INDUSTRIAL HYGIENE SURVEY
OF THE

B. F. Goodrich Chemical Company,
Polyvinyl Chloride Operations
Avon Lake, Ohio

SURVEY DATE
December 4-11, 1974

SURVEY CONDUCTED BY
James Jones
Geoffrey Langer
Jack Proud
Ken Wallingford
Ralph Zumwalde

REPORT WRITTEN BY
James Jones

DATE OF REPORT
March, 1976

Environmental Investigations Branch
Division of Field Studies and Clinical Investigations
National Institute for Occupational Safety and Health
Cincinnati, Ohio

PLACE VISITED:	B.F. Goodrich Chemical Company P.O. Box 134 Avon Lake, Ohio 44012
DATE OF VISIT:	December 4-11, 1974
PERSONS MAKING VISIT:	<u>NIOSH-DFSCI</u> James Jones Geoffrey Langer Jack Proud Ken Wallingford Ralph Zumwalde
PERSONS CONTACTED:	Robert N. Rylands, Plant Manager Doug Rider, Environmental Engineer Lynn Wallis, Safety Engineer
PURPOSE OF VISIT:	To conduct an industrial hygiene survey of vinyl chloride polymerization operations.
UNION:	None

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) has underway an industrywide study of the vinyl chloride (VC) industry. As part of this study, industrial hygiene surveys were conducted to determine "typical" VC exposure at plants using each of the four production processes for making polyvinyl chloride (PVC).

The B.F. Goodrich plant at Avon Lake, Ohio is one of four PVC plants where NIOSH worker mortality studies are being conducted. This plant is one of the largest PVC plants in the country and has a wide range of processes. For these reasons, it was decided to conduct an industrial hygiene survey at the Avon Lake plant. Initial contacts were made, background information was obtained and a walk-through survey of the plant was conducted on March 6 and 7, 1974 by James Jones. On December 4, 1975, after a one day delay due to a 25 inch snowfall in northeastern Ohio, the survey personnel, James Jones, Geoffrey Langer, Jack Proud and Ralph Zumwalde, met with plant personnel and made preparations for sampling to begin the following day. Ken Wallingford replaced Ralph Zumwalde for the second week of the survey. The survey continued through December 11.

During this survey approximately 250 air samples were taken for evaluation of VC exposures. In addition, samples were taken to evaluate exposure to PVC dust. Noise measurements were also made in selected areas.

DESCRIPTION OF THE FACILITY

Although the Avon Lake plant is predominately a PVC production facility, milling and calendering of PVC are also done here. VC is currently used in two separate processes to make PVC: the suspension process and the emulsion process. Also plasticizers, polyurethanes and acrylates are produced here.

The plant began operations in 1951 with the production of PVC emulsion resins. Suspension resin production began in 1957 and emulsion PVC latex in 1963. Several copolymers of PVC have also been produced: acrylonitrile from 1952 to the present, bisphenol-A from 1964 to 1973, n-butyl acrylate from 1963 to present, 2-ethyl hexylacrylate from 1963 to present, isobutylene from 1957 to 1962, styrene from 1966 to present, vinyl acetate from 1957 to present and vinylidene chloride from 1963 to present.

The work force consists of approximately 700 people, 200 of whom actually work in the PVC polymerization areas. There is no union at this plant. They operate three eight hour shifts per day, seven days per week.

MEDICAL, INDUSTRIAL HYGIENE AND SAFETY PROGRAMS

This facility has an in-plant dispensary with nurses on duty 24 hours per day, 5 days per week. All foremen and guards are trained in first aid. Two physicians each spend two hours per day at the dispensary five days per week. An emergency vehicle is available at all times. Hospitals are ten to fifteen minutes away in Lorain, Elyria and Bay Village. The corporate medical department sets guidelines for routine medical tests and physical examinations. Pre-employment physicals including blood tests, pulmonary function tests, audiometry and a medical history are required. Retesting of employees is done periodically depending on the work location.

