APPENDIX

1. Department of Labor, Occupational Safety and Health Administration: Exposure to Vinyl Chloride, *Federal Register,* Volume 39, No. 194, pp. 35890-35898, Friday, October 4, 1974.

2. Vendors' Publications on Analytical Instruments:
   - Century Systems Corporation, Portable Organic Vapor Analyzer, Model OVA-98.
   - Analytical Instrument Development, Inc., Portable Flame Photometric Gas Chromatograph, Model 511.
   - Mine Safety Appliances Company, Model S Monitaire Sampler.

3. Methods of Analysis for Determining Vinyl Chloride in Air and in Resin:
   - Vinyl Chloride, Determination in Air by Gas Chromatography.
   - Vinyl Chloride, Determination in Air by Adsorption on Activated Charcoal and Analysis by Gas Chromatography.
   - Determination of Residual Vinyl Chloride Monomer in Vinyl Resins.
   - Dust, Determination of Total and Respirable Airborne Dust by Membrane Filter Sampling and Gravimetric Analysis.

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PART II

DEPARTMENT OF LABOR

Occupational Safety And Health Administration

■

EXPOSURE TO VINYL CHLORIDE

Occupational Safety and Health Standards

Title 29—Labor

CHAPTER XVII—OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION, DEPARTMENT OF LABOR

PART 1910—OCCUPATIONAL SAFETY AND HEALTH STANDARDS

Standard for Exposure to Vinyl Chloride

Pursuant to sections 6(b), 6(c), and 8(c) of the Occupational Safety and Health Act of 1970 (84 Stat. 1593, 1596, 1599; 29 U.S.C. 655, 657) Secretary of Labor's Order No. 12-71 (36 FR 8754) and 29 CFR Part 1911, § 1910.93 of Part 1910 of Title 29, Code of Federal Regulations is hereby amended in the manner set forth below, in order to provide an Occupational Safety and Health standard dealing with the exposure of employees to vinyl chloride.

I. *Background*—(1) *Vinyl chloride.* Vinyl chloride (chloroethene), Chemical Abstracts Service Registry No. 75014, is a synthetic organic chemical made from ethylene or acetylene and chlorine by any of several processes. It is the parent compound of a series of thermoplastic resin polymers and copolymers which are widely used for containers, wrapping film, electrical insulation, pipe, conduit, and a variety of other industrial and consumer products. Vinyl chloride has been made commercially in this country since 1939, and present production is in excess of seven billion pounds per year. The vinyl chloride industry divides into three segments: monomer production, polymer production, and fabrication. Production of the monomer is a large-scale continuous process, involving only a few firms. There are comparatively few employees in this segment of the industry, because the processes lend themselves to automation.

Vinyl chloride (VC) is used primarily in the production of polyvinyl chloride (PVC), a resin which is produced through batch processing. The conversion of the VC monomer into a polymer or copolymer is an incomplete process, i.e., not all of the monomer is reacted.

PVC is fabricated by a variety of techniques, including extrusion, injection molding and calendering, to form a finished product that needs no further chemical handling. The vast majority of employees involved in the VC industry are employed by fabrication firms. Such firms range in size from those with few employees and simple equipment to large plants involving many employees and considerable capital.

Vinyl chloride (VC), a gas at ambient temperature and pressure, is a chlorinated hydrocarbon, which heretofore has been regarded as having moderate liver toxicity. The initial standard, contained in Table G-1 of 1910.93, established a ceiling value of 500 parts of VC per million parts of air.

(2) *The emergency temporary standard.* On January 22, 1974, the Occupational Safety and Health Administration (OSHA) was informed by the National Institute for Occupational Safety and Health (NIOSH) that the B. F. Goodrich Chemical Company had reported that deaths of several of its employees from a rare liver cancer (angiosarcoma) may have been occupationally related. As a result of this notification and after consultation with NIOSH, and a joint inspection of the B. F. Goodrich plant by OSHA, NIOSH and the Kentucky Department of Labor, a fact-finding hearing was announced on January 30, 1974 (30 FR 3874) and held on February 15, 1974.

Information obtained from this hearing, particularly the preliminary reports of experiments conducted by Professor Cesare Maltoni of the Instituto di Oncologia, Bologna, Italy, demonstrated that vinyl chloride induced angiosarcoma in rats at levels as low as 250 ppm, and in other species at higher levels. Experiments performed at lower levels of exposure were not completed at that time. Other testimony from medical witnesses and NIOSH, and the results of autopsies, led to the conclusion that the Goodrich workers had angiosarcoma of the liver and that VC probably was the causal agent in the angiosarcomas observed.

In post hearing comments, additional angiosarcoma deaths were reported among workers who had been exposed to VC in plants operated by Union Carbide Corporation, Firestone Plastics Corporation and Goodyear Tire & Rubber Company.

On the basis of all information available at that time, and the fact that employees were being exposed at levels around the experimentally observed effect level of 250 ppm, an emergency temporary standard (ETS) was promulgated on April 5, 1974 (39 FR 12341) pursuant to section 6(c) of the Act, as 29 CFR 1910.93q.

This standard reduced the permissible exposure level from a ceiling of 500 ppm to a 50 ppm ceiling, and established other requirements, including, for example, monitoring and respiratory protection. It was expressly recognized that this standard limiting exposures to a 50 ppm ceiling was a tentative, interim standard, and that the whole question of exposure to VC would be considered more fully in the light of additional information, especially the results of experiments which were known to be underway at that time.

On April 15, 1974, information and data were presented to representatives of OSHA, NIOSH, and the Environmental Protection Agency by the Industrial Bio-Test Laboratories, Northbrook, Illinois, concerning results of animal exposure studies with VC. These studies were sponsored by the Manufacturing Chemists Association. Although only preliminary in nature at that time, these results revealed that 2 out of 200 mice exposed to VC concentrations of 50 ppm for 7 hours a day, five days a week, for approximately 7 months, had developed angiosarcoma of the liver.

(3) *The proposed permanent standard.* Based on the demonstrated evidence of VC's carcinogenicity in three animal species (rats, mice and hamsters), and the substantial probability that VC had been the causal agent in the cases of liver angiosarcoma found in workers both here and abroad, OSHA proposed to revise 1910.93q and published a comprehensive proposal (39 FR 16896) on May 10, 1974, to protect employees from hazards of exposure to VC. The proposal called for limitation of employee exposure to VC to "no detectable level," as measured by a sampling and analytical method sensitive to 1 ppm, with an accuracy of 1 ppm ±50 percent. The proposal also called for the establishment of regulated areas and limited access to such areas to authorized persons. A requirement for monitoring of employee exposures was proposed, along with engineering and work practice controls to be implemented when exposures over the detectable limit were measured.

Respiratory protection would have been required while engineering and work practice controls were being implemented or where exposures exceeded the permissible limit even after feasible engineering controls were instituted.

In addition, the proposed standard included requirements for medical surveillance, protective clothing, emergency procedures, training, specific protection during maintenance and decontamination operations, transportation loading and unloading operations and recordkeeping.

(4) *Hearing on the proposal.* The proposal, as published on May 10, 1974, allowed 30 days for interested parties to submit written comments and to request an informal rulemaking hearing. Informal contacts with OSHA staff and early responses indicated that the subject was of great interest and importance to many persons. Because of the limited time available before expiration of the six month period provided in section 6(c)(3) of the Act for promulgation of a final standard, it was decided to hold a hearing as soon as possible. Accordingly, on May 24, 1974, a notice of a hearing was published (39 FR 18303), setting a hearing date of June 25, 1974. The hearing was conducted from June 25 through June 28, and again from July 8, through July 11, before Administrative Law Judge Gordon J. Myatt. All participants were given the opportunity to present testimony and to cross-examine other witnesses. Persons participating in the hearing were given until August 23, 1974, to file additional posthearing comments, including various items of information which were requested during the examination of witnesses.

(5) *Economic and technical impact study.* During the hearing, OSHA determined that additional facts would be needed to determine the practicality of certain aspects of the proposed standard. Accordingly, OSHA contacted an independent consultant, Foster D. Snell Corporation, to conduct studies of the feasibility of compliance at various exposure levels, including those proposed by OSHA and others advanced by industry spokesmen. Snell was also commissioned to collect information regarding the economic costs of compliance. This action was announced at the close of the hearing, and Judge Myatt further announced that the record would be kept

open for a period [illegible] 39, to allow interested persons to submit comment in writing on the study. On August 26, 1974, OSHA announced that the preliminary study was available and that comments were to be submitted no later than September 6, 1974 (39 FR 30844). On September 13, 1974, OSHA invited comments on both the preliminary and the final study, which was to be received on or before September 25, 1974 (39 FR 33009).

(6) *Environmental impact statements.* A notice of intent to file an environmental impact statement assessing the impact of a proposed standard on occupational exposure to VC was published in the FEDERAL REGISTER on April 24, 1974 (39 FR 14522). The notice invited any person having information or data on the environmental impact to submit it to OSHA by May 17, 1974. On June 12, 1974, a draft environmental impact statement was prepared and circulated to all interested persons. Ten copies were forwarded to the Council of Environmental Quality (CEQ), which published a notice of its filing and availability in the FEDERAL REGISTER on June 25, 1974 (39 FR 22975). A 45 day period was allowed for the submission of comments on the draft statement. On September 5, 1974, the final environmental impact statement was prepared and a copy of it and all substantive comments were sent to appropriate governmental agencies, private organizations, and other interested persons. CEQ published a notice of availability for the final statement on September 6, 1974 (39 FR 32350). The submission of comment was invited until September 25, 1974. The final statement and all significant comments have been carefully considered in arriving at the final standard on occupational exposure to VC.

(7) *The record.* The record in this proceeding is one of the most exhaustive ever relied upon by OSHA. It consists of pre and post-hearing comments and testimony received at both factfinding and rulemaking hearings, the studies and inspections conducted by OSHA personnel, the environmental impact statements, the economic and technical impact studies, and all other relevant information. In all, over 600 written comments have been received, with more than 200 separate oral and written submissions made with regard to the two hearings. The record itself exceeds 4,000 pages. Employers, employees, labor unions, public health groups, independent experts, physicians, research scientists, and specialists in many fields have been invited to submit information and have made their views, knowledge and experience available to OSHA. The entire record encompassing these submissions was thoroughly reviewed and evaluated in reaching the determinations set forth below.

II. *Findings regarding carcinogenicity, exposure levels and feasibility*—(1) *Carcinogenicity of vinyl chloride.* The carcinogenicity of vinyl chloride for three animal species (rat, mouse, hamster) has been documented on the record by the studies of Maltoni and Bio-Test Laboratories. Moreover, Maltoni's investigations have demonstrated a dose-dependent relationship for induction of tumors (i.e., more tumors occur at higher exposure levels), including angiosarcoma of the liver, in rats. The investigations of Industrial Bio-Test Laboratories have demonstrated a similar relationship for both rats and mice. These investigators have induced angiosarcoma of the liver in rats and mice at exposure concentrations of 50 ppm, and in hamsters at higher concentrations of exposure. Additional tumors involving other organs, including the kidneys, lungs, and skin of exposed animals, were also observed in frequencies much in excess of control animals. The incidence of tumors in mice in the Industrial Bio-Test Laboratories investigations is particularly pertinent. Of 200 mice (100 males, 100 females) exposed to 50 ppm of vinyl chloride by inhalation for eleven months, 100 died. Sixty-four animals died without gross postmortem pathologic examination being performed. Of the 36 remaining animals for which a gross postmortem pathologic examination was performed, 13 (36 percent) were found with liver tumors (including angiosarcomas), 21 (58 percent) with lung tumors, 9 (25 percent) with skin tumors, and one with a kidney tumor.

According to the 1970 report by the Surgeon General's Ad-Hoc Committee on the Evaluation of Low Levels of Environmental Chemical Carcinogens, the finding of cancer in two or more animal species may be extrapolated to indicate a carcinogenic hazard to humans. Here, such a finding was made in three species that were exposed to VC by inhalation—a route comparable to employee exposure. In addition, there were at least 13 confirmed cases of angiosarcoma of the liver among employees exposed to VC, a particularly significant number in view of the extreme rarity of this cancer in the U.S. adult male population (testimony of Dr. Marcus Key, Director of NIOSH, at the rulemaking hearing).

The findings of angiosarcoma of the liver in both experimental animals and exposed employees is compelling evidence that exposure of humans to vinyl chloride induces this tumor. Industry spokesmen, at the hearing, conceded that VC is carcinogenic for humans (e.g. testimony of Dr. McBurney, Rulemaking hearing, 1041). Accordingly, it is concluded that VC must be regarded as a human carcinogen, and the probable causal agent of angiosarcoma of the liver, and that exposure of employees to VC must be controlled.

Additional evidence of tumor induction in a variety of other organs, including lung, kidney, brain and skin, as well as non-malignant alterations, such as fibrosis and connective tissue deterioration, indicates additional oncogenic and toxicologic properties of vinyl chloride, which must be considered in establishing control regulations. (See testimony and results of studies by Bio-Test Laboratories, Tabershaw-Cooper, Maltoni, NIOSH, and Selikoff.)

(2) *Exposure limits.* Upon finding that exposure of employees to vinyl chloride may create a carcinogenic hazard, the amount of exposure which is hazardous must be determined. The Surgeon General's Ad Hoc Committee referred to above concluded that safe exposure levels for carcinogenic substances cannot be scientifically determined. This position is supported by the testimony of NIOSH at the hearing, its recommendations for a standard of no detectable level, and by the testimony of expert witnesses from the National Cancer Institute.

Several witnesses and persons who submitted comments have taken a contrary view and have suggested that man is less sensitive to biologic aberrations induced by vinyl chloride exposure than experimental animals. Proponents of this position have argued that if humans were as sensitive as rodents, an "epidemic" of cancer resulting from VC exposures should have already been discovered among employees. They also argue that the employees in whom tumors have been observed are those who have considerable employment experience as polymerization reactor cleaners. Because it is generally agreed that reactor cleaning involved high exposures to vinyl chloride in years past, it is argued that the lower levels currently found in the workplace have not induced cancer and are therefore safe. We reject this argument.

The fact that approximately three-quarters of those employees with the longest exposure to VC (greater than 20 years since initial exposure) have not yet been located, makes it impossible to determine the actual number of affected employees. The cases of liver tumors observed to date have an average latency period, since initial exposure, of approximately 20 years. If it is assumed that induction of angiosarcoma is a dose-related phenomenon, and if employees engaged in cleaning reactors did, in fact, receive larger doses of vinyl chloride, it would be expected that such tumors would be observed earlier for this employee population. For this reason, the significance of presumed lower doses cannot be accurately assessed until a longer period of time has passed, as a longer induction period would be expected.

Initiation of exposure to chemical carcinogens and induction of cancer are not necessarily synchronous events. Because of the physiologic complexities involved with carcinogenesis, induction of tumors does not occur in all employees with similar exposure histories. For example, Dr. Schneiderman of the National Cancer Institute emphasized during his testimony that only about a fifth of longer-term heavy smokers develop lung cancer. Accordingly, the industry contention that exposure levels have been dramatically reduced since the 1940's is not reliable evidence that current levels of exposure are safe.

Some industry spokesmen also suggested that the apparent nonrandom distribution of observed cancer in employees may indicate an exposure threshold for tumor induction, based on variations in the workplace design or practice and resultant employee exposures

(testimony and questioning by Tenneco Chemicals, Inc.). It has also been emphasized that in only 3 of 8 polymerization plants where employees have been exposed to VC *for* more than 20 years have any employees dereloped angiosarcoma of the liver. This argument is very similar to that raised concerning variability of past employee exposure. Although geographic and workpractice differences may ultimately be demonstrated to be factors in distribution of angiosarcoma, sufficient information is unavailable to exclude from consideration of risk those employees in workplaces for which cases of angiosarcoma have not been observed.

