

# National Occupational Research Agenda



*Shifting the spectrum of research to achieve more balance between etiologic research and problem-solving research.*

*NOA Teams are partnerships in and of themselves.*

- Preventing hearing loss in construction workers
- Measurement and control of diesel exposures in mines
- Preventing back and shoulder injuries among nursing home workers
- Respiratory protection against bioaerosols in agriculture

**Update 2003**

## **NORA VISION**

No single organization has the resources necessary to conduct occupational safety and health research to adequately serve the needs of workers in the United States. These constraints mandate that the entire occupational safety and health community engage in collaboration and coordination of its resources.

The National Institute for Occupational Safety and Health (NIOSH) and its public and private partners developed the National Occupational Research Agenda (NORA) to provide a framework to guide occupational safety and health research - for NIOSH and the entire occupational safety and health community.

## **NIOSH VISION**

Delivering on the Nation's promise: safety and health at work for all people...through research and prevention.

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National Occupational

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Research Agenda

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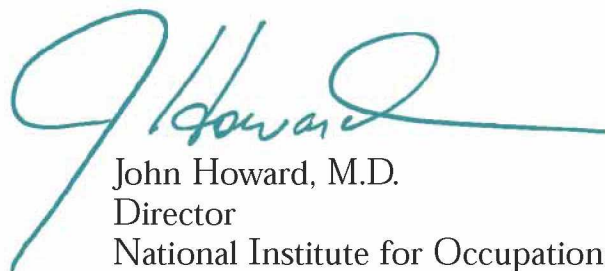
*Update 2003*

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## Message from NIOSH Director

This year marks the seventh year of NORA implementation. NIOSH remains committed to NORA, which continues to provide a unique vehicle for partnerships and advances in occupational safety and health research. The fourth bi-annual NORA Symposium, June 23-24, 2003, will provide an exciting forum to share scientific research in NORA priority areas. It will also provide us with a unique opportunity to focus on how NORA research makes a difference in the lives of workers. The issue of moving NORA research to public health practice is critical and something that NIOSH is intent upon examining as part of a larger effort to assess NORA's impact and future shape. NIOSH will continue to turn to our partners for input as we evaluate NORA and plan for the future.

A handwritten signature in blue ink, appearing to read "J. Howard", with a long horizontal flourish extending to the right.

John Howard, M.D.  
Director  
National Institute for Occupational  
Safety and Health

## NORA History

Each day, an average of 9,000 U.S. workers sustain disabling injuries on the job, 16 workers die from an injury sustained at work, and 137 workers die from work-related diseases.

In April 1996, the National Institute for Occupational Safety and Health (NIOSH) and partners from across the nation unveiled the National Occupational Research Agenda (NORA™) as a framework to guide occupational safety and health research into the next decade. NORA arose from the recognition of four key factors: 1) work-related injury and disease continue to have a significant human and economic toll; 2) emerging hazards have joined historical occupational safety and health problems to create new challenges; 3) the workforce is growing older and becoming increasingly diverse; and 4) occupational safety and health research in both the public and private sectors would benefit from targeting limited resources. Approximately 500 organizations and individuals outside of NIOSH provided input into the development of NORA. NORA has succeeded in addressing topics that were designated by stakeholders as those that are most pressing and likely to yield gains to the worker and the nation. These topics consist of 21 research priority areas, in three categories:

### **NORA Priority Research Areas**

#### Disease and Injury

Allergic and Irritant Dermatitis  
Asthma and Chronic Obstructive Pulmonary Disease  
Fertility and Pregnancy Abnormalities  
Hearing Loss  
Infectious Diseases  
Low Back Disorders  
Musculoskeletal Disorders of the Upper Extremities  
Traumatic Injuries

#### Work Environment and Workforce

Emerging Technologies  
Indoor Environment  
Mixed Exposures  
Organization of Work  
Special Populations at Risk

#### Research Tools and Approaches

Cancer Research Methods  
Control Technology and Personal Protective Equipment  
Exposure Assessment Methods  
Health Services Research  
Intervention Effectiveness Research  
Risk Assessment Methods  
Social and Economic Consequences of Workplace Illness and Injury  
Surveillance Research Methods

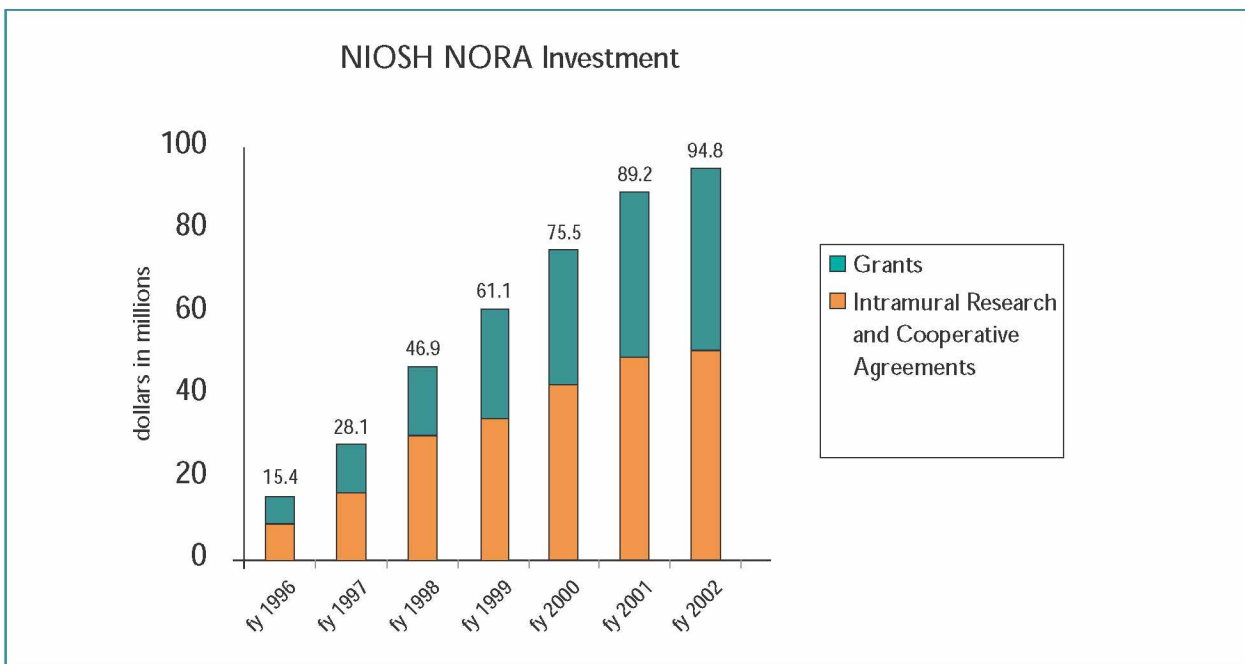
## Investment in NORA

According to the 2002 Liberty Mutual Workplace Safety Index, the direct and indirect costs of occupational injuries alone are estimated at \$240 billion (in 1999 dollars).

NORA was designed to be a research agenda not only for NIOSH, but for the entire occupational safety and health community. Over the past seven years, NORA has energized occupational safety and health research at NIOSH and throughout the federal government. NORA has also been successful in uniting NIOSH and other federal partners to co-sponsor research in NORA priority areas.

### NIOSH Investment in NORA:

NIOSH has made a strong commitment to conducting and supporting research in the 21 priority research areas. When NORA was unveiled in 1996, NIOSH funding (intramural and extramural) of the 21 NORA priority areas was \$15.4 million. A refocusing of NIOSH baseline resources and targeting of Congressionally appropriated new funds brought NIOSH funding for NORA to \$94.8 million in fiscal year 2002.

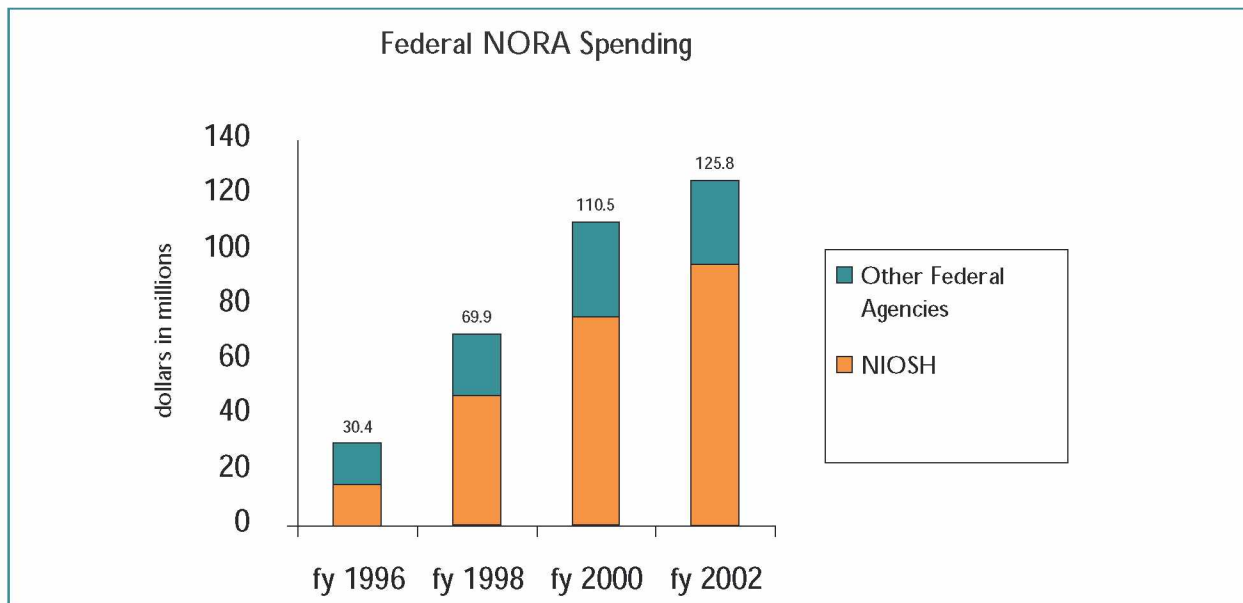


Funding for individual NORA priority research areas has also increased. For example, from 1996 to 2002, research conducted or funded by NIOSH to develop and evaluate the effectiveness of solutions to prevent work-related injury and illness (control technology and personal protective equipment, exposure assessment methods, and intervention effectiveness research) has increased nearly six-fold, from about \$5.5 million to \$33 million. This represents one of the most substantial shifts in research priorities for occupational safety and health since NORA was initiated, and responds to widespread support among stakeholders seeking for NIOSH-funded research to increasingly focus on the development and testing of practical solutions to causes of injury and illness.

## Total Federal Investment in NORA:

As part of NORA, a survey of federal occupational safety and health research outside of NIOSH is conducted biennially. The first survey, covering Fiscal Year 1996, provided a baseline identifying a total of \$15 million for NORA-related research from other federal sources. This investment increased to \$23 million in Fiscal Year 1998 and \$35 million in Fiscal Year 2000. Fiscal Year 2002 saw a slight decrease, with federal NORA investment totaling \$31 million. Four NIH institutes (National Heart, Lung and Blood Institute; National Institute of Arthritis and Musculoskeletal and Skin Diseases; National Institute of Environmental Health Sciences; and National Institute on Deafness and other Communication Disorders) and the Department of Veterans Affairs invested more than \$3 million each in NORA priority research areas in FY 2002.

Because some partners were unable to respond this year, these numbers likely underestimate the amount of federal dollars spent on NORA research. It is possible that some decreases are due to concentrated efforts on bioterrorism and other emergency preparedness and response since the 2001 terrorists attacks on the World Trade Center and Pentagon. NIOSH remains committed to working with federal partners to identify areas for collaboration and funding in NORA priority areas.



## Federal Funding Partners:

NORA has made possible the largest infusion of federal government funding for extramural occupational safety and health research ever. The number of federal partners funding NORA research collaboratively with NIOSH has increased steadily since fiscal year 1996. In fiscal year 2002, 14 federal agencies - including 12 partners at the National Institutes of Health, the Health Resources and Services Administration, and the Agency for Healthcare Research and Quality - co-sponsored extramural research announcements with NIOSH. A complete list of FY 2002 NORA funding partners is included here.



