supplied respirators
 - .. self-contained breathing apparatus

Work which may reasonably be expected to release VCM in concentrations in excess of 50 ppm, such as the

- repair
- maintenance
- cleaning

of a reactor or other equipment containing VCM, should be accomplished only by employees wearing type C continuous flow or pressure demand air-supplied respirators or self-contained breathing apparatus.

(2) The Proposed Permanent Standard (PPS) For Exposure To VCM⁽¹⁾

The PPS states that engineering controls are favored methods of compliance because they tend to avoid contamination of the ambient air in the workplace. However, until these controls are instituted it requires the use of respirators of the continuous flow or pressure demand types only. The PPS requires

(1) 29 CFR 1910 Occupational Safety and Health Standards, Proposed Standard.

- a respiratory protection program in accord with CFR §1910.134 should be established and implemented where respirators are required to be used by the PPS
- respirators should be used only in cases of emergency and where engineering controls or change in work practices have not as yet been instituted
- respirators or combinations of respirators for protection from VCM should be selected from among the following types:
 - .. positive pressure full facepiece self-contained breathing apparatus
 - .. pressure demand full facepiece self-contained breathing apparatus operating in the pressure demand mode
 - .. combination type C pressure demand full facepiece respirator operating in the pressure demand mode and a pressure demand self-contained breathing apparatus operating in the pressure demand mode
 - .. combination type C continuous flow respirator and a pressure demand self-contained breathing apparatus operating in the pressure demand mode

Employee entering regulated areas should be provided with full-body protective clothing, footwear or shoe cover, at no cost to the employee. The employee should be required to wear this clothing. Where PVC powder contains detectable levels of VCM in handling, employee should also be

- provided and required to wear head covering
- required to remove all protective clothing at each exit from the regulated area

- required to shower after the last exit of the day
- clean protective clothing should be provided whenever contaminated or soiled, but not less frequently than weekly
- contaminated clothing should be decontaminated before re-use by removal for laundering or disposal

Where employees are required by the PPS to wear protective clothing and equipment, change rooms should be provided in accordance with §1910.141 (e) .

Where employees are required by this section to shower, shower facilities should be provided in accordance with § 1910.141 (d) (3) .

The PPS prohibits in regulated areas

- the storage or consumption of food or beverages
- the storage or use of smoking or non-food chewing products
- the storage or application of cosmetics

2. A SUMMARY WAS DEVELOPED OF THE STATEMENTS OF INDUSTRY AND GOVERNMENT REPRESENTATIVES PRESENTING COMPARISONS OF PROTECTIVE EQUIPMENT TYPES AT THE OSHA HEARINGS ON THE PPS

This section presents summaries of selected statements of witnesses at the OSHA public hearings who gave test results on detailed comparisons of respiratory protective devices and protective clothing. These are presented in five exhibits.

- Exhibit D-1 presents the statement of Karl Oelfke, Dow Chemical Company comparing the types of respiratory devices.
- Exhibit D-2 details the presentation of Dr. Joseph F. Tomashefski of the Cleveland Clinic also comparing various types of respiratory equipment.

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4. A SUMMARY WAS PREPARED OF SNELL INTERVIEWS WITH VCM AND PVC PRODUCERS TO DETERMINE THE COST OF RESPIRATORY EQUIPMENT AND PROTECTIVE CLOTHING UNDER THE ETS AND THE PROJECTED EXPENDITURES FOR VCM LEVELS BELOW THE ETS

In this section of Appendix D the results of Snell's interviews with the VCM and PVC producing industry in relation to present and projected costs of respiratory equipment and protective clothing are presented. The exhibits detail:

- . Purchased equipment and clothing types
- . Capital costs
- . Operating and maintenance costs (O&M)
- . Procurement lead times
- . Relevant industry comments regarding topics such as human factors

The information is arranged in the following manner:

- . Exhibit D-10 summarizes the costs to the industry for protective equipment under the ETS.
- . Exhibit D-11 presents case studies of cost profiles for respiratory equipment as a function of VCM levels and projected covered workers, including expected wearing time.

- . Exhibit D-3 is another contribution of Dr. Tomashefski. This exhibit is an in-depth discussion of human factors relating to the use of respirators.
- . Exhibit D-4 is a summary of the statement of Dr. Marcus Key, NIOSH, Cincinnati discussing breakthrough times of VCM in air purifying respiratory equipment.
- . Exhibit D-5 is a general composite statement of several individuals relating to the human factors involved in wearing protective clothing.

3. BASED ON A SURVEY, SNELL COMPILED RESPIRATORY DEVICES AND PROTECTIVE CLOTHING TYPES INCLUDING DESCRIPTIONS, COMPARISONS, THEIR COST AND AVAILABILITY

This portion of the appendix gives detailed description and comparison of the various types of respiratory devices and protective clothing. Also included are their costs and availability to the industries studied by type and manufacturer. As in the previous section, an exhibit format is used for the presentation of the information.

- . Exhibit D-6 is a general presentation detailing the procedure for the selection of the proper type of respiratory protective devices as a function of use.
- . Exhibit D-7 is an in-depth of matrix presentation listing respiratory devices and detailing by type important topics including:
 - function
 - advantage
 - disadvantage
 - comparisons with other types
 - Bureau of Mines approval
- . Exhibit D-8 presents the costs and availability of typical respiratory devices by type and manufacturer.
- . Exhibit D-9 is a comparison to Exhibit D-8 as it describes typical protective clothing types and their cost and availability by manufacturers.

EXHIBIT D - 1

USDOL/OSHA

STATEMENT OF KARL OELFKE
COMPARING TYPES OF RESPIRATORY DEVICES
AT OSHA HEARINGS

Respiratory Device	Advantages	Disadvantages	Breakthrough Time
Nose-mouth cartridge or canister respirator (N-M)	• Easy to don • Small size • Lightweight • Easy to wear and carry	• Interferes with certain types of eye protection such as goggles • Can't fit all faces	100 cc canister has breakthrough time of 15 min. at 1 ppm VCM and flow rate of 300 L/min.
Full face canister type respirator (FF) w/face mounted canister	• Has larger canister than N-M type last longer • Eye protection is an integral part of mask	• Wearing of hard hat becomes difficult • Can't fit all faces	Acme canister of 300 cc size had breakthrough time to 1 ppm of 23 min. at 1000 ppm VCM.
Full face canister type w/chest mounted canister	• Longer breakthrough time than above	• Bulkiness • Can't fit all faces • Poor mobility for worker due to air hose	1 ppm breakthrough after 167 min. Same conditions as above.
Continuous flow air supplied hood (Acid Hood)	• Good head spill protection	• Bulkiness • Vision restriction • Lack of head movement • Poor mobility for worker	(NA)
Continuous flow air supplied hood (Acid Hood)	• Good protection	• Vision restriction • Poor mobility for worker due to air hose	(NA)
Continuous flow air supplied full mask	• Best of air supplied breathing apparatus	• Wearing of hard hat becomes difficult • Poor mobility for worker due to air hose	(NA)
Self-contained breathing apparatus	• Mobility	• Air supply is normally limited to 15-20 minutes in the pressure demand mode	(NA)
Portable breathing air cylinders	• Mobility • Long respiratory protection. Two hours at a demand of 55 L/min.		(NA)

Source: Karl Oelfke, Production Manager for Vinyl Chloride, Texas Div., Dow Chemical Co., Statement presented to USDOL/OSHA Hearings on Vinyl Chloride; Occupational Exposure Standard, June 25, 1974 and Snell assessment.

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EXHIBIT D-2

USDOL/OSHA

STATEMENT OF DR. JOSEPH F. TOMASHEFSKI COMPARING TYPES OF RESPIRATORY EQUIPMENT AT OSHA HEARINGS

Respiratory Device	Purpose	Method of Operation	Advantages	Disadvantages	General Comments
1. Air Purifying Type	Used to remove contaminants from an atmosphere that contains an adequate concentration of O_2 (>10% by volume).	Work by either filtration, adsorption, or a chemical reaction to remove contaminants.	Canister masks have attached to them a canister containing an adsorbent. Such masks are of value in protection against: - Organic vapors - Acids - Ammunitions - Carbon dioxide They are very effective and they can provide effective and reliable protection.	Respirators intended to filter particulates offer no protection against gases or vapors. Air purifying respirators produce high resistance to breathing. Adequate fit to the face counter because of differences in size and shape and anthropological characteristics is often a problem. Many times masks must be molded to individuals—as a result leakage commonly occurs. The resistance to both inspiration and expiration causes most workers to discard filter type masks especially if they can't see the dust; yet this time, non-visible dust may be most harmful. Chemical cartridge type masks are usually of the half mask variety, the chemical adsorbents (charcoal, soda lime, or silica gel) have very limited application and are of value when used against vapors and gases of low toxicity.	To prevent clogging of the canister and to decrease the resistance to breathing it is permissible to remove the filter within such units where protection against particulates is not required.
2. Air-Supplied	Usually employed for specific tasks or for hazardous environments.	This type has a hose connected to an uncontaminated air source. They may be equipped w/o blowers or they may have an airline attachment for continuous or demand flow.	They may be used with full face masks, hoods, or with full body suits. Many air-supplied respirators employ a slight positive pressure in order to prevent inward leaks. They are good for hazardous environments not immediately dangerous to life.	When blowers are employed with such respirators, it is necessary to have an individual attending the blower or a stand-by. Such respirators produce an increased resistance to breathing. They frequently have a long hose attached, which, in itself, may be a nuisance or a safety hazard. There are limitations on the maximum length of hose that can be used: - Use w/blower: < 50 ft. - Use t/blower: 150 ft. to 200 ft.	One must be sure that compressed air supplied is free of CO and CO ₂ .
3. Self-Contained	Provides complete respiratory protection for any concentration of toxic gas or oxygen deficiency.	<u>Pressure-demand type.</u> The slight negative pressure initiated by the individual at the beginning of inspiration triggers the valve so that the gas will flow as it is needed at an appropriate rate.	They can be used with an air source or an oxygen source.	The self-contained apparatus is heavy, bulky and requires highly trained individuals for use.	It is necessary when one employs self-contained respirators to have warning devices indicating that the pressure supply is getting low.

Source: Joseph F. Tomashefski, M.D., Head of Pulmonary Disease Department of The Cleveland Clinic, statement presented to USDOL/OSHA hearings on vinyl chloride; Occupational Exposure Standard, June 25, 1974 and Social Movement.

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EXHIBIT D-3 (1)

USDOL/OSHA

STATEMENT OF DR. JOSEPH F. TOMASHEFSKI
DISCUSSING HUMAN FACTORS IN RESPIRATOR USE AT
THE OSHA HEARINGS - PROPOSED PERMANENT STANDARD

GENERAL PROBLEMS ASSOCIATED WITH RESPIRATOR USE

<u>Problem Areas</u>	<u>Problems</u>
1. Safety in Terms of Fit and Improper Sealing of Mask	• If a leak occurs at the mask, especially an inward leak, the toxic materials may be inhaled and a false security will be provided. • There is a marked variability in the contour of faces-- therefore it is very important that any mask fit comfortably, otherwise an individual using it over a long period of time may find a mask to be intolerable.
2. Perspiration	• When effort is expended and work is performed requiring increased oxygen demand, perspiration is not adequately evaporated-- it remains within the mask and produces an unpleasant effect. • Toxic substance may become trapped between the skin and the mask causing local irritation. • Allergic reactions have been known to occur.
3. Psychological	• Many people find the confinement and sense of isolation distressing. • Others are uneasy about the need to work in an environment that requires the use of such equipment.
4. Respirator and Mask Dead Space	• It is very important that the individual not rebreathe exhaled air, and that the dead space in the mask be kept to <150 cc or that the mask be adequately ventilated to flush out the dead space. Otherwise there would be rebreathing of exhaled CO₂ and a deficiency in inspired O₂.