It has also been suggested that the absence of cancer in a population of 335 Dow Chemical Company polymerization employees monitored over a period of 7 years, indicates that exposure to vinyl chloride at concentrations of less than 200 ppm is safe. (See study by Dr. Cook, submitted at the hearing by Dow Chemical Company.) However, the group surveyed did not include all workers who had been exposed, and the missing employees included many who had the longer term (over 20 years) exposures. Moreover, the statistically insignificant size of the sample population decreases the possibility that tumors would be observed.

Dow also presented preliminary data in testimony at the hearing on the possible metabolic pathways of VC. The hypothesis presented was that VC may exert its carcinogenic effect by a metabolite, and that the metabolite is produced only when VC is metabolized by a secondary metabolic pathway operating only when enzymes regulating the primary pathway are saturated, as would be the result at higher exposures. The preliminary data indicated the possibility of an additional pathway for metabolism of VC in rats exposed to concentrations of VC in excess of 220 ppm. However, the occurrence of angiosarcoma in both rats and mice at VC exposure concentrations of 50 ppm indicates that if a metabolite of VC is the ultimate carcinogen, then it must be generated at lower exposure concentrations in these species. Although this research may be helpful to the thorough understanding of the carcinogenicity of VC, it appears that it does not yet offer evidence which can assist in determination of safe exposure concentrations for employees, or even that such safe exposures exist.

A number of witnesses representing employers have stressed that there is no evidence of cancer, either in employees or experimental animals, at exposure concentrations of VC less than 50 ppm. (See e.g., testimony of Firestone, Tenneco Chemicals.) The conclusion of these witnesses was that no decision can be made concerning risk of exposure to VC at concentrations less than 50 ppm.

On the other hand, the testimony of most expert witnesses, including some industry biomedical experts, stated that quantification of a safe exposure concentration is not possible with the present state of scientific knowledge. (See e.g., testimony of Selikoff, Firestone, NCI, and NIOSH.)

In our view, the demonstration of cancer induction in humans at a particular level is not a prerequisite to a determination that a substance represents a cancer hazard for humans at that level. It would be imprudent to assume man to be less sensitive to VC exposure than experimental animals in the absence of conclusive evidence. It would also be unfounded to assume that animals will not develop tumors when exposed at concentrations of VC of less than 50 ppm. Should a sufficiently large number of experimental animals be exposed to VC at concentrations of less than 50 ppm, Schneiderman said that it would be expected that some would develop VC induced tumors.

(3) *Feasibility.* There is virtually no dispute that most, if not all, fabricators are currently capable of reaching exposure levels of 1 ppm through engineering controls. These employers employ well over 95 percent of all employees exposed to VC. Indeed, several fabricators are already operating at this level (see SPI testimony). However, industry spokesmen have universally claimed that it is infeasible for the VC and the PVC industries to remain below 1 ppm consistently, using engineering controls. In addition, the Snell study on technical feasibility concluded that a 1 ppm ceiling is not feasible for the VC and PVC industries with present technology, but that the VC industry could currently attain lower exposure levels than the PVC industry. Labor union spokesmen and the Health Research Group, Inc., however, have suggested that such a level is attainable.

Since there is no actual evidence that any of the VC or PVC manufacturers have already attained a 1 ppm level or in fact instituted all available engineering and work practice controls, any estimate as to the lowest feasible level attainable must necessarily involve subjective judgment. Likewise, the projections of industry, labor, and others concerning feasibility are essentially conjectural. Indeed, as Firestone has suggested, it is not possible to accurately predict the degree of improvement to be obtained from engineering changes until such changes are actually implemented.

We agree that the PVC and VC establishments will not be able to attain a 1 ppm TWA level for all job classifications in the near future. We do believe, however, that they will, in time, be able to attain levels of 1 ppm TWA for most job classifications most of the time. It is apparent that reaching such levels may require some new technology and work practices. It may also be necessary to utilize technology presently used in other industries. In any event, the VC and PVC industries have already made great strides in reducing exposure levels. (See testimony of Dow Chemical Co., TR 973). For example, B. F. Goodrich testified (TR 1120) that it has reduced average exposure levels in several PVC plants from 35–40 ppm early this year to 12–13 ppm at the time of the hearing. We are confident that industry will continue to do so.

(4) *Conclusions.* The conclusions below are based on a thorough review and evaluation of all the evidence submitted. Where decisions can be based on record evidence, this has been done. Where, however, factual certainties are lacking or where the facts alone do not provide an answer, policy judgments have been made.

There is little dispute that VC is carcinogenic to man and we so conclude. However, the precise level of exposure which poses a hazard and the question of whether a "safe" exposure level exists, cannot be definitively answered on the record. Nor is it clear to what extent exposures can be feasibly reduced. We cannot wait until indisputable answers to these questions are available, because lives of employees are at stake. Therefore, we have had to exercise our best judgment on the basis of the best available evidence. These judgments have required a balancing process, in which the overriding consideration has been the protection of employees, even those who may have regular exposures to VC throughout their working lives.

Based on the available evidence and in view of the above considerations, including feasibility, we believe that employee exposures to VC must be reduced to a 1 ppm time-weighted average (TWA). We also believe that PVC and VC establishments will, in time, be able to attain that level through engineering controls, and that fabricators can do so in the immediate future.

In addition to the TWA requirement, we have established a 5 ppm ceiling (averaged over a 15-minute period) in order to prevent exposure of employees to unacceptable high excursions. From an operation standpoint, this ceiling level is realistic because minor excursions up to the ceiling level are likely to occur on a regular basis.

III. *The final standard*—(1) *Scope and application.* Both the ETS and the proposal would apply the standard to the entire VC industry, including manufacturers of VC and PVC and fabricators, but excluding employers handling or using fabricated products made from VC.

There is no dispute that a standard is required for the monomer and polymer industries. However, the Society of Plastics Industry (SPI) and various fabricators (see testimony of Goodyear, General Cable, etc.) recommended that fabricators be excluded from the standard, or that a separate requirement be established for them because many of them were already at or below the proposed ceiling level.

The record evidence establishes that at least some employees in the fabricating industry are exposed in excess of the permissible control limits (See NIOSH testimony, TR 106; Robintech TR 642). In these circumstances, we believe that it is imprudent to grant a blanket exemption for all fabricators. Therefore, the final standard is applicable to the fabrication industry, as well as the monomer

and polymer industries. Employers who, in fact, are substantially below the exposure limit will be subjected to only minimal burdens by virtue of the "action level" to be discussed below.

Where employers in the fabricating industry have exposures approaching the permissible limit, they will appropriately be subject to the standard. Employers handling or using fabricated products made of PVC were not included in the ETS or the proposal and are excluded from the final standard. This conclusion is based on the absence of adequate evidence of exposure to VC in these operations. The final standard clarifies the exemption by defining a fabricated product as a product made wholly or partly from PVC which does not require further processing at temperatures, and for times, sufficient to cause mass melting of the PVC. SPI and others (cf. TR. 344) requested that PVC resins with less than 0.1 percent residual monomer be exempted from the regulation now, and that the exemption level be reduced to 0.01 percent in three years. SPI suggested that the exemption of materials with less than 0.1 percent of 14 carcinogens from 29 CFR 1910.93p (39 FR 3756) was an appropriate precedent. The cases are not comparable, because no attempt had been made to set air concentration limits for the 14 carcinogens. The record did not include information that reliable monitoring and measuring techniques were available. Moreover, the exemption did not exempt airborne traces of carcinogens. The administrative cutoff was provided to avoid regulation of materials about which there was no health hazard information, and which would have broadly extended the application of the regulation beyond the record. Herein, no information was presented to show safe concentration results from the use of resins with specific levels. Indeed, the proposal to change the level later, when improved technology would permit such reduction, would seem to indicate that SPI has doubts about the safety of 0.1 percent residue level. Diamond Shamrock (Exhibit 142) testified that there is no direct relation. They indicate that the airborne concentration is more related to the physical form of the resin and the ventilation provided. Also, monitoring data from industry (cf. Exhibits 131, 168, 170) and OSHA (Exhibit 151) indicate that levels in excess of 1 ppm may be found in fabrication operations. In view of these facts and of the opportunity for employers to discontinue many duties upon a showing of no exposures above the action level, it does not appear that any residue exemption is either justified or necessary at this time. This course also agrees with a number of industry proposals (cf. TR 660).

SPI (TR 345), among others, asked that compounded PVC pellets be exempted from the standard on the grounds that the pellets had too low a residue to cause harmful or measurable emissions. While it appears that PVC pellets would have a lower residue level than virgin PVC, the fact that the pellets must be heated to a molten mass at the same temperature as PVC, for further processing, indicates that a potential for release of the residue still exists. It appears that the exemption of fabricated products should be limited to just those items which will not undergo such mass heating. Further, the opportunity to demonstrate that exposures are below the action level, and thus, discontinue many duties of the standard, provides a more positive control and an adequate relief.

(2) *Permissible exposure limit.* The standard sets an exposure limit of 1 ppm averaged over any 8 hour period, and a ceiling of 5 ppm averaged over any period not exceeding 15 minutes.

As more fully discussed above, this limit is based on an evaluation of the best available evidence and on a judgment that the health and safety of employees must be protected to the fullest extent feasible. In view of the fact that release of VC in the VC and PVC manufacturing processes are variable, the 1 ppm ceiling level provided in the proposal would require maintenance of an average level significantly more difficult to attain through feasible engineering controls. Therefore, the exposure limit prescribed in the proposal has been rejected.

(3) *Action level.* The final standard, unlike the ETS and the proposal, provides for an "action level" of 0.5 ppm TWA, one-half of the permissible exposure limit. The purpose of the action level is to minimize the impact of the standard on the employers who have attained exposure levels well below the permissible limit. Thus, where the results of monitoring under paragraphs (d)(1) or (d)(2) demonstrate that no employee is exposed in excess of 0.5 ppm TWA, employers may, in effect, be exempted from some provisions of the standard. For example, fabricators who are below the action level are not required to provide medical surveillance or to monitor again, unless the employer has reason to suspect that any employee is exposed in excess of the action level. In our judgment, exposures below the action level do not present a sufficient hazard to warrant application of the entire standard to the many employers who are or will be below that level.

(4) *Monitoring.* The final standard, like the proposal, requires that individual employee exposure levels be determined. This may be accomplished by personal or area monitoring. Some witnesses and persons who submitted comments did not understand the meaning of the term "95 percent confidence level" in the proposal. Essentially it means that the employer is required to take a sufficient number of measurements so that the results obtained are statistically valid. We have modified the proposal to establish accuracy range requirements for various measurement levels. These ranges are narrow enough to ensure that a determination of compliance can be made, and broad enough to allow the application of a variety of technologies

All covered employers are required to conduct initial monitoring. Where monitoring and measuring results are at or below the action level, no further monitoring is required unless the employer has reason to suspect that any employee is exposed in excess of the action level, or unless changes have been made in production; process, control, type of resin, etc.

Where the exposure level, without regard to respirators, exceeds the permissible levels, monitoring must be conducted at least monthly. Where exposures are less than the permissible levels, but greater than the action level, monitoring must occur at least quarterly.

(5) *Methods of compliance.* The standard, like the proposal, requires that employers immediately institute feasible engineering and work practice controls to reduce exposures to at or below the permissible exposure limit.

Where feasible engineering and work practice controls will reduce exposures below the permissible levels, they must be instituted. Where such controls will not reduce exposures below the permissible level, they must nonetheless be implemented to reduce exposures to the lowest practicable level, and be supplemented by the use of respirators to provide the necessary protection. Thereupon, a continuing program of engineering and work practice controls must be instituted to reduce exposures to the lowest practicable level. When exposures are at or below the permissible exposure limits, the program may be discontinued.

In addition, a plan for achieving control by engineering and work practice methods must be drawn up and be made available, upon request, to representatives of OSHA and NIOSH.

We recognize that many employers covered by the standard can not currently achieve compliance with the permissible exposure limit solely by the use of feasible engineering and work practice controls. The record also reflects broad generic distinctions between the compliance capabilities of the VC and PVC industries. Some industry spokesmen, including SPI (TR. 358–362), recommended that a schedule of different permissile exposure limits and compliance dates be established for the VC and PVC segments of the industry.

This view assumes that the ability and the time required to feasibly reach increasingly lower control levels is similar within each industry, but differs markedly between industries. While the record does suggest that such differences do exist between industries, as noted above, it is clear that intra-industry differences also exist. Thus, the ability and time required by each employer to attain lower control levels may depend upon such factors as the climate in which the plant is located, the age of equipment, the size of reactors, or the type of resin manufactured or used. (Snell study, Firestone testimony, etc.)

Monitoring data also tends to support such intra-industry variations. (See, e.g. Dow, Firestone, Tenneco.)

As noted above, the standard requires all employers to institute feasible engineering controls to the fullest extent and to continue to improve and apply engi-

...ance until full compliance is ...established any deadlines ...full compliance through engineering controls because we are presently unable to determine when it will be feasible for most establishments to reduce exposure levels to the permissible level.

We also believe that the requirement that each employer reduce airborne concentrations to the permissible level, or to the lowest level feasible as soon as practicable will provide for inter-industry and intra-industry technological differences which do exist, and will avoid the setting of separate industry standards on the basis of the general situation and conditions in each industry.

(6) *Regulated areas.* The proposed standard would have required that regulated areas be established, that access be limited to authorized employees, and that daily rosters or summaries of those entering be kept for at least 20 years. In objection to these requirements, it was asserted that such control of access was not necessary from a health standpoint. Secondly, it was claimed that these controls would interfere with operations by preventing access of needed employees or non-employees, such as contractors, truck drivers, customers and consultants.

The purpose of establishing regulated areas in the proposal was to limit the risk of exposure to as few employees as possible. This concern is still paramount, and thus the limited access feature remains. The final standard amends the proposal slightly to allow "authorized persons" to enter regulated areas. This change, it is felt, will allow operations to continue without undue interference. The final standard has also increased the length of time daily rosters must be maintained from 20 to 30 years. This change was based largely on epidemiological considerations. (See NIOSH testimony, tr. 119.)

(7) *Respiratory protection.* The final standard, like the proposal, requires the use of respirators where employee exposures exceed the permissible control level. Industry representatives made a number of objections to proposed requirements for respiratory protection. They stated that the "no detectable level" would effectively require continuous wearing of respirators in PVC and VC plants, and that this is not feasible because respirators are cumbersome, present a safety hazard, and employees would not use them.

We would agree that respirators have many drawbacks; the proposal did not contemplate them as a final solution. The record shows that the PVC industry particularly may need several years before plant environmental levels can be reduced so that respirators are necessary only occassionally. However, we cannot agree that respiratory protection should not be required simply because it is inconvenient, may require additional personnel, interferes with production, or may require extensive retraining of employees and restructuring of work practices. We have carefully considered all the objections, and have concluded that if the environmental level is not controlled to the permissible exposure limit, then employees must be afforded respiratory protection.

While exposures in excess of the permissible level do constitute a hazard, we believe that it is necessary to mitigate some of the problems associated with implementing a program of respiratory protection while employees are being fitted and trained in respirator use, and while other adjustments which may be required are implemented. Therefore, until January 1, 1976, where exposures are not in excess of a 25 ppm ceiling, each employer must provide each employee with an appropriate respirator. However, employees whose exposures do not exceed a 25 ppm ceiling, may decline to use the respirator, in which case the employer is not obligated to require its use. During this adjustment period, employees will be trained in the uses, purposes and limitations of respirators, and the hazards of exposure to vinyl chloride. Moreover, each employee will be notified in writing if he has been exposed in excess of the permissible exposure limit.

Where exposures exceed a 25 ppm ceiling, respiratory protection is mandatory in light of our judgment that much greater risks are associated with such exposures.

The provisions in the final standard regarding the selection and use of respiratory protective devices differ from those in the proposal. The descriptions of atmosphere-supplying respirators have been revised to indicate more clearly the types of devices intended, and the maximum permissible concentration level for each device. Moreover, the number of types of atmosphere-supplying devices has been increased.

