

# ENVH 555

## Industrial Hygiene Methods: Laboratory

Spring, 2009

Class Website: <http://courses.washington.edu/envh555>

### **Instructors:**

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### **Schedule**

Course hours are on Monday and Wednesday, 12:30 - 4:30. The attached schedule of the experiments gives more information about the types of sampling and analysis that will be covered in each experiment.

### **References**

The course text for ENVH 555 is the Lab Manual. Additional readings may be assigned for specific lab experiments, and those are noted in the lab guide for each experiment. Those students who have not taken ENVH 553 should ask about additional reference material. Suggested references are:

Ramachandran, G., Occupational Exposure Assessment for Air contaminants, CRC Press, Boca Raton FL

McDermott, H.J., Air monitoring for toxic exposures, 2<sup>nd</sup> Ed. John Wiley and sons, Hoboken, NJ

Cohen, BS and McCammon, CS Jr., eds. Air Sampling Instruments, 9th edition.  
Cincinnati: ACGIH, 2001. (Reserve Copy in the Department Library)

Methods of Air Sampling and Analysis, APHA ISC, Lodge, Third Ed., 1989.

NIOSH Manual of Analytical Methods (NMAM), Online at <http://www.cdc.gov/niosh/nmam/>

0500--Nuisance Dust

0600--Respirable Dust

7400--Sampling and Analysis of Fibers in air

3500--Formaldehyde

7082--Lead

7030--Zinc

1500—Hydrocarbons

9002--Bulk Asbestos Method

Perkins, J. Modern Industrial Hygiene, Van Nostrand Reinhold, NY(1997).

OSHA Analytical Methods Manual, Pt 1. Organic substances, Vol. 1-4 ('90-93);  
Pt. 2, Inorganic substances, Vol. 1 & 2 ('91)

The Occupational Environment: Its Evaluation and Control, Edited by S.R.DiNardi,  
AIHA Press, 1998.

Copies of important readings from the references should be on reserve in the  
Environmental Health Library (F453), the Laboratory (T564) or in Room F226, HSB.

## **Course Description:**

This course and the companion lecture course ENVH 553 cover the detection, sampling and analysis techniques for Industrial Hygiene assessment and monitoring. ENVH 553 is taught in the previous quarter to avoid scheduling problems with experiments sometimes coming before the corresponding descriptive and theoretical material has been covered. The laboratory experiments are intended to simulate typical industrial hygiene measurement situations and to provide a basis for the selection of sampling and analytical techniques and for the critical evaluation of the laboratory results.

The course emphasizes industrial hygiene sampling and measurement techniques primarily for airborne exposures to chemical agents. Students are introduced to the most common types of field measurements, sampling methods and laboratory analyses, which are used in evaluating occupational health hazards. A familiarization with the instrumentation and techniques is obtained through application in a laboratory-based scenario. The direct measurement techniques are compared to each other and to laboratory based methods. Methods of generating test atmospheres are used to provide concentrations for field type sampling methods. Typical samples are collected for later laboratory analysis. The principles of sampling are emphasized and the laboratory results and environmental results are evaluated by use of quality control measures. The students will learn the format as well as the content of a number of the standard methods that are used.

## **Content**

- Calibration of airflow measuring devices
- Aerosol sampling using filter samplers, cyclones and cascade impactors. Aerosol analysis using gravimetric and real-time methods.
- Direct measurement techniques for gases and vapors: Detector tubes, direct reading instruments, colorimetric wet chemical methods.
- Infra red spectroscopy: non-dispersive carbon dioxide monitor and the dispersive MIRAN instrument for the measurement of single compounds and the evaluation of mixtures in air.
- Adsorption sampling for organic gases using charcoal tube and badge samplers and analysis by gas chromatography.
- Asbestos is identified in bulk materials by polarized light microscopy and is analyzed in air samples by NIOSH Method 7400 using phase contrast microscopy.
- Computer spreadsheet technology will be applied to the processing of the data and for testing method reliability.
- Atomic absorption and x-ray fluorescence spectroscopies for analysis of metals in airborne particles and surface samples.

