Final Progress Report

Industrial Hygiene Training

July 1, 1999 to June 30, 2004

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Abstract

The Industrial Hygiene masters degree program at the University of Oklahoma Health Sciences Center, Department of Occupational and Environmental Health, has been in existence for nearly 40 years and has been accredited by the Accreditation Board for Engineering and Technology (ABET) since 1994. The department's innovative "dual track" in Industrial Hygiene and Environmental Management (EM/IH), which was begun in 1994, received separate ABET accreditation in 2000. The rigorous program is oriented to the training of highly-qualified industrial hygiene practitioners, and includes a masters thesis that teaches the scientific method and prepares practitioners to be critical users of scientific information. The NIOSH Training Program Grant (TPG), awarded in 1999 for five years, has been crucial to the program's continued advancement and success. Sixteen trainees have been supported on the grant; five of these trainees have graduated from the program, nine have completed didactic coursework and are in various stages of thesis research, and two are continuing in their second year of study. The availability of NIOSH training support, together with funded research assistantships, has enabled the department to attract highly qualified students and maintain robust enrollments even while increasing the rigor of the program's entrance requirements and curriculum.

Significant Findings

- The NIOSH Training Program Grant (TPG) has enhanced the ability of the Department of Occupational and Environmental Health at the University of Oklahoma to maintain robust enrollment in its scientifically rigorous Industrial Hygiene master of science program even during a period of declining enrollments nationwide in graduate Industrial Hygiene programs.
- The TPG has succeeded in its goals of attracting Native Americans and students of diverse academic and professional backgrounds into the industrial hygiene field.
- The Industrial Hygiene program is relatively long, including 39 didactic semester hours for the Industrial Hygiene track and 49 didactic course hours for the Industrial Hygiene and Environmental Management "dual track", plus a minimum of 4 semester hours of thesis research. Development and completion of the masters research project in timely way can be a significant challenge for many students, including some NIOSH trainees.

Final Progress Report

Introduction

The Department of Occupational and Environmental Health (OEH) at the University of Oklahoma Health Sciences Center (OUHSC) College of Public Health has provided graduate education in industrial hygiene (IH) leading to the Master of Science (MS), Master of Public Health (MPH), Doctor of Philosophy (PhD) and Doctor of Public Health (DrPH) degrees. The industrial hygiene program has been in existence for nearly 40 years and has over 250 doctoral and masters graduates. The MS and MPH degree tracks in Industrial Hygiene (IH) have been accredited by the Accreditation Board for Engineering and Technology (ABET) since 1994, and the department's innovative "dual track" in Industrial Hygiene and Environmental Management (EM/IH), which was begun in 1994, received separate ABET accreditation in 2000.

Achieving ABET accreditation was an early milestone in the departmental goal of gaining national stature in the graduate education of industrial hygienists. Other steps included the recruitment of nationally and internationally recognized faculty, the addition of a tenure line in IH, building the department's research base, and revising the curriculum to increase the rigor of its IH and EM/IH programs.

In accordance with the department's increased research emphasis, departmental policy instituted in 1997 required completion of a research masters' thesis for the MS degree. While recognizing that only a small proportion of masters level graduates will pursue doctoral work or a research career, the department faculty believes that the graduate research experience greatly enhances the education of the professional industrial hygienist by teaching the scientific method, providing a platform for the development of skills in experimental design, data analysis, and technical communication, and fostering independent study aimed at acquiring greater depth of understanding of a subject than would typically occur in didactic coursework. Moreover, the research experience prepares graduates to use scientific knowledge more critically in their professional lives through increased insight into the way such knowledge is obtained.

The research aspect of the IH and EM/IH program is balanced by the didactic curriculum, which is informed by the extensive practice experience of the core IH and EM faculty. Graduates of this program are in high demand as practitioners and readily find IH-related professional employment in government, industry, consulting, and the military. Most graduates who are Oklahoma residents initially take jobs in the south central or southwestern regions of the United States. The available regional job market for program graduates includes very active energy and manufacturing industries, as well as industrial hygiene consulting firms, healthcare organizations, and state government. Additionally, program graduates compete successfully for jobs on the national level. Longstanding ties with Los Alamos National Laboratory, the Army, Navy, and Air Force, and the Public Health Service (especially the Indian Health Service) provide avenues for recruitment of program graduates into government service.

The visibility of the IH and EM/IH program to potential employers in all sectors has been enhanced in recent years by the remarkable record of its students' successful national competition for prestigious scholarships. Since 1998, students in this program, including one NIOSH trainee, have won seven American Industrial Hygiene Foundation scholarships and three 3M Industrial Hygiene scholarships. This record reflects (1) the excellence of students recruited into the program; (2) the ability of the program to attract relatively high numbers of eligible full-time students during a period of declining enrollments nationwide; and (3) the personal

knowledge, confidence, and pride that the faculty have in the students they nominate for these awards.

