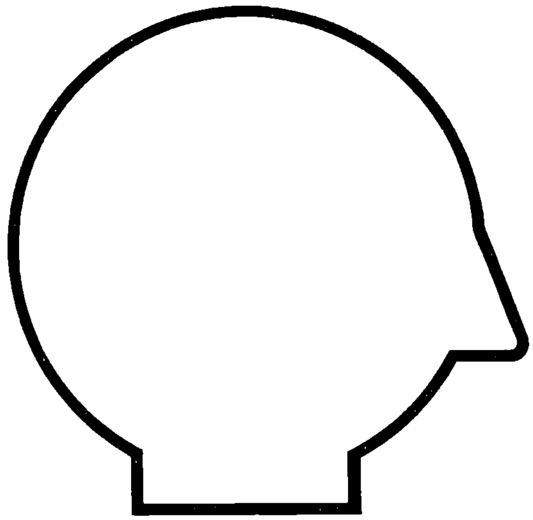
DOCUMENT RESUME

ED 204 582 | CE 029 505

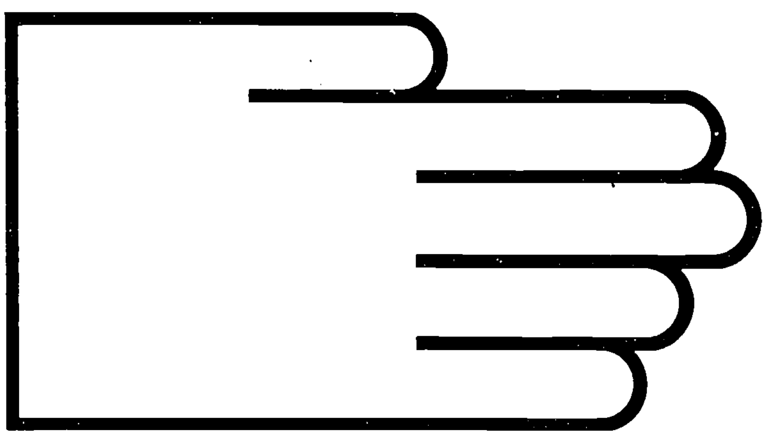
TITLE	Measuring Airflow in Local Exhaust Ventilation Systems. Module 23. Vocational Education Training in Environmental Sciences.
INSTITUTION	Consumer Dynamics Inc., Rockville, Md.
SPONS AGENCY	Office of Vocational and Adult Education (ED), Washington, D.C.
PUB DATE	[81]
CONTRACT	300-80-0088
NOTE	38p.: For related documents see CE 029 482-507.
AVAILABLE FROM	National Technical Information Service, U.S. Dept. of Commerce, 5285 Port Royal Rd., Springfield, VA 22161.
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Air Flow; Competency Based Education; Educational Equipment; *Environmental Education; *Environmental Technicians; Learning Activities; *Measurement Techniques; Programed Instructional Materials; Public Health; Tests; *Ventilation; Vocational Education
IDENTIFIERS	*Anemometers; Environmental Health

ABSTRACT

This module, one of 25 on vocational education training for careers in environmental health occupations, contains self-instructional materials on measuring airflow in local exhaust ventilation systems. Following guidelines for students and instructors and an introduction that explains what the student will learn are three lessons: (1) naming each part of the swinging vane anemometer and describing its function; (2) assembling the anemomenter and checking its operation; and (3) making velocity measurements in hoods and ducts within the measurement accuracy of the anemometer used. Each lesson contains objectives, recommended methods and locations for practice, performance criteria, equipment and supplies to perform a task, detailed step-by-step instructions for learning a task, and performance exercises. Two performance tests cover checking the operation of the swinging vane anemometer while assembling it, and making air velocity measurements in hoods and ducts. (CT)



Measuring Airflow in Local Exhaust Ventilation Systems



Module 23

U.S. DEPARTMENT OF EDUCATION, Office of Vocational and Adult Education

The Curriculum and Instruction Branch of the Office of Vocational and Adult Education, U.S. Department of Education, identified a need to improve the training opportunities for vocational education students interested in pursuing careers in environmental health. To fulfill that need, Consumer Dynamics, Inc., a Rockville, Maryland, based company, was awarded the contract to develop performance-oriented, competency-based modules in the environmental health sciences.

MEASURING AIRFLOW IN LOCAL EXHAUST VENTILATION SYSTEMS is one of the modules in the series, "Vocational Education Training in Environmental Health Sciences." The module content is based on selected materials in the environmental health field. The module is intended to supplement existing course materials.

CONTENTS

USING THESE SELF-INSTRUCTION MATERIALS

This [illegible] instruction learning package or module is designed to allow [illegible] students and instructors flexibility of use. Although pri[illegible] tended for use in existing training programs, the mod[illegible] be used by anyone interested in learning new skills or per[illegible]d ones. Therefore, two sets of guidelines are prese[illegible] set addressed to students and the other set address[illegible] instructors. First, find out how you, the student, should us[illegible] materials in this book.

GUIDELINES FOR STUDENTS

Take the Performance Test as a pretest.

When you pick up this book and work through it, your goal will not be a letter grade or a high score on an exam. Instead, you will work to develop skills that you can measure. You will not have to worry about how well someone else is doing. Before you start work on this module, you should, first, find out if you have sufficient skills to start training by reading through the section called PERFORMANCE TEST. If you think you can do all or most of the items in this test, ask your instructor to obtain the necessary equipment and supplies. You should have some working knowledge of science, but you do not need special preparation in mathematics or physics. Other than knowing how to orient the Pitot, diffuser, and static pressure probes of the swinging vane anemometer to make measurements within the accuracy of the instrument, you do not have to have specialized skills to enter training in this module. The basic skills for using the instrument are included in the module. You will not be able to design or evaluate, but only collect, air velocity data in industrial hoods and ducts. Measurement and calculation of total pressure using velocity pressure and static pressure data may be covered by your instructor at his or her discretion.

Work on parts you need to practice.

If you do everything well, according to the criteria in the Performance Test guidelines, you will not need to spend time working on this module. If after taking the Performance Test you discover there are parts you need to practice, follow the key to each item in FOR FURTHER STUDY.

USING THESE SELF-INSTRUCTION MATERIALS

Work straight through each lesson in the order presented.

Should you decide to completely work through this module, begin with the INTRODUCTION and go straight through each of the three lessons. The lesson begins with the OBJECTIVE of the training. Follow the instruction for each part in the order presented. Practice each step in a lesson until you can do it according to the criteria stated for the step. At the end of a lesson, do the EXERCISES. When there are audiovisuals listed at the end of a lesson, ask your instructor for help in obtaining them.

