

Statement of John L. Nelson
Vice President-Manufacturing, B.F. Goodrich Chemical Company
Prepared For
Presentation At
Department of Labor Hearings On
Vinyl Chloride, Occupational Exposure Standard
July 8, 1974

I am John L. Nelson, vice president-manufacturing of B.F. Goodrich Chemical Company, a Division of The B.F. Goodrich Company. Our headquarters are at 6100 Oak Tree Boulevard, Cleveland, Ohio 44131.

I received a B.S. in Chemical Engineering from the University of Wisconsin in 1939. My experience in the chemical industry covers a period of thirty-five years, all of which has been with Goodrich, and most of which has been directly or indirectly connected with the production of vinyl chloride and polyvinyl chloride. I was located in our Louisville plant for nineteen years, during the last ten of which I served as plant manager.

Seated on this panel with me are all of the Goodrich representatives who participated in the presentation by The Society of the Plastics Industry, who will be available to answer questions on our testimony. They are:

- Mr. Anton Vittone
President, B.F. Goodrich Chemical Company
- Mr. Philip J. Weaver
Director of Industry Affairs, B.F. Goodrich Chemical Company
- Dr. Roger W. Strassburg
Director of Environmental Affairs, The B.F. Goodrich Company
- Dr. Maurice N. Johnson
Director of Environmental Health, The B.F. Goodrich Company

Also included on this panel is Dr. Condict Moore, Professor of Surgery and Director of the Cancer Center, University of Louisville School of Medicine. Dr. Moore will present a statement summarizing the program which the University is initiating pursuant to a grant from Goodrich.

The main purpose of my testimony will be to examine the question of technical feasibility in the light of our current engineering and scientific knowledge. In addition, I will discuss on-going research and development programs directed at the reduction of vinyl chloride losses from our manufacturing operations. Our goal is to reduce vinyl chloride exposure to the lowest feasible levels and to preserve the jobs dependent upon this widely used and versatile plastic material.

We will discuss these subjects in terms of our own extensive experience. Specifically, we will review:

1. Vinyl chloride exposure levels in Goodrich plants.

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There are many variations within these types; solutions applicable to one type of process, product or plant are not necessarily applicable to other processes, products or plants.

The equipment used in the conversion of monomer to polymer in all three processes consists of multiple units of vessels, pumps, piping and valves, with thousands of potential sources of small fugitive or elusive leakage of vinyl chloride gas. The process is batch-type and, after each reaction is completed, the vessel in which it is conducted requires varying kinds of purging, entering, cleaning, and preparation before the next batch can be started. These vessels, which we call polymerizers or reactors, have gone through an engineering evolution over the past thirty-five years.

During our first twenty years in the business, we used 1100-gallon reactors of stainless steel construction, which required entry and manual cleaning after every charge. This cleaning took about one hour, during which time workers cleaning vessels were exposed to vinyl chloride levels of an estimated 200-500 ppm. The worker would clean an average of five vessels every eight-hour work shift. We can only estimate early exposure levels, since the analytical sophistication to determine low levels of vinyl chloride in air has only been available in recent years. Our estimates were based on fragmentary data and interviews with employees to determine how often odor was evident, if and when they were aware of the intoxicating effect, and what level of explosimeter readings they might recall. While this method used to estimate exposure levels may seem crude by today's standards, our estimates are consistent with other similar testimony presented in this hearing.

Peak exposure levels ten and twenty years ago were one hundred times today's emergency standard, and probably averaged forty times today's average levels. My personal PVC experience goes back to when levels of exposure were of this magnitude.

Beginning in 1959, we experimented with glass-lined polymerizers and revisions to agitators and baffles to minimize buildup and cleaning time and did, as a result, reduce cleaning time to 20-30 minutes.