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GENERAL PROBLEMS ASSOCIATED WITH RESPIRATOR USE (Cont'd.)

<u>Problem Areas</u>	<u>Problems</u>
5. Design Problems Associated With the Eyepiece on Full-Face Masks	• They should not distort the vision. • They do decrease the field of vision. • If an individual wears glasses, the glasses can become fogged or the eyepiece itself may become fogged. • The individual with bifocal vision may have difficulty in performing his task. • It may be necessary to construct the eyepieces by means of special grinding with built-in lenses • Anti-fogging compounds may have to be employed or a nose clip worn to prevent fogging of the eyepiece. • All of these can decrease efficiency and be uncomfortable and unpleasant for the individual.
6. Speech Transmission	• Upon movement of the jaws, the mask may become distorted and leaks occur. • It may be necessary to equip the masks with special diaphragms, microphones, amplifiers, and radios to provide ability for communication.
7. People With Respiratory Diseases	• People who have bronchitis, emphysema or chronic asthma should not be employed in work using respirators. • This limitation knocks out a large segment of the working population (approx. 32% of all males and females over the age of 35).
8. Personnel Training in the Use of Respirators	• Personnel must be trained in respirator use, workings and care.

GENERAL PROBLEMS ASSOCIATED WITH RESPIRATOR USE (Cont'd.)

<u>Problem Areas</u>	<u>Problems</u>
9. Maintenance of Respirators	• Masks must be inspected monthly. • They have to be cleaned and examined after each use. The washing should be done with soap and water or with detergent and allowed to be air or force dried. • Occasionally it may be necessary to sterilize the mask, because it may become a source for bacterial contamination and disease transmission. • Cleaning and repair stations have to be set up where masks or respirators are being used.
10. Storage	• Storage is another factor that must be considered. Proper facilities must be provided to keep the respirators and their component parts in good condition.

Source: Joseph F. Tomashefski, Head of Pulmonary Disease Department, The Cleveland Clinic, Statement presented to USDOL/OSHA Hearings on Vinyl Chloride; Occupational Exposure Hazard, June 25, 1974 and Snell assessment.

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EXHIBIT D-4

USDOL/OSHA

SUMMARY OF THE STATEMENT OF
DR. MARCUS M. KEY AT OSHA HEARINGS - AIR
PURIFYING EQUIPMENT TO VINYL CHLORIDE MONOMER
BREAKTHROUGH TIMES

<u>Respiratory Device</u>	<u>Test Conditions</u>	<u>Breakthrough</u>	<u>Comments</u>
Organic Vapor Cartridges	• VCM concentration: 50 ppm • 50% R. H. • Flow rate consistent with a moderately heavy work rate	• 10% breakthrough in 40 to 75 minutes • Service life decreases as R. H. increases	Because the odor threshold of VCM is considerably higher than the breakthrough concentration, it is
Canister Gas Masks	• VCM concentration: 100 ppm • 50% R. H. • Flow rate consistent with a moderately heavy work rate	• 10% breakthrough in 200-350 minutes • Service life decreases as R. H. increases	the position of NIOSH that the only suitable respiratory protective devices for VCM are
Gas Mask Facepieces	• VCM concentration: 100 ppm • 50% R. H. • Flow rate consistent with a moderately heavy work rate	• 1% leakage	supplied respirators or positive mask self-contained breathing apparatuses.

Source: Marcus M. Key, M.D., Director, NIOSH Center for Disease Control, Statement presented to USDOL/OSHA Hearings on Vinyl Chloride; Occupational Exposure Standard, June 25, 1974 and Snell assessment.

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EXHIBIT D-6 (1)

USDOL/OSHA

STATEMENT OF INDUSTRY REPRESENTATIVES ON HUMAN FACTORS RELATING
TO PROTECTIVE CLOTHING AT THE OSHA HEARINGS

Industry Representative	Clothing Type	Advantages	Disadvantages	Physiological Considerations	Human Factors	Comments
K. H. Oelke ⁽¹⁾	Full impervious pressurized suit	Protective against vinyl chloride	Places worker in situation of unacceptable heat stress	A worker, while wearing such a suit in a test after 5 minutes sitting at 85° F ambient temperature, had a skin temperature of 100.9° F. After five additional minutes of slow walking the skin temperature was 101.8° F and the body temperature which had been 98.4° F at the beginning of the test, rose to 102.6° F.	Suit tends to be a safety hazard because of its bulkiness and limited visibility. Hearing is difficult. Communication with others is almost impossible.	The use of this type suit should be limited to emergency situations.
F. F. Hoy ⁽²⁾	Full body impervious air supplied suit	Prevents vinyl chloride gas from contacting body	Prevents body heat and moisture from passing to the atmosphere. Garment would guarantee long-term exposure to VCM if, by chance, some of the gas entered the garment.	The heat and discomfort produced will produce fatigue reducing employee alertness. Respiration generated by the suit will cause severe discomfort.	Reduction of employee's efficiency due to cumulative effects of fatigue, unsure footing. Reactor cleaners, required by their job to be sure footed, will be greatly impaired by bulk of suit. Employee efficiency will drop as much as 75% when such suits are worn.	Premium wages will be required to induce employees to wear suits. Recognizing the fact that the suits represent a safety hazard, the Secretary of Labor did not require their use in the carcinogen standards. Because reactor cleaners are identified as a group of maximum risk they should be supplied with "protective" rather than impervious clothing and gloves in order to protect them from skin contact.
	Impervious gloves	Prevents vinyl chloride from contacting hands	Gloves will diminish employee's dexterity		Operators will find it difficult to operate controls and keep records, and maintenance men, particularly instrument and electrical repairmen, will not be able to perform their jobs safely and properly.	

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EXHIBIT D-5 (2)

Industry Representative	Clothing Type	Advantages	Disadvantages	Physiological Considerations	Human Factors	Comments
H. H. Fawcett (3)	Air supplied suits	Designed for exactly the kind of situation as reactor cleaning			People could work for long periods of time wearing air supplied suits if the air were directed throughout the suit. Equipment can be used if people are educated to use it and know the advantages and necessity for using it	People don't want this type of equipment because it is trouble and costs money

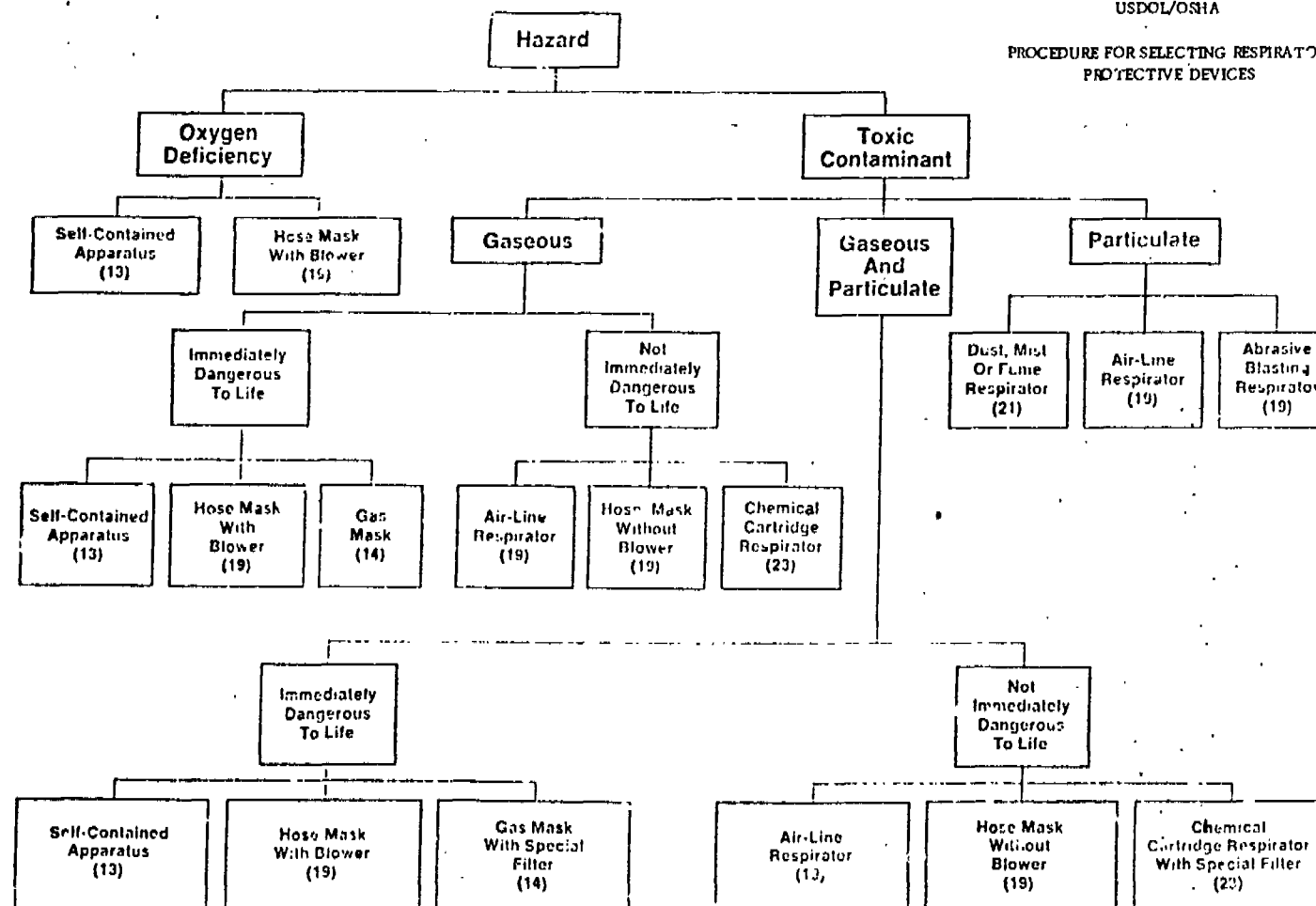
Sources: (1) Written submission by K. H. Oelke, Production Manager at the Texas Division of Dow, Chemical U.S.A. presented at the USDOL/OSHA Hearing on the proposed permanent standard for occupational exposure to vinyl chloride, June 28, 1974

(2) Statement of F. F. Hoy, plant manager, Firestone Plastics Company, Ferryville, Maryland presented at USDOL/OSHA Hearing on the proposed permanent standard for occupational exposure to vinyl chloride, July 10, 1974

(3) Statement of H. H. Fawcett, Chairman of the Committee on Chemical Safety of the American Chemical Society at the USDOL/OSHA Hearings on the proposed permanent standard for occupational exposure to vinyl chloride, July 9, 1974.

(4) Snell assessment.