Take the Performance Test as a posttest.

Finally, after you have mastered all of the exercises in each lesson, ask your instructor to watch you do each item in the Performance Test. The items in the Performance Test are intended for use as a posttest to evaluate the quality of your performance. Turn now to the Performance Test.

GUIDELINES FOR INSTRUCTORS

Approach

The approach of these materials is to provide the student with the skills to accomplish all of the objectives at a satisfactory level of skill. The modules use instrumentation commonly found in technical laboratories. You may find that the instrument(s) found in this module differ from those you have available. You may need to write supplementary instructions to point out the equipment differences. The skills tested on the Performance Test are designed for use with any make and model of instrumentation.

Independent Study

Students can work independently and at their own pace. Depending on the time frame you set for completing each lesson, you may want to start a group off in each lesson with a demonstration and informal presentation.

As a Laboratory Workbook

Alternatively, you may choose to use this module as a laboratory workbook in a structured laboratory session. With this option, you may allow students greater access to your assistance, especially in watching them perform the pre- and posttest portions of the training.

6

General Instructions

Read through each lesson to anticipate what equipment and supplies you will need to make available for students to use. Also, order any audiovisuals or reading materials you think may present a complementary perspective to the training in this module. Use the items in the Performance Test as the minimum requirements for gauging successful completion of the training.

Specific Instructions

So that students can work with simple hoods and ducts, set up a couple of simple systems incorporating 6-, 8-, 10-, or 12-inch-diameter ducts and squirrel cage fans each capable of delivering 2,000 cfm.

Schedule time for students to work with slot hoods, laboratory hoods, and paint spray booths at the chemistry labs and industrial shops in your facility or institution. Select ventilation systems at these locations that are routinely evaluated. The student will not be required to select measuring points or to drill holes since the student will be limited to collecting airflow data only.

Closely observe the measurement techniques employed by each student as a gauge in determining the accuracy of the air velocity readings they report.

BACKGROUND

Performing airflow measurements in local exhaust ventilation systems is a necessary aspect of evaluating how well potentially harmful airborne contaminants are removed from the point at which they are generated. The Occupational Safety and Health Administration, U.S. Department of Labor, has determined that use of a local exhaust ventilation system is the primary engineering method for controlling airborne contaminants that are produced by, or result from, industrial processes.

There are two categories of ventilation systems: general and local exhaust. General ventilation is the supply and/or removal of air with respect to a large area, room, or building. This category of ventilation has two purposes: (1) to dilute contaminated air with clean air in an effort to remove nuisance odors and dust, and (2) to prevent acute discomfort or injury that may be caused by extremes in temperature and humidity. Most air-conditioning (heating and cooling) ventilation systems are considered general ventilation systems.

Local exhaust ventilation is employed in industrial facilities or chemistry laboratories to control the dispersion of airborne contaminants, including dusts, fumes, mists, vapors, and gases produced during, or resulting from, a manufacturing or production process. In addition to air movers, ductwork, and air filters common to both categories of ventilation systems, the local exhaust ventilation system also includes a hood. A hood is an extension of the duct used to: (1) contain the dispersion of a contaminant generated within the hood, and includes enclosed devices such as the laboratory hood, glove box, and paint spray booth; and (2) capture the airborne contaminant as close to the point of generation as possible to draw it into the ventilation system. This latter use of hoods includes such devices as slot hoods, canopy hoods, movable hoods, and downdraft hoods.

To measure the efficiency of a ventilation system, airflow characteristics are determined, including air velocity, capture velocity, and static pressure. Air velocity is the speed of air moving through the system. Capture velocity is the speed of air required to transport an airborne contaminant away from its source and into the local exhaust ventilation system via the hood. Static pressure is the pressure in inches of water exerted by air flowing against the inside walls of ducts. Instructions on how to collect air velocity, capture velocity, and static pressure data are included in the module.

By using standard airflow data for different sizes and shapes of hoods and types of contaminants, the minimum air velocity can be calculated. If the air velocity at the entry point of the hood or at the point at which the contaminant is generated is lower than required or has dropped since it was last checked, other points in the system are checked. If dust and dirt accumulate on the walls of ducts or in bends or curves of ductwork, the system's overall efficiency will decline. To determine if the lower-than-required face velocity or capture velocity is due to a design flaw or a maintenance problem, airflow measurements are taken at selected points along the ductwork.

Several airflow instruments are available; some are more routinely used than others. In the following table, the instruments and their purposes are provided.*

Instrument	Purpose
Smoke tubes[1]	Visualization of airflow patterns
Rotating vane[1] anemometer	Measures air velocity
Vane anemometer[1]	Measures air velocity and static pressure
Heated wire anemometer[1]	Measures air velocity, static pressure, and temperature
Pitot tube[2]	Measures total, velocity, and static pressure
Manometer[2]	Measures total, velocity, and static pressure
Aneroid gauge[2] (magnehelic)	Measures total, velocity, and static pressure

[1]Instruments are usually used to test airflow outside of the ventilation system.

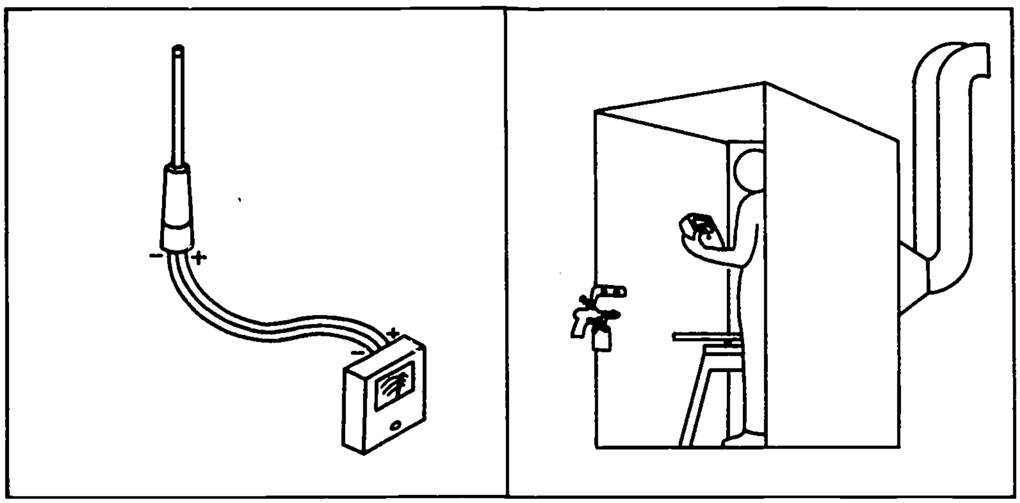
[2]Instruments are usually used to make measurements inside ducts.