## **Course Learning objectives:**

At the end of this course, students should be able to accomplish the following:

1. Identify literature sources of standard methods for measurement of occupational exposures to chemical contaminants

2. Identify the advantages and the limitations inherent in a variety of techniques and instruments used for industrial hygiene measurements (and what specific factors in the sampling situation might prevent accurate application of that approach).
3. Provide a framework for selection of appropriate methods for measurements of specific workplace contaminants.
4. Demonstrate knowledge of the operating principles of several kinds of currently-used field meters for chemical agents. Demonstrate proficiency in the use of these devices.
5. Demonstrate knowledge of the operating principles, advantages and limitations of several kinds of major laboratory instruments commonly used for chemical analysis, including: FTIR, UV/visible absorption spectrometers, gas chromatographs, atomic absorption spectrometers. Demonstrate proficiency in the operation of these devices.
6. Apply basic concepts in quality control and quality assurance for chemical measurement data.
7. Critically evaluate the reliability of chemical measurement data.
8. Express and interpret correctly the chemical measurement results in terms that are applicable to occupational standards and situations.
9. Demonstrate competency in technical writing
10. Demonstrate the ability to work effectively and co-operatively as part of a team.

### **Responsibilities**

The student responsibilities for the course are the following:

1. Prepare in advance of each lab period. Read/understand each experiment and assigned readings before class. Complete all necessary calculations for adequate sampling times, for standards preparations and for dilution schemes to provide appropriate concentrations.
2. Submit a lab report on each experiment. Reports will be due one week from the scheduled completion date for each experiment, unless otherwise announced.

The students will work in pairs or small groups for most of the experiments. However, each student is responsible for taking part in all phases of each experiment and for preparing and submitting a report of their lab results and findings.

### **Class organization:**

Refer to the class schedule. The course consists of laboratory sessions every Monday and Wednesday. Teams of 3-5 students will work co-operatively to undertake each experiment. Students will prepare individual reports describing their finding from each experiment. These reports are due one week after the completion of each laboratory experiment.

**Grading**

Each experimental report will be graded as described in the Reports Section. The questions at the end of the procedures will be given emphasis because of their importance. Penalties for late reports could affect the grades.

**Students with Disabilities:**

To request academic accommodations due to a disability, please contact Disabled Student Services, 448 Schmitz, 206-543-8924 (voice/TTY). If you have a letter from Disabled Student Services indicating that you have a disability that requires academic accommodations, please present the letter to me so we can discuss the accommodations you might need in this class

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**LABORATORY SAFETY**

**Fire and Emergency- Know the locations of the following:**

Telephone (RED) in South Main Hall outside T-568.

Fire and Emergency: **9-911**

Hazardous Spill (large): **9-911**

Other important numbers: **See Red Wall Chart by Door Room T564**

**Fire Extinguishers:**

Type A - For wood, paper, etc.

Type B - Chemical

Type C - Electrical

**Fire Alarm:**

Located next to T-Wing main stairwell, 5th Floor Entrance.

**Deluge and eyewash showers:**

Showers: outside in South hall. Eyewash Nozzles at main lab sinks.

**First Aid Kit**

By South doors to each lab.

**Injury, Illness, and Incident Reporting:**

Within 24 hours of an incident, an SIAR (Supervisors Incident Accident Report must be filled out by the instructor).

If you report in to Hall Health or Hospital Emergency for treatment of a lab reported illness, they must fill out a form.

For info call campus Environmental Health and Safety, **543-7262**.

**Personal Protection**

Safety Glasses are a must and are available at University Bookstore or T564.

Know about the chemicals used in lab.

Use common sense. Control your own exposures.

Lab coats and protective gloves are available and should be used when handling hazardous chemicals.

Ask any questions about Lab Safety before you act.

Consumption of food and beverages in the laboratory is forbidden. Use the shelving in the hallway outside for storage of open food and beverage containers.

Wear appropriate footwear to protect feet from chemical spills and broken glass.

**Chemical Hygiene Plan**

The Chemical Hygiene Plan is available on the reference shelf of the Laboratory in Room T564. All Students should familiarize themselves with contents of the Plan, especially for the following topics:

## **Chemical Storage:**

MSDS Library – know where it is, be familiar with what you use!

Label samples and standards for storage until the next period.

Storage in refrigeration; follow guidelines for combustibles.

Lab Techniques- prevent bulk sample and stock contamination.

## **Safety of Compressed Gasses**

Tanks are to be secured by straps to walls and benches.

Tanks not in use will have their caps secured. Especially during transportation.

Each tank has a labeled regulator. Many regulator fittings are designed for specific gasses to prevent cross-mixing and other hazards.

