

SECOND DECADE IN REVIEW | 2006–2016



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National Occupational Research Agenda: Second Decade 2006–2016

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FOREWORD

I am pleased to deliver this comprehensive report on the second decade of the National Occupational Research Agenda (NORA). Launched by NIOSH in 1996, NORA shows how public and private partnerships can chart the course for occupational safety and health to reduce injury and illness and improve workplace practices and policies.

The second decade of NORA was designed to answer a fundamental question: How can research be better moved into practice in the workplace?

To respond to that challenge, the second decade of NORA focused on 10 industry sectors representing major areas of the U.S. economy. NORA developed 10 broad stakeholder partnerships, called sector councils, which set priority research goals for the nation.

This report chronicles the activities, effectiveness, outcomes, and impacts of a decade of work by NIOSH and our NORA partners. Impact stories highlight the result of NORA activities and their influence on the health, safety, and wellbeing of the U.S. workforce. The report concludes by discussing the results of partnership and research-to-practice activities during the decade. The supplement to this report provides program-specific results on the work of each of the 10 NORA sectors and 24 NIOSH programs (known as cross sectors), which were developed by NIOSH to support the NORA sector program goals and objectives.

This review represents a tremendous effort across NIOSH and our stakeholders. I acknowledge the leadership of Dr. Sarah Felknor, the NORA Evaluation Team, and many other NIOSH contributors who helped make this review of a decade of work possible. I also acknowledge the contributions of our stakeholders and the public in collecting stories of impact and making recommendations for the future.

NIOSH sector and cross-sector programs provided critical leadership and support of the second decade of NORA goals and activities, and we gratefully acknowledge their contributions. Together, the NIOSH program leadership and NORA sector councils created the fabric that made NORA such a success. The appendices of this report list the NIOSH program leadership and NORA sector council members whose contributions made the second decade of NORA such a success.

As we look to 2026 and beyond, we hope this report and supplement informs the plans and structure of the next 10 years of successful partnerships to address the most pressing needs and do the most important work to protect the U.S. workforce.

John Howard, MD
Director, National Institute for Occupational
Safety and Health
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ABBREVIATIONS

AAMI	Association for the Advancement of Medical Instrumentation
AATCC	American Association of Textile Chemists and Colorists
ACOEM	American College of Occupational and Environmental Medicine
AFF	Agriculture, Forestry and Fishing
AIHA	American Industrial Hygiene Association
ANSI	American National Standards Institute
ASABE	American Society of Agricultural and Biological Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASSE	American Society of Safety Engineers
ASTM	American Society for Testing and Materials
BLS	Bureau of Labor Statistics
CDC	Centers for Disease Control and Prevention
CON	Construction
DLO	Divisions, Laboratories, and Offices
DOL Wage Hour	Department of Labor—Wage and Hour Division
DOL WC Program	Department of Labor—Office of Workers' Compensation Programs
DOT FMCSA	Department of Transportation, Federal Motor Carrier Safety Administration
ENG	Engineering Controls
EPA	Environmental Protection Agency
FY	Fiscal Year
HHE	Health Hazard Evaluation
DHHS	U.S. Department of Health and Human Services
HRQL	Health-related Quality of Life
HSA	Healthcare and Social Assistance
ICP-MS	Inductively coupled plasma mass spectrometry
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
ISA	International Society of Automation
LOA	Letter of Agreement
MIN	Mining
MIO	Oil and Gas Extraction
MNF	Manufacturing
MOU	Memorandum of Understanding
MSD	Musculoskeletal Disorders
MSHA	Mine Safety and Health Administration

NAN	Nanotechnology
NIOSH	National Institute for Occupational Safety and Health
NORA	National Occupational Research Agenda
NAICS	North American Industry Classification System
NFPA	National Fire Protection Association
NMFS	National Marine Fisheries Service
OECD	Organization for Economic Cooperation and Development
OSH	Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
NTEA	National Truck Equipment Association
r2p	Research to Practice
SPS	Public Safety
STEPS	National Service, Transmission, Exploration & Production Safety (STEPS) Network
SVC	Services
TAPPI	Technical Association of the Pulp and Paper Industry
TWH	Total Worker Health®
TWU	Transportation, Warehousing and Utilities
UL	Underwriters Laboratory
WHO	World Health Organization
WRT	Wholesale and Retail Trade

DEFINITIONS

All Sectors: Classification for NIOSH research that applies to most, if not all sectors. NIOSH catalogs and tracks most of its research (including outputs and outcomes) by the most closely associated one or two NORA sectors. However, some research inherently relates to most or all industries, such as some occupational health disparities research, so NIOSH's sector classification for that research or output is "All Sectors."

Intermediate Outcome: Actions by stakeholders in response to NIOSH products or efforts (such as making policy changes; producing standards or regulations; adopting NIOSH-developed technologies; using publications, technologies, methods, or recommendations by workers, industry, and occupational safety and health professionals in the field; and citing NIOSH research by industry and academic scientists.)

End Outcome: Improvements in safety or health in the workplace that can be attributed to NIOSH efforts—specifically, reducing work-related injuries, illnesses, or deaths or reducing hazardous exposures in the workplace.

Impact: A collective term used to refer to both intermediate and end outcomes. Impacts can be qualitative (a success story) or quantitative (an increase or decrease in a numerical indicator). They can occur at any scale, ranging from a single workplace to the local, state, or national level.

NIOSH: Federal safety and health institute in the Department of Health and Human Services, Centers for Disease Control and Prevention, responsible for generating new knowledge in the field of occupational safety and health and transferring it into practice globally. To accomplish this mission, NIOSH does scientific work that includes research, field investigations, surveillance, and authoritative recommendations.

NIOSH Cross-Sector Program: Internal program established and managed by NIOSH to coordinate its research and partnership efforts associated with a topic area that has application across many or most industrial sectors. Each cross-sector program sets priorities for NIOSH research and develops relationships with academic, government and private stakeholders interested in their topic area. Cross-sector programs are organized into health and non-health outcome areas to support the sectors in accomplishing their goals for the nation and coordinate priorities that affect multiple sectors. The health outcome cross-sectors represent the major occupational safety and health issues faced by workers, and non-health outcome cross-sectors represent research methods, approaches and core activities such as surveillance, hazard exposure, interventions, information dissemination and statutory programs.

NIOSH Sector Program: Internal program established by NIOSH to coordinate its research and partnership efforts associated with each of 10 defined NORA sectors. Each sector program sets priorities for NIOSH research and develops partnerships with academic, industry, labor, and government stakeholders related to those industries.

NIOSHTIC-2: A searchable bibliographic database of occupational safety and health publications, documents, grant reports, and other communication products supported in whole or in part by NIOSH.

NORA: Partnership program to stimulate innovative research and improved workplace practices. Established by NIOSH in 1996, NORA has provided a research framework in occupational safety and health for NIOSH and the nation. NORA participation is broad, including stakeholders from universities, large and small businesses, professional societies, government agencies, and worker organizations. These diverse parties collaborate to identify the most critical issues in workplace safety and health.

NORA Sector: Industry group based on business sector definition in the North American Industry Classification System (NAICS), organized into [NORA Sectors](#) based on similarities they face in workplace safety and health issues.

NORA Sector Council: Partnership volunteers that represent a broad range of stakeholders in one of the 10 NORA sectors. Councils meet to set goals for the nation, develop strategies, encourage partnerships, and promote improved workplace practices in their sector. NIOSH facilitates their work.

BACKGROUND

At the end of each decade of the National Occupational Research Agenda (NORA), NIOSH reviews the contributions of the decade toward improving the occupational safety and health of workers and transferring new knowledge into practice. This review was designed to assess the contributions across three main domains during the second decade: (1) research, (2) sector programs, and (3) partnerships and Research to Practice (r2p). Within each domain, NIOSH assessed the activities, effectiveness, outcomes, and impact. This report includes two documents: the *NORA Second Decade in Review Report*, and the *Sector and Cross-Sector Program Supplement*.

Purpose and Scope

The review of the second decade of NORA was guided by a multidisciplinary team at NIOSH and was designed to assess the overall investment, approach, and impact of the decade.

The review set about to answer three fundamental questions:

1. What did we do? (Activities and Outputs)
2. How well did we do it? (Effectiveness)
3. What were the outcomes and impacts? (Outcomes and Impact)

This review informs funding agencies, stakeholder groups, policy makers, employers and employees, and other occupational safety and health organizations and thought leaders. The results of this review will also shape the next decade of NORA by sharing lessons learned and building on the many successes and impacts of the second decade.

Methods

The second decade review assessed activities, effectiveness, and impact across three main domains: (1) research, (2) sector programs, and (3) partnerships and r2p. NIOSH used a mixed methods approach to answer the key evaluation questions with data collected from a broad stakeholder base with qualitative and quantitative measures. Sources included NIOSH research investment and output data, cross-sectional surveys of key informants, collection of impact stories from programs, public comment, and altmetrics describing the reach of NIOSH's work beyond the traditional scientific measures of publications and citations.

The NIOSH Office of Planning, Policy and Evaluation provided project data. The NIOSH Office of Research to Practice provided partnership data. The data collection period for research project counts and investment was FY2007–FY2015, and for other outcomes of interest it was FY2007–FY2014.

NORA sector council data was obtained from a survey of current and former council members for whom current contact information was available. A total of 407 sector council members were invited to participate in the survey and 215

HEALTHCARE DRUGS

NIOSH recommendations to reduce healthcare workers' exposures in preparing and administering hazardous drugs helped healthcare facilities improve their procedures, as well as helped lead to a new law to protect workers in Washington state.

WORK-RELATED CANCER

NIOSH studies of work-related cancer deaths provided information that helped the International Agency for Research on Cancer to classify additional chemicals as known human carcinogens.

LONG-HAUL TRUCKERS

NIOSH surveyed long-haul truck drivers, finding unhealthy weights and long work hours. The research contributed to improved work conditions, including updated Hours of Service regulations at the Federal Motor Carriers' Administration and wellness programs at private companies.

BODY MEASUREMENTS

NIOSH work with industry partners to improve truck-driver safety by compiling accurate body measurements of truck drivers led to some manufacturers using these measurements to redesign their truck cabs.

completed surveys were returned for a 53% response rate. Companion surveys were administered to the NIOSH sector and cross-sector programs. Ten NIOSH sector programs responded (100%) and 20 cross-sector programs responded (83%).

Limitations

Three main limitations apply to this evaluation design: (1) the data collection period was from FY2007–FY2015 for research project counts and investment, and the period was from FY2007–FY2014 for other outcomes of interest, providing 8–9 years of data of the decade; (2) the cross-sectional nature of the survey design limits the generalizability of the results because of the chance of selection bias in self-reported questionnaires; and (3) data is incomplete for certain outcome measures, including the bibliometric, altmetrics, and partnership data. Publication and citation counts likely represent an under-reporting of the true numbers because not all publications are found in available data sources. Coding of projects to a particular sector was also limited, and only those attributions that could be unambiguously identified are reported. These limitations are noted in the relevant sections of the report, and they likely cause the true impact achieved during the decade to be underestimated.

EXECUTIVE SUMMARY

The Second Decade of NORA

The second decade of the National Occupational Research Agenda (NORA) launched in 2006. It was built on a well-established and successful partnership program to stimulate innovative research and improve workplace practices. Begun in 1996, NORA provides a research framework in occupational safety and health for NIOSH and the nation. Diverse parties collaborate with NIOSH to identify the most critical issues in workplace safety and health. These partners work together to develop goals and objectives to address specific, recognized needs through innovative research. Subsequent research applies to putting practices and actions into place. Varied groups participate in NORA, including stakeholders from universities, large and small businesses, professional societies, government agencies, and worker organizations.

