LABORATORY MANUAL

EOH 466B

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Laboratory Exercise 1

Computer Lab

Introduction

The purpose of this lab is to introduce the use of a personal computer to the class. You are expected to use a computer to prepare laboratory reports, to conduct calculations and to prepare graphs and tables.

As an exercise for this lab, use a spreadsheet to calculate the value of a savings account under two scenarios:

1. Invest $50 per month starting at age 25; assume simple interest at 5 % per year. What will the account balance be at age 65?

2. Invest $100 per month starting at age 35; assume simple interest at 5 % per year. What will the account balance be at age 65?

Graph the data, with both curves on the same graph. Label axes and give the graph a title.

FORMAT FOR ALL LAB REPORTS

For most labs, produce:

- A one-page executive summary of what you did in lab.
- A clean presentation of the data.
- Answer all assigned questions.

LAB REPORTS ARE DUE AT THE NEXT LAB MEETING. LATE REPORTS WILL SUFFER A GRADING PENALTY. THEY MUST FOLLOW STANDARD FORMAT OR POINTS WILL BE DEDUCTED.

Laboratory Exercise 2

Pump Calibration

INTRODUCTION

In order to obtain long-term samples of air concentrations of environmental contaminants, a known volume of air is passed through a filter. It is essential that the volume of air be known, so the time-weighted average concentration of contaminants can be calculated.

We will be using five techniques in this lab: a soap bubble burette, a mini-Buck automatic soap bubble meter, an automated frictionless meter, a Kurz mass flow meter, and a Wet Test Meter.

We will calibrate a low-flow pump.

We will also calibrate a rotameter and a critical orifice.

Reading: Chapter 8

Materials

Personal air sampling pumps
1000 ml burette
500 ml burette
Soap solution
DC LITE Flow Calibrator
Buck Flow Calibrators
Kurz Model 541 mass flow meter
Wet test meter
Rotameter
Limiting orifice

Method

Each group will use one personal air sampling pump, taking it to each test stations I through V. Set the pump to an indicated flow rate of 2 L/min. Record all data on the chart included in this protocol. Note the brand name and number, and the serial number of each pump you use. Calculate the mean and standard deviation of each set of calibrations. Each calibration should be repeated 5 times.

I. **Soap bubble burette**

Pour the soap solution into the burette. Gently roll the burette, so the

entire inner surface is coated with soap solution. Clamp the burette to a stand, or use the burette holder. Place a beaker containing a small amount of soap solution under the inverted burette. Attach a length of tubing to the top of the burette; place a 37-mm filter cassette in line. Time how long it takes for a bubble to rise from the mark at the bottom (inverted top) of the burette to any marked point on the burette. To create bubbles, touch the soap solution in the beaker to the bottom of the burette. If the bubble bursts before reaching your mark, disregard that run and try again.

II. **mini-Buck flow calibrator**

Attach the pump to the top of the flow calibrator, using plastic tubing. Place a 37-mm filter cassette in line between the pump and the calibrator. The calibrator is operated by briefly depressing the button on the side of the plastic column. You should see one or more bubbles rise through the device. Record the flow as measured by the calibrator. If the device flashes "E-E-E-E", switch it off and then on again.

III. **DC-Lite calibrator.**

Attach the pump to the flow calibrator. Place a 37-mm filter cassette in line between the pump and the calibrator. Pressing a button operates the calibrator; you can operate it in manual or automatic mode.

IV. **Kurz mass flow meter**.

Attach the pump using a length of plastic tubing with a filter in line. Make sure the direction of airflow follows the arrow imprinted on the flow sensor.

V. **Wet Test Meter**

The wet test meter operates by filling four chambers inside the device with air. As each chamber is filled, the drum rotates, turning the dial on the face of the instrument. The instrument can be read in two ways:

- By observing the flow of air passing through the meter in one minute.
- By observing how long it takes for a specific volume of air to pass through the meter.

The smaller dials are used for logging large volumes of air through the instrument. The wet test meter records air volume in units of cubic feet. You will have to convert between cubic feet and liters.

There is a U-tube manometer attached to the wet test meter. It must contain water if the meter is to operate properly. The indicated pressure should not exceed 2 inches of water. The temperature and atmospheric pressure are normally recorded as well, although adjustment for pressure and temperature is normally not significant.

Conduct one series of tests by observing the volume of air measured in one minute. Compare the markings on the inner and outer dial, and note that the inner dial is 60 times the outer dial. The volume measured on the inner dial in one minute will give flow rate in standard cubic feet per hour. Convert your observations in order to report the calibration in liters per minute.