The combination of a nationally recognized program, below-average out-of-state tuition levels and low cost of living attracts applicants from across the United States and abroad. The applicant pool for the department is ethnically very diverse, resulting in the enrollment over the past five years of well-qualified Native American students from the local tribes in Oklahoma, as well as African-American students, Hispanic-American students, and international students from Africa, Eastern Europe, South America, the Indian subcontinent, and the Asian-Pacific region. The industrial hygiene program has also attracted individuals with established careers in professions such as nursing, medical technology, and environmental management who wanted to make the transition into industrial hygiene practice or research.

The award of the NIOSH training program grant (TPG) in 1999 was a crucial part of the program's recent advancement and success. The following report will review the outcomes of the TPG in terms of its impact both on the students directly supported and on the industrial program more generally.

Project Objectives

The specific aims of the training program grant, as stated in the original grant proposal, were:

1) To enhance graduate education in industrial hygiene on a two track basis: one track offering an educational opportunity in the traditional format with a strong technical orientation in any one of the traditional industrial hygiene sub-specialties, and the other track offering an educational opportunity in industrial hygiene with an emphasis on integrated occupational and environmental health management aspects of industrial hygiene.
2) To attract qualified Native American students to the industrial hygiene profession.
3) To strengthen current educational activities through the recruitment of students with diverse technical backgrounds.
4) To attract highly qualified students to further graduate study in industrial hygiene.
5) To remove a recruiting handicap superimposed by NIOSH support of almost all other graduate industrial hygiene programs (including some non-accredited programs).

Support was limited to Master of Science students in Industrial Hygiene (IH) or in Industrial Hygiene and Environmental Management (EM/IH). Trainees received up to two years (6 semesters) of support, during which time they were required to be enrolled as full time students. The IH track consists of 39 semester hours of didactic coursework and a minimum of 4 hours of thesis research. The EM/IH track consists of 49 hours of didactic course work and a minimum of 4 hours of thesis research. On average, the funding level was sufficient to support two new trainees and two continuing trainees each year with tuition, fees, and a modest stipend.

Criteria for Admission and Traineeship Appointments

The admissions process for the program has followed the admissions requirements of the OUHSC Graduate College. Minimum requirements for admission to the Graduate College

include an undergraduate degree from an accredited institution and a GPA of 3.0 or higher for the last 60 hours taken. In special cases an applicant could be allowed to enroll as a non-degree "special student" with a GPA as low as 2.75. The performance of each "special student" was evaluated by the department after the first 12 hours of graded coursework, at which time the student could be admitted to the degree program in full standing if he/she had maintained a GPA of at least 3.0 with no grade lower than "B".

The departmental requirements for admission, which were more rigorous than the minimum requirements, were based on the admissions criteria for ABET-accredited programs in effect at the 1999-2000 accreditation cycle. Successful applicants had a background in the physical, life or health sciences or engineering, as well as clearly stated career goals compatible with department objectives. Applicants needed at least 60 semester hours of basic sciences, mathematics, and technology, including at least 15 hours in the upper division or graduate level, and 21 hours of coursework in the humanities, social sciences, and communications. Applicants were required to have taken at least 12 hours of chemistry, including organic chemistry, and mathematics through college algebra. Preference was given to applicants with coursework in calculus and physics. Starting in Fall 2001, the Graduate Record Examination (GRE) was also required; GRE scores were weighed in the light of the applicant's transcript, the rigor of the undergraduate program, and the department's expectation of good verbal, quantitative, and analytical abilities as a prerequisite for success in the graduate program.

Applications were reviewed by all faculty members, who recommended to "admit", "deny", or "hold for further information". If the faculty was not unanimous on disposition of an application, the case was discussed at the next department faculty meeting. Ultimate authority to admit or deny applicants resided with the department chair. An otherwise well qualified applicant who lacked one required undergraduate course could be admitted on the condition that the deficiency was made up during the first 20 hours of graduate enrollment.

In response to the unsatisfactory performance of one NIOSH trainee and concerns about the commitment of other potential trainees to a career in industrial hygiene or closely allied field, effective in 2002 the department adopted the following procedure for awarding fellowships, traineeships, and scholarships:

1) At least two weeks before the beginning of the semester, the Faculty Selection Committee will draw up a list of all potentially eligible students. This list will include, but not be limited to, all students admitted for that semester in full standing.
2) Objective information (enrollment status, degree track, transcripts, citizenship, etc.) for each student will be reviewed to determine eligibility.
3) Each eligible student will be invited to take part in an interview. Students who decline the interview will not be considered for fellowship, traineeship, or scholarship support from the Department for that semester.
4) Each student applicant must be interviewed by at least one member of the Faculty Selection Committee. The interviewer will be responsible for providing a brief written evaluation to the full committee. This evaluation will focus on the interviewer's judgment of the student's potential to fulfill the requirements of the fellowship and/or scholarship. The interviews will be conducted before the beginning of the semester.
5) The committee will meet to select awardees before the first day of classes.