## NIOSH's FY 2002 Federal Funding Partners: Supporting NORA Research

Agency for Healthcare Research and Quality

Health Resources and Services Administration

Maternal and Child Health Bureau

The National Institutes of Health

National Heart, Lung and Blood Institute

National Institute of Child Health and Human Development

National Institute on Drug Abuse

National Institute on Mental Health

National Institute on Nursing Research

National Cancer Institute

National Institute on Aging

National Institute on Alcohol Abuse and Alcoholism

National Institute of Allergy and Infectious Diseases

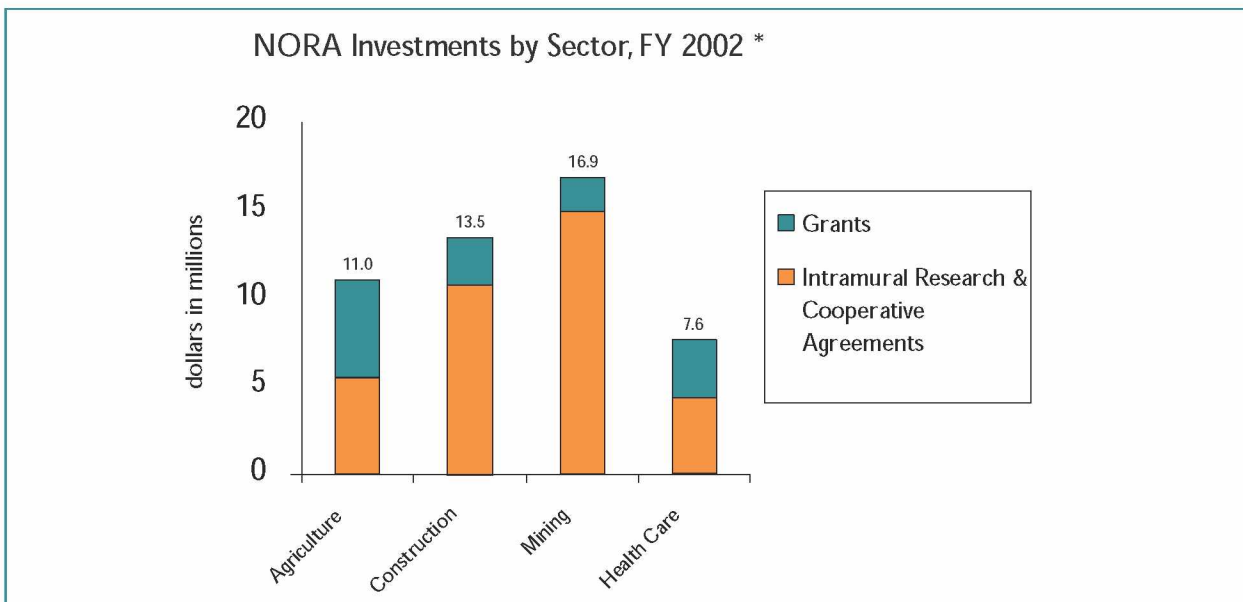
National Institute of Arthritis and Musculoskeletal and Skin Diseases

National Institute on Deafness and Other Communication Disorders

National Institute of Environmental Health Sciences

### Sector-Specific Research Funding:

To most effectively address research needs in specific sectors (such as construction, mining, agriculture, and health care), NIOSH applies a matrix approach of coordinated research in some or all of the 21 priority areas, as appropriate for each sector. As such, it is clear that NORA has increased sector-focused research. In FY 2002, over \$48 million of NIOSH's \$95 million investment in NORA is being allocated to NORA research in agriculture (\$11.0 million), construction (\$13.5 million), mining (\$16.9 million), and health care (\$7.6 million). These figures do not include NIOSH's nonresearch activities in these sectors (e.g., funding of the nine Centers for Agricultural Disease and Injury Research, Education, and Prevention, that are involved in both research and non-research activities).



\* Graph reflects investment in NORA research, not total NIOSH investment in sector.

## NORA Partnerships

Partnership is an essential element of NORA's approach to research and prevention

Partnerships are the cornerstone of NORA. Public-private collaboration resulted in strong consensus about which priority areas to include in the agenda. Moreover, partnerships have continued to play a vital role in NORA implementation. For example, NORA has created research partnerships, where NIOSH and other researchers share scientific expertise and creative problem-solving skills, while partners in labor and industry provide the laboratories for evaluating interventions in real work settings. Instances of these partnerships appear throughout descriptions of NORA research, which begins on page 13. Other key NORA partnerships include the NORA Partnership Teams and the NORA Liaison Committee.

### **NORA Partnership Teams:**

The NORA priority areas are represented by NORA Partnership Teams, which help guide implementation efforts and identify potential research partners. The NORA Teams are partnerships in and of themselves, consisting of NIOSH scientists and external partners from the academic community, industry, trade organizations, labor unions, and other federal agencies. NORA Teams better define the research needs of each particular priority area by establishing partnerships, sponsoring meetings to address their issues, and publishing research white papers in their areas. The white papers use variable approaches to advance issues in each priority area, such as summarizing the research in a priority area, defining gaps, and identifying opportunities for collaboration. Several Teams, including Infectious Diseases and Mixed Exposures, are finalizing such papers. Recently published white papers include:

**Exposure Assessment Methods:** Exposure assessment is an essential tool for understanding, managing, controlling, and reducing occupational health risks in large and small workplaces. Data from exposure assessments are used in toxicology, epidemiology, and engineering studies. Advancing the science of exposure assessment can lead to: 1) better identification of at-risk workers; 2) better identification of the most cost-effective control and intervention strategies; 3) better understanding of exposure-response relationships; and 4) improved baseline data for standard setting and risk assessment. While important gains have been made in creating new methods and detecting even lower exposures for some substances and agents, important challenges remain. The NORA Exposure Assessment Team prioritized the research needs, which fall into four areas: study design, monitoring methods, applied toxicology, and education. Specific recommendations are discussed in the document, *Exposure Assessment Research Needs and Priorities* which is available on the NIOSH web site at <http://www.cdc.gov/niosh/docs/2002-126/2002-126.pdf>.

*Woebkenberg ML, Abell M, Armstrong T, DeBord G, Groce D, Keane M, Knechtges P, Pegram D, Reh B, Rogers B, Stenzel M, Utterback D, Weeks J, Williams K [2002]. Exposure assessment needs and priorities. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2002-126.*

**Indoor Environment:** The multidisciplinary NORA Indoor Environment Team used member consensus and quantitative estimates, with extensive external review, to develop a specific research agenda for indoor nonindustrial work environments. The Team outlined the following priority research topics: building-influenced communicable respiratory infections, building-related asthma/allergic diseases, and nonspecific building-related symptoms; indoor environmental science; and methods for increasing implementation of healthful building practices. Available data suggest that improving building environments may result in health benefits for more than 15 million of the 89 million U.S. indoor workers, with estimated economic benefits of \$5 to \$75 billion annually. Research on these topics, requiring new collaborations and resources, offers enormous potential health and economic returns.

*Mendell MJ, Fisk WJ, Kreiss K, Levin H, Alexander D, Cain WS, Girman JR, Hines CJ, Jensen PA, Milton DK, Rexroat LP, Wallingford KM [2002]. Improving the health of workers in indoor environments: priority research needs for a national occupational research agenda. Am J Public Health 92:1430-40.*

**Organization of Work:** Over the past two decades, the face of the American workforce has changed dramatically. Both employers and employees are now faced with downsizing, restructuring, contracting out, longer working hours, telecommuting, flextime, and an aging and more diverse workforce. These changes have occurred quickly, outpacing scientists' ability to gauge their implications for work life quality, job-related stress, and workplace safety and health. A document by the NORA Organization of Work Team, *The Changing Organization of Work and the Safety and Health of Working People: Knowledge Gaps and Research Directions*, is the first national attempt to develop a comprehensive research agenda for addressing these issues. Key needs targeted by the agenda include improved surveillance of changes in the organization of work, accelerated research on safety and health effects of these changes, intervention research to prevent adverse effects, and more formal attention to organization of work in the occupational safety and health field. Future work in this area will serve to further define and leverage critical research needs such as studies on the safety and health effects of long work shifts. The report has already made a significant contribution to training efforts by recognizing that training venues were absent for equipping researchers and practitioners in methods and knowledge in work organization as it relates occupational safety and health. Although NIOSH had already taken the first steps to provide this type of training, recognition of this training gap by the NORA Team served to fortify NIOSH efforts in this area, and presently graduate level training programs in work organization and health have been seeded by NIOSH at 11 universities nationwide. The document is available on NIOSH's web site on-line at <http://www.cdc.gov/niosh/02-116pd.html>.

*Sauter S, Brightwell WS, Colligan MJ, Hurrell JJ, Katz TM, LeGrande DE, Lessin N, Lippin RA, Lipscomb JA, Murphy LR, Peters RH, Keita GP, Robertson SR, Stellman JM, Swanson NG, Tetrick LE [2002]. The changing organization of work and the safety and health of working people. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2002-116.*

**Cancer Research Methods:** Focus on occupational cancer research methods is important both because occupational factors play a significant role in a number of cancers, resulting in significant

morbidity and mortality, and also because occupational cohorts (because of higher exposure levels) often provide unique opportunities to evaluate health effects of environmental toxicants and understand the carcinogenic process in humans. Despite an explosion of new methods for cancer research in general, these have not been widely applied to occupational cancer research. In this paper published in *Environmental Health Perspectives*, the NORA Cancer Research Methods Team identifies needs and gaps in occupational cancer research methods in four broad areas: identification of occupational carcinogens, design of epidemiologic studies, risk assessment, and primary and secondary prevention. Progress in occupational cancer will require interdisciplinary research involving epidemiologists, industrial hygienists, toxicologists, and molecular biologists.

*Ward EM, Schulte PA, Bayard S, Blair A, Brandt-Rauf P, Butler MA, Dankovic D, Hubbs AF, Jones C, Karstadt M, Kedderis GL, Melnick R, Redlich CA, Rothman N, Savage RE, Sprinker M, Toraason M, Weston A [2003]. Priorities for development of research methods in occupational cancer -- National Occupational Research Agenda Team. Environ Health Perspect 111:1-12.*

**Fertility and Pregnancy Abnormalities:** There is a significant public health concern about the potential effects of occupational exposure to toxic substances on reproductive outcomes. Several toxicants with reported reproductive and developmental effects are still in regular commercial or therapeutic use and thus present potential exposure to workers. Examples of these include heavy metals, organic solvents, pesticides and herbicides, and sterilants, anesthetic gases, and anticancer drugs used in health care. Many other substances are suspected of producing reproductive or developmental toxicity but lack sufficient data. Progress has been limited in identifying hazards and quantifying their potencies and in separating the contribution of these hazards from other etiologic factors. Identifying the causative agents, mechanisms by which they act, and any potential target populations, present the opportunity to intervene and protect the reproductive health of workers. The pace of laboratory studies to identify hazards and to underpin the biologic plausibility of effects in humans has not matched the pace at which new chemicals are introduced into commerce. Though many research challenges exist today, recent technologic and methodologic advances have been made that allow researchers to overcome some of these obstacles. This paper, written by the NORA Fertility and Pregnancy Abnormalities Team, recommends future directions in occupational reproductive health research including prioritization of research needs, potential surveillance activities, new studies on gene-environment interaction and effects of chemical mixtures, and communication.

*Lawson CC, Schnorr TM, Datson GP, Grajewski B, Marcus M, McDiarmid M, Murono E, Perreault SD, Shelby M, Schrader SM [2003]. An occupational reproductive research agenda for the third millennium. Environ Health Perspect 111:584-92.*

### **Liaison Committee:**

The NORA Liaison Committee, chaired by Dr. Bonnie Rogers, consists of 24 members representing industry, labor, academia, professional organizations, and government (see membership listed below). The NORA Liaison Committee is charged with assisting in the successful implementation

of NORA by activities such as providing comments to NIOSH and its partners on the progress of NORA, providing outreach to interested stakeholders, encouraging participation in research and implementation teams, and facilitating appropriate avenues for initiating the proposed research. In 1999, the Liaison Committee undertook a survey of key occupational safety and health stakeholders to gauge their opinions regarding NORA and to measure progress in NORA implementation. The Liaison has repeated this survey in 2003, with results to be presented at the 2003 NORA Symposium.