The second decade of the National Occupational Research Agenda (NORA) focused on 10 industry sectors representing major areas of the U.S. economy. The agenda was designed to answer a fundamental question that shaped the activities and structure of the second decade:

How can research be better moved into practice in the workplace?

In response to that question, the 10 NORA sectors developed broad stakeholder partnerships known as sector councils, and they set priority research goals for the nation. NIOSH established 10 internal sector programs to respond to and support the work of the NORA sectors. Together, the NORA sector councils and NIOSH sector programs identified and addressed the most pressing needs in occupational safety and health in major U.S. industry sectors and economic areas.

The 10 sectors of the decade were:

- | | |
|-------------------------------------|---|
| ■ Agriculture, Forestry and Fishing | ■ Public Safety |
| ■ Construction | ■ Services |
| ■ Healthcare and Social Assistance | ■ Transportation, Warehousing and Utilities |
| ■ Manufacturing | ■ Wholesale and Retail Trade |
| ■ Mining | |
| ■ Oil and Gas Extraction | |

Activities and Outputs

Activities of the second decade include research, NORA sector council and NIOSH sector program activities, and activities related to partnerships and r2p. Highlights of these activities are provided here. Please see the [research](#), [sector programs](#) and [partnerships](#) sections in this report for a full discussion of activities.

TALKING SAFETY

The NIOSH “Talking Safety” curriculum helps many organizations and school systems teach students about work safety. For example, Oregon State University uses Talking Safety to teach 4H summer school students basic workplace safety and health skills, and Florida and Oklahoma use Talking Safety in their schools.

PPE FIT RESEARCH

NIOSH research to improve the design and fit of personal protective equipment informs manufacturers of respirators for healthcare workers, gear for firefighters, and fall protection harnesses for construction workers.

WINCH SAFETY

Building on NIOSH partnerships to protect commercial fishermen from entanglement and death in winches on fishing vessels, all three major manufacturers of capstan winches in the Pacific Northwest now provide NIOSH-developed emergency E-Stops as standard safety features on their new seine winches. Captains are installing the system, and NIOSH has created a training video with real commercial fishermen who promote winch and deck safety awareness.

An average of 740 active NIOSH projects per year during the decade applied to one or more NORA sectors. Active NIOSH projects per year remained relatively stable in number across the decade, with a high of 839 active projects in FY2010 ranging to a low of 616 active projects in FY2015.

NIOSH invested an average of \$243.8 million per year in NORA research projects during FY2007–FY2015. Funding supported intramural projects that were carried out by NIOSH scientists working with partners, and extramural projects by researchers outside of NIOSH. These projects addressed 95% of NORA strategic goals.

More than 10,450 publications were developed through NIOSH-funded research during FY2007–FY2014. Intramural and extramural researchers described the results of their research in a variety of publications. Journal articles were the most numerous publication type produced during the decade, with 5,504 published articles, followed by 1,650 NIOSH publications, 1,213 abstracts, and 644 conference proceedings.

Central to the national occupational research agenda was the sector structure that included external NORA sector councils comprising key stakeholder partners and the NIOSH sector program, which provided scientific and program support to sector activities to advance the national agenda.

All 10 sectors developed a national agenda, and all of the NIOSH sector programs developed external partnerships. Sector activities included participating in NORA sector council meetings, developing sector agendas and other products, and creating partnerships.

NORA sector council membership included government, industry, academia, labor/union, occupational safety and health professional associations, and other research organizations. Nine of ten (90%) of NORA sector councils had federal, state, or local government partners and industry or corporations; 80% had academia represented; 70% had labor/union and occupational safety and health professional association members; and 60% had membership from other research organizations.

NORA sector council members leveraged NIOSH investment. Council members contributed individual financial resources ranging from up to \$1,000 per year (33%); to \$1,001 to \$5,000 per year (29%); to more than \$5,000 per year (17%).

NIOSH sector programs generated more than 10,000 individual products during the second decade. These products include NORA sector research agendas; scientific or technical publications; and newsletters, brochures, web pages and fact sheets. Trade journal publications, videos for stakeholder use, and social media programs were also products of the second decade.

Partnerships were a fundamental hallmark of the second decade of NORA and critical to the r2p initiative. Partners collaborated in planning and conducting research and other efforts to improve safety and health in workplaces.

More than 2,000 partnerships were formed and 285 formal partnership agreements created during the second decade of NORA, greatly enhancing the reach of NIOSH activity. Throughout the second decade of NORA, NIOSH

had both formal and informal partnerships to advance occupational safety and health. Partners provided access to workplaces, carried out interventions in special-emphasis populations, and disseminated safety and health training materials.

Effectiveness

Effectiveness of the second decade assesses how research aligns to NORA strategic goals, how effectively sector councils meet goals and objectives, and how partnerships align with strategic goals. This report offers examples that highlight effectiveness in the second decade of NORA. The [research](#), [sector programs](#), and [partnerships](#) sections later in this report discuss NORA's effectiveness.

During the second decade, 95% of the NORA strategic goals were addressed by NIOSH research projects in the intramural and extramural programs. The 10 NORA sectors had a total of 106 strategic goals during the decade, and research projects addressed 101 (95%) of these goals. Strategic goals were addressed in all sectors, except for Oil and Gas, which had one goal that was not addressed, and Healthcare and Social Assistance, which developed five goals in FY2013 that were implemented in FY2014 at the end of the reporting period. Projects during the data collection period addressed one of these five new goals.

The most effective aspect of the NORA sector council's activities during the decade was developing the national research agenda and goals, followed by the stakeholder involvement that marked the second decade of NORA.

Stakeholders saw the sector structure as an effective way to organize the second decade of NORA. NIOSH sector program leaders gave input on the effectiveness of the sector structure, and a clear majority (80%) said the sector structure was an effective way to organize the second decade.

Effectiveness of partnerships and r2p was measured in terms of "reach" and "beyond reach." NIOSH's work in developing new knowledge and transferring that knowledge into practice was an indicator of reach. The use, adoption, or adaptation of NIOSH information was an indicator that went beyond reach.

One measure of reach is found in the number of formal collaborations with partners that were aligned with the NIOSH strategic goals (2010–2015) [NIOSH 2014]. Partners included industry, government, international and non-governmental organizations, academia, professional associations, and trade and labor groups.

NIOSH strategic goals were advanced by 285 formal partnership agreements during the second decade.

- Strategic Goal 1: "Conduct research to reduce work-related illnesses and injuries" was advanced by 180 partner agreements.
- Strategic Goal 2: "Promote safe and healthy workplaces through interventions, recommendations and capacity building" was advanced by 89 partner agreements.
- Strategic Goal 3: "Enhance international workplace safety and health through global collaborations" was advanced by 16 formal partner agreements.

LADDER SAFETY APP

NIOSH developed the Ladder Safety Smartphone Application (more than 50,000 downloads by the end of 2015). Workers with smartphones can easily download the application (app) on the job site and use it to help them position ladders at the correct angle to prevent serious fall injuries.

EXPLOSIBILITY METER

An instrument company commercialized the NIOSH Coal Dust Explosibility Meter (CDEM) to evaluate coal mine dust samples in real-time to help keep coal dust levels below concentrations that can pose the risk of combusting and propagating a methane explosion. The Mine Safety and Health Administration's approved this meter in 2011.

RESPIRATOR DATA

Respirator manufacturers and academicians use NIOSH data on representative face and head sizes and shapes in the modern workforce when designing, sizing, and testing new respirator facepieces.

AIRCRAFT VENTILATION

Based on NIOSH studies, several universities collaborated on or conducted independent research on aircraft cabin ventilation and potential disease transmission to better understand and address flight crews' risk for infection.

News articles mentioned NIOSH more than 2,700 times, trade publications mentioned NIOSH more than 350 times, and NIOSH publications had more than 980 mentions. Another measure of reach is how many times nonscientific publications mention NIOSH, which expands the reach outside of the research community into workplaces and professional associations. These numbers indicate that NIOSH information and outputs reach the public.

Outcomes and Impact

NIOSH defines impact to be an intermediate or end outcome (see logic model in Figure 1). In the NORA logic model, intermediate outcomes occur when someone outside of NIOSH uses NIOSH outputs. End outcomes are improvements in workplace safety and health. Highlights of the outcomes and impact from the decade are given here. The [research](#), [sector programs](#), and [partnerships](#) sections later in this report discuss impact. See also [Appendix A](#) for selected impact statements of the second decade of NORA.

A total of 4,819 scientific journal articles were cited 89,035 times during the decade. Citations of NIOSH-funded scientific journal articles were identified through the Scopus database, which tracks publications and their citations.

Authors in 164 countries cited NIOSH work. One measure of the impact of NIOSH work is demonstrated by its reach across the world. An analysis of the three top-cited publications shows 5,712 citations by authors in 164 countries. Countries with the highest number of citations were (in order of number citations): the United States, United Kingdom, China, and Germany.

NIOSH numbered publications had more than 1.2 million electronic downloads and 2.7 million hard copies distributed during the decade. Data showed 722 NIOSH numbered publications were requested in hard copy or downloaded electronically. NIOSH publications were downloaded 1,215,979 times, and 2,750,061 hard copies were distributed. The sector with the most publications was Mining, with 150 publications, 66,227 downloads, and 62,194 hard copies. Healthcare and Social Assistance had the most electronic downloads at 288,458, and Agriculture, Forestry and Fishing had the most hard copies distributed at 1,509,384.

The impact of NIOSH research is seen in five major areas. These impacts are evidence that NIOSH work is translated into the workplace to protect the health and safety of the workforce. The Research Activities, Effectiveness, Outcomes, and Impact sections in this report highlight impacts across the decade. These impacts include the following:

- **Setting standards, guidance, and policy**—NIOSH studies of work-related cancer deaths provided information that helped the International Agency for Research on Cancer classify more chemicals as known human carcinogens.
- **Recommendations impact manufacturers, trade associations, and others**—NIOSH research to improve the design and fit of personal protective equipment informs manufacturers of respirators for healthcare workers, gear for firefighters, and fall protection harnesses for construction workers.
- **Technology adopted**—NIOSH developed the Ladder Safety Smartphone Application (downloaded more than 50,000 times by the end of 2015).

Workers with smartphones can easily download the application on the job site, helping them position ladders at the correct angle to prevent serious fall injuries.

- **NIOSH research builds knowledge base**—NIOSH scientists invented a way to suspend carbon nanotubes in air while controlling the concentration of particles. This a true breakthrough, because it was the first time a well-characterized controlled aerosol of carbon nanotubes had been generated, providing a resource for studies on these minute particles whose properties and characteristics are not well understood.
- **NIOSH outputs widely disseminated**—NIOSH recommendations for Prevention through Design (PtD) were promoted by textbook publishers, the Occupational Safety and Health Administration, the American Industrial Hygiene Association, the American Society of Safety Engineers, the Transportation Research Board, and others in textbooks and engineering education modules.

The NIOSH YouTube channel had more than 1,100 subscribers, and 138 NIOSH video clips had been viewed a total of more than 288,000 times as of June 2015. The social media reach of NIOSH helps disseminate occupational safety and health information through nontraditional communications channels that further extend the reach of NIOSH work.

Highlights in every sector of the most impactful research of the decade. The word cloud below portrays the high impact story narrative of the second decade of NORA. Evidence of the impact achieved during the second decade of NORA is illustrated through selected impact stories featured in this report and the accompanying supplement.

Sector programs addressed the most pressing needs, resulting in improved workplace safety or leading to the adoption of improved workplace practices.



Most NORA sector council members said their research agenda targeted the most critical issues within their sectors. About half of the NORA Sector Council members reported the agenda led to improved safety and workplace practices. Highlights of research impact from each of the 10 sectors follow.