*NIOSH, The Industrial Environment--Its Evaluation & Control, 1973, p. 585.

Two basic types of instruments are available that can be used to measure air velocity and static pressure: the swinging vane anemometer and the heated wire, or thermoanemometer. The latter instrument is more accurate and easier to use at low airflows. However, since it is unknown how many of the older mechanical anemometers are still in use, instructions on the use of the swinging vane anemometer are included.

WHAT YOU WILL LEARN

When you finish working through the steps and exercises in this module, you will be able to measure air velocity in enclosed hoods, slot hoods, and at designated measurement points in ductwork of local exhaust ventilation systems.



You will learn these aspects about the swinging vane anemometer in three lessons:

- <u>Lesson One</u>

  You will be able to name each part of the swinging vane anemometer and describe its function.

- <u>Lesson Two</u>

  You will be able to assemble the swinging vane anemometer and check its operation.

- <u>Lesson Three</u>

  You will be able to make velocity measurements in hoods and ducts within the measurement accuracy of the anemometer you use.

OBJECTIVE

You will be able to name each part of the swinging vane anemometer and describe its function.

WHERE AND HOW TO PRACTICE

You should practice doing this lesson on a table or desk where there is room to spread out parts and also this book. Read each step before attempting to do it, and make sure you can perform the step as well as described in "How Well You Must Do." Practice labeling parts by using the diagrams in "Exercises."

HOW WELL YOU MUST DO

You must be able to name all the parts of the swinging vane anemometer and describe in your own words how the anemometer and its parts function.

THINGS YOU NEED

You will need a swinging vane anemometer and various probes and range selectors, as well as the instrument operating manual. The Alnor anemometer P-6000 is used as a model because it is similar to other types of swinging vane anemometers.*

Instructions: Now turn to the next page and being work on Lesson One, "Getting There--Steps."

*Presentation of information in this module on any type or model of equipment should not be construed as an endorsement of the equipment by the U.S. Department of Education.

GETTING THERE--STEPS

STEP 1

Place the velometer and its accessories in front of you. Look at the scales on the meter face. Different scales are used with different probes.

The two lowest scales on the meter face are used with the static pressure probe (1):

- 0-1 inch of H_2O
- 0-10 inches of H_2O

The next scale is used with the low-flow probe (2):

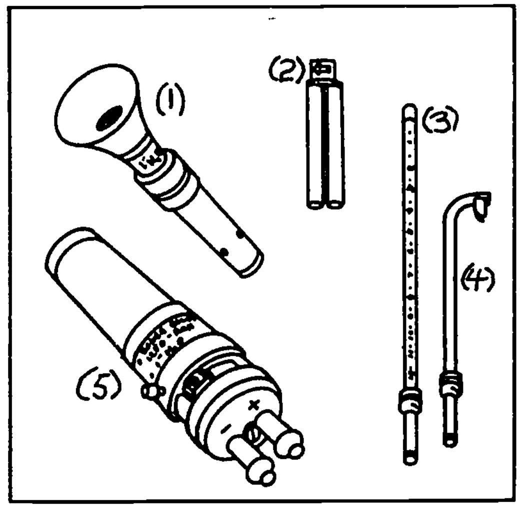
- 0-300 feet/minute airflow

The next four scales are used with the Pitot (3) and diffuser (4) probes:

- 0-1,500 feet/minute airflow
- 0-2,500 feet/minute airflow
- 0-5,000 feet/minute airflow
- 0-10,000 feet/minute airflow

Probes (1), (3), and (4) are used with a range selector (5). Although the scales start at zero, that does not mean they register accurately at zero. For example, the 0-300 scale will not register airflow until 50 fpm is reached.

KEY POINT 1

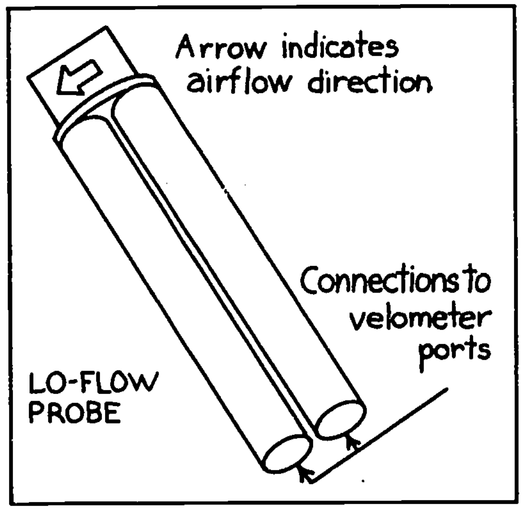


Different scales are used with different probes.

STEP 2

The low-flow probe is used in the effective velocity measuring range of 50-300 fpm, and is particularly suited for the direct measurement of drafts in rooms or open spaces and to measure face velocities at ventilating hoods, spray booths, or similar applications. The low-flow probe connects directly to the velometer ports. Inside the probe is a filter to protect the velometer from particulate matter that may be in the air stream.

KEY POINT 2

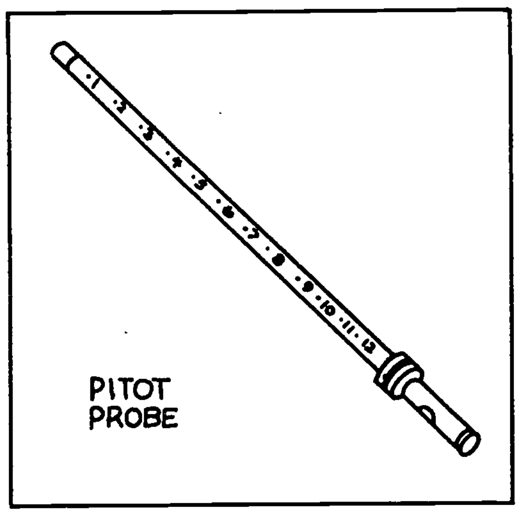


Low flows of 0-300 fpm are measured by the low-flow probe.

STEP 3

The Pitot probe is a general purpose velocity pressure measuring probe primarily suitable for making measurements at supply openings, return openings, and within ducts. It must be used with one of the range selectors.

