

# **NIOSH SPIROMETRY TRAINING GUIDE**

## **NIOSH SPIROMETRY TRAINING GUIDE**

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Prepared by

**UNIVERSITIES OCCUPATIONAL SAFETY AND HEALTH  
EDUCATIONAL RESOURCE CENTER**

**CONTINUING EDUCATION AND OUTREACH PROGRAM**

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Department of Environmental and Community Medicine  
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and

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The Universities Occupational Safety and Health Educational Resource Center (UOSHERC) is one of sixteen Educational Resource Centers (ERCs) - now called Education Research Centers - located at universities throughout the United States. The ERCs, which were first established in 1977 in response to the OSHA Act, receive sponsorship from the National Institute for Occupational Safety and Health (NIOSH) to provide undergraduate, graduate, and continuing education for occupational safety and health professionals. Educational programs are primarily designed to meet the needs of occupational health physicians, occupational health nurses, industrial hygienists, safety professionals, and those professionals in related disciplines.

UOSHERC served New York, New Jersey, Puerto Rico, and the U.S. Virgin Islands.  
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Occupational Medicine Program  
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## **DISCLAIMER**

The opinions, findings and conclusions expressed herein are not necessarily those of the National Institute for Occupational Safety and Health (NIOSH), the University of Medicine and Dentistry of New Jersey (UMDNJ) or the Universities Occupational Safety and Health Educational Resource Center (UOSHERC), nor does mention of company names or products constitute endorsement by NIOSH, UMDNJ or UOSHERC.

**NOTE:** Due to printing constraints of the **NIOSH SPIROMETRY TRAINING GUIDE**, the distance representing one second may vary from one spirogram to another. Measure at the top of the spirogram to determine the distance for one second for each example and exercise.

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The original draft version of this manual was completed in 1991 under the direction of Dr. Audrey R. Gotsch, Director, Continuing Education and Outreach Program, UOSHERC and Associate Professor of Environmental and Community Medicine, UMDNJ-Robert Wood Johnson Medical School. In 1994, the American Thoracic Society updated their spirometry recommendations. The manual was updated in 1997 by Dr. John Hankinson to reflect the changes in the ATS 1994 spirometry recommendations. This version was edited and updated by Dr. Lu-Ann Beeckman-Wagner to expand the quality control procedures and to reflect new spirometry reference equations.

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## **NOTICE TO ALL COURSE ATTENDEES:**

Section (h) (1) (iii) of the Cotton Dust Standard (29 CFR 1910.43) promulgated by OSHA in 1978 and amended December 13, 1985 states: "Persons other than licensed physicians, who administer the pulmonary function testing required by this section shall have completed a NIOSH-approved training course in spirometry."

Within NIOSH, the responsibility of approving courses had been delegated to the Division of Training and Manpower Development but currently resides in the Division of Respiratory Disease Studies. Minimum requirements for approval of a course are contained in Appendix D. of the Standard and include criteria for apparatus, technique, interpretation, course content and hours of instruction. In addition, NIOSH has established criteria for staff qualifications and course format.

When NIOSH approves a course, it is attesting to the fact that the course meets the minimum OSHA/NIOSH criteria for teaching individuals to perform spirometry in the Cotton Dust Industry. This does not mean that the individual taking the course is certified as a pulmonary function technician by NIOSH. Students have merely completed a NIOSH-approved course. The Standard does not require the completion of a second/update course nor is there a requirement that an update course must be taken to complete the first course approved by NIOSH.

## INTRODUCTION

**BACKGROUND:** The **NIOSH Spirometry Training Guide** is based on two earlier publications, the **NIOSH Spirometry Workbook** and the **NIOSH Manual of Spirometry in Occupational Medicine**. In the new curriculum, the material covered in the **NIOSH Manual of Spirometry in Occupational Medicine** has been simplified and incorporated into the content of the **NIOSH Spirometry Workbook**. New material has also been added, including a comparison of volume and flow spirometers and volume/time and flow/volume tracings, quality assurance procedures, occupational lung diseases and hazards, and information from the **American Thoracic Society Standardization of Spirometry--1994 Update (1)**.

The American Thoracic Society is the medical section of the American Lung Association. It has provided a leading thrust in the standardization and upgrading of spirometric instruments and practices. Its first set of standards, **ATS Statement--Snowbird Workshop on Standardization of Spirometry** was essentially incorporated by OSHA in the Cotton Dust Standard, which was promulgated on June 23, 1978. The Snowbird Workshop standards were revised in 1987 (2), and again in 1994, and released as the **ATS Standardization of Spirometry--1994 Update (1)**.

