MSHA INSTRUCTION GUIDE A-2

INSTRUCTOR'S TEACHING GUIDE

SURVEYING INHALATION CONTAMINANTS IN ABOVE-GROUND METAL AND NONMETAL MINING AND PROCESSING WORK AREAS

For MSHA Inspectors

Prepared for

UNITED STATES DEPARTMENT OF INTERIOR
Bureau of Mines

Contract No. JO 255001

Prepared by

LFE CORPORATION
ENVIRONMENTAL ANALYSIS LABORATORIES
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Richmond, California 94804

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This instructors guide is intended for use in a course which teaches metal and nonmetal mine inspectors to perform surveys for inhalation contaminants in above ground metal and nonmetal mine work areas. The handbook entitled "Handbook for Surveys of Inhalation Contaminants in Above Ground Metal and Nonmetal Mining and Processing Work Areas" is used as a manual during the course. The manual contains a survey check list, rules for determining if sampling is required, a list of most frequently encountered contaminants, a list of candidate contaminants and their sampling conditions, and a description of control procedures and devices. There are several experiments in this guidebook which the trainees perform to acquaint them with the sampling systems.

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FOREWORD

This report was prepared by LFE Corporation, Environmental Analysis Laboratories, Richmond, California 94804, under USBM Contract Number JO 255001. The contract was initiated under the Metal and Nonmetal Mine Health and Safety Program. It was administered under the technical direction of the Pittsburg Mining and Safety Research Center with Dr. R. W. Freedman acting as the Technical Project Officer. Mr. B. G. Horton was the contract administrator for the Bureau of Mines.

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TABLE OF CONTENTS

PREFACE

This is one of a series of instruction guides developed to help instructors in the presentation of health and safety training courses to the people of the metal and nonmetal mining industry. The course is intended to train MESA inspectors in the use of the survey handbooks. This training will be invaluable to the inspectors when performing surveys of above ground metal and nonmetal mining and processing work areas for inhalation hazards. The guide contains three sections: Suggestions to the instructor, an introduction to the course stating its objective and recommended class time, and the text of the course. Standard 8 x 10 transparencies have been prepared for use by the instructor. Other training aids required for the course consist of sampling equipment which is used in the demonstrations.

SUGGESTIONS FOR THE INSTRUCTOR

This course is designed as a mutual endeavor between trainees and instructor. In a sense, it is a "graduate" course, providing additional information on general subjects that the trainees already have some fundamental knowledge about. It can only be successful if a sense of mutual cooperation is established immediately at the start of the training period. Too often resentment about extra study reacts negatively on the ability to learn.

To this end, the course is not designed as a series of lectures to be read or recited to the trainees. Such a procedure could only be destructive. Rather, the course is set up to provide the instructor with the basic materials he is to present, but the actual technique of presentation is left up to the instructor; he alone can tell from the start what type of class he is facing, what their attitudes may be, and what their reactions prove to be.

Frequent emphasis is made on the need for class discussion. Any question dealing with the subject is legitimate food for consideration. THE MOST EFFECTIVE WAY OF LEARNING IS TO SHARE EXPERIENCE. The instructor is urged to solicit experience/response and to use it as much as possible in his presentation of the material.

Frequent reference is made in the course to the handbook, entitled "Handbook for Surveys for Inhalation Contaminants in Above Ground Metal and Nonmetal Mining and Processing Work Areas". The trainees should become familiar with this document, should constantly refer to it, and should recognize it as a vital tool in their work. Knowing how and when to use the handbook is as essential as learning the content of this course.

INTRODUCTION

The inhalation hazards which have been found in the above ground metal and nonmetal mining and processing work areas include dusts, mists, vapors and gases. During this course the students will learn how to sample for harmful concentrations of these inhalation hazards. Most of the students have some familiarity with the proper use of the sampling systems which will be described. These include the personal sampler system, detector tubes and hand pumps.

The handbook entitled "Handbook for Surveys of Inhalation Contaminants in Above Ground Metal and Nonmetal Mining and Processing Work Areas" has been developed to assist these inspectors to perform these surveys. The handbook should be provided to each inspector for use as a manual during the course. Considerable detail has been included in the handbook in order that it may guide the inspectors during their surveys and assist them in interpreting the results from their determinations.

Purpose

The purpose of this course is to provide metal and nonmetal mine inspectors with the knowledge necessary to perform surveys for inhalation contaminants in the above ground metal and nonmetal mining and processing work areas.

Goals and Methods

The goals of this course are to assist metal and nonmetal mine inspectors in:

1. Learning how to use the handbooks in performing surveys for inhalation contaminants in above ground metal and nonmetal mining and processing work areas.
2. Learning how to interpret the results of the determinations which are obtained.

The training methods employed will include lecture-discussion and demonstration techniques reinforced with the use of audio-visual materials. Class participation should be encouraged for the motivation of interest and the further development of concepts.

Objectives

The objectives of this course are to enable MSHA mining inspectors to:

1. Develop the capability for performing surveys for inhalation contaminants in above ground metal and nonmetal mining and processing work areas.
2. Prevent exposures of workers to concentrations of inhalation contaminants exceeding the standards by issuing violations when airborne concentrations of contaminants are found to exceed the standards listed in the Code of Federal Regulations, Title 30, Chapter I, Subchapter N, Part 55, Section 55.5 and Part 57, Section 57.5.

Time

The instruction time required to cover the materials in this course will vary according to the instructor's needs. However, the recommended time is a minimum of 12 hours.

Tools and Supplies Required

Items	Number Required
Metal and Nonmetal Mine Inspector Inhalation Contaminants Handbook	1 for each student
TLV Standards - Handout I (see page 28)	"
Instruction Sheets for Experiments (see Appendix)	"
Personal Sampling Pump, MSA Type G	1
3' Sampling Hose with Clamp, Bendix Catalogue No. 3900-908	1
Personal Sampling Pump, Bendix Catalogue No. 3900	1
Cassette with Weighed Membrane Filter, MSA Catalogue No. 457193	1

Items	Number Required
Cyclone, MSA Catalogue No. 456228	1
Charcoal Tube, MSA Catalogue No. 459004	1
Charcoal Tube Holder, MSA Catalogue No. 459054	1
Gas Sampler, 12 cc, Bistable, Chemical Projects Ltd., Toronto, Canada	1
Hand Pump, MSA Catalogue No. 83499 with Instruction Sheet	1
Detector Tubes, MSA CO_2, Catalogue No. 85976	1 box
Detector Tubes, MSA CO, Catalogue No. 919229	1 box
Detector Tubes, MSA Chlorinated Hydrocarbons, Catalogue No. 88536	1 box
Pyrolyzer, MSA Catalogue No. 87505 with Instruction Sheet	1
Freon, 10 ml	1 bottle
Toluene, 10 ml	1 bottle
Pipette with Rubber Bulb	1
Beaker, 2 liter or coffee can, 2 lb	1
Hand Pump, Drager Model No. 31 with Instruction Sheet	1
Detector Tubes	
Drager (5/a) Toluene, Catalogue No. CH 23001	1 box
Drager (5/c) Carbon Monoxide, Catalogue No. CH 20601	1 box
Rubber Hose, 1/4" ID, 4" length	1
Flow Meters	
Matheson, 603 with Calibration Curve	1
Matheson, 601 with Calibration Curve	1

Items	Number Required
Charcoal Tube Plastic Cap with Both Ends Open	1
Marking Pen	1
Clipboard	1
Pocket Calculator	1

Note this course must be taught by a qualified industrial hygienist or safety officer. He should thoroughly review this course material before presenting it. It is particularly important that he verify that all the training aids (transparencies and sampling equipment) are available. The instructor should perform the demonstrations before class time. He may rearrange the material in order to present it in a manner most suited to his desires. Also the instructor should keep abreast of current federal regulations to present this course in the most updated form.

COURSE A-2

INSTRUCTOR'S TEACHING GUIDE

SURVEYING INHALATION CONTAMINANTS IN ABOVE GROUND METAL AND NONMETAL MINING AND PROCESSING WORK AREAS

The purpose of this handbook is to train MSHA mining inspectors to recognize hazards from inhalation contaminants in above ground work areas of metal and nonmetal mining and processing facilities and to evaluate these hazards by collecting samples, making field determinations and interpreting these results. Title 30, Code of Federal Regulations, Part 55 Health and Safety Standards: Metal and Nonmetallic Open Pit Mines and Part 57 Health and Safety Standards: Metal and Nonmetallic Underground Mines require MESA to survey these work areas for specific inhalation contaminants and to issue violations when personal exposures exceed their standards. Generally the standards are those adopted by the American Conference of Governmental Industrial Hygienists in "Threshold Limit Values of Airborne Contaminants (1973)." Such enforcement is necessary in order for these work areas to be safe for the employees.

In the presentation of this course the handbook entitled "Handbook for Surveys of Inhalation Contaminants in Above Ground Metal and Nonmetal Mining and Processing Work Areas" will be used as a manual. This handbook was developed to serve as a guide for inspectors when they are performing surveys in the metal and nonmetal mining and processing areas. The handbook is intended to be a reference which can be carried with the inspector on surveys.

A health and safety survey is divided into 3 portions: recognition, evaluation, and control. (Slide No. 1)

RECOGNITION

In order for an inspector to recognize hazardous situations involving inhalation contaminants which require sampling, he should be thoroughly familiar with all the activities associated with metal and nonmetal mining and processing work areas. Obviously he must also be familiar with the candidate contaminants for each type of work area. Table 1 on page 4 of the handbook was prepared as a check list to assist the inspector in remembering the candidate contaminants for each work operation and to serve as a check list indicating those which could require sampling. Coded designations which refer to Table 2 are used for

SLIDE 1

Elements of performing health and safety surveys for hazardous situations:

RECOGNITION

EVALUATION

CONTROL

specific contaminants. The work areas listed in Table 1 cover those in strip mining as well as in the above ground work areas for the underground metal and nonmetal mines and the processing facilities. To familiarize the students with the checklist (and Table 2), discuss the contaminants which are listed for the following work functions:

Drying
Explosive Storage
Field Maintenance
Floating
Heavy Equipment Operation
Machinery Repair
Painting

Emphasize that this check list indicates the possible contaminants in each work area. As additional contaminants are found for these work areas, they should be added to the check list and also to Table 2.

To assist the inspector determine situations which should be sampled for specific contaminants, we have provided the following basic rules which are listed below and found on pages 2 and 3 of the handbook:

1. A visible dust or fume cloud is present in the working environment. In addition, there may be visible quantities of settled dust in the work area.
2. A strong odor or eye irritation is noticed by the inspector upon entering the work area.
3. There is evidence of corrosion of ventilation systems or other equipment in the work area.
4. Visible clouds are observed coming from poorly maintained ventilation systems such as holes in ducts.
5. The local ventilation system is not capturing all of the contaminants which are produced by an operation.
6. Chemicals are mishandled as evidenced by chemical spills and careless handling of highly toxic materials.
7. Substances which are hazardous under normal conditions of control and handling such as carcinogens are located at the worksite.

8. Worker's comments and symptoms indicate exposure to at least one contaminant. See Appendix 1.
9. Recognized hazardous situations are present such as operations of internal combustion equipment, unvented combustion heaters, or spray equipment in confined areas. Another hazard would be the vapors in explosive storage areas.
10. In cases of doubt concerning the use of the above rules or in suspect situations not covered, tests should be made.

The instructor should illustrate these rules with specific examples from his experience. The students will not likely be familiar with the physical forms and physiological effects of most of the contaminants listed in Table 2. This information in addition to modes of entry for the contaminants is provided in Appendix 1 of the large handbook. Referring the students to this appendix, present the physical forms and physiological effects for carbon monoxide, disulfide, hydrogen cyanide, stoddard solvent, welding fumes and welding gases.

It is helpful to the inspector to remember that the following contaminants have been found in metal and nonmetal mining and processing surface work areas in concentrations exceeding their standards. These are listed on page 5 of the handbook and are presented below:

1. Welding fumes.
2. Fumes from metal cutting with torches.
3. Solvent vapors from degreasing operations.

For practice the instructor should show the basic rules or effects which each of these contaminants would exhibit if their concentrations exceeded their standards. For instance the production of welding fumes and fumes from metal cutting torches illustrates Rule 1. Solvent vapors from degreasing operations illustrate Rule No. 2.

Although initial studies have not indicated concentrations of airborne asbestos dust which exceeded the standard for workers blowing dust from brake drums or working near devices with exposed asbestos lined brakes, appropriate respirators to be worn during these operations would be recommended.

Frequently the inspectors will encounter commercial materials with

compositions that cannot be determined readily. Several of these "trade name " products which have been encountered in above ground metal and nonmetal mine surveys are listed in Appendix II of this handbook. Their compositions are also listed in this Appendix.

When a suspicious material is encountered whose composition cannot be determined from the information at hand, the inspector should contact his MSHA district office or Technical Support Center providing them with the trade name of the material, the manufacturer's name and address and any special precautions which are listed on the label or flyer for the material.

The chief result of the work which will be performed during the Recognition Phase will be to list the candidate contaminants in each work area which will be sampled during the Evaluation Phase. Usually one can list this information on a copy of the checklist (Table 1).

Before starting the Evaluation Phase, the instructor should ask the class for questions concerning the material previously covered. Use Slide No. 2 to summarize the Recognition Section.

Evaluation

General - In this section we shall discuss the sampling and field measurement techniques which are used to determine the atmospheric concentrations of the candidate contaminants. In addition we shall discuss how these results are evaluated to determine if a violation should be issued.

Using the list of candidate contaminants which was prepared in the previous section, the inspector should review the sampling systems and sampling conditions for each contaminant. A minimum of 4 contaminants per page of Table 2 in the large handbook should be reviewed. Formulas, Threshold Limit Values or standards, most probable locations or tasks, and field sampling or field determination methods should be covered. The instructor should also make a special effort to mention contaminants which illustrate all the 8 notes which are mentioned on page 11. It is likely that many of the students will be unfamiliar with the meaning of most of the terms used here. Therefore each of these terms should be defined (described) briefly with the promise that they will be covered in greater detail later in the course. All of these terms are defined in Appendix III of the handbook.

STEPS IN RECOGNIZING AN INHALATION HAZARD

1. Use Table I to indicate candidate contamina for each work area.

2. Use Thumb Rules (page 2-1) to disclose hazardous situations.

3. Use the List of Most Significant Contaminar (page 2-2) as a reminder to suspect these particular contaminants.

4. Prepare a List of Suspicious Trade-Name Products with their addresses and send this to MESA District Office or Technica Center.

Sampling Devices - These consist of two types: Sample collection systems whose samples must be analyzed in a laboratory and direct reading devices. Examples of the first type are cassettes with membrane filters and charcoal tubes. Detector tubes and direct reading instruments are of the other type (direct reading instruments). When collecting respirable samples, the inspector should attach a cyclone upstream of the membrane filter to remove particles larger than 10 micrometers (μm). Only particles whose diameters are less than 10 μm are retained by the lungs.