### **To obtain a gas from a compressed gas tank.**

1. Attach the proper regulator and tighten the nut.
2. Assure valve of regulator's second stage is closed (counter clockwise).
3. Be sure gas outlet valve (to the system) is closed.
4. Open the valve on the compressed gas tank. (usually in a counter-clockwise direction) and observe pressure on first stage of the regulator.
5. Open second stage regulator to desired pressure (turn clockwise).
6. Attach sample bag or sample line or container to outlet and open valve.

### **To shut off (Proper shut down) of the Compressed tanks**

Shut off tank valve (Usually turn handle clockwise till tight.)

Observe pressure gauges drop to zero

Close second stage regulator valve and outlet valve.

After class experiments, help the instructor turn-off tanks, remove regulators, cap tanks and store regulators. Write the last primary tank pressure with the date on the tag.

## **Chemical Disposal**

Follow approved procedures--ask instructors and/or see the Chemical Hygiene Plan

**Do not dispose of chemicals down the drain or into the trashcans.**

Dispose of organic solvents into the Organic Waste Bottle in the Hood.

Dispose of strong acids into the Acid Waste Bottle in the Hood.

Dispose of metals solutions into the Metal Waste Solutions bottle in the hood.

When in doubt ask an instructor how to dispose of your chemicals.

## **Standard Operating Procedures**

See the appropriate procedures (SOPs) in the Chemical Hygiene Plan Notebook.

## LABORATORY SCHEDULE

<u>NO.</u>	<u>DAY/DATE</u>	<u>EXPERIMENT</u>
1 CS	<b>Mon. 3/30</b>	Introduction & Orientation <i>Briefings: Course Overview</i> <i>Laboratory Safety</i> <b>I. PUMP OPERATION &amp; AIR FLOW CALIBRATION</b>
2 CS	<b>Wed. 4/1</b>	Pump operation and air flow calibration (cont.)
3 CS	<b>Mon. 4/6</b>	<b>II. AIRBORNE PARTICLE CHARACTERIZATION</b> <i>Lecture: Particle Sampling</i> <i>Size Selective Sampling</i> <i>Direct Reading Instruments</i>
4 CS	<b>Wed. 4/8</b>	Airborne Particle Characterization (cont.)
5 CS	<b>Mon. 4/13</b>	<b>III. DIRECT MEASUREMENT</b> <i>Lecture: Detector tubes</i> <i>Direct reading instruments</i>
6 CS	<b>Wed. 4/15</b>	<b>Direct measurement (cont.)</b>
7 CS	<b>Mon. 4/20</b>	<b>IV. ADSORPTION SAMPLING Analyzed by GC</b> <i>Lecture: Gas Chromatography &amp; adsorption sampling</i>
8 CS	<b>Wed. 4/22</b>	GC ANALYSIS (cont'd.)
9 CS	<b>Mon. 4/27</b>	<b>V. AEROSOL ANALYSIS: Metals by AAS</b> <i>Calibration Regression Curves</i> <i>Atomic Absorption Spectrometry.</i> <i>Serial Dilution &amp; Standard Additions</i> <i>Alternative methods for elemental analysis: ICP/XRF</i>
10 CS	<b>Wed. 4/29</b>	Metal analysis (cont.)
11 LM	<b>Mon. 5/4</b>	<b>VI. ROOM VENTILATION RATE by IR</b> <i>Discussion: FTIR and MIRAN,</i> <i>Discussion: Infra Red</i>
12 LM	<b>Wed. 5/6</b>	Gas Mixtures by IR
13 MM	<b>Mon. 5/11</b>	<b>VII. SPECIAL FIELD PROJECT</b> (all methods)
14 MM	<b>Wed. 5/13</b>	Special Field Project (cont'd.)
15 LM	<b>Mon. 5/18</b>	<b>VIII. ASBESTOS DETERMINATION</b>
16 LM	<b>Wed. 5/20</b>	Asbestos determination (cont.)
17	<b>Mon. 5/25</b>	Holiday (Memorial Day)
18	<b>Wed. 5/27</b>	Final lab report due
19	<b>Mon. 6/1</b>	no class – AIHCE meeting
20	<b>Wed. 6/3</b>	no class – AIHCE meeting

Note: AIHCE conference, May 30-June 4, Toronto

## **Guidelines for preparation of laboratory reports**

All students will be required to submit an individual lab report for each lab. Students are encouraged to actively participate in all aspects of generating the data in the laboratory to better learn and understand all of the principles and procedures. This is essential in order to be able to independently carry out such surveys and make the required reports in the future. Data should be kept in bound laboratory notebooks to prevent loss or compromise.