**PURPOSE:** The **NIOSH Spirometry Training Guide** was prepared for use as an **adjunct** or **supplement** to a NIOSH approved course on spirometry. It is not intended to serve as a self-instructional package. Learning spirometry requires observation, demonstration, and hands-on practice.

**INTENDED AUDIENCE:** This **Guide** is intended for individuals who are responsible for conducting spirometry in the workplace. It will be of special interest to occupational health physicians, nurses, and other health professionals.

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## **COURSE GOAL AND OBJECTIVES**

**Goal:** The goal of this course is to increase the number of spirometry technicians who:

1. Use standardized methods to obtain acceptable and reproducible spirograms.
2. Correctly perform calculations for basic spirometric parameters.
3. Implement appropriate quality assurance procedures for spirometric equipment.
4. Recognize the applications, strengths, and limitations of spirometry in the occupational health setting.

**Objectives:** At the end of this course, students will be able to do the following:

### **Unit One: Overview of Pulmonary Anatomy and Physiology**

Briefly describe:

- a. The function of the respiratory system and the mechanics of respiration.
- b. Mechanisms within the respiratory system to protect the lungs from airborne hazards.
- c. Obstructive and restrictive lung diseases.

### **Unit Two: Overview of Spirometry**

Briefly describe:

- a. Common spirometric terms.
- b. Volume and flow spirometers.
- c. Volume/time and flow/volume tracings.
- d. Forced Expiratory Maneuver, Forced Vital Capacity (FVC), and Forced Expiratory Volume at One Second (FEV<sub>1</sub>).
- e. The role of spirometry in evaluating pulmonary function and detecting occupational lung diseases.
- f. The limitations of spirometry as a screening tool.
- g. The importance of accuracy and precision in spirometry.

### **Unit Three: Quality Assurance Procedures**

Perform spirometric equipment quality assurance procedures:

- a. Calibrate volume for volume and flow spirometers.
- b. Check that the mechanical recorder is working properly.
- c. Verify the accuracy of the ambient temperature reading.
- d. Inspect that the start of the test begins at the right time and at the right place on the graph paper.

- e. Check that the electronically-derived FEV<sub>1</sub> is calculated using the back extrapolation method.
- f. Verify that the electronically-derived predicted normal values are calculated correctly.
- g. Maintain spirometer records and calibration and maintenance logs.
- h. Perform infection control procedures appropriate for the type of spirometer used.

#### **Unit Four: Spirometric Technique**

- a. Properly prepare equipment prior to testing.
- b. Identify suitable subjects and criteria for postponing the test.
- c. Prepare subjects to perform the test.
- d. Perform the test correctly.
- e. Determine the acceptability of spirograms obtained.
- f. Determine the reason(s) why the subject is having difficulty in completing a satisfactory test and make appropriate coaching changes as needed for retesting.
- g. Obtain at least two spirograms that are reproducible from at least three that are acceptable.
- h. Maintain subject records that include date/time, age, height, sex, race, testing position used, ambient air temperature, barometric pressure, spirometer used, tests performed, test results, predicted normal values used, and comment on subject cooperation and effort.

#### **Unit Five: Basic Spirometric Calculations**

Correctly calculate the basic measures used for interpreting test results:

- a. Forced Vital Capacity (FVC) and variability between the two largest FVCs.
- b. Forced Expiratory Volume in One Second (FEV<sub>1</sub>) and variability between the two largest FEV<sub>1</sub>s.
- c. Back extrapolation and extrapolated volume.
- d. FEV<sub>1</sub>/FVC%.
- e. Forced Mid-Expiratory Flow Rate (FEF<sub>25-75%</sub>) (optional measurement).
- f. Conversion to BTPS.

#### **Unit Six: Comparing Observed to Predicted Normal Values**

- a. Select predicted normal value tables that are appropriate for the subjects and the employment setting.
- b. Use the same set of predicted values for all spirometric calculations and for future comparisons.
- c. Determine subjects' predicted normal values and calculate the subjects' percentage of the predicted values.
- d. List factors that affect normal predicted values (e.g., age, sex, height, race).
- e. Calculate the race correction factor for appropriate ethnic categories and occupational settings.

#### **Unit Seven: Comparing Changes in Follow-Up Spirograms**

- a. Determine subjects' absolute change and percent change in follow-up spiromograms.
- b. Identify common non-pathological factors that potentially affect changes in follow-up spiromograms (e.g., age, height, season, time of day, etc.).

**Unit Eight: Overview of Standards for Spirometric Equipment**

- a. List instrument specification for spirometers and calibration equipment from the Cotton Dust Standard and American Thoracic Society recommendations.

**Unit Nine: Additional Exercises**

- a. Successfully complete the exercises.