Personal Pumps - Only Bureau of Mines approved pumps should be used with the above sampling systems. Show the students a personal sampler system which consists of a cyclone, cassette with preweighed 5 μm PVC filter and a personal pump. This is the same system which inspectors routinely use for dust sampling. In order for a cyclone to function properly, the pump should operate at a flow rate of 2.0 liters per minute. The sampling period for respirable dust samples is generally a complete shift. Using Slide No. 3, decribe the components of the cyclone and its operation. Caution the inspectors against dumping the large particles onto the filters by inverting the cyclones.

List the operating characteristics of the personal pump:

Flow Rate - 1/2-2 liters per minute

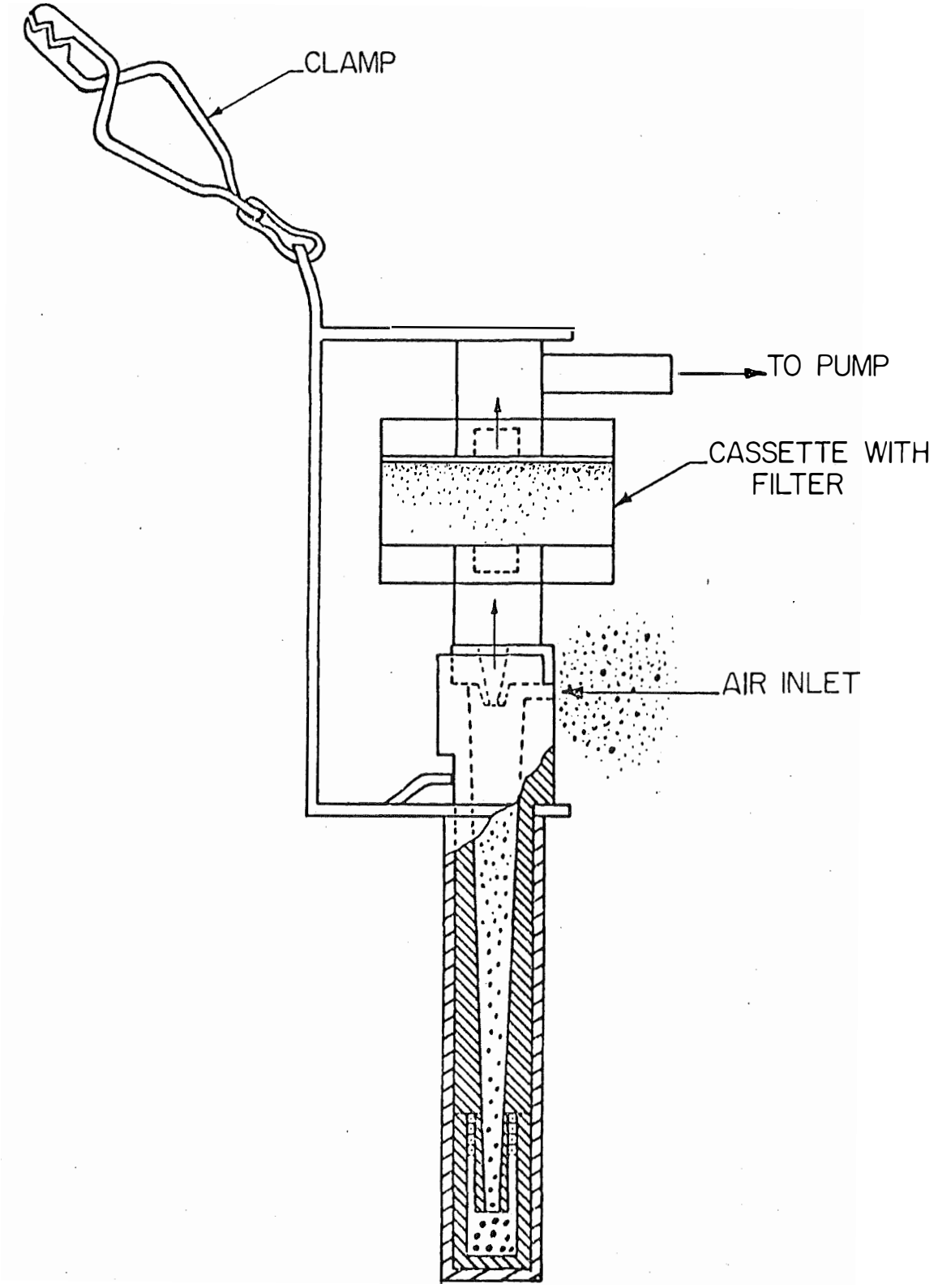
Typical Operating Period - 8 hours before recharging is required.

Recharging Period - 16 or 64 hours.

Portability - It can be worn by an employee performing his usual duties.

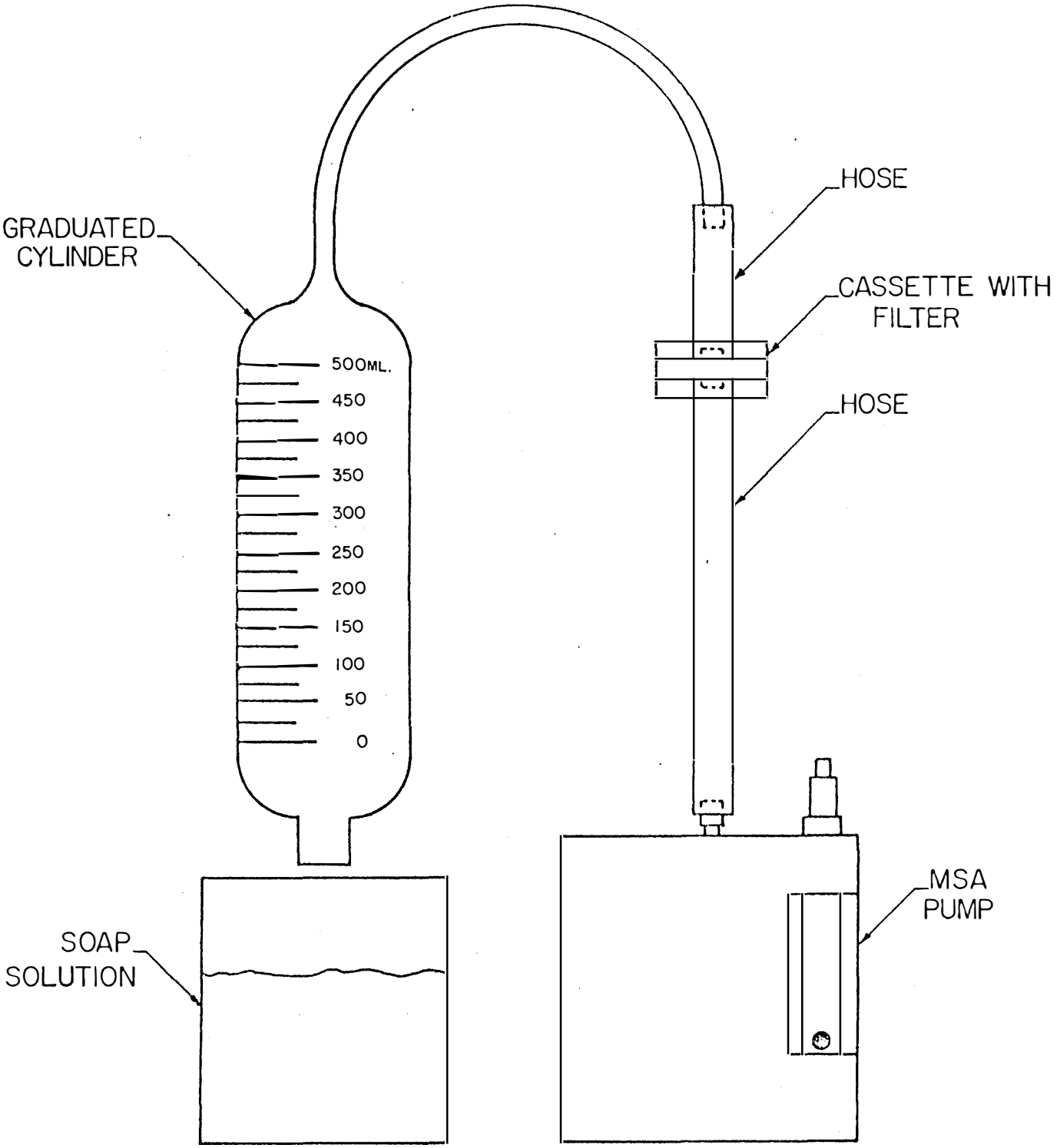
The flowmeters on the pumps must be calibrated for each type of collector which is used. Wet test meters or soap-bubble meters are recommended for the calibration of personal pumps. With both these instruments, the time required for a known volume of air to be drawn through the collector by the pump is determined. Slide No. 4 shows a sketch of a soap-bubble meter. The known air volume is obtained having a soap-bubble pass between two markings on the burette. The times (t) for this volume of air (V) to pass through the collector at various pump flowmeter settings are recorded using a stop watch. The flow rate (FR) is determined from the equation:

$$\text{FR in liters per minute} = \frac{\text{V in liters}}{\text{t in minutes}}$$



CYCLONE USED FOR RESPIRABLE SAMPLING

SLIDE 4



SOAP-BUBBLE METER SYSTEM

The standard conditions are a temperature of 77°F and one atmosphere pressure 29.92" of mercury. As long as the test conditions are between 90°F and 64°F and 30.67" and 29.17" of mercury, these errors will be below 5%. If conversion of the flow rate to standard conditions (FR_{sc}) is desired, use the equation shown in Slide No. 5.

Generally the sample collectors are placed in the worker's breathing zone (within 36" of his mouth). While the sampler systems are being operated, the inspectors should check them at frequent intervals to verify that,

the pumps are operating,

the filters have not been plugged by high dust concentrations and

the workers appear to be performing their duties as anticipated.

The flow rate during the sampling period is average of that at the beginning and the end of this period.

The Sipin flow-rate personal pumps Models SP-1 and SP-2 are excellent for sampling organic vapors.

Show a Sipin pump with charcoal tube and holder. Use Slide No. 6 showing the Sipin pump, charcoal tube holder, and recharger being sure to point out the air volume indicator (stroke counter), flow rate adjustment, charging jack, and off-on switch. The primary advantage of low-flow rate pumps is that they extend the time for collecting a 10 liter sample on a charcoal tube from 10 minutes (for MSA or Bendix personal pumps) to 200 minutes. The longer sampling time allows one to evaluate the worker's 8 hour exposure with fewer samples. The Sipin pumps are portable, battery operated, and rechargeable. Be sure to emphasize the stroke counter allows one to calculate the volume sampled in a unique way.

No. of Strokes x cc/stroke = Volume Sampled in cc

Explain that cc are cubic centimeters which are ~1/1000 of a liter. The Sipin pumps must be calibrated for each type of collector which is used. They should be calibrated at several flow rates such as 25, 50, and 100 cubic centimeters per minute.

Membrane Filters - As mentioned earlier the personal sampler system consists of a cyclone, a cassette with a pre-weighed 5 μm PVC membrane filter and a personal pump which is recommended for sampling fumes, mists, and airborne dusts except for asbestos. The part numbers for these items which are

$$FR_{SC} \text{ in liters per min.} = \frac{V \text{ in liters}}{t \text{ in min.}} \times \frac{460 + T \text{ in } °F}{460 + 77°F} \times \frac{29.9 \text{ "Hg}}{P \text{ in "Hg}}$$