This procedure was designed to ensure that all prospective trainees received a fair evaluation and that trainees' career plans were consistent with the purpose of the training program.

Trainee Outcomes

Sixteen trainees have been supported on the training grant to date. A summary of the trainee appointments is given in Table 1. The distribution of trainees by race and gender was: one African-American female, one Hispanic/multiracial female, two Native American males, four white females, and eight white males. Twelve of the trainees were recent graduates from bachelors programs in biological sciences, environmental health sciences, industrial safety, and fire protection engineering, with limited professional work experience. The other four trainees had considerable work experience as, respectively, an environmental consultant, an environmental engineer, a sanitarian, and a cardiac intensive care nurse.

One trainee was terminated after one semester due to unsatisfactory performance. Otherwise, trainee performance has met expectations; trainee grade point averages have ranged from 3.5 to 4.0, and all trainees have passed the department's Quantitative Skills Examination on their first attempt.

As of June 30, 2004, five trainees have graduated from the M.S. program. The first graduate was subsequently admitted to our Ph.D. program in Fall 2001 and was also employed as a data manager for a major occupational epidemiology study being conducted in this department. The second graduate, who after completion of his didactic coursework had left Oklahoma in early 2001 for a health and safety management position with a leading healthcare organization, defended his thesis in Spring 2002. The third graduate defended her thesis in Summer 2002 and was promptly hired as an occupational/environmental health and safety professional by a major federal government contractor. The fourth and fifth graduates completed their degrees in Fall 2003; one entered a school of osteopathic medicine and the other found employment as an occupational health nurse at a hospital.

Two former trainees recruited in Spring 2000 completed their didactic coursework in Fall 2001, but have not finished the masters thesis. Both of these students are Native Americans employed full time as occupational/environmental health and safety professionals in their tribal communities. Although both students have expressed interest in completing their theses, their lack of substantive progress, despite the support and encouragement they have received from the faculty, raises concerns that their degree program could eventually be terminated by the Graduate College.

Two trainees appointed in Fall 2002 are currently conducting their masters thesis research pursuant to approved research prospectuses. Four additional trainees, who received appointments during the final year of the grant for one semester only to pay tuition and fees, are also working on their masters theses. Their thesis topics include: professional judgment in mold sampling; exposure to mouse urinary antigen in laboratory animal care facilities; leaching of lead into foods cooked in Mexican-made bean pots; analysis of excursions in continuous monitoring of particle size distributions; and determining how well the personal samples in a large occupational exposure database conform to a hypothetical random sampling strategy.

Finally, two trainees appointed in the 2003-2004 academic year have begun their second year of full-time study.

Table 1. Trainees Appointed during Project Period

Trainees appointed to the training program during the project period July 1, 1999 to June 20, 2004 (Project Years 01-05). All trainees pursued the Master of Science degree in Industrial Hygiene (IH) or Industrial Hygiene and Environmental Management (EM/IH).

Trainee Race & Gender	Occupational or academic background	Appointed	Graduated	Major
White male	Hydrogeologist	FA 1999	SP 2002	EM/IH
White female	Botany	SP 2000	SU 2001	EM/IH
Black female	Environmental science	SP 2000	SU 2002	EM/IH
Native American male	Environmental engineering	SP 2000		EM/IH
Native American male	Sanitarian	SP 2000		EM/IH
White female	Zoology	FA 2001	FA 2003	IH
White male	Safety education	FA 2001*	continuing	EM/IH
White female	Nursing	SP 2002	FA 2003	EM/IH
White male	Biology/laboratory animal care	FA 2002	continuing	EM/IH
White male	Environmental science	FA 2002	continuing	EM/IH
White female	Environmental design	FA 2003	continuing	EM/IH
White male	Environmental health	FA 2003**	continuing	EM/IH
White male	Biology	SP 2004	continuing	EM/IH
White male	Environmental science	SU 2004**	continuing	EM/IH
White male	Environmental science	SU 2004**	continuing	EM/IH
Hispanic/multiracial female	Biology	SU 2004**	continuing	EM/IH

*Traineeship terminated after one semester due to unsatisfactory performance. This individual has remained in the program as a part-time student.
**Tuition and fees paid during one semester only in final year of grant.

Trainee publications are included in the section "Publications during Project Period (1999-2004). To date, trainees have authored one peer-reviewed journal article, authored or co-authored three published abstracts for national conference presentations, and authored five masters theses.