The safety department consists of two safety engineers and two safety inspectors. Hard hat, safety glasses and respirator programs are in operation. Workers are required to wear fresh air supplied respirators when entering vessels for cleaning or when performing other jobs, such as filter cleaning, that have a high potential for VC exposure. Safety is stressed to the workers through monthly safety meetings, short weekly safety meetings in the operating areas, special safety meetings to discuss new topics and by posting information on bulletin boards. Equipment inspection is carried out by the plant guards under the supervision of the safety department. These inspections include such things as routine checks of relief valves, rupture discs and fire extinguishers. All plant personnel receive fire extinguisher and hose training. The plant has a fire truck with foam generation and dry chemical equipment. A yearly safety audit is performed by B.F. Goodrich Chemical Division personnel. Semi-annual safety audits are conducted by plant safety personnel.

Historically, industrial hygiene services were provided by corporate level people. Since 1973, plant safety and environmental control personnel have been performing this function under the guidance of the corporate industrial hygienists. A safety engineer and an environmental control engineer handle this activity. Routine industrial hygiene audits were in the planning stages at the time of the survey. At that time, the priority item was VC sampling to determine regulated areas for the new OSHA standard. Sampling was also being conducted in various parts of the plant for disocyante, carbon monoxide, vinylidene chloride and PVC dust.

Also, two engineers were on full time temporary assignment to implement changes to bring the plant in compliance with the new OSHA standard. One of these changes was the installation of an automatic sequential VC sampling system in each polymerization building. This sampling system consists of a Bendix total hydrocarbons analyzer in the suspension and emulsion resin buildings and a gas chromatograph in the latex building. Each of these instruments is tied into six sampling points with changes being made to add six additional sampling points to each system. At the time of the visit, analysis time was two minutes for each point, so each point is sampled every twelve minutes. With the additional sampling points, analysis time would be reduced to one minute, so that each point would still be sampled every twelve minutes. These sample results are fed to a mini-computer, which stores peak values for each point and calculated eight hour shift averages for each point along with floor and building averages.

These systems also actuates a visual alarm in the production areas whenever levels go over a pre-set limit. At the time of our survey this was twenty-five ppm.

In addition to area sampling, workers on each shift use Century Organic Vapor Analyzers to conduct a routine inspection of valves, pump seals, etc. for early detection of VC leaks. Also, when a high VC level is detected by the automatic sampler, they use the Century to determine the cause of the reading and see that it is fixed.

DESCRIPTION OF THE PROCESSES

VC is shipped to this plant from BFG's Calvert City, Kentucky plant in railroad cars. It is stored under pressure in two spheres. VC is then transferred from these spheres to two process buildings.

Emulsion Resin Process

VC is metered into a stirred pre-mix vessel along with emulsifiers, catalyst and water. Here the ingredients are mixed, then fed through a homogenizer into stirred autoclaves where PVC is produced by a free radical aqueous polymerization process. After the reaction reaches a predetermined completion the PVC-water slurry is transferred to a "blowdown" tank where excess VC is removed. The VC that is removed from the slurry is compressed, condensed and returned to the system. After the slurry has been stripped, it is pumped to blend tanks where batches from several autoclaves are blended for product uniformity. The slurry is then concentrated, blended further and fed to a spray drier. After being dried the resin is ground and bagged. The product has a very small particle size in the range of 1 to 10 micrometers.

Latex Process

The latex process is an emulsion process in which the PVC-water emulsion is fed to the blend tanks from the autoclaves after removal of excess VC. The emulsion is then packaged in drums or loaded in tank trucks or railroad tank cars for shipping.

