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FINAL PERFORMANCE REPORT

Covering the Project Period
July 1, 1990 - June 30, 1995

**DIVISION OF COMMUNITY AND ENVIRONMENTAL HEALTH
SCHOOL OF HEALTH RELATED PROFESSIONS
UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85719**

GRADUATE TRAINING PROGRAM IN INDUSTRIAL HYGIENE

Program Director: Clifton D. Crutchfield, Ph.D.
NIOSH Training Grant Number: T01/CCT910446

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16. Abstract (Limit: 200 words) The University of Arizona graduate training program in Industrial Hygiene for the period July 1, 1990 through June 30, 1995 was described. During this reporting period a total of 26 Industrial Hygiene students were graduated from the program. Fourteen of them completed the Industrial Hygiene/Toxicology track and received the Masters of Science Toxicology Degree offered through the Department of Pharmacology and Toxicology in the College of Pharmacy. Twelve students received the BSHS degree in Occupational Safety and Health offered through the School of Health Related Professions. During the reporting period a new program was developed with a heavy emphasis in industrial hygiene. A number of students gained valuable industrial experience by serving a summer internship during the period of study. A total of nine fellowships were awarded to University of Arizona students during the reporting period. Masters theses for the Industrial Hygiene students, faculty and student papers and presentations, employment status of graduates, and internship placements for the period were listed.			
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Abstracts

The Arizona Industrial Hygiene Program established a good record of productivity during the reporting period. The ability to synthesize and embellish basic and applied research findings is an important characteristic of students in the program. The masters theses produced by Industrial Hygiene students during the period are listed in Table I. A list of publications and presentations produced in the program during the period is included as Table II.

Table I. Masters Theses Produced by University of Arizona Industrial Hygiene Students during the period 1990-1995

<u>Student</u>	<u>Thesis Title</u>
Le-Trinh Kim Pham	"Determination of Average Inspiratory Pressures and Flow Rates in Industrial Respirators at Various Work Rates"
Jon-Pierre Michaud	"A Timed Exposure Diffusive Sampler for Monitoring in Epidemiology"
John Decker	"A Method to Determine Respirator Protection Factors Using Biological Monitoring of Exhaled Air"
Jin Zhang	"The Impact of Air Velocity and Various Other Cure Parameters on the Release of 4-PCH from Carpet Backed with Carboxylated SBR Latex"
Lynnda Reid	"Use of Staphylococcal Enterotoxin A-Induced Interleukin 2 Production as an Indicator of Immunotoxicity of Industrial Compounds"
Mary Flynt	"Effects of Cure Temperature and Time on the Release of 4-PCH from SBR Backed Carpeting"
Lisa Parola	"Ovarian Toxicity of 4-PCH in Mice".
Melissa Gonzales	"Dermal and Urinary Monitoring of Tree Crop Harvesters Exposed to Azinphos-Methyl Residues"
Caryl Shaver	"Development of a Protocol for Treatment of Acute Arsenic Exposures by Chelation"
Gloria Brown	"Effect of Carpet Boundary Layer on Solvent Emission Rates from Latex Glues."

Table I. Masters Theses Produced by University of Arizona Industrial Hygiene Students during the period 1990-1995 (cont.)

<u>Student</u>	<u>Thesis Title</u>
Marshall Krotenberg	"Evaluation of Nafion Dryer Performance in the Analysis of Ambient Air."
Jacqueline Scott	"A New Method for Evaluating the Performance of Laboratory Fume Hoods."
Jeff Burgess	"Evaluation of the Safety of Self-Contained Breathing Apparatus for Fire Fighters during High Exertion."
Steve Black	"Determination of Respirator Leak Rates Associated With a Qualitative Fit Test"

Table II. Industrial Hygiene Faculty and Student Papers and Presentations During the Reporting Period

Crutchfield, C., T. Pham, and M. Van Ert: "Determination of Challenge Pressures and Flowrates for Workrate Dependent Quantitative Respirator Fit Testing". American Industrial Hygiene Conference, Orlando, 1990.