The next engineering breakthrough occurred in the late 1960's, with the Goodrich development of hydraulic reactor cleaning. This is a programmed high pressure water mechanism which is inserted into a polymerizer to remove buildup almost completely. This has greatly reduced human entry into polymerizers for manual cleaning. On some of our products, human entry has been reduced to as few as 3% of the batches. On some products, entry is still required after each batch. Over our total product mix, entry is required in about 10% of the batches.

Concurrent with the evolution of polymerizer design and mechanized cleaning, we installed additional equipment to improve the removal of vinyl chloride from the reactor prior to entry. With our current multi-step procedure, we have reduced vinyl chloride levels in open polymerizers down to the ambient level in the buildings today. The worker is further protected from vinyl chloride release from PVC resin buildup by use of an air line supplied respirator during the cleaning operation.

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Also included with this statement (EXHIBIT 3) is a six-months' history of area measurements of vinyl chloride levels by plants and by buildings showing the percentages of readings above 50 ppm and below 10 ppm.

This improvement is the result of aggressive and comprehensive programs carried out in each of our PVC plants and in our VCM plant to identify and correct leaks, initiate operating improvements and emphasize increased employee communications. Here are some of the more important parts of these programs.

Leak Reduction

Leak reduction has been the single greatest source of reduced vinyl chloride levels. The indispensable key to this progress was diligent monitoring on a 24-hour a day, seven days per week basis to record concentrations of monomer and track down the exact source of each leak. Early in January, personnel were assigned in each plant to do nothing but measure and record monomer concentrations and identify sources of the concentrations. Then, corrective action followed swiftly. OVA monitoring is still being done to locate sources of leaks.

Now, continuous recording fixed Bendix organic vapor analyzers are installed in all polymerization buildings in all plants. The Bendix instrument shows a higher reading if there is a significant leak anywhere in the area. The leak is tracked down with the portable OVA and repaired.

Operating Improvements

We have also made many operating improvements that have helped to reduce vinyl monomer concentrations in the work area. These include:

Vessels and pipelines containing monomer such as polymerizers, strainers, tank car unloading lines and Hamer blind installations, are being more thoroughly evacuated to recovery pumps before opening.

New procedures have been implemented for opening reactor manhole covers which reduce emission to the work area.

Regular vinyl monomer recovery operations have been improved and monomer efficiency raised.

Number of entries and time of each entry into polymerizer vessels for cleaning has been reduced.

Better manhole lid closure seals have been developed for polymerizers.

General ventilation has been greatly improved in many buildings. Localized ventilation has been installed at some repetitive trouble spots, such as pump seals.

Compressor and vacuum pump seal water have been put into closed systems.

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Although this new facility incorporates our latest technology, we fully expect to make additional improvements resulting from our on-going research and development work. It is expected that some of these improvements will take up to 24 months after the completion of the developmental effort.

Research and Development

Goodrich is doing everything it can with current technology, as rapidly as possible, to reduce vinyl chloride exposure levels. Further improvements and reductions in levels will come from the engineering changes and work practices we outlined previously. Improvements beyond these can only be achieved through future technological breakthroughs. In the past five months, we have redirected and greatly accelerated our research and development efforts. We have 135 scientists and technicians at our Research and Development facilities and in our plants working on process and product improvements directed at lower vinyl chloride losses and reduced exposure. Our goal is to approach negligible losses of vinyl chloride from all sources.

About a quarter of the research and development effort is involved with analytical techniques and equipment, analyst training, and developmental analyses directed at worker exposure and residual monomer content of resins. During 1973, this effort resulted in selection of direct reading portable and sequential continuous monitoring equipment which have been essential tools in our efforts to reduce vinyl chloride levels in work areas of our production plants. Current effort is being directed toward more precise and rapid measurement of worker exposure.

About half of this research and development effort concerns fundamental process improvements to reduce losses inherent in our present processes. To our knowledge, there is no PVC production plant in the world operating in a completely closed polymerizer mode because of the buildup problem in reactors. Our programs toward this end include investigations of the fundamental mechanisms leading to resin adherence to polymerizer surfaces and a wide variety of methods aimed at eliminating adherence, chemically and/or mechanically. It is difficult to estimate how soon, if ever, we might achieve our goals in a practical way.