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PROCEDURE FOR SELECTING RESPIRATORY
PROTECTIVE DEVICES

Note: Numbers in parentheses refer to Bureau of Mines Schedules and Provisions then of.
 Source: After Bureau of Mines Information circular 7752

EXHIBIT D-7 (1)

USDOL/OSHA

COMPARISON OF RESPIRATORY PROTECTION DEVICES

Respiratory Device	Application	Method of Operation	Limitations	Useful Life	NIOSH Approval	Comments
1. Air Purifying Devices	Air Purifying Devices remove contaminants from the atmosphere.	Various chemicals remove specific gases and vapors and mechanical filters remove particulate matter.	Can be used only in atmospheres containing sufficient oxygen to sustain life (at least 19% by volume at sea level) and within specified concentration limitations of the specific device.	The useful life of an air purifying device is dependent upon the concentration of the contaminants, the breathing volume of the wearer, and the capacity of the air purifying medium.		
(1) <u>Mechanical Filter Respirators</u>	Mechanical Filter Respirators provide respiratory protection against particulate matter such as non-volatile dusts, mists, or metal fumes. Selection of the appropriate respirator is based on the type, toxicity, and particle size of the particulate matter.	They consist essentially of a soft resilient facepiece of either half-mask or full-face design, to which is directly attached one of several types of mechanical filters made up of some fibrous material which removes the harmful particles by physical trapping as air is inhaled through the material. Gaseous matter such as air itself will pass through the filter, but solid or liquid particles are trapped in much the same manner as rocks and pebbles are separated from sand in a screening process. The filter must be highly efficient however to stop the small harmful particles.	Mechanical Filter respirators do not provide against gases, vapors or oxygen deficiency.		Schedule 21	Other than the difference between a half-mask facepiece and a full facepiece, which is used when the particulate exposure is harmful or irritating to the eyes as well as the respiratory tract, the filter is the most essential distinction among classes of respirators. The most desirable compromise must be worked out for each class with respect to breathing area (dise), resistance to breathing, efficiency in filtering particulates of specific size ranges and time required to clog the filter.
(2) <u>Chemical Cartridge Respirators</u>	Chemical Cartridge Respirators afford protection against light concentrations (.05% to .1% by volume, depending upon the contaminant) of certain acid gases, alkaline gases, organic vapors, and mercury vapors by utilizing various chemical filters to purify the inhaled air.	They differ from mechanical filter respirators only in that they use small cartridges containing chemicals to remove harmful gases and vapors.	Chemical Cartridge Respirators are non-emergency respiratory protective devices and should never be used in immediately dangerous atmospheres, except for escape purposes. However, to clarify this general statement, it will be well to list four other major negative rules which apply to Chemical Cartridge Respirators: • Do not use Chemical Cartridge Respirators for protection against gaseous material which is extremely toxic in very small concentrations (carcinogens such as VCM). • Chemical Cartridge Respirators should not be used for exposures to harmful gaseous matter which cannot clearly be detected by odor (such as VCM) in concentrations > 200 ppm.		Schedule 20	<u>Mouthpiece type chemical cartridge respirators</u> offer protection against intermittent exposures to light concentrations of gases and vapors or may be used for self-rescue in times of catastrophe. The mouthpiece & sign permit compactness--such a respirator can be conveniently carried by the worker during all working hours or stored conveniently near the work location for immediate availability. <u>Combination mechanical filter-chemical filter respirators</u> utilize dust, mist, or fume filters with a chemical cartridge for dual or multiple exposure. Respirators with independently replaceable mechanical filters are preferred for this type because the dust filter normally plugs before the chemical cartridge is exhausted. One combination mechanical-chemical filter respirator employs a back mounted filter element and is especially well suited for spray painting and welding operations, where the air contaminant is concentrated in front of the worker.

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EXHIBIT D-1 (2)

Respiratory Device	Application	Method of Operation	Limitations	Useful Life	Performance Approval	Comments														
			- Chemical Cartridge Respirators should not be used against any gaseous material in concentrations which are highly irritating to the eyes. - Obviously, Chemical Cartridge Respirators cannot be used for protection against gaseous material which is not effectively stopped by chemical fill utilized, regardless of concentration.																	
(2) Gas Masks	Gas masks have been used effectively for many years for respiratory protection against certain gases, vapors and particulate matter which otherwise might be harmful to life or health. They provide simplicity of operation, compactness, ease of maintenance and economy.	Use large canisters mounted on wearers torso, same principle of operation as in the cartridge systems. Some canisters located on chin. Canisters differ from cartridges in that they are much larger than the latter.	Because gas masks are air purifying devices, designed solely to remove specific contaminants from the air, it is essential that their use be restricted to atmospheres which contain sufficient oxygen to support life (at least 10% by volume at sea level) and which contain generally no more than 2% concentrations of toxic gases and vapors by volume.	The service life of an air purifying canister type gas mask depends on the following factors: - The design, including the quality and amount of chemical fill, packing uniformity and density. - Variable exposure conditions, including concentration of contaminants in the air, breathing rate of the wearer, temperature and humidity. Generally, higher concentrations, breathing rates and humidity conditions adversely affect service life. Since the exposure conditions are subject to wide variation, it is most difficult to estimate the service life of a gas mask canister. However, for guidance purposes, actual tests were performed under Bureau of Mines Schedule 14F stipulate the following minimum service requirements at an average breathing rate of 25 liters per minute in concentration of 2% for most gases and vapors of 2% ammonia: <table><tr><td>- Industrial Size</td><td></td></tr><tr><td>.. Canister</td><td>30 minutes</td></tr><tr><td>- Type M Canister</td><td></td></tr><tr><td>.. Acid Gases</td><td>15 minutes</td></tr><tr><td>.. Organic Vapors</td><td>33 minutes</td></tr><tr><td>.. Ammonia</td><td>18 minutes</td></tr><tr><td>.. Carbon Monoxide</td><td>30 minutes</td></tr></table> Super Size Canister, because of their greater volume of chemical fill, will last approximately twice as long as the equivalent Industrial Size Canister. Chin Style Canisters, because of their small size, should be used in concentrations not in excess of 0.2%.	- Industrial Size		.. Canister	30 minutes	- Type M Canister		.. Acid Gases	15 minutes	.. Organic Vapors	33 minutes	.. Ammonia	18 minutes	.. Carbon Monoxide	30 minutes	Schedule 14	<u>Canister Replacement</u> It is generally recommended that gas mask canisters used for emergency purposes should be replaced after each use. Specific indications for canister replacement and/or return to fresh air are: - If canisters with window indicators show the specified color changes. - If any leakage is detected by smell, taste, eyes, nose or throat irritation. - If high breathing resistance develops. - If the canister shelf life is exceeded. <u>Warning Signs</u> Specific warning signs which require immediate return to fresh air are: - Uncomfortable heat in the inhaled air. (A properly operating canister will become warm on exposure to certain gases or vapors, but a canister which becomes extremely hot indicates that concentrations above the canister limits have been encountered.) - If nausea, dizziness or signs of dizziness develop.
- Industrial Size																				
.. Canister	30 minutes																			
- Type M Canister																				
.. Acid Gases	15 minutes																			
.. Organic Vapors	33 minutes																			
.. Ammonia	18 minutes																			
.. Carbon Monoxide	30 minutes																			

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Respiratory Device	Application	Method of Operation	Limitations	Useful Life	Minimum Approval	Comments
2. <u>Supplied Air Devices</u>	Provide air from outside source for long periods of time.	Deliver breathing air through a supply hose connected to the wearer's facepiece.	Shall be used only in atmospheres not immediately harmful to life. Air source must be located in clean air and monitored frequently.	As long as air is supplied and wearer is comfortable.	Schedule 19	
(1) <u>Air-Line Respirators</u>		The air-line respirator is connected to a suitable compressed air source by a hose of small inner diameter and air is delivered to the user continuously or intermittently in sufficient volume to meet the wearer's breathing requirements.	Air-Line Respirators shall be used only in atmospheres not immediately harmful to life or from which the wearer can escape without the use of the respirator. This limitation is necessary because the air-line respirator is entirely dependent upon an air supply which is not carried by the wearer of the respirator. If the air supply fails, the wearer is without respiratory protection and might not escape from the immediately hazardous atmosphere. Another limitation of air-line respirators is that the air supply hose limits the wearer to a fixed distance from the air supply source. The Bureau of Mines approves air-line respirators under Schedule 19 which has the following significant requirements. The maximum hose length for which approval is granted is 250 feet, and the maximum permissible inlet pressure is 125 psig. Approval is sought for specific hose lengths and inlet pressures. With the longest hose lengths for which approval is sought assembled to the respirator, and the lowest inlet pressure introduced to the air supply hose, constant flow units must deliver at least four cubic feet per minute (CFM) measured at the facepiece. The exhalation resistance at 85 liters per minute shall not exceed one (1) inch of water-column height. When helmets or hoods are used, the same requirements must be met except that the flow rate must be at least six (6) cubic feet per minute. For both types of assemblies with the highest inlet pressure and shortest hose length, the maximum flow shall not exceed fifteen (15) cubic feet per minute.			Accessory equipment such as pressure regulators, pressure relief valves and air filters may be necessary to ensure that the air is at the proper pressure and quality for breathing. Air-line respirators are furnished in many types, but there are three basic classes. These are constant flow, demand flow and pressure demand flow, with the respirator equipped with half masks or full facepieces. If eye protection is required, a full face-piece must be used. The air supply is the responsibility of the user, and the air-line respirator is approved for use only when it supplies respirable air at the correct pressure and flow. The compressed air shall meet the most recent requirements of Compressed Gas Association Specification G7.1 for Type I, Class D gaseous air. This currently requires that the carbon monoxide level not exceed 20 parts per million (ppm), the carbon dioxide content not exceed 1000 ppm, and condensed hydrocarbons not exceed 5 milligrams per cubic meter. With internally lubricated piston-type compressors, overheating may produce carbon monoxide, so routine testing for carbon monoxide or the installation of a constant monitoring analyzer is desirable. Some air compressors are manufactured specifically to provide respirable air. They use compression seal liquids such as water or diaphragms for delivering the air.
Constant flow types	Constant flow units are normally used where there is an ample air supply such as provided by an air compressor. Constant-Flow Air-Line Respirators with facepieces alone are used where respiratory protection only is needed. A hood can be added to the facepiece for protection against sand or dust blizzards and frequently a helmet is used for this application with a hood or cape fitted to it. Such units are used also for lead grinding.					

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Respiratory Device	Application	Method of Operation	Limitations	Useful Life	Subline Approval	Comments
Demand types	Demand type are generally used where only compressed air cylinders are available.	Demand type air-line respirators with half masks or full facepieces deliver air flow only during inhalation with exhalation to the atmosphere.	A suitable pressure regulator is required to ensure that the air is at the proper pressure for breathing. The same requirements for approval apply to the demand type as to the constant flow units, except the minimum flow at a maximum resistance of two (2) inches of water-column height measured at the facepiece shall be at least four (4) cubic feet a minute and not more than fifteen (15) cubic feet a minute with all hose lengths within the latest pressure range for which approval is sought. The exhalation resistance at 85 liters per minute shall not exceed one (1) inch of water.			
Pressure demand types	For those conditions where the possible inward leakage caused by the negative pressure during inhalation always present in demand systems is unacceptable and there can't be the relatively high air consumption of the constant flow units.	It provides a positive pressure during both inhalation and exhalation.	It must meet the same requirements for demand systems except that the static pressure in the facepiece shall not exceed 1.5 inches of water, the exhalation resistance at 85 liters/minute shall exceed the static pressure in the facepiece by more than 2.0 inches of water and that there be at least 4 CFM air flow during inhalation before a negative pressure is developed in the facepiece.			
(2) <u>Hose Masks</u>						
With blower	Hose masks with blowers may be approved by Bureau for respiratory protection in any atmosphere regardless of the degree of contamination or oxygen deficiency, providing clean, breathable air can be reached within the distance of the permissible hose length.	Blower forces air into mask.	Hose masks with blowers can be used with up to 500 ft. of hose. The blower should always be used with this type of equipment. Only hand driven blowers are currently approved. The air hose must have a large inside diameter, approximately one inch, so, in case of blower failure, the wearer can breathe through the hose while escaping from the contaminated area; and it must be highly resistant to petroleum vapors as well as be able to withstand crushing weight. This accounts for the heavy wire reinforced construction of hose-mask hoses.			The entire hose mask assembly, including facepieces, harness, air hose, and blower, is usually packaged in a portable trunk. The blower operator serves also as a standby or guard, ready to aid the workman in case of mishap.
Without blowers	Hose masks without blowers are used when contaminated air can be reached within a distance of 75 feet.	Wearer forces air into mask through his own breathing.	Can only be used up to a distance of 75 feet. These units, however, carry only limited approval and cannot be used in atmospheres immediately harmful to life. Bureau of Mines Approval.			