where FR_{SC} = Flowrate at standard conditions

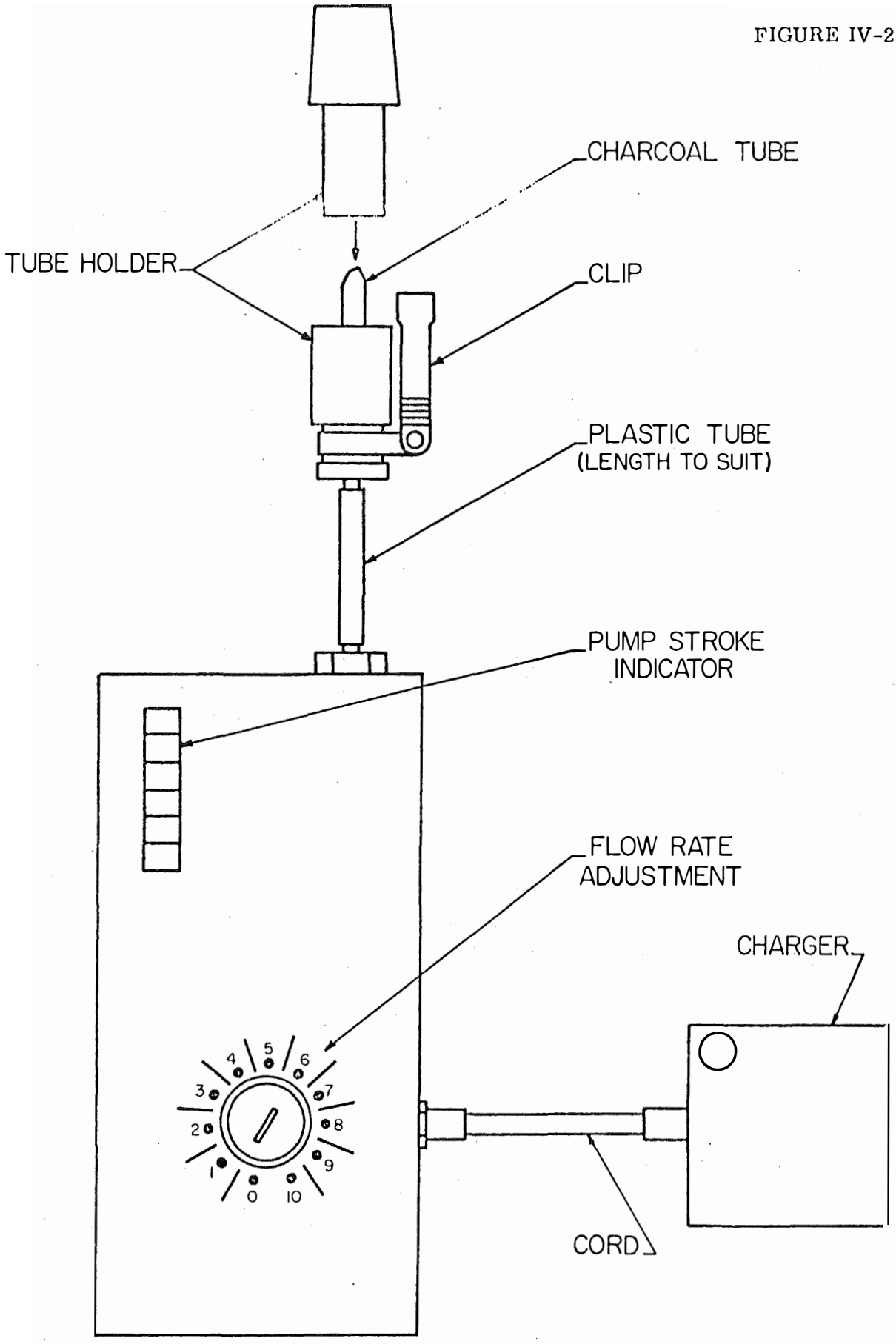
V = Volume of air tested

t = Time for V to pass through collector

T = Room temperature during test

P = Atmospheric pressure during test

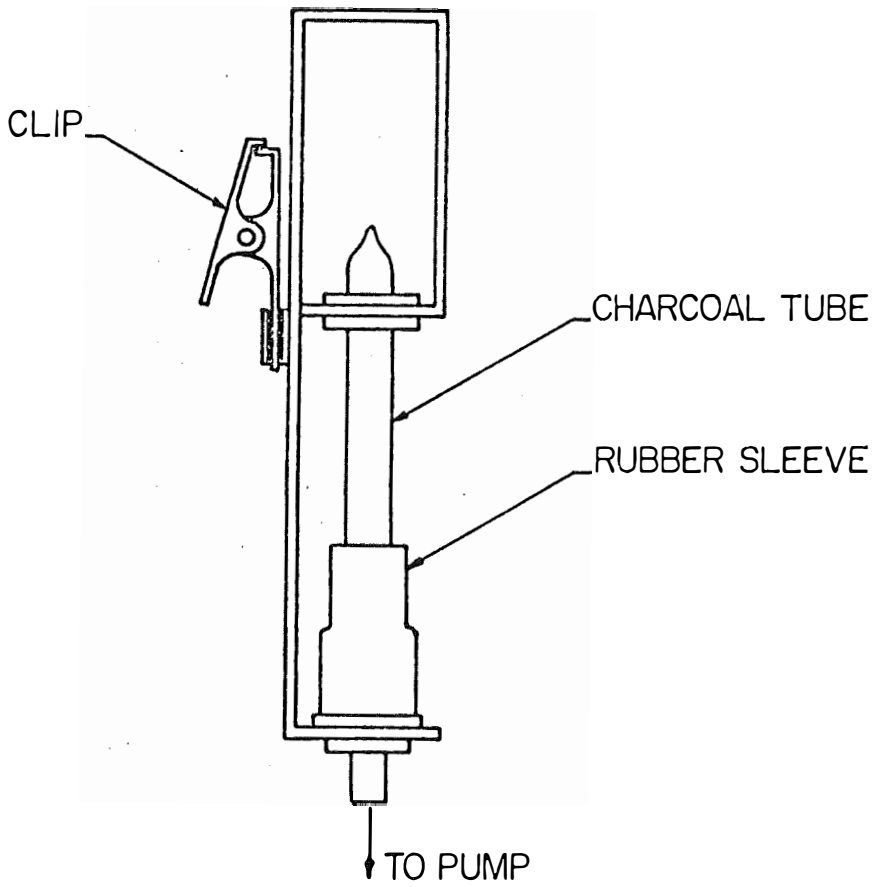
FIGURE IV-2



SIPIN PUMP, CHARCOAL TUBE HOLDER AND CHARGER

manufactured by MSA and Bendix are listed in the handbook on page 13. These casettes come with blue and white sampling data cards. The blue cards indicate the samples were collected by government rather than company personnel. The company personnel use the white card for their samples. Generally full shift collections at 2 liters per minute are made with these sampling systems. Figure 1 on page 14 illustrates the collection system used for airborne asbestos fibers. Note that this system consists of a 3 piece plastic cassette and a Millipore filter with 0.8μm pores. When this system is used, the top cap of the filter cassette is removed and sample is collected with the cassette pointing downward. Refer to the sampling conditions and analytical method for airborne asbestos which are listed in Table 2 on page 7. Asbestos is sampled at 2 liters per minute for 15 minutes to 4 hours depending on the airborne asbestos and background dust concentrations and analyzing the samples manually by phase contrast microscopy at 450X.

Charcoal Tubes - Specially manufactured charcoal tubes are used with personal sampling pumps for collecting samples with gases and vapors. The MSA Company and SKC, Inc., are two of the manufacturers of these tubes. These tubes which are illustrated in Figure 2 are about 3 inches long by 1/4" in diameter. As shown in Figure 2, they are provided with plastic end caps to seal the tubes after the ends are broken off to permit air to be drawn through. The instructor should now demonstrate how these tubes are properly used by using the hole in key or in one of the plastic cassettes to break off the sealed ends. He should insert the tube into the special holder (Slide No. 7) making sure that the air will flow through the tube in the proper direction as indicated by the arrow. The instructor should point out that there are two layers of charcoal, an initial and backup layer which are usually analyzed separately. Generally the back-up layer is used to indicate when the front section was overloaded. The hose on the special holder should be attached to a sampling pump and the holder with the charcoal tube should be attached to instructor's collar so that it hangs a few inches from his mouth. The pump should now be attached behind the instructor on his belt with the hose running up over his left shoulder. The pump should now be turned on for a short period of time to simulate the sampling period. The system should now be removed from the instructor. He should disconnect the charcoal tube and seal it immediately with the plastic caps which are supplied. The tube should now be placed in a coin envelope measuring about 3 to 4 inches. It should be sealed and labeled with the sample designation.



SPECIAL HOLDER FOR CHARCOAL TUBE

Collection times are usually limited to 10 minutes at 1 liter/min using the standard sampling pumps. Thus the volume sampled will be 10 liters. As described previously, the Sipin low-flow rate pumps are frequently used to increase the sampling time without increasing the volume sampled. At 50 cc/min they can increase the time to 200 min for collecting a 10 liter sample. A blank tube will be sent with the collected samples to the laboratory for analysis. Also send to the laboratory in a separate package, small bottles of the liquids producing the vapor. About 20 ml of material in each container is sufficient. The material in these bottles will be used as standards to assist the laboratory in the identification of the vapors collected. (At this time it is not planned for the inspectors to use the charcoal tubes to collect the samples. This material was included to familiarize the inspectors with this sampling system because it is likely that in the future they will use this method.)

Gas Collectors - Gas collector systems are 250 ml evacuated glass sampling bottles, 10 ml syringes, and 10 ml vacutainers. In addition there is the Bistable gas sampler, produced by Chemical Projects Limited, Toronto, Canada, in which a vacuum is produced by bending this flexible metal container which is informally called the "crickett." (One of these units should be passed around the class.) These samples which are called grab samples are collected by quickly opening the containers in the atmosphere to be sampled.

Detector Tube Systems - On Figure 3 on page 16 the gas detector tube systems are illustrated. These systems consist of hand operated suction pumps which draw fixed volumes of air through sealed glass tubes containing chemically impregnated packing which indicates the concentration of contaminant in the air by the length of chemically produced color change in the packing. The manufacturers of detector tube sampling systems include Bendix/Gastec, Draeger, Matheson-Kitagawa, and MSA. The instructor should now illustrate the use of the MSA system to show that the background concentration of carbon dioxide is approximately 0.03%. Be sure to follow the instructions for the pump and tubes being used. Pumps should be used only with pumps made by the same manufacturer. The following steps should be taken:

1. Select proper orfice if required.
2. Break off the tips of the tube and insert it in the pump.

3. Position the pump in the zone being sampled.
4. Wait the required periods during strokes in order for the required air volume to pass through the tube.
5. Insure that the stain has the proper color and none of the interferences listed on the instruction sheet are present.
6. Read the contaminant concentration directly by comparing the stain length to the markings on the tube or the scale on the instruction sheet. When determining the stain length, the observer should have his eye directly above the tube.

In accordance with manufacturers' instructions detector tubes should be stored in a refrigerator. Detector tubes should not be used with pumps made by other manufacturers. The detector tube pumps are of two types - piston and bellows. The piston pumps should be checked every three months in accordance with the manufacturers' instructions to insure that they operate with the proper flow rates. These tests involve the use of a wet test meter or bubble meter.

To allow the students to obtain direct experience in the use of the detector tube systems, two sets of experiments are recommended. In order to keep the groups performing these tests small, a third set with personal sampling systems is included. The instructor should determine before class time if he desires to use all these experiments. It is recommended all the experiments be used. He should check out the experiments beforehand to insure he can perform them properly.

Divide the class into 3 teams. Each team will have a team leader and will work independently at one of 3 tables to perform the required tests for that position. After the instructor has verified that each team has completed the tasks for its position, the teams will be rotated to new positions until all experiments are completed at the three positions by each team. It will require 20-30 minutes to complete the experiments at each position.

It will take a few minutes for the instructor to arrange the materials and equipment on the three tables for these experiments. If practical, give the class a coffee or lunch break at this time. Instruction sheets for performing each experiment are presented in the Appendix. These instruction sheets are numbered 1A, 1B, 2A, 2B, 3A and 3B. Each contains a list of equipment and

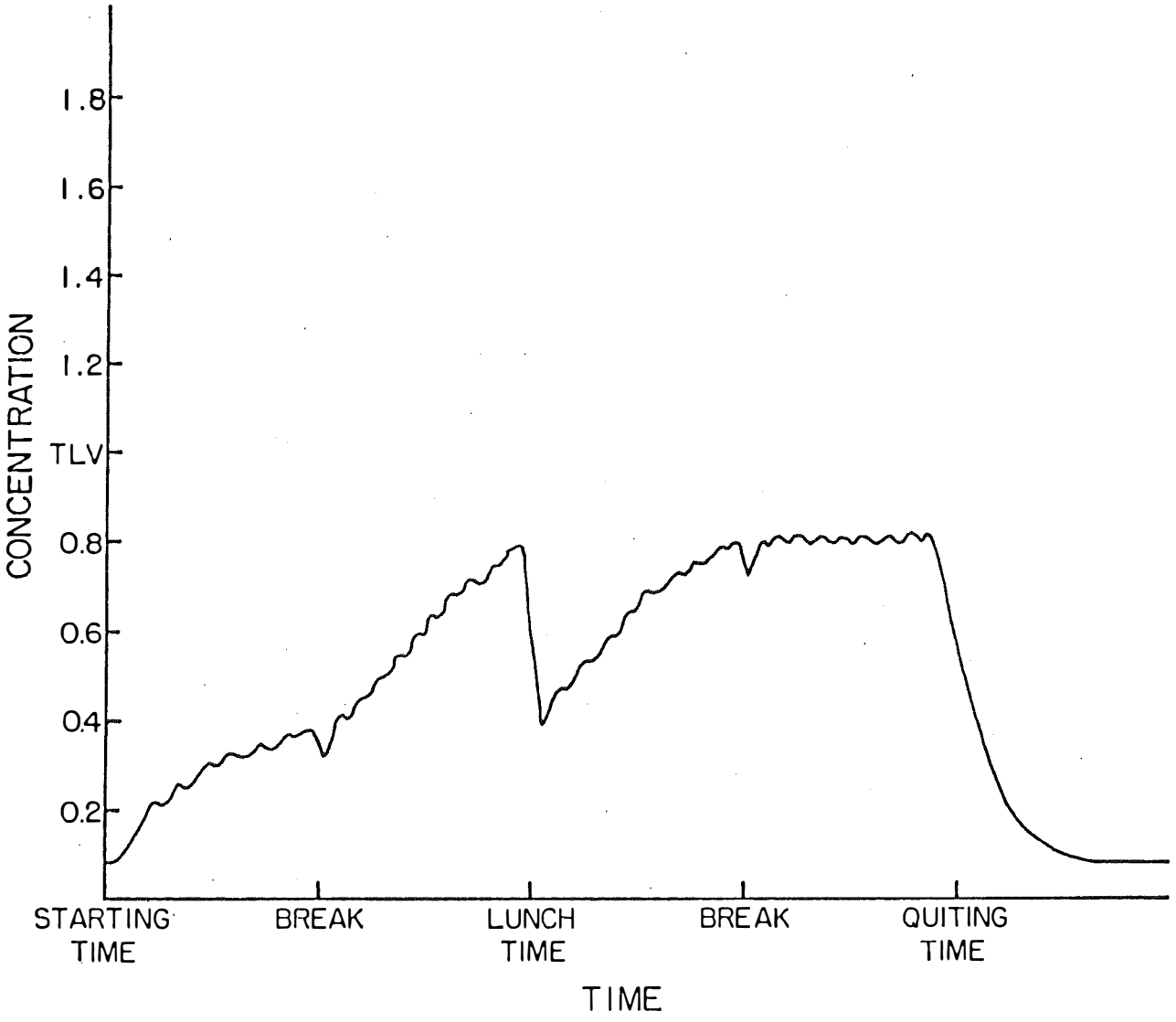
materials required for the experiment. At each position the instructor should provide all the students with copies of the instruction sheets for the experiments to be performed at that position. Experiments 1A and 1B, 2A and 2B, 3A and 3B are to be performed at the same tables. The teams should complete the A experiments before starting the B experiments. As indicated earlier, the teams will be rotated among the positions until all experiments have been completed.

Direct Reading Instruments - As illustrated in Figure 4, direct reading instruments are those which employ a sensitizing cell which produces a signal electronically that indicates the concentration of a contaminant on a dial or recorder. Inspectors are likely familiar with such instruments for measuring noise and methane. Others are available for determining ozone, total oxides of nitrogen, nitrogen oxide, carbon monoxide, carbon dioxide and oxygen and organic halides. Usage of these instruments is not recommended; however, it is anticipated that in the future these instruments will be made available to field inspectors.

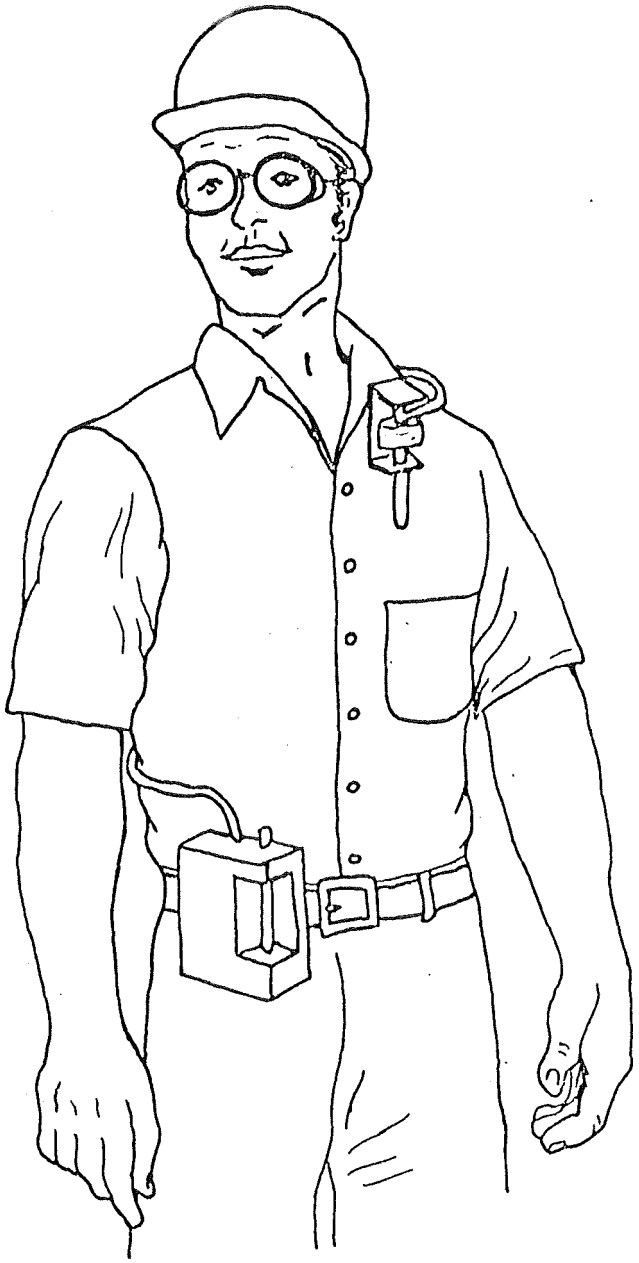
The instructor should advise the inspectors to follow the operating instructions and particularly to look for compounds which interfere with the readings and the inspector should check the section about the Number of Samples to Collect to verify that he makes an appropriate number of readings throughout the 8 hour shift.