Suspension Resin Process

In this process, VC, dispersant, catalyst and water are metered into stirred autoclaves where PVC is produced by a free radical aqueous polymerization reaction. After the reaction reaches a predetermined completion, the PVC-water slurry is transferred to a "blowdown" tank where excess VC is removed by vacuum. This unreacted VC is compressed, condensed and recycled to the process. The stripped PVC-water slurry is then transferred to blend tanks where batches from several autoclaves are blended for product uniformity. From the blend tanks, the PVC-water slurry is pumped to a dewatering centrifuge where approximately 90% of the water is removed. The PVC resin wet cake is conveyed from the centrifuge to a rotary dryer where the remaining water is removed. The dry PVC resin is then screened and pneumatically conveyed to storage, compounding, bagging or bulk shipping. This product has a particle size in the range of 100 to 200 micrometers.

INSPECTION OF PLANT

Ventilation

Each of the polymerization buildings have chemical ventilation systems. Building 451 has a ventilation system that provided 7 to 9 air changes per hour under emergency conditions. Building 461's system provided 7 to 13 air changes per hour normally and 11 to 18 air changes per hour under emergency conditions. Building 464's system provides 7 to 8 changes per hour normally and 22 to 29 air changes per hour under emergency conditions. During the winter the ventilation systems are operated at normal levels but during the summer they were routinely operated at emergency levels to provide cooling.

A ventilation system to provide fresh air to reaction vessels prior to and during entry by workers for cleaning provided 0.67 to 1 air changes per minute in the vessel.

Potential Health Hazards

Potential health hazards observed during this survey were as follows:

1. Respiratory exposure to VC.
2. Respiratory and skin exposure to acrylates
3. Respiratory and skin exposure to acrylonitrile
4. Respiratory exposure to vinyl acetate
5. Respiratory exposure to vinylidene chloride
6. Respiratory exposure to PVC dust
7. High noise exposures in various production areas

SURVEY PROCEDURES

General

Air samples were collected in this plant for evaluating exposure to VC and PVC dust. A noise survey was also conducted. The following paragraphs describe the methods used to collect and analyze the air samples and take noise measurements.

Vinyl Chloride

Both personal and general area samples for VC were collected in the PVC production areas using charcoal adsorption tubes. The area samples were collected in control rooms or at operator's desks. The samples were taken with Sipin SP-1 pumps at a flow rate of approximately 50 milliliters per minute for a maximum of 100 minutes. Standard SKC charcoal tubes were used. At the end of each day, all samples collected that day were packed in dry ice, to prevent loss of VC. At the end of each week of sampling, these samples were shipped to the NIOSH laboratory in Salt Lake City, Utah. There the samples were desorbed with carbon disulfide and analyzed by gas chromatography according to NIOSH Physical and Chemical Analysis Method #178. (See Appendix)

Polyvinyl Chloride Dust

Personal samples for airborne PVC dust were collected in the bagging areas of the plant. Most of these samples were total dust gravimetric samples taken for approximately four to five hours at a flow rate of two liters per minute. Also samples were collected to allow microscopic examination of airborne dusts.

All gravimetric samples were collected on 37 millimeter (mm) diameter Mine Safety Appliance (MSA) PVC membrane filters with a 5 micrometer (μm) pore size. Samples collected for microscopic examination were collected on 37 mm Millipore AA membrane filters with a pore size of 0.8 μm. Three piece Millipore filter cassettes were used with the cap on and only the small plug removed (leaving a 4 mm diameter opening). An MSA Model G portable air sampling pump was used to draw air through the filter. Gravimetric sample filters were tared and re-weighed on the twenty milligram "A" scale of a Cahn Gram Electrobalance.

Noise

In addition to air sampling, spot noise measurements were made in selected production areas. A General Radio Type 1565-A sound level meter calibrated with a Type 1562-A calibrator was used for all measurements. The meter response was set on the slow position and measurements were made on the "A" weighting network.

