

EXHIBIT II-X(1)
 USDOL/OSHA
 VINYL CHLORIDE/POLYVINYL CHLORIDE
 PRODUCERS VISITED AND INTERVIEWED
 BY PHONE BY SNELL 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

Firm or Organization VisitedPurpose of Visit

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

Goodyear Tire & Rubber Co.
Niagara Falls, New York

Great American Chemical Co.
Fitchburg, Massachusetts

Hooker Chemical Corp.
Florence, New Jersey

Monsanto
Springfield, Massachusetts

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

Olin-Thompson Plastics
Assonet, Massachusetts

Pantasote
Passaic, New Jersey

Robintech, Inc.
Painesville, Ohio

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

Stauffer Chemicals
Delaware City, Del.

Tenneco
Burlington, New Jersey

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

Plant visit on PVC

Plant visit on PVC

Plant visit on PVC

Phone interview on PVC

Technical and engineering data collection on PVC

Plant visit on PVC

Plant visit on PVC

Plant visit on PVC

Technical and engineering data collection on VCM
Plant visit on VCM

Plant visit on PVC

Plant visit on PVC

VRD 0002013622

EXHIBIT II-1(3)
USDOL/OSHA

Firm or Organization Visited

Union Carbide, Inc.
So. Charleston, West Virginia

Unitroyal Chemical Co.
Akron, Ohio

Source: Snell

Purpose of Visit

Technical and engineering data collection on PVC

Plant visit on PVC

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.

National Institute for Occupational Safety and Health
Cincinnati, Ohio

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

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

II. Industry Organizations

Manufacturing Chemists Association
New York, New York

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

Society of the Plastics Industry
New York, New York

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

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

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

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

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

Source: Snell

General data collection and attend hearings

Discussion on medical, monitoring, and protective equipment

General data collection

Industry marketing data collection

Discussions on technical feasibility and marketing data

General discussion

Discussions on technical feasibility

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

Medical surveillance data collection

Protective equipment data collection

Safety program data collection

EXHIBIT II-3 (1)

USDOL/OSHA

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

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

Source: Snell

Edmont-Wilson
Coshocton, Ohio

Mars, Inc.
Ashville, North Carolina

Uniroyal, Inc.
New York, New York

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

EXHIBIT III - 3

USDOL/OSHA

VINYL CHLORIDE PRODUCTION WORKERS - 1974

<u>Broad Job Classification</u>	<u>Approximate 1974 Number of Workers</u>	<u>Percent of Total</u>
Production ⁽¹⁾	410	44%
Maintenance ⁽¹⁾	250	27
Laboratory	60	6
Management and Support ⁽²⁾	<u>220</u>	<u>23</u>
Total	<u>940</u>	<u>100%</u>

Notes: (1) Includes line supervisors, such as foremen
(2) Includes plant managers, engineering staff, clerical, etc.

Source: Snell survey of industry covering approximately 65% of 1974-1975 nameplate capacity

IIIB. POLYVINYL CHLORIDE PRODUCTION

This section defines the structure of the polyvinyl chloride (PVC) manufacturing industry. The exhibits supporting this discussion appear sequentially after the text of this section.

1. 21 COMPANIES OPERATE 36 MAJOR PLANTS

- . A profile of PVC producers in terms of plant locations, nameplate capacities, and probable polymerizer (reactor) sizes is summarized in Exhibit III-4. Exhibits III-5 and III-6 provide interpretation of these data.
- . The total 1974 nameplate capacity of the industry is approximately 5.4 billion pounds per year, with over 1.9 billion pounds of new capacity scheduled over the next two years.
- . As shown in Exhibit III-5, no single company dominates PVC production.
 - Goodrich, the largest single producer with five plants, produces approximately 20% of the nation's PVC.
 - The next five largest producers, with a total of nine plants, each produce between 6% and 9% of total production. These producers are Firestone, Conoco, Union Carbide, Borden and Diamond Shamrock.
 - Each of the next thirteen producers, with a total of twenty plants, shares from 1% to less than 5% of total production.
 - The remaining two companies, with a total of two plants, each shares less than 1% of total PVC production.

PVC is produced in sixteen states, as shown in Exhibit III-6. Production is close to raw material supply (VCM) or near resin market centers:

- Over 50% of PVC resin capacity is concentrated in five states - Ohio, New Jersey, Texas, Massachusetts and California.
- Within these five states are located eighteen producing plants.
- Only ten plants are located in warm climates where open structures are possible; the remaining twenty-six plants are sited in states having moderate to cold temperatures. ✓

A majority of the operating plants are older than ten years, as estimated in Exhibit III-7.

- About 58% of the plants are older than ten years.
- Only 8% of operating plants are less than five years old, with the newest plant starting operation in 1971.
- Two new plants are scheduled to come on stream in late 1974, and several others are planned for later construction, seen from Exhibit III-4.

Historically, PVC production has been a batch operation and manufacturing was conducted in relatively small reactors to maintain product flexibility, quality, and most important, these reactors were not available in large capacities.

- As shown in Exhibit III-4, reactor sizes are almost equally divided between those plants using reactors less than 2,500 gal. capacity, and those between 2,500 gal. and less than 7,500 gal.
- Only nine plants use polymerizers equal to or larger than 7,500 gal.

According to recent technological developments, the trend is toward larger reactors in new plants. An industry-wide summary of PVC homopolymer production as a function of reactor size in 1972 vs. 1975 is summarized in Exhibit III-8.