Direct reading instruments can also be used to estimate Excursion or Ceiling Limit concentrations, which are the maximum average concentrations permitted for short intervals (15 minutes) during a work day. Excursion and ceiling concentrations will be discussed in greater detail later in this section. Some direct reading instruments are attached to recorders which plot concentration against time (Slide 8) and integrators which show the average concentration during the period sampled.

Types of Samples (Personal or Area) - There are two types of samples, personal or area, which one may collect. The personal samples, the ones where the sampling system is worn by the employee, are generally preferred. Slide No. 9 illustrates how a personal sampling system is mounted on an employee. This type of sample should be collected from an employee's breathing zone which is considered to be within 36" of his mouth; however, one should always observe the worker frequently while he is performing his duties to determine that the concentration of contaminant being sampled approximates the one he is breathing.



TYPICAL RESULTS FROM RECORDER ATTACHED TO A DIRECT READING INSTRUMENT



PERSONAL SAMPLING SYSTEM MOUNTED ON AN EMPLOYEE

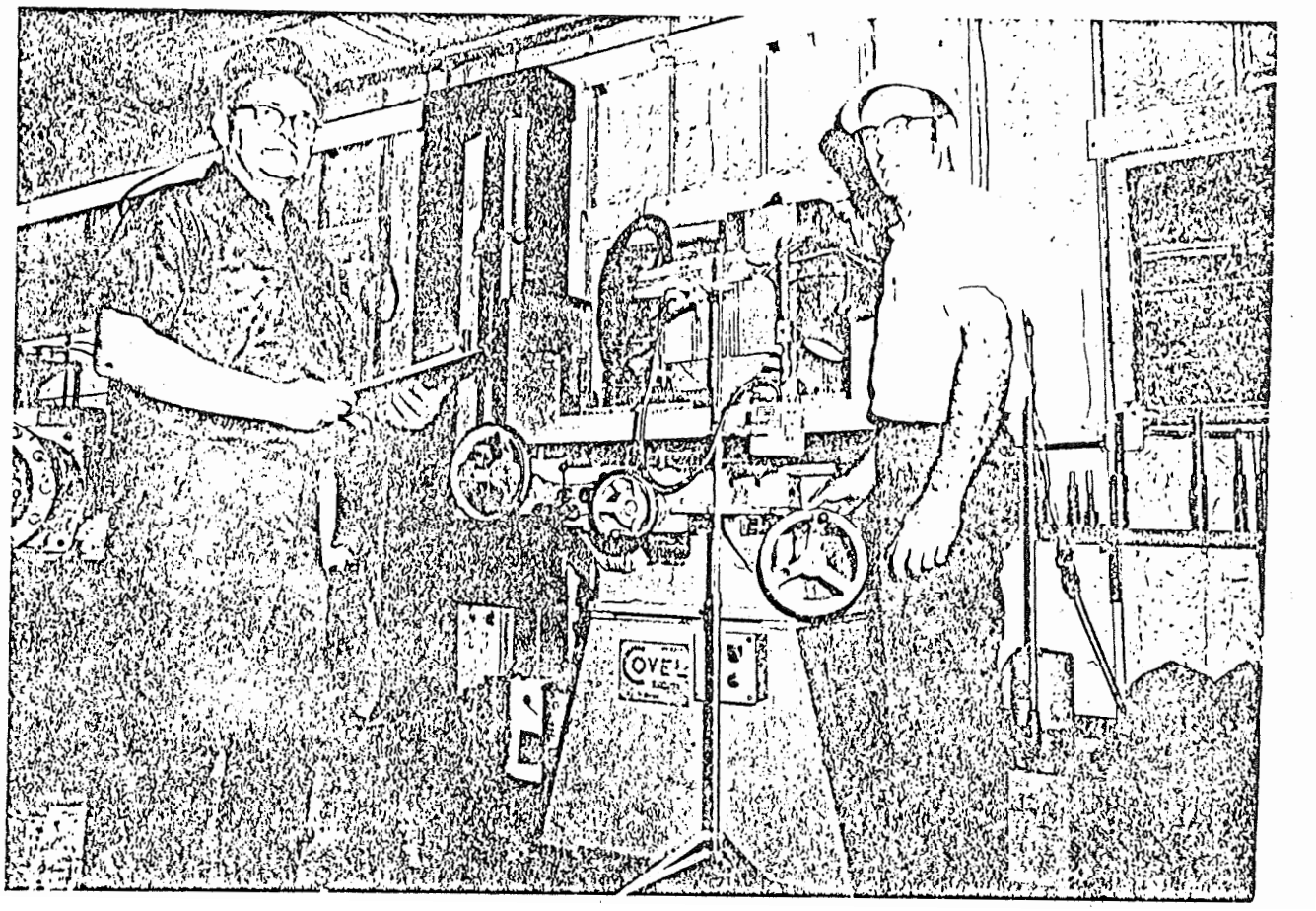
For example,a welder might have his head in the smoke plume from his work, while the plume could be so narrow that 6" away where the sample collector was placed that there would be no smoke. Personal samples are preferred to area samples, those collected at fixed locations, because the former are more representative of the workers' exposures. The collection of an area sample is illustrated in Slide No. 10. A telescoping tripod support can be used as shown or the collection system may be taped to a support. Area samples should be collected at heights corresponding to the average heights of the breathing zones of workers while performing their usual duties in the work area being sampled. In a few instances one must collect area samples because the average daily period that the workers are exposed to the contaminant is less than the minimum collection time for the sampling method.

Standards - The Threshold Limit Values (TLV's) which are listed in Table 2 are standards which are the maximum permissible 8 hour time-weighted average (TWA) concentrations except for contaminants having a "C" before their name. The regulations which make these TLV's standards are in the Code of Federal Regulations, Title 30, Chapter I, Subchapter N, Part 55, Section 55.5-1 (c) and part 57, Section 57.5-1 (c). A copy of these sections which are included should be given to each student as Handout No. 1. The TLV's for the "C" compounds are Ceiling Limit concentrations (C) and will be considered later in this section. TWA's are average concentrations of contaminants for 8 hour work shifts. These are determined by collecting samples throughout the entire work shift. Calculation of an 8 hour TWA for an operation lasting less than the entire work shift is shown in Section 4a (page 18) in the handbook.

The instructor should present a similar situation of a sample collected using a personal sampler, mounted on a welder and operated at 2 liter per min. for 8 hours. When the membrane filter was weighed, it was found to have collected 11.5 mg of respirable dust. The concentration is then calculated in Slide No. 11. Comparing this value to the TLV for nuisance dust which is 10 mg/m^3, we see that this 8 hr. TWA definitely exceeds the standard.

Note 7, on page 11 of the handbook states: "All welding and cutting fume samples should first be weighed to determine if a nuisance dust violation exists. If the nuisance dust standard is not exceeded, the individual metallic and gaseous contaminants will not generally exceed their respective TLV's."

SLIDE 10



TYPICAL AREA SAMPLING SYSTEM

[§55.4--28 added at 41 F.R. 23612, effective July 15, 1976.]

55.4-29 *Mandatory.* When welding or cutting, suitable precautions shall be taken to insure that smoldering metal or sparks do not result in a fire. Fire extinguishing equipment shall be immediately available at the site.

[§55.4--29 amended at 37 F. R. 14369; effective September 2, 1972.]

55.4-30 Employees should be trained in the use of firefighting equipment.

55.4-31 A firefighting organization should be established, equipped, and trained in firefighting; drills should be held at least twice a year.

[§55.4--32 revoked at 38 F. R. 23380; effective August 29, 1973.]

55.4-33 *Mandatory.* Valves on oxygen and acetylene tanks shall be kept closed when the contents are not being used.

55.4-34 Belt conveyors in locations where fire would create a hazard to personnel should be provided with safety switches to stop the drive pulley automatically in the event of excessive slippage.

55.4-35 Mandatory. Before any heat is applied to pipelines or containers which have contained flammable or combustible substances, they shall be drained, ventilated, thoroughly cleaned of residual substances and filled with either an inert gas or, where compatible, filled with water.

[§55.4--35 added at 41 F.R. 23612, effective July 15, 1976.]

[§55.4--36 through 55.4--38 reserved.]

55.4-39 Suitable fire extinguishers should be provided on self-propelled mobile equipment with enclosed cabs.

[§55.4--27 renumbered as 55.4--39 at 41 F.R. 23612, effective July 15, 1976.]

55.4-40 *Mandatory.* Fire alarm systems shall be provided and maintained in operating condition or adequate fire alarm procedures shall be established to warn promptly all persons endangered by a fire.

55.4-41 Two exits should be provided where men work or congregate.

[§55.4--42 thru 55.4--47 Reserved.]

55.4-48 *Mandatory.*—All employees shall be instructed at least once each calendar year on fire alarm signals and applicable procedures to be followed in case of fire or other emergency. Records of instruction shall be kept for two years.

[§55.4--48 added at 38 F.R. 23380, effective August 29, 1973--see ¶ 8916.]

55.4-49 Combustible materials, grease, lubricants, or flammable liquids should not be allowed to accumulate where they can create a fire hazard.

[§55.4--12 renumbered as 55.4--49 at 41 F.R. 23612, effective July 15, 1976.]

[34 F.R. 12504, July 31, 1969, as amended at 35 F.R. 3661, Feb. 25, 1970; 35 F.R. 18568, Dec. 8, 1970]

[¶7901.05]

§ 55.5 Air quality and physical agents.

Air Quality

55.5-1 *Mandatory.* Except as permitted by § 55.5-5:

(a) Except as provided in paragraph (b), the exposure to airborne contaminants shall not exceed, on the basis of a time weighted average, the threshold limit values adopted by the American Conference of Governmental Industrial Hygienists, as set forth and explained in the 1973 edition of the Conference's publication, entitled "TLV's Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1973," pages 1 through 54, which are hereby incorporated by reference and made a part hereof. This publication may be obtained from the American Conference of Governmental Industrial Hygienists by writing to the Secretary-Treasurer, P.O. Box 1937, Cincinnati, Ohio 45201, or may be examined in any Metal and Nonmetal Mine Health and Safety District or Subdistrict Office of the Mining Enforcement and Safety Administration. Excursions above the listed thresholds shall not be of a greater magnitude than is characterized as permissible by the Conference.

(b) The 8-hour time weighted average airborne concentration of asbestos dust to which employees are exposed shall not exceed 5 fibers per milliliter greater than 5 microns in length, as determined by the membrane filter method at 400-450 magni-

[The next page is 5245-7]

fication (4 millimeter objective) phase contrast illumination. No employee shall be exposed at any time to airborne concentrations of asbestos fibers in excess of 10 fibers longer than 5 micrometers, per milliliter of air, as determined by the membrane filter method over a minimum sampling time of 15 minutes. "Asbestos" is a generic term for a number of hydrated silicates that, when crushed or processed, separate into flexible fibers made up of fibrils. Although there are many asbestos minerals, the term "asbestos" as used herein is limited to the following minerals; chrysotile, amosite, crocidolite, anthophyllite asbestos, tremolite asbestos, and actinolite asbestos.

(c) Employees shall be withdrawn from areas where there is present an airborne contaminant given a "C" designation by the Conference and the concentration exceeds the threshold limit value listed for that contaminant.

[§55.5--1 amended at 39 F. R. 24316, July 1, 1974.]

55.5-2 *Mandatory.* Dust, gas, mist, and fume surveys shall be conducted as frequently as necessary to determine the adequacy of control measures.

55.5-3 *Mandatory.* Holes shall be collared and drilled wet, or other efficient dust control measures shall be used when drilling nonwater-soluble material. Efficient dust control measures shall be used when drilling water-soluble materials.

55.5-4 Muckpiles, haulage roads, rock transfer points, crushers, and other points where dust is produced in amounts sufficient to cause a health or safety hazard should be wetted down as often as necessary, unless dust is controlled adequately by other methods.

55.5-5 *Mandatory.* Control of employee exposure to harmful airborne contaminants shall be, insofar as feasible, by prevention of contamination, removal by exhaust ventilation, or by dilution with uncontaminated air. However, where accepted engineering control measures have not been developed or when necessary by the nature of work involved (for example, while establishing controls or occasional entry into hazardous atmospheres to perform maintenance or investigation), employees may work for reasonable periods of time in concentrations of airborne contaminants exceeding permissible levels if they are protected by appropriate respiratory protective equipment. Whenever respiratory protective equipment is used a program for selection, maintenance, training, fitting, supervision, cleaning, and use shall meet the following minimum requirements:

(a) Mining Enforcement and Safety Administration approved respirators which are applicable and suitable for the purpose intended shall be furnished, and employees shall use the protective equipment in accordance with training and instruction.

(b) A respirator program consistent with the requirements of ANSI Z88.2-1969, published by the American National Standards Institute and entitled "American National Standards Practices for Respiratory Protection ANSI-Z88.2 1969," approved August 11, 1969, which is hereby incorporated by reference and made a part hereof. This publication may be obtained from the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018, or may be examined in any Metal and Nonmetal Mine Health and Safety District or Subdistrict Office of the Mining Enforcement and Safety Administration.

(c) When respiratory protection is used in atmospheres immediately harmful to life, the presence of at least one other person with backup equipment and rescue capability shall be required in the event of failure of the respiratory equipment.

[§55.5--5 amended at 39 F. R. 24316, July 1, 1974.]

55.5-6 through 55.5-14 [Reserved]

[34 F.R. 12504, July 31, 1969, as amended at 35 F.R. 3661, Feb. 25, 1970; 35 F.R. 18586, Dec. 8, 1970]

Physical Agents

55.5-50 Mandatory. (a) No employee shall be permitted an exposure to noise in excess of that specified in the table below. Noise level measurements shall be made using a sound level meter meeting specifications for type 2 meters contained in American National Standards Institute (ANSI) Standard S1.4-1971, "General Purpose Sound Level Meters," approved April 27, 1971, which is hereby incorporated by reference and made a part hereof, or by a dosimeter with similar accuracy. This publication may be obtained from the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018, or may be examined in any Metal and Nonmetal Mine Health and Safety District or Subdistrict Office of the Mining Enforcement and Safety Administration.

PERMISSIBLE NOISE EXPOSURES

Duration per day, hours of exposure:	*Sound level, dBA, slow response*
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

No exposure shall exceed 115 dBA. Impact or impulsive noises shall not exceed 140 dB, peak sound pressure level.

NOTE. When the daily noise exposure is composed of two or more periods of noise exposure at different levels, their combined effect shall be considered rather than the individual effect of each.