Program Changes Achieved through TPG Funding

The NIOSH Industrial Hygiene Training Program Grant (TPG) awarded in 1999 helped to underpin the department's efforts at upgrading its masters program and securing research as an important feature of this program. NIOSH support was requested for MS students only, a decision that served to foster a growing research culture even among the majority of students not receiving NIOSH support. As shown in Figure 1, the proportion of IH students completing a masters thesis has increased dramatically since the mid 1990's. Before Fall 1997, students enrolling in the MS degree track were not required to write a thesis. The main difference between the MPH and the MS was that the MPH required 6 more semester hours of public health core courses outside the department. After the thesis was made a requirement for the MS, students who did not wish to do a thesis opted for the MPH degree; this was reflected in the drop in the proportion of students graduating with an MS in the two academic years 1998-2000. In the four academic years 2000-2004, however, corresponding to years 2-5 of the training grant, 96% of IH and EM/IH graduates (25/26), including five NIOSH trainees, completed an MS degree with thesis. The only IH graduate who did not do a masters thesis was an international student who, as a health practitioner, considered the MPH degree to be the more desirable credential.

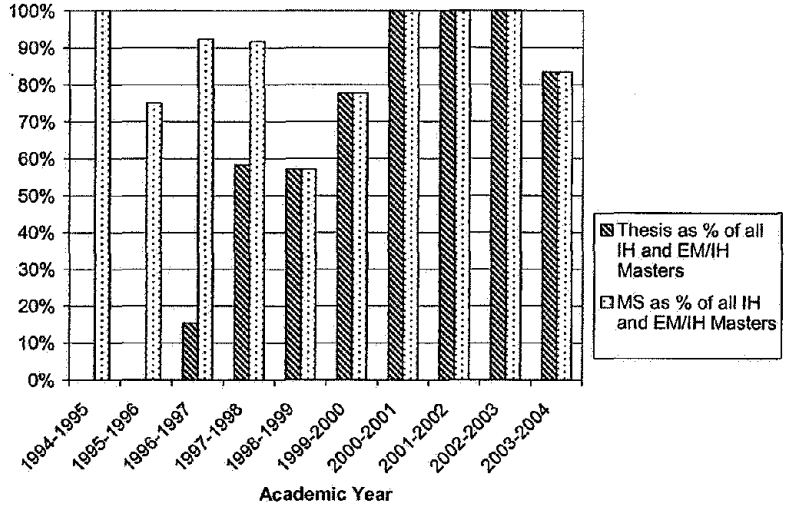

Figure 1. Proportion of masters graduates in Industrial Hygiene or Industrial Hygiene/ Environmental Management dual track completing a masters thesis and receiving the MS degree.

The department's ability to attract and support highly qualified students with NIOSH traineeships and sponsored research assistantships has enabled it to make a limited but important enhancement to increase the rigor of the curriculum. Effective in Fall 2001, entering students in the Industrial Hygiene program and the Environmental Management program have been required to take a newly developed introductory course OEH 5033 titled "Environmental Issues". In contrast to the former introductory course OEH 5013 "Environmental Health", which is a purely descriptive overview suitable for all Public Health students, the new course has an emphasis on fundamental physical science applied to qualitative and quantitative examination of

environmental problems impacting human health. The syllabus for OEH 5033 is provided in Appendix A. The content of "Environmental Issues" is coordinated with the content of OEH 5723, "Occupational and Environmental Hazards". The two courses are taken together during the first Fall semester of the program to promote students' early mastery of fundamental physical-chemical concepts and quantitative skills.

Program Enhancement through Training Related Expenses.

During Years 1-4 of the TPG, training related expenses funded under the TPG were limited to the cost of travel to the annual coordination meeting of program directors. These meetings have been a valuable forum for the discussion of common challenges.

Toward the end of Year 5, unused stipend funds were rebudgeted to purchase supplies (ELISA kits) for one NIOSH trainee who was pursuing an independent research project for his masters thesis. The ability to spend modest amounts of TPG funds "above the line" for trainee research supplies greatly enhances the scope and type of independent research projects that are feasible for masters students.

Program Enrollment and Completion

During the period covered by this final project report, enrollments in graduate IH program across the United States declined. Our department has also experienced a decline in enrollments from a total of about 95 students (masters and doctoral students in all degree tracks) in 1995-96 to about 40 students in 2003-2004. Most of this decline was intentional, as the department adopted more rigorous admissions standards. At current staffing levels (7 full time faculty, plus several part-time faculty members), a total enrollment of about 50-55 students is considered optimal in that it allows for the large amount of one-on-one interaction necessary to guide a masters student through the thesis process, while keeping class sizes large enough (typically 6-15 students) to use faculty time efficiently in didactic courses.