FALL STRATEGIES

Researchers and professional societies used NIOSH-generated knowledge and simulation methods to develop innovative and practical strategies to prevent falls. These strategies include developing and deploying graded lumber and the incorporating a plywood/sheeting overlay on the planks to provide the minimum weight protection as required by OSHA. The New Jersey Turnpike Authority adopted the method in 2009 and has since added contract language specifications for temporary catch platforms for contractors bidding on related projects.

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NORA SECTORS (2006–2016)



Agriculture, Forestry and Fishing

[Pesticide Poisoning Monitoring Program Protects Farmworkers.](#) NIOSH alerted authorities in Florida and North Carolina about new birth defects cases using monitoring program data. North Carolina created a task force whose findings motivated the state legislature to pass anti-retaliation and recordkeeping laws, training mandates to protect the health of agricultural workers, and funding for improved surveillance. The Florida state legislature provided funding to add 10 new pesticide inspectors.

Construction

[Contractors Participate in National Falls Campaign and Safety Stand-down.](#) NIOSH, OSHA, The Center for Construction Research and Training, and their partners started a national campaign to prevent fatal falls from roofs, ladders, and scaffolds. Currently, more than 7,000 construction employers and more than 2.5 million construction employees participate in campaign events.

Health Care and Social Assistance

[Online Training Helps Protect Nurses and Others from Workplace Violence.](#) The NIOSH online training course offers free training designed to meet the needs of today's generation of workers. From the time the course became available in August 2013 through December 2015, about 14.9 thousand people completed the course. Most healthcare professionals earned education credits. Healthcare facilities and nursing schools are evaluating whether the course is adaptable for ongoing educational offerings.

Manufacturing

[Wind Blade Manufacturer Reduces Styrene Exposures.](#) A company identified potential styrene over-exposures for some workers and requested

PTSD WORK GUIDANCE

The U.S. Department of Veterans Affairs and other veterans' organizations disseminated NIOSH information on return-to-work issues for veterans with Post Traumatic Stress Disorder.

IMMIGRANT WORKERS

The American Society of Safety Engineers and other construction partners and stakeholders disseminated a NIOSH trade journal article on culturally meaningful and effective safety training of Latino immigrant workers.

PTD WIDELY USED

NIOSH recommendations for prevention through design were promoted by textbook publishers, the Occupational Safety and Health Administration, the American Industrial Hygiene Association, the American Society of Safety Engineers, the Transportation Research Board, and others in textbooks and engineering education modules.

NIOSH assistance. Afterward, the company made changes that eliminated the need for workers to enter the confined space inside of the wind turbine blade while using styrene. Styrene exposures were reduced by an order of magnitude.

Mining

Underground Mine Communications Systems Improved through Research. The MINER Act of 2006 required mines to have wireless communications and electronic tracking systems. NIOSH conducted needed research to allow quick installation of workable systems. About 35% of companies that installed systems in the United States selected one of the NIOSH-developed communication systems. NIOSH support helped develop improved technologies.

Oil and Gas Extraction

Identification and Control of Silica Exposures during Hydraulic Fracturing. In field studies during hydraulic fracturing operations, NIOSH identified a previously unrecognized hazard exposure to silica dust. Industry responded positively and immediately to the NIOSH recommendations that stemmed from the field study. A national workgroup formed to enact the recommendations and promoted them throughout the industry.

Public Safety

Preventing Firefighter Deaths through Investigations. NIOSH found that self-contained breathing apparatus (SCBA) facepiece failures from high heat and flame exposure contributed to a number of firefighter fatalities. NIOSH participation on the National Fire Protection Association (NFPA) Technical Committee on Respiratory Protection Equipment led to a revised standard to help protect firefighters.

Services

Reducing Worker Disease and Death from Spray-on Truck Bed Liner Applications. NIOSH sampling methods were adopted by international standards organizations, so risks of over-exposure to methylene bisphenyl isocyanate (MDI) can be detected and corrective actions taken. A NIOSH Alert helped inform an influential industry organization of the dangers, and it provided proven improvements for spray-on truck bed liner operations. It also provides an important information source on the organization's extensive safety-related website.

Transportation, Warehousing and Utilities

Security Cameras Reduce Taxi Driver Homicides. NIOSH studied the effectiveness of cameras and partitions in taxicabs to reduce the driver homicide rate. NIOSH found cameras reduced homicides, but partitions did not. The NIOSH studies are on an external partner's website that provides resources for taxi driver safety and other issues. They also informed a 2014 letter from the Philadelphia Fraternal Order of Police to the city's taxicab regulatory agency urging approval of an ordinance requiring cameras in cabs. Philadelphia

adopted the improved safety equipment, and New Orleans and Montreal also made changes in light of the NIOSH results.

Wholesale and Retail Trade

Retail Stores Reach for Safety. NIOSH took a business-to-business approach in a series of three workshops to introduce retailers to manufacturers of devices willing to consider design changes to reduce overexertion injuries of employees in grocery stores. The workshops and a NIOSH ergonomic document led to a dozen of the industry-leading retail chains contracting with different device providers to use, modify, or develop equipment.

The Third Decade of NORA

The third decade of NORA launched on October 1, 2016, and it builds on the many successes and lessons learned from the first two decades of this unique partnership approach to setting the research course for occupational safety and health. The guiding questions that will frame the work of the third decade will be:

What research should be done in 2020 and beyond?

Can an efficient and effective structure be found to identify and integrate research priorities?

NORA enters the third decade with an enhanced structure. The 10 sectors formed for the second decade will continue to prioritize occupational safety and health research by major areas of the U.S. economy. Seven cross-sectors will also be organized according to the major health and safety issues affecting the U.S. working population.

The national agenda in the third decade will be developed and implemented through the [NORA Sector and Cross-Sector Councils](#). Diverse partners will come together and identify critical issues in workplace safety and health. Partners will develop broad strategic objectives for research to address those needs.

NIOSH will use key criteria related to burden, need, and impact to identify priorities and align investment in the third decade to ensure that NIOSH does the most important work to protect the health and safety of the workforce.

More will be revealed as the decade unfolds, and this review of the second decade of NORA will help inform the direction and scope of the next 10 years of doing the most important work to protect the health and safety of the workforce.

More information is provided in this report and accompanying supplement on the accomplishments of the second decade of the National Occupational Research Agenda.

NANO BREAKTHROUGH

NIOSH scientists invented a way to suspend carbon nanotubes in air while controlling the concentration of particles. This was a true breakthrough because it was the first time a well-characterized controlled aerosol of a carbon nanotube had been generated, providing a resource for studies on these minute particles, whose properties and characteristics are not well understood.

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NATIONAL OCCUPATIONAL RESEARCH AGENDA: NIOSH AND NORA

NIOSH

The National Institute for Occupational Safety and Health (NIOSH) conducts research and makes recommendations to prevent worker injury and illness. Created under the Occupational Safety and Health Act of 1970 (Public Law 91-596), NIOSH is part of the U.S. Centers for Disease Control and Prevention, in the U.S. Department of Health and Human Services. NIOSH has the mandate to assure “every man and woman in the nation safe and healthful working conditions and to preserve our human resources.” NIOSH has more than 1,300 employees from diverse fields, including epidemiology, medicine, nursing, industrial hygiene, safety, psychology, chemistry, statistics, economics, and many branches of engineering. NIOSH works closely with the Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA) in the U.S. Department of Labor.

NIOSH provides national and world leadership through science to prevent work-related illness, injury, disability and fatalities. NIOSH’s mission is to generate new knowledge in the field of occupational safety and health and to transfer that knowledge into practice to prevent worker injury, illness, and death. To accomplish this mission, NIOSH conducts scientific research, develops methods to prevent occupational hazards, develops guidance and authoritative recommendations, translates scientific knowledge into products and services, disseminates information, identifies factors underlying work-related disease and injury, and responds to requests for workplace health hazard evaluations [National Research Council 2009; NIOSH 2010, 2013a]. NIOSH has a breadth of activities that include: (1) surveillance, (2) research, and (3) technology transfer. NIOSH actively involves partners and stakeholders to achieve activities and goals.

Research at NIOSH

NIOSH funds both internal and external research studies. Intramural (internal) research, including surveillance, is conducted by multidisciplinary NIOSH scientists within divisions, laboratories, and offices (DLOs) of the institute. The NIOSH DLOs are organized around research approaches and fields of study, and they report to the NIOSH Office of the Director. The NIOSH extramural (external) research program includes a diverse portfolio of multidisciplinary research and training that is organized into priority areas to address the most pressing occupational safety and health issues. These portfolios include mechanisms such as investigator-initiated research projects, mentored research scientist career development awards, cooperative research agreements, conference grants, and small business innovation research projects.

CLEANING CHEMICALS

OSHA collaborated with NIOSH to develop and disseminate information on choosing and using cleaning chemicals to reduce risks of chemical burns, rashes, asthma, and other adverse effects.

NANO RESEARCH USED

Other organizations, including the Occupational Safety and Health Administration, National Institutes of Health and American College of Occupational and Environmental Medicine (ACOEM) helped disseminate information about NIOSH research and recommendations for minimizing exposures in the manufacturing and industrial use of nanomaterials, as well as conducting health surveillance of workers.

NIOSH GUIDANCE

Stakeholders learned about NIOSH guidance from other organizations, including the Occupational Safety and Health Administration, National Nanotechnology Initiative, National Institutes of Health, Massachusetts Labor and Workforce Development, Safe Work Australia, National Institute of Environmental Health Sciences, and American Chemistry Council.

Research to Practice

The Research to Practice (r2p) efforts at NIOSH focus on transferring scientific knowledge, interventions, and technology into effective workplace prevention practices and products evaluations [National Research Council 2009; NIOSH 2010, 2015a, 2015b]. This initiative consists of NIOSH collaborations with external partners to identify research needs, design and conduct studies, translate research knowledge into workplace practice, develop effective products, and target dissemination efforts. The overall goals of r2p are to reduce workplace injuries, illness, and fatalities, and to make NIOSH’s occupational safety and health research more relevant to stakeholders. The r2p initiative is integrated into the breadth of NIOSH research activities.

NORA

The National Occupational Research Agenda (NORA) is a partnership program to stimulate innovative research and improved workplace practices [NIOSH 2013b]. Begun in 1996, NORA has provided a research framework in occupational safety and health for NIOSH and the nation. Diverse parties collaborate with NIOSH to identify the most critical issues in workplace safety and health. These partners work together to develop goals and objectives to address specific, recognized needs through innovative research and subsequent r2p actions. A broad variety of groups participates in NORA, including stakeholders from universities, large and small businesses, professional societies, government agencies, and worker organizations. These partners work alongside NIOSH researchers.

NORA is structured in 10-year program cycles and entered the third decade in 2016. Near the end of each decade, the program is evaluated and the results inform the next decade of NORA.

The First Decade (1996–2006)

More than 500 individuals and organizations in the research and occupational safety and health community participated in setting priorities for the first decade of NORA (1996–2006). No previous occupational research agenda had captured such broad input. During this decade, NORA focused on 21 priority areas in the field of occupational safety and health to address these fundamental questions: What will the workplace of 2006 look like? What research will be needed to ensure a safe and healthy workplace? The focus areas of the first decade of NORA were grouped under the general categories of (a) Disease and Prevention, (b) Work Environment and Workforce, and (c) Research Tools and Approaches.