At the hearing Mr. Edwin C. Hyatt, an OSHA consultant, made suggestions regarding the use of particular respiratory devices. We have concluded that his suggestions are meritorious. Therefore, the provisions for selection of atmosphere-supplying devices follow closely the recommendations contained in his testimony of SPI and B. F. Goodrich) (TR with Hyatt's suggestions. (See e.g. testimony of SPI and B. F. Goodrich) (TR 85 ff) We had originally omitted air-purifying respirators because none had been approved by NIOSH for use against VC, principally because they lacked indicators to signal the expiration of the service life of the sorbent. Hyatt and other witnesses discussed in detail the desirability of being able to use canisters or cartridge air-purifying respirators, provided a sorbent could be shown to effectively absorb vinyl chloride with an adequate service life. Recently, OSHA has received respiratory data from laboratories regarding the effectiveness of commercially available canisters and cartridges for vinyl chloride. These evaluations were conducted separately by NIOSH and by the B. F. Goodrich Company and submitted to OSHA in post-hearing comments. The results indicate that certain presently available canisters and cartridges effectively absorb vinyl chloride at relatively low concentrations. In discussions of these findings with NIOSH, it has indicated that it is willing to consider on an expedited basis the approval of air-purifying respirators for use against VC. Consequently, we have included three types of air-purifying respirators in the list of acceptable units, subject to the approval of such units by NIOSH. The maximum concentration for which each respirator may be used is based upon our evaluation of the data submitted by NIOSH and Goodrich. Because air-purifying respirators do not indicate sorbent exhaustion or breakthrough of VC, and because VC has no inherent warning properties at levels for which these devices are used, strict administrative controls will be required for their use. Such controls include a program to assure timely replacement of canisters or cartridges and an alarm system to alert employees when vinyl chloride concentrations exceed the concentrations allowed for the particular type of respirator in use.

(8) *Hazardous operations.* This is a new section within the final standard. It encompasses essentially the proposal's requirements for maintenance and decontamination but has restated them in terms of performance language to allow greater flexibility for employers to deal with such operations. The intent of the new section is to protect employees engaged in activities that present a risk of exposure to vinyl chloride in excess of the permissible levels. An example would be the cleaning of a filter where resin containing high residual monomer is trapped.

The proposal's requirement for full-body, impervious clothing has been replaced by the direction to use impervious garments suited to the particular situation and probable extent of exposure. Thus, full-body clothing is not always necessary, and is therefore not required where less protection is adequate. Since vessel entry falls within the definition of a hazardous operation, the vessel entry section of the proposal has been deleted from the final standard.

(9) *Emergency situations.* The definition of emergency has been recast in terms of an unexpected massive release. The main objection to the section on emergency situations in the proposal was that, as the term was defined, many ordinary leaks or operations resulting in a small release of vinyl chloride would be considered emergencies. This was not the intent of the proposal. The final standard has been clarified to correct this ambiguity. It should be noted that the written operational plan required by the standard need not be developed for minor excursions above the permissible exposure limit, and that such excursions need not be reported.

(10) *Signs and labels.* The thrust of the signs and labels section is to apprise employees of the cancer and fire hazards. No objections have been raised with respect to informing employees of the fire hazard. However, a number of objections were raised at the hearing and in written submissions to the requirement that the word "cancer" appear on all signs and labels. The principal argu-

ment advanced against its use was that the term "cancer" or "cancer-suspect agent" scares employees and that instead, the message should contain instructions on how to deal with the substance (TR. 347). We believe that a diluted form of warning will not suffice. We appreciate the concern of employers with the reaction of their employees. But we consider it imperative that a worker be fully informed, and that he realize the possible risks involved in his occupation. Coupled with the training requirement in the standard, we believe that the signs and labels required will adequately inform employees of the hazard. In addition, such signs will warn unauthorized personnel to keep out of regulated areas.

The proper application of most protective measures requires an amount of training and indoctrination of employees that cannot easily be conveyed on a sign or label. Also, the variety of measures that could be prescribed would result in an unwieldly or excessively detailed legend. Consequently, the required message on signs and labels will not include information on precautions, relevant symptoms, etc. The addition of suitable information by the employer would be permitted, providing it does not detract in any way from the required statement.

The requirement in the proposal for labeling containers of vinyl chloride has been amended by deleting the reference to the possible hazard of violent polymerization. Very little information was developed on this hazard during the standard-setting procedure. It does appear that this hazard is essentially under control and that the fire and carcinogenic hazards at present are the most significant. Since labeling or placarding that is in compliance with the U.S. Department of Transportation regulations (49 CFR Part 173, Subpart H) already warns of the fire hazard, only a statement concerning the carcinogenic hazard need be added to the Department of Transportation labels.

(11) *Medical surveillance.* The principal questions that have been raised regarding medical surveillance are the necessity and efficacy of requiring certain specific serum enzyme determinations (SMA–12 series) and the application of medical examination requirements to the fabrication segments of the industry where employees are exposed to lower levels of VC. The objection has also been raised that the specification of tests and procedures interferes with the application of advances in medical knowledge.

A particular difficulty in considering medical surveillance is that the most commonly discussed lesion, angiosarcoma of the liver, currently cannot be diagnosed until the victim is terminal and, usually, within months of death. Precursor physiologic alterations, which might be reversible, have not yet been directly associated with the lesion. Consequently, there are no specific diagnostic tests which can be prescribed which will determine presence or absence of this tumor at an early stage of development. However, most medical witnesses indicated that the medical tests [illegible] are currently the only ones [illegible] which are useful for medical surveillance (TR 121, Exh. 95, TR 589–591). Consequently, the specific blood tests proposed have been retained as a minimum requirement to assist the examining physician in determining fitness of potential employees for assignment to workplaces involving VC exposure. In addition, alternative medical examinations may be used where the examining physician determines that they are at least as good as those specified by the standard.

The Tabershaw-Cooper study and the various animal experiments suggest that VC may produce a wide spectrum of malignant and non-malignant disorders. The general scope of the required medical examination has, therefore, been broadened to include kidneys, skin, connective tissue, spleen, and pulmonary system, as well as the liver. No additional specific procedures or tests are required, but recommendations have been included in the Appendix to assist the examining physician. Because of the nonspecific nature of the required medical tests, it is not appropriate to prescribe timing, or type of followup tests, or to mandate withdrawal from exposure based solely on results of the tests. Instead, the employer is required to obtain a statement from the examining physician of the employee's suitability for continued exposure, when the examining physician has completed such tests as he considers appropriate. The employer is required to withdraw an employee only when this statement indicates that the employee may be at added risk from continued VC exposure.

As with monitoring, there appears to be no basis for complete exemption of the fabrication industry from the requirement for medical examination. The record does show fabricating establishments with concentrations of VC monitored considerably above the action level. In these instances, medical surveillance of affected employees will provide baseline data for future evaluation of their health, even if both monitoring and medical surveillance are discontinued because improved controls reduce concentrations below the action level. Where exposures are below the action level, the medical surveillance requirements do not generally apply.

(12) *Training.* A separate provision for employee training has been added to the final standard rather than including it within the section on emergency situations as in the proposal. The new paragraph provides for training of employees concerning the carcinogenic hazard of VC, emergency procedures, the need for monitoring and an annual review of the standard. It also provides for training of employees concerning the purpose for, proper use of, and limitations connected with respiratory protection.

(13) *Records and reports.* The provisions for recordkeeping contained in the final standard require the preparation and maintenance of essentially the same information required by the proposal. The major change from the original proposal is the maintenance [illegible] and daily roster [illegible] of authorized persons for 30 years, instead of 20 years. Additionally, the employer is required to maintain medical records for the duration of an employee's employment plus 20 years, or 30 years, whichever is longer. The original proposal called for only 20 years.

This change has been implemented because the latency period for induction of angiosarcoma ranges up to 30 years from initial exposure. Therefore, as a minimum, medical records must be maintained for at least that long. It should be noted that spokesmen for both labor and industry recommended that this change be made.

The reporting requirements are not significantly different from those in the original proposal. However, instead of the requirement for reporting incidents which result in the release of VC into areas where employees may be exposed, the final standard clarifies our original intent by stating that only emergencies must be reported. Also the requirement for filing a detailed, written report within 15 days has been deleted. It has been concluded that submission, within 24 hours, of an initial report that includes facts immediately available, would ordinarily be sufficient. However, if the OSHA Area Director requests further information relevant to the emergency, the employer will be required to furnish such information.

(14) *Deleted portions of the proposal.* The proposal contained provisions requiring that shower facilities and change rooms be provided, and that storage or consumption of food be prohibited in regulated areas. We have deleted these provisions because it is our conclusion they are no longer necessary. Showering facilities are not required because protective clothing, where required by the final standard, should protect employees from skin absorption by direct contact with VC and because there is no reliable evidence that VC vapor is absorbed through the skin. In addition, since we anticipate that most employees will not be wearing protective clothing and that employees who wear protective clothing will change such clothing infrequently, we are not requiring that change rooms be provided.

In addition, we feel that there is inadequate evidence showing that hazardous amounts of VC can be absorbed through ingestion. For this reason, the requirement prohibiting the storage or consumption of food in regulated areas has been deleted.

The proposal also contained provisions on maintentance and decontamination, transportation loading and unloading, and polymer handling operations. These requirements are not mentioned in the final standard because attention to these items is implicit in the requirement that each employer reach the permissable exposure limit or attain the lowest feasible level.

(15) *Effective date.* In order to ensure that affected employers and employees will be informed of the existence of these

provisions and that employers affected are given an opportunity to familiarize themselves and their employees with the existence of the new requirements, the effective date of the amendment to § 1910.93q will be January 1, 1975. To provide continued protection for employees until that date, the provisions currently contained in § 1910.93q are hereby promulgated, pursuant to section 6(b), 6(c) and 8(c) of the Occupational Safety and Health Act, as an occupational safety and health standard effective October 4, 1974, the amendment to § 1910.93q set out below will supersede these provisions as of January 1, 1975.

Accordingly, upon consideration of the whole record of this proceding, Part 1910 of Title 29, Code of Federal Regulations is amended, effective January 1, 1975, by revision of § 1910.93q to read as follows:

§ 1910.93q Vinyl chloride.

(a) *Scope and application.* (1) This section includes requirements for the control of employee exposure to vinyl chloride (chloroethene), Chemical Abstracts Service Registry No. 75015.

(2) This section applies to the manufacture, reaction, packaging, repackaging, storage, handling or use of vinyl chloride or polyvinyl chloride, but does not apply to the handling or use of fabricated products made of polyvinyl chloride.

(3) This section applies to the transportation of vinyl chloride or polyvinyl chloride except to the extent that the Department of Transportation may regulate the hazards covered by this section.

(b) *Definitions.* (1) "Action level" means a concentration of vinyl chloride of 0.5 ppm averaged over an 8-hour work day.

(2) "Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or his designee.

(3) "Authorized person" means any person specifically authorized by the employer whose duties require him to enter a regulated area or any person entering such an area as a designated representative of employees for the purpose of exercising an opportunity to observe monitoring and measuring procedures.

(4) "Director" means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare, or his designee.

(5) "Emergency" means any occurrence such as, but not limited to, equipment failure, or operation of a relief device which is likely to, or does, result in massive release of vinyl chloride.

(6) "Fabricated product" means a product made wholly or partly from polyvinyl chloride, and which does not require further processing at temperatures, and for times, sufficient to cause mass melting of the polyvinyl chloride resulting in the release of vinyl chloride.

(7) "Hazardous operation" means any operation, procedure, or activity where a release of either vinyl chloride liquid or gas might be expected as a consequence of the operation or because of an accident in the operation, which would result in an employee exposure in excess of the permissible exposure limit.

(8) "OSHA Area Director" means the Director for the Occupational Safety and Health Administration Area Office having jurisdiction over the geographic area in which the employer's establishment is located.

(9) "Polyvinyl chloride" means polyvinyl chloride homopolymer or copolymer before such is converted to a fabricated product.

(10) "Vinyl chloride" means vinyl chloride monomer.

(c) *Permissible exposure limit.* (1) No employee may be exposed to vinyl chloride at concentrations greater than 1 ppm averaged over any 8-hour period, and

(2) No employee may be exposed to vinyl chloride at concentrations greater than 5 ppm averaged over any period not exceeding 15 minutes.

(3) No employee may be exposed to vinyl chloride by direct contact with liquid vinyl chloride.

(d) *Monitoring.* (1) A program of initial monitoring and measurement shall be undertaken in each establishment to determine if there is any employee exposed, without regard to the use of respirators, in excess of the action level.

(2) Where a determination conducted under paragraph (d)(1) of this section shows any employee exposures, without regard to the use of respirators, in excess of the action level, a program for determining exposures for each such employee shall be established. Such a program:

(i) Shall be repeated at least monthly where any employee is exposed, without regard to the use of respirators, in excess of the permissible exposure limit.

(ii) Shall be repeated not less than quarterly where any employee is exposed, without regard to the use of respirators, in excess of the action level.

(iii) May be discontinued for any employee only when at least two consecutive monitoring determinations, made not less than 5 working days apart, show exposures for that employee at or below the action level.

(3) Whenever there has been a production, process or control change which may result in an increase in the release of vinyl chloride, or the employer has any other reason to suspect that any employee may be exposed in excess of the action level, a determination of employee exposure under paragraph (d)(1) of this section shall be performed.

(4) The method of monitoring and measurement shall have an accuracy (with a confidence level of 95 percent) of not less than plus or minus 50 percent from 0.25 through 0.5 ppm, plus or minus 35 percent from over 0.5 ppm through 1.0 ppm, and plus or minus 25 percent over 1.0 ppm. (Methods meeting these accuracy requirements are available in the "NIOSH Manual of Analytical Methods").

(5) Employees or their designated representatives shall be afforded reasonable opportunity to observe the monitoring and measuring required by this paragraph.

(e) *Regulated area.* (1) A regulated area shall be established where:

(i) Vinyl chloride or polyvinyl chloride is manufactured, reacted, repackaged, stored, handled or used; and

(ii) Vinyl chloride concentrations are in excess of the permissible exposure limit.

(2) Access to regulated areas shall be limited to authorized persons. A daily roster shall be made of authorized persons who enter.

(f) *Methods of compliance.* Employee exposures to vinyl chloride shall be controlled to at or below the permissible exposure limit provided in paragraph (c) of this section by engineering, work practice, and personal protective controls as follows:

(1) Feasible engineering and work practice controls shall immediately be used to reduce exposures to at or below the permissible exposure limit.

(2) Wherever feasible engineering and work practice controls which can be instituted immediately are not sufficient to reduce exposures to at or below the permissible exposure limit, they shall nonetheless be used to reduce exposures to the lowest practicable level, and shall be supplemented by respiratory protection in accordance with paragraph (g) of this section. A program shall be established and implemented to reduce exposures to at or below the permissible exposure limit, or to the greatest extent feasible, solely by means of engineering and work practice controls, as soon as feasible.

(3) Written plans for such a program shall be developed and furnished upon request for examination and copying to authorized representatives of the Assistant Secretary and the Director. Such plans shall be updated at least every six months.

(g) *Respiratory protection.* Where respiratory protection is required under this section:

(1) The employer shall provide a respirator which meets the requirements of this paragraph and shall assure that the employee uses such respirator, except that until December 31, 1975, wearing of respirators shall be at the discretion of each employee for exposures not in excess of 25 ppm, measured over any 15-minute period. Until December 31, 1975, each employee who chooses not to wear an appropriate respirator shall be informed at least quarterly of the hazards of vinyl chloride and the purpose, proper use, and limitations of respiratory devices.

(2) Respirators shall be selected from among those jointly approved by the Mining Enforcement and Safety Administration, Department of the Interior, and the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part 11.

(3) A respiratory protection program meeting the requirements of § 1910.134 shall be established and maintained.