KEY POINT 3

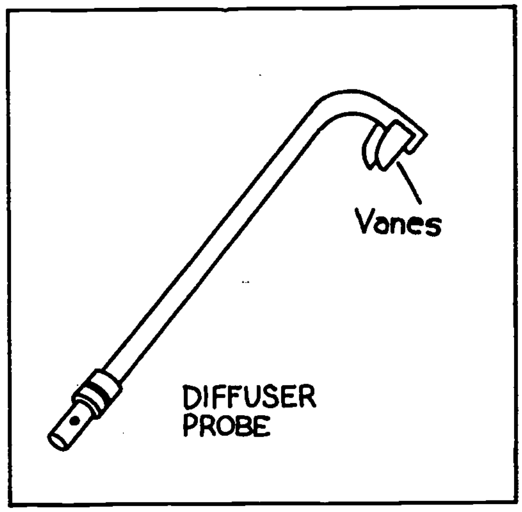


The Pitot probe is a general-purpose measuring probe.

STEP 4

The diffuser probe is primarily designed for measuring the air velocity flowing through diffuser vent grills on air supply ducts. Vanes on the probe head assist in orienting it to the airflow direction. It must be used with a range selector. A correction factor must be applied to the measurements you make in order to report accurate airflow data. The correction factor is usually supplied by the manufacturer.

KEY POINT 4

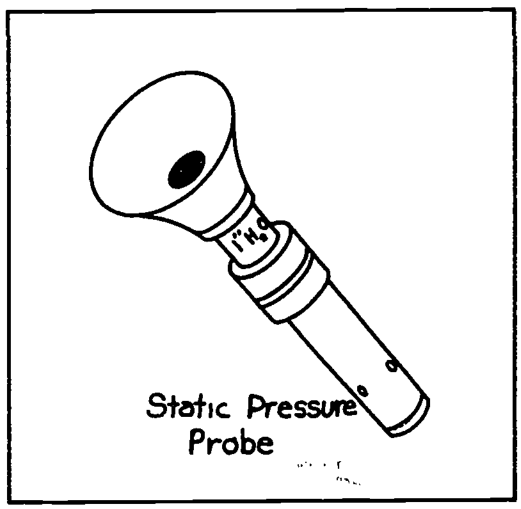


Measure air flowing through diffuser vent grills, using a diffuser probe.

STEP 5

Pick up the static pressure probe and note the rubber cup on the probe head. Press the cup down on a tabletop and quickly pull it up. The pop you hear is the release of the positive seal that is formed. The probe is placed over a small hole on the flat or gently curved surface of a duct. Results are expressed as pressure in inches of water. It must be used with a range selector.

KEY POINT 5

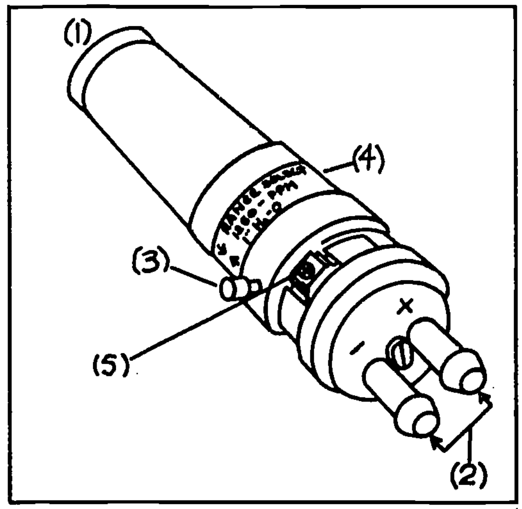


Obtain a positive seal by pressing the rubber cup against a flat surface.

STEP 6

Pick up the range selector. On one end, note the plug-in port (1) that accept the probes described in previous steps. On the other end are the fittings (2) that connect the range selector to the rubber connection hoses. Find the air vent button (3). Depress it for use with the diffuser and static pressure probes, and release it when the Pitot tube is used. Find the range (4) in feet per minute printed on the side of the selector. If the range selector is the same as shown in Key Point 6, slide the range selector switch (5) to the left for 1,250 fpm and to the right for 2,500 fpm.

KEY POINT 6

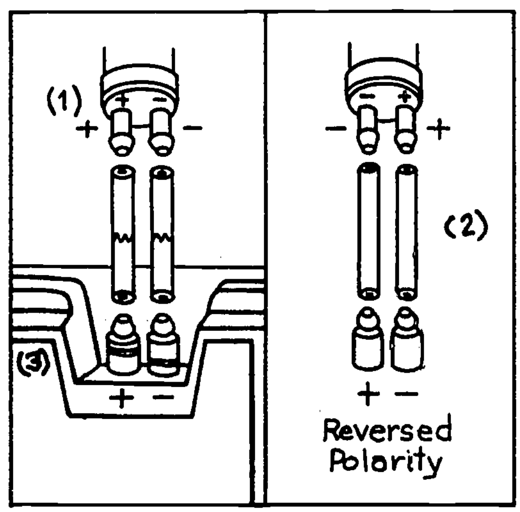


Slide the range selector switch to the desired range, and either release or depress the air vent button.

STEP 7

Pick up the connection hoses, the range selector, and the velometer. Push one end of each hose onto the range selector fittings (1). Note the "+" and "-" markings. For many air velocity measurements, the hoses must be connected as shown in Key Point 7. For static pressure measurements, the hoses must be reversed (2) when attached to the velometer: "+" to "-" and "-" to "+". Push the free ends of the hoses all the way onto the velometer fittings (3).

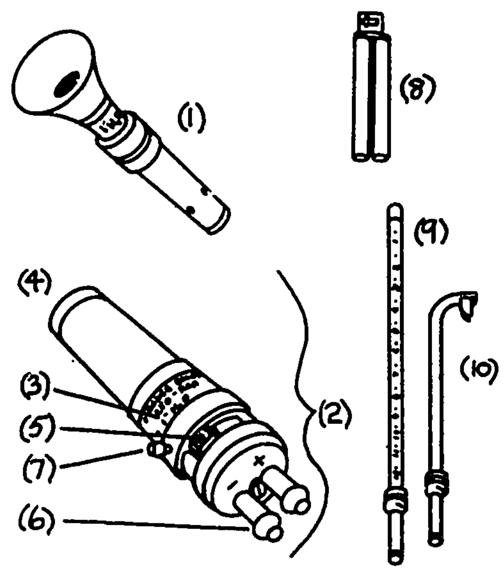
KEY POINT 7



Insert connection hoses, using the proper polarity ("+" or "-").

EXERCISES

Instruction 1: With the swinging vane anemometer and its accessory parts in front of you, practice naming each part and its function. Then label the following drawings to test your knowledge.



(1) ____________________

(2) ____________________

(3) ____________________

(4) ____________________

(5) ____________________

(6) ____________________

(7) ____________________

(8) ____________________

(9) ____________________

(10) ____________________

Instruction 2: When you have correctly labeled each drawing and can tell what each part does, begin work on Lesson Two.

OBJECTIVE

You will be able to assemble the swinging vane anemometer and check its operation.