Conduct a second series of tests by observing the time it takes for the instrument to measure one liter of air. Use the outer dial - you will have to know how many cubic feet are in one liter of air.

THE NEXT TWO STEPS SHOULD BE CARRIED OUT USING THE ALTERNATE PUMPS, SO YOU WILL HAVE USED A VARIETY OF PUMPS IN THIS EXERCIZE.

VI. **Calibrate a rotameter**

Connect the top of a rotameter in line with the air-sampling pump. Make sure the valve to the rotameter is open, but too loose. Do not adjust this valve during the calibration.

Read the rotameter setting by observing the float position. Read the rotameter using the middle of the float. Keep your eyes parallel to the float to avoid parallax error.

Connect the bottom of the rotameter to a flow calibrator, and observe the actual airflow. Take five measurements of flow rate.

Use the pump to change the float position, and repeat the calibration for five float positions. You should try to spread out the measurements along the scale of the rotameter.

VI. **Calibrate a critical orifice**

1. Set up a line to vacuum with a critical orifice in place.
2. Measure airflow with the vacuum on.
3. Calibrate the orifice using a primary standard.

Questions: ANSWER ALL QUESTIONS

1. Define precision and accuracy. How are they measured?

2. Graph the data collected when you calibrated the rotameter. Perform a linear regression between airflow and rotameter indication. Use a computer spreadsheet to generate the graph and the regression. Report the r-square value generated by the regression. What information does this graph provide?

Calibration with burette			
Test no.	Volume (L)	Time (seconds)	Calculated Flow rate (L/min)
1			
2			
3			
4			
5			
Calibration with mini-Buck			
Test no.	Volume (L)	Time	Measured Flow rate (L/min)
1	N/D	N/D	
2	N/D	N/D	
3	N/D	N/D	
4	N/D	N/D	
5	N/D	N/D	
Calibration with Kurz Mass Flow Meter			
Test no.	N/D	N/D	Measured Flow rate (L/min)
1	N/D	N/D	
2	N/D	N/D	
3	N/D	N/D	
4	N/D	N/D	
5	N/D	N/D	

Calibration with Wet Test Meter				
Test no.	**1 minute sample** (measured volume in cubic feet)	Calculated Flow rate (L/min)	**1 liter sample** (measured time in seconds)	Calculated Flow rate (L/min)
1				
2				
3				
4				
5				

Laboratory Exercise 3

Standards Generation

Introduction

In order to calibrate direct reading instruments, it is necessary to generate known concentrations of organic vapors. Injecting a known amount of a test substance into a known volume of air does this.

Reading: Chapter 7

Equipment

1. Gas sampling bags
2. Wet test meter
3. Micro syringe
4. Toluene
5. MSA Meter
6. Gastech meter

Procedure

1. Calculate the amount of liquid toluene needed to generate 10, 20, 50 and 100 ppm toluene vapor inside a gas sampling bag. Sample volumes should be 20 to 50 liters.

$$\mu l = \frac{(L\ liters)(C\ ppm)(MW\ \frac{g}{mole})(298^{o}K)(P_1\ mmHg)(1000)}{(24.5\ \frac{L}{mole})(\rho\ \frac{g}{ml})(T_1^{o}K)(760\ mmHg)(10^{6})}$$

Where:

L is volume of air in sample bag (liters)
C is desired toluene concentration (ppm)
MW is molecular weight of toluene
P_1 is atmospheric pressure in the lab (mm Hg)
ρ is density of toluene (g/cc)
T_1 is the room temperature ^{o}K

2. Use the wet test meter to measure a volume of air into a gas-sampling bag. Pick a bag with a rated volume slightly larger than the volume of air you will need.

3. Inject the appropriate amount of toluene using a micro syringe. After each use of the bag (that is each time a bag is used to generate a known concentration of toluene), the

bag should be flushed out in the hood with clean air.

4. Measure the toluene concentrations you have generated using the Photovac Microtip and the TLV Sniffer. These measurements will be used to calibrate the instruments.

Questions:

1. Calibrate the instruments: Graph each instrument's response on the Y-axis vs. the known toluene concentration on the X-axis. Perform a linear regression on the data.

2. Discuss potential sources of error in this exercise, and interpret the calibration data. What do they indicate concerning instrument response?