If the sum

$$\frac{C_1}{T_1}+\frac{C_2}{T_2}+\ \ldots\ \frac{C_n}{T_n}$$

exceeds unity, then the mixed exposure shall be considered to exceed the permissible exposure. C_n indicates the total time of exposure at a specified noise level, and T_n indicates the total time of exposure permitted at that level. Interpolation between tabulated values may be determined by the following formula:

$$\log T = 6.322 - 0.0602\,SL$$

Where T is the time in hours and SL is the sound level in dBA.

(b) When employees' exposure exceeds that listed in the above table, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce exposure to within permissible levels, personal protection equipment shall be provided and used to reduce sound levels to within the levels of the table.

[§55.5--50 added at 39 F.R. 28433, August 7, 1974.]

§ 55.6 Explosives.

The term "explosives" as used in this § 55.6 includes blasting agents. The standards in this section in which the term "explosives" appears are applicable to blasting agents (as well as to other explosives) unless blasting agents are expressly excluded.

Storage

55.6-1 *Mandatory.* Detonators and explosives other than blasting agents shall be stored in magazines.

57.4-75 *Mandatory.* Belt conveyors shall be equipped with slippage and sequence switches.

[§57.4--73 - 56.4--74 added at 38 F.R. 23382, August 29, 1973. §56.4--75 effective October 1, 1973.]

57.4-85 Mandatory. Stationary diesel equipment shall not be supported on a combustible base.

[§57.4--85 added at 41 F.R. 23616, effective July 15, 1976.]

57.4-86 Mandatory. Stationary diesel equipment shall be provided with a thermal sensor which automatically stops the diesel engine should overheating occur.

[§57.4--86 added at 41 F.R. 23616, effective July 15, 1976.]

[¶7903.05]

§ 57.5 Air quality, ventilation, radiation and physical agents.

Air Quality

GENERAL--SURFACE AND UNDERGROUND

57.5-1 *Mandatory.* Except as permitted by § 57.5-5: (a) Except as provided in paragraph (b), the exposure to airborne contaminants shall not exceed, on the basis of a time weighted average, the threshold limit values adopted by the American Conference of Governmental Industrial Hygienists, as set forth and explained in the 1973 edition of the Conference's publication, entitled "TLV's Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1973," pages 1 through 54, which are hereby incorporated by reference and made a part hereof. This publication may be obtained from the American Conference of Governmental Industrial Hygienists by writing to the Secretary-Treasurer, P.O. Box 1937, Cincinnati, Ohio 45201, or may be examined in any Metal and Nonmetal Mine Health and Safety District or Subdistrict Office of the Mining Enforcement and Safety Administration. Excursions above the listed thresholds shall not be of a greater magnitude than is characterized as permissible by the Conference.

(b) The 8-hour time weighted average airborne concentration of asbestos dust to which employees are exposed shall not exceed 5 fibers per milliliter greater than 5 microns in length, as determined by the membrane filter method at 400-450 magnification (4 millimeter objective) phase contrast illumination. No employee shall be exposed at any time to airborne concentrations of asbestos fibers in excess of 10 fibers longer than 5 micrometers, per milliliter of air, as determined by the membrane filter method over a minimum sampling time of 15 minutes. Asbestos is a generic term for a member of hydrated silicates that, when crushed or processed, separate into flexible fibers made up of fibrils. Although there are many asbestos minerals, the term "asbestos" as used herein is limited to the following minerals; chrysotile, amosite, crocidolite anthophyllite asbestos, tremolite asbestos, and actinolite asbestos.

(c) Employees shall be withdrawn from areas where there is present an airborne contaminant given a "C" designation by the Conference and the concentration exceeds the threshold limit value listed for that contaminant.

[§57.5--1 amended at 39 F.R. 24319, July 1, 1974.]

57.5-2 *Mandatory.* Dust, gas, mist, and fume surveys shall be conducted as frequently as necessary to determine the adequacy of control measures.

57.5-3 *Mandatory.* Holes shall be collared and drilled wet, or other efficient dust-control measures shall be used when drilling non-water-soluble material. Efficient dust-control measures shall be used when drilling water-soluble materials.

57.5-4 Muckpiles, haulage roads, rock transfer points, crushers, and other points where dust is produced in amounts sufficient to cause a health or safety hazard should be wetted down as often as necessary, unless the dust is controlled adequately by other methods.

57.5-5 *Mandatory.* Control of employee exposure to harmful airborne contaminants shall be, insofar as feasible, by prevention of contamination, removal by exhaust ventilation, or by dilution with uncontaminated air. However, where accepted engineering control measures have not been developed or when necessary by the nature of work involved (for example, while establishing controls or occasional entry into hazardous atmospheres to perform maintenance or investigation), employees may work for reasonable periods of time in concentration of airborne contaminants exceeding permissible levels if they are protected by appropriate respiratory protective equipment. Whenever respiratory protective equipment is used a program for selection, maintenance, training, fitting, supervision, cleaning, and use shall meet the following minimum requirements.

(a) Mining Enforcement and Safety Administration approved respirators which are applicable and suitable for the purpose intended shall be furnished, and employees shall use the protective equipment in accordance with training and instruction.

(b) A respirator program consistent with the requirements of ANSI Z88.2-1969, published by the American National Standards

Institute and entitled "American National Standards Practices for Respiratory Protection ANSI Z88.2-1969, approved August 11, 1969, which is hereby incorporated by reference and made a part hereof. This publication may be obtained from the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018, or may be examined in any Metal and Nonmetal Mine Health and Safety District or Subdistrict Office of the Mining Enforcement and Safety Administration.

(c) When respiratory protection is used in atmospheres immediately harmful to life, the presence of at least one other person with backup equipment and rescue capability shall be required in the event of failure of the respiratory equipment.

[§57.5--5 amended at 39 F.R. 24320, July 1, 1974.]

57.5-6 through 57.5-9 [Reserved]

SURFACE ONLY

57.5-10 through 57.5-14 [Reserved]

UNDERGROUND ONLY

57.5-15 Mandatory. Air in all active workings shall contain at least 19.5 volume percent oxygen.

[§57.5--15 amended at 41 F.R. 23616, effective July 15, 1976.]

57.5-16 through 57.5-17 [Reserved]

VENTILATION

GENERAL—SURFACE AND UNDERGROUND

57.5-18A through 57.5-18Z [Reserved]

SURFACE ONLY

57.5-19A through 57.5-19Z [Reserved]

UNDERGROUND ONLY

57.5-20 [Reserved]

57.5-21 Main fans should be installed on the surface; if it is necessary to locate them underground, they should be in fire-resistant areas and should be provided with remote controls.

57.5-22 *Mandatory.* Fan housings and air ducts connecting main fans to underground openings shall be fire-resistant.

57.5-23 Separate mine openings should be provided for main intake- and return-air currents except during early stages of development. A multiple compartment shaft is a single opening for the purpose of this standard.

57.5-24 [Reserved]

57.5-25 Main fans should be inspected and maintained properly.

57.5-26 Instruments should be provided to test the mine atmosphere quantitatively for carbon monoxide, nitrogen dioxide, and other gases that occur in the mine. Tests should be conducted as frequently as necessary to assure that the required quality of air is maintained.

57.5-27 Flame safety lamps or other suitable devices should be used to test for acute oxygen deficiency.

57.5-28 *Mandatory.* Unventilated areas shall be sealed, or barricaded and posted against entry.

57.5-29 When used, ventilation tubing should be installed so that the air current sweeps the face areas effectively. Maximum distance of the end of the tubing from the face generally should be 30 feet for blowing and 6 feet for exhausting.

57.5-30 Ventilation doors not operated mechanically should be designed and installed so that they are self-closing and will remain closed regardless of the direction of the air movement.

57.5-31 Mandatory. Ventilation doors shall be:

(a) Substantially constructed.

(b) Covered with fire-retardant material, if constructed of wood.

(c) Maintained in good condition.

(d) Self-closing, if manually operated.

(e) Equipped with audible or visual warning devices, if mechanically operated.

[§57.5--31 added at 41 F.R. 23616, effective July 15, 1976.]

57.5-32 Mandatory. When ventilation control doors are opened as a part of the normal mining cycle, they shall be closed as soon as possible to re-establish normal ventilation to working places.

[§57.5--32 added at 41 F.R. 23616, effective July 15, 1976; corrected at 41 F.R. 28266, July 9, 1976.]

[§57.5--33 thru 57.5--36 Reserved.]

RADIATION

In those standards in § 57.5 which relate to radiation, a "working level" (WL) means any combination of the short-lived radon daughters in one liter of air that will result in the ultimate emission of 1.3×10^5 MeV (million electron volts) of potential alpha energy, and exposure to these radon daughters over a period of time is expressed in terms of "working level months" (WLM). Inhalation of air containing a radon daughter concentration of 1 WL for 170 hours results in an exposure of 1 WLM.

The calculation of the volume sampled is as follows:

8hr. × 60min. per hr. = 480min.

480min. × 2 l. per min. = 960 l. or $0.96m^3$

The average dust concentration during the period sampled is calculated by:

$$\frac{11.5mg.}{0.96M^3} = 12.0mg. \text{ per } m^3$$

However, he should submit this filter in the cassette which was originally collected to a laboratory for determination of the individual metallic constituents. Let us assume that the rod which the welder used throughout this shift was Hobart LH 718 which we find from Appendix 2 in the handbook to contain fluoride, iron, and manganese in quantities which could produce harmful airborne concentrations. The report which we get from the laboratory contains the data shown in Slide 12.

These results indicate that none of the 8 hr TWA's exceed their TLV's. The number of samples which one should collect, if sampling over an entire shift is not possible, will be discussed later in Section II-6.

Example "a" on page 18 of the manual should now be discussed in detail with the students. Likewise example "b" on page 18 should be covered because this shows how the results from 3 - 100 minute samples are averaged to determine an employee's 8 hour TWA.

Ceiling limits (C's) are the maximum peak concentrations for certain contaminants which take precedence over their TWA's. The period of time that a peak is measured is usually defined to be 15 min. Thus in sampling for C compounds one must look over the work operation to find the instances where peaks would be expected. Then the peaks which are considered to be the highest will usually be sampled.

Suppose there is a dip tank operation where the worker is exposed for only 5 minutes. One would start sampling at the beginning of the dipping operation and continue for 15 minutes, that is 10 min. after the completion of that operation. Suppose the operation required 30 minutes. Then one would sample for the 15 minute period that the maximum concentrations was expected. The C contaminants which are listed in Table 2 are hydrogen chloride, formaldehyde, manganese oxide fume, and nitrogen dioxide.

The next section about Excursion Concentrations, the maximum peaks permitted for other than C contaminants, should be presented essentially as listed in the handbook at the bottom of page 18 and continued on page 19. Notice there are several examples listed in the middle of page 19 which should be covered. Fifteen minutes is the usual period of sampling for Excursion Concentrations and Ceiling Concentrations. The two paragraphs at the bottom of page 19 should be covered in detail with the students because the first paragraph instructs the inspector to collect samples from individuals in a work area who would likely receive

CONTAMINANT	AMOUNT DETECTED (mg.)	VOLUME SAMPLED (m^3)	CONC. ($mg./m^3$)	8hr. TWA ($mg./m^3$)	TLV ($mg./m^3$
Fluoride	2.0	0.96	2.1	2.1	2.5
Iron	6.5	0.96	6.8	6.8	10
Manganese	1.0	0.96	1.0	1.0	C 5

the highest exposures. He can then assume that the others in this work area should have exposures which would be less than that for the individuals sampled. The second paragraph stresses the importance of sampling other shifts, various seasons and weather conditions. It is pointed out that in winter, ventilation systems may be altered. Heating systems will also be operating and may produce additional contaminants.

Record of Sampling Conditions - A record of sampling conditions must be prepared during sampling. A data sheet such as shown in Figure 5 which is page 21 in the handbook shall be filled as the sample is collected. Figure 5 contains typical information for one of these sheets. The instructor should go over this data with his students and explain the importance of recording this information. Particularly the importance of drawing the sketch of the work operation should be indicated to the students. It is particularly important that throughout the sampling period the inspector should check his pumps and the workers which are being sampled to verify that the pumps are functioning properly and the workers are performing their duties as expected. The checking should be on an unpredictable basis, about 1 to 2 times per hour.

Number of Samples to Collect - A single sample over a work shift is preferable. If not, then consecutive samples should be collected. This number will usually vary from 3 to 5 samples per shift. One would then average the concentrations obtained from these samples to indicate the 8 hour TWA. If grab samples are collected such as with detector tubes, then 6 to 10 randomly spaced determinations should be made. When there is a cyclic or a non-continuous work cycle, the number of samples will have to be determined from a time study of the operation. To verify that a concentration exceeds the "C" value, one should average the results of at least 3 determinations.

Submission of Samples for Analysis - The samples after collection should be labeled properly and sent with a copy of the completed sampling data sheets to the appropriate MESA Technical Support Center for analysis.

Interpretation of Results - As we have indicated earlier, when one is determining if the standard has been exceeded, he should compare the appropriate standard with the concentration either in ppm or mg/m^3 with the 8 hour TWA, the ceiling, or excursion concentration. Often these concentrations will be averages of determinations for the same contaminant under identical conditions. As was indicated earlier several samples must be collected to obtain the 8 hour TWA if a single 8 hour collection is inconvenient.