WHERE AND HOW TO PRACTICE

Continue using the area you selected for practicing Lesson One. Carefully read each step. If you have any question about how to perform any step in this lesson, request help from your instructor.

HOW WELL YOU MUST DO

You must be able to determine if the velometer needs to be recalibrated, to check the meter zeroing, to check the accessories for wear, and be able to attach all accessories so the instrument works within the accuracy stated in the manufacturer's operating instructions. These procedures should take less than 5 minutes.

THINGS YOU NEED

You need the same equipment as in Lesson One.

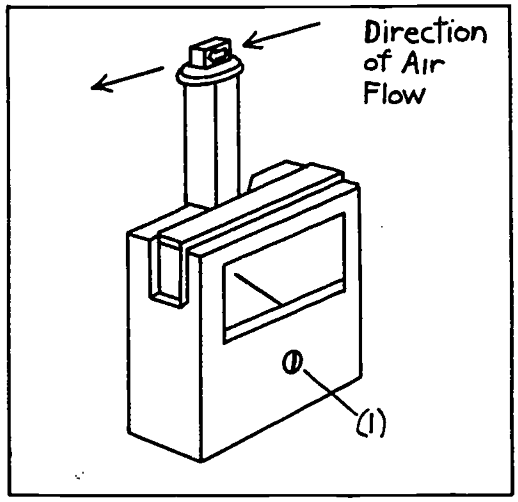
Instructions: Now turn to the next page and begin work on Lesson Two, "Getting There--Steps."

GETTING THERE--STEPS

STEP 1

Check the internal calibration of the velometer. Remove the range selector if you did not do it in Lesson One. Cap or tape the inlet and outlet ports. Lay the velometer down so the meter scales face upward. Turn the zero adjust (1) so that the meter reads slightly upscale from zero. Raise the velometer so that the meter is vertical and observe any change in the reading. If the needle moves over one-fourth of an inch, the unit needs recalibration. Remove the tape from the ports. Blow very gently into the larger air ("+") intake orifice, moving the pointer to full scale. Watch for any sticking of the pointer as it returns downscale to zero. If the air intake port becomes clogged while making measurements, use a rounded toothpick to pick loose any accumulation of dirt or dust.

KEY POINT 1



Check the velometer for calibration and free needle movement.

STEP 2

Place the velometer in a vertical position in front of you. Recap or tape the two ports. Check the zero. The needle should rest exactly on the zero points of the scale. If the needle is not in this position, turn the zero adjustment screw on the front of the case until the pointer is on zero.

KEY POINT 2

The two velometer ports should be closed while zeroing the instrument.

STEP 3

Pick up the low-flow tube. The low-flow probe fits only one way onto the velometer; that is, with the arrow on the probe head pointing to the left when viewing the velometer from the front. Push the low flow tube completely onto the port fittings in the velometer.

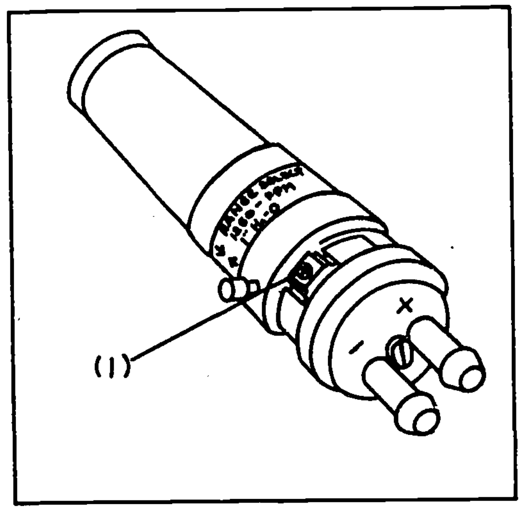
KEY POINT 3

Since no other attachments are necessary, the velometer can now be used to make airflow measurements between 50 and 300 fpm.

STEP 4

Remove the low-flow probe. Pick up the range selector. Check the tightness of the switch plate. If it is loose, tighten the "takeup" adjustment screw (1) located between the two base fittings on the switch housing assembly. When there is a noticeable effort to slide the range selector switch back and forth, the switch plate will be tight enough.

KEY POINT 4

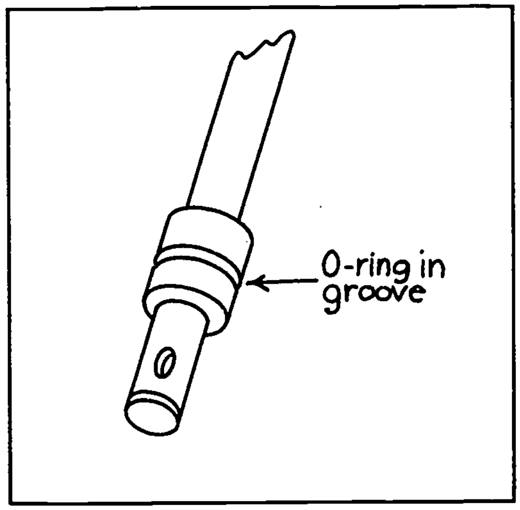


A noticeable effort to change ranges indicates the switch plate is properly tightened.

STEP 5

Pick up the Pitot probe and locate the rubber O-ring near the base. Look for cracks, determine if it fits snugly against the fitting, and check the roundness. If it needs replacement, slip the old O-ring off and lubricate the fitting with silicone grease. Slide the new O-ring on, making sure it is the correct size. The ring should fit snugly with little or no play from side to side.

KEY POINT 5

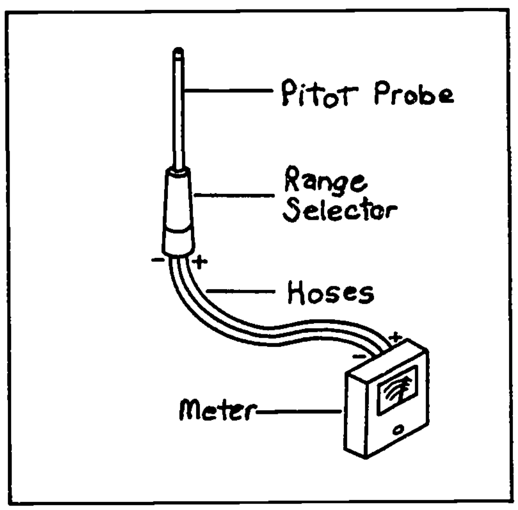


The O-ring should fit snugly, be round, and be free of cracks.

STEP 6

Insert the Pitot probe into the range selector. Push the probe down firmly until the collar of the probe rests against the face of the range selector. Attach the hoses as you did in Step 7 of Lesson One. Make sure the air vent switch is released. The velometer with Pitot tube and range selector is now ready for use.