Beginning in 2000, the Liaison Committee is also responsible for administering the NORA Partnering Award for Worker Safety and Health, which is described below.

### **Committee Members**

**Bonnie Rogers, DrPH, COHN-S, LNCC, FAAN** (Committee Chair)  
Past President, American Association of Occupational Health Nurses  
The University of North Carolina at Chapel Hill

**Jacqueline Agnew, PhD, MPH, COHN-S, FAAN**  
Association of University Programs in Occupational Health and Safety

**Henry Anderson, MD**  
Council of State and Territorial Epidemiologists

**James August, MPH**  
American Federation of State County and Municipal Employees

**Edward J. Bernacki, MD, MPH**  
American College of Occupational and Environmental Medicine

**Carol Boraiko, CIH, CSP, MPH**  
American Chemistry Council

**Thomas F. Bresnahan, CSP**  
American Society of Safety Engineers

**William B. Bunn, MD, JD, MPH**  
International Truck and Engine

**Leo Carey**  
National Safety Council

**Tai Chan, PhD, CIH**  
General Motors

**Harry Ettinger, PE, CIH**  
American Industrial Hygiene Association

**Janie Gittleman, PhD, MRP**  
Center to Protect Workers' Rights

**Gwendolyn Keita, PhD**  
American Psychological Association

**Tom B. Leamon, PhD**  
Liberty Mutual Insurance Company

continued

**Wayne Lednar, MD, PhD**

Eastman Kodak Company

**Pamela Tau Lee**

Environmental Justice Committee

**Mei-Li Lin, PhD**

National Safety Council

**Jane Lipscomb, RN, PhD, FAAN**

American Public Health Association  
University of Maryland

**Joseph Main**

United Mine Workers of America

**Franklin Mirer, PhD**

International Union, United Auto Workers

**Grace Paranzino, MS, RN, CHES, FAAOHN**

Association of Occupational and Environmental Clinics

**Margaret M. Seminario**

AFL-CIO

**Michael A. Silverstein, MD, MPH**

Washington State Department of Labor and Industries and OSHSPA

**Frank White**

Organization Resources Counselors, Inc.

**NORA Partnering Award:**

The first NORA Partnering Award for Worker Safety and Health was presented at the 1999 NORA Symposium. This award honors exemplary teamwork, innovative thinking, and strong science in the interest of worker safety and health. It was created to recognize those organizations participating in NORA-related collaborative research partnerships that result in the development of new equipment, practices, products, procedures, or policies that reduce hazardous exposures and/or adverse outcomes in order to protect worker health and safety. The NORA Liaison Committee is responsible for soliciting nominations for the award and selecting the winner.

For 2003, the winning partnership project is "Evaluation of a Best Practices Back Injury Prevention Program in Nursing Homes." This research project was a collaborative effort between BJC Health Care, employees of BJC Health Care through the Occupational Health Nurse Council, Washington University, West Virginia University, EZ Way, Inc., Arjo, Inc., and NIOSH. This research partnership consisted of a laboratory study and a field study, designed to develop and evaluate the effectiveness of a "best practices" injury prevention program for reducing the incidence, severity, and cost of low back and other musculoskeletal injuries to workers in nursing homes. The best practices program included the use of mechanical patient lifting devices, worker training on how to use the devices, a zero-lift policy prohibiting manual lifting of non-weight bearing patients, and medical management of injured workers. The field study, which was conducted in partnership with BJC Health Care, documented a 57% reduction in injury frequency, a 58% reduc-

tion in injury rates, and a 71% reduction in workers' compensation medical and indemnity expenses related to patient lifting and transferring injuries among nursing staff. The laboratory study determined that lifting equipment manufactured by Arjo, Inc. and EZ Way, Inc. removed two-thirds of the lifting-stress exposure, while demonstrating efficiency and comfort.

Based on the positive results of this collaborative study, BJC Health Care (one of the largest non-profit health care systems in the United States) is implementing the best practices program in their acute care hospitals. In addition, NIOSH is preparing a scientific article summarizing the results of the study and is developing a practical users' guide, which will be widely disseminated to other health care providers for use in developing and implementing effective programs to reduce injuries during patient handling activities.

The 2003 Partnering Award will be presented at the NORA Symposium 2003: Working Partnerships Research to Practice on June 23-24, 2003.

## NORA Workshops

Throughout the implementation of the agenda, NORA Partnership Teams have sponsored numerous workshops and conference to focus on priority research areas. Highlighted here are a few examples of upcoming and recent workshops.

The Third National Occupational Injury Research Symposium (NOIRS) will be held on October 28-30, 2003, in Pittsburgh, PA. NOIRS is a national forum for the presentation of latest findings and methods in occupational injury research and a major focus for the NORA **Traumatic Injuries Team**. It will consist of presentations on research studies, methods, and findings related to traumatic work-related injuries. For more information, visit the NIOSH web-site at [www.cdc.gov/niosh/noirs/noirmsain.html](http://www.cdc.gov/niosh/noirs/noirmsain.html) or call NIOSH at 1-800-35-NIOSH (1-800-356-4674).

The NORA **Special Populations at Risk Team** is joining the NIH's National Institute for Child Health and Development (NICHD) and the Sloan Family Foundation in cosponsoring a June 2003 conference entitled *Workforce/ Workplace Mismatch: Work, Family, Health, and Well-Being*. The conference is the first step in a 5-year initiative by NICHD to develop workplace based intervention programs. The conference will review the state of science pertaining to how different dimensions of work and family act independently and interact to affect the health and well-being of workers, families, children, communities and workplaces from numerous disciplinary perspectives.

The NORA **Hearing Loss Team** and the National Hearing Conservation Association have co-sponsored three best practices workshops. The most recent, Best Practices Workshop: Impulsive Noise, occurred in May 2003. Leading national and international experts on impulsive noise from labor, industry, academia, and government provided updates of the current state of the art concerning the effects of impulsive noise on the auditory system, techniques for capturing and analyzing impulsive noise, and the relevancy of present federal exposure limit guidelines. Working groups developed strategies for the measurement and characterization of impulsive noise, identified gaps in knowledge and measurement capabilities, and established specific future goals and research priorities. The presentation materials are being finalized and will be posted on the NIOSH website, with a publication of the proceedings to follow.

The NORA **Organization of Work Team** provided technical and financial support for the 5th International Conference on Work, Stress and Health, which is the only international scientific conference worldwide to examine occupational safety and health risks of changing organizational practices. This conference, conducted in Toronto in March 2003, attracted nearly 700 scientists from 22 countries and every continent.

In May 2002, the **Cancer Research Methods Team**, in conjunction with the NIH's National Cancer Institute and National Institute of Environmental Sciences and the American Chemistry Council, held a two-day workshop entitled Applying New Biotechnology to the Study of Occupational Cancer. The workshop brought together researchers who study worker populations and those who are developing and validating new biotechnologies. The event fostered collaborations and promoted discussion and exploration of current and future directions of research to prevent occupational cancer. Abstracts are available on the NIOSH web site at <http://www.cdc.gov/niosh/crmw.html>.

The NORA **Mixed Exposures Team** sponsored and led a session at the International Conference on Chemical Mixtures in September 2002. The conference was sponsored by the Agency for Toxic Substances and Disease Registry, the Food and Drug Administration, the U.S. Environmental Protection Agency, the NIH's National Institute of Environmental Health Sciences, NIOSH, the Health Council of the Netherlands, the International Joint Commission, and the Society for Toxicology. The conference addressed issues pertaining to chemical mixtures research, mixtures health risk assessment, and computational modeling of chemical mixtures. The NORA session focused on the priorities for mixed exposures research and risk assessment approaches.

In September 2002, as part of the special NORA research initiative Development of Dermal Policy Based on Laboratory and Field Studies (see page 14), NIOSH co-sponsored the International Conference on Occupational and Environmental Exposures of Skin to Chemicals: Science and Policy. This was the first conference to bring together dermatologists, occupational hygienists, engineers, laboratory researchers, policy makers, and others to focus on the science, knowledge gaps, and policy opportunities related to occupational and environmental exposures of the skin to chemicals. Conference sessions discussed the challenges of defining and identifying hazards of skin exposures, developing policies for prevention, and effectively communicating methods to protect workers from dermal exposures. Approximately 135 individuals attended, including many from outside of the U.S. The Proceedings are available on the NIOSH website at [www.cdc.gov/niosh/topics/skin/conference/index.html](http://www.cdc.gov/niosh/topics/skin/conference/index.html). A second conference is scheduled for 2004.



## NORA Research

Over the past seven years, NORA has energized occupational safety and health research. NIOSH has aggressively aligned its intramural research program with NORA and has made scientific progress in many of the priority research areas. NIOSH's NORA intramural research budget has risen from \$8.7 million in Fiscal Year 1996 to \$50.7 million in Fiscal Year 2002. NIOSH has also increased its funding of extramural NORA projects and allocates three-quarters of new NORA funding to expand extramural research.

### **Intramural Research:**

NIOSH conducts a diverse program of scientific research to prevent or reduce work-related illnesses and injuries. Highlighted here are recent accomplishments from some of the projects in NIOSH's NORA intramural research portfolio. Of note is the role of partnerships in many of these efforts.

### **Special NORA Research Initiatives**

NORA has helped NIOSH focus its intramural research to create large programmatic initiatives composed of interrelated and coordinated research projects aimed at high-priority occupational topics of national importance. This multidisciplinary effort, referred to as "Big NORA," has resulted in increased collaboration, intensive peer review of internal research, and integration of projects and resources. These initiatives focus on the following areas:

- \*Organizational Risk Factors for Depression and Cardiovascular Disease
- \*Occupational Traumatic Injury Prevention
- \*Identifying Effective Hearing Loss Prevention Strategies
- \*Strategies to Prevent Injuries among Nurses
- \*Research for Occupational Asthma Reduction
- \*Exposure-response and Intervention Program for the Prevention of Work-related Musculoskeletal Disorders
- \*Development of Dermal Policy Based on Laboratory and Field Studies

These initiatives encompass a variety of projects, which are currently at different stages. For example:

Research for Occupational Asthma Reduction is monitoring the occurrence of occupational asthma, evaluating the effectiveness of interventions, developing new methods for monitoring work environments, reviewing asthma cases from field investigations and surveillance systems, and encouraging interaction and communication among NIOSH investigators and extramural scientists.

Exposure-response and Intervention Program for the Prevention of Work-related Musculoskeletal Disorders is designed to quantify risk for work-related MSDs at varying levels of exposure to job physical stressors and to evaluate interventions to reduce exposure and prevent musculoskeletal disorders. The program goals also include developing and testing practical exposure and health assessment methods. NIOSH is collaborating with four external partners to conduct cohort studies at a variety of worksites. This large, coordinated research program will be carried out over a 5-year period.

Development of Dermal Policy Based on Laboratory and Field Studies encompasses 11 projects, with a focus on gathering data to make recommendations for conducting effective occupational hygiene investigations of potential skin exposure hazards, including a special emphasis on improved skin notations. One recent study in this area used mathematical approaches to better understand how the components of the stratum corneum (the outermost skin layer) and their geometrical arrangement provide the barrier properties of skin. This work provides a way to understand the details of chemical transport through the skin even for complex exposures, such as intermittent exposure. In addition, last year NIOSH established a unique occupational skin research laboratory, using state-of-the-art instrumentation to objectively measure damage to the skin, secondary to chemical and physical trauma. For example, it is now possible to conduct digitized image analysis of the surface of the skin to assess its physical properties. Such highly sensitive and objective means to assess skin condition can be used to supplement more traditional, subjective evaluations. This combined approach to analyzing the skin has never been previously utilized in occupational health studies.