(4) Selection of respirators for vinyl chloride shall be as follows:

Atmospheric concentration of vinyl chloride	Required apparatus
(i) Unknown, or above 3,600 ppm	Open-circuit, self-contained breathing apparatus, pressure demand type, with full facepiece.
(ii) Not over 3,600 ppm	(A) Combination type C supplied air respirator, pressure demand type, with full or half facepiece, and auxiliary self-contained air supply; or (B) Type C, supplied air respirator continuous flow type, with full or half facepiece, and auxiliary self-contained air supply.
(iii) Not over 100 ppm	(A) Combination type C supplied air respirator demand type, with full facepiece, and auxiliary self-contained air supply; or (B) Open-circuit self-contained breathing apparatus with full facepiece, in demand mode; or (C) Type C supplied air respirator, demand type, with full facepiece.
(iv) Not over 25 ppm	(A) A powered air-purifying respirator with hood, helmet, full or half facepiece, and a canister which provides a service life of at least 4 hours for concenrations of vinyl chloride up to 25 ppm, or (B) Gas mask, front- or back-mounted canister which provides a service life of at least 4 hours for concentrations of vinyl chloride up to 25 ppm.
(v) Not over 10 ppm	(A) Combination type C supplied-air respirator, demand type, with half facepiece, and auxiliary self-contained air supply; or (B) Type C supplied-air respirator, demand type, with half facepiece; or (C) Any chemical cartridge respirator with an organic vapor cartridge which provides a service life of at least 1 hour for concentrations of vinyl chloride up to 10 ppm.

(5) (i) Entry into unkown concentrations or concentrations greater than 36,000 ppm (lower explosive limit) may be made only for purposes of life rescue; and

(ii) Entry into concentrations of less than 36,000 ppm, but greater than 3,600 ppm may be made only for purposes of life rescue, firefighting, or securing equipment so as to prevent a greater hazard from release of vinyl chloride.

(6) Where air-purifying respirators are used:

(i) Air-purifying cannisters or cartridges shall be replaced prior to the expiration of their service life or the end of the shift in which they are first used, whichever occurs first, and

(ii) A continuous monitoring and alarm system shall be provided where concentrations of vinyl chloride could reasonably exceed the allowable concentrations for the devices in use. Such system shall be used to alert employees when vinyl chloride concentrations exceed the allowable concentrations for the devices in use.

(7) Apparatus prescribed for higher concentrations may be used for any lower concentration.

(h) *Hazardous operations.* (1) Employees engaged in hazardous operations, including entry of vessels to clean polyvinyl chloride residue from vessel walls, shall be provided and required to wear and use:

(i) Respiratory protection in accordance with paragraphs (c) and (g) of this section; and

(ii) Protective garments to prevent skin contact with liquid vinyl chloride or with polyvinyl chloride residue from vessel walls. The protective garments shall be selected for the operation and its possible exposure conditions.

(2) Protective garments shall be provided clean and dry for each use.

(i) *Emergency situations.* A written operational plan for emergency situations shall be developed for each facility storing, handling, or otherwise using vinyl chloride as a liquid or compressed gas. Appropriate portions of the plan shall be implemented in the event of an emergency. The plan shall specifically provide that:

(1) Employees engaged in hazardous operations or correcting situations of existing hazardous releases shall be equipped as required in paragraph (h) of this section;

(2) Other employees not so equipped shall evacuate the area and not return until conditions are controlled by the methods required in paragraph (f) of this section and the emergency is abated.

(j) *Training.* Each employee engaged in vinyl chloride or polyvinyl chloride operations shall be provided training in a program relating to the hazards of vinyl chloride and precautions for its safe use.

(1) The program shall include:

(i) The nature of the health hazard from chronic exposure to vinyl chloride including specifically the carcinogenic hazard;

(ii) The specific nature of operations which could result in exposure to vinyl chloride in excess of the permissible limit and necessary protective steps;

(iii) The purpose for, proper use, and limitations of respiratory protective devices;

(iv) The fire hazard and acute toxicity of vinyl chloride, and the necessary protective steps;

(v) The purpose for and a description of the monitoring program;

(vi) The purpose for, and a description of, the medical surveillance program;

(vii) Emergency procedures;

(viii) Specific information to aid the employee in recognition of conditions which may result in the release of vinyl chloride; and

(ix) A review of this standard at the employee's first training and indoctrination program, and annually thereafter.

(2) All materials relating to the program shall be provided upon request to the Assistant Secretary and the Director.

(k) *Medical surveillance.* A program of medical surveillance shall be instituted for each employee exposed, without regard to the use of respirators, to vinyl chloride in excess of the action level. The program shall provide each such employee with an opportunity for examinations and tests in accordance with this paragraph. All medical examinations and procedures shall be performed by or under the supervision of a licensed physician, and shall be provided without cost to the employee.

(1) At the time of initial assignment, or upon institution of medical surveillance;

(i) A general physical examination shall be performed, with specific attention to detecting enlargement of liver, spleen or kidneys, or dysfunction in these organs, and for abnormalities in skin, connective tissues and the pulmonary system (See Appendix A).

(ii) A medical history shall be taken, including the following topics:

(A) Alcohol intake;

(B) Past history of hepatitis;

(C) Work history and past exposure to potential hepatotoxic agents, including drugs and chemicals;

(D) Past history of blood transfusions; and

(E) Past history of hospitalizations.

(iii) A serum specimen shall be obtained and determinations made of:

(A) Total bilirubin;

(B) Alkaline phosphatase;

(C) Serum glutamic oxalacetic transaminase (SGOT);

(D) Serum glutamic pyruvic transaminase (SGPT); and

(E) Gamma glustamyl transpeptidase.

(2) Examinations provided in accordance with this paragraph shall be performed at least:

(i) Every 6 months for each employee who has been employed in vinyl chloride or polyvinyl chloride manufacturing for 10 years or longer; and

(ii) Annually for all other employees.

(3) Each employee exposed to an emergency shall be afforded appropriate medical surveillance.

(4) A statement of each employee's suitability for continued exposure to vinyl chloride including use of protective equipment and respirators, shall be obtained from the examining physician promptly after any examination. A copy of the physician's statement shall be provided each employee.

(5) If any employee's health would be materially impaired by continued exposure, such employee shall be with-

drawn from possible o... chloride.

(6) Laboratory analyses for all biological specimens included in medical examinations shall be performed in laboratories licensed under 42 CFR Part 74.

(7) If the examining physician determines that alternative medical examinations to those required by paragraph (k)(1) of this section will provide at least equal assurance of detecting medical conditions pertinent to the exposure to vinyl chloride, the employer may accept such alternative examinations as meeting the requirements of paragraph (k)(1) of this section, if the employer obtains a statement from the examining physician setting forth the alternative examinations and the rationale for substitution. This statement shall be available upon request for examination and copying to authorized representatives of the Assistant Secretary and the Director.

(l) *Signs and labels.* (1) Entrances to regulated areas shall be posted with legible signs bearing the legend:

CANCER-SUSPECT AGENT AREA AUTHORIZED PERSONNEL ONLY

(2) Areas containing hazardous operations or where an emergency currently exists shall be posted with legible signs bearing the legend:

CANCER-SUSPECT AGENT IN THIS AREA PROTECTIVE EQUIPMENT REQUIRED AUTHORIZED PERSONNEL ONLY

(3) Containers of polyvinyl chloride resin waste from reactors or other waste contaminated with vinyl chloride shall be legibly labeled:

Contaminated with
VINYL CHLORIDE CANCER-SUSPECT AGENT

(4) Containers of polyvinyl chloride shall be legibly labeled:

POLYVINYL CHLORIDE (OR TRADE NAME)
Contains
VINYL CHLORIDE
VINYL CHLORIDE IS A CANCER-SUSPECT AGENT

(5) Containers of vinyl chloride shall be legibly labeled either:

(i)

VINYL CHLORIDE
EXTREMELY FLAMMABLE GAS UNDER PRESSURE
CANCER-SUSPECT AGENT

or (ii) In accordance with 49 CFR Part 173, Subpart H, with the additional legends:

CANCER-SUSPECT AGENT

applied near the labor or placard.

(6) No statement shall appear on or near any required sign, label or instruc... ...ion or any required warning, information or instruction.

(m) *Records.* (1) All records maintained in accordance with this section shall include the name and social security number of each employee where relevant.

(2) Records of required monitoring and measuring, medical records, and authorized personnel rosters, shall be made and shall be available upon request for examination and copying to authorized representatives of the Assistant Secretary and the Director.

(i) Monitoring and measuring records shall:

(A) State the date of such monitoring and measuring and the concentrations determined and identify the instruments and methods used;

(B) Include any additional information necessary to determine individual employee exposures where such exposures are determined by means other than individual monitoring of employees; and

(C) Be maintained for not less than 30 years.

(ii) Authorized personnel rosters shall be maintained for not less than 30 years.

(iii) Medical records shall be maintained for the duration of the employment of each employee plus 20 years, or 30 years, whichever is longer.

(3) In the event that the employer ceases to do business and there is no successor to receive and retain his records for the prescribed period, these records shall be transmitted by registered mail to the Director, and each employee individually notified in writing of this transfer.

(4) Employees or their designated representatives shall be provided access to examine and copy records of required monitoring and measuring.

(5) Former employees shall be provided access to examine and copy required monitoring and measuring records reflecting their own exposures.

(6) Upon written request of any employee, a copy of the medical record of that employee shall be furnished to any physician designated by the employee.

(n) *Reports.* (1) Not later than 1 month after the establishment of a regulated area, the following information shall be reported to the OSHA Area Director. Any changes to such information shall be reported within 15 days.

(i) The address and location of each establishment which has one or more regulated areas; and

(ii) The number of employees in each regulated area during normal operations, including maintenance.

(2) Emergencies, and the facts obtainable at that time, shall be reported within 24 hours to the OSHA Area Director. Upon request of the Area Director, the employer shall submit additional information in writing relevant to the nature and extent of employee exposures and measures taken to prevent future emergencies of similar nature.

(3) Within 10 working days following any monitoring and measuring which discloses that any employee has been exposed, without regard to the use of respirators in excess of the permissible exposure limit, each such employee shall be notified in writing of the results of the exposure measurement and the steps being taken to reduce the exposure to within the permissible exposure limit.

(o) *Effective dates.* (1) Until January 1, 1975, the provisions currently set forth in § 1910.93q of this Part shall apply.

(2) Effective January 1, 1975, the provisions set forth in § 1910.93q of this Part shall apply.

APPENDIX A—SUPPLEMENTARY MEDICAL INFORMATION

When required tests under paragraph (k)(1) of this section show abnormalities, the tests should be repeated as soon as practicable, preferably within 3 to 4 weeks. If tests remain abnormal, consideration should be given to withdrawal of the employee from contact with vinyl chloride, while a more comprehensive examination is made.

Additional tests which may be useful:

A. For kidney dysfunction: urine examination for albumin, red blood cells, and exfoliative abnormal cells.

B. Pulmonary system: Forced vital capacity, Forced expiratory volume at 1 second, and chest roentgenogram (posterior-anterior, 14 x 17 inches).

C. Additional serum tests: Lactic acid dehydrogenase, lactic acid dehydrogenase isoenzyme, protein determination, and protein electrophoresis.

D. For a more comprehensive examination on repeated abnormal serum tests: Hepatitis B antigen, and liver scanning.

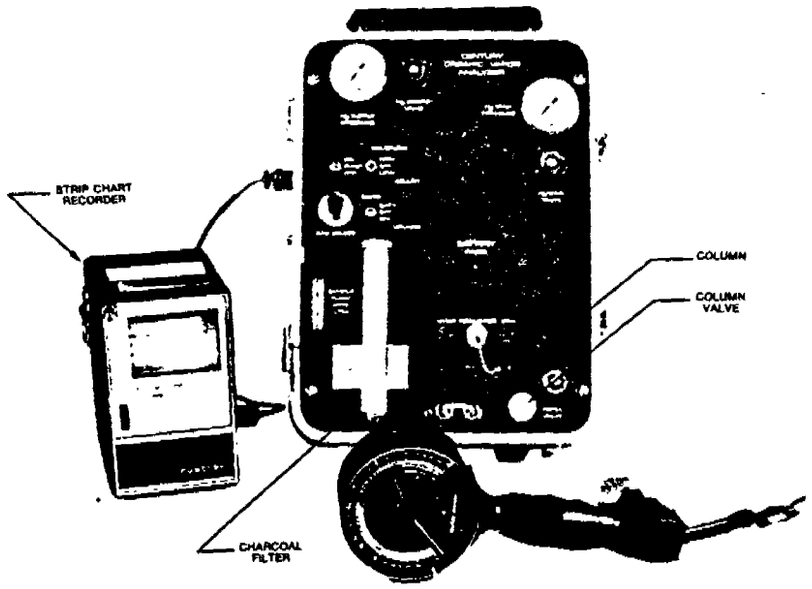
(Secs. 6 and 8, 84 Stat. 1596, 1599 (29 U.S.C. 655, 657); Secretary of Labor's Order No. 12-71, 36 FR 8754)

Signed at Washington, D.C., this 1st day of October, 1974.

JOHN STENDER,
Assistant Secretary of Labor.

[FR Doc.74-23176 Filed 10-1-74;3:54 pm]

Century Adds Chromatographic Capability to their Portable and Fixed Organic Vapor Analyzers



CENTURY MODEL OVA-98 PORTABLE INSTRUMENT WITH CHROMATOGRAPH ADAPTION & STRIP CHART RECORDER ADDED AS SHOWN.

Now for the first time a portable, continuous sampling Organic Vapor Analyzer which also has gas chromatographic capability is available in our OVA instrument series. And the most exciting fact of all is that this new analyzer, including the strip chart recorder, still maintains the lightweight portability and reliability features which are characteristic of all OVA's.

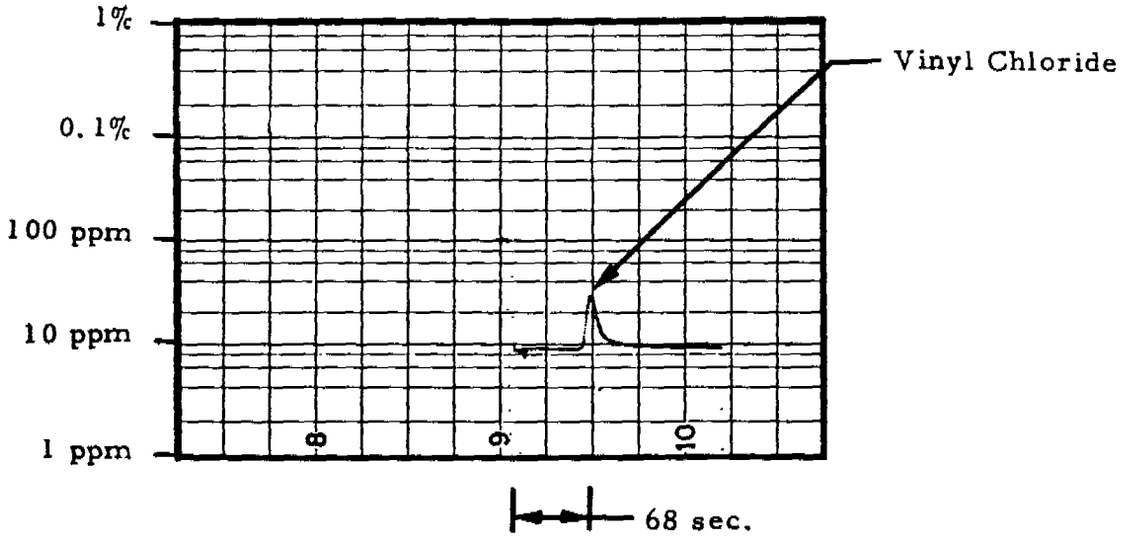
This unique instrument permits not only the detection and quantitative analysis of potentially hazardous vapors but also an "on-the-spot" qualitative analysis within minutes, depending upon the components under analysis. Elaborate and time-consuming laboratory analysis is now significantly reduced because a compact, unique, gas chromatograph system is built right into the instrument.