RESULTS AND DISCUSSION

Vinyl Chloride Samples

Emulsion Resin Area - Building 451 (Polymerization Building)

Results of each sample are given in Table 1 and are summarized in Table 7. The lowest personal VC concentration observed was 1.4 parts per million (ppm) and the highest was 103.8 ppm. Mean personal VC concentration for the various job classifications ranged from 1.4 ppm to 22.7 ppm. These means represent time weighted average (TWA) exposures for these jobs. The highest exposure job categories were blowdown operator and helper. The helpers clean out the autoclaves, but wear air supplied respirators when inside the autoclaves. Therefore, the average concentration for this job category does not reflect the man's actual exposure to VC.

Area concentrations found in the control room and at the operator's desk varied from 1.0 ppm to 15.9 ppm. The mean concentration for the control room was 2.9 ppm and that for the operator's desk 7.2 ppm.

Suspension Resin Areas

Building 452 (Dryer Building)

Results of each sample are given in Table 2 and are summarized in Table 8. The personal VC concentration ranged from 0.2 ppm to 9.6 ppm. The mean concentration for job types ranged from 1.3 ppm to 4.0 ppm. No area samples were collected in this building.

Building 455 (Dryer Building)

Results of each sample are given in Table 3 and summarized in Table 8. Only one man works in the building. His VC concentrations varied from 1.1 ppm to 21.0 ppm with a mean of 6.8 ppm. No area samples were collected in this building.

Building 461 (Polymerization Building)

Results of each sample are given in Table 4 and summarized in Table 8. The personal VC concentrations ranged from 1.3 ppm to 160.6 ppm. The mean concentrations for job types ranged from 7.2 ppm to 58.4 ppm. The highest exposure job category was relief operator, but helpers again had a high VC exposure.

Area concentration found in the control room varied from 1.0 ppm to 11.5 ppm with a mean of 6.2 ppm.

Building 464 (Polymerization Building)

Results of each sample are given in Table 5 and summarized in Table 8. Personal VC concentrations varied from 0.8 ppm to 78.6 pp. Mean concentrations for job types varied from 3.0 ppm to 21.0 ppm. The highest exposure job category was recovery operator.

Area VC concentrations found in the control room varied from 0.1 ppm to 1.6 ppm with a mean of 0.7 ppm.

Transfer Operations

Results of these samples are presented in Table 6 and summarized in Table 8. Personal VC samples were collected for tank car disconnecting operations, which varied from 1.4 ppm to 2.8 ppm with a mean of 2.1 ppm, and resin bulk car loading, which varied from 1.0 ppm to 1.2 ppm with a mean of 1.1 ppm.

No samples were taken in the latex process area because the process was not in operation during the time of the survey. This was due to a lack of customer orders for PVC latex material.

Polyvinyl Chloride Dust

Dust samples were only collected in Building 452. These sample results are given in Table 9. Emulsion resin baggers total dust concentrations ranged from 2.00 milligrams per cubic meter (mg/m^3) to 18.62 mg/m^3 with a mean of 7.82 mg/m^3. The only sample taken on a suspension resin bagger showed a dust concentration of 0.47 mg/m^3.

A sample was collected on an emulsion resin bagger and also on a suspension resin bagger for optical microscopic examination and sizing using a Porton reticle. Eighty-seven particles were sized from the emulsion resin bagger sample and ninety-three particles from the suspension resin bagger sample. The examination of these two samples showed very similar size distributions. All particles were below 6.7 μm in size and approximately 90 percent were below 2.4 μm in size. The small size of the dust, which correlated with the small particle size of PVC emulsion resin, suggests that the suspension resin bagger's dust concentration was primarily due to emulsion resin dust carried to his work station from the emulsion resin bagging operations, approximately fifty feet away.

NOISE MEASUREMENTS

Noise levels in Building 451 ranged from 73 dBA in the control room to 90 dBA. High noise levels seemed to be caused predominately by fan noise. Fans with different style blades for less noise production were being installed.

Noise levels in Building 452 ranged from 62 dBA to 96 dBA. Most of the high noise levels were found on the third level where there was little employee exposure. The other high noise exposure operation was bagging.