3. How much hexane must be injected into a 50 L volume of air to generate a concentration of 50 ppm?

Laboratory Exercise 4

Dynamic Standards Generation

Reading: Using permeation tubes pamphlet.

The Dynacalibrator is an automated standards generator, using a permeation tube to generate a vapor at a known concentration.

Temperature and Flow rate Calculations:

The Dynacalibrator is a device that will automatically deliver a known concentration of vapor that can be used to calibrate instruments. It is useful if large volumes of calibrant are needed, and buying prepared standards is inconvenient or too expensive. A portable model is available.

The principle of operation involves the use of a permeation tube, which allows a known mass of solvent to be released into an air stream. If the solvent mass flow is known, and the airflow rate is known, the concentration of the calibration stream will also be known.

Prior to installing a permeation device in the Dynacalibrator and preparing it for operation, you must determine the temperature at which you will operate the chamber and the dilution flow rates for the desired output concentration. The chamber operating temperature, among other factors, will determine the method of preconditioning the permeation device.

It is necessary to go through these calculations to make sure the Dynacalibrator will generate gas at a known concentration, at a flow equal to or greater than the flow into the instruments being calibrated. For example, it is possible that you must raise the operating temperature of the Dynacalibrator if the output flow at the standard temperature is too low.

The data in these examples are taken from a sulfur dioxide diffusion tube, and not for the tube you are using in this lab. They are being used to illustrate the process you must follow.

STEP 1: Calculate dilution flow needed at the standard operating temperature for the permeation tube.

Before deciding on the temperature at which your device is to be used, you should calculate the dilution flow at the standard operating temperature for the tube. You can find this information on the data sheet describing the tube. Use the following formula:

$$F_d = \frac{P\,K_m}{C} - F_c$$

where F_d = dilution flow rate in cc/min

P = device mass permeation rate in ng/min at the specified temperature

K_m = molar volume constant of the device gas, 24.47 / MW

C = desired output concentration in ppm

F_c = carrier flow rate of the Dynacalibrator (this is 172 cc/min for our Dynacalibrator.)

For example, a 0.5 ppm concentration is desired using a 2 cm standard emission SO_2 Dynacal tube (normal permeation rate @ 30 °C = 2 x 400 = 800 ng/min).

$$F_d = \frac{(800)(0.382)}{0.5} - 171$$

or 439 cc/min

IMPORTANT: The total calibrator flow (F_d + F_c) output must ALWAYS exceed the suction rate of the analyzer being calibrated. If the total flow is too low, you must increase the permeation rate from the tube.

STEP 2: Pick total flow rate that exceeds the suction rate of the analyzer being calibrated, and calculate the permeation rate needed at this flow rate.

In our example, we found the dilution flow to equal 440 cc/min. This is a low flow, and we may desire to use a higher flow. Using the rotameter Calibration Data sheet for this Dynacalibrator we can select a more desirable flow rate, in our example, 1340 cc/min. (Please note that this is **not** the flow rate we will use in lab.) Solve the formula above to calculate the required permeation rate of the Dynacalibrator.

$$P = \frac{(F_d + F_c)C}{K_m}$$

$$= \frac{(1340 + 171)(0.5)}{0.382} = 1978\,\frac{ng}{\min}$$

STEP 3: Calculate the temperature needed to obtain the new permeation rate.

Next, the temperature at which the tube must be operated to produce the required permeation rate is determined from the following formula:

$$T_1 = \frac{\log P_1 - \log P_0}{a} + T_0$$

where T_1 = required temperature in °C

P_1 = required permeation rate in ng/min

P_0 = permeation rate at T_0, either 30 °C or certified temperature (refer to tube description.

and a = 0.034 (temperature coefficient for high permeation rate tubes)

STEP 4: Find the actual operating temperature and calculate actual permeation rate.

The required operating temperature, to the nearest integral, is then 42 °C. The next step is to use this in the above formula and determine the actual permeation rate, based on the temperature recorded by the oven thermometer:

$\log P_1 = \log P_0 + a(T_1 - T_0) = \log 800 + 0.034(42 - 30)$
$= 2046$ ng/min

STEP 5: Based on the expected permeation rate, calculate the expected concentration generated by the Dynacalibrator.