KEY POINT 6



Release the range selector air vent switch when using the Pitot tube.

EXERCISES

Instruction 1: Practice setting up the velometer using the diffuser probe and range selector. (Repeat Steps 5 and 6.) Plug the diffuser probe into the range selector. Push the air vent switch button in and latch it down. The diffuser probe is now ready for use.

Instruction 2: Locate the static pressure probe, range selector, attachment hose, and velometer. (Repeat Steps 5 and 6.) Assemble these parts following the steps observed in assembling the Pitot probe and diffuser probe, except reverse the polarity of connecting tubes.

Instruction 3: Practice setting up the various combinations of probes and range selectors until you become proficient at making any combination of probes and selectors (with selector in appropriate mode for the probe). Checking the components and assembling each set of attachments should take less than 5 minutes.

OBJECTIVE

You will be able to make velocity measurements in hoods and ducts within the measurement accuracy of the anemometer you use.

WHERE AND HOW TO PRACTICE

Read through each step and then do the exercises. Your instructor will set up, in a laboratory or classroom, a simple local exhaust ventilation system, including ductwork and an air mover. Also, you will need to practice the steps and exercises in this lesson at additional locations. The following list identifies the type of hood or duct and the recommended practice location:

Enclosed hood -- chemistry laboratory and paint spray booth

Slot hood -- industrial shop in which plating or degreasing is performed

Ducts -- in the classroom and in industrial facilities.

Work through the exercises until you gain skill in performing each type of measurement in each type of hood or duct described in the lesson.

HOW WELL YOU MUST DO

You must be able to make air velocity measurements that adequately represent an average air velocity value at the entry point of enclosed hoods, measurements representative of capture velocity of slot hoods, and measurements that represent the air velocity and static pressure in a duct. You must be able to orient each anemometer probe so the air enters the probe head orifice in a direct line and not at an angle.

THINGS YOU NEED

In addition to the equipment you used in the previous lessons, you will need a measuring tape at least 20 feet in length.

GETTING THERE--STEPS

STEP 1

The purpose of the enclosed hood is to contain an airborne contaminant that is generated inside the hood. The air velocity across the face or entry point of the hood determines whether the contaminant will remain in the hood and be drawn into the exhaust ductwork.

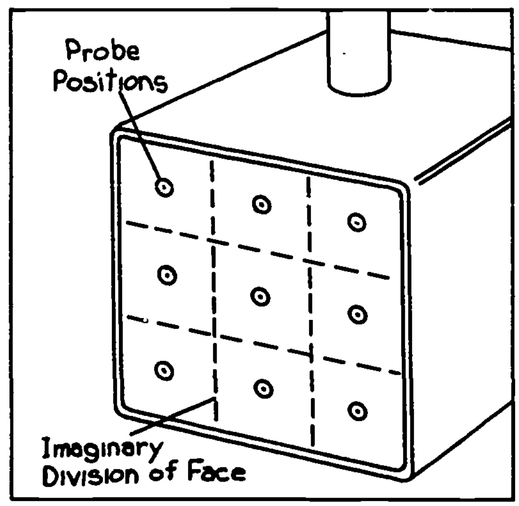
KEY POINT 1

The source of contamination is generated and contained inside an enclosed hood.

STEP 2

Measure the height and width of the chemistry laboratory hood opening (hood face). If the hood opening is equal to or less than 9 square feet, make a minimum of nine separate readings. When the hood face is greater than 9 square feet, make one measurement for each square foot of face area.

KEY POINT 2



Make nine measurements for hoods equal to or less than 9 square feet; make one measurement per square foot of area over 9 square feet.

STEP 3

For the square or rectangular hood you are measuring, determine the number of measurement points using the rule in Step 2 as a guide. Turn on the air mover in the system. You may need to use the low-flow probe if the air velocity is less than 300 fpm in a walk-in enclosed hood or booth.

KEY POINT 3

Determine the number of measurements and prepare the instrument for measuring.

STEP 4

Keeping the probe perpendicular to the direction of airflow, take readings at the center of each 1 foot square. Record the readings in feet per minute (fpm) here:

(1) ______fpm (6) ______fpm

(2) ______fpm (7) ______fpm

(3) ______fpm (8) ______fpm

(4) ______fpm (9) ______fpm

(5) ______fpm

Add the measurements and divide by the number of measurements made. Record this average here:

__________ fpm

KEY POINT 4

Record the face velocity of the hood in linear feet per minute.

STEP 5

How well a slot hood is operating can be determined by measuring its capture velocity. The capture velocity is the air velocity required to move a contaminant from outside the hood to inside the hood.

KEY POINT 5

The efficiency of the slot hood depends on its capability to pull airborne contamination into the exhaust system.

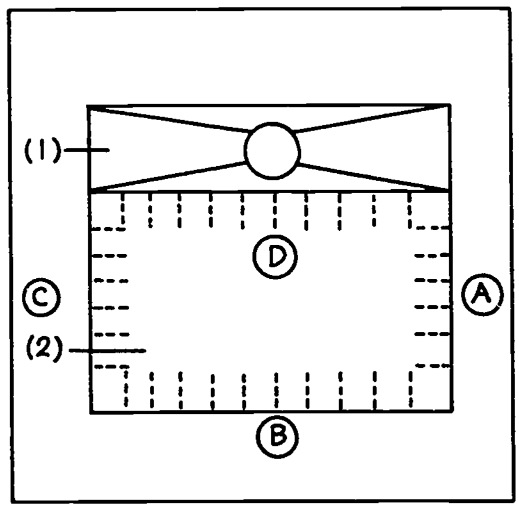
STEP 6

Using the diffuser probe, make measurements to determine air velocity of a slot hood (1) on a tank (2) (degreasing or plating). Turn on the slot hood fan and adjust the slot opening to obtain a velocity of 2,000 fpm at the slot face. Place the diffuser probe into the 1250-2500 fpm range selector. Keep the probe head perpendicular to the direction of flow. Obtain readings at 3-inch intervals for each side, A through D. Record the average for each side here:

A ________fpm
B ________fpm
C ________fpm
D ________fpm

The value for side B will most likely be the lowest of the four values.

KEY POINT 6



Average the readings for each of the four sides; side B will most likely be the lowest average.