- Approximately 85% of the homopolymer produced in 1972 was made in reactors with 7,500 gallons or smaller capacity.
- By 1975, it is expected that the smaller reactors will account for less than 60% of total production.
- Bulk polymerization capacity is expected to almost double.
- The use of small reactors is expected to continue in the long run, but only for production of specialty resins.

The four methods used for polymerizing PVC include suspension, emulsion, bulk, and solution polymerization, with suspension polymerization being used at a majority of plants as shown in Exhibit III-9.

- Suspension resin production is reported in 33 plants, accounting for 78% of 1973 output.
- Emulsion resin production is reported in 17 plants, accounting for 13% of 1973 output.
- Four plants produce bulk resins, while 2 plants produce solution resins, accounting for 9% of 1973 output.

2. THE PVC MANUFACTURING INDUSTRY HAS APPROXIMATELY 5,000 PLANT EMPLOYEES

Based on an essentially total survey of PVC producers by Snell, estimates were developed of the 1974 number of production and related personnel in the industry, as shown in Exhibit III-10.

- The approximately 3,100 workers identified with suspension processes represent 62% of industry employment, while emulsion process workers represent 26%; bulk and solution process workers represent 12%.
- 55% of PVC plant employment is represented by production workers, while 24% by maintenance personnel; these approximately 3,900 workers have the highest likelihood of VCM exposure.

The Snell survey identified 4,965 plant employees. A confidential study by industry sources independent of Snell, presented in Exhibit B-1, identified 5,045 workers.

* * * * *

This section defined the structure of the PVC manufacturing sector. The section that follows defines key PVC markets.

EXHIBIT III - 4(1)

USDOL/OSHA

PROFILE OF POLYVINYL CHLORIDE PRODUCERS

Producer	Location	Approximate 1974 Nameplate Capacity (million lbs.)	Planned ⁽²⁾ Million Lbs. Per Year	Additions ^(2,3) Starting Date	Probable Polymerizer ⁽²⁾ Size Range (gallons)		
					> 2,500	2,500 - <7,500	≥ 7,500
Air Products	Calvert City, Ky.	125 ⁽²⁾	200-300	planned		x	
	Pensacola, Fla.	80 ⁽²⁾				x	
American Chemical	Long Beach, Cal.	160 ⁽²⁾			x	x	x
Atlantic Tubing			50	2nd qtr. 1974			
Borden	Illioopolis, Ill.	125 ⁽²⁾	200	late 1974		x	
	Leominster, Mass.	190 ⁽²⁾			x	x	
	Springfield, Mass.	70 ^(1,2)			x		
Certain-Teed	Lake Charles, La.		300	late 1974		n. a.	
Conoco	Aberdeen, Miss.	250 ⁽²⁾	{50	4th qtr. 1974	x	x	x
	Oklahoma City, Okla.	215 ⁽²⁾					x
Diamond Shamrock	Deer Park, Tex.	250 ⁽²⁾	200	late 1974		x	x
	Delaware City, Del.	100 ^(1,2)				x	x
Ethyl	Baton Rouge, La.	180 ⁽¹⁾	unspecified	under way		x	
Firestone	Pottstown, Pa.	190 ⁽²⁾	{50	planned by mid 1975	x	x	
	Perryville, Md.	315 ⁽²⁾				x	
General Tire & Rubber	Ashtabula, Ohio	125 ⁽¹⁾			x	x	

EXHIBIT III - 4(2)

USDOL/OSHA

PROFILE OF POLYVINYL CHLORIDE PRODUCERS

Producer	Location	Approximate 1974 Nameplate Capacity (million lbs.)	Planned ⁽²⁾ Million Lbs. Per Year	Additions ^(2,3) Starting Date	Probable Polymerizer ⁽²⁾ Size Range (gallons)		
					> 2,500	2,500 - <7,500	≥7,500
Georgia-Pacific	Plaquemine, La.		220	4th qtr. 1974		n. a.	
B. F. Goodrich	Avon Lake, Ohio	315 ⁽²⁾			x	x	
	Henry, Ill.	235 ⁽²⁾			x	x	
	Long Beach, Calif.	190 ⁽²⁾			x	x	
	Louisville, Ky.	180 ⁽²⁾			x	x	
	Pedricktown, N.J.	160 ⁽²⁾			x	x	
Goodyear	Niagara Falls, N. Y.	100 ^(1,2)			x		x
	Plaquemine, La.	100 ⁽¹⁾	100	3rd qtr. 1974	x	x	
Great American Chemical	Fitchburg, Mass.	70 ⁽²⁾			x		
Hooker Chemical	Burlington, N. J.	180 ^(1,2)	{ expansion held in abeyance				
	Hicksville, N. Y.	15 ^(1,2)			x		
Keysor-Century	Saugus, Cal.	35 ⁽¹⁾			x		
National Starch	Meredosia, Ill.	10 ⁽⁴⁾			x		
Olin	Assonet, Mass.	150 ^(1,2)			x	x	
Pantasote	Passaic, N.J.	60 ^(1,2)			x		
	Point Pleasant, W. Va.	95 ^(2,5)			x	x	

EXHIBIT III - 4(3)