CONCLUSIONS AND RECOMMENDATIONS

The sample results showed that VC levels had been lowered significantly since the walk-through survey in March, 1974. Additional changes were planned or being implemented to bring concentrations down even further. VC concentrations were not below the current OSHA standard of 1 ppm, but were below the standard of 50 ppm in effect at that time.

No single process seemed to have higher VC exposures than any other. The newest polymerization building, Building 464, had the lowest VC concentrations, probably due to fewer process mishaps or equipment breakdowns. The dryer buildings had appreciable VC concentrations. These will probably be lowered as process changes to reduce residual VC monomer in the PVC resin are introduced.

An attempt is being made to correlate both personal and area sampling for VC conducted by B. F. Goodrich personnel with data collected by NIOSH personnel. Since data is available from Goodrich for a time before extensive modifications were made to lower VC concentrations to the present levels, this could serve to help make a better estimate of past VC exposures.

Table 1

Vinyl Chloride Sample Result - Emulsion Resin Area - Building 451

B.F. Goodrich - Avon Lake, Ohio

Sample Date	Sample Location	VC Concentration ppm
12-4-74	Control Room	2.5
12-4-74	Control Room	1.4
12-5-74	Control Room	3.7
12-5-74	Control Room	1.9
12-5-74	Control Room	1.0
12-6-74	Control Room	5.9
12-6-74	Control Room	3.6
12-4-74	Operators Desk-3rd Floor	7.4
12-4-74	Operators Desk-3rd Floor	8.5
12-5-74	Operators Desk-3rd Floor	15.9
12-5-74	Operators Desk-3rd Floor	7.9
12-6-74	Operators Desk-3rd Floor	2.2
12-6-74	Operators Desk-3rd Floor	1.4
12-4-74	Charge Operator	5.1
12-4-74	Charge Operator	6.1
12-4-74	Charge Operator	6.7
12-5-74	Charge Operator	6.5
12-5-74	Charge Operator	3.9
12-5-74	Charge Operator	6.3
12-5-74	Charge Operator	4.7

Table 1 (Continued)

Sample Date	Sample Location	VC Concentration ppm
12-6-74	Charge Operator	5.1
12-6-74	Charge Operator	6.2
12-6-74	Charge Operator	5.6
12-6-74	Charge Operator	6.8
12-6-74	Charge Operator	5.5
12-6-74	Charge Operator	7.4
12-4-74	Recovery Operator	33.8
12-5-74	Recovery Operator	13.5
12-5-75	Recovery Operator	2.3
12-5-74	Recovery Operator	3.8
12-5-74	Recovery Operator	6.8
12-6-74	Recovery Operator	6.8
12-6-74	Recovery Operator	12.8
12-6-74	Recovery Operator	4.4
12-4-74	Blowdown Operator	98.0
12-4-74	Blowdown Operator	8.4
12-5-74	Blowdown Operator	13.4
12-5-74	Blowdown Operator	12.1
12-5-74	Blowdown Operator	31.5
12-6-74	Blowdown Operator	5.2
12-6-74	Blowdown Operator	6.3
12-6-74	Blowdown Operator	6.4
12-6-74	OVA Operator	1.4

Table 1 (Continued)

Sample Date	Sample Location	VC Concentration ppm
12-4-74	Helper	6.9
12-4-75	Helper	3.5
12-4-75	Helper	5.6
12-4-74	Helper	6.5
12-4-75	Helper	7.3
12-4-75	Helper	5.0
12-5-74	Helper	19.4
12-5-74	Helper	6.1
12-5-74	Helper	10.1
12-5-74	Helper	68.0
12-5-74	Helper	10.3
12-5-74	Helper	11.3
12-5-74	Helper	103.8
12-5-74	Helper	16.4
12-5-74	Helper	36.1
12-6-74	Helper	16.2
12-6-74	Helper	8.7
12-6-74	Helper	7.4
12-6-74	Helper	12.5
12-6-74	Helper	10.2
12-6-74	Helper	9.2
12-6-74	Helper	21.1
12-6-74	Helper	8.8
12-6-74	Helper	5.0