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Respiratory Device	Application	Method of Operation	Limitations	Useful Life	Approval Schedule	Comments
2. <u>Self-Contained Breathing Apparatus</u> (1) <u>Oxygen Cylinder Submersible and Self-Generating Types</u>	Self-contained breathing apparatus provide complete respiratory protection in toxic gases and where there is oxygen deficiency. The wearer is independent of the surrounding atmosphere because he is breathing with a system admitting no outside air. The oxygen or air supply of the apparatus (which takes care of respiratory require means,	Self-contained breathing apparatus are divided into three basic types--oxygen cylinder rebreathing, demand, and self-generating. The oxygen cylinder rebreathing type in use today is the "lung-governed" type which automatically compensates for the varying breathing demand of the user. It consists of a relatively small cylinder of compressed oxygen, reducing and regulating valves, a breathing bag, facepiece or mouthpiece plus nose clip, and a chemical container to remove carbon dioxide from the exhaled breath. The self-generating type uses the principle of rebreathing; but it has no mechanical operating components. Both types function in the same manner and will be discussed together. The high-pressure oxygen from the cylinder is reduced in pressure to a breathing level by means of a reducing and regulating valve. In some units there is a constant flow plus a lung-controlled valve which adds any required additional flow. Other apparatus have only an admission valve which delivers the oxygen from the breathing bag to the wearer's face. Exhaled breath passes down another tube into the container holding the carbon dioxide removing chemical and then through a canister. Finally, the purified exhalation flows into the breathing bag where it mixes with the incoming oxygen from the cylinder. The rebreathing principle permits the most efficient utilization of the oxygen supply. The exhaled breath contains both oxygen and carbon dioxide. As the human body extracts only a small part of the oxygen inhaled,	Major problem or limitation is lifetime of apparatus. The oxygen cylinder must be refilled and the carbon dioxide-removing chemical replaced after each use. As is true of all respiratory protective equipment, training in proper use and maintenance is essential for the most efficient operation. The one hour service life for the self-generating type apparatus is based on test procedures of Bureau of Mines Approval Schedule 13 and in use a longer or longer protection period may result based on the user and his level of exertion.	Dependent on size of air cylinder and, in the case of the rebreathing types, on the CO₂ removal container. The types of cylinder rebreathing units now manufactured are approved by the Bureau of Mines for two, three or four hour duration. The self-generating type apparatus is approved by the Bureau for one hour.	Schedule 13	The self-generating breathing apparatus differs from conventional cylinder rebreathing apparatus in that it utilizes a chemical canister which evolves oxygen and removes the exhaled carbon dioxide in accordance with breathing requirements. It eliminates high pressure cylinders, regulating valves, and other mechanical components. The canister, which contains potassium superoxide, evolves oxygen when contacted by the moisture and carbon dioxide in the exhaled breath, and retains the carbon dioxide and moisture. Retaining moisture is important as it aids in preventing lens fogging. In use, the self-generating unit operates as other rebreathing apparatus except that the wearer, using the canister, makes his own oxygen instead of drawing from a compressed gas cylinder. The outstanding features of this type are its simplicity of construction and use, and lesser need for maintenance when compared with high pressure apparatus. There are several methods for refilling or recharging high pressure air or oxygen cylinders. Compression is sometimes used, but the simplest and most convenient method is to cascade from large supply to small apparatus cylinders.

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Respiratory Device	Application	Method of Operation	Limitations	Useful Life	Bumlines Approval	Comments
		As the user exhales into the container, the carbon dioxide is removed by the chemical and the oxygen which is left is reused. That method of operation applies to all oxygen cylinder rebreathing type apparatus as well as to the self-generating type.				
(8) Demand Type	Demand-type apparatus are available in different models for specific applications. Of particular application to some industries is a short duration unit known as a "escape mask." It is normally worn by a worker at times when he is in an area where a potentially toxic atmosphere, above the capacity of a gas mask exists. Areas to which high pressure gases are piped fall into this category. Another type of short duration unit is put on at the time escape is necessary. A work mask type of apparatus is used for planned maintenance work. The apparatus is actually a two-fold unit. - A self-contained apparatus with which the wearer can move freely about by using a small cylinder to enter or leave the toxic atmosphere--either routinely or in the failure of the main breathing supply. - There is a provision for connecting a hose to the demand regulator so that the wearer can breathe during the work period from a large cylinder which has a pressure reducing valve attached to provide low pressure for the connecting hose. Manifold assemblies can be provided to permit more than one worker to work from a common breathing source. It is imperative that the small emergency cylinder be used with this type of apparatus; otherwise, a failure of the supply from the large cylinder would expose the wearer to the toxic atmosphere.	All consist of a high pressure cylinder, a demand regulator connected either directly or by high-pressure tube to the cylinder, a facepiece and tube assembly with an exhalation valve or valves, and a method of mounting the complete apparatus on the body. In use, the wearer turns on the cylinder valve after putting on the facepiece, inhales at breathing pressure through the demand regulator to the facepiece and then exhales through a valve in the facepiece to the surrounding atmosphere.	All demand apparatus are relatively inefficient when compared with the rebreathing type, because the exhaled oxygen is released to the atmosphere instead of being re-used. Work mask types are limited by the connecting hose which limits the free movement of the wearer to the length of the hose. It is not an emergency type unit as, for use, it requires setting up some auxiliary equipment. The duration of the demand type apparatus depends on such factors as: - The degree of physical activity of the user; - The degree to which the user's breathing is increased by excitement, fear or other emotional factors; - The degree of training or experience which the user has had with this or similar equipment; whether or not the cylinder is fully charged at the start of the work period; - The possible presence in the compressed air of carbon dioxide concentrations greater than the .04% normally found in atmospheric air; - The atmospheric pressure; - The condition of the apparatus. Under the current Schedule 13E, all demand type apparatus must satisfy tests conducted at -20°F, although low temperature components such as neoprene to reduce fogging may be added if needed.	Typical demand type apparatus such as the MSA "Air Cub" are certified by Bumlines for 15 minutes. Others such as the MSA "Air Mask" are certified for 30 minutes under schedule 13 for entry into and escape from irrespirable atmospheres. These service life ratings are based on tests by the Bureau of Mines on men performing moderate to heavy work in each of the different types of work tests or breathing machine tests at a rate of 40 liters per minute. The user should not expect to obtain the exact rated service life on each use. The work being performed may be more or less strenuous.	The term, demand regulator, means that the air flow is on inhalation demand, automatically regulating itself to the desired level to compensate for variations in breathing needs. Demand apparatus depend upon watching a pressure gauge to learn when the breathing supply has dropped to a point where the user must return to fresh air. A self-actuating warning device is required for Bureau of Mines Approval. The warning device can be either audible or use increased breathing resistance to alert the wearer to return to fresh air.	

Source: Basic Elements of Respiratory Protection, Mine Safety Appliances and Snell Telephone Survey of Respiratory Equipment Industry.

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EXHIBIT D-8(1)

USDOL/OSHA

COSTS AND AVAILABILITY OF TYPICAL RESPIRATORY DEVICES

Respiratory Device/Manufacturer	Components		Lot Size	Cost Per Unit (1974 Dollars)	Availability (Weeks To Receive After Order)
	Catalog Number	Description			
1. Air Purifying Devices					
(1) Mechanical filter respirators					
. Bausch and Lomb (B&L)	R 10	Provides protection against dusts (single cartridge).	Up to 50 units	\$ 7.35	Stock item
	R 20	Same as above but with dual cartridge.		8.90	Stock item
	5-15-10	Replacement filters.	Pack of 50	0.28	Stock item
. Mine safety apparatus (MSA)	96000	Dustfoe 77 provides protection from dusts and mists having a TLV of not less than 2.4 million particles/cu. ft.	24-71	7.25	Stock item
	96106	Filters	Pack of 50	0.13	Stock item
	79983	Dustfoe provides protection against finely divided aerosols up to 0.3 microns diameter (99.98% effective).	72-143	8.35	Stock item
	79984	Type "H" cartridge.	144 and up	2.55	Stock item
	8201-R	Duo-seal dual cartridge high efficiency dust filter (0.3 micron particles).	50-99	9.00	Stock item
. Scott	8004-R	Replacement cartridge.			
	8101-R	Same as above respirator but single cartridge.	50-99	8.99	Stock item
	502-R	Replacement cartridge.	50-99	2.80	Stock item
. Welsh	7680	Protex dual cartridge respirator for dusts with TLV more toxic than 0.1 mg/m ³ full face mask.	1	45.75	
	7600-8	Replacement cartridge.	4	1.34	
	7406	Protex single cartridge half face mask.	72-143	5.50	
	7500-6B	Static wool filter replacement.	72-143 packages of 100 ea.	0.13	
(2) Chemical cartridge respirators					
	R 21	Provides protection against low concentrations of organic vapors.	50-99	10.70	
. B&L	5-15-21	Organic vapor cartridge replacement for R 21.	50-99 boxes of 6	1.51	Stock item
. MSA	85556	MSA chemical cartridge respirator for protection against organic vapors (0.1%).	72-143	9.70	Stock item
	44135	Replacement cartridge for 85556.	100-140	1.45	Stock item
	76853	MSA same as 85556 but with single cartridge for organic vapor.	72-143	9.30	Stock item
	76880	Replacement cartridge for 76853.	100-140	2.05	Stock item

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EXHIBIT D-8 (2)