Disease and Prevention

- | | |
|--|---------------------------|
| Allergic and Irritant Dermatitis | Infectious Diseases |
| Asthma and Chronic Obstructive Pulmonary Disease | Low Back Disorders |
| Fertility and Pregnancy Abnormalities | Musculoskeletal Disorders |
| Hearing Loss | 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

This initial structure of the first decade of NORA consisted of a NORA Liaison Committee and 20 NORA Research Teams. Twenty-two people participated on the Liaison Committee with the focus of facilitating communication with stakeholders, recruiting research team participants, and recognizing potential research opportunities in the above-identified priority areas. In addition, 20 NORA teams were formed to develop a research agenda for their priority area and distribute new research, targeting these essential workplace safety and health areas.

The Second Decade (2006–2016)

Based on a review of the first decade of NORA, the program entered its second decade in 2006 with a new structure based on industry sectors to better move research to practice within workplaces. The second decade of NORA sought to answer this fundamental question: How can research be better moved into practice in the workplace? In response to that challenge, 20 business sectors in the United States as defined by the North American Industry Classification System (NAICS) were organized into industry sectors based on similarities in the workplace safety and health issues they faced. The second decade of NORA consisted originally of 8, and later 10, sector groups organized around major areas of the U.S. economy.

NORA Sectors

Agriculture, Forestry and Fishing Sector (AFF) comprises establishments primarily engaged in growing crops, raising animals, harvesting timber, and harvesting fish and other animals on a farm, ranch, or from their natural habitats.

Construction Sector (CON) comprises establishments that build or renovate roads, houses, workplaces, and utilities.

Healthcare and Social Assistance Sector (HSA) comprises such establishments as offices of physicians and other healthcare providers, hospitals, nursing and residential care facilities and social assistance establishments providing individual and family services, community food and housing and emergency services, vocational rehabilitation services, and child day-care services.

SAFE-IN-SOUND

Industries shared their innovative noise programs with NIOSH and partners as part of the Safe-in-Sound award to identify and disseminate best practices.

NIOSH PRODUCTS USED

The Occupational Safety and Health Administration, Department of Homeland Security, Environmental Protection Agency, World Health Organization and other stakeholders have adopted or promoted use of many NIOSH products, including Fast Facts cards, Alerts, Workplace Solutions documents and topic pages covering different hazards.

NSC HELPS WITH R2P

The National Safety Council (NSC) collaborated on an r2p (research to practice) track at the annual NSC conference and on other efforts to disseminate NIOSH products and information.

HEALTHCARE SURVEY

Healthcare professional practice organizations partnered with NIOSH to develop and market a web-based survey of healthcare workers. This gave respondents FAQs, tabular, and chart presentations of example results, and links to health and safety information germane to the healthcare sector.

Manufacturing Sector (MNF) comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products.

Mining Sector (MIN) comprises establishments that conduct or support coal mining, metal ore mining, and nonmetallic mineral mining and quarrying.

Oil and Gas Extraction Sector (MIO) comprises establishments that explore for crude petroleum and natural gas; drill, service and operate wells; and prepare oil and gas for shipment from the producing property.

Public Safety Sector (SPS) comprises establishments engaged in corrections, emergency medical services, firefighting, and law enforcement.

Services Sector (SVC) comprises establishments that provide education; accommodations and food; professional, scientific, and technical expertise; financial and insurance services; administrative support and waste management; public administration (excluding military services and public safety) and other services.

Transportation, Warehousing and Utilities Sector (TWU) comprises establishments that transport passengers and cargo whether by air, water, rail, ground or pipeline; warehouse or store goods; and service, treat, or distribute electric power, natural gas, steam, water, and sewage.

Wholesale and Retail Trade Sector (WRT) comprises establishments involved with retail or wholesale sales of merchandise, generally without transformation, and rendering services incidental to the sale of merchandise.

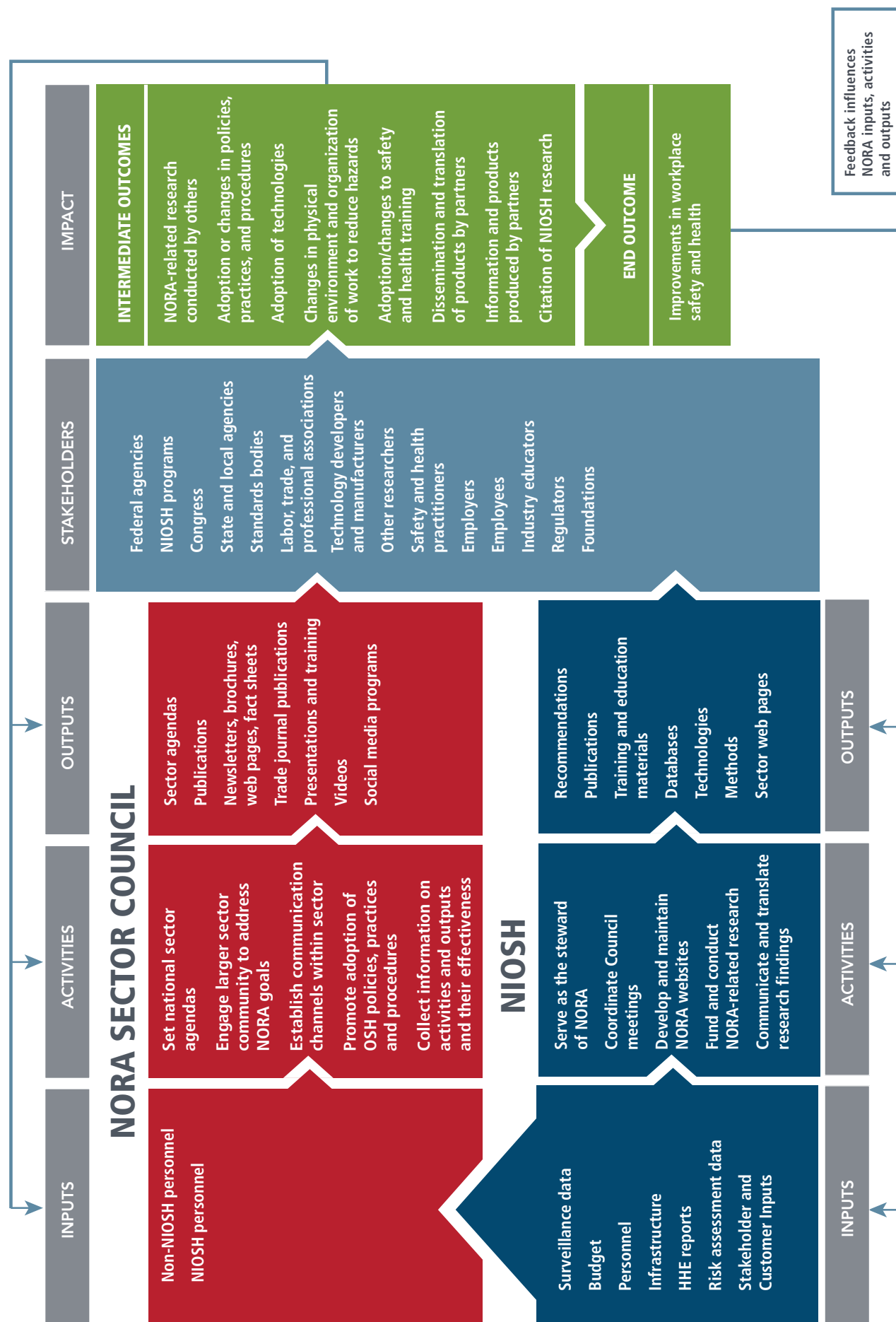
NORA Sector Councils

During the second decade, each NORA sector established an external council that was made up of diverse stakeholders within the NORA sector and NIOSH researchers. The councils identified and promoted priority research needs, critical knowledge needed to fill gaps in occupational safety and health, and innovative partnerships within the sectors [NIOSH 2010]. In particular, each council developed and implemented for the nation sector-based research goals, called the national sector agenda. The collection of these national sector agendas became the agenda for the nation for improvements in occupational safety and health through research and partnerships. As a part of the agenda, NORA sector councils established research goals and strategies, encouraged partnerships and new research collaborations outside of NIOSH, and advocated for improved workplace practices [NIOSH 2013b]. NORA sector councils also identified opportunities to maximize impact through partnerships by promoting widespread adoption of improved workplace practices. Additional information about the national sector agendas is on the NIOSH website page, [“The National Occupational Research Agenda”](#) [NIOSH 2013b].

NORA Logic Model

Figure 1 depicts a logic model for the second decade of NORA, providing a concise description of this initiative. The logic model displays resources (inputs) and activities involved in implementing the second decade of NORA. Activities lead to products (outputs), which are intended to be used by stakeholders and

Figure 1. NORA Sector Council inputs, outputs, and activities



FARM HEARING SAFETY

Multiple influential organizations worked with NIOSH to develop and disseminate brochures and other educational materials to promote hearing conservation on farms.

NY SAFETY PROGRAM

The NIOSH-funded New York Fatality Assessment and Control Evaluation program led to new worker protections in the state.

customers to make changes (intermediate outcomes) that lead to improved occupational safety and health (end outcomes).

Aspects associated with NORA councils are in red, and those directly related to NIOSH programs are in dark blue. Both NORA councils and NIOSH programs contribute to intermediate and end outcomes, shown in light blue. Program activities and outputs are varied, ranging from dissemination of educational materials to the development of sector agendas, new products, and research studies. The overall aim of the second decade of NORA is to improve workplace safety and health by conducting quality research to address the most pressing problems and moving workplace solutions into practice.

NIOSH's Role in NORA

NIOSH serves as the steward of NORA, facilitating the work of NORA participants. The Institute invests both financial and staff resources into NORA, and it determines how to address NORA goals and objectives when developing new research projects. NIOSH also leads planning and evaluations of NORA decades. NIOSH reviewed NORA's first decade in 2005 [NIOSH 2006], and this report reviews the second decade [NIOSH 2016].

NIOSH Sector Programs

During the second decade of NORA, NIOSH sector programs were established representing each NORA sector area. The NIOSH programs focused on facilitating NORA sector councils' work. The programs encourage high-priority NIOSH research in their sector based on the national sector agenda created by the NORA sector council and other inputs. The programs oversee quality research-to-practice initiatives and development of partnerships to improve workplace safety and health practices. The NIOSH sector programs also tracked impacts and outcomes of NIOSH research projects and partnerships that addressed NORA national goals. NIOSH sector programs consisted of NIOSH staff who served as internal program leadership and, typically, a steering committee of other interested NIOSH scientists. NIOSH sector program leaders typically also served as members of the NORA sector councils.

NIOSH Cross-Sector Programs

During the second decade, NIOSH organized internal cross-sector programs that represented the major occupational safety and health outcomes in the United States. The NIOSH cross-sector programs supported the core activities, methodological approaches, special emphasis areas, and mandates that were central to NIOSH's work. Although not officially part of the structure of the second decade of NORA, the NIOSH cross-sector programs were organized to support the sectors in accomplishing their goals for the nation and to coordinate priorities that affect multiple sectors. NIOSH cross-sector programs established strategic priorities based on the national sector agendas and other inputs.