Notwithstanding the overall decrease in enrollments, as shown in Table 2 enrollment in our IH program has actually remained stable throughout the period of the TPG, and has declined only modestly since 1995. This stability reflects the strength of the dual EM/IH track, which has consistently attracted students who might otherwise have majored in Environmental Management. Also, in 2001 the department eliminated the Environmental Epidemiology (EE) and Environmental Toxicology (ET) program, which had been losing enrollment and did not reflect the core teaching strengths of the department. Applicants who might otherwise have pursued a degree in EE and ET typically opted instead for the EM/IH track.

It should further be noted from Table 2 that the proportion of students enrolled full-time in the IH program has increased from about 30% in 1995 to about 45% during the TPG project period. The availability of the NIOSH traineeships as well as graduate research assistantships from funded research projects has fostered a culture of full-time commitment to graduate study, though the program continued to accommodate the needs of working professionals seeking graduate credentials.

As indicated in Table 3, the number of IH students graduating from the program, though relatively stable at 6-7 graduates per year during the TPG project period 1999-2004, has decreased by about half compared to numbers from the mid-1990's. As already noted, the decrease in the annual number of IH graduates was an intended result of more rigorous departmental standards. However, the inconsistency between stable enrollment numbers and

Table 2. Degree Track and Enrollment Status of IH Students

Number of Masters students enrolled in the Industrial Hygiene training program (academic years beginning 1995-2003). Enrollment figures during the project period appear below the solid line.

	MPH IH	MS IH	MPH EM/IH	MS EM/IH	Full Time	Part Time	Total
1995	7	21	0	10	11 (29%)	27 (71%)	38
1996	7	18	0	9	13 (38%)	21 (62%)	34
1997	6	12	0	16	16 (47%)	18 (53%)	34
1998	5	8	0	16	10 (34%)	19 (66%)	29
1999	3	4	2	20	13 (45%)	16 (55%)	29
2000	1	3	3	23	16 (53%)	14 (47%)	30
2001	0	6	3	17	12 (46%)	14 (54%)	26
2002	2	9	1	19	14 (45%)	17 (55%)	31
2003	1	10	1	20	14 (44%)	18 (56%)	32

reduced graduation numbers in the IH program reflects the difficulty many students experience in completing their masters thesis in a timely fashion. Students often need to remain enrolled in thesis research hours for 2-3 semesters after completion of their didactic coursework.

The department faculty discussed the problem of timely completion of the M.S. degree at a faculty retreat in October 2003. The following measures were agreed to:

- Explicitly identify and publish our departmental expectations (as opposed to university requirements.)
- Define a schedule of expected progress with explicit decision criteria for determining progress status.
- Require progress review of each student's overall progress by the entire faculty each semester.
- Require progress review for each thesis/dissertation student by the thesis/dissertation committee each semester.

Table 3. Industrial Hygiene Masters Graduates (1995-2004)

	MPH IH	MS IH	MPH EM/IH	MS EM/IH	Total
1995	4	11	0	1	16
1996	1	10	0	2	13
1997	1	6	0	5	12
1998	3	3	0	1	7
1999	2	2	0	5	9
2000	0	1	0	5	6
2001	0	3	0	5	8
2002	0	2	0	2	4
2003	1	1	0	4	6

Departmental and Institutional Changes during the Project Period

Since 1997, the Department of Occupational and Environmental Health has had four full-time tenure lines in Industrial Hygiene, three of which are currently filled by tenured faculty members (Drs. Margaret Phillips, David Johnson, and Tom Hall), and three full-time tenure lines in Environmental Management, two of which are currently filled by tenured faculty members (Drs. Daniel Boatright and Robert Lynch). The TPG was originally secured under the leadership of Dr. Nurtan Esmen, chair of Occupational and Environmental Health from 1997 to 2002 and Program Director of the IH program until 2003. In 2003, Dr. Phillips, then vice chair of OEH, assumed the role of Program Director. Dr. Esmen left the University of Oklahoma in August 2003. Dr. Johnson, who became chair of OEH in 2002, remained assistant program director throughout the period of the TPG.

Other faculty changes affecting the program during the TPG period included the retirement in 2000 of Dr. Ronald Coleman, who taught the Industrial Toxicology and Environmental Toxicology courses. These courses were reassigned to tenure-line faculty members and their content was revised as part of the curricular changes implemented in 2001. Dr. Candida West, a former EPA environmental scientist with research interests in groundwater,

was hired in 2000 after a national search at the assistant professor level, and was assigned to teach two courses required in the IH or EM/IH program. Frank Bryant, MS, CSP, CIH, was also hired in 2000 as a non-tenure line part-time faculty member to teach two required courses in the IH program. Dr. West left the University of Oklahoma in 2002 to return to the EPA. After another national search in 2003 at the assistant professor level, two faculty members, Dr. Rod Clinkenbeard and Dr. Brenda Elledge, who had previously held non-tenure track appointments with teaching responsibilities in the IH program, were hired into tenure track positions. The expected open-rank national search for an environmental scientist to fill the position vacated by Dr. Esmen did not take place due to the very unpromising state budget situation that prevailed through 2003.