USDOL/OSHA

PROFILE OF POLYVINYL CHLORIDE PRODUCERS

Producer	Location	Approximate 1974 Nameplate Capacity (million lbs.)	Planned (2) Million Lbs. Per Year	Additions (2, 3) Starting Date	Probable Polymerizer (2) Size Range (gallons)		
					> 2,500	2,500 - <7,500	>7,500
Robintech	Painesville, Ohio	250 ^(1, 2)	220	4th qtr. 1974		x	
Stauffer	Delaware City, Del.	160 ⁽²⁾	10	3rd qtr. 1975		x	x
			55	3rd qtr. 1976			
Tenneco	Burlington, N. J.	150 ⁽²⁾				x	x
	Flemington, N. J.	85 ⁽²⁾			x	x	
	Pasadena, Tex.		300	4th qtr. 1974		N. A.	
Union Carbide	S. Charleston, W. Va.	160 ⁽¹⁾				x	
	Texas City, Tex.	240 ⁽¹⁾				x	x
Uniroyal	Painesville, Ohio	120 ⁽²⁾			x	x	
Total Nameplate Capacity		5,435	Planned or Anticipated New Capacity		22	27	9

Notes: (4) Operates a pilot plant at Plainfield, N. J. with an estimated capacity of 0.2 million pounds
 (5) Jointly owned by Pantasote and General Tire & Rubber, and operated by Pantasote

Sources: (1) Chemical Marketing Reporter, May 20, 1974
 (2) Industry interviews
 (3) Modern Plastics, May 1974

N. A. - not available

EXHIBIT III - 5

USDOL/OSHA

COMPANY CAPACITY AS PERCENT OF TOTAL
POLYVINYL CHLORIDE PRODUCTION CAPACITY

<u>Company</u>	<u>Company Nameplate Capacity (million lbs.)</u>	<u>Share of Total Capacity at mid 1974 (percent)</u>	<u>Accumulated Percent</u>
B. F. Goodrich	1080	19.9	19.9
Firestone	505	9.3	29.2
Conoco	465	8.6	37.8
Union Carbide	400	7.4	45.2
Borden	385	7.1	52.3
Diamond Shamrock	350	6.4	58.7
Robintech	250	4.6	63.3
Tenneco	235	4.3	67.6
Air Products	205	3.8	71.4
Goodyear	200	3.7	75.1
Hooker	195	3.6	78.7
Ethyl	180	3.3	82.0
Stauffer	160	2.9	84.9
American Chemical	160	2.9	87.8
Pantasote	155	2.9	90.7
Olin	150	2.8	93.5
General Tire	125	2.3	95.8
Unitoyal	120	2.2	98.0
Great American	70	1.3	99.3
Keysor-Century	35	0.6	99.9
National Starch	10	0.2	100.1 ⁽¹⁾
Total	<u>5,435</u>	<u>100.1⁽¹⁾</u>	

Note: (1) Does not add to 100% because of rounding errors

Source: Exhibit III - 4 and Snell estimates

EXHIBIT III - 6

USDOL/OSHA

GEOGRAPHIC DISTRIBUTION OF
POLYVINYL CHLORIDE PLANTS

<u>State</u>	<u>Number of Plants</u>	<u>Production Capacity (million lbs.)</u>	<u>Share of Total Capacity (percent)</u>	<u>Accumulated Percent</u>
Ohio ⁽¹⁾	4	810	14.9	14.9
New Jersey ⁽¹⁾	5	635	11.7	26.6
Texas ⁽²⁾	2	490	9.0	35.6
Massachusetts ⁽¹⁾	4	480	8.8	44.4
California ⁽²⁾	3	385	7.1	51.5
Illinois ⁽¹⁾	3	370	6.8	58.3
Maryland ⁽¹⁾	1	315	5.8	64.1
Kentucky ⁽¹⁾	2	305	5.6	69.7
Louisiana ⁽²⁾	2	280	5.2	74.9
Delaware ⁽¹⁾	2	260	4.8	79.7
West Virginia ⁽¹⁾	2	255	4.7	84.4
Mississippi ⁽²⁾	1	250	4.6	89.0
Oklahoma ⁽²⁾	1	215	4.0	93.0
Pennsylvania ⁽¹⁾	1	190	3.5	96.5
New York ⁽¹⁾	2	115	2.1	98.6
Florida ⁽²⁾	1	80	1.5	100.1 ⁽³⁾
TOTAL	<u>36</u>	<u>5,435</u>	<u>100.1%⁽³⁾</u>	
Notes: (1) Sited in moderate to cold climate				
	26	3,735	68.7	
(2) Sited in warm climate				
	<u>10</u>	<u>1,700</u>	<u>31.4</u>	
	<u>36</u>	<u>5,435</u>	<u>100.1%⁽³⁾</u>	

Source: Exhibit III-4 and Snell estimates

EXHIBIT III - 7(1)

USDOL/OSHA

U. S. POLYVINYL CHLORIDE PLANT AGE

Producer	Location	Plant Age As Approximately Indicated By Startup Date ⁽¹⁾ (years)					
		0 - 5	6 - 10	11 - 15	16 - 20	21 - 25	over 26
Air Products	Calvert City, Ky.				x		
	Pensacola, Fla.			x			
American Chemical	Long Beach, Calif.			x			
Borden	Leominster, Mass.			x			
	Illioopolis, Ill.			x			
	Springfield, Mass.					x	
Conoco	Aberdeen, Miss.		x				
	Oklahoma City, Okla.	x					
Diamond Shamrock	Deer Park, Tex.					x	
	Delaware City, Del.		x				
Ethyl	Baton Rouge, La.		x				
Firestone	Pottstown, Pa.					x	
	Perryville, Md.		x				
General Tire	Ashtabula, Ohio				x		
Goodrich Chemical	Avon Lake, Ohio					x	
	Henry, Ill.		x				
	Long Beach, Calif.			x			
	Louisville, Ky.						x
	Pedricktown, N. J.	x					