Table 2

Vinyl Chloride Sample Results - Drying area - Building 452
B.F. Goodrich, - Avon Lake, Ohio

Sample Date	Sample Location	VC Concentration ppm
12- 9-74	Spray Drier Operator	3.6
12- 9-74	Spray Drier Operator	5.5
12-10-74	Spray Drier Operator	1.6
12-10-74	Spray Drier Operator	1.2
12-10-74	Spray Drier Operator	1.3
12-11-74	Spray Drier Operator	9.6
12-11-74	Spray Drier Operator	1.4
12-11-74	Spray Drier Operator	0.5
12-11-74	Spray Drier Operator	9.5
12-11-74	Spray Drier Operator	3.8
12-11-74	Spray Drier Operator	2.6
12-10-74	Vent Operator	1.2
12-10-74	Vent Operator	1.4
12- 9-74	Rodney Hunt Operator	4.2
12- 9-74	Rodney Hunt Operator	3.9
12-10-74	Rodney Hunt Operator	1.9
12-10-74	Rodney Hunt Operator	1.5
12-11-74	Rodney Hunt Operator	4.9
12-11-74	Rodney Hunt Operator	2.3
12-11-74	Rodney Hunt Operator	2.9

Table 2 (Continued)

Sample Date	Sample Location	VC Concentration ppm
12- 9-74	Transfer Operator	4.3
12- 9-74	Transfer Operator	5.4
12-11-74	Transfer Operator	4.5
12-11-74	Transfer Operator	1.9
12-11-74	Transfer Operator	4.8
12- 9-74	Helper	2.4
12- 9-74	Helper	3.3
12- 9-74	Helper	2.3
12- 9-74	Helper	3.6
12-10-74	Helper	0.6
12-10-74	Helper	0.8
12-11-74	Helper	1.0
12-11-74	Helper	0.7
12-11-74	Helper	0.7
12- 9-74	Bagger	2.0
12- 9-74	Bagger	3.2
12- 9-74	Bagger	2.5
12- 9-74	Bagger	3.4
12- 9-74	Bagger	3.5
12- 9-74	Bagger	4.1
12- 9-74	Bagger	1.0
12- 9-74	Bagger	0.2
12- 9-74	Bagger	2.1
12- 9-74	Bagger	2.6

Table 3

Vinyl Chloride Sample Results - Dryer Area - Building 455

B.F. Goodrich - Avon Lake, Ohio

Sample Date	Sample Location	VC Concentration ppm
12- 9-74	Dryer Operator	1.1
12- 9-74	Dryer Operator	1.2
12- 9-74	Dryer Operator	21.0
12-10-74	Dryer Operator	8.2
12-10-74	Dryer Operator	3.4
12-10-74	Dryer Operator	6.1

Table 4

Vinyl Chloride Sample Results - Suspension Resin Area - Building 461
B.F. Goodrich - Avon Lake, Ohio

Sample Date	Sample Location	VC Concentration ppm
12- 4-74	Control Room	8.3
12- 4-74	Control Room	9.9
12- 4-74	Control Room	11.5
12- 5-74	Control Room	1.8
12- 5-74	Control Room	4.2
12- 5-74	Control Room	9.4
12- 6-74	Control Room	5.1
12- 6-74	Control Room	1.0
12- 6-74	Control Room	4.8
12- 4-74	Charge Operator	18.3
12- 4-74	Charge Operator	16.5
12- 4-74	Charge Operator	12.2
12- 4-74	Charge Operator	9.9
12- 4-74	Charge Operator	9.6
12- 4-74	Charge Operator	11.6
12- 5-74	Charge Operator	15.0
12- 5-74	Charge Operator	6.1
12- 5-74	Charge Operator	9.0
12- 5-74	Charge Operator	13.8
12- 5-74	Charge Operator	19.7