After location of potentially hazardous vapors, using the standard quantitative sample survey and analysis methods described in the brochure "Century Portable Organic Vapor Analyzer", simply depressing the Column Valve will "switch" the chromatographic system into operation. This diverts a portion of the vapor sample through the column for separation and subsequent readout on the strip chart recorder. At the same time, a charcoal filter is switched into the sampling system to reduce the hydrocarbon background during analysis.

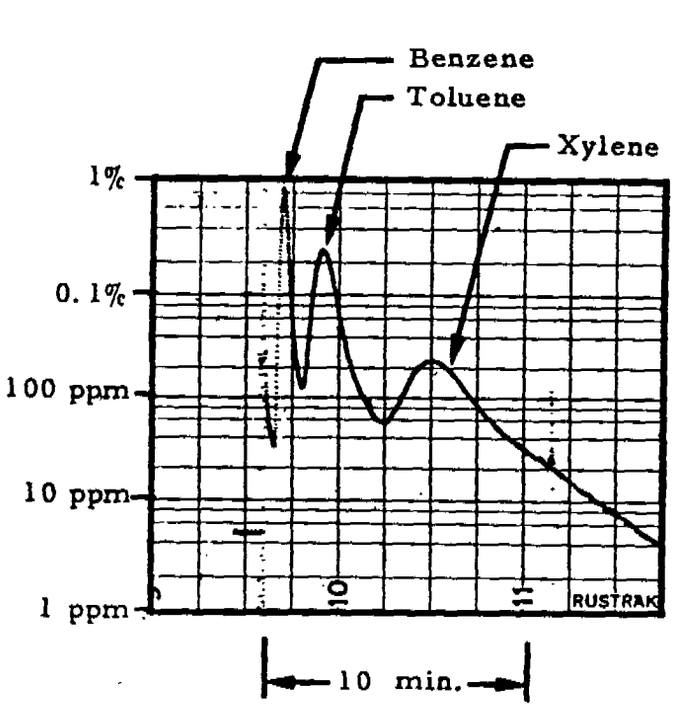
When the Column Valve is depressed, an immediate negative reference indication is printed on the strip chart recorder which establishes a "starting time baseline" for the chromatographic analysis. Subsequently, each component of the sample exits from the column into the detector chamber after its respective retention time. Each produces a peak on the logarithmic strip chart recorder and on the hand-held, logarithmically scaled meter. Examples of typical analysis recordings of the linear time versus logarithmically scaled vapor level are shown in this brochure.

Column selection for specific applications is facilitated by the availability of interchangeable columns, which can easily be changed by simply loosening two swagelok fittings. In addition to standard columns, which are designed for most standard industrial applications, special custom columns can be provided to customer specifications or the customer can easily provide his own column.

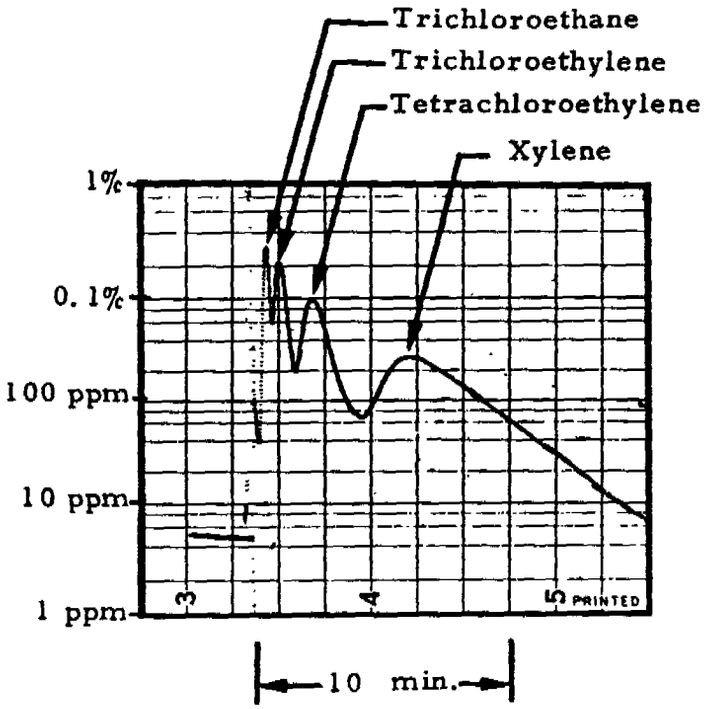
In summary, employers concerned with the safety of their employees can now rapidly determine the ppm composition of potentially hazardous gases within minutes after the "heart and extent of the problem" is determined. Give the OVA with column and recorder options a close look. It's at least one state of the art level ahead of any instrument available for industrial hygiene or air quality control applications



3 ft. DNOP Column



3 inch DNOP Column



3 inch DNOP Column

Note that time base is linear but hydrocarbon level is log scaled for measurement of low level trace elements.

TYPICAL OVA PRINTOUTS SHOWING CLEAR COMPONENT SEPARATION

CENTURY
Portable Organic Vapor Analyzer

CENTURY Portable Organic Vapor Analyzer protects you and the environment

INTRODUCTION

A completely portable Organic Vapor Analyzer (OVA) is now available to detect and measure hazardous gases found in almost all industries, including manufacturing, petro-chemical, and natural gas transmission and distribution. The Century OVA is a highly sensitive instrument designed to measure trace quantities of organic materials in air. It incorporates a hydrogen flame ionization detection system which has similar analytical capabilities to those utilized in gas chromatographs. The flame ionization detector is an almost universal detector for organic compounds with the sensitivity to analyze for them in the parts per million range (V/V) in air in the presence of moisture, nitrogen oxides, carbon monoxide and carbon dioxide.

The instrument has broad application, since it has a continuous, chemically resistant air sampling system and can be readily calibrated to measure almost all organic vapors. It has a single logarithmically scaled readout from 1 ppm to 100,000 ppm or with lower maximum level, if desired. Designed for use as a portable survey instrument, it can also be readily adapted to fixed remote monitoring or mobile installations. It is ideal for the determination of many organic air-pollutants and in the monitoring of air in potentially contaminated areas.

The unique feature of the instrument is its complete *portability* which enables an entire facility to be surveyed rapidly and thoroughly. When vapors are detected, the continuous sampling feature enables the origin of those vapors to be readily traced and corrective action initiated. In most cases a qualitative analysis is not justified until the presence of potentially hazardous vapors is detected and the source of the vapors is determined. If, after locating the source, the vapors or mixture of vapors cannot be readily identified, a sample can be taken and a qualitative analysis performed on standard laboratory equipment. However, location of the vapor source will many times reveal the type of vapor and the concentration level can then be read directly, by simply changing the instrument calibration to the predetermined setting for that particular vapor. The OVA thus enables a comprehensive survey of an entire facility to be performed rapidly and economically in contrast to ineffective and costly spot sampling techniques.

PRINCIPLE OF OPERATION

The instrument includes a detector chamber where the organic vapor being analyzed is introduced into a small hydrogen flame. Air sample is drawn into the instrument at a constant rate of nominally two (2) liters per minute through a chemically resistant line and pump. The oxygen in the air sample is used to support the small hydrogen flame.

Flames characteristically have electrical conductivity due to the presence of electrons and ions generated from the burning fuel. When even trace amounts of organic material enter the hydrogen flame, carbon-containing ions are formed and the electrical conductivity increases significantly. This change in conductivity is measured and the output is directly related to the concentration of organic materials. The exception to this phenomenon is carbon monoxide and carbon dioxide which evidently, due to their structure, do not produce appreciable ions in the detector flame. Thus, other organic materials may be analyzed in the presence of CO and CO_2.

An electric field in the chamber drives the ions to a collecting electrode which causes a current to flow into a preamplifier that is proportional to the ion collection rate. The rate of ion generation is a function of the quantity and structure of the carbon compound present in the sample. The ionization current is amplified in a logarithmic electrometer preamplifier, the output of which varies as the logarithm of the input. This logarithmic feature enables measurement and readout of ionization rates over a range of up to five (5) decades (1 to 100,000) without range scaling. The output signal from the preamplifier is fed to the signal conditioning and control circuits for subsequent readout and alarm signalling.

A fuel handling system including storage tank, valves, regulators and gauges is incorporated to maintain the small hydrogen flame jet in the chamber. The instrument response is read on a hand held meter assembly or can be read out utilizing the external monitor signal. An audible detection alarm is provided which can be pre-set to any desired level and which has a frequency modulated tone which varies as a function of the signal level. The standard instrument includes an audible flame out alarm, battery test indicator and internal electronic calibration. The internal electronic calibration provides reference signals which are used in conjunction with a panel mounted gas selector adjustment to readily change the instrument calibration from one gas to another.

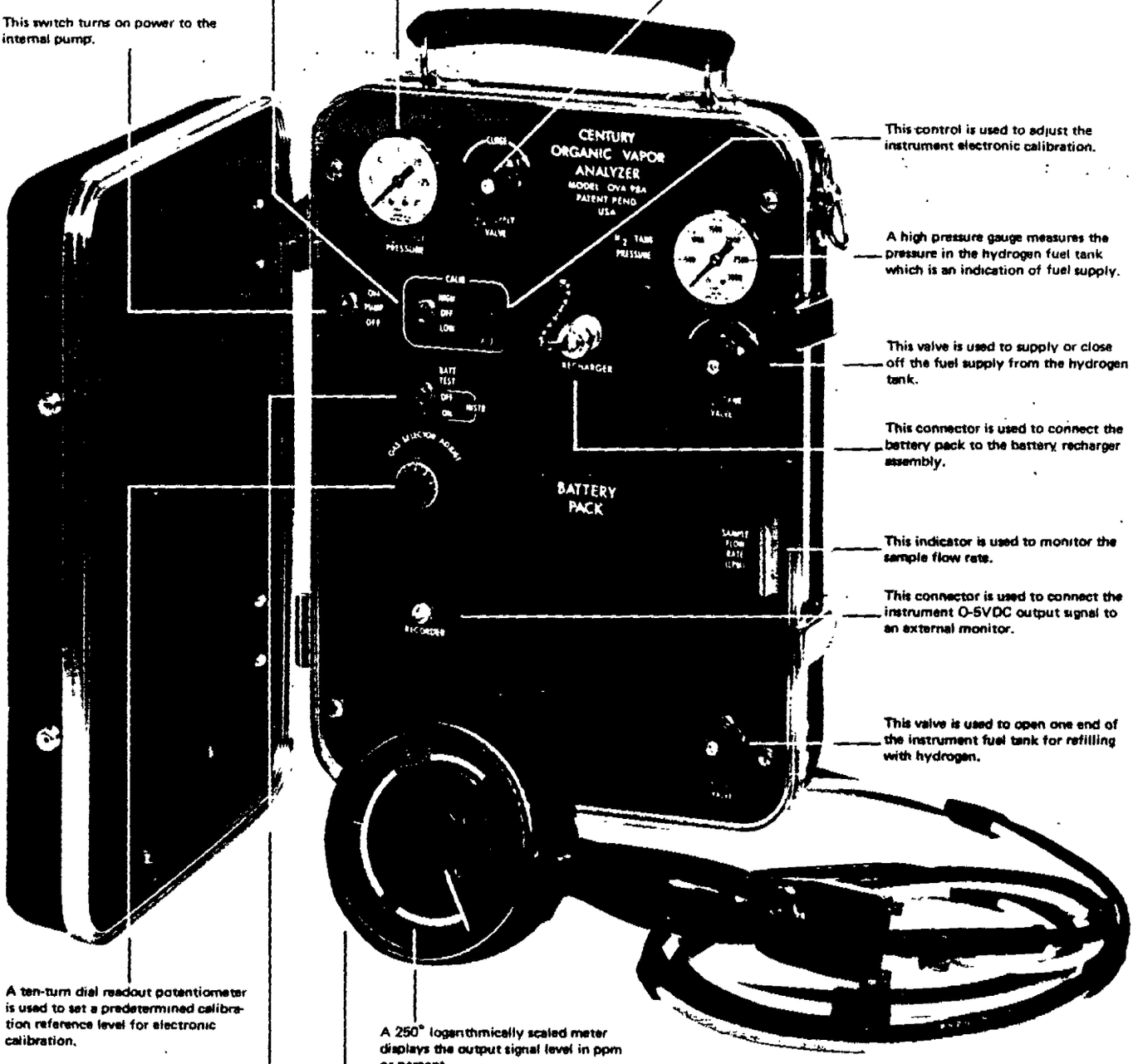
Since the response of the instrument is dependent upon the chemical nature of the material being analyzed, it is necessary to calibrate the device with a standard sample of that particular organic vapor. However, the approximate response of the instrument to hydro-carbons or compounds containing halogens, oxygen, or nitrogen can be ***estimated*** from the structure of the compounds and utilization of empirical data. The internal electronic reference signals are provided so the operator can readily recheck the instrument response from the point of ion collection to the read ut meter.

This switch is used to introdu
HIGH or LOW calibration sig
currents.

low pressure gauge is used to moni-
hydrogen pressure at the cap-
restrictor.

This valve is used to supply or close off the hydrogen fuel to the detector chamber.

This switch turns on power to the internal pump.



This control is used to adjust the instrument electronic calibration.

A high pressure gauge measures the pressure in the hydrogen fuel tank which is an indication of fuel supply.

This valve is used to supply or close off the fuel supply from the hydrogen tank.

This connector is used to connect the battery pack to the battery recharger assembly.

This indicator is used to monitor the sample flow rate.

This connector is used to connect the instrument O-5VDC output signal to an external monitor.

This valve is used to open one end of the instrument fuel tank for refilling with hydrogen.

A ten-turn dial readout potentiometer is used to set a predetermined calibration reference level for electronic calibration.

A 250° logarithmically scaled meter displays the output signal level in ppm or percent.

This switch is used to turn on all instrument electrical power except the pump power and also to display the battery charge condition.

A potentiometer on back of meter is used to set the vapor detection level at which the audible alarm is actuated.

APPLICATIONS

(1) Measurement of most toxic organic vapors present in industry for compliance with OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) requirements.
(2) Survey of gas distribution and transmission lines and equipment for compliance with OFFICE OF PIPELINE SAFETY (OPS) requirements.
(3) Various measurement and monitoring applications in the air pollution field.
(4) Leak detection in gas handling equipment.
(5) Detecting explosive-level gas conditions in indoor and outdoor locations.
(6) Measurement of methane in underground mines.

OTHER TYPICAL USES

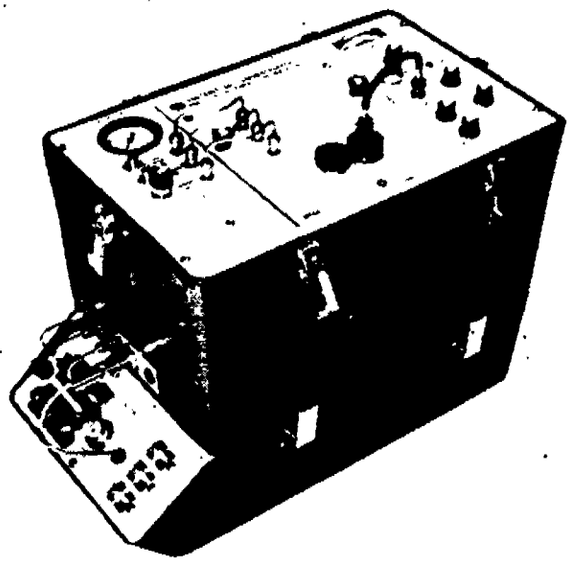
(1) Controlling and monitoring atmospheres in manufacturing and packaging operations.
(2) Mudlogging, gas and mineral exploration.
(3) Leak detection related to volatile fuel handling equipment.