Decker, J.: "An Evaluation of Toxic Gas Disposal Equipment Used in the Semiconductor Industry". An SSA Scholarship Paper Presented at the SSA National Conference, Phoenix, 1990.

Decker, J.: "An Evaluation of Toxic Gas Disposal Equipment Used in the Semiconductor Industry". L. Gary Garrison Memorial Scholarship Outstanding Paper Winner. SSA Journal 4(2):15, 1990.

Decker, J.: "A Method to Determine Respirator Protection Factors Using Biological Monitoring of Exhaled Air". Presented at the Arizona Section, American Industrial Hygiene Association, Tucson, 1990.

Reid, L.: "Use of Staphylococcal Enterotoxin A-Induced Interleukin 2 Production as an Indicator of Immunotoxicity of Industrial Compounds". Presented at the Arizona Section, American Industrial Hygiene Association, Tucson, 1990.

Crutchfield, C. A Guide to the Prevention of Heat Stress. North Carolina Department of Labor, Division of Occupational Safety and Health, Raleigh, 1991.

Crutchfield, C.D., and S.T. Sparks: "Effects of Noise and Vibration on Farmworkers" in Occupational Medicine: State of the Art Reviews. Vol. 6., No. 3, edited by Dorian H. Cordes. Hanley and Belfus, Philadelphia, 1991.

Crutchfield, C. and J. Sullivan: "Situations and Exposures Immediately Dangerous to Life and Health" in Hazardous Materials Toxicology. edited by John B. Sullivan. Williams and Wilkins, Baltimore, 1991.

Crutchfield, C., M. Eroh and M. Van Ert. "A Feasibility Study of Quantitative Respirator Fit Test by Controlled Negative Pressure." Am. Ind. Hyg. Assoc. J. 52(4):172-176, 1991.

Crutchfield, C.D., R.M. Murphy, and M.D. Van Ert: "A Comparison of Controlled Negative Pressure and Aerosol Quantitative Respirator Fit Test Systems Using Fixed Leaks." Am. Ind. Hyg. Assoc. J. 52(6):249-251, 1991.

Sullivan, J., Darcy, J. and Van Ert, M.: "Evaluation of Hazardous Environments" in Hazardous Materials Toxicology. edited by John B. Sullivan. Williams and Wilkins, Baltimore, 1991.

Table II. Industrial Hygiene Faculty and Student Papers and Presentations During the Reporting Period (cont.)

Sullivan J., Van Ert M., and Krieger, G.: "Indoor Air Quality and Human Health", Hazardous Materials Toxicology. edited by John B. Sullivan. Williams and Wilkins, Baltimore, 1991.

Sullivan, J., Van Ert, M. and Lewis, R.: "Chemical Hazards in the Tire and Rubber Manufacturing Industry", Hazardous Materials Toxicology in Hazardous Materials Toxicology. edited by John B. Sullivan. Williams and Wilkins, Baltimore, 1991.

Van Ert, M., and Sullivan, J.: "Organochlorine Pesticides" in Hazardous Materials Toxicology. edited by John B. Sullivan. Williams and Wilkins, Baltimore, 1991.

Sullivan, J. and Van Ert, M.: "Alkylbenzene Solvents and Aromatic Compounds" in Hazardous Materials Toxicology. edited by John B. Sullivan. Williams and Wilkins, Baltimore, 1991.

Sullivan, J., Van Ert, M. and Durham, B.: "Hospital and Community Preparation for Hazardous Material Release" in Hazardous Materials Toxicology. edited by John B. Sullivan. Williams and Wilkins, Baltimore, 1991.

Tunget, C.: "Potential Adverse Effects of Noise Exposure in the Semiconductor Industry at Levels Below the Current OSHA Action Level." SSA Journal 5(2):42-47, 1991.

Crutchfield, C. "Respirator Fit Testing by Controlled Negative Pressure", Pre-Rulemaking Conference on Evaluating the Workplace Performance of Respirators, National Institute for Occupational Safety and Health, Morgantown, 1991.