Respiratory Device/Manufacturer	Components		Lot Size	Cost Per Unit (1974 Dollars)	Availability (Weeks To Receive After Order)
	Catalog Number	Description			
Scott	8201-OV	Duo-seal respirator for organic vapors. Dual cartridge	50-99	\$ 9.00	Stock item
	82004-OV	Replacement cartridge for 8201-OV	100-499 pr.	2.50	Stock item
	8101-OV	Same as 8201-OV but with single cartridge	100-499	8.30	Stock item
	502-OV	Replacement cartridge for 8101-OV	100-499	2.30	Stock item
Welsh	7601	Full-face respirator for organic vapors. Dual cartridge	1	45.95	
	7500-1	Replacement cartridge for 7601	72-143 packs with 6 pieces/pack	1.28	
(3) Gas masks					
MSA	457081	MSA industrial size for up to 2% by volume organic vapors and toxic dusts with full face mask and body mounted canister	6-11	78.05	Stock item
	77705	Replacement canister for 457081	12-71	7.45	Stock item
	457112	MSA chin type mask for up to 0.5% by volume organic vapors	6-11	53.80	Stock item
	88339	Replacement canister for 457112	100 and up	5.85	Stock item
Scott	679-1	Chest style gas mask for up to 2% by volume organic vapor protection with full facepiece	18 and up	75.43	3 weeks
	184-OV	Replacement canister for 679-1 (1000cc)	12-71	6.50	Stock items
	661-1	Chin style gas mask for organic vapor protection (full face)	18 and up	42.16	Stock item
	282-OV-L	600cc replacement canister for 666-1	50-99	5.10	Stock item
2. Supplied Air Devices					
(1) Air line respirators					
Constant flow					
MSA	457162	Ultra-Vue facepiece and low pressure control valve (10-16 psig with 50 foot hose)	1	82.30	Stock item
	457161	Same as 457162 box with hyper-flo control valve (40-100 psig with up to 250 feet of air- hose)	1	82.30	Stock item
Scott	4622-10	Zephyrair-complete full vision mask with belt mounted filter, body and manual control valve. Adjust air pressures as follows with 3/8" ID hose	18 and up	60.94	2 weeks
		<u>Hose Length</u> <u>Pressure at Hose Inlet</u>			
		15' to 50'	8 to 17 psi		
		50' to 250'	17 to 30 psi		

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EXHIBIT D-8 (3)

Respiratory Device/Manufacturer	Components		Lot Size	Cost Per Unit (1974 Dollars)	Availability (Weeks To Receive After Order)
	Catalog Number	Description			
Demand types	7600A	Low pressure (10-25 psi) full facepiece.	1	\$ 57.85	
- MSA	457157	Mask-mounted demand air-line respirator w/ultra-vue facepiece 30-125 psi/15-250 ft. hose lengths.	1	95.90	Stock item
	457165	Belt mounted demand flow air-line respirator w/ultra-vue facepiece 30-125 psi/15-250 ft. hose lengths.	1	95.90	Stock item
- Scott	4637-1	Demand type respirator w/full vision mask 50-125 psi/15-250 ft. of hose length.	18 and up	75.43	3 weeks
Hose masks/MSA	457140	One man combination hose mask, with hand operated blower (centrifugal) and 50 ft. of hose.	1	688.00	60-90 days
	457142	Same as 457140 but is a two man unit.	1	972.00	60-90 days
Accessories for air-line systems					
- Compression systems/MSA	32057	"Clear air" blower that washes, cools, and humidifies air for 12 masks (Nash Co. compressor)	1	2,586.00	16-18 weeks
	81857	Air-line filter for removal of dusts, mists, fumes as a final.	1	44.55	Stock item
	46727	Replacement chemical cartridge for 81857 filter (2 required).	1-71	2.40	Stock item
	78030	Particulate element replacement for 81857 filter.	1	4.80	Stock item
	66716	MSA pressure regulator reduces plant-compressor air pressure to the rated value for the equipment.	1	34.90	Stock item
	66709	Pressure relief valve-16 psi.	1	9.80	Stock item
	68265	Pressure relief valve-25 psi.	1	14.65	Stock item
- Pressure regulators/MSA	68858	Required accessory when air-line respirators are operating from a high pressure cylinder 0-4000 psi hi-pressure gauge 0-200 psi low-pressure gauge.	1	94.35	Stock item
- Air-lines and manifolds/MSA	455020	Air hose - 15 ft. long	1	18.65	Stock item
	455021	Air hose - 25 ft. long	1	23.95	Stock item
	455022	Air hose - 50 ft. long	1	43.20	Stock item
	93931	Manifold-4 man (snap-tite)	1	59.20	30 days

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EXHIBIT D-8 (4)

Respiratory Device/Manufacturer	Components		Lot Size	Cost Per Unit (1974 Dollars)	Availability (Weeks To Receive After Order)
	Catalog Number	Description			
3. Self Contained Respirators					
(1) Pressure demand-full-facepiece self-contained breathing apparatus 1, 2 MSA	95069	With single lens clear-vue facepiece and audible alarm	1	\$515.00	Two weeks
(2) Combination pressure demand full facepiece respirator and pressure-demand self-contained breathing apparatus 1, 2 MSA	96396	Complete in carrying case	1	689.00	Two weeks
(3) Positive pressure full facepiece self-contained breathing apparatus 1, 2		Would be very wasteful of compressed air			Not available
(4) Combination continuous flow respirator and a pressure demand self-contained breathing apparatus 1, 2		Would be very wasteful of compressed air			Not available
(5) Demand work mask w/quick-connect/disconnect assembly which can be attached to primary air supply MSA	457189	MSA unit complete with ultra-vue facepiece assembly, speaking diaphragm, demand regulator, harness, and 12 cu. ft. capacity air cylinder in carrying case	1	496.00	2 weeks
4. Cylinder Recharger Systems					
MSA	<u>Cascading System for Cylinder Recharging</u>				
	68850	Air coupler tee	1	17.80	Stock item
	68851	Air pigtail	1	22.95	Stock item
	68846	Air outlet connection, complete with gauge	1	34.93	Stock item
	77263	High pressure airfilling hose, 8 ft. long.	1	94.50	Stock item

Notes: (1) Permitted types under the temporary 50 ppm standard.
(2) Permitted types under the proposed permanent no detectable standard.
(3) Stock items are delivered in not more than one week.

Sources: Bausch & Lomb Safety Products Division Catalog, 1974.
Mine Safety Appliances Respiratory Protection Catalog, 1974.
Scott/Airco Products Respiratory Protection Equipment and Accessories Catalog, 1971.
Walah Catalog 72R, 1974.
Results of Shell survey of the respiratory equipment manufacturers.

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EXHIBIT D-9 (1)

USDOL/OSHA

COST AND AVAILABILITY OF PROTECTIVE CLOTHING

Protective Clothing/Manufacturer	Catalog No.	Components Description	Lot Size	1974 Cost Per Unit (Dollars)	Availability
I. Disposable Clothing					
1. Coveralls, Hoods and Shoe Coverings, Gloves					
Donafab	-	Coverall made of Dupont Tyvek ^(R) with elastic wrist and ankle for tight fit.	-	\$ 2.25	Stock item
	700205	Shoe cover made of Dupont Tyvek ^(R) Hightop with drawstring for tight fit.	100	0.51	Stock item
	520205	Hood made of Dupont Tyvek ^(R) with drawstring for tight fit around face.	300	0.40	Stock item
Arrow Disposables	-	Coverall made of Dupont Tyvek ^(R) with elastic wrist and ankle for tight fit.	-	2.00	In development 2 - 3 months before available in quantity.
Mam Inc.	-	Coverall made of Dupont Tyvek ^(R) with elastic wrist and ankle for tight fit.	-	2.00	Stock item
Pioneer Rubber	V-5	Disposable liquid proof gloves.	144	0.21	30 weeks
2. One-Piece Pressurized Suits					
MSA	91783	Airfed positive internal pressure suit made of vinyl. Complete with attached hood with clear vinyl face-piece. Room for respiratory protective equipment. Designed for one use only.	1	47.00	Stock item
II. Permanent Clothing					
1. Full Impervious Pressurized Suits					
American Optical	6111	Vapor chemical suit pressurized with self-contained breathing equipment.	1	298.45	6-8 weeks
MSA	75096	Chemprux ^(R) suit complete with case, hood and air supply system. Used with manifold and airline suit develops positive internal pressure.	1	393.45	15-17 weeks
	33490	Reduced Protection Suit can be worn with MSA air mask not supplied with unit	1	178.12	6-8 weeks

Note: Stock items are delivered in one week or less.

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EXHIBIT D-9 (2)

Protective Clothing/Manufacturer	Components		Lot Size	1974 Cost Per Unit (Dollars)	Availability
	Catalog No.	Description			
2. Acid Resistant Suit					
. MSA	37108	Sun Ray ^(R) suit, vinyl coated nylon made to be decontaminated after each use. Jacket has safety cuffs and is fastened with ball and socket fasteners. Pants have bib front and no fly.	1	\$ 47.50	2-3 weeks
	31934	Rubber utility suit jacket has stand-up collar with storm fly front. Pants have bib front with no fly. All seams pressure welded.	12	21.50	Stock item
. Unroyal	MRU-A27	Neoprene coated on nylon jacket with attached hood with drawstring for tight face fit. Closed with storm fly front.	1	11.65	Not less than 2 months
	MRO-957	Neoprene coated on nylon bib type pants with snap fly.	1	9.45	No less than 2 months
. American Optical	9011	Acid resistant coveralls made of neoprene coated on nylon.	1	25.00	6-8 weeks
	503-1	Acid resistant jacket made of heavy duty vinyl with storm fly front.	1	25.80	6-8 weeks
	512	Acid resistant bib type pants made of heavy duty vinyl.	1	22.90	6-8 weeks
	524	Hood made of heavy duty vinyl with clear vinyl facepiece covering shoulders and upper chest.	1	48.70	6-8 weeks
3. Cloth Work Clothes					
. MSA	39134	Coveralls made of synthetic fiber fabric Dynel ^(R) made to cover or replace the worker's street clothes.	12	18.80	3-4 weeks

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EXHIBIT D-9 (3)

Protective Clothing/Manufacturer	Components		Lot Size	1974 Cost Per Unit (Dollars)	Availability
	Catalog No.	Description			
4. Gloves					
• MSA	36688	Heavy duty acid resistant rubber designed with curved fingers and using high quality latex for pliability and chemical resistance over a wide temperature range.	12	\$ 4.02	2-3 weeks
	37643	Flexible, completely coated with vinyl 12" gauntlet type.	72	1.71	Stock item
• Pioneer Rubber	N-31	Lightweight designed to give liquid tight protection. Glove is not particularly durable.	12	0.91	6-8 weeks
5. Boots					
• Uniroyal	MB801	Knee length acid resistant rubber with steel safety toe.	12	16.90	Stock item
	MB990	Knee length medium weight acid resistant rubber with safety toe.	12	15.55	Stock item
	MB951	Knee length imported acid resistant rubber with safety toe.	12	12.70	Stock item

Sources: Durafab 1974 sales brochure, Mine Safety Appliances 1974 catalogue, Uniroyal 1974 catalogue, Pioneer Rubber 1974 Catalogue and Snell Survey of Protective Clothing Manufacturers.