The above formula is not exact but will generally predict the permeation rate for a 10 °C shift in temperature within ±5%. The last step in the process is to use the final permeation rate with the selected dilution flow rate and the Dynacalibrator's specified carrier flow rate to calculate the output concentration and see if it is within desired limits.

$$C = \frac{P K_m}{F_d + F_c}$$
$$= \frac{(2046)(0.382)}{1340 + 171} = 0.52 \text{ ppm}$$

Procedure

We will use the Dynacalibrator to generate a 50-ppm toluene calibration gas. The

output from the Dynacalibrator will be fed to a 5-gallon glass bottle. A line will be fed to a photoionization detector, with an extra line open to the atmosphere for venting.

The **total flow** rate (dilution flow and chamber flow) from the Dynacalibrator will be **1461 cc/min**. Following the procedure outlined above, and the data sheets contained in this manual, calculate the correct operating temperature for the Dynacalibrator.

Using the PID, we will obtain a measurement of toluene concentration in the bottle once per minute. The observed concentration will be compared to expected, calculated using the formula for exponential build up of a vapor:

$$C_t = C_0(1 - e^{-\frac{Qt}{V}}).$$

C_t = concentration at any time, t.
C_0 = calibration concentration.
Q = total flow into the chamber.
t = time (minutes)
V = volume of the chamber (liters)

Then, with the calibration flow turned off (only dilution air entering the bottle), we will observe the decline in toluene concentration at the bottle is purged.

Questions:

1. Plot the observed toluene concentration (y-axis) vs. time (x-axis). Compare the observed data with those predicted by the formula for exponential build-up and decay of toluene.
2. How will changes in dilution flow (F_d) alter the prediction line? Generate graphs using a computer to do this analysis. (Hint: $F_d + F_c = Q$)
3. How will changes in toluene permeation rate resulting from a change in oven temperature alter these predictions? Generate graphs using a computer to do this analysis.

Laboratory 5

Asbestos Analysis

Introduction

In some situations, it is desirable to perform visual counting of collected aerosol particles, both to observe the particles and to evaluate their size distribution.

Background:

In this exercise, we will use a light microscope to count and size fibers collected on a glass slide.

Please visit this web site for a tutorial on asbestos fiber counting.

Materials

Microscope fitted with graticle
Stage micrometer
Lens paper
Data sheet

Procedure

We will have several microscopes set up, with the graticle in place. There will also be a collection of asbestos slides for you to view. Select one, and try to count asbestos fibers, using the method discussed in the web site referenced above. When you are done, compare your count to the 'known' count.

There will also be a collection of microscope slides with a wide variety of materials to inspect. Take some time to view the samples of interest.

Laboratory 6

Particle Size Selective Sampling

Introduction

In many situations, it will be necessary to obtain particle-size specific air samples. We will use several methods in this lab: total dust sample, using a closed-face 37 mm cassette; respirable particulate mass, using a cyclone; inspirable particulate mass, using an IOM sampler; and particle size distribution, using a personal cascade impactor.

Reading: Chapter 12

Equipment

Personal sampling pumps
37-mm filter holder (2)
37-mm glass fiber filters
Cyclone for obtaining respirable mass samples
DeVilbiss® Model 40 nebulizer
Portable aerosol monitor
IOM inspirable mass monitor
Marple® cascade impactor.

Procedure

1. Calibrate 4 personal sampling pumps:

   1 to flow at 2.75 L/min ± 5%.
   4 to flow at 2 L/min ± 5%

2. Weigh a filter 3 times on the Cahn Electrobalance. Record the average initial weight on the data sheet. Load the filter on a 37-mm sampling cassette. Repeat for another filter. Make sure you have labeled the cassettes.

3. Connect one 37mm filter to a pump calibrated to 2 L/min. This will provide a measurement of 'total' mist.

4. Assemble a second, with a cyclone in line, to the pump calibrated to 2.75 L/min. This will provide a measurement of respirable mist.

5. Weigh a filter for the IOM sampler and connect it to a pump calibrated to 2 L/min. This will provide a measurement of inspirable mist.

6. Weigh the Mylar filters used in the personal cascade impactor stages. Assemble the device, connecting it to a pump set to 2 L/min. Be sure that the slots in the

Mylar filters align with the slots in the impactor stages. This device should measure all the mist being generated, up to a particle size of 25 microns.

7. Attach one pump calibrated to a flow of 2 Lpm to the automated dust monitor. The monitor will be set to log the concentration it observes. This will provide a measure of respirable mist concentration.

8. A mineral oil aerosol will be generated in the aerosol chamber using the DeVilbiss nebulizer. Place the pumps in the chamber. Turn the pumps on and record the start time. Place the aerosol monitor immediately above the filters, horizontally, so you can read its display from outside the hood. Turn the aerosol monitor on.