Crutchfield, C., J. Decker and M. Van Ert. "Feasibility of a New Method to Determine Respirator Protection Factors by Breath Analysis", Pre-Rulemaking Conference on Evaluating the Workplace Performance of Respirators, National Institute for Occupational Safety and Health, Morgantown, 1991.

Crutchfield, C., J. Decker and M. Van Ert. "Feasibility of a New Method to Determine Respirator Protection Factors by Breath Analysis", American Industrial Hygiene Conference Abstracts, Salt Lake City, 1991.

Gonzales, M. "Dermal and Urinary Monitoring of Tree Crop Harvesters Exposed to Azinphos-Methyl Residues". Farmsafe 2000 - Surgeon General Specialty Conference, Des Moines, 1991.

Gonzales, M. "Dermal and Urinary Monitoring of Tree Crop Harvesters Exposed to Azinphos-Methyl Residues". Arizona Section, American Industrial Hygiene Association, Phoenix, 1991.

Table II. Industrial Hygiene Faculty and Student Papers and Presentations During the Reporting Period (cont.)

Tunget, C.: "Potential Adverse Effects of Noise Exposure in the Semiconductor Industry at Levels Below the Current OSHA Action Level". Semiconductor Safety Association Conference, Phoenix, 1991.

Cordes, D., Foster, D., and Crutchfield, C.: "Teaching Students about Occupational Health Issues Through Worksite Visits." Acad. Med. 67(1):17-18, 1992.

Crutchfield, C.D., R.M. Murphy, and M.D. Van Ert: "A Comparison of Controlled Negative Pressure and Aerosol Quantitative Respirator Fit Test Systems Using Human Subjects." Am. Ind. Hyg. Assoc. J. 53(12):10-14, 1992.

Crutchfield, C.D., Ruiz, A.M., and Van Ert, M.D.: "A Validation Study of Respirator Fit Testing by Controlled Negative Pressure". Presented at American Industrial Hygiene Conference, Boston, 1992.

Black, S.: "Determination of Respirator Leak Rates Associated with a Qualitative Fit Test." Presented at American Industrial Hygiene Conference, Boston, 1992.

Black, S.: "Determination of Respirator Leak Rates Associated with a Qualitative Fit Test." Presented to Arizona Section, American Industrial Hygiene Association, Tucson, 1992.

Ruiz, A.: "A Validation Study of Respirator Fit Testing by Controlled Negative Pressure". Presented to Arizona Section, American Industrial Hygiene Association, Tucson, 1992.

Black, S.: "Lockout/Tagout - A Review of Regulations and Sample Policy". Presented at Semiconductor Safety Association National Conference, Phoenix, 1992.

Shoub, M.: "Application of Odor Thresholds to Hazard Analysis in the Semiconductor Industry". Presented at Semiconductor Safety Association National Conference, Phoenix, 1992.

Crutchfield, C.D.; Pham, T.K.; Van Ert, M.D.: Determination of Inspiratory Pressures and Flow Rates for Work Rate Dependent Quantitative Respirator Fit Testing. Appl. Occup. Environ. Hyg. 8(2):103-107, 1993.

Crutchfield, C., J. Decker and M. Van Ert: "Feasibility of a New Method to Determine Respirator Protection Factors by Breath Analysis", J. Int. Soc. Resp. Prot. 11(1): 6-19, 1993.

Crutchfield, C., and M. Van Ert: "An Examination of Issues Affecting the Current State of Quantitative Respirator Fit Testing." J. Int. Soc. Resp. Prot. 11(2):5-18, 1993.

Table II. Industrial Hygiene Faculty and Student Papers and Presentations During the Reporting Period (cont.)

Crutchfield, C.D.; Ruiz, A.M.; Van Ert, M.D.: A Validation Study of Respirator Fit Testing by Controlled Negative Pressure. Appl. Occ. Environ. Hyg.: (Accepted for publication, September, 1993).

Crutchfield, C.D., Park, D.L. Henshel, J.L., et al.: "Determinations of Known Respirator Leakage Using Controlled Negative Pressure and Ambient Aerosol QNFT Systems", Presented at the American Industrial Hygiene Conference, New Orleans, 1993.