SPECIFICATIONS

Sensitivity:	1 ppm (methane)
Response time:	Less than 2 seconds
Readout:	250° logarithmic scaled meter, various scales in the range of 1-100,000 ppm.
	External monitor connector.
Sample flow rate:	Nominally 2 liters per minute.
Fuel supply:	75 cubic centimeter tank of pure hydrogen at max. pressure of 2300 PSIG, fillable while in case.
Primary electrical power:	Rechargeable and replaceable battery pack, at 12 VDC.
Service life:	Hydrogen supply and battery power – 8 hours operating time minimum.
Size:	Side Pack Assembly 8⅝" wide x 11⅝" long x 4¼" deep.
	Probe/Readout Assembly – variable
Weight:	Side Pack Assembly – less than 9 pounds.
	Probe/Readout Assembly – less than 2 Pounds.
Operator requirements:	One man, one hand operation.
Detection alarm:	Frequency modulated audible alarm. Can be pre-set to desired level. Frequency varies as a function of detection level.
Flame-out indication:	Audible alarm plus visual meter indication.
Battery test:	Battery charge condition indicated on readout meter or battery recharger.
Pickup fixtures:	Variety of types for various applications.
Probe:	Telescoping adjustment over 8 inches or probe can be completely removed from Readout Assembly.
Umbilical cord:	Five (5) feet long with connectors for electrical cable and sample hose.
Filtering:	In-line disposable and permanent particle filters and optional activated charcoal filter.
Side pack case:	Molded high impact plastic case with carrying handle and shoulder strap.
Standard accessories:	1) Instrument carrying and storage case.
	2) High pressure fuel filling hose assembly.
	3) A.C. Battery charger.

LITHO IN US

MODEL 511
FLAME IONIZATION
PORTABLE GAS CHROMATOGRAPH



- COMPLETELY PORTABLE
- RECHARGEABLE BATTERIES
- SELF-CONTAINED, REFILLABLE GAS SUPPLY
- ON-SITE ANALYSIS
- LOW POWER CONSUMPTION
- LOW WEIGHT — 40 lbs.
- ISOTHERMAL OPERATION TO 175°C
- ON-COLUMN INJECTION
- INTERCHANGEABLE FID-EC-TC DETECTORS
- USES GLASS OR METAL COLUMNS

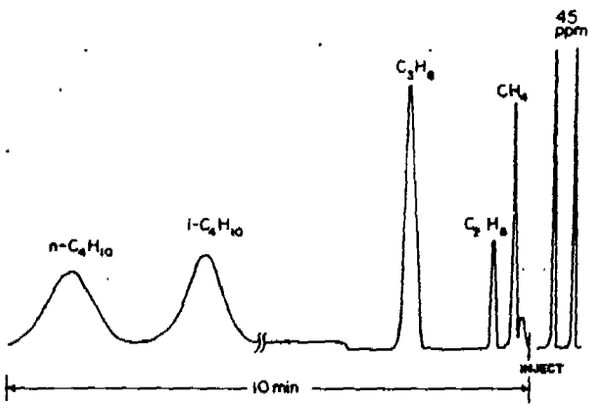
The Model 511 Portable Gas Chromatograph is a completely self-contained instrument. Containing rechargeable Nickel-Cadmium batteries and a refillable gas supply this instrument may be carried fully operational to the sampling area and operated immediately upon arrival. The availability of three interchangeable detection systems allows the selection of the appropriate detector to perform virtually any isothermal gas chromatographic analysis.

Accessability to the column and detector compartment is readily accomplished by the removal of the lid assembly from the instrument. Located on this lid assembly are the column, injector, detector, heaters and associated feed back circuits. For operator ease, all electrical connections are made through a mating plug.

Incorporating state of the art electronic design, the Model 511 Portable Gas Chromatograph may be powered from a 110 volt source or from the self-contained Nickel-Cadmium batteries. The batteries are capable of powering the instrument for a minimum of 8 hours at oven temperatures of up to 200°C before they must be recharged. While the batteries are being recharged the instrument remains operational and may be used to perform additional analyses. Where external gas supplies are available, they may be used with the instrument in order to conserve the gases located in the power pack.

APPLICATIONS

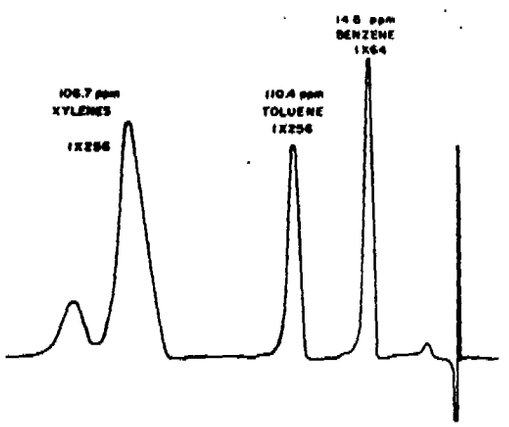
...ethane, Total and Non-Methane Hydrocarbons



The use of valving systems allows the analysis of Total Hydrocarbons in one mode of operation and the separation of these materials in the other mode. Utilization of the back flush valve after the methane has been determined flushes all of the other compounds back into the detector where they can be measured if desired.

Organic Solvent Vapors

The determination of the various individual compounds present in an air sample is an important analysis in the Environmental Health and Industrial Hygiene areas. Since the Model 511 separated the sample into its individual compounds it is possible to determine the concentration of each chemical.



HOW TO ORDER

Model 511 Portable Flame Ionization Gas Chromatograph including rechargeable Nickel-Cadmium batteries, recharger and lecture bottles of all gases required for detector operation. Also includes a 6 ft. x 1/8 inch column packed with 10% DC-200 on Chromosorb W HP. Fittings provided on power pack for recharging lecture bottles to high pressure.

Consult Price List for instrument and accessory prices.

ANALYTICAL INSTRUMENT DEVELOPMENT, INC.
RT. 41 & NEWARK RD., AVONDALE, PA. 19311 PHONE: (215)-268-3181

All Prices FOB Avondale, Pa.

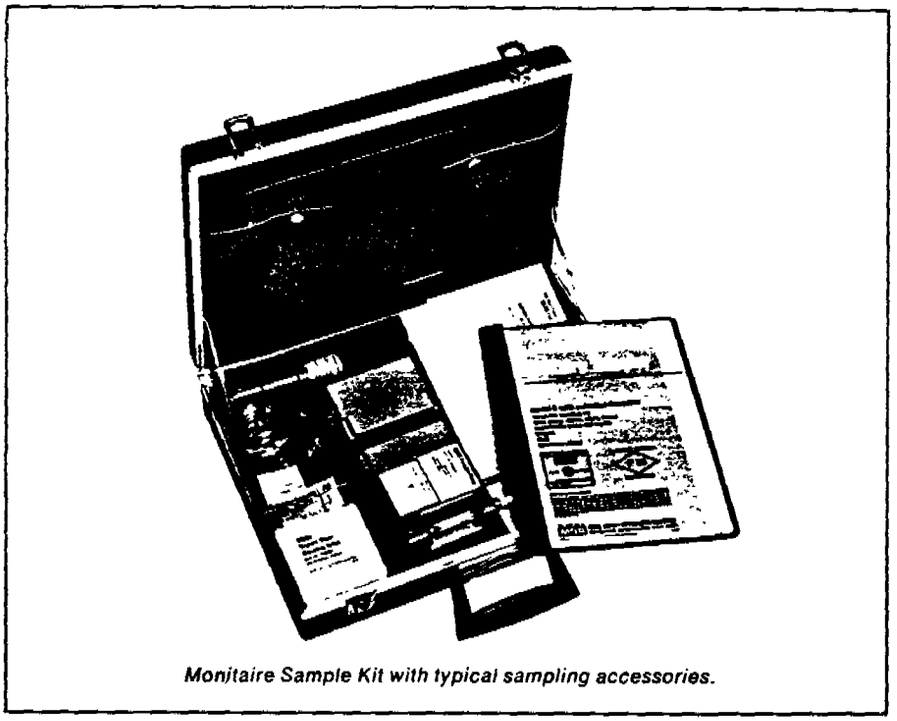
PB122 7/73

Printed in USA

MSA

Data Sheet
08-01-01

Model S Monitaire Sampler



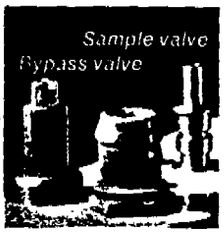
Monitaire Sample Kit with typical sampling accessories.

Application

The Model S Monitaire™ Sampler by MSA provides the necessary vacuum for sampling atmospheres which may contain certain toxic and combustible gases, vapors, dusts, fumes, and mists.

Description

The Model S Monitaire Sampler is a rechargeable-battery-operated diaphragm pump which supplies a vacuum source for many atmospheric testing devices including filter paper holders, charcoal tubes, impingers, and numerous MSA portable gas detection instruments. Flow rate is adjustable. Pump can be clipped to a worker's belt so that a continuous air sampling can be made over several working hours.



The Model S pump features a dual-valve assembly: a sample valve controls the sample flow directly, and a bypass valve controls bypass air which may enter through the center of the stem.

The bypass valve permits the pump to operate efficiently by compensating for sample-flow restrictions. Low sample-flow requirements or highly restrictive sample devices introduce a pressure differential which must be reduced. The bypass valve introduces atmospheric air directly into the pump, reducing the pressure differential; the bypass may be partially or totally closed at higher sample rates. Proper bypass settings are specified in the instruction materials that are part of the Monitaire Sampler Kit.

A tube fitting on the exhaust side of the pump permits use of the Monitaire Sampler for pressure operations.

The battery charger has two charging rates to charge the Model S pump overnight or over weekends; fully charged battery will run the pump continuously for up to eight hours.

The Model S Monitaire Sampler Kit includes: self-contained battery-operated pump, battery charger, instruction manual, pump maintenance card, and attaché- type carrying case with room for accessories.

Approvals and standards

Sampling pump has USBM Approval No. 2G-2239-2 as "permissible" for methane/air atmospheres. Factory Mutual approved as "intrinsically safe" for Class I, Division I, Groups C and D hazardous locations.

Specifications

Pump

Type: diaphragm
Dimensions: 2½ in. x 5 in. x 5 in.
Weight: 31 oz, including battery
Battery and performance: 6-volt rechargeable battery, 8-hour continuous operation on full battery charge
Flow indication: 0 to 10 scale
Maintenance: (1) valve stems should be cleaned periodically by removing valve and blowing with air; (2) flow-tube assembly is easily removed and replaced; (3) pump and charger should be stored in container when not in use

Battery charger

Dimensions: 2⅛ in. x 3 in. x 4½ in.
Weight: 12½ oz
Power source: 16-hour rate for overnight charging, 64-hour rate for weekend charging

Ordering information

Catalog numbers

Model S Monitaire Sampler

459660	Kit, complete with pump, charger, maintenance card, instruction manual, and carrying case
458475	Pump, Model S
456059	Battery charger
996097	Maintenance card
996338	Instruction manual
459662	Carrying case
93385	Flow-tube assembly, 0 to 10 range
459182	Battery pack, replacement
457629	Calibration check unit for sampling pumps

Dust and mist collection accessories

92944	Holder assembly, filter disc
456243	Holder assembly, respirable dust, complete with cyclone and sampling line assemblies
456242	Holder assembly only, respirable dust
456228	Cyclone assembly only
456226	Sampling line assembly
456246	Kit, supplementary parts, including: 1 press/pry tool for 2- or 3-piece aerosol filter holder (456223) 1 brush (625416) 1 tweezer (625417) 3 screens, stainless steel support (456224)
625412	Holder, aerosol filter, 2-piece; pkg of 12
449347	Holder, aerosol filter, 3-piece; pkg of 10
459743	Coupler, sampling line; pkg of 3
457392	Coupler, stainless steel, for aerosol filter holder sampling with cyclone assembly
457391	Coupler, plastic, for pre-weighed cassette sampling with cyclone holder assembly
39642	Balance, filter weighing
39643	Carrying case for balance

Charcoal sampling tubes and accessories

459003	MSA Charcoal Sampling Tubes, mercury vapor, pkg of 12
459004	MSA Charcoal Sampling Tubes, organic vapor, pkg of 12
459054	MSA Tube Holder

Impinger test accessories

93470	Connector assembly for Midget Impinger flask
93495	Tubing for TDI or MDI flask

Note: This Data Sheet contains only a general description of the Model S Monitaire Sampler. While uses and performance capabilities are described, under no circumstances should this device be used until the instructions, labels, or other literature accompanying the product have been carefully read and the precautions therein set forth followed. Only they contain the complete and detailed information concerning this product.

MSA MINE SAFETY APPLIANCES COMPANY
400 PENN CENTER BLVD., PITTSBURGH, PA. 15235

At your service: 76 branch offices in the United States; **MSA CANADA**, Downsview, Ontario (Metro Toronto), Halifax, Montreal, Winnipeg, Saskatoon, Edmonton, Calgary, Vancouver; representatives in principal cities of the world, cable address—"MINSAF" Pittsburgh

Data Sheet 08-01-01 Printed in U.S.A. 748 (L)

VINYL CHLORIDE

DETERMINATION IN AIR BY ADSORPTION ON ACTIVATED CHARCOAL AND ANALYSIS BY GAS CHROMATOGRAPHY

15-MINUTE SAMPLE

1 **PURPOSE AND LIMITATIONS** This paper describes a procedure for measuring the exposure of personnel to vinyl chloride in the working environment. The method describes the preparation of standards which will determine vinyl chloride in the range of 9 to 90 parts per million by volume in air, based on a 15-min. sample at a flow rate of 100 ml per minute. Lower or higher ppm ranges can be determined by preparing additional standards to cover the range desired. (Vinyl chloride can be determined to at least 0.05 ppm by volume in air by this procedure, using more dilute standards.)

2 **PRINCIPLE** The sample is collected by passing air through a glass tube containing activated charcoal which adsorbs any vinyl chloride vapors present. The vinyl chloride is then desorbed from the charcoal by carbon disulfide extraction and analyzed by gas chromatography.

3 **INSTRUMENT PARAMETERS**

Chromatograph	AID (Analytical Instrument Development, Inc.) Portable Chromatograph, Model 511, or equivalent chromatograph, with flame ionization detector.
Column	Six-foot x 1/8-inch stainless steel packed with 10% di(2-ethylhexyl) sebacate on Chromasorb P, 80/100 mesh, NAW.
*Column temperature	100°C isothermal
Injection temperature	100°C
Detector	flame ionization detector
Carrier	helium or nitrogen
Hydrogen flow rate	23 cc per minute
Air flow rate	133 cc per minute
Sample size	2 µl solvent flush technique
Retention time	0.5 minute (adjust carrier flow until vinyl chloride elutes at this time)

*Note: If this column is used in a conventional chromatograph, better separation of vinyl chloride from other light boiling impurities will be obtained by operation of the column oven near ambient temperature ≈30°C. The AID portable chromatograph cannot be used at ambient temperature without modification since the heat from the flame ionization detector will cause the temperature in the column oven to rise to 60 to 70°C.