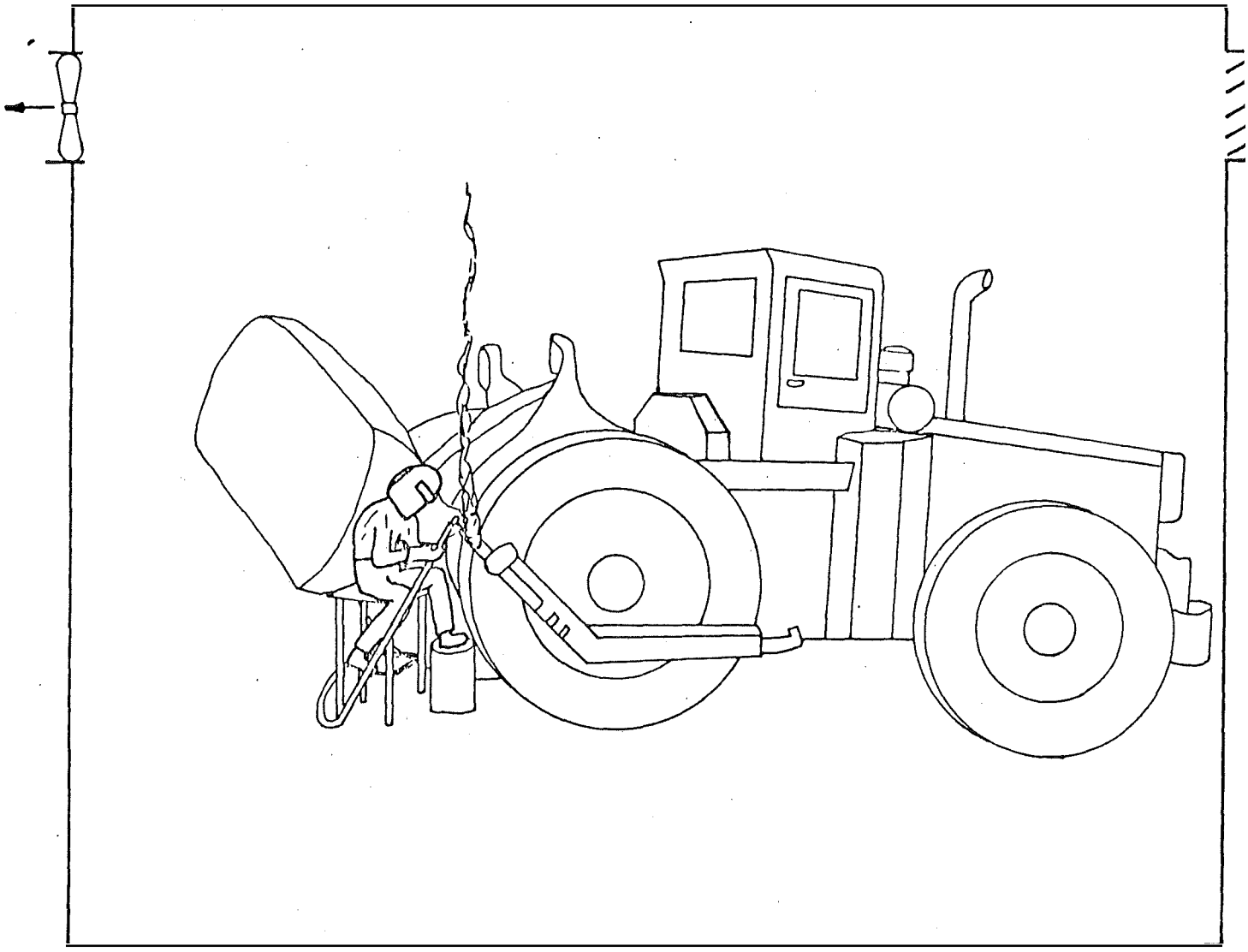
Paragraphs 55.5-1(c) and 57.5-1(c) of the regulations provide that all persons including employees shall be withdrawn from any area in which there is a concentration of an airborne contaminant which exceeds the ceiling or "C" value listed for that contaminant. As stated before, one should average the results of at least 3 determinations to verify that the "C" concentration is exceeded. Of course the inspector must prepare a survey report from his own field notes and the information he receives from the laboratory. Quite often these results will be presented in tabular form. Table 3 is an illustration of the manner in which this material can be presented.

Controls

Introduction - It must be emphasized that the inspector has no formal responsibility for recommending, designing or installing proper controls or maintaining inhalation contaminants at safe levels in the work areas. However, some basic knowledge of control methodology will assist the inspector in recognizing if installed or planned control methods are appropriate for the problems at hand. Control methods are divided into 3 types of devices. These are engineering controls, work practices, and personal protective equipment.

Ventilation - Ventilation may be either natural or mechanical. Natural ventilation consists of thermal effects which causes contaminants to rise, and wind which causes their concentration to be diluted. These natural forms of ventilation usually must be aided by mechanical means because they are not dependable. Thermal effects become less noticeable with the increasing air temperatures and winds vary in velocity and direction. Other factors which are important in specifying the requirements of mechanical ventilation are the rate of generation of the contaminant, the volume of the building, the effectiveness of supply and exhaust air openings, and the capacity of existing ventilation equipment. The two forms of mechanical ventilation will be described below.

General or Dilution - General ventilation involves the use of large quantities of supply and exhaust air to the work area to dilute the concentration of the contaminants. This may be achieved using a combination of mechanical and natural air supply and exhaust systems. The worker should be located between the air intake and the exhaust to obtain the optimum removal of contaminants (Slide No. 13). In addition pedestal fans may be used which will be directed at the sources of the contaminants to reduce their concentration in the breathing



EXAMPLE OF GOOD DILUTION VENTILATION

zone of nearby workers. It is important that adequate makeup air be provided whenever general ventilation is used. Makeup air must be heated so that drafts are eliminated. Pedestal fans are particularly useful for reducing concentrations of welding fumes for welders working on large or complex vehicles.

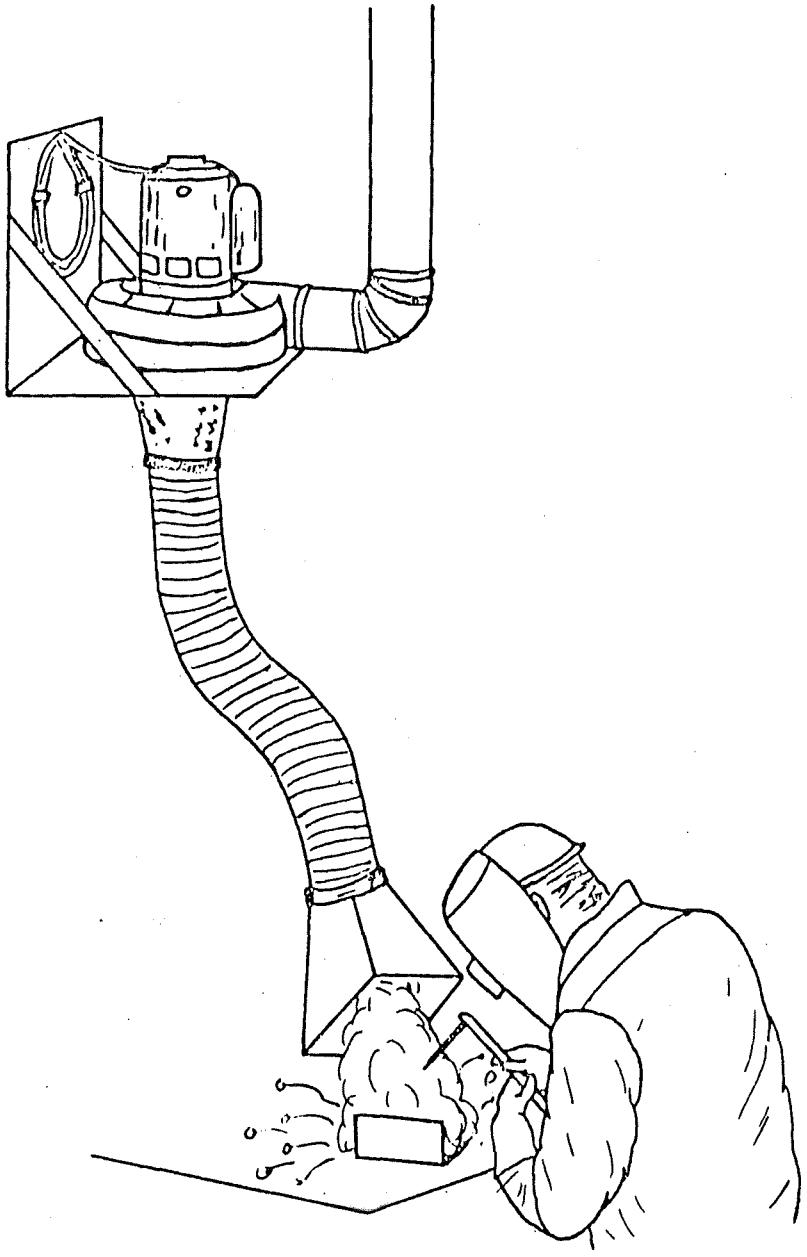
Local - A local exhaust system captures a contaminant where it is produced or emitted. A local system consists of a hood or duct opening which leads to an exhaust fan, an air cleaning device, and finally an opening to the outside atmosphere. The local system (Slide No. 14) usually operates on the principle of a high capture velocity for the contaminant but a rather low volume of air used. Thus the advantage of a local over a general exhaust system is that the local requires a much smaller volume of air. Local exhaust systems are excellent where fixed operations such as bench welding are performed. Solvent vapor degreasers when properly operated require no ventilation systems.

Isolation of Operations, Workers and Machinery - This section as well as the ones describing application of water and other wetting agents and other modification processes should be presented essentially as they are in the handbook on page 26.

Work Practices - It should be pointed out that often workers normally develop good work habits which will greatly reduce their exposures to contaminants. For instance they can position their work so it will be downstream from the direction of air movement thus reducing their exposures. They also often work with the item at almost an arms length from them and they may have their heads to the side of the work rather than directly over it, in order to reduce their exposures. Thus, they may frequently adjust their position relative to their work to be in a more advantageous position. Notice that the above mentioned work practices are essentially common sense which one should use to reduce his exposures. Likewise it would be important that good housekeeping be performed to reduce dust exposures such as cleaning up accumulations of dust. Solvent spills must be wiped up promptly. Machines must be maintained so that oil fumes are not produced. Ventilation equipment should be checked frequently to make sure it is operating properly. Frequently the substitution of products is possible. In fact one can often use this means as an inexpensive one for controlling exposure to contaminants.

Personal Protective Equipment

Respirators - Respirators are devices placed over the worker's face to filter or absorb contaminants from the air or supply pure air from a fan or



ADJUSTABLE PICK UP USED IN BENCH WELDING

air line hose to the worker. These devices should not be used except during periods when engineering controls are being installed, proper work practices are being instigated, engineering control and work practices are not feasible, and in emergency situations. Whenever respirators are used they should be selected from those approved by MSHA and the National Institute for Occupational Safety and Health (NIOSH) and used only for the contaminants specified in the approvals.

Instruction should be provided to show the workers how to wear and adjust the respirators for proper fitting. The respirators should be cleaned and inspected regularly. Worn and deteriorated parts should be replaced.

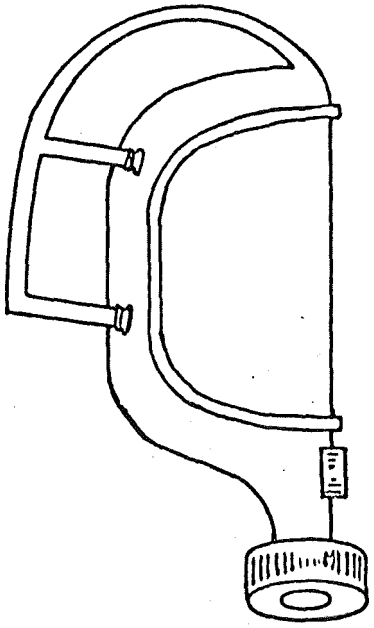
Air Purifying Respirators - Air purifying respirators (Slide 15) contain filters or chemical cartridges and may or may not be reuseable. They remove contaminants from the air being breathed. The contaminants for which they were suitable are listed on canisters or the mask itself.

Even though excessive concentrations of airborne asbestos dust and paint fumes were not found in the initial study of inhalation contaminants in above-ground mining and processing activities, it is recommended that appropriate respirators be worn by individuals exposed to visible dust containing asbestos during brake changing operations or from braking cable drums on large shovels and drag lines. Also employees engaged in paint spraying should wear proper air purifying respirators for protection from paint fumes and mists.

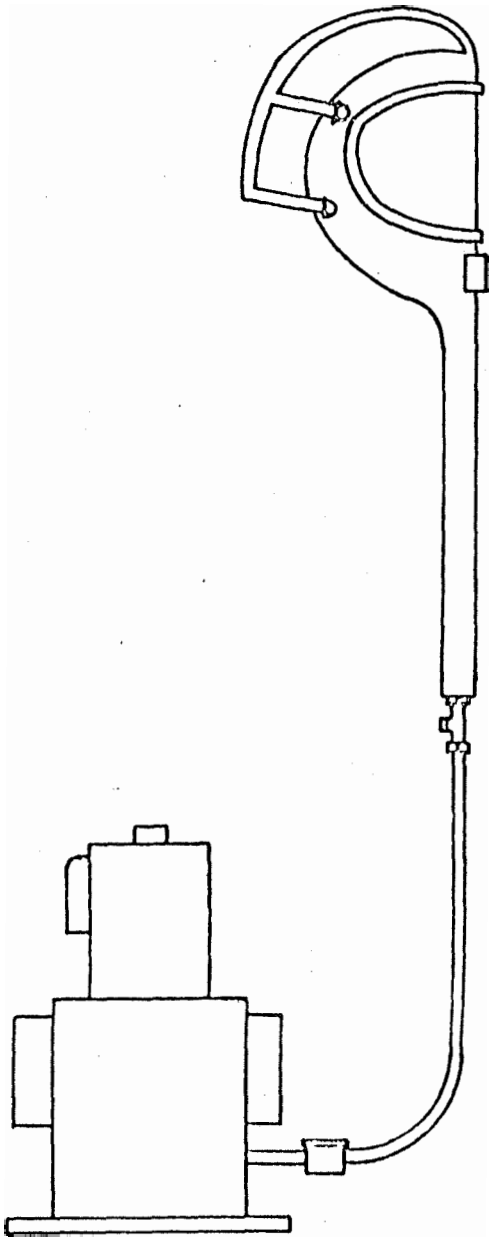
Supplied-Air Respirators - Supplied-air respirators (Slide No. 16) are two types: continuous flow and pressure demand. Each respirator supplies the worker with an atmosphere which is independent of the ambient air. The continuous flow device supplies the wearer with a select amount of air fed continuously to it. The demand type has a regulator at the lower end of the breathing tube and a diaphragm-actuated valve that opens upon inhalation and closes upon exhalation. In both cases, it is required that the compressed air supply for the respirators not contain harmful amounts of carbon monoxide, oil mists or other contaminants.

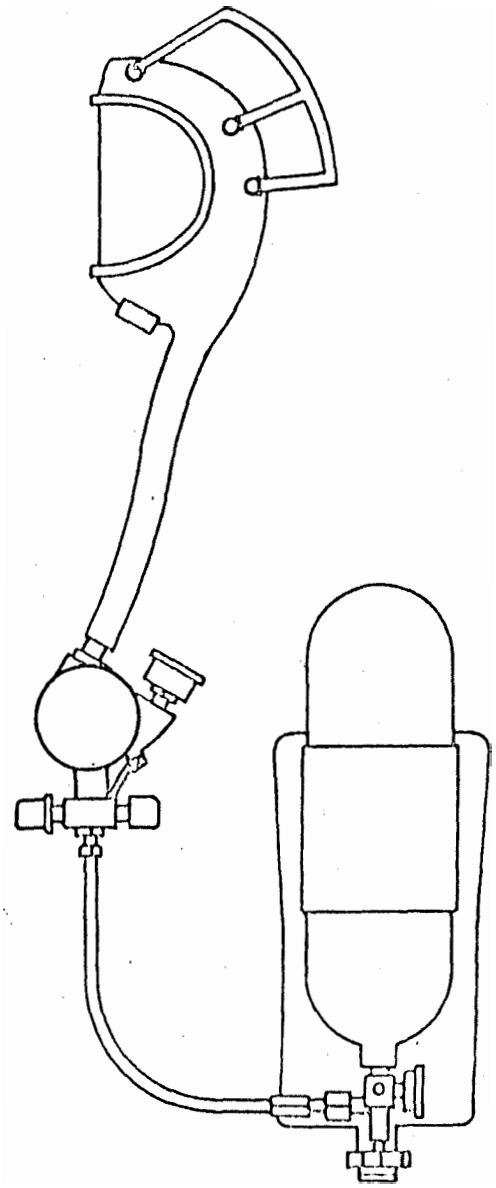
Protective Clothing - Protective clothing consists of aprons, gloves, special clothing, creams, face shields and safety glasses. These are usually used to prevent skin absorption or skin irritation from the contaminants. Equipment must have MSHA and NIOSH approval.