Gavin, J.: "Application of the OSHA Process Safety Management Standard in a High Technology Industry", Presented at the Semiconductor Safety Association National Conference, Scottsdale, AZ, 1993.

Park, D.: "Respirator Fit Testing - A Measurement for Quality Control", Presented at the Semiconductor Safety Association National Conference, Scottsdale, AZ, 1993.

Burgess, J.: "Evaluation of the Safety of Self-Contained Breathing Apparatus for Fire Fighters during High Exertion", Presented at the Arizona Section, American Industrial Hygiene Association meeting in Phoenix, April, 1993.

Crutchfield, C.D., Park, D.L. Henshel, J.L., et al.: "Determinations of Known Respirator Leakage Using Controlled Negative Pressure and Ambient Aerosol QNFT Systems." Am. Ind. Hyg. Assoc. J. (accepted for publication, March, 1994).

Burgess, J. and C. Crutchfield: "Tucson Fire Fighter Exposures to Products of Combustion: A Risk Assessment". Appl. Occup. Environ. Hyg. (accepted for publication, April, 1994).

Burgess, J. and C. Crutchfield: "Quantitative Respirator Fit Test of Fire Fighters and Measurement of Negative Pressure Excursions During Exertion". Appl. Occup. Environ. Hyg. (accepted for publication, April, 1994).

Park, D. and C. Crutchfield: "Fundamental Measurements of Respirator Leakage Using Controlled Negative Pressure and Ambient Aerosol QNFT Systems", Presented at the American Industrial Hygiene Conference, Anaheim, 1994

Significant Findings

A total of 26 Industrial Hygiene students were graduated during the reporting period. Fourteen students completed the IH-TOX track and received the M.S. Toxicology Degree, which is offered through the Department of Pharmacology and Toxicology in the College of Pharmacy. Twelve students received the B.S.H.S. Degree in Occupational Safety and Health. That degree is offered through the School of Health Related Professions. A list of graduates and their current employment status is included in Table III.

A new M.P.H. Degree in Environmental and Occupational Health, with a heavy emphasis in industrial hygiene, was developed and implemented during the reporting period. The MPH Degree is offered through the Section of Preventive Medicine and Public Health, Department of Family and Community Medicine in the College of Medicine.

A number of Industrial Hygiene students gained valuable industrial experience by serving a summer internship during the reporting period. A variety of internship positions provided a wide range of field experiences. Intern placement sites utilized during the reporting period are shown in Table IV.

The quality of the Arizona's Industrial Hygiene program has also been recognized by the American Industrial Hygiene Foundation, which awarded a total of nine fellowships to University of Arizona students during the reporting period.

Table III. Graduation Date and Current Employment Status of Industrial Hygiene Graduates for Reporting Period.

<u>Student</u>	<u>Degree</u>	<u>Graduation Date</u>	<u>Current Employment Status</u>
Le-Trinh Kim Pham	MS	05/90	Industrial Hygienist Santa Clara Water District Santa Clara, CA
Jon-Pierre Michaud	MS	05/90	Ph.D. Candidate Dept of Pharmacology and Toxicology University of Arizona
John Decker	MS	08/90	Industrial Hygienist NIOSH/Atlanta Regional Office Atlanta, GA
Jin Zhang	MS	08/90	Industrial Hygienist Arizona State Compensation Fund Phoenix, AZ
Lynnda Reid	MS	08/90	Ph.D. Candidate Department of Environmental Sciences University of Washington
Mary Flynt	MS	12/90	Industrial Hygienist Inhalation Tox. Research Institute Albuquerque, NM
Lisa Parola	MS	12/90	Industrial Hygienist Alsa Pharmaceuticals San Mateo, California
Melissa Gonzales	MS	05/91	Ph.D. Candidate School of Public Health University of California, Berkely
Carol Shaver	MS	05/91	Occupational Physician Helian, Inc. Tucson, Arizona
Christy Gussio	BSHS	05/91	Employment status unknown
Gloria Brown	MS	12/91	Industrial Hygienist EnviroMd, Inc. Tucson, Arizona

Table III. Graduation Date and Current Employment Status of Industrial Hygiene Graduates for Reporting Period. (cont.)