It should be noted that for the past four years, the core IH faculty has included four Certified Industrial Hygienists (CIHs) (Drs. Hall, Johnson, and Phillips and Prof. Bryant) with over 70 years combined experience as practitioners. Additionally, the Industrial Hygiene and Environmental Management faculty have historically been well integrated together in both teaching and research.

The College of Public Health (COPH) implemented important changes to the MPH degree beginning in the 2003-2004 academic year. The MPH degree, which had formerly been administered as a graduate degree by the Graduate College, was designated as a professional degree under the control of COPH. All MPH students are now admitted to COPH under uniform admissions criteria administered by a college-level admissions and advisement committee. MPH students are admitted into departments only after completion of six core public health courses. Because these changes in the administration of the MPH represented a partial loss of control of the MPH curriculum and admissions by the Department of Occupational and Environmental Health, thus potentially compromising departmental standards for this ABET-accredited degree, and because very few students were opting for the MPH degree, the department elected to terminate the MPH degree track in IH and EM/IH effective in 2003. This change did not affect the TPG, as only MS students were eligible for NIOSH traineeships. It is possible, however, that potential MS applicants with an interest in IH were diverted into the MPH program through the college-wide admissions process, reducing the number of applications to the IH program in Year 5 of the TPG.

Conclusions

All five specific aims of the TPG were met to varying degrees:

1) "To enhance graduate education in industrial hygiene on a two track basis…": This aim was fully realized, in that enrollments in the IH and EM/IH tracks of the program remained robust even during a period of declining enrollments in graduate IH programs nationwide. Furthermore, during the project period, the innovative EM/IH track achieved the distinction of being the first such program to receive its own ABET accreditation separate from the classic IH track.
2) "To attract qualified Native American students to the industrial hygiene profession": Two Native American students were recruited into the program. These students performed well in didactic coursework but have not completed the masters thesis requirement. They have, however, been able to apply their industrial hygiene training in their jobs as environmental health and safety specialists within their tribal communities.

3) "To strengthen current educational activities through the recruitment of students with diverse technical backgrounds": The program has been successful in recruiting students with established careers in various environmental and healthcare specialties, as well as recent graduates in the environmental and biological sciences.
4) "To attract highly qualified students to further graduate study in industrial hygiene": To date, one former trainee has been admitted to the department's doctoral program. The masters research experience which has been fostered with the help of the TPG has also stimulated other masters graduates, who were not NIOSH trainees, to consider doctoral study.
5) "To remove a recruiting handicap": As noted under item (1) above, enrollments have remained robust throughout the project period, indicating that the program is competing successfully for students regionally, nationally, and internationally. Though international students are not eligible for NIOSH traineeships, NIOSH support of a fixed number of eligible students allows the department to be flexible in allocating funded graduate research assistantships so as to attract and retain other highly qualified students without regard to citizenship status.

Key concerns for the future are maintaining enrollments at the optimal level of 7-8 students per full-time faculty member and improving the timely completion of the masters thesis. NIOSH traineeships and other support mechanisms can and should be used more proactively; outstanding applicants would be more likely to enroll if they were offered financial support at the time they are notified of their acceptance into the program. To improve throughput of the MS program, the department must implement enhanced advisement procedures, supplemented by specific didactic instruction, to ensure that students clearly understand the research process and maintain a satisfactory rate of progress toward completion of the masters thesis.

Publications during the Project Period (1999-2004)

Student authors are indicated by **bold type**
NIOSH trainee authors are indicated by **bold underlined type**

Journal Articles

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Masters Theses and Doctoral Dissertations

Faculty advisor is given in parentheses.

BTEX and VOC Emissions from Glycol Dehydrators: Major Concern for the Oil and Natural Gas Industry - **Victoria Sanchez**, M.S. Thesis (Phillips, Esmen), May 2004.

Comparative Analysis of Airborne Fine Particulate Matter Sampling Devices - **Cheryl L. Marcham**, PhD Dissertation (Esmen, Johnson), May 2004.

Evaluation of a Knowledge Based Artificial Intelligence Program for Occupational Hygiene Applications - **Karen L. Johnston**, M.S. Thesis (Phillips, Esmen), December 2003.

A Comparison of Sound Exposure Profiling with the Basic Sound Survey as Applied in an Academic Laboratory Environment - **James A. Cross**, M.S. Thesis (Phillips), December 2003.