## Other NORA Intramural Research

### Disease and Injury

#### [Assessing the Effectiveness of Hearing Loss Prevention for Carpenters](#)

Currently, estimated figures show that 2.9 million workers in the construction industry are exposed to potentially damaging noise levels, and that only 17% of carpenter apprentices wear hearing protectors properly. A NIOSH study of over 600 carpenters found that by age 25, carpenters have hearing equivalent to that of a 50-year-old non-noise exposed worker and by 55 years of age, most carpenters need hearing aids. To help reduce the incidence rate of hearing loss, NIOSH researchers have developed training methods to help carpenter apprentices understand their risk of occupational hearing loss and learn ways to protect their hearing from hazardous noise. Future evaluations of these training methods will help NIOSH researchers develop effective, efficient hearing loss prevention programs not only for carpenters, but the entire construction industry.

#### [Female Reproductive Effects of Exposure to Jet Fuel](#)

Approximately 116,000 women work for the United States Air Force (USAF) as officers, enlisted personnel, and civilians. Women in the USAF hold jobs that involve handling jet fuel, of which over three billion gallons have been issued annually to the Department of Defense. Evidence has accumulated that hydrocarbons, such as those found in jet fuel and solvents, are reproductive toxicants that have been shown to reduce female fertility. NIOSH researchers, in collaboration with the University of Cincinnati and USAF, conducted a controlled, cross-sectional, prospective study of women's reproductive health among USAF personnel working with jet fuel and solvents. The principal finding of the study is that women with increased exposure to jet fuel experience a 32% reduction in the preovulatory luteinizing hormone (LH) surge, the endocrine signal that triggers ovulation. While more research is needed to determine if these effects are temporary or long-lasting, and what role they may have in impeding women's reproductive ability, the new findings are consistent with data relating to other types of hydrocarbons, and will help scientists focus further studies that would be needed to make a conclusive link.

### Reducing Traumatic Injuries from Off-Highway Dump Trucks

Blind spots around haulage equipment were identified as the cause of five worker fatalities at surface mines in 2000. To address this problem, NIOSH is investigating methods to monitor blind spots and alert operators to objects, people, and sudden changes in terrain. Partnerships have been established with Phelps Dodge, Inc., and Trimble Navigation, Inc., to develop and test various technologies, such as video cameras, radar, and Global Positioning Systems (GPS). This year, a collision warning system based on GPS technology was developed and tested for the first time on an off-highway dump truck. Other systems based on video cameras and radar are also being tested in a production setting at a Phelps Dodge copper mine in Morenci, Arizona.

### Slips, Trips, and Falls Prevention in Health Care Workers

Slips, trips, and falls (STF) in the workplace represent a significant burden of injury and disability on American workers. The STF incidence rate for hospitals is 50% higher than the rate for all private industry. NIOSH researchers are leading a collaborative study with the Liberty Mutual Research Center for Safety and Health (LMRCSH), the Finnish Institute for Occupational Health (FIOH), BJC Health Care, and the Department of Veterans Affairs (VA) to develop and implement a STF prevention program in six hospitals and evaluate the impact of the program in a longitudinal study. NIOSH will disseminate the results of this study through all appropriate channels to health care workers, policy makers, standards organizations, unions, and flooring and shoe manufacturers involved with the prevention of STF incidents.

### Virtual Reality Technology Application for Fall Prevention Research

Falls from elevation are a persistent occupational hazard, accounting for approximately 10% of all occupational fatalities, and for more than one third of fatal incidents in the construction industry. NIOSH researchers are using virtual reality technology to simulate elevated workplaces and study the risk factors for falls. Instability when working at heights is increased by other conditions in the work environment such as decreased surface firmness and increased slope. Because the increased instability on elevated and sloped surfaces is not adequately perceived by workers, the risk of loss-of-balance incidents and falls is increased. In addition, research demonstrated that close visual references improve balance at elevation. The results from these groundbreaking studies provide the scientific basis for further applications of virtual reality simulations in fall prevention research. Future research may include dose-response studies using hybrid virtual environments (simulated and real structures) to further evaluate the stabilizing effects of close visual references; and studies to evaluate other potential contributing factors for loss of balance at height such as the effect of footwear type on balance control while working on roofs. Ultimately, findings from this and future research should lead to changes in the work environment, procedures, and protective equipment which should reduce the incidence of fall-related injuries and fatalities.

### Occupational Asthma and Skin Exposure to Isocyanates

Public health surveillance systems have indicated that isocyanate compounds are the most commonly identified causes of occupational asthma. In cooperation with partners in industry, labor, and academia, NIOSH has developed a collaborative research and intervention activity directed at isocyanate asthma. Recently, a significant relationship was observed between the development of asthma-like symptoms and reports of skin staining with isocyanate, suggesting skin contact can be

an important risk factor for isocyanate asthma. This is consistent with results of several prior animal exposure studies. These findings were communicated to isocyanate manufacturers who will include information on the concerns NIOSH identified in their product guidance.

## Work Environment and Workforce

### Lung Infections and Mixed Dust Exposure

Epidemiological studies have reported increased lung morbidity and mortality in populations exposed to increased levels of particulate matter that has high metal content. In addition, studies have suggested that welders, boilermakers, and construction workers who have inhaled metal-containing particles of mixed composition such as diesel exhaust particles, residual oil fly ash, or welding fumes may be more susceptible to lung infections than the general population. To date, the mechanisms of the effects of these particles and fumes on lung defense are largely unknown. NIOSH conducted an animal study to assess the role by which metals may alter host defense mechanisms. It was demonstrated that different occupational particles have vastly different effects on host pulmonary defense mechanisms. Metal composition and particle solubility played important roles in particle-induced effects on macrophage function and lung defense mechanisms. Better understanding the mechanisms by which the occupational exposure to metal particles increases worker susceptibility to infection will lead to the development of effective interventions to protect workers at risk.

### Work Organization and Depression in Women

Depression exacts an enormous toll on workers, their families, and their employers—both personally and economically. Working women suffer from depression at nearly twice the rates of working men. Work organization factors such as harassment, discrimination, and balancing work and family responsibilities may contribute to the higher levels of depression among women. A NIOSH study is examining the relationship between work organization stressors and depression. Study findings will provide valuable knowledge of workplace factors that may lead to depression among working women, as well as information on workplace policies and programs that can reduce the prevalence of the disease in this population.

### Assessment of Health Issues in Minority Farm Operators

Some diseases are less prevalent in various racial and ethnic groups of minority farm operators than in white farm operators, but others are more prevalent, according to a recent NIOSH study. The findings, which were reported at the American Public Health Association's Annual Meeting in November 2002, were drawn from a survey conducted by NIOSH and the U.S. Department of Agriculture's (USDA) National Agricultural Statistics Service. The survey used a population sample from USDA's Census of Agriculture. For the first time, this study provides researchers with a large enough data base for analyzing health status of farm operators by gender, race, and ethnicity. The study showed that fewer Hispanic farm operators reported health problems than white, non-Hispanic farm operators - except for diabetes, which was reported by more Hispanic men and women. Fewer Asian American farm operators reported health problems than white farm operators - except for diabetes in both genders and dermatitis in women, where Asian Americans reported a greater prevalence of each condition, but not at statistically significant rates. In addition,

African American farm operators reported a greater variability of health problems by gender and type of health problem than did white farm operators. American Indian and Alaska Native farm operators had a higher prevalence of respiratory problems, hypertension, and diabetes than white farm operators did. American Indian and Alaska Native men reported a greater prevalence of musculoskeletal problems. The study points to areas where additional, focused research will be critical for determining whether various illnesses in those occupational groups are job-related, and for identifying ways to keep the growing number of minority and female operators healthy and safe.

## Research Tools and Approaches

### [EarTalk: An In-The-Ear Communication System for First Responders](#)

NIOSH researchers designed and patented a communication system, EarTalk, that is built into a hearing protector. The EarTalk device uses subminiature microphones and speakers that are embedded inside an earplug or an earmuff to pick up the speech signal from the ear canal. The speech is transmitted via radio and is electronically processed to restore its natural sound quality. In tests of speech intelligibility in noise conducted at an air force base, EarTalk demonstrated excellent performance when compared to much bulkier commercial and military communication headsets. NIOSH researchers also have been working with the Federal Laboratory Consortium for Technology Transfer to showcase EarTalk to firefighters, law enforcement, and the military.

### [Employer Survey of Respirator Research Needs](#)

NIOSH and the Department of Labor's Bureau of Labor Statistics (BLS) collaborated to design and launch a new voluntary survey of employers' use of respirators as part of ongoing occupational safety and health programs. Employers from private industry in manufacturing, construction, mining, agriculture, health care, and services responded to the survey. The survey found that in the previous 12 months, respirators were used by 3.3 million employees in 281,800 business establishments, which represents 3.1 percent of all employees and 4.5 percent of all business establishments in the United States. Dust masks were the most commonly used respirator, comprising 71 percent of all respirators used. Air-purifying respirators were most commonly worn to protect workers from exposure to paint vapors and dust, while air-supplied respirators were most commonly worn to protect workers from paint vapors and solvents. The findings of the survey will help NIOSH and its partners target respirator research to address the greatest areas of need.

### [Safe and Effective Method for Cleaning Soiled Work Clothing](#)

Dust-contaminated work clothing is a constant source of increased dust exposure to a worker until it is cleaned or removed. Previous studies have shown that heavily soiled work clothing, a common problem in many industries, can cause a tenfold increase in a worker's respirable dust exposure. NIOSH, working in cooperation with a mineral-processing corporation, has developed a quick and effective system for cleaning soiled work clothing. The system uses a compressed air nozzle manifold to blow dust from the clothing in an enclosed booth, which is connected to a dust collector. Testing of the system at a silica sand operation showed that it quickly and effectively cleans clothing with minimum exposure to respirable dust when the worker wears properly fit-tested respiratory personal protective equipment. The new method could markedly reduce silicosis and other related chronic lung diseases by directly reducing exposures for as many as 128,000 workers in stone,

nonmetal, and sand and gravel operations. Possibly, this method also could be used in surface coal mines, reducing exposures for another 40,000 workers, or any other industry where worker's clothing becomes contaminated with product or dust.

### [A Method for Assessing Exposure to Anthrax or Multiple Pesticides](#)

NIOSH developed and validated a new, faster, and less costly method for analyzing urine and blood to determine whether decontamination workers are exposed to anthrax, and whether agricultural workers are exposed to potentially hazardous pesticides. Existing methods required separate analyses for individual samples. The new NIOSH method can be used to identify and measure four pesticides simultaneously in a urine sample, and to detect anthrax antibodies in a blood specimen. In a study designed to evaluate the validity of the new test for anti-anthrax antibodies, the new test was shown to be accurate.

### [New Method to Identify Risk for Job-Related Histoplasmosis](#)

A new method developed and patented by NIOSH offers an inexpensive, fast way to determine if workers are at risk of exposure to fungal spores that cause histoplasmosis, a respiratory infection. Histoplasmosis produces flu-like symptoms such as fever, chest pain, chills, cough, and joint or muscle pain. It also can result in chronic lung disease. In its severest form, the infection can cause fatal illness. The fungus that causes histoplasmosis, *Histoplasma capsulatum*, is found widely in soil. Workers at risk of exposure include construction workers, bridge inspectors and painters, farmers, gardeners, chimney cleaners, workers who install and service heating and air conditioning systems, roofers, and pest control workers. The new analytical method developed by NIOSH employs a DNA analytical technique, polymerase chain reaction (PCR), to identify the fungus in a laboratory sample that can be soil, dust, or other environmental materials from a work area suspected of being contaminated. A laboratory analysis using PCR can be completed in less than two days at a cost of \$60. The traditional, multi-step method requires the analysis of tissue cultures from laboratory mice, takes several weeks to complete, and typically costs several hundred dollars.