EXHIBIT III - 7(2)

USDOL/OSHA

U.S. POLYVINYL CHLORIDE PLANT AGE

<u>Producer</u>	<u>Location</u>	<u>Plant Age As Approximately Indicated By Startup Date⁽¹⁾ (years)</u>					
		<u>0 - 5</u>	<u>6 - 10</u>	<u>11 - 15</u>	<u>16 - 20</u>	<u>21 - 25</u>	<u>over 26</u>
Goodyear	Niagara Falls, N. Y. Plaquemine, La.	x					x
Great American	Fitchburg, Mass.				x		
Hooker	Hicksville, N. Y. Burlington, N. J.		x		x		
Keysor-Century	Saugus, Calif.				x		
National Starch	Meredosia, Ill.				x		
Olin	Assonet, Mass.		x				
Pantasote	Passaic, N. J. Point Pleasant, W. Va.		x ⁽²⁾		x		
Robintech	Painesville, Ohio		x				
Stauffer	Delaware City, Del.		x				
Tenneco	Flemington, N. J. Burlington, N. J.					x	

EXHIBIT III - 7(3)

USDOL/OSHA

U. S. POLYVINYL CHLORIDE PLANT AGE

<u>Producer</u>	<u>Location</u>	<u>Plant Age As Approximately Indicated By Startup Date ⁽¹⁾ (years)</u>					
		<u>0 - 5</u>	<u>6 - 10</u>	<u>11 - 15</u>	<u>16 - 20</u>	<u>21 - 25</u>	<u>over 26</u>
Union Carbide	S. Charleston, W. Va. Texas City, Tex.		x x				
Uniroyal	Painesville, Ohio						x
Total		<u>3</u>	<u>12</u>	<u>6</u>	<u>8</u>	<u>4</u>	<u>3</u>

Notes: (1) Or when plant underwent drastic rebuilding
 (2) Joint plant with General Tire & Rubber and operated by Pantasote

Source: Snell Industry interviews

EXHIBIT III - 10

USDOL/OSHA

POLYVINYL CHLORIDE PRODUCTION WORKERS - 1974

<u>Broad Job Classification</u>	<u>Workers By Process Type</u>					<u>Percent of Total</u>
	<u>Suspension</u>	<u>Emulsion</u>	<u>Bulk</u>	<u>Solution</u>	<u>Total</u>	
Production	1,660	690	190	185	2,725	55%
Maintenance	680	410	35	(	~ 1,190	24
Laboratory	225	80	{ 35	{ 125	~ 335	7
Management and Support	530	120	{	{	~ 715	14
Total	<u>3,095</u>	<u>1,300</u>	<u>260</u>	<u>310</u>	<u>4,965</u>	<u>100%</u>
Percent of Approximate 1974 Capacity Covered by Snell Survey	92	77	100	100		

Notes: (1) Includes line supervisory, such as foremen
 (2) Includes plant managers, engineering staff, clerical, etc.

Sources: Snell survey of industry

EXHIBIT III - 12

USDOL/OSHA

POLYVINYL CHLORIDE OUTPUT AND PRICE FORECASTS

<u>Resin</u>	<u>1970⁽¹⁾</u>	<u>1972⁽¹⁾</u>	<u>July 1974⁽²⁾</u>	<u>1978-1980⁽¹⁾</u>
Homopolymer Resins, \$/lb.	0.10	0.10 - 0.11	0.21 - 0.23	0.22 - 0.25
Copolymer Resins, \$/lb.	0.12	0.13	0.23 - 0.25	0.24 - 0.28
Dispersion Resins, \$/lb.	0.19	0.19	0.31 - 0.35	0.32 - 0.38
Total PVC Production, ⁽³⁾ Million Lbs.			~ 4,700	6,300 - 6,800
PVC Capacity ⁽³⁾ Million Lbs./Year			~ 5,000	6,120 - 7,120
VCM Capacity ⁽³⁾ Million Lbs./Year			~ 6,200	~ 7,500

Note: 1978-1980 values do not include any impact of OSHA regulations, and price projections are judged by Snell to be on the low side.

Sources: (1) Disch, G. E., Plastics--Raw Materials to End Markets and Coatings--New Technology and Markets, American Chemical Society, Brooklyn, 1974, p. 7

(2) Chemical Marketing Reporter, July 22, 1974

(3) Hydrocarbon Processing, May 1974, p. 83

EXHIBIT III - 17

USDOL/OSHA

MAJOR RESIN TYPES AND THEIR TYPICAL
FREE MONOMER LEVELS RELATED TO
FABRICATION CATEGORY

<u>Resin Type</u>	<u>Typical Average Mid-1974 Residual VCM Levels⁽¹⁾ (ppm)</u>	<u>Calendering</u>	<u>Coating</u>	<u>Extrusion</u>	<u>Molding</u>	<u>Paste</u>	<u>All Other</u>	<u>1973 Total</u>
<u>Suspension</u>								
Pipe Grade	150			1,255				1,255
General Purpose	500	550	215	840	185			1,790
Copolymer	1000 - 7000	290			90		160	540
Overall	500							
<u>Dispersion</u>								
Latex	400		200					200
Other	25				240	155		395
Overall	~10							
<u>Bulk</u>								
High Porosity	25	70		205				275
Overall	~20							
<u>Solution</u>								
Overall	<1.5	910	70 485	2,300	515	155	65 225	135 4,590

Note: (1) Individual data points around the averages can vary by a factor of three or more. Before steps were taken to comply with the Emergency Temporary Standard these averages were significantly higher. Improved stripping is believed to have been achieved using state-of-the-art technology and operating procedures

Sources: Snell estimates and Exhibits III-14 and III-16 based on industry interviews

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>

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 (ϕ /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%

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- 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.