EXHIBIT D-10 (1)

USDOL/OSHA

SUMMARY OF SNELL INTERVIEWS WITH
VINYL CHLORIDE/POLYVINYL CHLORIDE MANUFACTURERS
RELATING TO PROTECTIVE EQUIPMENT PURCHASED

<u>VC or PVC Producer⁽¹⁾</u>	<u>Class of Protective Equipment</u>	<u>Number of Workers Requiring Protective Equipment</u>	<u>Cost of Equipment (1974 Dollars)</u>	<u>Operating and Maintenance Costs (1974 Dollars)</u>	<u>Comments</u>
11M-Int. -C and 17S-Int. -W	Respirators, half face air supplied	16-20 16-20	\$200,000 200,000	\$ 25,000 25,000	Several tripping accidents have been attributed to respirators and some of the workers are reluctant to wear them. Minute-by-minute supervision required to ensure use.
27	Respirators	57	16,000	N.A.	
20 and 21M-Int. -W	Respirators, half face air supplied	N.A.	N.A.	N.A.	6 weeks procurement lead
40L-New -W	1. Respirators, airline	88	60,000	5,000	
	2. Protective clothing				
	Disposable coveralls		30	300	
	Rubber gloves		30	300	
15	Respirators	20	4,750	6,300	
19L-New -W	Respirators, airline	12	14,000	6,500	MSA type.
	Respirators, airline				One incident of face and scalp rash from use of air mask.
41L-Old -W		16	13,000	5,000	
54M-New -C		16	8,000	5,000	
34	Respirators, pressure demand or continuous flow	6.5	10,000	6,000	
38	Same	3	4,000	2,500	

<u>VC or PVC Producer</u>	<u>Class of Protective Equipment</u>	<u>Number of Workers Requiring Protective Equipment</u>	<u>Cost of Equipment (1974 Dollars)</u>	<u>Operating and Maintenance Costs (1974 Dollars)</u>	<u>Comments</u>
10M-New-W	Respirators, half face mask	26	\$ 25,000	\$ 6,000	Workers complain of dry throat and impaired movement.
M-Int. C	Respirators	8	40,000	12,000	
	Protective clothing	N.A.			
	Coveralls				
	Shoe covers				
	Head covers				
	Gloves				
5L-Old-C	1. Respirator	112	23,500	N.A.	Scott type
	Airline masks		7,025	N.A.	
	Self-contained respirators		2,312	72,000	
	Cartridge respirators				
	2. Protective clothing	N.A.	Disposable clothing		
	Waterproof suits	N.A.	listed as operating	2,400	
	Head covers, dust shields, gloves		cost	1,500	
13	Respirators	81	67,000	18,000	MSA type.
	Airline				
	Cartridge		15,000		
8L-New-C	1. Respirators	50	5,000	3,000	Wehh and Scott type.
	2. Protective clothing				
14M-Int. -W	1. Respirators, self-contained cartridge	2	4,500	N.A.	There have been complaints by workers on wearing respirators. Scott type.
	2. Protective clothing coveralls	40	N.A.	N.A.	
				36,000	
	Disposable suits	N.A.		4,800	

EXHIBIT D-10 (3)

<u>VC or PVC Producer</u>	<u>Class of Protective Equipment</u>	<u>Number of Workers Requiring Protective Equipment</u>	<u>Cost of Equipment (1974 Dollars)</u>	<u>Operating and Maintenance Costs (1974 Dollars)</u>	<u>Comments</u>
49M-Old-C	1. Respirators, air supplied	N.A.	\$ 2,500	\$ 4,800	People with heart or lung problems have been advised not to wear respirators - have been reassigned to areas not requiring their use.
	Cartridge	N.A.	3,300	120,000	
	2. Protective clothing				
	Hard hats	N.A.	1,250	N.A.	
	Coveralls	N.A.		72,000	
	Waterproof suits	N.A.		14,400	
44M-New-C	1. Respirators	37	21,188	30,800	One worker with history of asthma became ill while wearing air-line mask.
	2. Protective Clothing			56,000	
22M-Old-C	Respirators, continuous flow airline	25	20,000	12,000	
9S-Int. -C	Respirator	N.A.	500	N.A.	Scott type. Individual cases of workers refusing to wear respirators.
30M-New-C	Respirators, full face mask type C continuous flow	76	45,000	3,000	2 - 5 weeks procurement lead time.
36S-Int. -C	Protective clothing	N.A.	5,000	26,000	
31M-New-C	Respirators	N.A.	25,000	N.A.	1 - 3 months procurement lead time. Problems in fitting masks on personnel with beards and mustaches.
42S-Int. -C and 39S-New -C	Respirators	N.A.	15,000	N.A.	Increased absenteeism and refusal of overtime has been attributable to use of respiratory equipment.
28L-New-C	Respirators, bottle supplied air masks	20	10,000	20,000	One complaint of ear problems caused by respirator use.
	Self-contained		1,700	N.A.	

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<u>VC or PVC Producer</u>	<u>Class of Protective Equipment</u>	<u>Number of Workers Requiring Protective Equipment</u>	<u>Cost of Equipment (1974 Dollars)</u>	<u>Operating and Maintenance Costs (1974 Dollars)</u>	<u>Comments</u>
36M-Int. -C	Protective Clothing Rain suits	N.A.	\$ 13,000	N.A.	
46M-Old-C	Respirators	200-300	41,000	\$ 18,000	3 months procurement lead time. Workers have complained of nasal and throat dehydration.

Note: (1) For meaning of producer code, see page II-6.

Source: Results of Snell interview with the VCM/PVC manufacturing industry.

NA = Not applicable.

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EXHIBIT D-11 (1)

USDOL/OSHA

EXAMPLE COSTS VS. NUMBER OF COVERED WORKERS NEEDING RESPIRATORY EQUIPMENT
AS A FUNCTION OF VINYL CHLORIDE MONOMER LEVELS BY PRODUCER

VCM/PVC Producer ⁽¹⁾	VCM Level ⁽²⁾ (PPM)	No. of Employees Wearing Respirators	Job Classification	Wearing Time (% of 8 Hr. Day)	Incremental Capital Costs (Dollars)	Operations and Maintenance Costs (1974 Dollars)	Comments
18	50	2	Tank car unloading	50%	\$11,000	\$1,000	Total for 50 ppm level.
		5	Maintenance	25			
		6	Ship loading	100			
		7	Operating (samples, etc.)	8			
		20					
	25	SAME AS ABOVE			111,500	7,200	With no engineering improvements.
		8	Operating	50			
		12	Maintenance	75			
		2	Laboratory	84			
		28	Ship loading	100			
	10						With engineering improvements.
		2	Operating	50			
		9	Maintenance	25			
		-	Laboratory	-			
		6	Ship loading	100			
	1				NA	NA	
		34	Operating	100			
		40	Maintenance	100			
		36	Supervising and support	100			
		18	Ship loading	100			
19L-New-W	50	4	Normal operation	18	14,000	6,500	
		12	Vessel cleaning	10			
		8	Routine maintenance	10			
		8	Non-routine maintenance	10			
		42					
	25				No increase		
		12	Normal operation	30			
		12	Vessel cleaning	20			
		8	Routine maintenance	17			
		8	Non-routine maintenance	17			
	"NO DETECTABLE"						NOT FEASIBLE
		14					
		26					
		40					
		40					

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VCM/PVC Producer	VCM Level (PPM)	No. of Employees Wearing Respirators	Job Classification	Wearing Time (% of 8 Hr. Day)	Incremental Capital Costs (Dollars)	Operations and Maintenance Costs (1974 Dollars)	Comments
48L-New-W	50	20	Reactor cleaning	20%	\$20,000	\$5,000	
		4	Large reactor operators	5			
		4	Large reactor lead operators	3			
		8	Small reactor lead operators	13			
		20	Small reactor operators	30			
		4	Reactor department shift supervisor	3			
		4	Dryer leads	3			
		8	Dryer operators	3			
		12	Dryer utilities	3			
		4	Dryer shift supervisor	3			
Total		88					
	25	20	Reactor cleaning	30	No Increase	NA	
		4	Large reactor operators	15			
		4	Large reactor lead operators	5			
		8	Small reactor lead operators	20			
		20	Small reactor operators	40			
		4	Reactor shift supervisor	5			
		4	Dryer leads	3			
		8	Dryer operators	3			
		12	Dryer utilities	15			
		4	Dryer shift supervisor	5			
Total		88					
34	50	12	Sampling	<1	10,000	5,500	
		8	Loaders	13			
		8	Maintenance	7			
		28					
Total		28					
	25	12	Sampling	7	No Increase for 50 ppm Level	7,000	
		8	Loaders	19			
		8	Maintenance	12			
		28					
Total		28					
	10	12	Sampling	7	NA	NA	
		8	Loading	100			
		8	Maintenance	25			
		20	Other	7			
Total		28					
Total	1	180	All jobs	100	350,000	NA	
		180					

DOW 1592

VCM/PVC Producer	VCM Level (PPM)	No. of Employees Wearing Respirators	Job Classification	Wearing Time (% of 8 Hr. Day)	Incremental Capital Costs (Dollars)	Operations and Maintenance Costs (1974 Dollars)	Comments
30	50	8	Loader	15%	\$ 4,000	\$2,500	
		4	Maintenance	8			
		<u>12</u>					
	25	8	Loaders	19	No Increase	No Increase	
		4	Maintenance	9			
		<u>12</u>					
	10	8	Loaders	82	NA	NA	
		4	Maintenance	100			
		<u>100</u>	Other	7			
St.-New-C	50	<u>112</u>					
		272	All	100	NA	NA	
		<u>272</u>					
	25	50	Poly building personnel	1	2,000	<50,000	
		70	Poly building personnel				
		<u>70</u>	Maintenance, technical	3			
	10 TWA and 25 (Ceiling)	70	Same as above	25	10,000	NA	
		<u>70</u>					
		<u>70</u>					
14M-LM, -W	50	1	NOT FEASIBLE				
		9	Charging polys	10	7,000	NA	
		8	Recovery polys	15			
		12	Helper	11			
		1	Bulk loading resins	15			
		4	Bagging resins	8			
		2	Maintenance, pipefitting	1			
		2	Maintenance, mechanics	1			
		1	Maintenance, electronics	8			
		1	Maintenance, instruments	1			
		<u>1</u>	Painting, lagging	3			
		<u>42</u>					
	25		Same as above but more use of air mask		No Increase		
	10		NOT FEASIBLE				

VCM/FVC Producer	VCM Level (PPM)	No. of Employees Wearing Respirators	Job Classification	Working Time (% of 8 Hr. Day)	Incremental Capital Costs (Dollars)	Operations and Maintenance Costs (1974 Dollars)	Comments
4RM-OM-C	50 (Ceiling)	4	Latex charge operator	5	\$2,550	\$4,500	Helps use both air-fed respirators and cartridge type respirators. The air-fed respirators are used for opening and cleaning polymers and the cartridge respirators are used on other jobs where the concentration might be above 25 ppm but below 50 ppm.
		4	Plastic latex operator	5			
		4	Latex recovery operator	1			
		4	Latex helper	20			
		30	Charge operator	5			
		30	Recovery operator	<1			
		24	HRC operator	15			
		4	Utility operator	25			
		28	Helper	30			
		12	Dryer operator	<1			
		18	Bagger	<1			
		4	Transfer operator	<1			
		150	Maintenance mechanics	15			
			Tank farm operator	25			
		16	Foreman	10			
		2	Day supervisor	<1			
		6	Engineers	<1			
		2	General foreman	<1			
		1	Department manager	<1			
Total		333					
	25 (Ceiling)	4	Latex charge operator	10	NA	NA	With a 25 ppm ceiling the use of cartridge respirators would be eliminated. The use of air-fed respirators would be increased and center masks would be used, increasing, because of their longer life and better mobility.
		4	Plastic latex operator	10			
		4	Latex recovery operator	5			
		4	Latex helper	25			
		10	Charge operator	10			
		30	Recovery operator	5			
		24	HRC operator	20			
		4	Utility operator	25			
		28	Helper	30			
		12	Dryer operator	5			
		18	Bagger	<1			
		4	Transfer operator	<1			
		150	Maintenance mechanics	20			
			Tank farm operator	25			
		16	Foreman	15			
		2	Day supervisor	5			
		6	Engineers	5			
		2	General foreman	5			
		1	Department manager	<1			
Total		328					

EXHIBIT D-11 (5)

VCM/PVC Producer	VCM Level (PPM)	No. of Employees Wearing Respirator	Job Classification	Wearing Time (% of 8 Hr. Day)	Incremental Capital Costs (Dollars)	Operations and Maintenance Costs (1974 Dollars)	Comments
48M-OM-C (cont.)	25 (Ceiling) 10 TWA	4	Latex charge operator	15	NA	NA	For this level the wearing of respirator would be increased as indicated.
		4	Plastic latex operator	15			
		4	Latex recovery operator	10			
		4	Latex helper	35			
		30	Charge operator	20			
		20	Recovery operator	10			
		24	HRC operator	25			
		4	Utility operator	40			
		28	Helpers	25			
		12	Dryer operator	12			
		18	Bagger	5			
		4	Transfer operator	5			
		150	Maintenance mechanics	30			
			Task farm operators	40			
		18	Foremen	20			
		2	Day supervisor	5			
		6	Engineers	5			
		2	General foremen	5			
		1	Department manager	<1			
Total		333					
	1		NOT FEASIBLE				
18	50	81	Sampling Drying equipment Opening equipment Repairs	5	\$22,200	\$18,000	
	25	81	Above, plus taking readings as going into unit while any leaks exist on VCM equipment.	12	No Increase	NA	
	10 (Ceiling) 5 TWA	81	Same as above	20	No Increase	NA	
	1		NOT FEASIBLE				

Note: (1) Ceiling levels unless otherwise stated.