The 21 cross-sector programs included in this report of the second decade were the following:

- **Authoritative Recommendations Program**—oversees the development, distribution, and evaluation of NIOSH documents and communication products that contain official recommendations and other policy statements.
- **Cancer, Reproductive and Cardiovascular Diseases Program**—coordinates research and other activities related to many types of occupational cancer, reproductive health, and cardiovascular disease as well as the evolving areas of occupational neurologic and renal disease.
- **Economics Program**—promotes the understanding of economic factors that affect worker safety and health, the economic outcomes of worker injury and illness, and the prevention opportunities that provide the most impact for the least cost.
- **Emergency Preparedness and Response Program**—coordinates research and collaborations to protect the health and safety of emergency-response providers and recovery workers by preventing diseases, injuries, and fatalities in anticipation of and during responses to natural and man-made disasters and novel emergent events. It started the decade as a coordinating program but has become an established office in NIOSH.
- **Engineering Controls Program**—develops and promotes adopting feasible and effective control solutions to protect workers by applying a hierarchy of controls.
- **Exposure Assessment Program**—develops and promotes effective approaches to identify and characterize workplace exposures and to evaluate the significance of exposure.
- **Global Collaborations Program**—contributes to the reduction of occupational diseases, injuries, and fatalities among all workers employed in the United States and globally through cultivating international partnerships and sharing of pertinent information.
- **Health Hazard Evaluation (HHE) Program**—responds to requests from employers, employees and their representatives, and government agencies; conducts investigations, if necessary; and disseminates the results to protect worker health.
- **Hearing Loss Prevention Program**—conducts research and develops practical solutions to reduce the prevalence of occupational hearing loss.
- **Immune and Dermal Diseases Program**—conducts research and develops solutions to reduce occupational irritant and allergic contact dermatitis, allergic rhinitis, work-related asthma, infectious diseases, and absorption of harmful chemicals through the skin.
- **Musculoskeletal Disorders Program**—conducts research and develops approaches to reduce disorders of the nerves, tendons, muscles, and supporting structures of the upper and lower limbs, neck, and lower back that are caused, precipitated, or exacerbated by sudden exertion or prolonged exposure to physical factors, such as repetition, force, vibration, or awkward posture.
- **Nanotechnology Program**—conducts research and promotes adoption of approaches to reduce adverse effects of exposures to materials containing structures with a length scale below 100 nanometers.

FLOTATION DEVICES

A NIOSH collaboration with the U.S. Coast Guard led to the fishing industry improving practices for personal flotation devices and hatch monitors.

SEA WORKER SAFETY

NIOSH research led to the National Marine Fisheries Service opening a Notice of Proposed Rulemaking in April 2011 to protect workers at sea (Standard 10 Guidelines).

LABELING FOR VETS

NIOSH work contributed to a drug manufacturer's improved product labeling for veterinarians, livestock farmers, and other workers to avoid unintended, potentially lethal self-injection when administering an animal antibiotic.

TRAFFIC SAMPLE PLANS

NIOSH sample traffic-control plans for road-construction areas contributed scientific information to federal and state training modules and best practice guidelines.

- **Occupational Health Disparities Program**—conducts surveillance and identifies research methods, intervention approaches, and dissemination tools to better reach vulnerable populations of workers.
- **Personal Protective Technology Program**—conducts research and promotes practices to support the development and use of personal protective equipment worn by individual workers to reduce the effects of their exposure to a hazard.
- **Prevention through Design Program**—promotes approaches to eliminate hazards and minimize risks early in the design or redesign process and incorporate methods of safe design into all phases of hazard and risk mitigation.
- **Respiratory Diseases Program**—conducts research and promotes solutions to reduce work-related airways diseases, interstitial lung diseases, infectious respiratory diseases, and respiratory malignancies.
- **Small Business Assistance and Outreach Program**—works to reduce occupational illnesses, injuries, and hazardous exposures in small enterprises through a focused program of research, prevention efforts, and public health activities.
- **Surveillance Program**—tracks occupational injuries, illnesses, hazards, and exposures over time and promotes efforts to improve worker safety and health based on the results.
- **Total Worker Health® Program**—advocates policies, programs, and practices that integrate protection from work-related safety and health hazards with promotion of injury and illness prevention efforts to advance worker wellbeing.
- **Traumatic Injury Program**—conducts research and promotes effective prevention activities to reduce the incidence of worker injuries and deaths due to trauma, defined as an injury or wound to a living body caused by the application of external force or violence.
- **Work Organization and Stress-Related Disorders Program**—conducts research and promotes effective solutions to reduce occupational stress, diseases, injuries, and fatalities in the workforce by addressing risk factors related to how jobs are designed and performed.

These sector and cross-sector programs do not represent the totality of NIOSH's work during the second decade of NORA. Additional NIOSH programs that were outside of the sector and cross-sector structure included: Climate Change Initiative; Direct Reading and Sensor Technologies; Maritime Safety and Health; Motor Vehicle Safety; Productive Aging and Work; Safe, Skilled, Ready Workforce Initiative; Translation Research; and Worker's Compensation Studies. Many of these programs contributed to the accomplishments of the second decade of NORA, and they are described in this report and the accompanying supplement. For a full understanding of the breadth and depth of NIOSH programs, please see the [Program Portfolio at NIOSH](#).

Partnerships

During the second decade of NORA, the NIOSH programs, NORA sector councils and individual NIOSH researchers established partnerships with other individuals and groups in the occupational safety and health field. Partnership

activities included identifying national research needs, designing and conducting research studies, translating research knowledge into workplace practices, developing effective products, and disseminating products and information. These alliances increase the relevance of NIOSH research to stakeholders in the field of occupational safety and health, which helps to reduce workplace injuries, illness, and fatalities.

DIAGRAMS HELP SAFETY

NIOSH diagrams for blind areas in road construction areas helped improve worker safety.

FALLS CAMPAIGN

NIOSH launched the National Construction Falls Campaign with the Occupational Safety and Health Administration and The Center for Construction Research and Training to decrease fall-related injuries among construction workers.

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THE BURDEN OF OCCUPATIONAL INJURY, ILLNESS AND FATALITY

The economic burden of worker injury and illness provides context for NIOSH investment in occupational safety and health research over the decade.

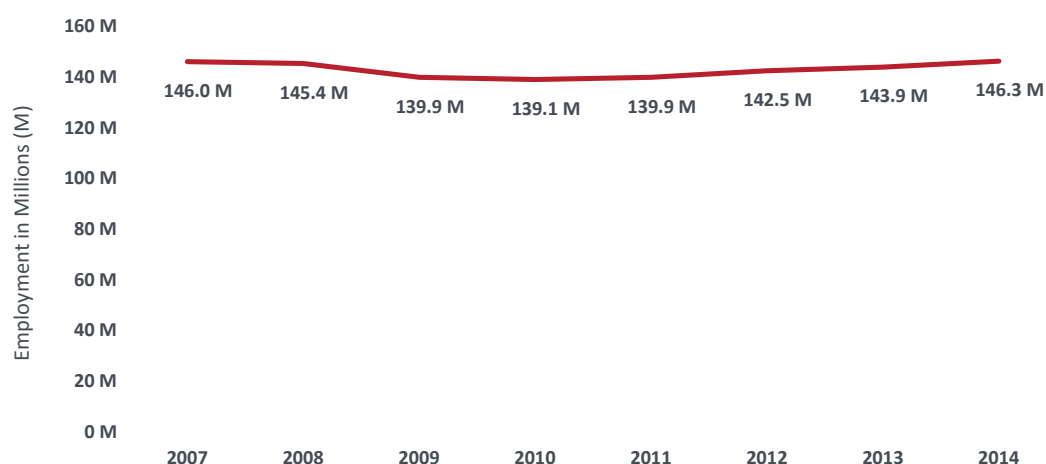
The societal cost of occupational fatalities, injuries, and illnesses was estimated at \$250 billion in 2007, based on methods focused on medical costs and productivity losses [Leigh 2011]. Using similar methods, preliminary unpublished NIOSH estimates show that this cost was about \$211 billion in 2013. After adjusting for inflation and extrapolating, **the average annual cost in the period from 2007 through 2015 was about \$246 billion in 2015 dollars, or a total of about \$2.215 trillion for the entire 9-year period.**

NIOSH-supported economic research helps to identify the causes of the economic burden of worker injury and illness, quantify the broad consequences of this burden using different economic methods and metrics, and identify the most cost-effective interventions.

National Trends in Employment, Injuries and Illnesses

Employment data provide estimates of the working population potentially at risk of workplace exposures and hazards. Work-related fatality, injury, and illness estimates show evidence of the burden of occupational causes. National trends in employment, injury, illness, and fatalities are displayed for 2007 through 2014. Employment data show a decrease during the recession that started in 2008 but indicate an overall steady level. The fatality data and injury and illness data show an overall decreasing trend that has existed for several decades. These decreases are due to the combined efforts of employers, workers, federal agencies, insurance companies, unions, trade associations, professional associations, international organizations, and others. Sector-specific trends are shown in the discussion of individual sectors, in the NIOSH Sector and Cross-Sector Program Supplement to this report.

Figure 2. Employment trends for all NORA sectors (2007–2014)



Current Population Survey (CPS) provided employment data that includes private industry and government (federal, state, and local) and the self-employed (but not volunteers) [BLS 2015a].

NAIL-GUN SAFETY

NIOSH work contributed scientific information to training and literature designed to prevent nail-gun injuries among construction workers.

COUNCIL ADOPTS PTD

NIOSH work with the U.S. Green Building Council to improve worker safety during and after building construction led to the council adopting the Prevention through Design approach.

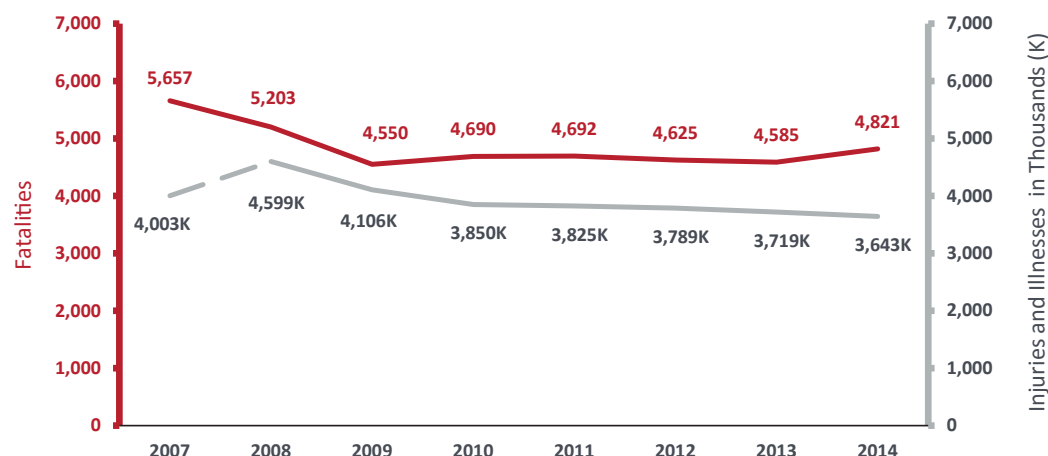
SCBA REQUIRED

NIOSH studies of firefighter exposures to gases, vapors, and particles led fire crews to require self-contained breathing apparatus worn throughout firefighting.

FIREFIGHTER PPE

A NIOSH study of the size of current firefighters provided fire apparatus and personal protective equipment manufacturers with data for updating their designs.

Figure 3. Fatality and injury or illness trends for all NORA sectors (2007–2014)



The [Census of Fatal Occupational Injuries](#) (CFOI) provided fatality data from private industry and government (federal, state, or local), including volunteers and those self-employed [BLS 2015b]. [Survey of Occupational Injuries and Illnesses](#) (SOII) provided injury and illness data from private industry and state and local government (but not federal government), excluding volunteers and those self-employed. Only private industry data were available before 2008 [BLS 2015b].

NIOSH Work to Reduce the Burden

The total burden of work-related injuries and illnesses is measured by their broad impact on society. This impact extends beyond the number of reported work-related injuries and illnesses, or the cost of workers' compensation claims for medical treatment and wage replacement. Improving our understanding of the total burden of work-related injuries and illnesses is increasingly important. Demand continues to grow for evidence that shows how investing in worker safety and health helps workers, employers, and society. To articulate this evidence, we need to understand the true scale of the burden, as well as how the burden is distributed. We also need to know how efforts to prevent work-related injuries and illnesses may reduce the burden, which includes understanding who benefits and by how much.