<u>Student</u>	<u>Degree</u>	<u>Graduation Date</u>	<u>Current Employment Status</u>
Marshall Krotenberg	MS	12/91	Industrial Hygienist City of Tucson Risk Management Dept. Tucson, Arizona
Jacqueline Scott	MS	05/92	Industrial Hygienist IBM Corporation Research Triangle Park, NC
Lori Detweiler	BSHS	05/92	Industrial Hygienist Bioenvironmental Engineering Office Davis-Monthan AFB, Arizona
Mark Gallet	BSHS	05/92	Industrial Hygienist Motorola Phoenix, Arizona
Lisa Van Ert	BSHS	05/92	M.D. Candidate University of Wisconsin Milwaukee, Wisconsin
Jeff Burgess	MS	05/93	Hazardous Materials Specialist Washington Poison Control Center Seattle, Washington
Joshua Bliss	BSHS	05/93	M.S. Candidate San Diego State University San Diego, California
Marty Flack	BSHS	05/93	Industrial Hygienist Tracer Environmental Research Corp. Tucson, Arizona
Eric Lehnertz	BSHS	05/93	Industrial Hygienist Scott, Allard & Bohannon Phoenix, Arizona
David Parsons	BSHS	05/93	Industrial Hygienist Tracer Environmental Research Corp. Tucson, Arizona

Table III. Graduation Date and Current Employment Status of Industrial Hygiene Graduates for Reporting Period. (cont.)

<u>Student</u>	<u>Degree</u>	Graduation	<u>Current Employment Status</u>
		<u>Date</u>	
Roger Griggs	BSHS	12/93	Industrial Hygienist Navajo Safety Department Window Rock, Arizona
Steve Black	MS	5/94	Industrial Hygienist Health Effects Group, Inc. Tucson, Arizona
Ken Sather	BSHS	5/94	Industrial Hygienist Environmental Systems, Inc. Fairbanks, Alaska
William Andrews	BSHS	5/94	Currently seeking employment
William Matthews	BSHS	5/94	Industrial Hygiene Technician Southwest Hazard Control Tucson, Arizona

Table IV. Industrial Hygiene Internship Placements During the Reporting Period.

<u>Student</u>	<u>Location</u>
John Decker	Ford Aerospace Microelectronics Division Colorado Springs, Colorado
Mary Flynt	National Semiconductor Tucson, Arizona
Lisa Parola	Bell Laboratories Princeton, New Jersey
Lynnda Reid	Belcor Princeton, New Jersey
Jacqueline Scott	IBM General Products Division Tucson, Arizona
Lisa Van Ert	Hughes Missile Systems Tucson, Arizona
Melissa Gonzales	California Department of Agriculture Davis, California
Janyne Gavin	Los Alamos National Laboratory Los Alamos, New Mexico
Lisa Van Ert	Phelps-Dodge Corporation Phoenix, Arizona
Marc Shoub	Motorola Corporation Chandler, Arizona
Steve Black	Intel Corporation Corvallis, Oregon
Lori Detweiler	Motorola Corporation Mesa, Arizona
Alyson Ruiz	IBM General Products Division Tucson, Arizona

Table IV. Industrial Hygiene Internship Placements During the Reporting Period. (cont)

<u>Student</u>	<u>Location</u>
Chuong Pham	Motorola Corporation Austin, Texas
Eric Lehnartz	Motorola Corporation Mesa, Arizona
Roger Griggs	Navajo Nation Safety Department Window Rock, Arizona
Lori Detweiler (2)	Motorola Corporation Mesa, Arizona
Debbie Park	IBM Corporation Tucson, Arizona
Steve Black (2)	Health Effects Group, Inc. Tucson, Arizona
Manuel Ocando	EnviroMd, Inc. Tucson, Arizona
Marc Shoub (2)	Inhalation Toxicology Research Institute Albuquerque, New Mexico

Report Body

Industrial Hygiene has been offered as an educational program at the University of Arizona since 1978. It was formally established as an undergraduate major in the School of Health Related Professions, where it comprised one of two tracks in the Occupational Safety and Health major that led to the Bachelor of Science in Health Sciences degree. The 40 graduates of the Occupational Safety and Health Program have had a significant impact on the state of occupational safety and health in Arizona and the nation. Twenty-one are practicing industrial hygienists in Arizona, while nine hold industrial hygiene positions across the United States. Thirteen Occupational Safety and Health graduates have gone on to graduate school in industrial hygiene/ environmental sciences (9), medical school (2), or environmental law (2).