(2) For meaning of producer codes see page D-4.

Source: Field assessment of the results of interviews with VC/PVC producers.

APPENDIX F

MEDICAL SURVEILLANCE OF EMPLOYEES

Don 1596

APPENDIX F

MEDICAL SURVEILLANCE OF EMPLOYEES

This appendix details the elements of routine medical surveillance and their attendant costs. All exhibits appear sequentially at the end of the appendix.

1. A REVIEW FOLLOWS OF THE TEMPORARY AND PROPOSED REQUIREMENTS FOR THE MEDICAL SURVEILLANCE OF EMPLOYEES IN VINYL CHLORIDE (VCM) AND POLYVINYL CHLORIDE (PVC) PLANTS

This section summarizes the medical surveillance required under the emergency temporary standard for exposure to VCM (50 ppm) and the medical surveillance required under the proposed permanent standard (no detectable limit).

(1) 50 ppm Emergency Temporary Standard (ETS)⁽¹⁾

The ETS does not recommend or require any medical surveillance of employees in VCM and PVC plants. It is concerned only with the fixing of exposure levels to 50 ppm value (127.0 ms/cm).

(2) Proposed Permanent "No-detectable" VCM Standard (PPS)⁽²⁾

Comprehensive requirements for employee medical examination are proposed, including necessary tests. Some additional guidance is included for the convenience of physicians. The proposed requirements have been recommended to OSHA by NIOSH (see below) as reasonable and appropriate to detect liver dysfunction which may be indicative of, or predisposing to, the development of liver angiosarcomas.

(1) 29 CFR 1910, Occupational Safety and Health Standards, Emergency Temporary Standard for Exposure to VCM.

(2) 29 CFR 1910, Occupational Safety and Health Standards, Proposed Standard.

Records of medical examination are to be kept with provision for access by appropriate OSHA and NIOSH officials. Specific requirements are made to furnish a copy of a medical record to an employee's physician on the employee request. In the event of an "emergency", that is, an unforeseen circumstance or set of circumstances resulting in the release of VCM into areas occupied by employees, a special medical surveillance by a physician shall be instituted within 24 hours for employees present in the affected area at the time of the emergency.

(3) NIOSH Recommendations For Medical Surveillance Referred To By The Proposed Permanent Standard

The following recommendations are directed primarily at medical screening to detect liver disease and/or hepatic tumor. They should be considered in the context of routine health screening for any general employee health problem, including non-hepatic health condition potentially related to VCM exposure. Routine health screening should include at the time of initial employment:

- . the recording of past medical history
- . the performance of
 - a general physical examination
 - certain basic laboratory procedures including:
 - .. complete blood count
 - .. urinalysis
 - .. chest x-ray

Provisions should also be made for routine periodic health follow-up examinations:

- (1) NIOSH, Recommended Occupational Health Standard For the Manufacture of Synthetic Polymer From VCM, March 11, 1974.

Employees covered by the following specific recommendations shall encompass all persons engaged in VCM production and polymerization including personnel peripherally involved such as in clerical and management assignments. The recommendations shall be applied both as a pre-employment requirement and as a part of periodic health follow-up. Screening priority should be given to current employees with prolonged and close potential exposure to VCM, whether in present or past work settings.

The recommended examination protocol is:

At the time of initial employment, or upon institution of screening, a physical examination shall be performed with specific attention to detecting enlargement of liver or spleen by abdominal palpation.

At the time of initial employment, or upon institution of screening and annually thereafter, a medical history check-list shall be completed by the employee. This list shall include questions concerning:

- alcohol intake
- past history of hepatitis
- past exposure to potential hepatotoxic agents including drugs and chemicals
- past history of blood transfusion
- past history of hospitalization

The completed medical check-list shall be reviewed by a physician and should be acted upon as medically indicated for each individual employee.

Don 1599

At the time of initial employment, or upon institution of screening, a serum specimen shall be obtained for screening with respect to the following five bio-chemical determinations of liver function:

- total bilirubin
- alkaline phosphatase
- serum glutamine oxalacetic transaminase (SGOT)
- serum glutamine pyruvic transaminase (SGPT)
- gama glutamyl transpeptidase (GGTP)

Additional tests that optionally may be considered for use in screening include

- lactic dehydrogenase (LDH)
- serum protein determinations
- serum protein electrophoresis
- platelet count

Laboratory analyses shall be performed in laboratories accredited by the College of American Pathologists, licensed in accordance with the provision of the Clinical Laboratories Improvement Act of 1967.

If results or laboratory screening are normal, screening shall be repeated on an annual basis. If the person being screened has been employed directly in vinyl chloride monomer production or polymerization for 10 years or longer, screening shall be repeated every six (6) months.

If one or more liver function tests are abnormal, serum testing shall be repeated as soon as possible, preferably within two (2) to four (4) weeks. If no abnormalities are present upon rescreening, testing should be repeated in three (3) months.

If abnormalities persist on rescreening, the employee shall be removed from contact with VCM operations and an individualized workup shall be instituted. Suggested as initial steps in medical workup are

- a complete physical examination
- various special procedures such as
 - .. hepatitis B antigen determination
 - .. liver scanning

If liver function abnormalities are determined to be unrelated to liver disease (e.g. elevated alkaline phosphatase in a young, physically active man or elevated bilirubin in Gilbert's syndrome) or to be transient (e.g. due to recent hepatitis or recent alcohol intake), the employee may be permitted to return to VCM related employment, subject to individual medical evaluation.

In view of the preliminary results of animal toxicology studies, it is recommended that no woman who is pregnant or who expects to become pregnant should be employed directly in VCM operations.

2. SNELL ASSESSMENT OF THE COST OF MEDICAL SURVEILLANCE UNDER THE PROPOSED PERMANENT STANDARD ⁽¹⁾

This section details the cost of medical surveillance needed by the VCM and PVC industries to comply with the requirements of the Proposed Permanent Standard (PPS). Costs are essentially based on the physical examinations and laboratory tests recommended to OSHA by NIOSH. ⁽²⁾

- . Exhibit F-1 presents a screening flow sheet for the physical examination and laboratory tests which may be performed. It details the screening steps which are given by the PPS.
- . Exhibit F-2 presents the time required for an average worker to spend on obtaining the needed physical examination and laboratory tests by a physician under contract to the VCM and PVC manufacture.
- . Exhibit F-3 details the types of laboratory tests which may be required as well as their normal values. It is from these tests that a portion of the total cost is based.
- . Exhibit F-4 summarizes the itemized costs for the various elements of the medical surveillance program from Snell estimates based on the detailed study. The Snell estimate is \$160 per worker.
- . Exhibit F-5 shows the costs which were reported by the VCM and PVC industry for their medical surveillance program. Their costs average out to \$143 per worker based on sixteen reporting firms.

(1) 29 CFR, 1910, Occupational Safety and Health Standards, Proposed Standard For Exposure to VCM

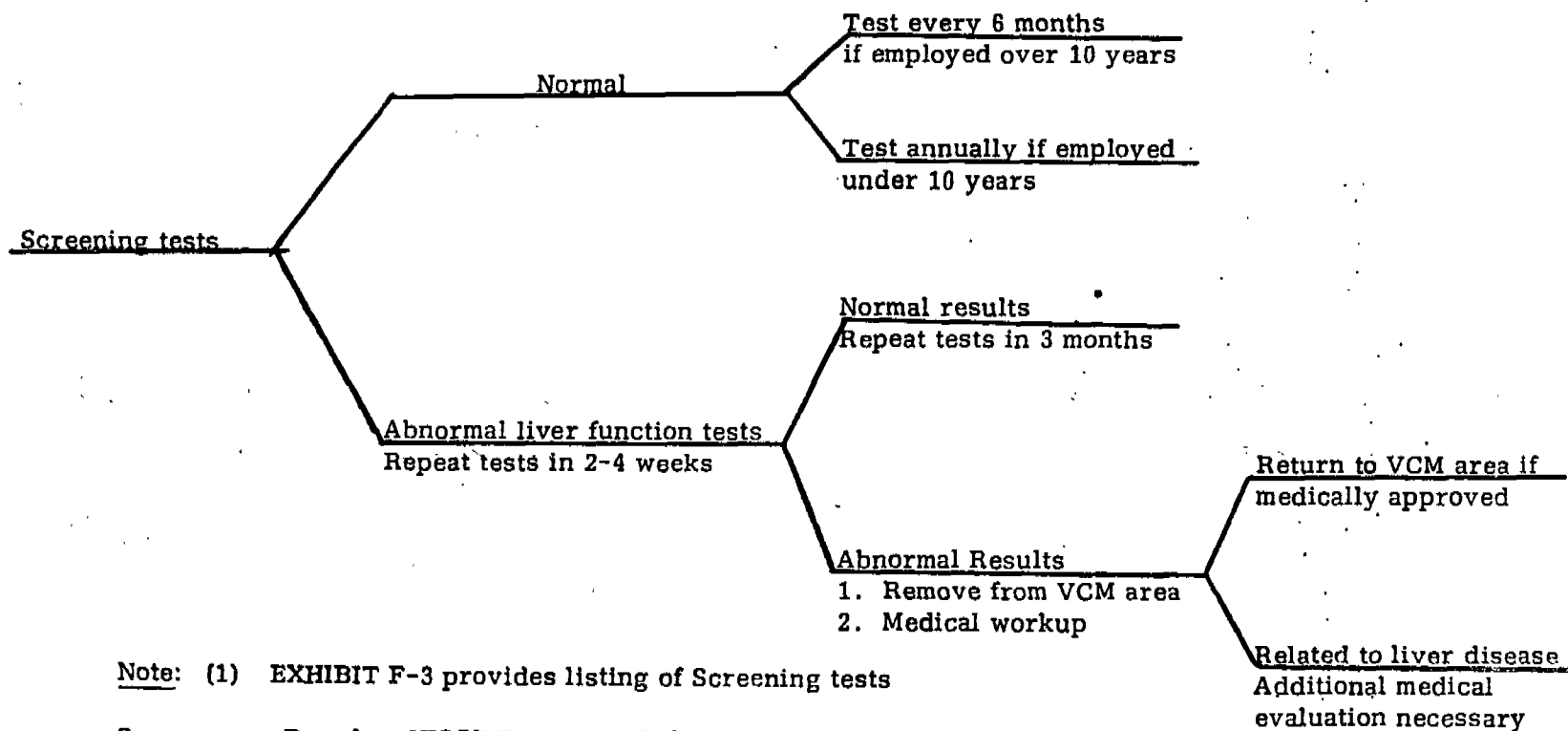
(2) NIOSH Recommended Occupational Health Standard For the Manufacture of Synthetic Polymer From VCM, March 11, 1974

3. REVIEW WAS COMPLETED OF THE INFORMATION BY NORMAN B. JAVITT, M.D., PH.D, HEAD,
DIVISION OF GASTROENTEROLOGY, DEPARTMENT OF MEDICINE, NEW YORK HOSPITAL-CORNELL
MEDICAL CENTER

- . According to Dr. Javitt in his letter to Snell, shown in Exhibit F-6, he reviewed the appendix and in his judgment, "the proposed protocol adequately reflects both the recommendations of the appropriate governmental agencies, and considering the constraints of time and expense, is carefully constructed to obtain a sensitive estimate of the existence of liver dysfunction as well as other ancillary data on health status."
- . Dr. Javitt in his letter also suggests modifications or clarifications to the NIOSH recommended protocol as is seen in the Exhibit.