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

EXHIBIT IV - 12(1)

USDOL/OSHA

TYPICAL TIME REQUIREMENTS FOR
IMPLEMENTING VARIOUS ENGINEERING CONTROL METHODS

<u>Method</u>	<u>Rationale</u>	<u>Time to Complete</u>
Major ventilation project	Increase rate of air changes in closed buildings	18 months
Minor ventilation	Install spot ventilation on a piece of equipment: pump, strainer, etc.	1/2 - 2 months
Venting of temporary tank car connection lines	Decrease release of VCM trapped between tank car valve, using vacuum and/or nitrogen flush	1 - 2 months
Installation of new gauging systems on tank car fleet	Eliminate the continuous emission of VCM which occurs with the dip tube system	12 - 24 months
Replacement or reconditioning of reactors (polys)	Reduce leakages at manholes, seals, etc.	18 - 24 months
Installation of solvent cleaning of reactors	Reduce need to clean manually	30 months
Installation of automatic water cleaning of reactors	(Alternative to solvent cleaning)	24 months
Additional stripping not requiring new steam generating facilities	Reduce VCM emissions downstream from the polymerization step	18 months
Additional stripping requiring new steam generating facilities	Reduce VCM emissions downstream from the polymerization step	36 months
Replacement of strainers	Eliminate open strainers and/or substitute closed self cleaning units	3 - 8 months

EXHIBIT IV - 12(2)

USDOL/CSHA

TYPICAL TIME REQUIREMENTS FOR
IMPLEMENTING VARIOUS ENGINEERING CONTROL METHODS

<u>Method</u>	<u>Rationale</u>	<u>Time to Complete</u>
Installation of rotary compressors to replace reciprocating compressors	Reduce VCM leakage during operation	18 months
Modifications to the piping	Reduce the number of flanged connections, etc.	1 - 12 months
Major processing change requiring R & D and demonstration	e.g. Change over from the batch to a continuous process	4 - 7 years
New plant construction	Install a complete redesigned facility	2.5 - 3 years

Sources: Snell's estimates based on interviews with producers, equipment manufacturers and engineering know-how

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

- 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/OSHA

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 (\$/1,000 lb.)</u>	<u>Annual (\$/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)	26
Total Direct Costs ⁽¹⁰⁾	<u>\$1.30</u>	<u>\$0.63</u>	<u>86%</u>
Productivity Loss	\$0.18	\$0.10	14%
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 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-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-3

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 SNELLSnell assessment of VCM level potentially achieved⁽¹⁾

Total plants in samples: 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

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</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⁾	\$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	<u>\$3.94</u>	<u>\$1.58</u>	<u>79%</u>
Productivity Loss ⁽¹⁰⁾	<u>\$0.64</u>	<u>\$0.41</u>	<u>21%</u>
Total Costs	<u>\$4.58</u>	<u>\$1.99</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 = 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.

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

	Direct Costs	Capital (\$/1,000 lb.)	Annual (\$/1,000 lb.)	Percent of Total Annual Cost
I. Engineering Costs ⁽⁴⁾		\$4.58	\$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 = Oxichlorination, STO = Stauffer Oxichlorination, DO = DOW Oxichlorination, DG = Direct Chlorination, G = Goodrich Oxichlorination.

(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.

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

EXHIBIT V - 6

USDOL/OSHA

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

VCMI 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		
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 VCMI ceiling and 1 ppm TWA
- (3) Endangered = management will seriously consider plant shutdown

Source: Exhibits V - 1 through V - 5

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-12 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.

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.. 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.

.. 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.

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.

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

EXHIBIT V-7

USDOL/OSHA

ESTIMATED INDUSTRY COSTS OF ACHIEVING A 50 PPM VCM CEILING LEVEL
IN PVC PLANTS AS CLAIMED BY INDUSTRY AND ASSESSED BY SNELLSnell assessment of VCM level potentially achieved⁽¹⁾: 25 ppm TWA, 40 ppm Ceiling

Total plants in sample: 23

Processes represented⁽²⁾: S, E, B, SOLocation of plants in sample⁽³⁾: 5W, 18C

Age of plants in sample:	Range, Years	0 - 5	6 - 10	11 - 15	16 - 20	21 - 25	> 26
	No. of Plants	2	10	2	4	2	3

Capacity of sample - millions lbs. per year (percent 1974 U.S. nameplate capacity):

3,750 (80%)

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

Negligible

	Direct Costs	Capital (\$/1,000 Lb.)	Annual (\$/1,000 Lb.)	Percent of Total Annual Cost
I. Engineering Costs ⁽⁴⁾	\$1.69	0.93 ⁽⁵⁾		13%
II. Personal Equipment Costs ⁽⁶⁾	0.16	0.23 ⁽⁷⁾		3
III. Monitoring	0.70 ⁽⁸⁾	0.74 ^(7,8,9)		10
Total Direct Costs	<u>\$2.55</u>	<u>\$1.90</u>		<u>26%</u>
Productivity Loss ⁽¹⁰⁾		<u>\$9.77</u>	<u>\$5.33</u>	<u>74%</u>
Total Costs		<u>\$12.32</u>	<u>\$7.23</u>	<u>100%</u>

Notes: (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) S = Suspension, E = Emulsion, Dispersion, B = Bulk, SO = Solution.