### [New Method for Detecting the Presence of Lead](#)

Workers involved in the renovation of building, removal of lead-based paint, or metal industries may be exposed to lead. NIOSH developed a new assessment method to detect worker exposure to this environmental hazard: a handwipe that can quickly and easily detect the presence of lead on skin, vehicles used in industries where lead is produced or used, and surfaces such as tables, floors, walls, and window sills. The handwipe, which was recently patented, indicates the presence of lead through a simple color change, thus alerting workers that there is some level of lead contamination and that he or she should perform more thorough hand washing.

### [Assessment of Engineering Noise Controls in Underground Metal Mines](#)

Noise-induced hearing loss is the most common occupational illness in the United States today. More than 30 million workers are exposed to excessive noise levels. Engineering controls for noise can address the problem of occupational hearing loss, but applying these controls to the mining industry has been difficult. NIOSH researchers have been assessing the effectiveness of existing noise controls and have found that many of them are ineffective. An example of an effective control is a "windshield" used on roof bolters that reduces noise levels by 5 dB(A) on average. The

findings of this study will be disseminated to the mining industry through handbooks and seminars to help focus noise control efforts on areas where they will have the most impact.

## NORA and Emergency Preparedness

The terrorist attacks of September 11, 2001 the anthrax attacks of October 2001 presented unprecedented levels of occupational safety and health risks to rescue and recovery workers, postal workers, government employees, and news media offices. In addition to providing immediate on-site technical expertise at the sites involved in these critical public health events, NIOSH initiated new research activities to address long-term needs and strengthen preparedness. Many of these activities address NORA priority research areas, such as Traumatic Injuries, Asthma and Chronic Obstructive Pulmonary Disease, Musculoskeletal Disorders, Emerging Technologies, Mixed Exposures, Special Populations at Risk, Control Technology and Personal Protective Equipment, and Exposure Assessment Methods.

### Highlights include:

\*Needs for research on approaches to help protect emergency responders in a terrorist attacks were identified by stakeholders at a national workshop convened by NIOSH in December 2001 to gather information and recommendations on the performance, availability, and appropriateness of personal protective equipment for emergency responders in terrorist attacks. The workshop drew more than 150 participants, including fire fighters, fire fighting special operations, emergency medical services, law enforcement, construction and other trade services, and health and safety professionals, including state and federal agencies, and focused on lessons learned from the terrorist attacks on the World Trade Center and the Pentagon last September and from the bombing of the Alfred P. Murrah Federal Building in Oklahoma City in 1995. NIOSH funded a report of the workshop, which was released by RAND and is available on-line at [www.cdc.gov/niosh/npptl](http://www.cdc.gov/niosh/npptl). The report shows a need for research, training and other strategic approaches to help protect emergency responders in terrorist attacks. The report also highlights the need for a research agenda that outlines comprehensive personal protective technology, and improved federal education and training programs and other activities pertaining to the health and safety of emergency responders in rescue, recovery, and restoration efforts. In combination with other information such as injury and exposure data, NIOSH is using the report in working with partner organizations to plan new research on emergency responder safety and personal protective technologies, identify priority needs for guidelines, develop guidelines in forms that will be most useful, and disseminate guidelines broadly.

\*NIOSH is evaluating research to develop and evaluate technologies for better protecting emergency responders and other workers in terrorist attacks.

\*NIOSH is developing guidelines for emergency responders on the selection, use, and maintenance of respirators and other personal protective equipment in disaster situations.

\*NIOSH is examining ways to use sampling technologies in innovative ways. For example, during the October 2001 anthrax attacks, NIOSH adapted a vacuuming technique using an "allergy sock," a method originally developed to measure allergens, to provide a more sensitive, comprehensive way to collect anthrax samples at large postal facilities.

\*NIOSH engineering experts and scientists evaluated 65 buildings to assess the vulnerabilities of building air environments, including heating, ventilation, and air-conditioning (HVAC) systems, to a terrorist attack with chemical, biologic, and radiologic agents and to develop cost-effective prevention and control strategies. NIOSH used the results of these assessments to develop guidelines for safeguarding building ventilation systems, which were published in May 2002. NIOSH published a companion document providing guidance for filtration and air-cleaning systems in May 2003. Both sets of guidelines were developed in conjunction with the Department of Homeland Security and are available on-line at [www.cdc.gov/niosh/topics/emres/default.html](http://www.cdc.gov/niosh/topics/emres/default.html).

## **Extramural Research:**

NORA has allowed NIOSH to diversify its research portfolio to fund research on the numerous occupational safety and health issues affecting workers. Each year NIOSH awards new grants in NORA priority research areas, frequently in conjunction with federal funding partners. In FY 2002, 14 federal agencies - including 12 partners at the National Institutes of Health, the Health Resources and Services Administration, and the Agency for Healthcare Research and Quality - co-sponsored announcements with NIOSH. NIOSH funded 71 new NORA awards in FY 2001 and 65 in FY 2002 (see listings below).

## **FY 2001 NORA Awards**

### **Allergic and Irritant Dermatitis**

#### ***Dermal Hazards in the Workplace: Assessment of Protection & Exposure***

Timothy Buckley, Ph.D.  
The Johns Hopkins University

#### ***Dermatopharmacokinetics and Pharmacodynamics: In Vivo Analysis of Common Paint Product***

Karla D. Thrall, Ph.D.  
Battelle Memorial Institute

### **Asthma & Chronic Obstructive Pulmonary Disease**

#### ***Disease in Chinese Textile Workers***

David C. Christiani, M.D.  
Harvard School of Public Health

#### ***Validated Asthma Questionnaire for Healthcare Workers***

George L. Delclos, M.D.  
University of Texas

#### ***PNOR/PNOC Exposures & the Development of COPD***

Henry Glindmeyer, D.Eng.  
Tulane University

#### ***Pulmonary Effects of Machining Fluid Aerosols***

Terry Gordon, Ph.D.  
New York University

#### ***Environmental Factors in PI\*Z Alpha 1-Antitrypsin Deficiency***

Lee S. Newman, M.D.  
National Jewish Medical & Research

### **Fertility & Pregnancy Abnormalities**

#### ***Endocrine Disruptors and Neurodevelopmental Outcome***

Brenda Eskenazi, Ph.D.  
University of California, Berkeley

#### ***Reproductive Effects from Occupational Exposure to Boron***

Wendie A. Robbins, Ph.D.  
University of California



## Hearing Loss

### *Adverse Effects of Noise on Hearing: Basic Mechanisms*

Barbara A. Bohne, Ph.D.  
Washington University

## Musculoskeletal Disorders: Low Back

### *Occupational Low Back Pain in Residential Carpentry: Elements of Posture and Strain*

Robin E. Herron, Ph.D.  
Colorado State University

### *Biomechanical and Psychosocial Risks for Low Back Disorders*

William S. Marras, Ph.D.  
Ohio State University

### *Floor Slope Effects on Lifting Kinematics and Kinetics*

Raoul F. Reiser, II, Ph.D.  
University of Wyoming

## Musculoskeletal Disorders: Upper Extremities

### *Effects of Repetitive Work on Fatigue of Long Duration*

Steven L. Lehman, Ph.D.  
University of California

### *Musculoskeletal Disorder Follow-up in Automobile Manufacturing*

Laura Punnett, Sc.D.  
University of Massachusetts

### *A Model for Wrist and Elbow Musculoskeletal Disorders*

David Michael Rempel, M.D.  
University of California

### *Cumulative Trauma Disorder: Skeletal Muscle Dysfunction*

William T. Stauber, Ph.D.  
West Virginia University

## Traumatic Injuries

### *Wisconsin Dairy Traumatic Occupational Injury Intervention*

Larry John Chapman, Ph.D.  
University of Wisconsin

### *Evaluation of Traumatic Injuries in Health Care Workers During Surgery*

Denise M. Korniewicz, DNSc  
University of Maryland

### *Work-Related Assault: Impact of Training and Policy*

Nancy Nachreiner, M.P.H.  
University of Minnesota

### *Trucking Firm Characteristics, Driver Injury and Outcome*

Arthur Oleinick, M.D.  
University of Michigan

### *Work-Related Motor Vehicle Crashes: Reducing the Burden*

Pamela B. Peele, Ph.D.  
University of Pittsburgh

### *A Strong Construction Injury Prevention Intervention at the Subcontractor Level*

Robert J. Pleasure, J.D.  
Centers to Protect Workers' Rights

## Indoor Environment

### *Floor-Supply Displacement Ventilation System*

Qingyan Chen, Ph.D.  
Massachusetts Institute of Technology

### *Health and Socioeconomic Consequences of Non-Specific Building-Related Illness*

Carrie Redlich, Ph.D.  
Yale University

### *An Indoor Environment Design Tool for Entire Buildings*

Jelena Srebric, Ph.D.  
Pennsylvania State University

## Mixed Exposures

### *Organic Solvent Mixtures & Neuropsychological Outcomes*

Ellen Kirrane, M.S.  
University of North Carolina

### *Silica Exposure & Silicosis:*

*Effect of Mixed Exposures*  
Gurumurthy Ramachandran, Ph.D.  
University of Minnesota

### *Microbiological Air Contamination from Machining Fluids*

Tiina Reponen, Ph.D.  
University of Cincinnati

### *Experimental and Computational Methods for Quantitating the Absorption of Complex Chemical Mixtures Through Skin*

Jim Riviere, D.V.M., Ph.D.  
North Carolina State University

***Complex Mixture Modeling of Organophosphate Pesticides***

Charles Timchalk, Ph.D.  
Battelle Memorial Institute

**Organization of Work**

***Extended Work Schedules and Health Outcomes in the US***

Fabio Barbone, M.D., Ph.D.  
University of Alabama

***Effects of Extended Work Hours on Intern Health and Safety***

Charles Andrew Czeisler, M.D., Ph.D.  
Brigham and Women's Hospital

***Impacts of Demanding Work Schedules: National Survey Findings***

Allard E. Dembe, Sc.D.  
University of Massachusetts

***Work Hours, Musculoskeletal Disorders and CVD Risk***

Paul A. Landsbergis, Ph.D.  
Mount Sinai University

***Work Organization and Health Among Home Care Workers***

Carles Muntaner, M.D.  
University of Maryland

***Difficult Work Conditions and Youths' Mental Health***

Elizabeth M. Smailes, M.P.H.  
Research Foundation for Mental Hygiene, Inc.

***Extended Work Schedules and Workplace Injury in Nurses***

Alison M. Trinkoff, Sc.D.,  
University of Maryland

**Special Populations at Risk**

***Casa A Campo:***

***Pesticide Safety for Farmworkers' Families***

Thomas Arcury, Ph.D.  
Wake Forest University

***Worker Genetic Susceptibility to Mutagenic Risk***

Paul Wesley Brandt-Rauf, M.D.  
Columbia University

***Effects of Aging on the Biomechanics of Slips and Falls***

Thurmon Eddy Lockhart, Ph.D.  
Virginia Polytechnic Institute

***Sustained Work Indicators of Older Farmers***

Deborah B. Reed, Ph.D.  
University of Kentucky

**Cancer Research Methods**

***Development of a Simplified 2-Stage Cancer Model***

David Kriebel, Sc.D.  
University of Massachusetts at Lowell

**Control Technology and Personal Protective Equipment**

***Field Studies with Innovative Safe Excavation Technologies***

Leonhard E. Bernold, Ph.D.  
North Carolina State University

***Sunscreens, Agricultural Chemicals & Dermal Absorption***

Rhonda Brand, Ph.D.  
University of Nebraska

***Safe Alternative Solvents for Antibiotics Extraction***

Jennifer F. Clark, Ph.D.  
Eltron Research, Inc.

***Respiratory Protection Against Bioaerosols in Agriculture***

Tiina Reponen, Ph.D.  
University of Cincinnati

***Hearing Protector Allowing Acoustic Communication***

Patrick M. Zurek, Ph.D.  
Sensimetrics Corp.