26

STEP 7

The duct conveys the airborne contaminant away from the hood to a filter or air cleaner. Clean air is exhausted to the atmosphere or, in some newer local exhaust systems, is recirculated. To take air velocity measurements in a round duct, first measure the diameter of the duct in inches, and then move 10 diameters downstream (in the direction of airflow) from a fan, curve, bend, or other source of turbulence to take measurements. These measurements will help you find the holes already made in the ducts.*

KEY POINT 7

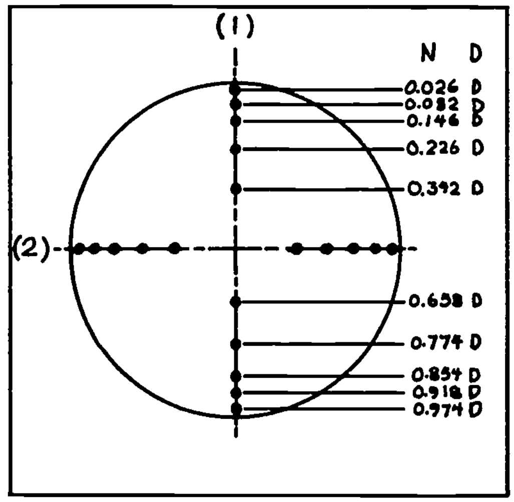
Select a measurement point on a round duct at least 10 diameters downstream from a source of turbulence.

*Measurement points will be selected by the industrial hygienist or safety professional with whom you will work.

STEP 8

There should be two holes (1) (2) at the measurement point, one perpendicular to the other. These holes are used in the traverse method of measuring airflow in a duct. For round ducts 6 inches in diameter and smaller, at least 6 traverse points should be selected across both diameters; at least 10 traverse points should be used for ducts larger than 6 inches in diameter. Use the diagram in the Key Point to find out how far to insert the Pitot probe. For example, if the diameter of the duct is 10 inches, calculate how far to insert the Pitot probe at the first point on the vertical traverse by multiplying the number at the point, 0.026, by the diameter, 10 inches, to obtain a distance of 1/4-inch.

KEY POINT 8



To obtain a measurement at each point along a traverse, insert the probe, N x D distance.

STEP 9

Take two sets of 10 readings, one horizontally (1), the other vertically (2). To help in orienting the Pitot probe in the duct, attach it to the range selector as shown in the Key Point. Insert the Pitot probe in the duct so the probe head (3) openings face upstream. Record the horizontal set of readings here:

d_1 ____ fpm d_6 ____ fpm

d_2 ____ fpm d_7 ____ fpm

d_3 ____ fpm d_8 ____ fpm

d_4 ____ fpm d_9 ____ fpm

d_5 ____ fpm d_{10} ____ fpm

Record the vertical set here:

d_1 ____ fpm d_6 ____ fpm

d_2 ____ fpm d_7 ____ fpm

d_3 ____ fpm d_8 ____ fpm

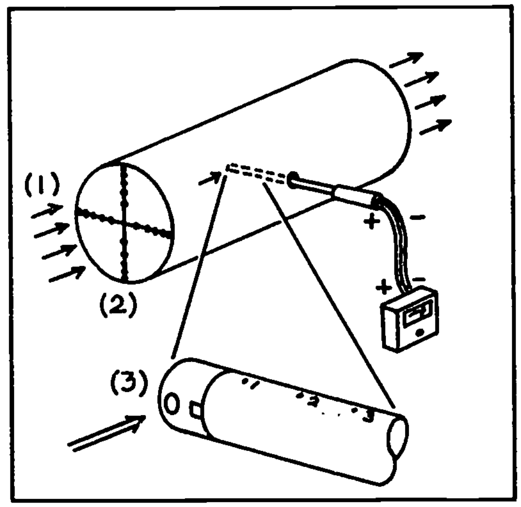
d_4 ____ fpm d_9 ____ fpm

d_5 ____ fpm d_{10} ____ fpm

Average the 20 readings by adding all the "d's" and dividing the result by 20. Record that number here: ____________ fpm.

This is the average velocity through the duct, but only at the point at which you measured. Additional measurements in the ductwork are necessary to determine the efficiency of the system.

KEY POINT 9



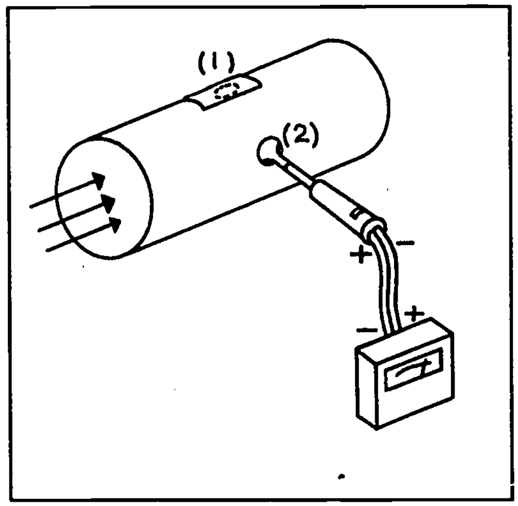
To do a 10-point traverse, take take 10 readings horizontally and 10 readings vertically.

STEP 10

Seal (1) one of the holes used to make traverse measurements. Use the other hole to take static pressure readings. Remove the Pitot probe from the range selector and replace it with a static pressure probe (2). Select the "1-inch water" or "10-inch water" probe depending on the range of static pressures anticipated in the duct. Since you will be performing measurements on a previously evaluated exhaust system, refer to previous measurement records for the range. Make sure you reverse the polarity of the hoses connecting the range selector with the probe, and that you push the range selector button in and latch it down. Make sure the rubber suction cup makes a good seal with the duct surface before making measurements. Take at least three readings to verify the measurement. Record the readings, in inches of water, here:

(1) ________ inches of H_2O
(2) ________ inches of H_2O
(3) ________ inches of H_2O

KEY POINT 10



Reverse the polarity of the connecting hoses, depress and latch the range selector switch, and obtain a good seal between the rubber suction cup of the static pressure probe and the duct surface.

EXERCISES

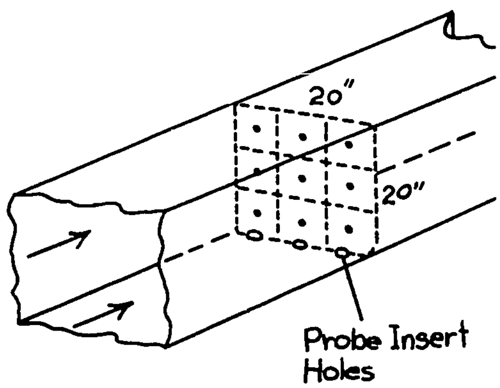
Instruction 1: Repeat Steps 1 through 4 in the same location except make 16 measurements equally spaced over the laboratory hood face. Record the readings in feet per minute (fpm) here:

1	____________ fpm	9	____________ fpm
2	____________ fpm	10	____________ fpm
3	____________ fpm	11	____________ fpm
4	____________ fpm	12	____________ fpm
5	____________ fpm	13	____________ fpm
6	____________ fpm	14	____________ fpm
7	____________ fpm	15	____________ fpm
8	____________ fpm	16	____________ fpm

Average the readings. Record that value here: ____________ fpm. How does this value compare with that recorded in Step 4?