The balance of our research and development program includes reduction of monomer losses beyond the polymerization area. This is the development of a process by which the vinyl chloride monomer is removed from the PVC resin slurry before drying, thus increasing the recovery of vinyl chloride monomer.

This would also result in lower residual vinyl chloride in our finished resins when proven in production plant installations. We can foresee completion of this work and installation of facilities in two to four years for the majority of our resins.

Finally, in order to reach levels below .01% residual vinyl chloride in some PVC resins, we see the necessity for some basic changes in our manufacturing technology and the structure of PVC particles. This will take time to complete the small-scale work and scale up to production facilities.

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in vinyl chloride monomer and polyvinyl chloride plants, including reactor cleaning, where exposure is at low levels, regular work type clothes (coveralls or pants and shirts with full length sleeves) should be adequate.

Vinyl Chloride Level in PVC

Goodrich supports the SPI proposal that appropriate labeling of PVC containers be required when vinyl chloride levels in PVC exceeds 0.1%, effective October 5, 1974 and, further, that the requirement for labeling be changed to 0.01% effective October 5, 1977.

Labeling

We support the SPI position that the language to be used on signs at regulated areas emphasize the precautionary steps to be taken, rather than "scare" language emphasizing the nature of the substance.

Similarly, we support the SPI concept of product labeling, both monomer and polymer, and agree that such labeling should be designed to provide information to those who need it, rather than a basis upon which to panic because of a potential disease characterization.

As part of our overall effort, on May 1, 1974, Goodrich made a grant to the University of Louisville Medical School Cancer Center. This was the result of Goodrich's desire to bring continuing comprehensive medical advice and consultation to the situation and to support a broad scientific inquiry into the problem.

At this time, I present Dr. Condict Moore, Professor of Surgery at the University of Louisville School of Medicine, who will summarize the program which the University is initiating pursuant to a grant from Goodrich. Dr. Moore's statement is attached.

IN SUMMARY, then, Goodrich's position is as follows:

1. We are committed to reduce vinyl chloride exposure to the lowest level that is feasible through a combination of engineering changes, work practices, the part-time use of respiratory equipment, and technological development.
2. A no-detectable level of VCM in its monomer and polymer plants is not technically feasible.
3. Full-time use of respiratory protection by PVC and VCM workers is not feasible.
4. We will be forced to shut down our PVC and VCM operations if the proposed permanent standard is adopted.

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EXHIBIT 1

PLANT START-UP DATA AND ENROLLMENT

<u>Plant and Location</u>	<u>Type of Product</u>	<u>Start-up Date</u>	<u>Current PVC or Monomer Enrollment</u>
Avon Lake, Ohio	PVC	1953	481
Henry, Illinois	PVC	1965	76
Long Beach, Cal.	PVC	1960	100
Louisville, Ky.	PVC*	1942	465
Pedricktown, N. J.	PVC	1970	118
Calvert City, Ky.	Monomer	1950	250
Total			1,490

*Also vinyl chloride monomer until 1968

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EXHIBIT 2

PERSONNEL MONITORING DATA

A limited amount of data have been taken during May and June, 1974. The data for various operations have been categorized to show the number of values in several ranges of vinyl chloride concentration. All data are time weighted averages over a four-hour period absorbed on carbon tubes and tested by gas chromatography. This data does not, in all cases, represent actual worker exposure since every worker wears respiratory equipment when the work atmosphere is greater than 25 ppm or where operations and experience show there is a risk of exceeding 25 ppm.