**Exposure Assessment Methods**

***Investigating Principles of Workroom Exposure***

Charles E. Feigley, Ph.D.  
University of South Carolina

***Numerical Modeling of Size-Specific Aerosol Concentration***

Michael Riordan Flynn, Sc.D.  
University of North Carolina

***Comparison of Concentrations at Personal Exposure Sampling Locations***

Steven E. Guffey, Ph.D.  
West Virginia University

***Evaluation of Air Samples with Field Analysis for Lead***

Martin Harper, Ph.D.  
University of Alabama

***Germicidal UV Occupational  
Exposure Personal Monitoring***

Gary D. Havey, MEE  
Advanced Medical Electronics Corp.

***Novel Hydrogen Sulfide Sensors for  
Portable Monitors***

Matthew Hooker, Ph.D.  
Nanomaterials Research Corporation

***Workplace Surface Contamination & Dermal  
Exposure to Isocyanate***

Roy Rando, Sc.D.  
Tulane University

***Real-Time Personal Monitor for the  
Drycleaning Industry***

Ross C. Thomas, Ph.D.  
Eltron Research, Inc.

***Electrostatic Sampling of Airborne Microorganisms***

Klaus Willeke, Ph.D.  
University of Cincinnati

***Molecular Analysis of Mycobacteria in Cutting Fluids***

Jagjit S. Yadav, Ph.D.  
University of Cincinnati

**Intervention Effectiveness Research**

***Effectiveness of Computer-Based Training: cTRAIN***

Kent W. Anger, Ph.D.  
Oregon University

***Innovative Health Care Worker Training:  
Infectious Disease Risk***

Robyn Gershon, DrPH  
Columbia University

***Effects of Physical Conditioning on  
Lifting Biomechanics***

Kevin P. Granata, Ph.D.  
University of Virginia

***Occupational Safety and Health  
Training for Teleworkers***

Susan Shemanski Harrington, M.S.  
Harrington Software

***Control of Workplace Noise Exposure***

Murray R. Hodgson, Ph.D.  
University of British Columbia

***Effectiveness of Farm Safety Day Camps for Children***

Debra Moehle McCallum, Ph.D.  
Institute for Social Science

***Effectiveness of a Machine Guarding Intervention***

David L. Parker, M.D.  
Minnesota Department of Health

***Evaluation of Farm Safety 4Just Kids Day Camps***

Deborah B. Reed, Ph.D.  
University of Kentucky

**Risk Assessment Methods**

***Physiologically-Based Pharmacokinetic/Clonal  
Growth Modeling: Predicting Cancer***

***Potential of Chemical Mixtures***

Raymond S.H. Yang, Ph.D.  
Colorado University

**Social and Economic Consequences of  
Workplace Illness and Injury**

***Disability Risk in Work-Related***

***Musculoskeletal Injuries***

Gary Michael Franklin, M.D.  
University of Washington

***Social/Economic Impact of Injury/Illness in  
Career Roofers***

Laura S. Welch, M.D.  
MedStar Research Institute

**Surveillance Research Methods**

***Occupational Surveillance Modules for Prevention***

David Bonauto, M.D., M.P.H.  
Washington Department of Labor and  
Industries

***Core Occupational Health Surveillance in  
Massachusetts***

Letitia K. Davis, Sc.D.  
Massachusetts Department of Public Health

**FY 2002 NORA Awards**

**Asthma & Chronic Obstructive  
Pulmonary Disease**

***COPD Risks in Carpenters***

David Wegman, M.D.  
University of Massachusetts

***Isocyanate Exposure Intervention Study in  
Body Shops***

Youcheng Liu, M.D., Sc.D.  
Yale University

***Longitudinal Study of Isocyanate Asthma in Body Shops***

Mark R. Cullen, M.D.  
Yale University

***Physiologic Characterization of Occupational Asthma***

Susan Sama, Sc.D.  
Harvard University

**Fertility & Pregnancy Abnormalities**

***Developmental Immunotoxicity of Atrazine***

John B. Barnett, Ph.D.  
West Virginia University

**Hearing Loss**

***Development of A School-Based Hearing Conversation Program for Use in Rural Areas***

Gregory A. Flamme, Ph.D.  
University of Iowa

***Models for Assessing Risk of Occupational Hearing Loss***

Laurence D. Fechter, Ph.D.  
University of Oklahoma

***Noise, Solvents, and Hearing Loss***

Peter M. Rabinowitz, M.D.  
Yale University

**Infectious Diseases**

***A Case-crossover Study of Sharps-related Injuries***

Murray A. Mittleman, M.D., DrPH  
Beth Israel Deaconess Medical Center

***Body Substance Exposures: Risk Factors and Psychological Impact***

Hilary M. Babcock, M.D.  
Washington University

**Musculoskeletal Disorders: Low Back**

***Lift Aid Use in Reducing Injuries in Nursing Personnel***

Paula Christine Bohr, Ph.D.  
Maryville University

***Neuro-Fuzzy Prediction of Spine Loads in Response to Risk Factors***

William S. Marras, Ph.D.  
Ohio State University

***Reducing Low-Back Disorders Using a New Sitting Design***

Mohsen Makhsous, Ph.D.  
Rehabilitation Institute of Chicago

**Musculoskeletal Disorders: Upper Extremities**

***Biomechanical Effects of Industrial Eccentric Exertions***

Robert G. Radwin, Ph.D.  
University of Wisconsin

***Computer Use and Musculoskeletal Disorders***

Carolyn P. Monteilh, M.D., Ph.D.  
Emory University

***Ergonomic Interventions for Garment Work***

Beate R. Ritz, M.D., Ph.D.  
University of California

***Musculoskeletal Stress in Repetitive Precision Tasks***

Victor Paquet, Sc.D.  
University of Buffalo

***Prevention of MSDs in Plant Nursery Work***

John A. Miles, Ph.D.  
University of California

***Upper Limb Musculoskeletal Disorders: Quantifying Risk***

Arun Garg, Ph.D.  
University of Wisconsin-Milwaukee

**Traumatic Injuries**

***Adolescent Farm Work, Fatigue and Injuries in Colorado***

Lorann Stallones, Ph.D.  
Colorado State University

***Auditory Motion and Pedestrian-Motor Vehicle Collisions***

John G. Neuhoff, Ph.D.  
College of Wooster

***Evaluation of California Initiatives to Reduce Violence in Health Care Settings***

Corrine Peek-Asa, Ph.D.  
University of Iowa

***Evaluation of Workplace Violence Prevention Intervention***

Jane A. Lipscomb, Ph.D.  
University of Maryland

### ***Organizational Factors Affecting Police Victimization***

Lorie Ann Fridell, Ph.D.  
Police Executive Research Forum

### ***Risks for Workplace Violence in Long-Haul Truckers***

Debra G. Anderson, Ph.D.  
University of Kentucky

### ***Spokane Workplace Domestic Violence Initiative***

Christopher Jay Blodgett, Ph.D.  
Washington State University

### ***Surveillance Research Methods in Construction Injury***

Judith E. Glazner, M.S.  
University of Colorado

### ***Workplace Violence Risk in the Home Health Work Place***

Jane A. Lipscomb, Ph.D.  
University of Maryland

## **Indoor Environment**

### ***Microanalytical System for Indoor VOC Monitoring***

Edward T. Zellers, Ph.D.  
University of Michigan

## **Organization of Work**

### ***Management Practices as a Factor in Workplace Violence***

Tony B. Lowe, MSW  
University of Pittsburgh

### ***Work Organizational Factors and Psychological Distress***

Omowunmi Y. Osinubi, M.D.  
University of Medicine and Dentistry of New Jersey

## **Special Populations at Risk**

### ***Biomechanics of Human Reactions to Slip Events***

Cham Dit Tham Rakie, Ph.D.  
University of Pittsburgh

### ***Biomechanics of Slips in Older Adults***

Rakie Cham Dit Tham, Ph.D.  
University of Pittsburgh

### ***Pilot Study of Ag-related Injuries Impacting Amish Community***

William E. Field, Ed.D.  
Purdue University

## **Cancer Research Methods**

### ***P53 Biomarker and Intervention in Occupational Cancer***

Paul W. Brandt-Rauf, M.D.  
Columbia University

### ***Susceptibility and Occupational Radiation Risks***

David B. Richardson, Ph.D.  
University of North Carolina

### ***Time-Factors in Exposure Effects Among Uranium Workers***

David B. Richardson, Ph.D.  
University of North Carolina

## **Control Technology and Protective Equipment**

### ***Bioelectronic Telemetry System for Firefighter Safety***

Michael Fred Masterman  
Extreme Endeavors and Consulting

### ***Control Measures for Silica Exposures for Tuckpointing***

William A. Heitbrink, Ph.D.  
University of Iowa

### ***Engineering Control of Longwall Machine Noises***

Yi Luo, Ph.D.  
West Virginia University

### ***Improved Health and Safety in Mining through Helical Drilling and Rock Bolt Anchoring***

John L. Hill, M.S.  
UTD Incorporated

### ***Integrated Stability Mapping System for Mines***

Keith A. Heasley, Ph.D.  
West Virginia University

### ***Measurements and Control of Diesel Emissions in Underground Mines***

Mingming Lu, Ph.D.  
University of Cincinnati

### ***On-Board Diagnostic Sensor for Respirator Breakthrough***

Debra J. Deiningner, B.S.  
Nanomaterials Research Corporation

### ***Use of Digital Imagery to Characterize Rock Masses***

John M. Kemeny, Ph.D.  
University of Arizona

## Exposure Assessment Methods

### *A Novel and Non-Invasive Method of Dermal Sampling for Exposure Assessment*

Samir Mitragotri, Ph.D.  
University of California

### *Biological Monitoring of Woodsmoke Exposure*

Christopher D. Simpson, Ph.D.  
University of Washington

### *Field Glove Permeation Instrumental Methods Development*

Shane Que Hee, Ph.D.  
UCLA

### *Health Effects of Occupational Exposures in PGDP Workers*

David J. Tollerud, M.D., M.P.H.  
University of Louisville

### *Improved Methods for Dermal Exposure Estimation*

Gerald B. Kasting, Ph.D.  
University of Cincinnati

### *Inhalation Dosimetry/Exposure Index of Fiber Aerosol in Human Respiratory Tract*

Yung-Sung Cheng, Ph.D.  
Lovelace Biomedical & Environmental Research Institute

### *New Methods for Evaluation of Organic Dust Aerosols-Colorado*

Stephen J. Reynolds, Ph.D.  
Colorado State University

### *Pesticide Dose Monitoring in Turf Applicators*

Shelley A. Harris, Ph.D.  
Virginia Commonwealth University

### *Predicting Relative Workload During Physically Demanding Work*

Tariq Abdelhamid, Ph.D.  
Michigan State University

### *Real-time In Situ Aerosol Monitoring in Mine Atmospheres*

Marc M. Baum, Ph.D.  
Oak Crest Institute of Science

### *Real-Time, In-Use PM Measurement from Diesel Engines*

Mridul Gautam, Ph.D.  
West Virginia University

### *Validation of Biomarkers in Humans Exposed to PAHs*

Qingshan Qu, M.D.  
New York University

## Intervention Effectiveness Research

### *Designing Ergonomic Interventions for the Fire Service*

Karen Conrad, Ph.D.  
University of Illinois

### *Effectiveness of Intervention on Health*

Lisa M. Brosseau, Sc.D.  
University of Minnesota

### *Evaluating Preassembly of Roof Structural Components*

Pamela A. Kidd, Ph.D.  
Arizona State University

### *Intervention Research on Work Organization Factors and Health*

Chantal Brisson, Ph.D.  
University of Quebec

## Risk Assessment Methods

### *Stochastic Models for Radiation Carcinogenesis: Temporal Factors and Dose-Rate Effects*

Suresh H. Moolgavkar, Ph.D.  
Fred Hutchinson Cancer Research Center

## Social and Economic Consequences of Workplace Illness and Injury

### *Unclaimed Injuries and Workers' Compensation Adequacy*

Darius N. Lakdawalla, Ph.D.  
RAND

## Surveillance Research Methods

### *Capture-Recapture Estimates of Workplace Injury Rates*

Leslie I. Boden, Ph.D.  
Boston University

### *Connecticut: Occupational Disease Surveillance Enhancement Project*

Mary Lou Fleissner, Dr.PH  
State of CO

## RFA's

In Fiscal Years 2002 and 2003, NIOSH announced the following Requests for Applications (RFAs) that target NORA-related areas of research. Note that two of the RFAs were funded collaboratively with NIH partners.