Selected examples of impactful economic research supported by NIOSH in the second decade of NORA included the following:

Allocating scarce healthcare resources requires a knowledge of disease costs. Estimates from 2007 reported 5,600 fatalities at a cost of \$6 billion. Nearly 8.6 million workplace injuries occurred at a total cost of \$186 billion. The number of fatal illnesses was estimated at 53,000, with nonfatal occupational illnesses estimated at more than 427,000. Fatal illnesses were estimated to cost \$46 billion and nonfatal illnesses were estimated to cost \$12 billion. The total estimated costs were about \$250 billion, compared with the inflation-adjusted cost of \$217 billion for 1992. Workers' compensation covered less than 25% of these costs, so all members of society shared the burden [Leigh 2011].

Using data from the National Health Interview Survey, NIOSH found that workers with access to paid sick leave (PSL) were 28% less likely than workers without access to paid sick leave to be injured at work. The association

varied across sectors and occupations. Introducing or expanding paid sick leave programs might help businesses reduce the incidence of nonfatal occupational injuries [Asfaw et al. 2012].

Two studies examined the consequences of reported mistreatment at work, which in 2010 involved 7.6% of U.S. workers. The first study concluded that being mistreated was associated with a 42% increase in the number of lost workdays. Therefore, workplace mistreatment was associated with \$4.1 billion (5.5%) of sickness absenteeism costs in 2010 [Asfaw et al. 2014]. The second study concluded that the estimated Health-related Quality of Life (HRQL) score was 77.8 for mistreated workers and 87.1 for workers who did not report mistreatment. Assuming HRQL=100 as perfect health status, workplace mistreatment was associated with a 72% greater health deficit [Ray et al. 2014]. Together, these studies revealed the economic importance of developing workplace mistreatment prevention strategies.

The consequences of occupational injuries for the health of family members have rarely been studied. Researchers hypothesized that nonfatal occupational injury would increase the incidence and costs of hospitalization among workers' families, and that family members of severely injured workers would experience greater increases in hospitalizations than family members of non-severely injured workers. Family hospitalizations were measured by the incidence of hospitalization of at least one family member. Among families of all injured workers, the odds of at least one family member being hospitalized were 31% higher in the 3 months following occupational injury than in the 3 months preceding the injury. Among the families of severely injured workers, the odds of hospitalization were 56% higher in the 3 months following injury. Hospitalization costs were found to rise by about the same percentage as hospitalization incidence [Asfaw et al. 2012].

Researchers explored the relationship between occupational injury and musculoskeletal disorders (MSD) among family members of injured workers. Family members of severely injured workers had a 15% increase in the total number of MSD outpatient claims and a 34% increase in the mean cost of MSD claims compared with family members of non-severely injured workers within 3 months after an injury. Extrapolating costs to the national level implied that severe occupational injury would be associated with between \$29 million and \$33 million additional cost of family member outpatient MSD claims [Asfaw et al. 2015].

Occupational hearing loss, primarily caused by high noise exposure, is the most common U.S. work-related illness. During 2003–2012 and across all industries, 2.53 healthy years were lost annually per 1,000 noise-exposed workers. Mild impairment accounted for 52% of all healthy years lost and moderate impairment accounted for 27%. Mining sector workers lost 3.45 healthy years per 1,000 workers, and construction sector workers lost 3.09 healthy years per 1,000 workers. Overall, 66% of the sample worked in the manufacturing sector and represented 70% of healthy years lost by all workers. This was the first known study to quantify the disability-adjusted life years attributable to hearing impairment for noise-exposed U.S. workers, and to estimate the prevalence at each level of hearing impairment by sector [Masterson et al. 2016].

SHIP BUILDING SAFETY

A NIOSH project to protect workers from hearing loss led to the shipbuilding industry using its training and recommendations.

STYRENE EXPOSURE

NIOSH work to protect workers from exposure to the chemical styrene led a wind blade manufacturer to change its design, reducing exposure during a procedure known as glue wiping.

SAFETY STAND-DOWN

NIOSH, OSHA, CPWR—the Center for Construction Research and Training, labor, and industry partnered on a National Safety Stand-Down To Prevent Falls in Construction in 2014 and again in 2015. These events gave guidance and resources for preventing painful, disabling, or fatal fall injuries. About 1 million workers and 25,000 businesses participated.

A study linked nonfatal injury cases reported to the New Mexico workers' compensation system for 1994–2000 with Social Security Administration data on individual earnings and mortality through 2014. The estimated mortality hazard ratio for lost-time injuries is 1.26 for women and 1.21 for men, suggesting that lost-time occupational injuries might substantially increase mortality risk. A substantial income effect was also evident. For both women and men, the hazard ratio in the lower income groups was elevated when compared with the higher income groups. Women earning less than \$10,000 per year had 1.94 times the mortality hazard as women earning at least \$50,000 per year. For men, this ratio was 2.37 [Boden et al. 2016].

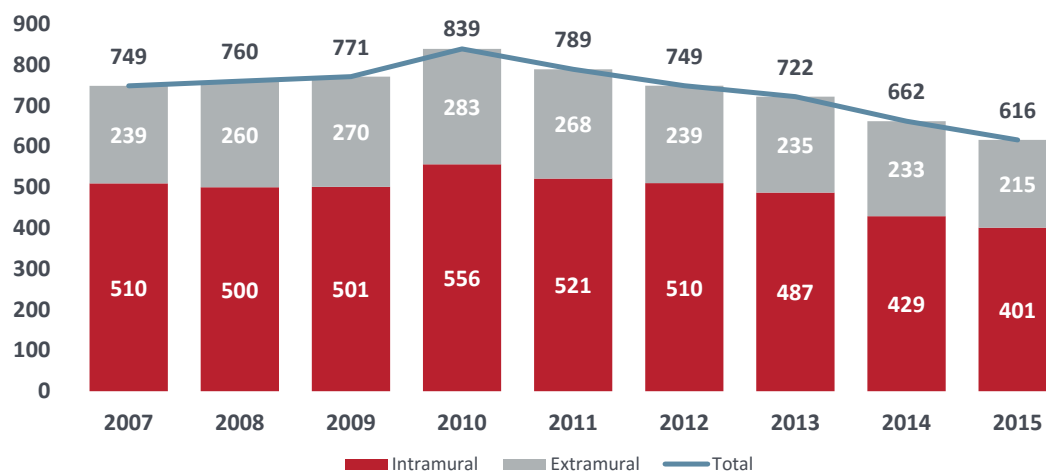
RESEARCH

NIOSH research investments support intramural and extramural research projects that generate new knowledge and improved interventions. The following information describes the overall research activities and investment, effectiveness, and impacts during the evaluation period for the second decade of NORA. A detailed review of sector- and cross-sector-specific research activities, effectiveness, and impact is included in the supplement to this report.

Activities and Outputs

One measure of NIOSH research activity is the number of research projects supported each fiscal year. The number of active projects per year is shown in Figure 4. An average of 740 active projects were funded annually during the reporting period of FY2007 through FY2015. The decade started with 749 active projects, reported a high of 839 active projects in FY2010 and ended the reporting period with 616 active projects in FY2015. The number of active projects by sector and fiscal year is provided in the Sector and Cross-Sector Program Supplement to the Second Decade of NORA Review Report.

Figure 4. Number of NORA research projects (FY2007–FY2015)



Note: An individual research project is typically active for several years. Project counts are reported for each fiscal year a project was active. Projects are counted by the percentage of each research project that was attributed to a NORA sector program.

PESTICIDE RESEARCH

The University of Iowa initiated further research on take-home pesticide exposure, with a study protocol largely developed based on the results from a NIOSH study.

SAFETY IN RETAIL

Researchers and practitioners furthered injury and illness prevention in the wholesale and retail trade sector, based on several key NIOSH publications that outlined key threats to and solutions for worker safety and health in the sector.

AIRCRAFT VENTILATION

Based on NIOSH studies, several universities collaborated on or conducted independent research on aircraft cabin ventilation and potential disease transmission to better understand and address flight crews’ risk for infection.

Figure 5 shows the dollars invested in intramural and extramural research projects during FY2007–FY2015. A total of \$2.195 billion was invested during the reporting period. Totals in Figure 5 are shown in millions of dollars.

Figure 5. NIOSH investment in research projects (FY2007–FY2015)

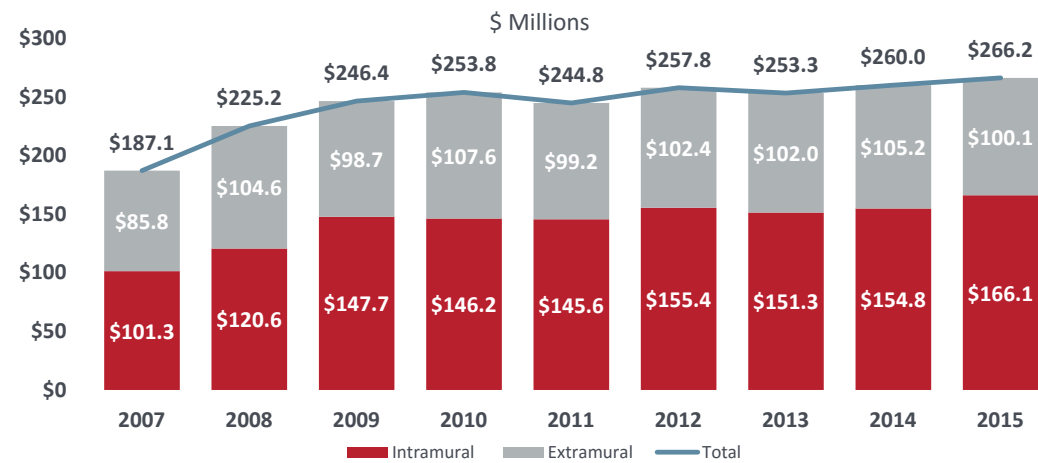
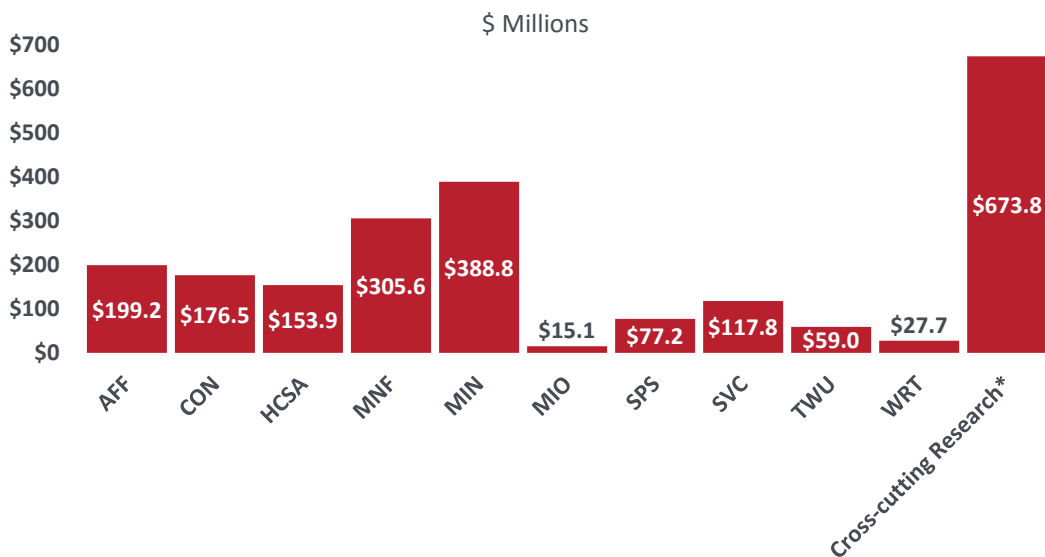


Figure 6 shows research investment for the same period by sector program. Investment ranged from \$15.1 million in the Oil and Gas Extraction Sector to \$673.8 million in cross-cutting research.