9. Immediately after the pumps and the mini-RAM have been started, close the chamber. Start the airflow through the chamber, and then start the nebulizer. You should observe a frothing of the oil in the nebulizer, but do not allow mist to enter the room air.

10. While the nebulizer is operating, each student should practice weighing filters, to get an idea of how the Cahn Electrobalance operates.

11. After half an hour, turn off the nebulizer, let the chamber continue to vent for a short time, and then open the chamber and turn the pumps and the mini-RAM off.

12. Remove the filters and reweigh them.

13. Measure the final flow rate of the pumps. In your calculations, use average flow to find aerosol concentration.

14. Transfer the logged data from the automated aerosol monitor to the computer for distribution to the class.

Observations/calculations	Respirable	Inspirable	'Total' mist
1. Final weight (mg)			
2. Initial weight (mg)			
3. Mass collected (mg) = 1-2			
4. Time on			
5. Time off			
6. Sampling Time (min) = 4 - 5			
7. Initial flow rate			
8. Final flow rate			
9. Average flow rate:			
10. Volume sampled (L) = 6 x 9			
11. Aerosol concentration (mg/M^3) = 3 / 10, check units			

Questions

1. For each of the samplers (37-mm cassette, cyclone separate and the IOM selector), what size particle should be collected at 50 % efficiency, and what size particle should be collected at 0 % efficiency? Refer to lecture notes and your textbook for answers to this question.

2. Calculate the 'total', inspirable and respirable aerosol mass concentration in mg/M^3. The data table provided will help answer this question.

3. Calculate the mass median aerodynamic diameter and geometric standard deviation of particles generated in the chamber, using the cascade impactor data and log-probability paper. Plot cumulative percent of the total mass (from smallest sized particles to largest) vs. particle aerodynamic diameter.

This table shows the impactor stages and the 'cut-points' for aerodynamic diameter for each stage of the impactor when it is operated at 2 L/min. For example, Stage 1 is assumed to collect 20-micron particles. You will need this information to answer question 4.

1	2	3	4	5	6	7	8	F
20	15	10	6	3.5	2	1	0.6	0

Laboratory Exercise 7

Direct Reading Instruments

Introduction

Many industrial hygiene and environmental surveys use portable, direct reading instruments to indicate concentrations of many contaminants. Each student should take time to handle each piece of equipment. Work in small groups.

Reading: Chapter 9

Equipment list

Gas sampling bags containing prepared standards
Mercury vapor monitor
Multi RAE Plus
Crowcon Triple Plus
Draeger Multi-Gas Detector, with tubes for CO and Toluene
Sensidyne Piston Pump with tubes for carbon dioxide
Quest AQ 5001
TSI Q-Trak Indoor Air Quality Meter
Calibration gas bottles: CO, H_2S, 50 % LEL Methane

Procedure

Station 1: Multi RAE Plus. Use this device to measure the concentration of toluene and xylene. Obtain measurements for all readings provided by the instrument.

Station 2: Crowcon Triple Plus. Use this device to measure % LEL for xylene and methane. The methane is contained in a gas bottle. In each case, measure the oxygen concentration. Measure the hydrogen sulfide concentration using the hydrogen sulfide calibration gas.

Station 3: Quest AQ 5001 and TSI Q-Trak. Measure carbon monoxide, carbon dioxide and relative humidity concentrations in the lab. Note that your exhaled breath can affect readings made by these instruments.

Station 4: Colorimetric tubes. Draeger Multi-Gas Detector: Two tube types are available: toluene and carbon monoxide. Use the toluene indicator tube to measure toluene concentration in one of the prepared standard bags. Use a carbon monoxide tube to measure one of the following conditions: a smoker's exhaled air (have the smoker breathe into a gas sampling bag); in the hallway; in the parking lot. The Sensidyne piston pump will be used to measure carbon dioxide at any location.

Station 5: Mercury vapor monitor: There will be a 5-liter bottle containing mercury in the

hood. Note how easily you can observe excessive concentrations of mercury; you can easily peg the meter. Record mercury concentration, if you can.

Laboratory Exercise 8

Nonionizing Radiation and Lighting

Objective: The purpose of this laboratory is to provide experience in evaluating lighting conditions and handling microwave (radiowave) detectors.