### FY 2002

- \*Mining safety related to hearing loss, particulate dust exposure, ground failure, large equipment operation, diesel exhaust exposure, and chemical hazards in mines.
- \*Hearing sensitivity and exposure to noise and/or chemicals.
- \*Exploratory/developmental grants in work organization: cardiovascular disease, work organization: depression, health care workers including violence, chronic obstructive pulmonary disease (COPD) and work, traumatic injury, hearing loss, agricultural injuries to children, and intervention effectiveness research in occupational health.
- \*Prevention and treatment of musculoskeletal disorders, funded collaboratively with the NIH's National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS).
- \*Workplace Violence Prevention Research related to risk factors and the development and evaluation of new/existing interventions (see page 28 for more information).

### FY 2003

- \*Environmental justice and building partnerships for communication, funded collaboratively with the NIH's National Institute of Environmental Health Sciences' (NIEHS) (see page 31 for more information).
- \*Childhood Agricultural Safety and Health Research for development and implementation of intervention strategies for youth, children and adolescents who are exposed to agricultural hazards. NORA targeted areas: traumatic injuries, special populations at risk, intervention effectiveness and social and economic consequences of workplace illness and injury.
- \*Community Partners program to conduct community-based pilot intervention /prevention research. NORA targeted areas: traumatic injuries, special population at risk, intervention effectiveness, and social and economic consequences of workplace illness and injury.
- \*Using exposure assessment methods to identify musculoskeletal disorders, specifically low back disorders.

## Progress in NORA Extramural Research

The following examples highlight research accomplishments in NORA priority areas made by some NIOSH-funded investigators, as well as some new NORA extramural research initiatives.

### Disease and Injury

#### Hearing Damage in Newly-Hired Construction Workers

Noise induced hearing loss, a common occupational disorder of construction workers, progresses slowly and is often undetected until hearing impairment interferes with communication and poses a safety hazard issue. NIOSH is funding a prospective study at the University of Washington to examine the exposure-response relationships for noise-induced hearing loss, particularly high-variable noise exposures found in construction. Noise exposures were monitored in newly hired con-

struction apprentices in a variety of trades to characterize the effects on hearing acuity. The study has begun to contribute to the knowledge of dose-response relationships of occupational noise exposure on cochlear function, hearing sensitivity, and noise-induced permanent threshold shifts.

### Isocyanate Asthma in Auto Body Shops

Exposure to isocyanates accounts for the highest number of reported cases of occupational asthma in developed countries. Limited knowledge of isocyanate exposure pathways and risk factors which lead to and exacerbate the disease, hinders diagnosis and prevention. Researchers at Yale University and NIOSH conducted a case-control study of auto body spray painters and co-workers exposed to hexamethyl diisocyanate (HDI) to develop a method for the diagnosis of isocyanate asthma, characterize exposure patterns and the relationship between exposure and risk for asthma development, and identify biomarkers of acquired and genetic susceptibility factors leading to improved diagnosis and prevention. Results indicate that while there was less isocyanate asthma diagnosed among auto body workers, more reports of symptoms and respiratory and immunological responses were observed. Understanding the mechanism of asthma due to chemicals could lead to strategies for control of other important causes of asthma, including factors responsible for the apparent epidemic of asthma in the United States and other developed countries.

### Occupational Traumatic Hand Injuries

Information on transient factors that exist prior to traumatic injury is limited. NIOSH funded researchers at Harvard University to conduct a case-crossover study of occupational traumatic injury to the hand, wrist, and fingers to identify and evaluate the association of these traumatic injuries to transient features of work equipment, work practices, worker-related factors, and interactions with workplace characteristics. Significant increases in the risk of traumatic hand injuries were observed due to certain work equipment, practices and environment factors such as unusual work method or task, distractions, and being rushed. These results can be used to develop specific interventions designed to reduce hand injuries.

### Endocrine Disruptors and Neurodevelopmental Outcome

Agricultural pesticides may be the most significant environmental endocrine disruptors in the United States. Although animal studies suggest that endocrine-disrupting pesticides potentially could affect neurodevelopment, no studies to date have examined these effects in humans. With support from NIOSH, researchers at the University of California, Berkeley, are conducting a prospective study of neurobehavioral function among children born to a cohort of Latino farm workers living in the Salinas Valley of California. The purpose of the study is to: 1) determine whether in utero exposure of children of women exposed to endocrine-disrupting pesticides is associated with adverse effects on the offspring's neurobehavioral development and 2) to develop appropriate interventions to reduce exposures to endocrine-disrupting pesticides.

### Workplace Violence Research Initiative

Workplace violence is a compelling safety and health problem, with 677 workplace homicides occurring in 2000. From 1993-1999, there were an estimated 1.7 million nonfatal victimizations at the workplace, accounting for 18% of all violent crime during that period. Acknowledging NIOSH's longstanding commitment to research on workplace violence, Congress appropriated \$2



million for this purpose in December 2001. Approximately \$1.8 million of these funds were targeted to support extramural research activity. In Fiscal Year 2002, NIOSH funded five new research grants that will add to the existing body of knowledge and improve the recommendations for prevention of workplace violence in various settings. Four will focus on identifying risk factors for workplace violence in four diverse occupational groups (social service workers, healthcare employees, police officers, and long-haul truckers), and the fifth will focus on research to increase the identification of domestic violence in the workplace. Also as part of the initiative, NIOSH will be conducting outreach to other federal agencies as well as a broad range of researchers, industry groups, union and worker representatives, and violence prevention groups. All projects address research priorities identified in recommendations from a workshop of experts from industry, labor, government, and academia held in April 2000. The workshop was co-sponsored by the University of Iowa Injury Prevention Research Center and NIOSH.

### Musculoskeletal Disorders in Nurses

Health care workers, especially nurses, are at increased risk for developing neck, shoulder, and back disorders. Through NIOSH funding, researchers at the University of Maryland examined the relationship between musculoskeletal disorders (MSDs) and physical work factors, as well as the effect of modifying the organization of work factors in particular work settings. Data on neck, shoulder and back MSDs were analyzed in 1,163 working nurses. It was shown that nurses performing tasks with high physical demands, such as use of force, awkward postures, and heavy lifting were more likely to experience MSDs than nurses performing tasks with low or moderate demands. In addition, individual and organizational factors were identified that affect the relationship between physical factors and MSDs. For example, modifying certain administrative procedures reduced the risk of disorders in nurses. These findings can be used to establish intervention strategies in health care and other industries.

### Symptoms of Musculoskeletal Disorders (MSDs) Among Apprentice Construction Workers

MSDs are a major cause of work-related disability and lost-time illnesses for many occupational groups. Through a cooperative agreement with NIOSH, the Center to Protect Workers' Rights (the research, development, and training arm of the Building and Construction Trades Department of AFL-CIO) gave a self-administered survey of related symptoms to apprentice construction workers in four trades in four states. A high prevalence of low back (54%) and wrist symptoms (43%) was documented which resulted in lost work time. These results have identified the need to target apprentice training programs to provide young workers prevention strategies, ergonomic education, and encouragement to seek early medical intervention to reduce chronic problems.

## Work Enforcement and Workforce

### Work Organization Factors and Life Expectancy

A study conducted by researchers at the University of Texas and jointly funded by NIOSH and the NIH's National Institute of Aging is the first to demonstrate a link between cumulative work experience in "passive" jobs and a risk of shortened life expectancy. Passive jobs were defined as those in which the individual has both few psychological demands and little job control. The study examined data from the Panel Study of Income Dynamics (PSID), an ongoing longitudinal study of a

representative sample of United States residents. The working conditions of over 8000 workers were assessed from 1968 through 1992. The study found that people who worked at jobs with little decision-making opportunities for their entire working life were 43% more likely to die than those with more of these opportunities. This effect could be seen even after adjusting for other significant stressors such as baseline health problems, retirement and periods of unemployment. In addition, the study demonstrated that for persons in passive jobs with low psychosocial demands and low control for their working life, the increased risk was 35% and could continue for up to 10 years after leaving the job. Another key finding is that income does not contribute to the worker's short-term mortality experience.

### [Impact of Low-Emission Diesel Engines on Underground Mine Air Quality](#)

Diesel exhaust, a complex mixture of noxious gases and diesel particulate matter, is classified as a potential carcinogen. Exposure to diesel exhaust is especially problematic in underground mines, where large diesel engines are used with minimal ventilation. To reduce emissions, some mine operators are adopting low-emission diesel engines and fuel with low sulfur content. NIOSH funded researchers at Michigan Technological University to investigate whether adoption of this new technology could inadvertently introduce new occupational health hazards. After measuring mass concentration, chemical composition, and physical characteristics of diesel particulate matter in an underground mine, it was concluded that electronically controlled, low-emission, low-sulfur engines significantly reduced levels of diesel particulate matter and other potentially hazardous components of diesel exhaust, without causing adverse health effects. This research has broad application for reducing occupational exposure to diesel emissions.

### [Assessing the Effectiveness of Pesticide Training for Adolescent Migrant Farmworkers](#)

Historically, both traditional agricultural youth activities and health/safety training programs for adult farmworkers often neglect the teen farm worker population. With NIOSH support, the University of California at Berkeley's Labor Occupational Health Program and its partners are assessing the effectiveness of training programs, specifically studying the effect of teaching teen farmworkers about agricultural health and safety through school-based ESL (English as a Second Language) classes. This study primarily focuses on Latino adolescent farmworkers living in California's San Joaquin Valley, and will focus on evaluating whether (1) exposure to an existing school-based curriculum increases agricultural safety and health knowledge among young farmworkers and (2) whether community-based curriculum increases these outcomes. Intervention findings from this study will be integrated into ESL curriculum with the intention of decreasing potential work-related illness and injury among adolescent migrant farmworkers through targeted occupational safety and health training in the classroom.

### [Extended Work Schedules and Health Outcomes](#)

Data from the Bureau of Labor Statistics (BLS) show that the proportion of persons working more than 40 hours per week increased during the 1990s. The National Sleep Foundation reports that in year 2000 Americans slept less, worked more, and spent less time to conduct leisure activities than ever before. Extended work schedules may result in adverse health outcomes, yet limited scientific evidence exists to support this hypothesis. NIOSH is funding researchers at the University of Alabama to assess the relationship between overtime work and worker health and

safety in various industries, controlling for other risk factors such as existing medical conditions and lifestyle choices. A nationally representative sample will be used from the Medical Expenditure Panel Survey. Results may be useful for the prevention of specific occupational safety and health hazards on a regional or national basis.

### Environmental Justice and Special Populations

NIOSH has joined the NIH's National Institute of Environmental Health Sciences (NIEHS) in a grant solicitation focusing on environmental justices and special populations. The purpose of this program is to strengthen the support of NIEHS and NIOSH for research aimed at achieving environmental justice for socioeconomically disadvantaged and medically underserved populations in the United States. The program is meant to promote health research, education, and intervention programs that will improve ways to serve low income, immigrant, and minorities who may be disproportionately exposed to environmental and occupational hazards.

## Research Tools and Approaches

### Surveillance Research Methods: State Cancer Registries

State cancer registries provide useful surveillance data on the incidence and mortality of cancers identified in state populations, but their usefulness in evaluating cancer incidence for occupational cohorts is relatively unexplored. With NIOSH support, the Minnesota Department of Health evaluated the use and limitations of record linkage between occupational cohort studies and the state cancer registry as a method for occupational cancer surveillance. Results demonstrated that statewide cancer registry data can be used to evaluate the incidence of cancer in two occupational cohorts.