A transition to graduate-level training was accomplished in academic year 1985 when the University's industrial hygiene faculty and laboratory resources were realigned with the Department of Pharmacology and Toxicology. Through selective consolidation and expansion of existing industrial hygiene and toxicology courses and development of two new core courses, an industrial hygiene track within the M.S. Toxicology program was developed and approved by the University Graduate Committee. An enhancement of the University's capabilities in both disciplines was achieved since the application of toxicological information plays a major role in industrial hygiene problem recognition and resolution.

In the spring of 1993, the Arizona Board of Regents approved a Master of Public Health (MPH) degree which is administered by the Preventive Medicine and Public Health Section of the Department of Family and Community Medicine in the College of Medicine. The College of Medicine is one of four units that comprise the Arizona Health Sciences Center. One of the approved MPH concentration areas is the Environmental and Occupational Health (EOH) Track. The addition of the MPH/EOH track makes use of existing resources and allows students to develop a strong appreciation for and competence in addressing public health concerns in the occupational and environmental arenas.

The MS and MPH tracks are both designed to prepare students with degrees in engineering, chemistry, and other physical and biological sciences for a professional career in industrial hygiene. Specialized training in the anticipation, recognition, evaluation, and control of industrial health hazards is emphasized. Course work is designed to provide comprehensive knowledge of sources of exposure, material toxicity, effects of physical hazards, legal and professional health standards, and engineering and administrative methods for achieving safe and healthful work environments.

The MS track also involves an in-depth applied research experience that is designed to prepare the student for more advanced academic training or for a research career.

The objectives of the MS Track are met through a rigorous two-year sequence of course work and research designed to provide a solid foundation in industrial hygiene and toxicological principles. A required thesis involving experimental design, data collection, and evaluation of results provides an opportunity to learn problem-solving techniques based upon the scientific method. The Master of Science in Toxicology degree is awarded upon successful completion of the program.

The MS Track requires a minimum of 43 units of graduate credit, 21 of which are composed of core industrial hygiene courses. Required courses and units for the MS Track are shown in the representative course sequence illustrated in Table V. Although the course work and thesis demands of the MS curriculum do not leave much room for elective study, several elective courses are utilized by industrial hygiene students to round out their study program. Electives in the areas of toxic and hazardous waste management, risk assessment, environmental toxicology, and health administration and policy are highly recommended for students completing the track.

An enhancement of industrial hygiene and toxicology course offerings was achieved by the integration of the MS Track into the M.S. Toxicology Program. For example, the four unit Industrial Toxicology and Chemical Exposures course shares a common didactic base with the Biototoxicology course that is core to the M.S. Toxicology Program. Following an in-depth exploration of toxicological principles and systems, the class is separated along the industrial hygiene and toxicology tracks. While the emphasis during the last half of the course for toxicology students is on animal models and kinetics, the MS Track focuses on the toxicology of major classes of industrial compounds as they relate to industrial processes. The needs of both tracks are met through this course integration which maximizes faculty expertise and effectiveness.

The Committee on Toxicology requires a formal written thesis for all Master's degree candidates. The Committee also oversees curriculum and research requirements and is interdisciplinary in nature. An oral final examination is administered by the student's thesis advisory committee at the time of the thesis defense. The University of Arizona Graduate Catalog contains regulations governing the thesis and final examination requirements for the Master of Science Degree.