Instruction 2: Repeat Step 6 using a different slot hood. Is the air velocity value at side B the smallest value?

Instruction 3: Take air velocity measurements in a square duct set up in the classroom or in an industrial setting. Measure the sides and divide the cross section into 9 equally spaced sections as shown below. To take measurements in each section, note that at least three holes need to be made.



Follow Step 9 for directions in orienting the probe head. Record your measurements here:

1	______	fpm	6	______	fpm
2	______	fpm	7	______	fpm
3	______	fpm	8	______	fpm
4	______	fpm	9	______	fpm
5	______	fpm			

Average the nine readings: ______________fpm.

Instruction 4: Repeat Instruction 3 except divide the cross section into 16 evenly spaced sections. A set of four probe insert holes must be made upstream or downstream from the set of 3 holes. Record your measurements here:

1	______	fpm	5	______	fpm	9	______	fpm	13	______	fpm
2	______	fpm	6	______	fpm	10	______	fpm	14	______	fpm
3	______	fpm	7	______	fpm	11	______	fpm	15	______	fpm
4	______	fpm	8	______	fpm	12	______	fpm	16	______	fpm

Average the 16 measurements: ________ fpm. Compare this value with that which you obtained in Instruction 3.

Instruction 5: Using the information in the table below, determine the immersion (insertion) distances for inserting the Pitot probe when making measurements in 6-, 8-, and 10-inch ducts. Calculate "d" using the 8- and 10-point traverse methods to measure air velocity in the 8- and 10-inch ducts.

Traverse Method	Probe Immersion in Duct Diameters									
	d_1	d_2	d_3	d_4	d_5	d_6	d_7	d_8	d_9	d_{10}
6 point	0.043	0.147	0.296	0.704	0.853	0.957	-	-	-	-
8 point	0.032	0.105	0.194	0.323	0.677	0.806	0.895	0.968	-	-
10 point	0.025	0.082	0.146	0.226	0.342	0.658	0.774	0.854	0.918	0.975

Instruction 6. Using the 6-point traverse method, make measurements in the 6-inch duct and obtain an average velocity value. Perform this task in ductwork used in an industrial setting, if possible.

Instruction 7. Using the 8- and 10-point traverse methods, make two sets of measurements in an 8-inch duct and in a 10-inch duct. Average the velocity values for each set of measurements you obtain on each duct. Perform this task in the same location as suggested in Instruction 6.

Instruction 8. Compare each set of values for each size duct measured in Instruction 7; i.e., compare 8- and 10-point traverse data collected on the 10-inch duct. What are your conclusions? Explain here:

____

____

____

____

Instruction 9. Repeat all instructions in industrial facilities where local exhaust systems are presently in use and are routinely evaluated.

OTHER READING

American Conference of Governmental Industrial Hygienists, Committee on Industrial Ventilation. Industrial Ventilation--Manual of Recommended Practice, 16th Edition, Lansing, MI, 1980.

Instructions: Check your skill level or progress by working through each of the items in this test. If you can perform each item as well as required, place a check in the space provided. When all of the items are checked, you are ready to demonstrate your skills to your instructor. You may use the following list if needed. You will be considered trained in a skill after your instructor approves your performance on each of the following items.

CHECKING THE OPERATION OF THE SWINGING VANE ANEMOMETER WHILE ASSEMBLING IT

No. 1 _____ Check the internal calibration of the velometer.

No. 2 _____ Zero the velometer meter needle so it rests exactly on the zero points of the scales.

No. 3 _____ Push the low-flow tube completely onto the velometer port fittings.

No. 4 _____ Tighten the switch plate on the range selector until there is a noticeable effort to change ranges.

No. 5 _____ Check the condition and fit of the O-ring on the Pitot, diffuser, and static pressure probes.

No. 6 _____ Attach the connecting hoses with the correct polarity (+ or -) for each probe, making sure the connections are tight.

No. 7 _____ Depress the air vent knob when using the diffuser and static pressure probes, and release it when using the Pitot probe.

No. 8 _____ Slide the range selector switch to the appropriate range for the airflow to be measured.

No. 9 _____ Check and assemble each set of attachments in less than 5 minutes.

FOR FURTHER STUDY

If you could not perform one or more of the nine items above, review and practice the following lesson steps:

No. 1
Lesson Two, Step 1

No. 2
Lesson Two, Step 2

No. 3
Lesson Two, Step 3

No. 4
Lesson Two, Step 4

No. 5
Lesson Two, Step 5

No. 6
Lesson One, Step 8

No. 7
Lesson One, Step 7; Lesson Two, Step 6

No. 8
Lesson One, Step 7

No. 9
Lesson Two, Exercises, Instruction 3

MAKING AIR VELOCITY MEASUREMENTS IN HOODS AND DUCTS

No. 1 ____ Determine the average face velocity in a hood by taking a minimum of nine readings in a hood face where the area is 9 square feet or less; the probe head must be kept perpendicular to the direction of airflow.

No. 2 ____ Determine the average velocity across an open tank exhausted by a slot hood; the probe head must be kept perpendicular to the direction of airflow.

No. 3 ____ Determine the average velocity in a round duct using a 10-point traverse; measurements must be free from the influence of turbulence.

No. 4 ____ Determine the static pressure in a round duct; the suction cup of the probe must make a good seal on the duct surface.

FOR FURTHER STUDY

If you could not perform one or more of the four items above, review and practice the following lesson steps:

<u>No. 1</u>
Lesson Three, Steps 1 through 4

<u>No. 2</u>
Lesson Three, Steps 5 and 6

<u>No. 3</u>
Lesson Three, Steps 7 through 9

<u>No. 4</u>
Lesson Three, Step 10

REFERENCES

Operating Instructions for the Alnor Velometer, Alnor Instrument Company, Niles, Illinois.

U.S. Department of Health, Education, and Welfare, National Institute for Occupational Safety and Health. The Industrial Environment--Its Evaluation and Control, Chapter 40, 1973.

U.S. Department of Health, Education, and Welfare, National Institute for Occupational Safety and Health, Division of Training and Manpower Development. Industrial Ventilation, Course 588, Cincinnati, OH, March 1979.

U.S. Department of Labor, Occupational Safety and Health Administration, Industrial Hygiene Field Operations Manual, Section 8 (OSHA Instruction CPL 2-2.20), April 1979.