OPERATION -- PVC POLYMERIZATION

	<u>PPM VC1 Ranges</u>				
	<u>0-5</u>	<u>6-10</u>	<u>11-20</u>	<u>21-35</u>	<u>Over 35</u>
Charge Operator	22	5	5	2	0
Recovery Operator	12	8	1	3	1
Hydraulic Reactor Cleaner Operator	6	2	2	0	2
Poly Cleaner	3	3	2	1	1

OPERATION -- MONOMER PRODUCTION

	<u>PPM VC1 Ranges</u>				
	<u>0-5</u>	<u>6-10</u>	<u>11-20</u>	<u>21-35</u>	<u>Over 35</u>
Furnace Operator	2	1	1	0	0
VC1 Purification Operator	7	0	0	0	0
Tank Farm Operator	0	2	1	2	0

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EXHIBIT 3

VCL MONITORING DATA

Area Measurements Using Portable and Fixed Instrumentation,
Measuring Total Hydrocarbons by the Flame Ionization Method

PLANT: AVON LAKE, OHIO

<u>Building</u>	<u>Product</u>	<u>Month</u>	<u>% Readings Above 50 PPM</u>	<u>% Readings Under 10 PPM</u>
451	Dispersion Resin	January	3.5	8.7
		February	3.9	14.4
		March	2.6	23.4
		April	4.9	42.9
		May	2.7	65.2
		June	4.7	72.5
461	Suspension Resin	January	4.7	24.1
		February	3.3	37.9
		March	2.5	21.7
		April	3.4	14.6
		May	2.2	59.3
		June	4.9	57.8
464	Suspension Resin	January	5.1	11.1
		February	3.1	10.3
		March	1.1	34.8
		April	0.0	58.9
		May	2.8	71.2
		June	2.8	82.5
463	PVC Latex	January	0.0	70.9
		February	0.2	91.7
		March	0.0	97.5
		April	0.7	97.6
		May	0.4	86.3
		June	1.9	82.3

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EXHIBIT 3 - Cont'd.

VCL MONITORING DATA

Area Measurements Using Portable and Fixed Instrumentation,
Measuring Total Hydrocarbons by the Flame Ionization Method

PLANT: HENRY, ILLINOIS

<u>Building</u>	<u>Product</u>	<u>Month</u>	<u>% Readings Above 50 PPM</u>	<u>% Readings Under 10 PPM</u>
731	Suspension and	January	33.0	20.3
	Dispersion	February	10.0	17.4
	Resins	March	2.0	27.9
		April	4.8	69.1
		May	2.3	82.0
		June	2.9	79.1

PLANT: LONG BEACH, CALIFORNIA

<u>Building</u>	<u>Product</u>	<u>Month</u>	<u>% Readings Above 50 PPM</u>	<u>% Readings Under 10 PPM</u>
812	Suspension	January	2.6	Data not analyzed
	Resin	February	1.8	" " "
		March	2.4	" " "
		April	2.2	" " "
		May	0.5	" " "
		June	1.3	84.4

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EXHIBIT 3 - Cont'd.

VCL MONITORING DATA

Area Measurements Using Portable and Fixed Instrumentation,
Measuring Total Hydrocarbons by the Flame Ionization Method

PLANT: LOUISVILLE, KENTUCKY

<u>Building</u>	<u>Product</u>	<u>Month</u>	<u>% Readings Above 50 PPM</u>	<u>% Readings Under 10 PPM</u>
121	Dispersion Resin and Latex	January	10.9	0.2
		February	3.2	5.9
		March	0.6	40.8
		April	1.7	62.0
		May	1.0	86.2
		June	0.9	88.3
111	Suspension Resin	January	9.1	0.2
		February	2.0	5.9
		March	1.5	36.0
		April	1.8	71.0
		May	1.7	90.2
		June	1.5	90.5
1	Suspension Resin	January	3.0	0.4
		February	0.6	7.8
		March	1.3	21.0
		April	1.3	73.8
		May	1.2	90.9
		June	1.1	91.2
15	Copolymers Solution Resin	January	6.4	0.7
		February	2.2	5.1
		March	1.2	29.4
		April	2.2	64.7
		May	4.6	62.9
		June	1.7	78.6
115	VCl Recovery Purification	January	- Data Not Taken -	
		February	3.0	0.5
		March	5.0	9.3
		April	1.9	34.7
		May	5.4	33.3
		June	0.8	25.2

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EXHIBIT 3 - Cont'd.