Alternate Column - Better Resolution

Instrument	Hewlett-Packard 5750 gas chromatograph - dual column, or equivalent.
Column	25-foot x 1/8 inch stainless steel packed with 25% by weight 75% CO880/25% Tergitol E-35 on 40/60 mesh rescreened Chromosorb P.
Detector	flame ionization
Column temperature	40° to 100°C at 4°C per minute
Detector temperature	125°C
Injector temperature	125°C
Carrier gas	helium, 30 ml per minute
Air flow	350 ml per minute
Hydrogen flow	30 ml per minute
Sample size	10 µl
Approximate elution time	6.5 minutes

4 REAGENTS AND APPARATUS

a) Personal sampling pump. MSA Model G or Bendix Micronair. Insert an in-line orifice made from a cut-off and restricted (pinched) hypodermic needle in the sampling line to the pump in order to obtain a 100 cc per minute flow on these pumps.

b) Hypo-vials, 15-ml size, Cat. No. 12911; Neoprene septa, Cat. No. 13233; alumina seals, Cat. No. 13214; and hand crimper, Cat. No. 13212, Pierce Chemical Company, Rockford, Illinois.

c) Carbon disulfide, spectrophotometric grade

d) Activated charcoal, Cat. No. 580-26, Barnebey-Cheney, Columbus, Ohio

e) Soap film flow meter, 10-ml size

f) Stop watch

5 PREPARATION OF THE ACTIVATED CARBON ADSORPTION TUBE

a) Prepare the activated charcoal by placing the charcoal on a 40-mesh sieve and wash with demineralized water until no visible fines appear in the washings.

b) Dry the carbon in a drying oven at 110°C until dry and free flowing (overnight). Store in a screw-top, glass bottle until needed.

c) Cut 8-mm O.D. x 6-mm I.D. Pyrex glass tubing into 6-inch lengths and fire polish the ends.

d) Insert a Pyrex glass wool plug two-thirds of the distance into the glass tubes. The longer section of tubing will be designated as the primary end, while the shorter side of the tubing is the back-up end.

) Pack the tubes with the activated carbon, using a length of 60 mm in the primary section and 35 mm in the back-up section. Retain the carbon with glass wool plugs.

f) Seal the tubes with a red rubber septum or parafilm until ready for use.

6 SAMPLING PROCEDURE

a) Remove the seals from the charcoal tube and attached the back-up section to a portable pump by means of a length of 1/4-inch Tygon tubing.

b) Set the flow rate at 100 ml per minute through the tube with a calibrated rotameter. (NOTE: The 10-ml soap bubble flow meter can be used to obtain a more precise reading of the air flow through the tube if desired).

c) Record the time the air sampling was started and the time when the sampling is completed. A 15-minute sample may be taken with this system.

d) After sampling, recheck the flow rate and reseal the ends of the charcoal tube. Return the tube to the laboratory for analysis.

e) Record the temperature and barometric pressure at the sampling site.

7 ANALYTICAL PROCEDURE

a) Make a small hook at the end of a piece of wire and remove the glass wool plug from the primary end of the charcoal tube. Make sure that no charcoal particles adhere to the glass wool plug.

b) Pour the charcoal into a 10-ml glass-stoppered volumetric flask and cool the flask and carbon in a wet-ice bath.

c) Pipet 3 ml of carbon disulfide (CS_2) into the cooled flask and stopper securely. (CAUTION: Carbon disulfide is toxic and should be handled under a hood.)

d) Agitate the flask periodically for at least 30 minutes.

e) **Solvent Flush Injection Technique.** This injection technique is designed to eliminate difficulties arising from blow-back or distillation with the needle of the microliter syringe.

f) Flush a 10-µl syringe with CS_2 several times to wet the barrel and plunger.

g) Draw 2 µl of CS_2 into the syringe and remove the tip of the needle from the solvent. Withdraw the plunger an additional 0.5 µl to separate the CS_2 from the sample with a pocket of air.

h) Dip the needle into the sample solution in the volumetric flask and withdraw the plunger until the air bubble between the solvent and the sample has passed the 2-µl mark on the syringe.

i) Remove the tip of the needle from the sample solution and adjust the volume in the syringe until the meniscus of the air bubble rests on the 2-µl mark. Remove the excess sample solution from the tip of the needle.

j) Pull the plunger back an additional 0.5 µl to prevent the sample solution from evaporating from the tip of the needle.

k) Inject the entire contents of the syringe into the chromatograph.

l) Measure the peak height and determine the vinyl chloride content from a previously prepared calibration curve.

8 CALIBRATION CURVE

a) Pipet 10 ml of carbon disulfide (CS_2) into each of five 15-ml hypo-vials. Cap the vials with the Neoprene septa and aluminum seals, using the hand crimper.

b) Place the hypo-vials in wet ice to reduce the vapor pressur of CS_2.

c) Cap one of the valves on a steel sample cylinder containing vinyl chloride with a 1/8-inch Swagelok tubing nut which has a chromatographic septum installed in the nut.

d) Insert a hypodermic needle through the septum on the cylinder, open the valve and allow the vinyl chloride to vent through the needle for about 10 seconds to purge the air from the system. Remove the needle.

e) Using the appropriate gas-tight syringe fitted with a number 27 gauge hypodermic needle, insert the needle through the septum on the cylinder and allow the pressure of the vinyl chloride to displace the volume of the syringe. Flush the syringe two times to remove any air which may have been trapped in the needle.

f) Into the respective hypo-vials, inject 0.2, 0.3, 0.5, 1.0, and 2.0 cc of vinyl chloride from the syringe.

g) Shake the hypo-vials for one minute to put the vinyl chloride in solution. These standards will contain 56, 82, 133, 260, 515 µgm of vinyl chloride per ml. (NOTE: These calculations are corrected for the dead space in the gas syringe needle. The cold CS_2 solutions in the hypo-vials are under slight negative pressure. Measurements have shown that the dead space in the syringe needle amounts to 0.04 cc, and 0.02 cc of this volume is pulled into the hypo-vial by the negative pressure.)

h) Allow the standards to warm up to room temperature, then inject these standards into the chromatograph using the procedure described in Section 7, paragraphs e through k. Shake the hypo-vials each time just prior to withdrawing a sample.

i) Plot peak height versus micrograms of vinyl chloride per ml.

9 CALCULATION

$$\frac{A \times 3 \times 24.5}{L \times 62.5} = \text{vinyl chloride, ppm by volume at 25°C and 760 mm}$$

A = µgm per ml of vinyl chloride read from calibration curve
L = total liters of air sample (flow rate x time)

VINYL CHLORIDE

DETERMINATION IN AIR BY ADSORPTION ON ACTIVATED CHARCOAL AND ANALYSIS BY GAS CHROMATOGRAPHY

4-HOUR SAMPLE

1 **PURPOSE AND LIMITATIONS** This paper describes a procedure for measuring the exposure of personnel to vinyl chloride in the working environment. The method describes the preparation of standards which will determine vinyl chloride in the range of 9 to 90 parts per million by volume in air, based on a 4-hour sample at a flow rate of 28 ml per minute. Lower or higher ppm ranges can be determined by preparing additional standards to cover the range desired. (Vinyl chloride can be determined to at least 0.05 ppm by volume in air by this procedure, using more dilute standards.)

2 **PRINCIPLE** The sample is collected by passing air through a glass tube containing activated charcoal which adsorbs any vinyl chloride vapors present. The vinyl chloride is then desorbed from the charcoal by carbon disulfide extraction and analyzed by gas chromatography.

3 **INSTRUMENT PARAMETERS**

Chromatograph	AID (Analytical Instrument Development, Inc.) Portable Chromatograph, Model 511, or equivalent chromatograph, with flame ionization detector.
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*Column temperature	100°C isothermal
Injection temperature	100°C
Detector	flame ionization detector
Carrier	helium or nitrogen
Hydrogen flow rate	23 cc per minute
Air flow rate	133 cc per minute
Sample size	2 µl solvent flush technique
Retention time	0.5 minute (adjust carrier flow until vinyl chloride elutes at this time)

*Note: If this column is used in a conventional chromatograph, better separation of vinyl chloride from other light boiling impurities will be obtained by operation of the column oven near ambient temperature ≈30°C. The AID portable chromatograph cannot be used at ambient temperature without modification since the heat from the flame ionization detector will cause the temperature in the column oven to rise to 60 to 70°C.

Alternate Column - Better Resolution

Instrument	Hewlett-Packard 5750 gas chromatograph - dual column, or equivalent.
Column	25-foot x 1/8 inch stainless steel packed with 25% by weight 75% CO880/25% Tergitol E-35 on 40/60 mesh rescreened Chromosorb P.
Detector	flame ionization
Column temperature	40° to 100°C at 4°C per minute
Detector temperature	125°C
Injector temperature	125°C
Carrier gas	helium, 30 ml per minute
Air flow	350 ml per minute
Hydrogen flow	30 ml per minute
Sample size	10 µl
Approximate elution time	6.5 minutes

4 REAGENTS AND APPARATUS

a) Personal sampling pump. MSA Model G or Bendix Micronair. Insert an in-line orifice made from a cut-off and restricted (pinched) hypodermic needle in the sampling line to the pump in order to obtain a 28 cc per minute flow on these pumps.

b) Hypo-vials, 15-ml size, Cat. No. 12911; Neoprene septa, Cat. No. 13233; alumina seals, Cat. No. 13214; and hand crimper, Cat. No. 13212, Pierce Chemical Company, Rockford, Illinois.

c) Carbon disulfide, spectrophotometric grade

d) Activated charcoal, Cat. No. 580-26, Barnebey-Cheney, Columbus, Ohio

e) Soap film flow meter, 10-ml size

f) Stop watch

5 PREPARATION OF THE ACTIVATED CARBON ADSORPTION TUBE

a) Prepare the activated charcoal by placing the charcoal on a 40-mesh sieve and wash with demineralized water until no visible fines appear in the washings.

b) Dry the carbon in a drying oven at 110°C until dry and free flowing (overnight). Store in a screw-top, glass bottle until needed.

c) Cut 8-mm O.D. x 6-mm I.D. Pyrex glass tubing into 6-inch lengths and fire polish the ends.

d) Insert a Pyrex glass wool plug two-thirds of the distance into the glass tubes. The longer section of tubing will be designated as the primary end, while the shorter side of the tubing is the back-up end.

e) Pack the tubes with the activated carbon, using a length of 60 mm in the primary section and 35 mm in the back-up section. Retain the carbon with glass wool plugs.

f) Seal the tubes with a red rubber septum or parafilm until ready for use.

6 SAMPLING PROCEDURE

a) Remove the seals from the charcoal tube and attached the back-up section to a portable pump by means of a length of 1/4-inch Tygon tubing.

b) Set the flow rate at 28 ml per minute through the tube with a calibrated rotameter. (NOTE: The 10-ml soap bubble flow meter can be used to obtain a more precise reading of the air flow through the tube if desired).

c) Record the time the air sampling was started and the time when the sampling is completed. A four-hour sample may be taken with this system.

d) After sampling, recheck the flow rate and reseal the ends of the charcoal tube. Return the tube to the laboratory for analysis.

) Record the temperature and barometric pressure at the sampling site.

7 ANALYTICAL PROCEDURE

a) Make a small hook at the end of a piece of wire and remove the glass wool plug from the primary end of the charcoal tube. Make sure that no charcoal particles adhere to the glass wool plug.

b) Pour the charcoal into a 10-ml glass-stoppered volumetric flask and cool the flask and carbon in a wet-ice bath.

c) Pipet 3 ml of carbon disulfide (CS_2) into the cooled flask and stopper securely. (CAUTION: Carbon disulfide is toxic and should be handled under a hood.)

d) Agitate the flask periodically for at least 30 minutes.

e) Solvent Flush Injection Technique. This injection techniqu is designed to eliminate difficulties arising from blow-back or distillation with the needle of the microliter syringe.

f) Flush a 10-µl syringe with CS_2 several times to wet the barrel and plunger.

g) Draw 2 µl of CS_2 into the syringe and remove the tip of the needle from the solvent. Withdraw the plunger an additional 0.5 µl to separate the CS_2 from the sample with a pocket of air.

h) Dip the needle into the sample solution in the volumetric flask and withdraw the plunger until the air bubble between the solvent and the sample has passed the 2-µl mark on the syringe.

i) Remove the tip of the needle from the sample solution and adjust the volume in the syringe until the meniscus of the air bubble rests on the 2-µl mark. Remove the excess sample solution from the tip of the needle.

j) Pull the plunger back an additional 0.5 µl to prevent the sample solution from evaporating from the tip of the needle.

k) Inject the entire contents of the syringe into the chromatograph.

l) Measure the peak height and determine the vinyl chloride content from a previously prepared calibration curve.

8 CALIBRATION CURVE

a) Pipet 10 ml of carbon disulfide (CS_2) into each of five 15-ml hypo-vials. Cap the vials with the Neoprene septa and aluminum seals, using the hand crimper.

b) Place the hypo-vials in wet ice to reduce the vapor pressure of CS_2.

c) Cap one of the valves on a steel sample cylinder containing vinyl chloride with a 1/8-inch Swagelok tubing nut which has a chromatographic septum installed in the nut.

d) Insert a hypodermic needle through the septum on the cylinder, open the valve and allow the vinyl chloride to vent through the needle for about 10 seconds to purge the air from the system. Remove the needle.

e) Using the appropriate gas-tight syringe fitted with a number 27 gauge hypodermic needle, insert the needle through the septum on the cylinder and allow the pressure of the vinyl chloride to displace the volume of the syringe. Flush the syringe two times to remove any air which may have been trapped in the needle.

f) Into the respective hypo-vials, inject 0.2, 0.3, 0.5, 1.0, and 2.0 cc of vinyl chloride from the syringe.

g) Shake the hypo-vials for one minute to put the vinyl chloride in solution. These standards will contain 56, 82, 133, 260, 515 µgm of vinyl chloride per ml. (NOTE: These calculations are corrected for the dead space in the gas syringe needle. The cold CS_2 solutions in the hypo-vials are under slight negative pressure. Measurements have shown that the dead space in the syringe needle amounts to 0.04 cc, and 0.02 cc of this volume is pulled into the hypo-vial by the negative pressure.)

h) Allow the standards to warm up to room temperature, then inject these standards into the chromatograph using the procedure described in Section 7, paragraphs e through k. Shake the hypo-vials each time just prior to withdrawing a sample.

i) Plot peak height versus micrograms of vinyl chloride per ml.

9 CALCULATION

$$\frac{A \times 3 \times 24.5}{L \times 62.5} = \text{vinyl chloride, ppm by volume at 25°C and 760 mm}$$

A = µgm per ml of vinyl chloride read from calibration curve
L = total liters of air sample (flow rate x time)

DETERMINATION OF RESIDUAL VINYL CHLORIDE MONOMER IN VINYL RESINS

1 PURPOSE

A procedure for determining the amount of residual vinyl chloride present in vinyl resins is described. The resin is dissolved in a solvent and the vinyl chloride analyzed using a gas chromatographic technique. The method is applicable for use with poly-(vinyl chloride), vinyl chloride-vinyl acetate copolymers and other vinyl resins in which there are no volatiles which interfere in the determination.

2 EQUIPMENT AND REAGENTS

Gas Chromatograph, Hewlett-Packard (F and M) Model 5750 or equivalent, equipped with a hydrogen flame ionization detector.

Tetrahydrofuran, reagent grade.

Balance with accuracy to 0.10 gram.

2 SAMPLE PREPARATION

Prepare the sample for chromatograph injection by dissolving the test resin in tetrahydrofuran (THF). Weigh 9 grams of THF into a suitable vial. Add 1 gram of the resin to be tested to the THF. Resin addition should be made as quickly as possible. Cap the bottle and place it on a can-roller to attain complete solution. When complete solution has occurred, the sample is ready for injection into the chromatograph.

4 INSTRUMENT PARAMETERS

Instrument	Hewlett-Packard (F and M) Model 5750 (or equivalent) equipped with hydrogen flame ionization detector.
Column	Six-feet by 1/8-inch stainless steel tubing packed with Chromosorb 102, 60/80 mesh.
Temperatures:	
Column	100°C for 4 minutes, manually increased to 250°C
Injector	100°C (maximum)
Detector	300°C (flame ionization)
Sample Size	4 Microliters
Flows:	
Helium Carrier Gas	25 cc/minute
Hydrogen	20 psi at cylinder head.
Compressed Air	40 psi at cylinder head.