SLIDE 15



AIR PURIFYING RESPIRATOR





SUPPLIED-AIR RESPIRATORS

PROCEDURE FOR HEALTH SURVEY INSPECTIONS

This is described on pages 30 and 31 of the handbook. The instructor should cover this procedure in detail for the students, particularly emphasizing the intended purpose of the condensed handbook which is that it should be carried with the inspector in the field to assist his health surveys. The large version of the handbook should be left in the field office and used as a reference.

The significance of the Glossary of Terms,which is included as an appendix in both handbooks, should be particularly emphasized. It is important that the instructor also mention the purpose of Appendix I in the large handbook, which is entitled "Mode of Entry and Physiological Effects." The various routes of entry of the contaminants in the body should be described as well as Table 1-1 which contains the physical properties and the physiological symptoms and effects of the various contaminants considered in the handbook. The physical form is important for the inspector to know in order to recognize the possibility of specific contaminants being hazards in various work instances. For instance, it would be proper to know that xylene is a volatile liquid not a gas or solid when he would be sampling for it. He should also know that ozone is a gas. Noting the physiological symptoms of candidate contaminants for a particular work area will help the inspector recognize the one or ones which are producing observable effects in the workers. It will also help him assign priorities for sampling the most significant contaminants. Recognition of these severe physiological effects would, of course, likely initiate termination of the exposures and would require that corrective action be taken.

REVIEW AND SUMMARY

Ask the students for any questions. Perhaps they would like to discuss certain topics previously covered. Ask if they have any questions concerning the Procedure for Health Survey Inspections because this section contains the heart of the course. Be sure to allow at least one hour for review and discussion at this time.

APPENDICES

INSTRUCTION SHEETS FOR EXPERIMENTS

EXPERIMENT 1A

INSTRUCTIONS FOR USING THE MSA DETECTOR TUBE SYSTEM FOR SAMPLING CARBON MONOXIDE

EQUIPMENT AND MATERIALS REQUIRED

1. One MSA universal sampling pump, Part No. 83499
2. One set of Instructions for Operating and Maintaining the MSA Universal Sampling Pump
3. One box of MSA detector tubes for carbon monoxide, Part No. 91229

PROCEDURE

1. In this test the background concentration of carbon monoxide will be determined. In this case background is the concentration of gases in the room from such sources as smokers in the room and industrial emissions located outside the room.
2. Follow the instruction sheets for the MSA universal sampler and the carbon monoxide detector tubes to set up this system for sampling background carbon monoxide.
3. Ask the instructor to check the system before proceeding with the test.
   a. Position the detector tube in the sample pump.
   b. Select the proper orfice (No. 1) on the pump.
   c. Break off the tips of the detector tube using the hole in the top of the pump.
   d. When the test is made wait the required period (a minimum 70 seconds) after each stroke. See notes at end of procedure.
4. After the test is completed, use the proper calibration scale on the instruction sheet for the detector tube to determine the carbon monoxide concentration. Generally the background concentration of carbon monoxide in a classroom will vary from 1-15 ppm.

Instructions for Using the MSA Detector Tube
System for Sampling Carbon Monoxide (continued)

NOTES

1. Do not permit smokers to blow smoke into the zone being sampled.

2. Do not permit student to be injured by the jagged glass tips on the ends of the detector tubes.

3. The carbon monoxide tubes can be reused if the stain penetrates only a portion of the detector chemical and the tube is reversed in the pump. The second test should not be delayed for more than 4 hours during which time the ends of the tube should be covered with rubber caps.

EXPERIMENT 1B

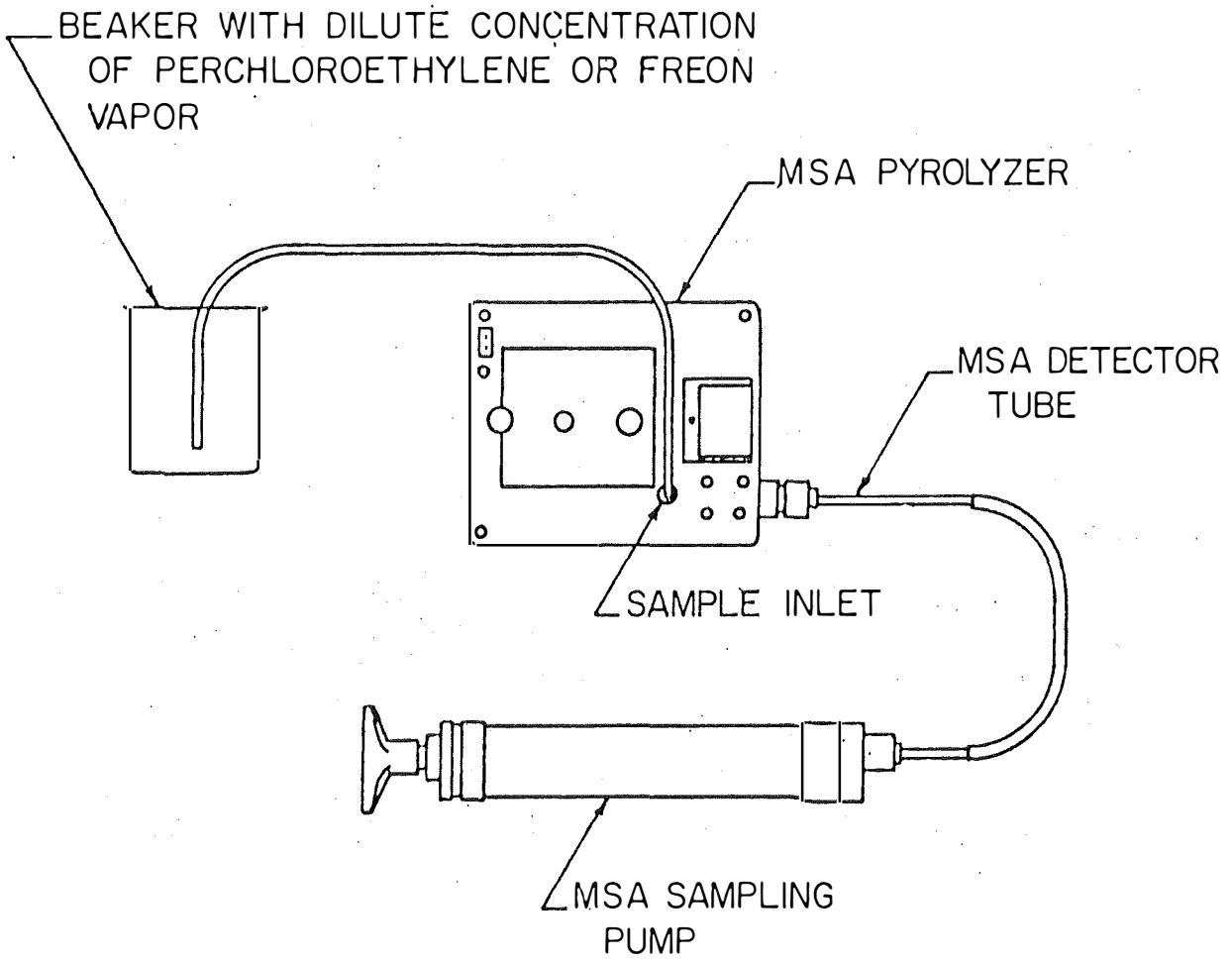
INSTRUCTIONS FOR USING THE MSA DETECTOR TUBE SYSTEM FOR SAMPLING FREON

EQUIPMENT AND MATERIALS REQUIRED

1. One MSA universal sampling pump, Part No. 83499
2. One set of Instructions for Operating and Maintaining the MSA Universal Sampling Pump
3. One MSA pyrolyzer, Part No. 87505
4. One set of Instructions for Operating and Maintaining the MSA Pyrolyzer
5. One box of MSA detector tubes for chlorinated hydrocarbons, Part No. 88536
6. One bottle of 10 ml of freon
7. One pipette with rubber bulb
8. One 2-liter beaker or 2 lb coffee can

PROCEDURE

1. Prepare an air mixture with freon by using the pipette to add three drops of freon to the beaker (or coffee can). Freon vapors are heavier than air and will tend to stay in the beaker.
2. Set up the pyrolyzer and MSA sampling system as shown by the instruction sheets for the universal sampler, the pyrolyzer and the chlorinated hydrocarbon detector tubes (see attached sketch). Ask the instructor to check the system before proceeding with the test.
    a. Position the sampling tube of the pyrolyzer with masking tape about 3" from the bottom of the beaker.
    b. Select the proper orfice (No. 2) for the pump.
    c. Break off the tips of the detector tube using the hole in the top of the pump. See note listed below.
    d. Turn the selection switch (black knob) on the pyrolyzer to "operate." Do not turn up the voltage control switch (red knob) to 3.25 volts until immediately before the test is made.
    e. When the test is made, wait the required period (a minimum 30 seconds) for pump to fill.



SKETCH OF SYSTEM USED FOR EXPERIMENT IB

f. Determine the length of the blue stain which develops in the tube by comparing it to the millimeter scale on the instruction sheet for the detector tubes.

3. After the test is completed, use the calibration chart on the instruction sheet for the detector tubes to determine the freon concentration. The freon concentration in this test will generally be about 500 ppm.

NOTE: Do not permit students to be injured by the jagged glass tips on the ends of the detector tubes.

EXPERIMENT 2A

INSTRUCTIONS FOR USING THE DRAGER DETECTOR TUBE SYSTEM FOR SAMPLING TOLUENE

EQUIPMENT AND MATERIALS REQUIRED

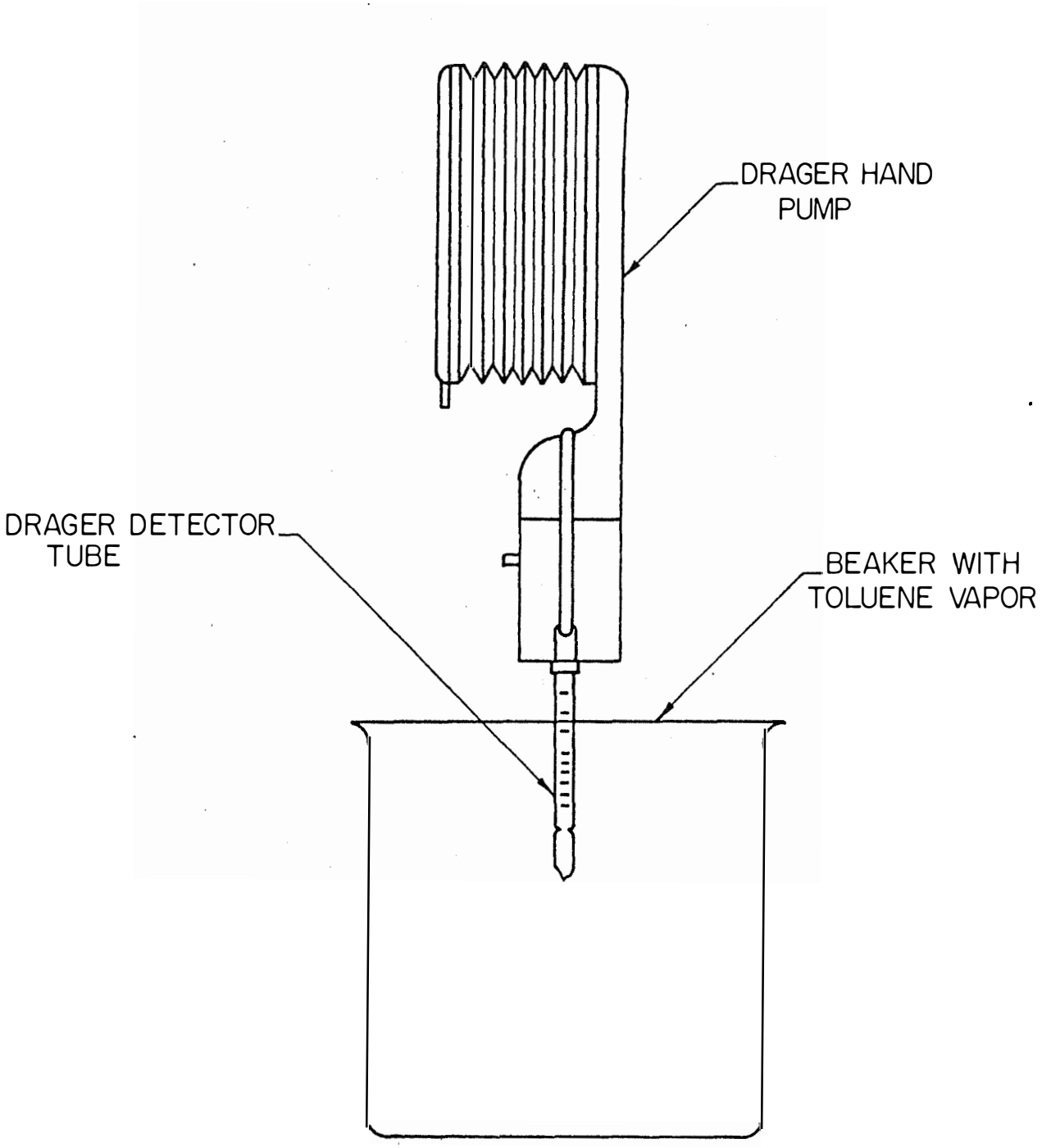
1. One Drager hand pump, Model No. 31
2. One box of Drager detector tubes (5/a) Catalogue No. CH23001 for toluene
3. One bottle with 10 ml of toluene
4. One pipette with rubber bulb
5. One 2-liter beaker (or 2 lb coffee can)

PROCEDURE

1. Prepare an air mixture with toluene by using the pipette to add three drops of toluene to the beaker or coffee can. Toluene vapor is heavier than air and will tend to remain in the beaker.
2. Follow the instruction sheet for the Drager detector tube for toluene to set up the sampling system. Ask the instructor to check the system before proceeding with the test.
   a. Have the inlet to the detector tube about 3" from the bottom of the beaker when the test is made.
   b. Break off the tips of the detector tube using the hole in a key.
   c. When the test is made, wait for the bellows to fill after each stroke.
3. After the test is completed, compare the length of the brown stain to the scales on the side of the tube to determine the concentration of toluene. Usually the concentration will be about 200 ppm. The MESA standard for toluene is 100 ppm for an 8 hour shift. See the notes listed below.

NOTES

1. Be sure to read the scale on the tube which corresponds to the number of strokes which are taken.
2. Do not permit the students to be injured by the jagged glass tips on the ends of the detector tubes.