Figure 6. NIOSH investment in research projects by sector (FY2007–FY2015)



*Includes projects that contribute to advancing all or most of the NIOSH sector programs and includes public health activities tools that cut across NORA industry sectors.

Evaluation of a NIOSH human lung dosimetry model by independent researchers in the United Kingdom and European Union found substantial improvement in fit to two new data sets on long-term clearance and retention of respirable particles in humans. Subsequently, the NIOSH computer model is being incorporated into the next revision of the International System of Radiological Protection to inform future versions of national standards and guidance worldwide.

Another measure of research activity is the number and types of outputs generated by research projects. The most common output is a publication. Intramural and extramural investigators describe the results of their research in a variety of types of publications. Table 1 displays publication counts by type that are found in the NIOSHTIC-2 bibliographic database. The sum of the intramural and extramural publication counts often exceeds the total figure, because some publications resulted from collaborating intramural and extramural investigators. The number of publications presented here likely represents an underestimate of all publications produced during the second decade of NORA due to the limitations of the data collection methods available. Not all publications from a program are included in the NIOSHTIC-2 bibliographic database and not all publications in the database can be associated with a specific program.

Table 1. Research outputs by type (FY2007–FY2014)

Publication Category	All NIOSH Publications	Intramural Publications	Extramural Publications
Journal article	5,504	2,954	2,680
Numbered publication or field study report	1,650	1,302	350
Abstracts or conference proceedings	1,857	1,461	423
Book or book chapter	400	300	102
Newsletter, trade, or lay publication	228	159	75
Other	847	200	650
Totals	10,486	6,376	4,280

Effectiveness

One activity of NORA's second decade was to develop sector research goals. NIOSH provided funding for intramural and extramural projects that were designed to address these goals. One measure of research effectiveness employed for the second decade review is the degree to which research activities addressed NORA strategic goals. Table 2 shows the number of strategic goals within each sector program that were addressed by at least one research project that contributed 50% or more effort to the sector program during the second decade of NORA. During the decade, 101 of the 106 (95%) NORA strategic goals were addressed by research projects in the intramural and extramural programs. Intramural research addressed 101 of the strategic goals and extramural research addressed 68 of the strategic goals. Four goals shown were not addressed in the Healthcare and Social Assistance sector because they were added in 2014, which was at the end of the data collection period, and no activity would have been reported. One goal was not addressed in the Oil and Gas Extraction sector. All of the nine goals addressed in Oil and Gas Extraction were addressed by intramural research only.

CYCLONE SAMPLER

Researchers use NIOSH's two-stage personal cyclone sampler to measure airborne viruses in pig barns, to sample grain dust mycotoxin, and to assess exposures on chicken farms.

Table 2. Strategic Goals by Sector

Sector	Number Strategic Goals	Goals Addressed	Goals Addressed Intramural	Goals Addressed Extramural	Number Goals Not Addressed
AFF	9	9	9	9	0
CON	15	15	15	13	0
HSA	10	6 (60%)	6	6	4 (40%)*
MNF	10	10	10	7	0
MIN	7	7	7	6	0
MIO	10	9 (90%)	9	0	1 (10%)
SPS	17	17	17	14	0
SVC	18	18	18	7	0
TWU	4	4	4	3	0
WRT	6	6	6	3	0
Total	106	101 (95%)	101 (95%)	68 (64%)	5 (5%)

*Five HSA goals were developed in FY2013 and implemented in FY2014, which was the end of the data collection period. No projects during the data collection period addressed four of these five new goals.

Outcomes and Impact

NIOSH defines impact to be an intermediate or end outcome (see logic model in Figure 1). In the NORA logic model, intermediate outcomes occur when someone outside of NIOSH uses NIOSH outputs. End outcomes are improvements in workplace safety and health.

Bibliometrics

One measure of impact is citations of NIOSH-funded scientific journal articles. Citations were identified through the Scopus database, which tracks publications and their citations. Table 3 provides data for journal articles in the NIOSHTIC-2 bibliographic database that were found in the Scopus database of publications and citations on September 6, 2016.

A total of 4,819 journal articles were found in the Scopus database, with 89,035 citations. Intramural authors wrote 2,488 journal articles, with 50,420 citations; extramural authors wrote 2,448 journal articles with 42,722 citations. These data represent an underestimate of the true impact due to limitations of the number of articles included in the Scopus database; 84% of intramural publications are represented and 91% of extramural journal articles are represented.

Table 3 provides citation data for publications by NORA sector, All Sectors, and publications for which no sector could be identified. The sum of intramural and extramural publications and citations may exceed the total. A publication with intramural and extramural authors is counted in both categories, and some publications were assigned to more than one sector.

Researchers adopted methods developed in a NIOSH study of bakery workers' sensitization to flour dust.

Table 3. Citations of NIOSH-funded journal articles by sector

Sector	Total Number of Journal Articles	Total Number of Citations	Intramural Journal Articles	Intramural Citations	Extramural Journal Articles	Extramural Citations
AFF	259	4,175	104	1,798	166	2,628
CON	299	3,314	207	2,387	94	934
HSA	213	2,686	140	1,786	79	1,048
MNF	924	24,788	684	20,796	285	6,589
MIN	311	3,739	297	3,557	21	263
MIO	5	83	5	83	0	0
SPS	106	991	82	720	29	316
SVC	152	2,163	110	1,778	43	395
TWU	76	1,057	64	903	12	154
WRT	22	206	16	104	7	107
All Sectors	888	14,585	205	4,110	707	10,819
No Sector	1,966	37,121	878	17,535	1,126	21,091
Totals	4,819	89,035	2,489	50,420	2,448	42,722

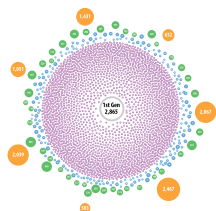
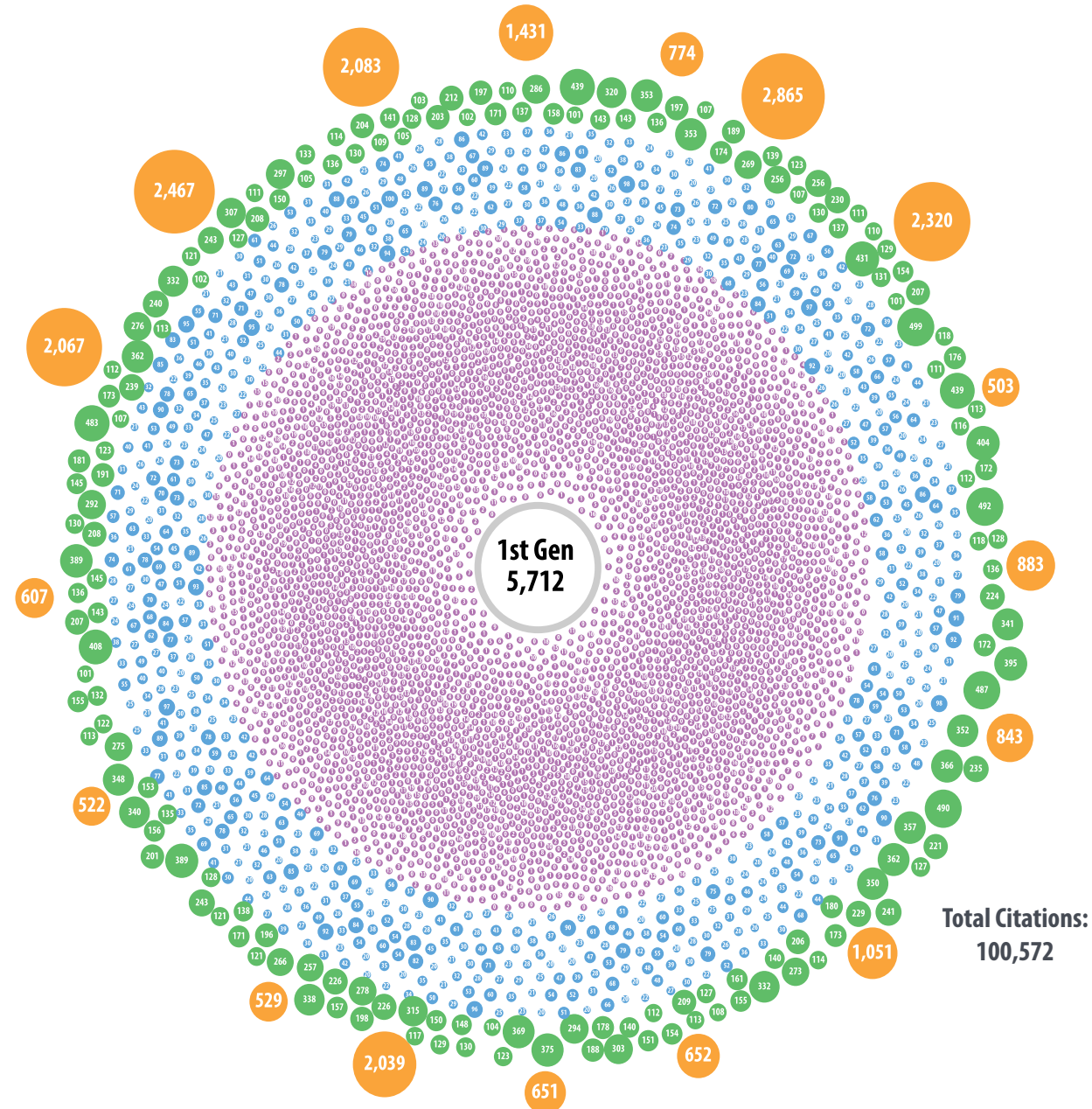
To further assess the reach of NIOSH publications, a network analysis was conducted of the first- and second-generation citations of the top three most-cited publications (Figure 7). The top three most-cited publications had 5,712 first-generation citations and 100,527 second-generation citations. Figure 7 is a network diagram that depicts the first- and second-generation citations. The center of the diagram displays a single circle representing the three most-cited publications. The size of the gold, green, blue, and purple bubbles represents the number of second-generation citations resulting from each one of the 5,712 first-generation citations. Purple bubbles represent fewer than 20 second-generation citations, blue bubbles represent 20–99 second-generation citations, green bubbles represent 100–499 second-generation citations, and gold bubbles represent more than 500 second-generation citations. Following are the top three NIOSH publications, from 2007 through 2016, in terms of first- and second-generation citations:

Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V, et al. [2012]. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 380(9859): 2095–2128, [http://dx.doi.org/10.1016/S0140-6736\(12\)61728-0](http://dx.doi.org/10.1016/S0140-6736(12)61728-0).

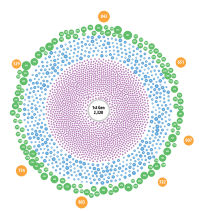
Murray CJ, Abraham J, Ali MK, Alvarado M, Atkinson C, Baddour LM, et al. [2013]. The state of U.S. health, 1990–2010: burden of diseases, injuries, and risk factors. *JAMA* 310(6):591–608, <http://dx.doi.org/10.1001/jama.2013.13805>.

Nel AE, Madler L, Velegol D, Xia T, Hoek EMV, Somasundaran P, Klaessig F, Castanova V, Thompson M [2009]. Understanding biophysicochemical interactions at the nano-bio interface. *Nat Mater* 8(7):543–557, <http://dx.doi.org/10.1038/NMAT2442>.