Table 4 (Continued)

Sample Date	Sample Location	VC Concentration ppm
12- 5-74	Charge Operator	4.7
12- 5-74	Charge Operator	12.5
12- 5-74	Charge Operator	14.0
12- 6-74	Charge Operator	31.1
12- 6-74	Charge Operator	33.7
12- 6-74	Charge Operator	13.3
12- 6-74	Charge Operator	9.6
12- 6-74	Charge Operator	11.8
12- 4-74	Blowdown Operator	12.8
12- 4-74	Blowdown Operator	5.7
12- 4-74	Blowdown Operator	20.0
12- 5-74	Blowdown Operator	5.9
12- 5-74	Blowdown Operator	5.3
12- 5-74	Blowdown Operator	8.1
12- 5-74	Blowdown Operator	11.4
12- 4-74	Relief Operator	5.5
12- 4-74	Relief Operator	160.6
12- 4-74	Relief Operator	114.3
12- 6-74	Relief Operator	5.6
12- 6-74	Relief Operator	6.2
12- 5-74	OVA Operator	12.8
12- 5-74	OVA Operator	4.2
12- 5-74	OVA Operator	6.5
12- 5-74	OVA Operator	5.5

Table 4 (Continued)

Sample Date	Sample Location	VC Concentration ppm
12- 4-74	Helper	8.8
12- 4-74	Helper	33.4
12- 4-74	Helper	16.3
12- 4-74	Helper	7.6
12- 4-74	Helper	30.3
12- 4-74	Helper	11.4
12- 5-74	Helper	12.8
12- 5-74	Helper	6.2
12- 5-74	Helper	6.4
12- 5-74	Helper	11.9
12- 5-74	Helper	13.1
12- 5-74	Helper	1.8
12- 5-74	Helper	18.3
12- 5-74	Helper	21.2
12- 5-74	Helper	13.8
12- 5-74	Helper	28.3
12- 5-74	Helper	8.1
12- 5-74	Helper	15.7
12- 5-74	Helper	27.0
12- 5-74	Helper	9.8
12- 5-74	Helper	11.2
12- 5-74	Helper	5.8
12- 5-74	Helper	5.8

Table 4 (Continued)

Sample Date	Sample Location	VC Concentration ppm
12- 5-74	Helper	5.9
12- 5-74	Helper	1.3
12- 5-74	Helper	12.1
12- 5-74	Helper	17.3
12- 5-74	Helper	18.3
12- 6-74	Helper	160.5
12- 6-74	Helper	13.6
12- 6-74	Helper	57.8
12- 6-74	Helper	10.9
12- 6-74	Helper	7.7
12- 6-74	Helper	51.3
12- 6-74	Helper	4.9
12- 6-74	Helper	10.3
12- 6-74	Helper	9.5
12- 6-74	Helper	8.7

Table 5

Vinyl Chloride Sample Results - Suspension Resin Area - Building 464
B.F. Goodrich - Avon Lake, Ohio

Sample Date	Sample Location	VC Concentration ppm
12- 9-74	Control Room	1.1
12- 9-74	Control Room	1.4
12- 9-74	Control Room	1.6
12-10-74	Control Room	0.1
12-10-74	Control Room	0.1
12-10-74	Control Room	0.1
12- 9-74	Charge Operator	9.8
12- 9-74	Charge Operator	2.7
12- 9-74	Charge Operator	2.8
12- 9-74	Charge Operator	4.1
12- 9-74	Charge Operator	5.4
12- 9-74	Charge Operator	5.7
12-10-74	Charge Operator	0.8
12-10-74	Charge Operator	1.1
12-10-74	Charge Operator	0.8
12-10-74	Charge Operator	0.8
12-10-74	Charge Operator	1.1
12-10-74	Charge Operator	1.2
12- 9-74	Blowdown Operator	2.6
12- 9-74	Blowdown Operator	4.5