### Methods for Developing and Testing Aerosol Samplers

Respiratory allergies and infections due to airborne microorganisms can result in workers taking more sick days, causing economic loss due to reduced productivity. The quality of exposure assessment for bioaerosol identification and concentrations present in agricultural, industrial, and indoor environments depends on the type and efficiency of the sampling method or instrument used. Funded by NIOSH, researchers at the University of Minnesota developed a sampling technique to collect microorganisms using an electrostatic field that maintains biological integrity for further evaluation. Collection efficiency and viability compared favorably with that of other collection methods in various indoor and field environments. This new method can be applied in occupational environments where airborne microorganisms are naturally present or released during the industrial processes.

### Exposure Assessment Methods: Biomarkers of Smoke Exposure Among Firefighters

A self-contained breathing apparatus, or SCBA, is standard protective equipment for firefighters. However, it is often not used during the cleanup "overhaul" phase of fighting a fire. Limited data are available about the types and levels of exposures to combustion products during the overhaul stage, and the potential health effects. NIOSH supported at the University of Arizona to characterize the types of contaminants present during overhaul, and assess the use of biomarkers to detect and measure acute pulmonary effects in firefighters after overhaul. Results demonstrated that fire-

fighters' exposures during this phase have potential to result in acute health effects, and also indicated that cartridge respirators were not effective in protecting firefighters from smoke exposure and adverse respiratory effects during overhaul activities.

### Personal Aerosol Sampler for Occupational Environments

With funding from NIOSH, researchers at the University of Cincinnati have developed a personal aerosol sampler with low sensitivity to ambient wind conditions, such as wind speed and direction. Additional funding provided by NIOSH was used to evaluate the sampler's performance in occupational environments contaminated with airborne dust and microorganisms, including seven species of bacteria and fungi. Airborne particles were used from different sources and with different characteristics such as size distribution, concentration, and chemical composition. For example, metal exposure was assessed among abrasive blasting workers at four U.S. Air Force Bases and among workers performing lead abatement in indoor environments. The assessment showed that the sampler can be successfully used in occupational environments to assess worker exposures. A new simplified protocol also was developed for testing at low cost personal aerosol samplers in small wind tunnels.

## **The Future of NORA**

NIOSH has begun a process to evaluate NORA. In March 2003, NIOSH leadership and the NORA Team Leaders created a foundation for an evaluation process. During 2003, NIOSH will take the opportunity at a number of scheduled conferences to gather input on ways to evaluate NORA and the shape of NORA's future. The June NORA Symposium, for example, will include a panel discussion and a working session on the past and future of NORA. During 2004, NIOSH will undertake a formal process for stakeholder input on both topics: an evaluation of NORA's effectiveness through 2002 and the future course of NORA.

## **NORA Milestones**

### **July 1995 - June 2003**

#### **NORA Development**

- July 1995 . . . . . NIOSH commits to lead the creation of a research Agenda for occupational safety and health
- September 1995 . . . . . Agenda framework developed and 50 potential topics identified by an initial working group of internal and external scientists
- November 1995 . . . . . First National public meeting convened to provide input into the Agenda and discuss criteria for priorities
- January 1996 . . . . . Four additional working groups (NIOSH, external researchers, health professionals, other stakeholders) expand and prioritize research areas
- February 1996 . . . . . Three town meetings (Boston, Chicago, and Seattle) convened
- March 1996 . . . . . Second national public meeting held to review the draft Agenda
- April 1996 . . . . . Final Agenda unveiled - The National Occupational Research Agenda identified 21 priority research areas to guide occupational safety and health research (released on NIOSH's 25th Anniversary)

#### **NORA Implementation Year 1**

- November 1996 . . . . . Partnership teams formed for each priority area to implement NORA
- February 1997 . . . . . First ever survey conducted of federal (non-NIOSH) resources (FY 1996) committed to occupational safety and health research
- July 1997 . . . . . First NORA Implementation Symposium held at the National Academy of Sciences, Washington, D.C.  
  
NORA Update 1997 document released

#### **NORA Implementation Year 2**

- November 1997 . . . . . Congress appropriated \$5 million for the implementation of NORA
- Jan-Feb 1998 . . . . . Three NIH Institutes each contributed \$1 million to NORA research Priorities
- March 1998 . . . . . NIOSH and NIH partners announced a Request for Applications (RFA) for the largest ever funding for targeted occupational safety and health research (\$8 million)  
  
American Association of Occupational Health Nurses and the American College of Occupational and Environmental Medicine established a joint research award, giving emphasis to NORA in the selection criteria

- April 1998 . . . . .NORA logo created
- May 1998 . . . . .NORA and the asphalt partnership both selected as semifinalists (two of 100 semifinalists; two of 19 federal semifinalists) for the Ford Foundation and Harvard University's 1998 Innovations in American Government Awards Program from an initial pool of 1,420 applicants
  - First issue of the NORA newsletter, NORA News, distributed
  - NORA Web site mounted
- July 1998 . . . . .NORA Update 1998 document released
- September 1998 . . . .Asphalt research partnership selected as one of 25 finalists in the 1998 Innovations in American Government awards program First private sector funds (Aetna U.S. Health Care) leveraged for NORA research (musculoskeletal disorders project)

### **NORA Implementation Year 3**

- October 1998 . . . . .First NORA research grants announced-50 grants totaling \$8 million make up the single largest infusion of funding ever by the federal government for extramural investigator-initiated occupational health and safety research
  - NIOSH received permission to trademark the NORA logo
  - Congress continued to provide support for NORA through an \$11 million appropriation in the FY 1999 NIOSH budget
- February 1999 . . . . .The President's FY 2000 budget proposal to Congress included \$12 million for NORA to support both intramural and extramural research and related activities
- March 1999 . . . . .Second survey of federal (non-NIOSH) resources (FY 1998) committed to occupational safety and health research conducted Liaison Committee conducted two surveys to determine the effectiveness and reach of NORA among associations and private industry
  - NIOSH/NIH invited NORA grant applications for FY 1999 (\$9 million)
- April 1999 . . . . .NIOSH/EPA/NCI announced RFA for \$1.5 million for research focusing on the development of cancer risk assessment methods and practices
- May 1999 . . . . .NORA Update 1999 document released
  - First NORA Partnering Award For Worker Health and Safety awarded to the Asphalt Research Partnership
  - NORA Symposium 1999: Partnership for Research held at the National Academy of Sciences, Washington, D.C.

NIOSH announced a cooperative agreement with the Association of Schools of Public Health to solicit applications for intervention effectiveness research.

NIOSH announced an RFA to fund research on intervention Effectiveness

August 1999 . . . . . NIOSH/NIH invited applications through a general program announcement (PA) for research in the 21 NORA priority areas

NIOSH/NCI/NIEHS announced a PA on research methods for occupational cancer

NIOSH announced the availability of approximately \$500,000 in grants to train occupational health services researchers

### **NORA Implementation Year 4**

October 1999 . . . . . NIOSH awarded \$5.4 million in grant funds for 23 projects in seven NORA areas

November 1999 . . . . . Congress continued to provide support for NORA through a \$11.3 million appropriation in the FY 2000 NIOSH budget

NIOSH/NIEHS and five other NIH partners announced a \$5 million RFA to stimulate new research on risk disparities among special Populations

February 2000 . . . . . The President's FY 2001 budget proposal to Congress included \$4.9 million to support research under NORA

March 2000 . . . . . NIOSH announced RFAs for intervention effectiveness (\$1.2 million); surveillance research (\$2.5 million); exploratory research in allergic and irritant dermatitis, social and economic consequences of workplace injury and illness, health services research, and fertility and pregnancy abnormalities (\$1 million); agriculture-related injuries to children (\$1.6 million) and musculoskeletal disorders (\$0.9 million).

April 2000 . . . . . NIOSH/EPA/NIEHS announced a \$5 million RFA on mixed Exposures

May 2000 . . . . . NORA Update 2000 document released

June 2000 . . . . . NIOSH/NIH/EPA announced a \$6 million RFA on endocrine disruptors and adverse health effects in humans, particularly on reproductive and development effects

December 2000 . . . . . Congress continued to provide support fro NORA through a \$9.2 million appropriation in the FY 2001 NIOSH budget

### **NORA Implementation Year 5**

February 2001 . . . . . NIOSH announced RFAs for traumatic occupational injury research (\$1 million); extended work schedules (\$1 million); and reproductive/develop-

- mental toxicants (\$2 million)
  - Third survey of Federal (non-NIOSH) resources (FY 2000) committed to occupational safety and health research conducted
- March 2001 . . . . . NIOSH announced training grants for occupational injury prevention (\$1 million)
- April 2001 . . . . . NIOSH celebrated its 30th Anniversary
  - NORA marked its fifth year
  - The President's FY 2002 budget proposal to Congress included \$1 million to support research under NORA
- June 2001 . . . . . NORA Symposium 2001: Leading Research in Occupational Safety and Health held in Washington, D.C.
  - Second NORA Partnering Award for Worker Health and Safety awarded to Oregon for "A Strategic Plan for Reducing Occupational Dermatitis in Oregon." Partners in Alaska were awarded Honorable Mention for "Crab Related Respiratory Illness in Dutch Harbor, Alaska."
  - NORA Update 2001 document released
- September 2001 . . . . . Terrorist attacks on the World Trade Center and the Pentagon
- October 2001 . . . . . (and November) . . . Envelopes containing B. anthracis spores were mailed to news media companies and government officials, leading to the first bioterrorism-related cases of anthrax in the United States
  - NIOSH announced RFAs for mining safety related to hearing loss, particulate dust exposure, ground failure, large equipment operation, diesel exhaust exposure, and chemical hazards in mines (\$900,000); hearing sensitivity and exposure to noise and/or chemicals (\$1 million); and exploratory research in work organization: cardiovascular disease, work organization: depression, health care workers including violence, chronic obstructive pulmonary disease and work, traumatic injury, hearing loss, agricultural injuries to children, and intervention effectiveness research in occupational health (\$3.2 million)
  - NIOSH/NIAMS announced a \$2 million RFA on the prevention and treatment of musculoskeletal disorders
  - NIOSH received \$5 million in emergency supplemental funding to enhance initiatives on emergency worker safety, including research.
- December 2001 . . . . . Congress provided support for NORA through a \$2 million appropriation for NIOSH-funded Education and Research Centers to expand research in support of NORA implementation and \$2 for a workplace violence research initiative in the FY 2002 NIOSH budget



## NORA Implementation Year 6

May 2002 . . . . . NIOSH announced a RFA for workplace violence prevention research, as part of the FY 2002 Workplace Violence Initiative (\$1.8 million)

October 2002 . . . . . NIOSH/NIEHS announced a \$2 million RFA on environmental justice and building partnerships for communication

## NORA Implementation Year 7

February 2003 . . . . . Due to budget constraints, NIOSH does not receive new Congressional appropriations for NORA in the FY 2003 budget

March 2003 . . . . . NIOSH announced a RFA for Childhood Agricultural Safety and Health Research for development and implementation of intervention strategies for youth, children and adolescents who are exposed to agricultural hazards (\$1 million). NORA targeted areas included traumatic injuries, special populations at risk, intervention effectiveness and social and economic consequences of workplace illness and injury.

April 2003 . . . . . NIOSH announced RFAs for the Community Partners program to conduct community-based pilot intervention /prevention research with NORA targeted areas of traumatic injuries, special population at risk, intervention effectiveness, and social and economic consequences of workplace illness and injury (\$850,000); and using exposure assessment methods to identify musculoskeletal disorders, specifically low back disorders (\$500,000).

June 2003 . . . . . NORA Symposium 2003: Working Partnerships: Research to Practice held in Crystal City, VA

Third NORA Partnering Award for Worker Health and Safety awarded to BJC Health Care, BJC Occupational Health Nurse Council, Washington University, West Virginia University, Arjo, Inc., EZ Way, Inc., and NIOSH for "Evaluation of a Best Practices Back Injury Prevention Program in Nursing Homes"

NORA Update 2003 document released



*NORA stimulates new research needed to address the problem of workplace injuries and illness. A framework to guide occupational safety and health research. Consisting of 21 research priorities. Developed from input from ~500 organizations and individuals outside of NIOSH. A collaborative effort between NIOSH and its many partners to guide and promote research. Helping NIOSH focus its intramural research and fund new extramural projects.*

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