Reading: International Light Lighting Handbook
Chapter 22

Materials

1. SPER Scientific light meter
2. Weston Illumination meter
3. Holaday Microwave Oven Survey Meters
4. Holaday Model HI 3002 Isotropic Broadband Field Strength Meter
5. Tecktronix J16 Illumination meter.
6. International Light meter with a ACGIH Actinic UV hazard sensor.
7. Holaday VDT Meter

Procedures

1. Lighting surveys

   Use available illumination meters to conduct lighting surveys in one location: hallway; classroom situation; office; computer room. Select one area to evaluate - your choice. Prepare a map indicating the physical layout of the areas evaluated and light sources present.

2. Microwave oven survey.

   Survey the microwave:

   1) Place a cup of water in the oven, and set the timer for several minutes. **When removing the cup, be cautious of the hot water!**

   2) Use the Holaday Microwave Oven Survey meter to conduct measurements along the door hinges, seals, face of oven and power cord. Measure leakage twice, with the probe rotated 45 degrees between measurements.

3. Diathermy equipment survey

   1) Use the Holaday Model HI 3002 Isotropic Broadband Field Strength Meter to test energy from the Diathermy equipment. Measure the field strength 6 inches from the antenna, and at the operator's position. Use

the markings on the plastic pipe to measure operator's exposure to both electric and magnetic fields.

4. VDT Survey

Use the VDT Survey meter to measure magnetic and electric field intensity at an operator's position, and also as close to the screen as you can measure.

5. UV Hazard

Use the portable UV lamp to measure exposure using the International light survey meter.

Laboratory Exercise 9

Noise Monitoring

Introduction

Noise exposure monitoring is a common practice in evaluation of workplace safety and health, since so many workers are exposed to excessive noise on the job. The purpose of this exercise is to allow students to become familiar with noise monitoring equipment such as sound level meters, dosimeters, octave band analyzers, etc.

Reading: Chapter 21

Equipment

B&K Type 2209 Impulse Precision Sound Level Meter with Type 1616 Octave Filter Set
B&K Type 4226 Multifunction Acoustic Calibrator
Dosimeters
Quest Model 2800 Integrated Sound Level Meter with Model OB-300 1/3 Octave Band Filter Set
Quest Model Q-200 Sound Dosimeters
RION Model NA-23 Sound Level Meter

Procedure

Dosimeter Operation: Use a DuPont / Ametek MK-1 dosimeter. Attach the instrument to the DuPont AC-1 calibrator. Turn the calibrator on, and measure the sound level at 94 and 114 dBA. Then turn the dosimeter and the calibrator off.

Turn the dosimeter on, and set the calibrator to operate at 94 dBA for 5 minutes. After 5 minutes, record the dosimeter indications of L_{avg} and Dose, %. Do this as quickly as you can. Set the calibrator to operate at 114 dBA, without turning the dosimeter off. After 5 minutes, turn the calibrator off, and record the dosimeter indications of L_{avg} and Dose, %. Again, do this as quickly as you can. The goal here is to generate a noise exposure consisting of 5 minutes at 94 dBA followed by 5 minutes at 114 dBA.

High frequency noise: A power strip will be set up, containing two Ultrasonic Pest Repellers. Use the B&K Type 2209 sound level meter. Measure sound at 25 000, 31 500 and 40 000 Hz. Record the sound level generated by the pest repellers at a distance of 1, 6 and 12 inches from the repellers.

Transmission Loss: Use a blender as a noise source in the sound box.

Record frequency-specific noise levels 24 inches from the box (all full octaves), using the Quest Model 2800 meter. Record the sound levels with and without the noise box cover in place.

A, C and F weighted calibration: Use the Quest Model 2800 Integrated Sound Level Meter and the B&K Type 4226 Multifunction Acoustic Calibrator. (Note: We may change the equipment used in this step.) You will measure instrument response at 125, 250, 500, 1000, 2000 and 4000 Hz, setting the sound level meter to A-weighting, C-weighting and linear response.

Questions:

1. Compare the dosimeter indications with your calculated values for L_{avg} and Dose, %. Refer to the dosimeter instruction manual for how these values are calculated.

2. Estimate the transmission loss for the aquarium glass by octave band and for all frequencies combined. Transmission loss is the arithmetic difference, in dB, with and without the aquarium glass in the path. Plot the octave band data (x-axis = octave band) in a histogram.

3. Compare the Quest Model 2800 meter response with the value obtained by adjusting calibrator output (114 dB) by the A and C weighting values in the table below.