Table 5 (Continued)

Sample Date	Sample Location	VC Concentration ppm
12- 9-74	Blowdown Operator	5.9
12-10-74	Blowdown Operator	2.1
12-10-74	Blowdown Operator	1.3
12-10-74	Blowdown Operator	7.2
12- 9-74	Relief Operator	6.9
12- 9-74	Relief Operator	4.3
12- 9-74	Relief Operator	6.8
12-10-74	Relief Operator	0.8
12-10-74	Relief Operator	1.3
12-10-74	Relief Operator	6.4
12- 9-74	Recovery Operator	7.8
12- 9-74	Recovery Operator	19.8
12- 9-74	Recovery Operator	78.6
12-10-74	Recovery Operator	4.1
12-10-74	Recovery Operator	2.3
12-10-74	Recovery Operator	13.3
12- 9-74	HRC Operator	4.4
12- 9-74	HRC Operator	55.1
12- 9-74	HRC Operator	3.6
12-10-74	HRC Operator	14.4
12-10-74	HRC Operator	2.8
12-1-74	HRC Operator	2.8

Table 6

Vinyl Chloride Sample Results - Miscellaneous Jobs
B.F. Goodrich - Avon Lake, Ohio

Sample Date	Sample Location	VC Concentration ppm
12-11-74	VC Tank Car Disconnecting	2.8
12-11-74	VC Tank Car Disconnecting	1.4
12-11-74	PVC Bulk Car Loading	1.0
12-11-74	PVC Bulk Car Loading	1.2

Table 7

Emulsion Resin area vinyl chloride sampling summary

B.F. Goodrich - Avon Lake, Ohio

Location or Job Title	No. of Samples	Mean VC Concentration ppm (TWA)	Standard Deviation-ppm
Building 451 - Control Room	7	2.9	1.7
Building 451 - Operator's Desk	6	7.2	5.2
Building 451 - Charge Operator	13	5.8	1.0
Building 451 - Recovery Operator	8	10.5	10.2
Building 451 - Blowdown Operator	8	22.7	31.6
Building 451 - OVA Operator	1	1.4	---
Building 451 - Helper	24	17.3	22.9

Table 8

Suspension Resin Area - Vinyl Chloride Sampling Summary
B.F. Goodrich - Avon Lake, Ohio

Location or Job Title	No. of Samples	Mean VC Concentration ppm (TWA)	Standard Deviation-ppm
Building 452 - Spray Drier Operator	11	3.7	3.2
Building 452 - Vent Operator	2	1.3	0.1
Building 452 - Rodney Hunt Operator	7	3.1	1.3
Building 452 - Transfer Operator	5	4.0	1.7
Building 452 - Helper	9	1.7	1.2
Building 452 - Bagger	10	2.5	1.2
Building 455 - Dryer Operator	6	6.8	7.5
Building 461 - Control Room	9	6.2	3.7
Building 461 - Charge Operator	19	14.3	7.4
Building 461 - Blowdown Operator	7	9.9	5.3
Building 461 - Relief Operator	5	58.4	74.0
Building 461 - OVA Operator	4	7.3	3.8
Building 461 - Helper	38	18.8	26.5
Building 464 - Control Room	6	0.7	0.7
Building 464 - Charge Operator	12	3.0	2.8
Building 464 - Blowdown Operator	6	3.9	2.3
Building 464 - Relief Operator	6	4.4	2.8

Table 8 (Cont'd)

Suspension Resin Area - Vinyl Chloride Sampling Summary

Location or Job Title	No. of Samples	Mean VC Concentration ppm (TWA)	Standard Deviation-ppm
Building 464 - Recovery Operator	6	21.0	28.9
Building 464 - HRC Operator	6	13.8	20.7
VC Tank Car Disconnecting	2	2.1	1.0
PVC Bulk Car Loading	2	1.1	0.1