A Comparison of Sound Exposure Profiling with the Basic Sound Survey as Applied in an Academic Laboratory Environment - James A. Cross, M.S. Thesis (Phillips), December 2003.
Pest Management in Oklahoma's Childcare Facilities - **Annie Cacy**, M.S. Thesis (Lynch), December 2003.

Volunteer Monitoring Group Water Quality Data in Oklahoma - **Damian D. Smith**, M.S. Thesis (Lynch), December 2002.

Concentration and Particle Size Characteristics of Aerosols Produced in Surface Abrasion Using Two Standard Grit Abrasives - **Keith Kilpatrick**, M.S. Thesis (Johnson), December 2002.

Cumulative Risk Index Analysis for Determining the Risk of Total Coliform Rule Maximum Contaminant Level Violations at Manufactured Housing Communities - **Marcie Martin**, M.S. Thesis (Phillips), December 2002.

Assessment of the Variability of Indoor Viable Airborne Mold Sampling Using the Andersen N-6 Single Stage Impactor - **Robert J. Agnew**, M.S. Thesis (Phillips), December 2002.

Environmental Tobacco Smoke Exposures in Native American Gaming Facilities - **Carol Crouch**, M.S. Thesis (Lynch), August 2002.

Characterization of a Modified Pitt3 Aerosol Generator - **LaTina Alston**, M.S. Thesis (Johnson), August 2002.

Methodological Issues in Ultra-Low Concentration Aerosol Sampling - **Heather McCutcheon**, M.S. Thesis (Johnson), August 2002.

In Vitro Transformation of Phagocytized Beryllium Oxide Particles in the Murine J774A.1 Cell - **Gregory A. Day**, PhD Dissertation (Esmen), June 2002.

An Evaluation of Zero Valent Iron Reactive Barrier Technology to Reduce High Concentrations of Chlorinated Solvents in Contaminated Groundwater- **Bryan K. Stolte**, PhD Dissertation (Boatright), April 2002.

Risk Perception Aspects of Foodborne Illness Outbreaks - **Brenda Elledge**, DrPH Dissertation (Boatright), April 2002.

Methodology Development for Evaluating Air Curtain Destructors in a Western Forest Environment - **Michael E. Dennis**, M.S. Thesis (Boatright), April 2002.

Evaluation of a Method to Estimate Contractor Safety Performance in U.S. Oil and Gas Exploration and Production - **Paul Hart**, M.S. Thesis (Hall), April 2002.

Ultraviolet Disinfection of Particle-Laden Metalworking Fluid Contaminated with *Pseudomonas fluorescens* Bacteria - **Timothy J. Havel**, M.S. Thesis (Johnson), April 2002.

The Assessment of Lead Leachability from Candy Wrappers - **Kirby Moss**, M.S. Thesis (Lynch), April 2002.

A Tool to Evaluate Generation and Management of Conditionally Exempt Small Quantity Generator Waste in Oklahoma County - **Keith Hodges**, M.S. Thesis (Boatright), December 2001.

The Effectiveness of Ventilated Sanders in Controlling Inhalable Dusts During Scuff Sanding of Military Aircraft - **Kalpesh B. Patel**, M.S. Thesis (Johnson), November 2001.

The Feasibility of Using Mining Waste Versus Conventional Materials as Highway Construction Material - **Farida Saifodine**, M.S. Thesis (Lynch), November 2001.

Dynamic Similtude Modeling of a Free-Standing Flanged Circular Hood - **Kenneth R. Mead**, M.S. Thesis (Johnson), July 2001.

Development of a Food Safety Survey of Oklahoma County Food Establishments - **Charles C. Griffith**, M.S. Thesis (Boatright), July 2001.

The Variability of Delivered Dose of Aerosols with the Same Respirable Concentration but Different Size Distributions - **Gina M. Agron**, M.S. Thesis (Johnson), May 2001.

Using Natural Ecological Theory in Modeling the Health of Human Communities - **Heather G. Basara**, M.S. Thesis (Boatright), May 2001.

Characterization of Lead Exposure During Routine and Maintenance Operations of Wave-Soldering Devices Before and After Interventions - **Suellen D. Dennett**, M.S. Thesis (Johnson), April 2001.

Manufacture and Evaluation of a Morphologically Accurate Tracheobronchial Model Utilizing Rapid Prototyping - **Rodney L. Clinkenbeard**, PhD Dissertation (Johnson), April 2001.

Evaluating Fugitive Emissions from Outdoor Asbestos Abatement Activities in an Idled Petroleum Refinery - **Robert D. Tutt**, M.S. Thesis (Phillips), March 2001.

Examining Statewide Trends in Biotic Integrity using Fish Communities - **David A. Altom**, M.S. Thesis (Lynch), December 2000.

Comparative Analysis of Temporal Behavior of PM2.5 and Five Gaseous Pollutants in Two Metropolitan Areas - **Daping Wang**, M.S. Thesis (Esmen), June 2000.