Table V. Representative Course Sequence for the Industrial Hygiene Toxicology (MS) Track

FALL - FIRST YEAR		<u>Units</u>
TOX 586 ^a	Fundamentals of Industrial Hygiene	(3)
TOX 565 ^a	Statistics for the Health Sciences	(3)
TOX 502 ^a	Industrial Hygiene Instrumentation	(4)
BIOC 560 ^a	Biochemistry	(5)
SPRING - FIRST YEAR		
TOX 587 ^a	Advanced Industrial Hygiene	(3)
TOX 585 ^a	Industrial Ventilation	(3)
TOX 580 ^a	Human Physiology	(4)
-- --	Elective	
SUMMER		
TOX 593	Internship	(6)
or		
TOX 900	Research	
FALL - SECOND YEAR		
TOX 554 ^a	Industrial Toxicology and Chemical Exposures	(4)
TOX 596 ^a	Industrial Hygiene Seminar	(1)
TOX 900 ^a	Research	(3)
FCM 596 ^a	Principles of Epidemiology	(3)
SPRING - SECOND YEAR		
OSH 510 ^a	Physical Exposures	(3)
TOX 596 ^a	Industrial Hygiene Seminar	(1)
TOX 910 ^a	Thesis	(3)
-- --	Elective	
REQUIRED CREDIT HOURS		43

^a Required course

A new Master of Public Health Degree Program was developed and implemented during the reporting period. An Environmental and Occupational Health (EOH/MPH) Track represents one of the major tracks within the MPH. The same core of industrial hygiene courses that are required for the MS degree are also required in the MPH/EOH curriculum, which is illustrated in the representative course sequence for the Environmental and Occupational Health (MPH) Track shown in Table VI. The primary differences between the MS and MPH tracks involve the MPH track's reduced emphasis on toxicology and research methods and increased emphasis on public health issues and competencies that are core to accredited MPH programs. The internship, which is a recommended elective for the MS degree, is required for the MPH. While a formal thesis is not required for the MPH, a technical report that addresses and examines a significant occupational health issue in depth is required.

Field experience incorporating industrial hygiene principles and instrumentation is offered through two primary strategies. In-plant experience in survey and monitoring techniques is required of each student during the Advanced Industrial Hygiene course, which includes a plant problem. Each student is required to conduct a preliminary survey (accompanied by IH faculty) of selected plants in the Tucson vicinity. The student is then required to plan and execute sufficient follow-up monitoring to allow characterization of exposure potentials. Findings are communicated via the required report which each student prepares as a graded portion of the course.

More extensive field experience is obtained through the summer internship program, which is highly recommended for MS students and required for MPH students. A comprehensive network of potential internship sites and hosts has been developed in the state, as well as nationally, through organizations such as the Semiconductor Safety Association (SSA). Dr. Crutchfield is a founding member of the SSA Academic Committee. Emphasis in the internship program is on the acquisition of professional skills in a realistic setting, as well as on observation of the structural and managerial aspects of operating comprehensive industrial hygiene programs. Interns are required to share their experiences and observations upon returning to campus through a formal presentation to their classmates. Guidelines for preparation of the required internship report are included as Table VII.

A third means of increasing student field experience levels involves having students accompany and assist faculty members on appropriate occasions when consultation services are provided to local government agencies and industries. Opportunity for student involvement and experience is one of the factors considered when responding to requests for faculty service.

Table VI. Representative Course Sequence for the Environmental and Occupational Health (MPH/OEH) Track

FALL - FIRST YEAR		<u>Units</u>
OSH 586 ^a	Fundamentals of Industrial Hygiene	(3)
FCM 570 ^b	Issues in Public Health	(3)
OSH 502 ^a	Industrial Hygiene Instrumentation	(4)
FCM 596 ^b	Principles of Epidemiology	(3)
 SPRING - FIRST YEAR		
OSH 587 ^a	Advanced Industrial Hygiene	(3)
FCM 574 ^b	Health Administration and Policy	(3)
OSH 585 ^a	Industrial Ventilation	(3)
---	--- Elective	
 SUMMER		
OSH 593 ^b	Internship	(6)
 FALL - SECOND YEAR		
FCM 576 ^b	Biostatistics	(3)
OSH 512 ^a	Hazardous Materials	(2)
FCM 575 ^b	Environmental and Occupational Health	(3)
---	--- Elective	
 SPRING - SECOND YEAR		
FCM 577 ^b	Social and Behavioral Aspects of Public Health	(3)
OSH 510 ^a	Physical Exposures	(3)
TOX 900 ^a	Research and Technical Report	(3)
---	--- Elective	
 REQUIRED CREDIT HOURS		45