Frequency (Hz)	A weighting correction	C weighting correction
125	-16	0
250	-9	0
500	-3	0
1000	0	0
2000	+1	0
4000	+1	-1

Laboratory Exercise 10

Temperature Extremes

Respirator Fit Testing

Procedure

WIBGET The WIBGET is an automated wet-bulb globe thermometer. We will set one instrument up in the hood, representing a cool, moist environment. At the same time, we will set up three thermometers, recording natural wet bulb temperature, dry bulb temperature and globe temperature.

On the lab counter, we will set up a hot, dry condition using two heat lamps. The same measurements will be made here. Compare data recorded using the automatic and manual wet bulb globe temperature measurement devices.

Respirator fit testing

Each student will undergo a Qualitative Fit Test, following the protocol preferred by OSHA in the lead standard. The protocol is reproduced below. QLFT test rooms will be plastic garment bags set up in 154D. Evaluation of individual sensitivity to isoamyl acetate will be conducted in 154H.

We will also conduct Quantitative Fit Testing, using the Portacount® 5000. Instructions for using this device accompany the unit.

QUALITATIVE FIT TEST PROCEDURES

This appendix specifies the only allowable qualitative fit test protocols permissible for compliance with the OSHA lead standard.

I. Isoamyl Acetate Protocol

A. Odor Threshold Screening

1. Three 1 -liter glass jars with metal lids (e.g. Mason or Bell jars) are required.

2. Odor-free Water (e.g. distilled or spring water) at approximately 25 C shall be used for the solution.

3. The isoamyl acetate (IAA) (also known isopentyl acetate) stock solution is prepared by adding 1 cc of pure IAA to 800 cc of odor free water in a 1-liter jar and shaking for 30 seconds. The solution shall be prepared new at least weekly.

4. The screening test shall be conducted in a room separate from the room used for actual fit testing. The two rooms shall be well ventilated but may not be connected to the same recirculating ventilation system.

5. The Odor test solution is prepared in a second jar by placing 4 cc of the stock solution into 500 cc of odor free water using a clean dropper or pipette. Shake for 30 seconds and allow it to stand for two to three minutes so that the IAA concentration above the liquid may reach equilibrium. This solution may be used for only one day.

6. A test blank is prepared in a third jar by adding 500 cc of odor free water.

7. The odor test and test blank jars shall be labeled 1 and 2 for jar identification. If the labels are put on the lids they can be periodically dried off and switched to avoid people

8. The following instructions shall be typed on a card and placed on the table in front of the two test jars (i.e. 1 and 2):

> "The purpose of this test is to determine if you can smell banana oil at a low concentration. The two bottles in front of you contain water. One of these bottles also contains a small amount of banana oil. Be sure the covers are on tight, then shake each bottle for two seconds. Unscrew the lid of each bottle, one at a time, and sniff at the mouth of the bottle. Indicate to the test conductor which bottle contains banana oil."

9. The mixtures used in the IAA odor detection test shall be prepared in an area separate from where the test is performed, in order to prevent olfactory fatigue in the subject.

10. If the test subject is unable to correctly identify the jar containing the odor test solution, the IAA QLFT may not be used.

11. If the test subject correctly identifies the jar containing the odor test solution he may proceed to respirator selection and fit testing.

B. Respirator Selection

1. The test subject shall be allowed to select the most comfortable respirator from a large array of various sizes and manufacturers that includes at least three sizes of elastomeric half face masks and units of at least two manufacturers. (NOTE: In this lab, only MSA respirators are available.)

2. The selection process shall be conducted in a room separate from

the fit test chamber to prevent odor fatigue. Prior to the selection process, the test subject shall be shown how to put on a respirator, how it should be positioned on the face, how to set strap tension and how to assess a "comfortable" respirator. A mirror shall be available to assist the subject in evaluating the fit and positioning of the respirator. This may not constitute his formal training on respirator use, only a review.

3. The test subject should understand that he is being asked to select the respirator that provides the most comfortable fit for him or her. Each respirator represents a different size and shape and, if fit properly, will provide adequate protection.

4. The test subject holds each facepiece up to his face and eliminates those that are obviously not giving a comfortable fit. Normally, selection will begin with a half-mask and if a fit cannot be found here, the subject will be asked to go to the full-facepiece respirators. (A small percentage of users will not be able to wear any half-mask.)

5. The more comfortable facepieces are recorded; the most comfortable mask is donned and worn at least five minutes to assess comfort. Assistance in assessing comfort can be given by discussing the points in #6 below. If the test subject is not familiar with using a particular respirator, he shall be directed to don the mask several times and to adjust the straps each time, so that he becomes adept at setting proper tension on the straps.