VCL MONITORING DATA

Area Measurements Using Portable and Fixed Instrumentation,
Measuring Total Hydrocarbons by the Flame Ionization Method

PLANT: PEDRICKTOWN, NEW JERSEY

<u>Building</u>	<u>Product</u>	<u>Month</u>	<u>% Readings Above 50 PPM</u>	<u>% Readings Under 10 PPM</u>
512	Mass Polymerization	January	5.1	35.7
		February	2.0	46.5
		March	1.1	69.3
		April	0.6	76.2
		May	1.4	79.3
		June	0.6	80.7
513	Suspension and Dispersion Resins	January	3.8	39.1
		February	2.4	66.0
		March	1.0	81.3
		April	0.7	78.8
		May	1.2	75.2
		June	0.5	75.9

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Statement of Dr. Condict Moore
Professor of Surgery
and
Director, Cancer Center
University of Louisville School of Medicine
Prepared For
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July 8, 1974

My name is Dr. Condict Moore. I am a Professor of Surgery and the Director of the Cancer Center at the University of Louisville School of Medicine.

I received my B.A. from Princeton and my M.D. from Columbia University. I served my internship in Methodist Hospital in Brooklyn 1942-1943.

Following service in the United States Navy, 1943-1946, I completed residencies in:

St. Luke Hospital, New York City (Pathology) 1946-1947
Methodist Hospital, Brooklyn (Surgery) 1947-1949
Memorial Hospital, New York (Resident & Fellow in Surgery) 1949-1952

I was certified by the American Board of Surgery in 1952 and, that same year, joined the faculty of the University of Louisville School of Medicine. Following a series of appointments at the Medical School relating to Pathology, Tumors, Cancer, and Surgery, I was made full Professor of Surgery (Oncology) in 1969. In addition, in 1972 I was appointed Director, Cancer Center, University of Louisville Health Science Center. My complete Curriculum Vitae is attached.

For the past two years a group of senior faculty members of the School of Medicine at the University of Louisville has been organizing the Cancer Center as a new interdepartmental, multidisciplinary organizational unit and functional focus of effort within the faculty of the University. This Cancer Center effort has gained much impetus from a historically strong University effort in the cancer field and from considerable consultative and financial support from the Cancer Centers office of the National Cancer Institute. The Cancer Center has begun an effective direction of effort, created a productive unit among the various faculties and schools of the University that has mobilized many different disciplines and enabled them to mount multi-departmental approaches to various specific tasks, both in terms of clinical and research cancer matters.

When, in January and February of this year (1974), it became apparent that the relatively large numbers of cases of angiosarcoma of the liver discovered in Louisville PVC workers of B.F. Goodrich would demand considerable clinical care and consultation and research investigation, the Director of the Cancer Center and the Cancer Center Steering Committee made some

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inquiries of Dr. John Creech, B.F. Goodrich Plant Physician, and Dr. Laszlo Makk, pathologist at St. Anthony Hospital, Louisville, Kentucky, who had been handling the clinical management of the affected workers. These inquiries were aimed at finding whether the University Medical School could be of help in any consultative or investigative way to the medical department of the B.F. Goodrich plant in Louisville. This struck a responsive chord, since Dr. Creech had been exploring with representatives of the Company the various possibilities of obtaining expert consultation and help in pursuing, managing and studying the problem which appeared to be of industry-wide and nationwide importance. Thus the two organizations, simultaneously, mutually sought out each other. The University was seeking to carry out its responsibilities for community health as well as seeking support for much needed research; the B.F. Goodrich Company was looking for clinical assistance and sophisticated scientific and academic guidance in medical surveillance and in medical consultation. Therefore, an agreement was reached within several weeks whereby the B.F. Goodrich Company would supply the University with funds through the Cancer Center organization to carry out a three-point program over a period of one year to eighteen months. The three points of this program consist of the following:

1. A medical surveillance program in which a clinical team from the University would formally screen, with specially designed questionnaires and complete physical examinations, all employees of the B.F. Goodrich plant, under the supervision of a new, unique specialist, a hepatologist, who would be added to the faculty to be the director of the program. With his help a revised protocol of laboratory testing would be instituted on all employees. Medical consultation and help would be provided from a panel of university specialists whenever required.