Evaluation of the End-of-Life Environmentally Sensitive Technological Products and the Development of Policy Directives for Recycling - **Sandra W. Bell**, M.S. Thesis (Boatright), May 2000.

Development of an Evaluation Tool to Characterize Conditionally Exempt Small Quantity Generator Wastestreams in Oklahoma - **Robert M. Craig**, M.S. Thesis (Boatright), April 2000.

Characterization of Powder Aerosol Produced During Use of Latex Gloves - **Cynthia Meagher**, M.S. Thesis (Phillips), March 2000.

Side-by-Side Comparison of IOM and a Modified 37-mm Sampling Cassette - **Rodney E. Clinkenbeard**, M.S. Thesis (Esmen), December 1999.

Comparison of Two Methods Used for Estimating Task Exposure Levels Using Multi-Task Data - **Joseph Costantino**, M.S. Thesis (Phillips), November 1999.

A Qualitative Field Evaluation of the Predictive Value of a Hand Held Drum Pressure Detection Device - **Michael A. Pannell**, Ph.D. Dissertation (Boatright), October 1999.

Design of a Survey Instrument to Determine the Effectiveness of the Public Service Company of Oklahoma's EMF Risk Communication Program - **Rhonda R. Langford**, M.S. Thesis (Boatright), October 1999.

The Design of a Strategy for Determining Compliance Requirements for 24 Air Source Categories, Tinker Air Force Base, Oklahoma - **Geri L. Hart**, M.S. Thesis (Lynch), September 1999.

Effect of Nebulization Time and Pressure on the Culturability of Gram Positive and Gram Negative Bacteria - **Roberta A. Stone**, M.S. Thesis (Johnson), September 1999.

Environment, Safety, and Health Return on Investment Methodology - **Darryl Sumrall**, M.S. Thesis (Boatright), September 1999

Appendix A

OEH 5033
ENVIRONMENTAL ISSUES

Fall Semester 2003
Course Coordinator: M. L. Phillips

Course Description:

This course is an introduction to the major concepts and range of concerns in environmental studies, with emphasis on fundamental physical science applied to qualitative and quantitative examination of environmental problems impacting human health. The course consists of a series of lectures by the faculty of the Occupational and Environmental Health Department, problem solving exercises, and readings from the textbook and course pack.

Course Objectives:

The main objectives of the course are:

- To provide OEH students with an understanding of the fundamental physical science that underlies environmental studies.
- To introduce OEH students to the major categories of environmental concerns.

Specifically, upon completion of this course, you should be able to:

1. Apply basic physical principles and algebraic methods to environmental issues.
   a) Use and convert commonly used units of measure.
   b) Perform typical calculations relating to environmental hazards
      i) Concentration
      ii) Partitioning between phases
      iii) Reaction equilibria
      iv) First order kinetics
      v) Mass balance
      vi) Fluid flow velocity
2. Describe the main sources, distribution, and control of chemical and biological contamination in important environmental media:
   a) Air
   b) Drinking water
   c) Ground water and soil
   d) Waste water
   e) Hazardous waste
   f) Food

Text: Hemond & Fechner-Levy, *Chemical Fate and Transport in the Environment*, 2nd Edition (Academic Press, 2000)

Course Pack: The course pack is available for purchase at Printing Services in the basement of the Rogers Building.

General rules

Assignments should be neatly written or typed. Show all work! Provide a citation for any information you may look up.

Examinations and grades

There will be a midterm exam covering the first six lectures and a final exam covering the remaining eight lectures. In addition, there will be 5-10 problem sets.

The grades will be based on:

• *Midterm*	34%	
• *Final*	51%	
Total of Exams		85%
Problem Sets		15%
Total		100%

The final assignment of letter grades will depend the distribution of the total points.

Fall 2003 Schedule

Class meets Tuesdays, 6:10-9:00, Room 420

Date	Topic	Instructor
Aug. 26	Overview of the physical environment; Terms, definitions, and quantitative skills	Phillips
Sept. 2	Review of thermodynamics	Phillips
Sept. 9	Phases and phase interactions.	Phillips
Sept. 16	Chemical reactions and kinetics	Phillips
Sept. 23	Transport phenomena	Phillips
Sept. 30	Recap/problem session	Phillips
Oct. 7	MID TERM EXAMINATION	--
Oct. 14	Ground water and soil contamination	Lynch
Oct. 21	Water supply	Boatright
Oct. 28	Wastewater	Boatright
Nov. 4	Hazardous waste	Lynch
Nov. 11	Indoor air quality	Johnson
Nov. 18	Air pollution	Hall
Nov. 25	Food sanitation	Elledge
Dec. 2	Biological hazards	Elledge
Dec. 9	FINAL EXAMINATION	---