Nov 1603

EXHIBIT F-1
USDOL/OSHA
SCREENING FLOW SHEET
BASED ON NIOSH RECOM-
MENDATIONS TO OSHA FOR
THE PROPOSED PERMANENT
STANDARD



Note: (1) EXHIBIT F-3 provides listing of Screening tests

Source: Based on NIOSH Recommended Occupational Health Standard
for the Manufacture of Synthetic Polymer from Vinyl Chloride, March 11, 1974

Don 1604

EXHIBIT F-2
 USDOL/OSHA
 TIME REQUIRED FOR TRAVEL,
 PHYSICAL EXAMINATION AND
 LABORATORY TESTS OUTSIDE
 OF PLANT

Worker Completes Medical History Checklist While Waiting	Blood Samples Taken	Urine Sample Provided	Chest X-ray Taken	EKG Taken	Physical Examination
<u>30</u> minutes	<u>5</u> minutes	<u>5</u> minutes	<u>10</u> minutes	<u>10</u> minutes	<u>30</u> minutes

Total Time Required

Examination and laboratory tests	<u>1.5</u> hours
Travel to and from examination facility	<u>2.5</u> hours
Maximum time required	<u>4</u> hours

Source: Snell estimates

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EXHIBIT F-3 (1)
USDOL/OSHA
NORMAL VALUES IN
LABORATORY TESTS

Laboratory Test

Purpose

Normal Values

Blood Chemistry

Cholesterol (1)	Cholesterol metabolism	150 to 300 mg/100 ml
Calcium (1)	Calcium metabolism	9 to 11.5 mg/100 ml
Inorganic Phosphorus (1)	Phosphorus absorption	2.5 to 4.5 mg/100 ml
Total Bilirubin (1,2)	Liver function	0.2 to 1.0 mg/100 ml
Total Protein (1)	Liver function	6.0 to 8.0 gm/100 ml
Albumin (1)	Kidney and liver function	3.5 to 5.0 gm/100 ml
Uric Acid (1)	Purine metabolism	2.5 to 7.5 mg/100 ml
BUN (1)	Kidney function	10 to 20 mg/100 ml
Glucose (1)	Carbohydrate metabolism	65 to 100 mg/100 ml
LDH (1,2)	Organ damage	67 to 122 technicon units
Alkaline Phosphatase (1,2)	Liver function	4 to 17 KA units
SGOT (1,2)	Organ damage	15 to 45 units
Creatinine (3)	Kidney function	0.9 to 1.7 mg/100 ml
GGTP (2)	Liver function	6 - 28 mU/ml
SGPT (1,2)	Organ (part. liver) damage	15 to 56 units
NPN (3)	Kidney function	25 to 38 mg/100 ml

EXHIBIT F-3 (2)
USDOL/OSHA
NORMAL VALUES IN
LABORATORY TESTS

<u>Laboratory Test</u>	<u>Purpose</u>	<u>Normal Values</u>
<u>Hematology</u>		
RBC (2)	Standard screening for all diseases	4.6 to 6.2 x 10 ⁶
WBC (2)	"	4.8 to 10.8 x 10 ³
Hgb (2)	"	15 to 18 gm
Hct (2)	"	42 - 52%
<u>Differential (2)</u>		
Polys	"	60 - 70%
Stabs	"	0 - 1%
Eosinophils	"	1 - 3%
Basophils	"	0.25 - 0.5%
Lymphocytes	"	25 - 33%
Atypical Lymphocytes	"	0 - 1%
Monocytes	"	2 - 6%
Platelets	"	2 - 4 x 10 ⁵
MCV	"	80 - 94 μ^3
MCH	"	273 $\mu\mu\text{g}$
MCHC	"	32 - 36%

Don 1607

EXHIBIT F-3 (3)

<u>Laboratory Test</u>	<u>Purpose</u>	<u>Normal Values</u>
<u>Urinalysis</u> ⁽²⁾		
Color	Standard screening for all diseases	Pale straw to amber
Appearance	"	Clear to slight hazy
Specific Gravity	"	1.905 to 1.002
pH	"	5.5 - 7
Albumin	"	Negative
Glucose	"	Negative
Acetone	"	Negative
Bile	"	Negative
Urobilinogen	"	Up to 2.1 Ehrlich units

- Notes:
- (1) included in automated SMA12 analysis
 - (2) recommended for determination within first screening or initial examination by NIOSH to OSHA specifically for liver function.
 - (3) included to obtain a total laboratory profile of the worker
 - (4) Recommend as a special test by NIOSH to OSHA.

Sources: Ivan K. Smith, Diagnostic Services, Inc., 520 Speedwell Ave., Morris Plains, NJ 07950;
 NIOSH, Recommended Occupational Health Standard for the Manufacture of Synthetic
 Polymer From Vinyl Chloride, March 11, 1974;
 Snell assessment of the NIOSH recommendations to OSHA

Don 1638

EXHIBIT F-4 (1)
 USDOL/OSHA
 APPROXIMATE COSTS OF PHYSICAL
 EXAMINATIONS AND LABORATORY
 TESTS COMPLETED OUTSIDE PLANT
 BASED ON A MANUFACTURING
 FACILITY WITH 500 COVERED WORKER

<u>Element</u>	<u>Cost (Dollars)</u>
Full-time clerical person for typing, filing, coordinating visits to labs and physicians, etc. (\$9,000 x 1.25 in fringe)	\$ 11,225
Records, stationary, postage, etc.	7,500
Overhead (1)	5,000
500 examinations by physician (general practioner) @ \$20 per examination	10,000
500 reviews of physical and laboratory examination results by physician @ \$15/review	7,500
500 chest x-rays @ \$20 per worker	10,000
500 laboratory test series @ \$24 per series (2)	12,000
500 EKG's @ \$25 per worker	12,500
125 repeat laboratory test series (25% of workers) @ \$24 per series (2)	3,000
125 repeat medical reviews by physicians @ \$15 per review	1,875
25 special laboratory tests @ 5% of the workers @ \$25 per worker (3)	625
25 reviews by physician at special laboratory tests @ \$15 per worker	<u>375</u>
 Total expenditures per annum for 500 covered workers	 \$ <u>81,500</u>
 Approximate cost of medical screening per worker	 160

EXHIBIT F-4 (2)
USDOL/OSHA

- Notes:
- (1) overhead includes electricity, telephone, heating, space allocations for clerical activities, etc.
 - (2) initial laboratory screening tests include SMA12, SGPT, GGTP, CBC with platelets and urinalysis
 - (3) special laboratory tests may include: serum hepatitis B determination, serum protein electrophoresis

Sources: Ivan K. Smith, Diagnostic Sciences, Inc., Morris Plains, NJ 07950; Snell assessment

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EXHIBIT F-5 (1)
 USDOL/OSHA
 RESULTS OF SNELL INTERVIEWS TO
 DETERMINE THE COSTS OF MEDICAL
 SURVEILLANCE COST PER WORKER
 PER YEAR

<u>Number of Workers</u>	<u>Total Cost (Dollars)</u>	<u>Cost per Worker per Year (Dollars)</u>
97	16,000	165
173	34,000	200
(NA)	(NA)	(NA)
57	3,000	52
222	(NA)	(NA)
1,137	(NA)	200
50	(NA)	(NA)
325	(NA)	150 - 200
128	12,000	94
420	12,900	40
(NA)	(NA)	(NA)
81	10,000	125
150	22,000	146
3,204	224,280	70
68	(NA)	200
74	(NA)	200
135	(NA)	(NA)

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EXHIBIT F-5 (2)
USDOL/OSHA

<u>Number of Workers</u>	<u>Total Cost (Dollars)</u>	<u>Cost per Worker per Year (Dollars)</u>
338	45,000	133
200	(NA)	(NA)
693	110,600	160
111	(NA)	(NA)
150	20,000	133
700	(NA)	200

Average annual cost per employee \$ 143⁽¹⁾

Notes: (1) Cost for examinations assumes tests are based on NIOSH recommendations..

Sources: Snell review and assessment of interviews with VCM and PVC manufacturers.

NA = not available

Don
1612

EXHIBIT F - 6(1)

USDOL/OSHA

LETTER OF DR. NORMAN B. JAVITT
TO SNELL REVIEWING THE
DATA IN APPENDIX F

525 EAST 68th STREET, NEW YORK, N.Y. 10021

THE NEW YORK HOSPITAL-CORNELL MEDICAL CENTER

DEPARTMENT OF MEDICINE
DIVISION OF GASTROENTEROLOGY

August 16, 1974

TO: John W. Keating, Ph. D.
Director, Biological Sciences
Foster D. Snell, Inc.

FROM: Norman B. Javitt, M.D., Ph. D.
Professor of Medicine and
Head, Division of Gastroenterology
New York Hospital-Cornell Medical Center

SUBJECT: Review of Appendix F (first draft) Technical Feasibility
and Economic Impact Study

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EXHIBIT F - 6(2)

USDOL/OSHA

I have reviewed the above appendix with special emphasis on Exhibits F-2 through F-5 and have the following comments:

1. In my judgement the proposed protocol adequately reflects both the recommendations of the appropriate governmental agencies, and considering the constraints of time and expense, is carefully constructed to obtain a sensitive estimate of the existence of liver dysfunction as well as other ancillary data on health status.

2. I would suggest consideration of the following modifications:

A. Routine tests:

1) Hepatitis B antigenemia (by RIA). A positive test should be an automatic exclusion from working with vinyl chloride because of the possibility of the person being a high risk for developing toxicity. Final judgement would require complete medical evaluation. Expense for this test is probably minimal since now, by state law, every unit of blood obtained for the purpose of transfusion must be tested for the presence of Hepatitis B antigen.

B. Special tests in the event of abnormal screening tests:

In the event of persistent abnormal test of liver function, the following further studies should be done:

- *1. Alpha₁ Fetoprotein (correlates with hepatoma)
- *2. Alpha₁ Anti-trypsin deficiency (at special risk to develop chronic lung and/or liver disease).

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1614

EXHIBIT F - 6(3)

USDOL/OSHA

- *3. 2-hour post-prandial serum bile acid. (The most specific sensitive test for hepatobiliary disease - not as yet activated-cost per test on contract basis, \$20 test).
- * Probably can be cost-accounted through Bio-Science Laboratories and other similar laboratories.

M. J. Smith

NBJ/bq

not
1615