(3) W = Sited in warm climate, C = Sited in cold climate (U.S. 26C, 10W).

(4) Includes ventilation, loading, reactor cleaning, stripping 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 by OSHA regulations.

Source: Industry interviews and Snell estimates.

EXHIBIT V-8

USDOL/OSHA

ESTIMATED INDUSTRY COST OF ACHIEVING A 25-40 PPM VCM
CEILING AND 15-25 PPM TWA LEVEL IN PVC PLANTS AS CLAIMED
BY INDUSTRY AND ASSESSED BY SNELL

Snell assessment of VCM level potentially achieved⁽¹⁾

Total plants in sample: 21

Processes represented⁽²⁾: S, E, BLocation of plants in sample⁽³⁾: SW, 16C

Age of plants in sample:	Range, years	0 - 5	6 - 10	11 - 15	16 - 20	21 - 25	> 26
	No. of Plants	2	10	1	4	2	2

Capacity in Sample - Millions lbs. per year (Percent 1974 U.S. nameplate capacity):

3,400 (72%)

Percent industry claimed capacity from sample subject to shutdown at a

25-40 ppm ceiling and 15-25 ppm TWA VCM level: 9%

	Direct Costs	Capital (\$/1,000 lb.)	Annual (\$/1,000 lb.)	Percent of Total Annual Cost
I. Engineering Costs ⁽⁴⁾		\$7.91	\$2.34 ⁽⁵⁾	19%
II. Personal Equipment Costs ⁽⁶⁾		1.00	0.61 ⁽⁷⁾	5
III. Monitoring		0.75 ⁽⁸⁾	0.80 ^(7, 8, 9)	6
Total Direct Cost		\$9.66	\$3.75	31%
Productivity Loss ⁽¹⁰⁾		16.08	8.48	69%
Total Costs		\$25.74	\$12.23	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) S = Suspension, E = Emulsion, Dispersion, B = Bulk, SO = Solution.

(3) W = Sited in warm climate, C = Sited in cold climate (U. S. 26C, 10W).

(4) Includes ventilation, loading, reactor cleaning, stripping 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, excluding plants which reported inability to meet the standard.

Source: Industry interviews and Snell estimates.

EXHIBIT V-9

USDOL/OSHA

ESTIMATED INDUSTRY COST OF ACHIEVING A 25 PPM VCM AND 10-15 TWA PPM
LEVEL IN PVC PLANTS AS CLAIMED BY INDUSTRY AND ASSESSED BY SNELL

Snell assessment of VCM level potentially achieved⁽¹⁾
 Total plants in sample: 16
 Processes represented⁽²⁾: S, E, B
 Location of plants in sample⁽³⁾: 4W, 12C

Age of plants in sample:	Range, Years	0 - 5	6 - 10	11 - 15	16 - 20	21 - 25	> 26
	No. of Plants	1	7	1	3	2	2

Capacity in sample - millions lbs. per year (percent 1974 U.S. nameplate capacity): 2,600
 Percent industry claimed capacity from sample subject to shutdown at a
 25 ppm ceiling and 10-15 ppm TWA VCM level: 31%
 Snell estimate of percent capacity from sample subject
 to shutdown at a 25 ppm ceiling and 10-15 ppm TWA VCM
 level

	Direct Costs	Capital (\$/1,000 Lb.)	Annual (\$/1,000 Lb.)	Percent of Total Annual Cost
I. Engineering Costs ⁽⁴⁾		\$28.79	\$10.00 ⁽⁵⁾	37%
II. Personal Equipment Costs ⁽⁶⁾		1.02	0.82 ⁽⁷⁾	3
III. Monitoring		0.87 ⁽⁸⁾	0.87 ^(7,8,9)	3
Total Direct Costs ⁽⁴⁾		\$30.68	\$11.69	43%
Productivity Loss ⁽¹⁰⁾		\$30.28	\$15.58	57%
Total Costs		\$60.96	\$27.27	100%

Notes: (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) S = Suspension, E = Emulsion, Dispersion, B = Bulk, SO = Solution.

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

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

(5) Includes capital amortized @ 12% - 10 yrs.

(6) Includes breathing equipment and clothing.

(7) Includes capital amortized @ 12% - 5 yrs.

(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 level, unimpacted by OSHA regulations. This is based on those plants that expected ability to meet the claimed level, shown in the Exhibit.

Source: Industry interviews and Snell estimates.

EXHIBIT V - 10(1)

USDOL/OSHA

ESTIMATED COST FOR THE FIRESTONE
TIRE AND RUBBER COMPANY TO ACHIEVE A
"NO DETECTABLE" VCM LEVEL

Snell assessment of VCM level potentially achieved⁽¹⁾

Total plants in sample

2 (Pottstown, Pa. and Perryville, Md.)