4 (Continued)

Elution Times

Vinyl Chloride	2.8 minutes
Tetrahydrofuran	6.3 minutes

5 CALIBRATION

Prepare solution mixtures of varying amounts of vinyl chloride in tetrahydrofuran to cover the expected range of concentration. Obtain from the chromatograph scan the area percent of vinyl chloride for each sample of known monomer content. Prepare a chart plotting the area percent vinyl chloride versus the known weight percent vinyl chloride to establish the relative detector response of the vinyl chloride with respect to tetrahydrofuran.

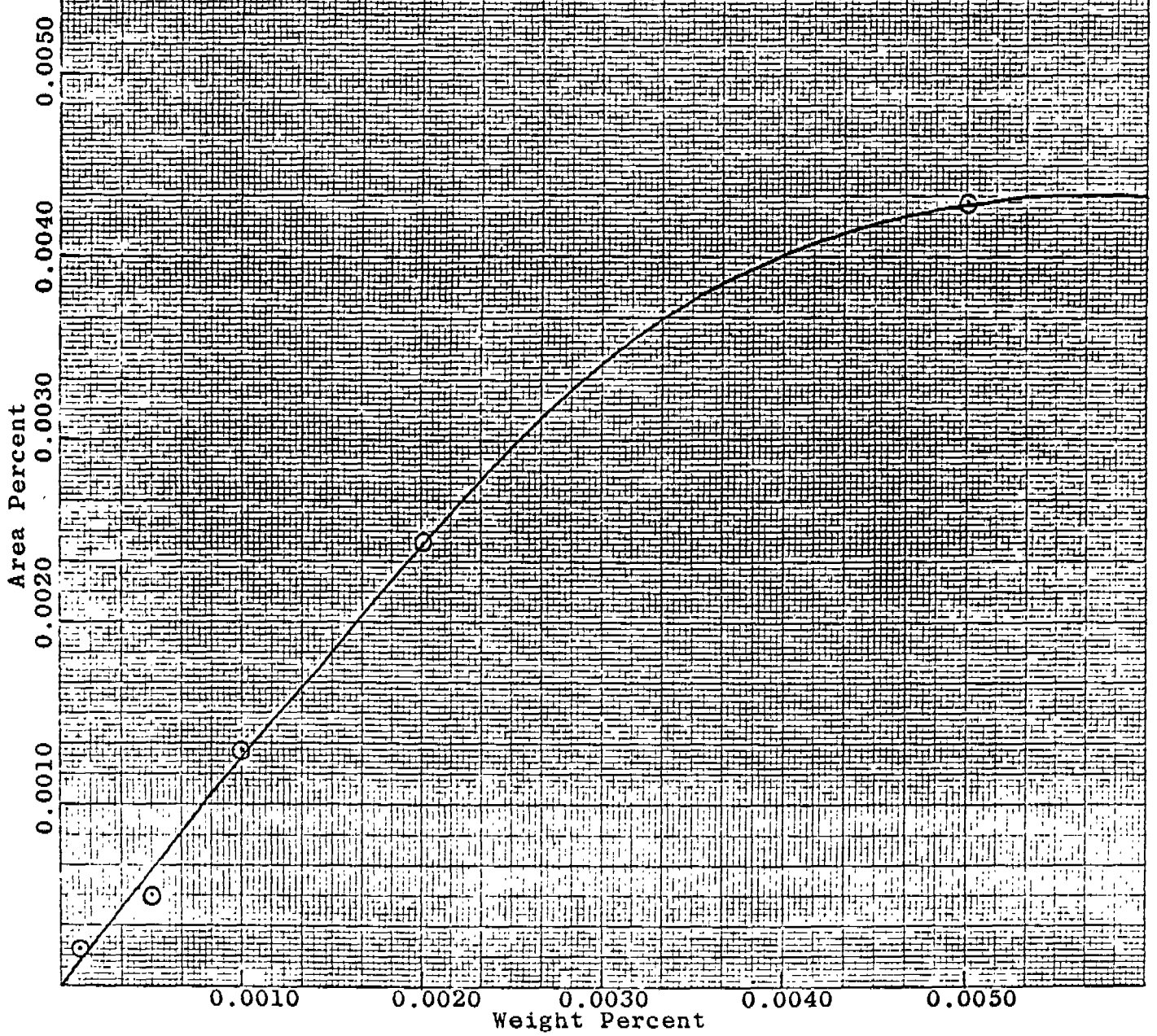
6 CALCULATION

Determine the area percent vinyl chloride from the chromatograph scan for the resin solution to be characterized. Multiply this figure by 10, which converts the data to area percent vinyl chloride based on resin weight. Using the chart developed with the calibration samples, read off the corresponding weight percent of vinyl chloride.

TYPICAL CALIBRATION CURVE

Residual Vinyl Chloride Monomer in Vinyl Resin

Area Percent Conversion to Weight Percent



DUST

DETERMINATION OF TOTAL AND RESPIRABLE AIRBORNE DUST BY MEMBRANE FILTER SAMPLING AND GRAVIMETRIC ANALYSIS

1 PURPOSE This procedure has been written to conform to recommended methods of sampling for dusts as published by the National Institute of Occupational Safety and Health (1) and the American Industrial Hygiene Association. (2)

2 PRINCIPLE Total dust concentration is measured by drawing a known volume of air through a preweighed, 37-mm polyvinyl chloride membrane filter, sampling with the top cover of the filter holder removed (open faced). The filter is dried by means of vacuum and reweighed to give a measure of the dust concentration. Respirable dust is measured by using a 10-mm nylon cyclone ahead of the membrane filter to remove the larger or non-respirable dust particles before they reach the filter. The filter is treated the same as described for total dust. The table below gives the theoretical deposition of the dust particles.

Aerodynamic diameter (μm), unit density sphere	Percent passing cyclone
2	90
2.5	75
3.5	50
5.0	25
10.0	0

3 APPARATUS

a) Personal sampling pump and charger, Model G, Part No. 456252, Mine Safety Appliance Co., Pittsburgh, Pa., or equivalent. (NOTE - Earlier models of the Model G pump were not equipped with a pulsation damper. If such a model is used, then the pulsation damper kit, MSA Part No. 449614 - should be ordered and installed before taking dust samples.)

b) Cyclone and holder; Part No. 456243, MSA holder assembly complete with cyclone and sampling line assemblies.

c) Filter holders for 37-mm filters; 2-section, Catalog No. M000037PO, 3-section Catalog No. M000037AO, Millipore Corp., Bedford, Mass.

d) Backup pad for 37-mm filter, Catalog No. AP1003700, Millipore Corp.

e) Polyvinyl chloride membrane filters; 5.0 μ pore diameter, Vinyl Metricel, VM-1, 37-mm diameter, Catalog No. 60714, Gelman Instrument Co., Ann Arbor, Mich.

f) Vacuum desiccator (use with a safety shield to contain glass fragments in the event of implosion if a glass desiccator is employed).
g) Mercury manometer
h) Analytical balance capable of weighing to the nearest 0.01 mg.
i) Vacuum pump - capable of reducing pressure in the desiccator to 5 mm of Hg.
j) Cellulose bands; 2-section holder part No. 625415, Mine Safety Appliances Co. 3-section holder - 41x25 mm, No. 28, Walter H. Jelly and Co., Franklin Park, Illinois.

PREPARATION OF FILTER

a) Place the VM-1 polyvinyl chloride filter into the vacuum desiccator and reduce the pressure to 5 mm Hg.
b) After 15 minutes at the 5-mm pressure, allow the desiccator to return to atmospheric pressure.
c) Make sure the balance is zeroed before weighing. Holding the filter by the edge with tweezers, place it on the balance pan and record the weight to the nearest 0.01 mg (W_1).
d) Insert a backup support pad into the bottom section of the filter holder. Carefully place the weighed filter on the support screen.
e) For total dust sampling (3-section filter holder), place the middle and top sections on the bottom section. Press the sections together firmly until the outer edge of the filter is tightly held against the backup support pad.
f) For respirable dust sampling (2-section filter holder) place the top section on the bottom section and press firmly.
g) Insert the red and blue plugs into the inlets of the filter holders and slip a cellulose band from the storage solution over the outside of the holder. Allow the band to dry thoroughly before using.

5 RESPIRABLE DUST AIR SAMPLING PROCEDURE

a) Remove the red and blue plugs from the 2-section filter holder, and insert the filter holder into the cyclone holder assembly, make sure the filter face is pointing downward toward the cyclone.
b) Clamp the filter holder securely into the cyclone holder, so that the O-rings are held tightly against the filter holder seats.
c) Clip the cyclone holder assembly on the shirt collar of the employee. Attach the sampling lines from the cyclone to the inlet of the portable pump.
d) Adjust the air flow through the cyclone by turning the adjusting screw on the pump until the flowmeter ball on the pump is centered on the red band on the flowmeter (1.8 liters per minute). If samples are to be taken for respirable coal dust, then the recommended flow rate through the cyclone and filter is 2.0 liters per minute. This can be obtained by adjusting the flow on the pump until the flowmeter ball is centered under the orange band on the flowmeter.

e) Place the pump on a belt around the employee's waist. Record the time the pump was started.
f) At the end of the working shift, stop the pump and record the time. Note: respirable dust samples need a minimum of 4-hours sampling time to provide enough sample to obtain an adequate amount of dust to weigh.
g) Carefully remove the sampling assembly from the employee. Remove the filter and holder from the cyclone assembly and replace the red and blue plugs. Do not invert the cyclone assembly during this time as the larger particles of dust from the cyclone can fall onto the filter to give an erroneous weight gain.
h) In the laboratory, split the cellulose band at the junction of the top and bottom section of the filter holder. Carefully pry off the top section.
i) Place the bottom section containing the filter into the desiccator and reduce the pressure to 5 mm Hg for 15 minutes to dry the filter.
j) After the desiccator returns to atmospheric pressure, gently lift the filter out of the bottom section of the filter holder by using a small rod through the hole in the bottom section.
k) Check the zero setting on the balance to make sure it hasn't changed from previous weighing of the filter. Grasp the edge of the filter with the tweezers and reweigh the filter on the balance. Record the weight to the nearest 0.01 mg (W_2).
l) Clean the dust from the cyclone body before the next use.

6 TOTAL DUST AIR SAMPLING PROCEDURE

a) Take a 3-section filter holder which has been prepared according to the directions in Section 4. Slice the cellulose band at the junction of the top section and center retaining ring.
b) Remove the top section and the plug from the bottom section outlet. Attach a piece of tubing from the bottom outlet and connect the other end of the tubing to the Model G MSA pump.
c) Adjust the air flow through the filter by turning the adjusting screw on the pump until the flowmeter ball on the pump is centered on the orange band (2.0 liters per minute).
d) Place the pump on a belt around the employee's waist and clip the filter to the shirt collar of the employee with the face of the filter pointing down.
e) Record the time the sampling pump was started.
f) At the end of the working shift, stop the pump and record the time.
g) Carefully remove the filter from the employee. Replace the top cover and the plug in the bottom outlet.
h) In the laboratory, split the cellulose band at the junction of the bottom section and the middle retaining ring. Carefully pry off the top and middle sections.
i) Place the bottom section containing the filter into the desiccator and reduce the pressure to 5 mm Hg for 15 minutes to dry the filter.

j) After the desiccator returns to atmospheric pressure, gently lift the filter out of the bottom section of the filter holder by using a small rod through the hole in the bottom section.

k) Check the zero setting on the balance to make sure it hasn't changed from previous weighing of the filter. Grasp the edge of the filter with the tweezers and reweigh the filter on the balance. Record the weight to the nearest 0.1 (W_2).

7 CALIBRATION OF MSA SAMPLING PUMP

a) Assemble the apparatus as shown in Figure 1. Tape the cap on the gallon bottle with vinyl electrical tape to insure a tight seal.

b) Start the pump and adjust the flow until the ball in the flowmeter is centered on the red band (1.8 liters per minute).

APPARATUS FOR CALIBRATION OF MSA PERSONAL SAMPLING PUMP

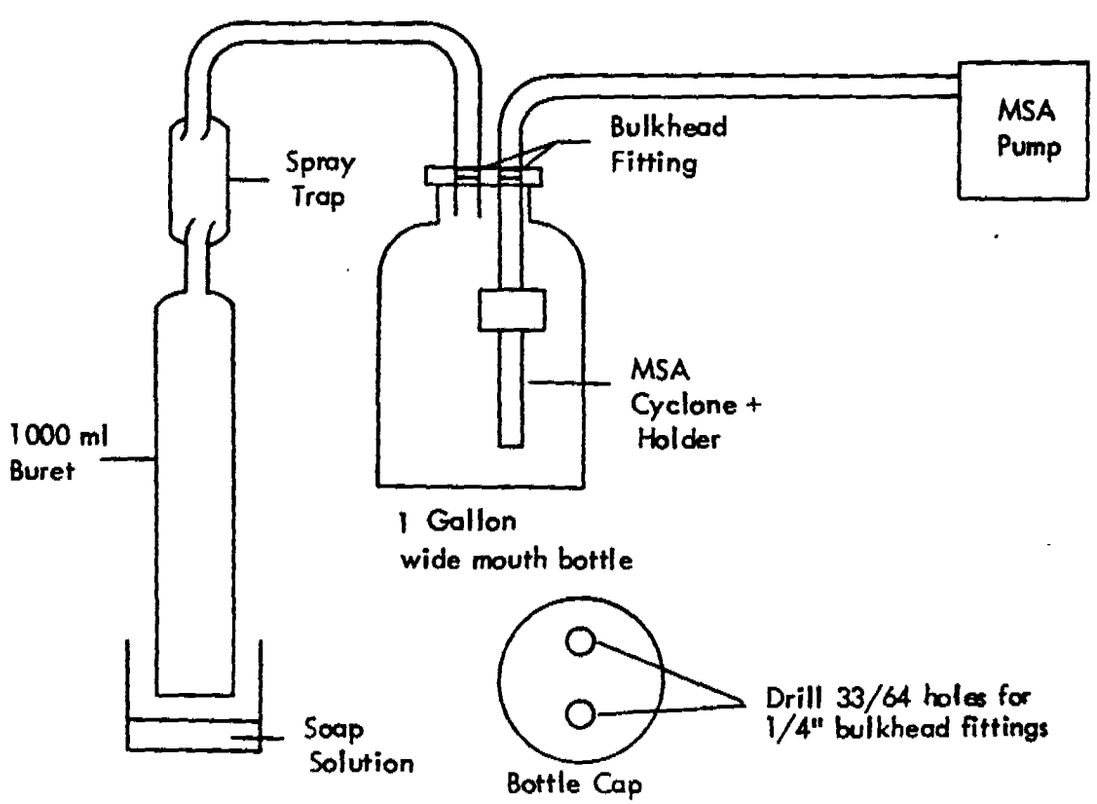


Figure 1

c) Moisten the interior surface of the buret with soap solution.
d) Dip the end of the buret into the soap solution to start a bubble moving up the buret.
e) With a stopwatch, measure the time in seconds that it takes for the bubble to move from the zero graduation mark on the buret to the 1000-ml mark.
f) Divide the time in seconds into 60 to obtain the flow rate in liters per minute.
g) Repeat the determination, centering the flowmeter ball on the pump on the orange band (2.0 liters per minute).
h) A wet test meter may be used in place of the soap-film buret if desired.

8 CALCULATIONS

a) Respirable dust

$$\frac{(W_2-W_1) \times 10^6}{F \times T}$$ = respirable dust concentration in milligrams per cubic meter (mg/M^3)

F = Flow rate in liters per minute through the cyclone and filter
T = Total sampling time in minutes
W_1 = Initial weight of the polyvinyl chloride filter in grams
W_2 = Final weight of the polyvinyl chloride filter in grams

b) Total dust

Use identical calculation except to report the value as total dust concentration in mg/M^3. (F = flow rate in liters through the filter)

federal register

39 FR Number 194

PART II

DEPARTMENT OF LABOR

Occupational Safety And Health Administration

EXPOSURE TO VINYL CHLORIDE

Occupational Safety and Health Standards