We are particularly interested in developing an improved protocol, since there has been consensus here and in the medical community that the current protocol is simply not discriminating enough nor sufficiently predictive.

As a further protocol problem, Dr. Johnson has informed us that Goodrich, in applying the SMA 12 to young applicants for employment, the test rejects an abnormally high number of young people who obviously are generally healthy and have had no VCM exposure.

2. The second area of commitment consists in establishing, with the help of a new epidemiologist and staff, a registry for all cases of diagnosed or suspected vinyl chloride-associated disease occurring at the plant in Louisville, a registry designed with the capability of being expanded throughout the industry, and open to participation by other companies.
3. The third part of the agreement was that the University would begin a University-wide, basic research program designed to study the toxic and disease-producing effects of vinyl chloride and related compounds, a program to be monitored by intramural and extramural scientific review committees.

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In short, we are addressing ourselves to finding out what vinyl chloride and related compounds will do to the human body, how we can predict pathological effects, how we can properly take care of people who have already had disease-producing exposures, and how to prevent other workers from getting a dangerous level of exposure.

The agreement was signed within the past month. Progress to date has consisted of the appointment of an outstanding hepatologist who will be on site within two months and who will make periodic visits within the next two months to help organize the program without delay. A team of clinicians has been formed and plans have been made in the medical department of the Louisville plant of the B.F. Goodrich Company to perform physicals and complete medical histories, and special questionnaires on all employees beginning July 1. This special clinical study should be completed by the middle of August. Input into the design of the questionnaire and the physical examination has been secured from numerous individuals in a variety of disciplines both within the institution and from the outside. Contact has been made with the several national and federal agencies interested in this problem, including the National Cancer Institute, NIOSH, and EPA. Representatives of these organizations have visited Louisville and been apprised of our plans. The long-range aspect of this program is periodic re-examination, re-study and careful follow-up on all previous, present and future employees. In the area of registry establishment, a person accomplished in epidemiology and biostatistics has been employed to begin work by the end of July in the design of various studies. In this regard we plan to draw upon the talents of Dr. E. Cuyler Hammond, Vice President and epidemiologist-statistician of the American Cancer Society in New York City, who has agreed to be consultant to our program. He has visited Louisville and consulted at length with company statisticians and with our multidisciplinary groups at the University.

In the area of basic research, 17 research proposals have been received and reviewed by special survey and review committees within the University. After a series of critical analyses, seven proposals have been funded at relatively low levels of funding to stimulate small pilot studies in the approved areas of research. We hope these will lead to larger studies with funding from other sources within the next year. These projects include the study of the value of electron spin resonance variations in detecting angiosarcoma and other changes in tissues exposed to vinyl chloride; the possible interaction between vinyl chloride and viral RNA or reverse transcriptase; electron microscopic studies of diseased liver tissue available to the University research group; measurements of sinus blood flow and Kupffer cell function as a possible guide to early liver damage and malignant transformation; liver-specific studies looking for these as indicators of chronic vinyl chloride exposure; and the use of mutagenicity experiments to indicate carcinogenicity of vinyl chloride and its related compounds or their metabolites.

We expect to have most aspects of this three-part program fully under way within the next year; that is, thorough, formal medical screening of all of the employees of the B.F. Goodrich plant in Louisville, a skeleton registry of vinyl chloride-exposed individuals begun so that it can be expanded and added to, and some indication of which pilot studies in basic research are worthy of further larger funding and more intensive pursuit in the laboratory.

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