Processes represented⁽²⁾

S and E

Location of plants in sample⁽³⁾

2C

Age of plants in sample:

Range, years
No. of plants

0 - 5

6 - 10
Perryville

11 - 15

16 - 20

21 - 25
Pottstown

>26

Capacity of plant:

Millions lbs per year (percent U.S. 1974 capacity)

507 (11%)

EXHIBIT V - 10(2)

USDOL/OSHA

ESTIMATED COST FOR THE FIRESTONE
TIRE AND RUBBER COMPANY TO ACHIEVE A
"NO DETECTABLE" VCM LEVEL

Direct Costs	Capital		Annual		Two Plant Average	
	Pottstown, Pa. (\$/1,000 lb)	Perryville, Md. (\$/1,000 lb)	Pottstown, Pa. (\$/1,000 lb)	Perryville, Md. (\$/1,000 lb)	Capital (\$/1,000 lb)	Annual (\$/1,000 lb)
I. Engineering ⁽⁴⁾	\$137.02	\$47.06	\$59.37 ⁽⁵⁾	\$24.82 ⁽⁵⁾	\$80.77	\$37.77
II. Personal Equipment ⁽⁶⁾	8.22	0.55	1.86 ⁽⁷⁾	0.17 ⁽⁷⁾	3.42	0.80
III. Monitoring	3.74 ⁽⁸⁾	1.43 ⁽⁸⁾	3.21 ^(7,8,9)	0.59 ^(7,8,9)	2.30	1.57
Total Direct Costs	<u>\$143.98</u>	<u>\$51.04</u>	<u>\$64.44</u>	<u>\$25.58</u>	<u>\$86.49</u>	<u>\$40.14</u>
Productivity Loss ⁽¹⁰⁾	136.32	27.42	79.15	16.15	59.98	38.26
Total Costs	<u>\$285.30</u>	<u>\$78.46</u>	<u>\$143.59</u>	<u>\$41.73</u>	<u>\$146.47</u>	<u>\$78.40</u>

Notes:

- (1) Snell estimates of VCM levels achievable in plants incorporating the level of control effort represented in the Exhibit
- (2) S = suspension, E = emulsion, dispersion
- (3) W = sited in warm climate; C = sited in cold climate
- (4) Includes ventilation, loading, reactor cleaning, stripping and other (piping, general pumps, maintenance, etc.)
- (5) Includes capital amortized @ 12% - 10 years and O & M charges
- (6) Includes breathing equipment and clothing
- (7) Includes capital amortized @ 12% - 5 years 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

Source:

Firestone presentation to 25 June 1974 OSHA hearing and Snell estimates

EXHIBIT V - 11

USDOL/OSHA

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

VCM Standard	Sample Total		End of Year									
	Number of Plants	Capacity (million lbs)	1974		1975		1976		1977		1978	
			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	23	3750	23	100%								
25 - 40 ppm ceiling & 15 - 25 ppm TWA	21	3400	-	-	1	3% ⁽¹⁾	7	39% ⁽¹⁾	8	32% ⁽¹⁾	5	26% ⁽¹⁾
25 ppm ceiling & 10 - 15 ppm TWA	16	2600	-	-	-	-	5	35% ⁽¹⁾	7	39% ⁽¹⁾	4	26% ⁽¹⁾
"No-detectable"												

Claimed "Not feasible"

Note: (1) Percent of sample 1974 capacity

Source: Industry interviews by Snell

EXHIBIT V - 12

USDOL/OSHA

SUMMARY OF THE COST IMPACTS AND DELAYS
TO COMPLIANCE EXPECTED BY PVC INDUSTRY
BY VCM TARGET LEVEL

VCM Level Claimed By Industry	Unit Costs, ¢/lb.			Compliance Period Required For Engineered Controls	Percent of Industry "Endangered" ⁽²⁾ Based On Sample
	Direct Costs of Compliance	Costs to Make Up For Loss of Productivity	Total Costs ⁽¹⁾		
50 ppm ceiling	0.19	0.53	0.72 ± 20%	0 to 6 months	negligible ⁽³⁾
25 - 40 ppm ceiling with 15 - 25 TWA	0.38	0.85	1.23 ± 35%	~ 2.5 years	9%
25 ppm ceiling with 10 - 15 TWA	1.17	1.56	2.73 ± 50%	~ 2.5 years	31%
"No Detectable" ⁽⁴⁾	4.01	3.83	7.84 ± 50%	~ 3 years	100%

Notes:

- (1) The percentage ranges of total costs represent Snell's estimates based on partial statistical analysis of data
- (2) Endangered = management will seriously consider plant shutdown
- (3) Temporary shutdowns for installation of controls were reported. In addition, one plant (not in sample) accelerated a planned shutdown by six months resulting in a loss of 50 million lbs per year
- (4) Economic data based on average data shown in Exhibit V - 10 for the Firestone plants which were not included in the sample for the reason explained in the text

Source:

Exhibits V - 7 through V - 11

EXHIBIT V - 13

USDOL/OSHA

ESTIMATED VINYL CHLORIDE ECONOMICS
IMPACTED BY SELECTED VCM LEVEL STANDARDS
(1974 dollars)

Item	Unimpacted by OSHA (¢/lb)	50 ppm Ceiling (¢/lb)	25 ppm Ceiling (¢/lb)	15 ppm Ceiling 5 - 10 ppm TWA (¢/lb)	<10 ppm Ceiling 1 - 5 ppm TWA ⁽²⁾ (¢/lb)
<u>Plant Investment⁽¹⁾</u>	4.08¢	4.23¢	4.35¢	4.54¢	4.81¢
<u>Cost of Manufacture</u>	6.13	6.20	6.25	6.33	6.55
Selling, general and ad- ministrative expenses	0.30	0.30	0.30	0.30	0.30
Pretax profit on total in- vestment (@ 20% at 1.2 x plant investment)	<u>0.98</u>	<u>1.01</u>	<u>1.04</u>	<u>1.09</u>	<u>1.15</u>
Net selling price (FOB plant)	<u>7.41¢</u>	<u>7.51¢</u>	<u>7.59¢</u>	<u>7.72¢</u>	<u>8.00¢</u>

Notes:

- (1) Unit Production Costs for a 500 million lb. ethylene oxychlorination plant of 1974 construction with total fixed capital of \$20.4 million unimpacted by OSHA costs include production loss replacement
- (2) Includes two plants which estimated the ability to achieve a 1 ppm VCM ceiling and 1 ppm TWA, essentially "no detectable"

Source:

Exhibit IV - 4 for basic economics and Snell estimates for compliance levels based on Exhibits V - 1 through V - 4

D.W.?