^a Required EOH Track course

^b Required MPH core course

Table VII. Guidelines for Industrial Hygiene Internship Report

PURPOSE:

A primary purpose of the Industrial Hygiene Internship is to bridge a portion of the space between theoretical considerations of health and safety programs and the actualities of industrial hygiene program organization, implementation, and administration in an operational setting. The objectives underlying the requirement for an internship report are to force an analysis of the space separating theory from practice, and to develop some appreciation for the ease or difficulty associated with moving back and forth across that space.

REPORT OUTLINE:

The objectives for the Industrial Hygiene Internship can be documented by presenting a report that details:

1. The nature of the host organization, to include its principal products/services.
 2. The structure of health and safety services within the host organization.
 3. The major hazard areas confronted by the organization.
 4. Specific projects assigned to and worked by the intern during the internship.
 5. At least two specific examples of where theory/principles have been successfully applied.
 6. At least two specific examples of where and how theory could possibly be applied to the enhancement of current practice.
 7. One or more examples of where theory would be very difficult or inappropriate to apply to a particular system.
 8. An example of a learning outcome derived from the internship experience.
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Primary responsibility for industrial hygiene program administration and implementation resides with Drs. Cliff Crutchfield (Director) and Mark Van Ert (Associate Director). They both hold primary faculty appointments in Family and Community Medicine and adjunct appointments in Pharmacology and Toxicology. Drs. Crutchfield and Van Ert devote all of their time to teaching the core industrial hygiene courses, advising IH students, guiding thesis research, coordinating student internships, and conducting IH research and service.

Dr. Crutchfield received his M.S.P.H. and Ph.D. degrees in industrial hygiene from the University of North Carolina at Chapel Hill. He has been certified in the comprehensive practice of industrial hygiene by the American Board of Industrial Hygiene since 1983. Since joining the University of Arizona faculty in 1979, Dr. Crutchfield has played a major role in developing both the MS and MPH degree tracks in industrial hygiene. He also developed approximately one-half of the core industrial hygiene courses, particularly in the areas of physical exposures, measurements, and controls. Dr. Crutchfield has won national recognition for his pioneering research in the area of respiratory protection, and received the 1994 John M. White Award from the American Industrial Hygiene Association Respiratory Protection Committee. He has also been an active participant in national efforts to develop consensus standards, evaluate health and safety research proposals, and evaluate the effectiveness of health and safety training at the national level.

Dr. Van Ert also received his M.S. and Ph.D. degrees in industrial hygiene from the University of North Carolina at Chapel Hill. He has been certified in the comprehensive practice of industrial hygiene by the American Board of Industrial Hygiene since 1982. Dr. Van Ert joined the Arizona faculty in 1978, when he developed and directed the B.S. degree in Occupational Safety and Health. He also played a major role in developing both the MS and MPH degree tracks in industrial hygiene, and teaches approximately one-half of the core industrial hygiene courses, particularly in the areas of exposure assessment, IH practice, and hazardous materials toxicology. Dr. Van Ert is nationally recognized for his contributions to the characterization of indoor air pollutants.

Equipment Inventory

Only one item of equipment with an acquisition cost of more than \$1,000 was acquired with grant funds during the reporting period. An ALNOR Model 360 Multipurpose Meter (serial number LM7794) with a Thermoanemometer Probe (ALNOR Model 265, serial number 3848) and a Hygrometer Probe (ALNOR Model 220, serial number 3893) was purchased in June, 1994 at a cost of \$1,350. 100% of the acquisition was made with grant funds. The purpose of the new ALNOR system was to replace a broken hot wire anemometer that was used in the industrial ventilation teaching lab. All components of the system are currently in good working order.