SKETCH OF SYSTEM USED FOR EXPERIMENT 2A

EXPERIMENT 2B

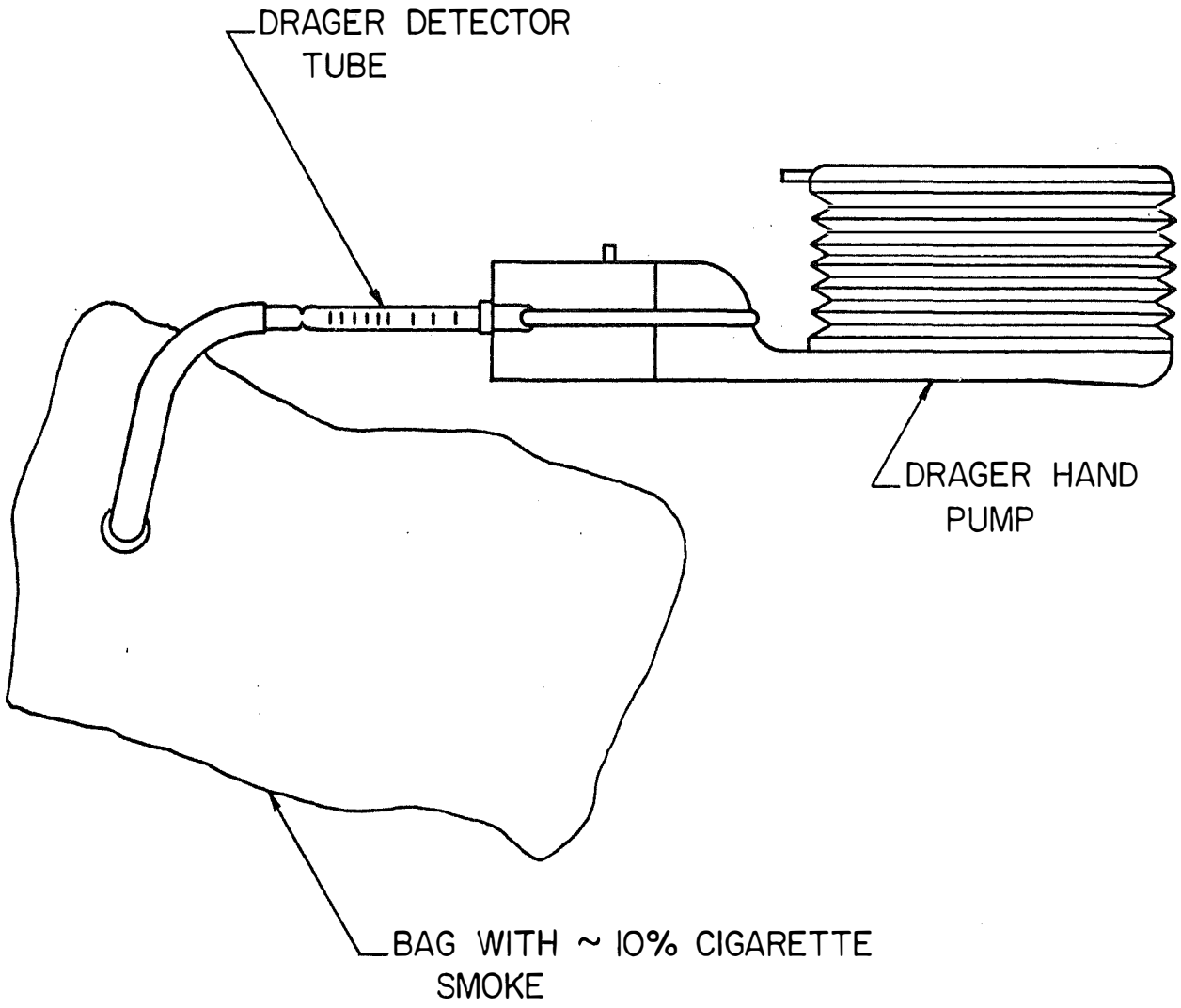
INSTRUCTIONS FOR USING THE DRAGER DETECTOR TUBE SYSTEM FOR SAMPLING CARBON MONOXIDE

EQUIPMENT AND MATERIALS REQUIRED

1. One Drager hand pump, Model No. 31
2. One 3-liter plastic gas bag, Environmental Measurements, Inc.
3. One box of Drager detector tubes (5/c) Catalogue No. CH 20601 for carbon monoxide
4. One 4" piece of 1/4" ID rubber hose

PROCEDURE

1. Ask one of the students who is smoking to exhale one breath of cigarette smoke into a 3 liter plastic bag half filled with air.
2. Knead the bag to mix its contents.
3. Follow the instruction sheet for the Drager detector tube for carbon monoxide to set up the sampling bag. Exhaust a few milliliters of air from the bag before the detector tube is attached to remove the high concentration of smoke which is trapped in the hose. Ask the instructor to check the system before proceeding with the test.
   a. Break off the tips of the detector tube using the hole in a key.
   b. When the test is made, wait for the bellows of the pump to fill after each stroke.
4. After the test is completed, compare the length of the brownish green stain to the scales on the sides of the tube to determine the concentration of carbon monoxide. Generally the concentration for this test will be about 200 ppm. The MESA standard for carbon monoxide is 50 ppm for an 8 hour shift. See the notes listed below.



SKETCH OF SYSTEM USED FOR EXPERIMENT 2B

NOTES

1. Be sure to read the scale on the tube which corresponds to the number of strokes which are taken.

2. Do not permit the students to be injured by the jagged glass tips on the ends of the detector tube.

3. After a negative result, this tube can be used up to 10 times on the same day.

EXPERIMENT 3A

INSTRUCTIONS FOR SETTING UP A SAMPLING SYSTEM FOR WELDING FUMES CONTAINING CADMIUM, LEAD OR SILVER

EQUIPMENT AND MATERIALS REQUIRED

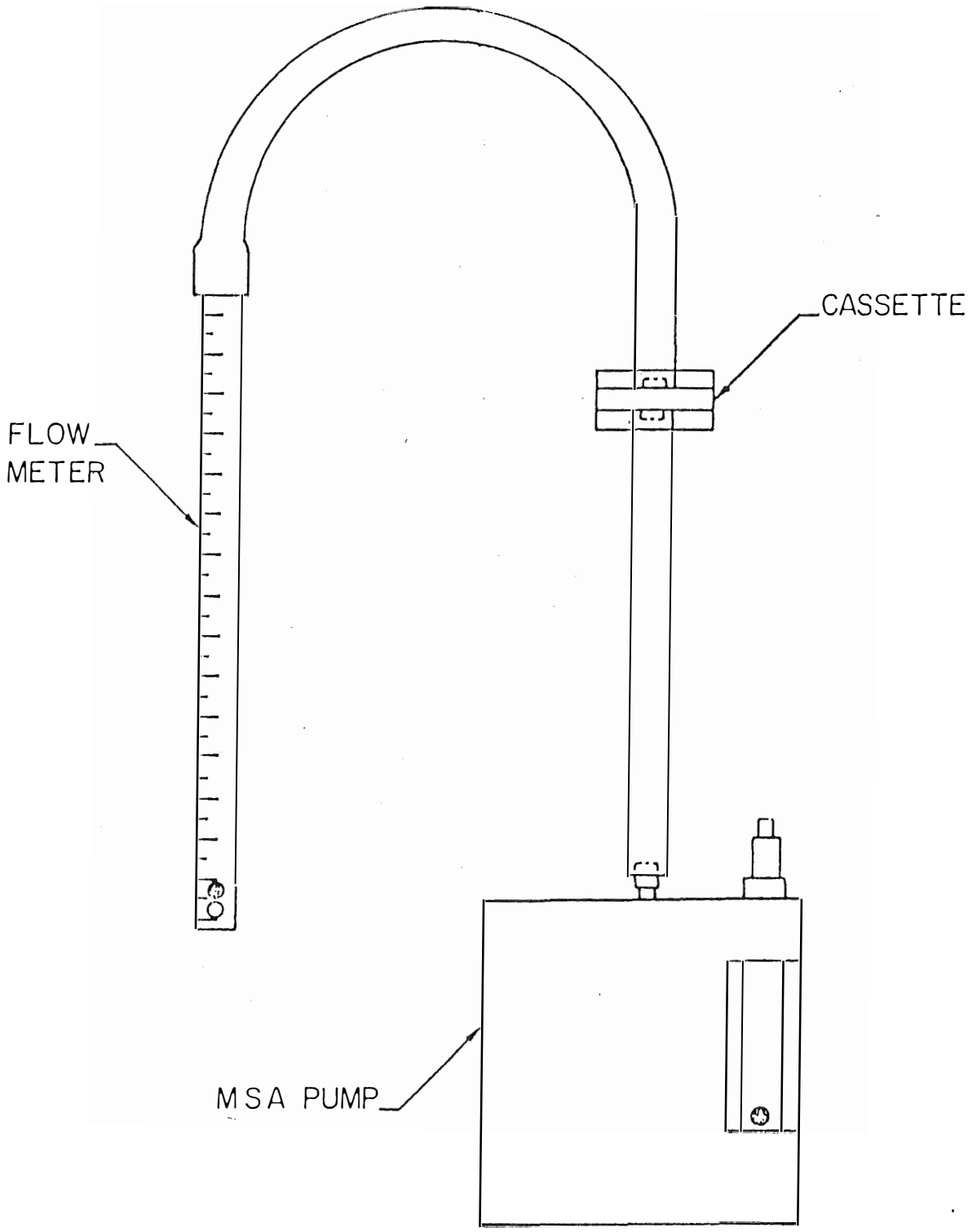
1. MSA personal sampling pump, Type G
2. One 3' piece of sampling hose, Bendix Catalogue No. 3900-908
3. One MSA cassette Part No. 457193
4. One 4" piece of 1/4" ID rubber hose
5. One flow meter such as the Matheson 603 with the calibration curve

PROCEDURE

1. Set up the sampling system for welding fumes containing cadmium, lead or silver by arranging the above items in the order presented.
2. Ask the instructor to check the system before proceeding with the test.
3. Use the calibration curve to indicate the proper setting for the flow meter to obtain the desired flow rate of 2.0 lpm. It has been found that this flow meter in the "upstream" measures the flow rate accurately as verified by a wet test meter or bubble meter.

NOTE

Attach the flow meter to the cassette only during the period that flow rate readings are desired.



SKETCH OF SYSTEM USED FOR EXPERIMENT 3A

EXPERIMENT 3B

INSTRUCTIONS FOR SETTING UP A SAMPLING SYSTEM USING THE CHARCOAL TUBE

EQUIPMENT OR MATERIALS REQUIRED

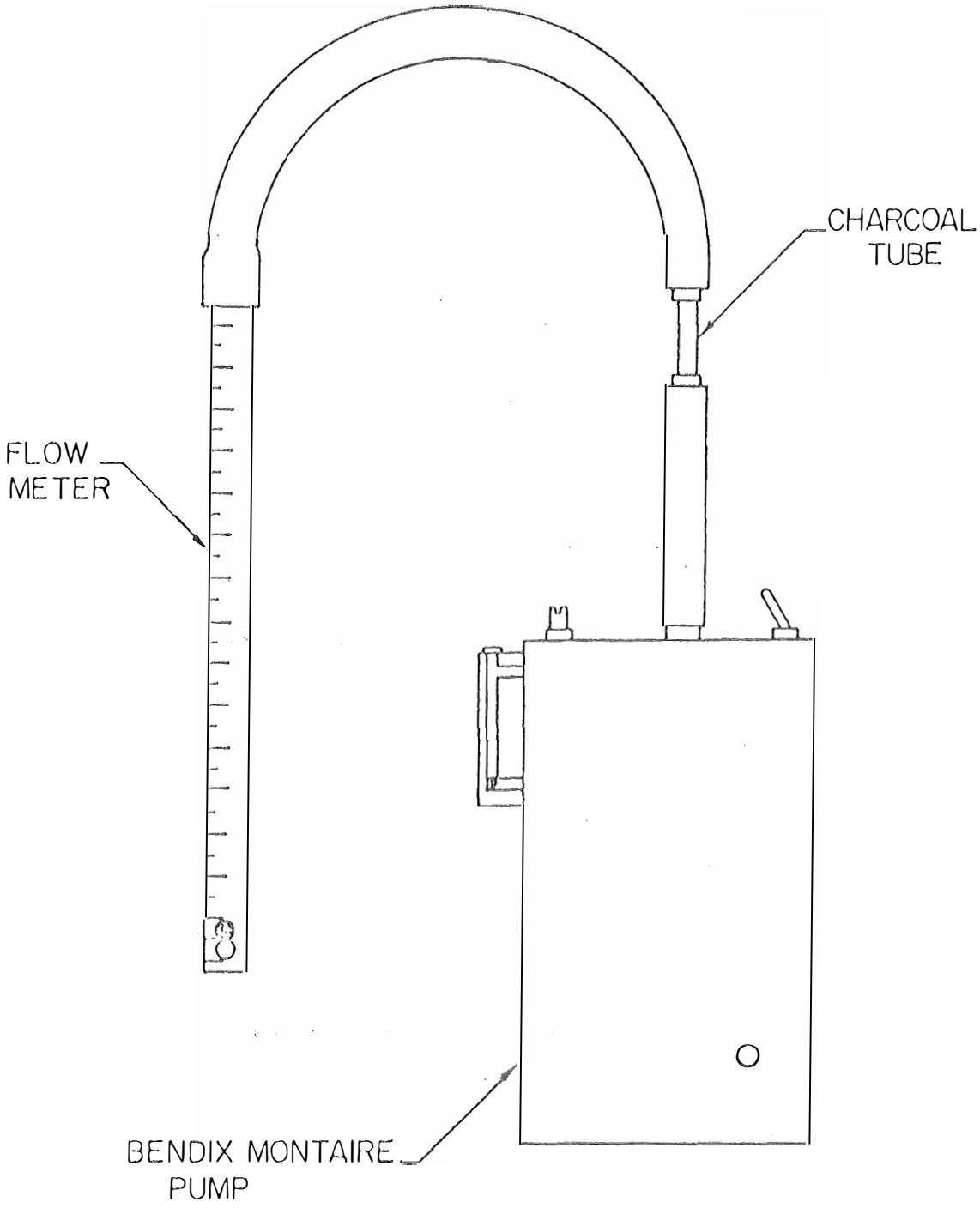
1. One Bendix 3900 personal sampling pump
2. One 3' piece of sampling hose, Bendix Catalogue No. 3900-908
3. One MSA charcoal tube holder, Catalogue No. 459054
4. One charcoal tube, MSA Catalogue No. 459004
5. One charcoal tube plastic cap with both ends opened
6. One 4" piece of 1/4" ID rubber hose
7. One flow meter such as the Matheson 601 with the calibration curve

PROCEDURE

1. Set up the sampling system for the charcoal tube using the charcoal tube by arranging the above items in the order presented. See attached sketch.
2. Ask the instructor to check the system before proceeding with the test.
3. Use the calibration curve to approximate the desired flow rate of 50 cc per minute. (Errors of 20% to 80% have been found for the flow rates when using this sampling system.) For accurate work one must prepare a special calibration graph based on wet test meter or bubble meter readings which will accurately determine the correct flow rates for the flow meter readings for each Bendix 3900 pump when used with a charcoal tube.

NOTE

The flow meter and the short piece of rubber hose are not left upstream of the cassette during the sampling period, but are attached when readings are desired.



SKETCH OF SYSTEM USED FOR EXPERIMENT 3B