6. Assessment of comfort shall include reviewing the following points with the test subject:

   Chin properly placed.
   Positioning mask on nose.
   Strap tension.
   Fit across nose bridge.
   Room for safety glasses.
   Distance from nose to chin.
   Room to talk.
   Tendency to slip.
   Cheeks fill out.
   Self-observation in mirror.
   Adequate time for assessment.

7. The test subject shall conduct the conventional negative and positive-pressure fit checks. Before conducting the negative or positive-pressure checks, the subject shall be told to "seat" his mask by rapidly moving the head side-to-side and up and down, taking a few deep breaths.

8. The test subject is now ready for fit testing.

9. After passing the fit test, the test subject shall be questioned again regarding the comfort of the respirator. If it has become uncomfortable, another model of respirator shall be tried.

10. The employee shall be given the opportunity to select a different facepiece and be retested if during the first two weeks of on-the-job wear the chosen facepiece becomes unacceptably uncomfortable.

C. Fit Test

1. The fit test chamber shall be substantially similar to a clear 55 gallon drum liner suspended inverted over a 2 foot diameter frame, so that the top of the chamber is about 6 inches above the test subject's head. the inside top center of the chamber shall have a small hook attached.

2. Each respirator used for the fitting and fit testing shall be equipped with organic vapor cartridges or offer protection against organic vapors. the cartridges or masks shall be changed at least weekly.

3. After selecting, donning and properly adjusting a respirator himself the test subject shall wear it to the fit testing room. this room shall be separate form the room used for odor threshold screening and respirator selection, and shall be well ventilated, as by an exhaust fan or lab hood, to prevent general room contamination.

4. A copy of the following test exercises and rainbow (or equally effective) passage shall be taped to the inside of the test chamber:

   Test Exercises

   i Normal breathing

   ii Deep breathing. Be certain breaths are deep and regular.

   iii Turning head from side-to-side. Be certain movement is complete. Alert the test subject not to bump the respirator on the shoulders. Have the test subject inhale when his head is at either side.

   iv Nodding head up-and-down. Be certain motions are complete and made about every second. Alert the test subject not to bump the respirator on the chest. Have the test subject inhale when his head is in the fully up position.

v Talking. Talk aloud and slowly for several minutes. the following paragraph is called the Rainbow Passage. Reading it will result in a wide range of facial movements, and thus be useful to satisfy this requirement. Alternative passages, which serve the same purpose, may also be used.

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. the rainbow is a division of white light into many beautiful colors. these take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. there is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.

vi Normal breathing.

5. Each test subject shall wear his respirator for at least 10 minutes before starting the fit test.

6. Upon entering the test chamber, the test subject shall be given a 6 inch by 5 inch piece of paper towel or other porous single ply material, folded in half and wetted with 3/4 ounce pure IAA. The test subject shall hang the wet towel on the hook at the top of the chamber.

7. Allow 2 minutes for the IAA test concentration to be reached before starting the fit test exercises. This would be an appropriate time to talk with test subject, to explain the fit test, the importance of his cooperation, the purpose for the head exercises, or to demonstrate some of the exercises.

8. Each exercise described in NO 4 above shall be performed for at least one minute.

9. If at any time during the test, the subject detects the banana-like odor of IAA, he shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.

10. Upon returning to the selection room, the subject shall remove the respirator, repeat the odor sensitivity test, select and put on another respirator, return to the test chamber, etc. The process continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject shall wait about 5 minutes before retesting. Odor sensitivity will usually have returned by this time.

11. If a person cannot be fitted with the selection of half-mask respirators, include full-facepiece models in the selection process. When a respirator is found that passes the test, its efficiency shall be demonstrated for the subject by having him break the face seal and take a breath before exiting the chamber.

12. When the test subject leaves the chamber he shall remove the saturated towel, returning it to the test conductor. To keep the area from becoming contaminated, the used towels shall be kept in a self-sealing bag. There is no significant IAA concentration buildup in the test chamber from subsequent tests.

13. Persons who have successfully passed this test may be assigned a protection factor of 10.

Questions:

1. Compare the QNFT and QLFT results. Do the tests correspond (if you pass one, will you pass the other)?

2. If you were responsible for running a respiratory protection program, which method of fit testing would you prefer? Why?

3. Calculate WBGT index for the indoors, and outdoors with a solar load using the temperatures recorded in the hood and on the bench top.