EXHIBIT V - 14(1)

USDOL/OSHA

POLYVINYL CHLORIDE ECONOMICS IMPACTED BY
SELECTED VCM LEVEL STANDARDS
(1974 dollars)

Item		50 ppm Ceiling	25 ppm Ceiling	25 ppm Ceiling	15 ppm Ceiling 5 - 10 ppm TWA	<10 ppm Ceiling 1 - 5 ppm TWA	1 ppm Ceiling 1 ppm TWA
VCM Standard	Unimpacted By OSHA	50 ppm Ceiling	25 - 40 ppm Ceiling	25 ppm Ceiling	25 ppm Ceiling 10 - 15 ppm TWA	25 ppm Ceiling 10 - 15 ppm TWA	"no detectable"(2)
PVC Standard			15 - 25 ppm TWA	10 - 15 ppm TWA			
Designed plant capacity (millions lbs/year)	200	200	200	200	200	200	200
Plant investment (\$ millions)	20	22.2	24.7	30.9	30.9	30.9	46.3
Production (millions lbs/year @ 90% utilization)	180	180	180	180	180	180	180
Plant investment per unit of production (¢/lb)	11.1	12.3	13.7	17.2	17.2	17.2	25.7
Cost of Manufacture	¢/lb	¢/lb	¢/lb	¢/lb	¢/lb	¢/lb	¢/lb
Vinyl chloride monomer (1.06 lb x net selling price from Exhibit III - 2 - 0.59¢/lb trans- pord added)	8.5¢	8.6¢	8.7¢	8.7¢	8.8¢	9.1¢	9.1¢

EXHIBIT V - 14 (2)

USDOL/OSHA

POLYVINYL CHLORIDE ECONOMICS IMPACTED BY
SELECTED VCM LEVEL STANDARDS
(1974 dollars)

<u>Item</u>		50 ppm Ceiling	25 ppm Ceiling	25 ppm Ceiling	15 ppm Ceiling 5 - 10 ppm TWA	<10 ppm Ceiling 1 - 5 ppm TWA	1 ppm Ceiling 1 ppm TWA
<u>VCM Standard</u>	Unimpacted By OSHA	50 ppm Ceiling	25 - 40 ppm Ceiling	25 ppm Ceiling	25 ppm Ceiling 10 - 15 ppm TWA	25 ppm Ceiling 10 - 15 ppm TWA	"no detectable"(2)
<u>PVC Standard</u>				10 - 15 ppm TWA	10 - 15 ppm TWA		
<u>Cost of Manufacture (cont.)</u>							
Operating labor and supervision	0.4						
Capital recovery (@ 12% - 10 years)	2.0	6.6	7.1	8.6	8.6	8.6	13.7
All other costs (catalysts, utilities, maintenance, etc.)	3.5						
Total cost of manufacture	<u>14.4¢</u>	<u>15.2¢</u>	<u>15.8¢</u>	<u>17.3¢</u>	<u>17.4¢</u>	<u>17.7¢</u>	<u>22.8¢</u>
<u>Profitability</u>							
Cost of manufacture	14.4¢	15.2¢	15.8¢	17.3¢	17.4¢	17.7¢	22.8¢
Selling, general and administrative	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Pretax profit (@ 20% x 1.2 plant investment)	<u>2.7</u>	<u>2.9</u>	<u>3.3</u>	<u>4.1</u>	<u>4.1</u>	<u>4.1</u>	<u>6.2</u>
Net Selling Price (FOB plant)	<u>18.6¢</u>	<u>19.6¢</u>	<u>20.6¢</u>	<u>22.9¢</u>	<u>23.0¢</u>	<u>23.3¢</u>	<u>30.5¢</u>

EXHIBIT V - 14(3)

USDOL/OSHA

POLYVINYL CHLORIDE ECONOMICS IMPACTED BY
SELECTED VCM LEVEL STANDARDS
(1974 dollars)

Notes: (1) Grass roots plant, located on Gulf Coast, producing general purpose suspension resin
(2) Based on Firestone data presented in Exhibit V - 10

Source: Snell estimates based on industry interviews and prices for VCM presented in Exhibit V - 13

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.

<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	14	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.

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.

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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 \$80,000

- . 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.

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.

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

- 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.

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.

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The chapter that follows presents next steps in the study.

VI. NEXT STEPS

This chapter will constitute the recommendations in the final report. For purposes of this preliminary report the work steps planned for the remaining study period are listed below:

Refinement of economic information

- based on further analysis of the exposure data in Appendix B, development of Snell's estimate of achievable compliance levels of VCM compared to those claimed by the PVC industry
- development of Snell's estimates of the fraction of the PVC industry "endangered" by various compliance levels of VCM with judgments as to the effects of plant age, size, location and technology
- analysis of the PVC economic data for case(s) between the "no detectable" level and 25 ppm (ceiling or TWA)
- ✓✓ - case study for a PVC plant representative of the industry with good exposure data and assumed to be under a 10 or 15 ppm TWA compliance limit for VCM

Expansion of PVC technical discussions

- the 35,000 gal. reactor technology
- polymerization cycles and reactor cleaning
- monomer stripping
- general R&D, such as carbon adsorption

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Appendices follow in a separate volume.