In general, lab reports should follow this outline:

Experimental Objectives - In 1 paragraph state the purpose of the lab.

Methods - List the citation for the methods and/or references used, serial numbers of the equipment utilized, and any procedural modifications. Do not re-write the manual. Also provide the calculations and the schemes for standards preparation and dilutions. (Reviewers cannot help troubleshoot errors without verification of standards and any questionable data.)

**The Objectives and Methods sections should not exceed 1 page combined.**

Results - Provide all sample data, standards data, and regression data with appropriate curves. Show precision of replicates and coefficient of variation for the method. Also give examples of all your calculations, equations and formulas, especially when serial calculations are calculated by spreadsheet. Copies of computer printouts or integrator data plots, should be accompanied by a listing of the formulas, constants and factors.

Discussion - Compare your observed vs. expected results where appropriate. Include any information of variables, which might have spuriously affected your results. Speculate as to the reasons your results may differ from theoretical. Address recovery problems, analytical errors, and uncertainties.

Conclusions - The conclusion section of the reports should provide not only your evaluation of the method and the validity of your data, but should also address the relation of the measured levels of contaminants to those of standards such as TLVs or PELs. The optimum length of the Discussion and Conclusion Sections should be but is not limited to 1 page each. Provide summary tables of all major results.

Questions - Questions may be included in the lab guide. These questions can be answered at an appropriate place in the report or in a separate section at the end.

Grading: The reports will be graded on the accuracy and precision of the results, the application of the techniques, the validity of the conclusions, the investigation and explanations of errors. The reports do not have to be typed or word processed, but must be neat, legible and organized. Grades can be affected by data that cannot be readily found and/or recognized because of poor organization of the report.

**SUMMARY INDEX CHART AND REFERENCES:** The following table outlines some of the common techniques of measurement, sample collection and analysis used in this lab, and by the Industrial Hygienists in general. Direct measurements and sample collection often supplement each other to provide a complete evaluation of the exposures.

Exposure	Instrument/Sampler	Analytes	Analysis	Expt #.	References
Air Volume*	Pumps			I	SKC Manual, P 389-412
	Rotameters, DryCal Mass Flow Meter Bubble Meters		Calibration	II	NESS App A, pp 488-511. ASI 238-245, 149-175.
	Filters	Total Dust	Gravimetric Microscopic	III	NESS 93-104, ASI 281-290 NIOSH 7400, P 508-528
Aerosols & Particulates	Cyclones Impactors Impingers	Respirable dust Size selection		III	NESS 104-121, ASI 135-146 ASI 316-346, P 528-547
		Mineral Dusts: Asbestos, (Silica)	Microscope (XRD)	VII	P 380-385 NIOSH 7400, 9002
		Metals: Pb, Zn, Fe	AA, (XRF), (ICP), (IC)	V	P 376-379
Gases	Meters	CO, CO <sub>2</sub>	IR, Electrochemical	VIII	ASI 507-517
	Detector Tubes (Bubblers**)		Wet Chemical**	IV	NESS 512, ASI 458-470 ASI 415-420, P 379-380
	Meters Detector Tubes Detector Tubes Impingers**	Solvents: TCE, toluene, xylene	OVA, TIP, IR	IV	NESS 220-241 ASI 458-470
Vapors	Bags, CT, CB	Formaldehyde	Colorimetric**, IR spectroscopy	IV	NESS 68-74, 518-522 NIOSH 3500, P379
		Solvents		IX	NESS 260-273, 513-518 P 379
	Adsorption tubes		Gas chromatography	VII	NIOSH 1500, P CH19, P370-374, ASI 415-457 NESS 51-68, 242-259

\*Accurate measurement of the volume of air sampled requires calibrated flow measuring devices.

\*\*Collection by bubblers and impingers with wet chemical and colorimetric analysis can be applied to numerous gas and vapor exposures.

Items in () are included for completeness but are not covered in the course.

References:

NESS-Air monitoring for toxic exposures, An integrated approach, Shirley A. Ness, VanNostrand Reinhold, New York, 1991.

ASI—Air Sampling Instruments, ACGIH, 9th Ed., 2001. P – Perkins, Modern Industrial Hygiene, 1997

NIOSH NMAM--NIOSH Manual of Analytical Methods, Online at <http://www.cdc.gov/niosh/nmam/nmammenu.html>