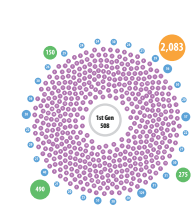
Figure 7. First- and second-generation network analysis of 3 top-cited papers (FY2007–FY2014)



Most-cited NIOSH publication from FY2007 through FY2014: "Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010."



Second-most-cited NIOSH publication from FY2007 through FY2014: "Understanding biophysicochemical interactions at the nano-bio interface."



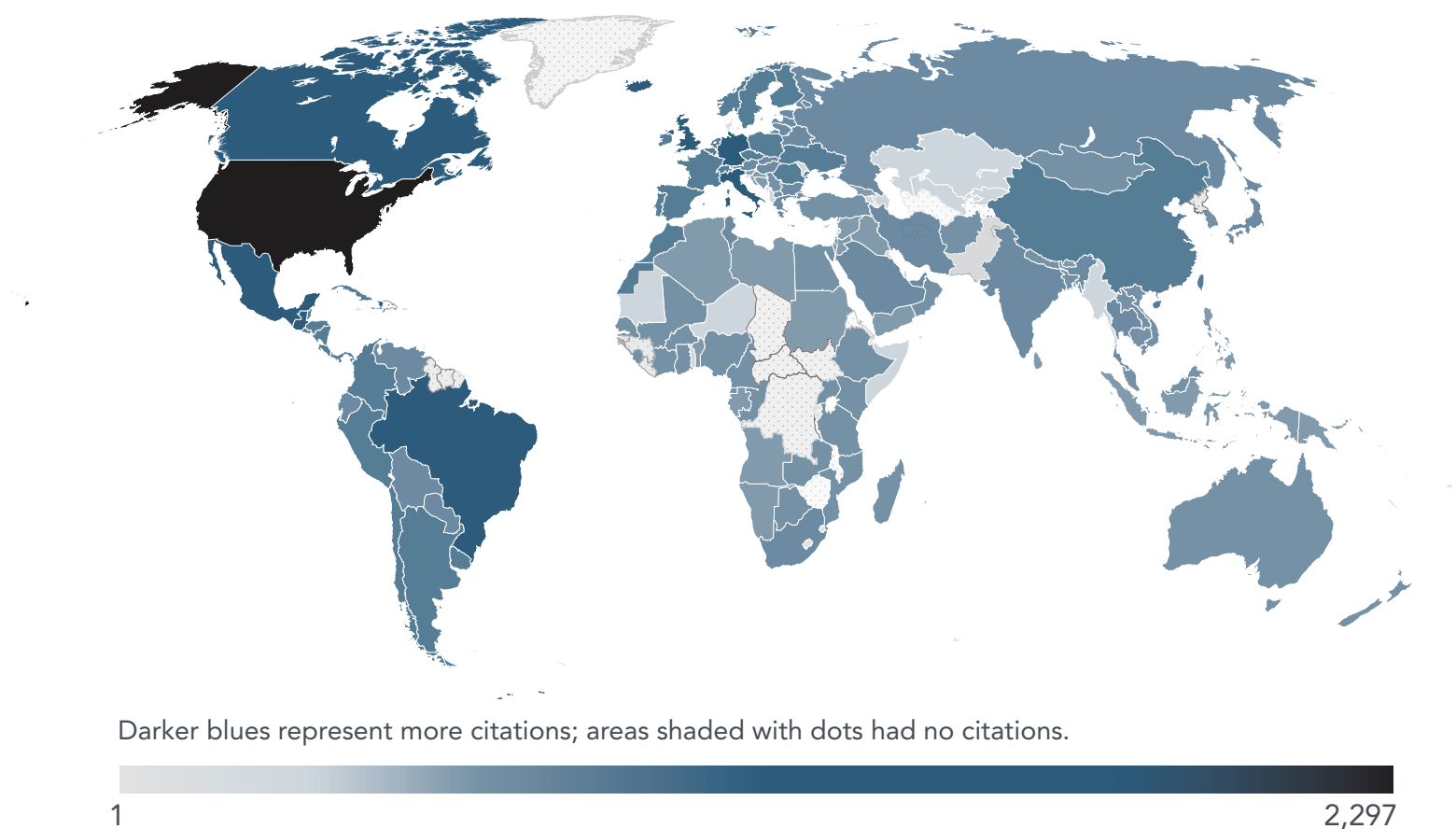
Third-most-cited NIOSH publication from FY2007 through FY2014: "The state of U.S. health, 1990–2010: burden of diseases, injuries, and risk factors."

The three most-cited NIOSH products from 2007 through 2014 had a total of 5,712 first-generation citations and 100,572 second-generation citations as of 2016. In this network analysis, each dot represents a paper that cited an article containing a first-generation citation of a top-three NIOSH publication. Numbers in the dots show how often the second-generation papers were cited, the size varies by that number, and the colors refer to the numerical ranges below.

- More than 500 second-generation citations
- 100–499 second-generation citations
- 20–99 second-generation citations
- Fewer than 20 second-generation citations

Another metric to assess the reach of NIOSH work is the number of countries where authors cite NIOSH work. NIOSH mapped the countries of coauthors who cited the top three NIOSH papers of the second decade and identified 164 countries. Countries with the highest number of citations were (in order of number citations): the United States (2,297 citations), United Kingdom (738 citations), China (628), and Germany (473 citations).

Figure 8. First generation citations by country of coauthor



TB RISK PREVENTION

Academicians and researchers are using NIOSH findings to improve tuberculosis risk and prevention education in workplaces.

Another important measure of research includes the number of outputs that have been used by others. In this review, data were obtained on the number of NIOSH numbered publications, requested in hard copy or downloaded electronically, that were associated with active projects during the second decade of NORA. A total of 722 NIOSH numbered publications were produced during the decade, with 1,215,979 electronic downloads and 2,750,061 hard copies distributed.

NIOSH numbered documents are attributed to individual sectors where possible. In some cases, one publication is attributed to more than one sector. Table 4 shows the number of NIOSH publications by sector and their corresponding number of electronic downloads and hard copies distributed. The sector with the largest number of publications produced was Mining, at 150. Healthcare and Social Assistance had the highest number of electronic downloads, at 288,458. Agriculture, Forestry and Fishing had the highest number of hard copies distributed, at 1,509,384.

Table 4. Electronic and printed distribution of NIOSH numbered publications by sector (FY2007–FY2014)

Sector	NIOSH Publications*	Electronic Downloads*	Hard Copy Distribution*
All Sectors	67	108,059	227,214
Agriculture, Forestry and Fishing	61	116,647	1,509,384
Construction	68	127,598	146,569
Healthcare and Social Assistance	57	288,458	422,749
Manufacturing	70	176,235	117,472
Mining	150	66,227	62,194
Oil and Gas Extraction	5	14	645
Services	25	26,765	64,241
Public Safety	65	180,434	367,301
Transportation, Warehousing and Utilities	17	17,996	3,471
Wholesale and Retail Trade	7	3,317	3,297
No sector could be assigned	179	268,686	160,104

*Publications, downloads, and hard copies may be attributed to more than one sector, and are counted in each sector they are attributed to.

Altmetrics

An emerging measure of research outcomes is altmetrics. Examples of altmetrics include the number of times a journal article has been downloaded or discussed in online research forums. Since 2013, the National Science Foundation has considered metrics related to researchers and products in addition to publications when awarding certain funding streams. The foundation has accepted a wide variety of research products, including data sets, software, online research notebooks, patents, copyrights, YouTube videos, and blogs [Priem et al. 2010]. This suggests that future altmetrics of importance could include participating in collaborative websites related to research endeavors, such as GitHub (an open-source software collaboration site).

Other researchers utilize the findings from NIOSH studies to initiate new research on physiological countermeasures for firefighter personal protective equipment.

A query ran on the CDC-licensed Altmetric.com site, for data related to NIOSH-funded publications during the second decade of NORA, yielded altmetrics results for 1,119 publications. This list of publications represented 11% of the total 10,487 NIOSH-funded publications during the decade. The results from Altmetric.com give insight into the extent that the general public is influenced by, exposed to, promotes, and engages with NIOSH-funded research online.

Altmetric.com gives every publication a weighted score to identify the level of online activity surrounding it. Scores for 383 NIOSH funded publications are in the 75th percentile or higher out of all the publications tracked by Altmetric.com. Data from Altmetric.com measures the following dimensions:

- **Attention**—Number of people exposed to or engaged with a NIOSH-funded research output through mentions of publications in the news or saving citations in library reference managers, such as Mendeley.
- **Dissemination**—The extent to which the public shares NIOSH research through blogs and social media sites like Facebook and Twitter.
- **Influence and Impact**—Signals that NIOSH research is changing a field of study, public health, or affecting larger society through influencing public policy.

The following tables give additional measures of outcomes and impact in each of these three dimensions. Social media impact and the meaning of associated alternative metrics is an emerging field of study. Significant emerging research is identifying the degree of impact indicated through altmetrics. Early findings suggest "... social media altmetrics are a significant contributor to citation prediction ... (and) altmetrics can indicate impact on varied audiences [Priem et al. 2010]." Social media is being studied as an extension of social marketing research that describes the movement of information through social networks and the influence of thought leaders within communities. At these early stages of study, altmetrics can suggest which social media channels resonate with different audiences and how successful the channels are in pushing information through audience communities. Social media engagement can also be used as an indicator of interest in information and resources as well as influence of research traveling through online research and academic communities.

Table 5. Altmetrics measures of research outcomes and impact—attention

Metric	Definition	Mendeley	CiteULike	News Outlets	Wikipedia
Attention	Number of people exposed to or engaged with a research output	21,105 instances of a publication added to a user's library for 1,104 publications	133 instances of a citation added to a user's library for 80 publications	138 publications mentioned 457 times in mainstream media outlets	185 Wikipedia pages mentioning 104 publications
		Average 19 library additions per publication	Average 2 library additions per publication	Average 3 media mentions per publication	Average 2 Wikipedia pages per publication

RESPIRATOR SENSORS

Researchers use NIOSH methods and information on developing, testing, and evaluating end-of-service-life sensors for respirators.

Table 6. Altmetrics measures of research outcomes and impact—dissemination and influence

Metric	Definition	Twitter	Facebook	Blogs	Public Policy Documents
Dissemination	The extent to which research is being shared and discussed among researchers and the public	5,574 individuals posted tweets on 875 publications	1,650 Facebook posts on 267 publications	232 blogs mentioning 148 publications	
		Average 6 tweeters per publication	Average 6 posts per publication	Average 2 blogs per publication	
Influence and Impact	Signals that research is changing a field of study, public health, or affecting larger society				38 documents reference 34 publications
					Average 1 document per publication

NIOSH broadcasts information through many social media channels. As of June 15, 2015, the Institute had three Facebook profiles with a total of 103,600 likes. NIOSH maintains 14 Twitter accounts, which have more than 375,318 followers total. NIOSH maintains 3 profiles on LinkedIn with a total of 2,000 members. At the time of this report, the NIOSH YouTube channel had 138 video clips, which had been viewed a total of 288,552 times, with 1,136 subscribers. Other NIOSH social media initiatives include the NIOSH Science Blog, Flickr, and Pinterest. Instagram was added in 2015. Although Wikipedia is not a social media site, it should be noted that NIOSH materials were cited by more than 900 Wikipedia articles in 2013. In the second quarter of 2015, the NIOSH Wikipedia page averaged about 15,000 views per week.

Selected Research Impacts

Research impact during the second decade was also assessed through high impact r2p stories. Information about impact was provided by NIOSH sector and cross-sector program leaders and NORA sector council members through surveys, in data collected about high impact outputs and associated intermediate outcomes of individual research projects previously mentioned, as well as in public comments that were submitted from NORA partners and members of the general public. Selected impact stories for sector programs and the cross-sectors are provided in the supplement to this report. For more impact stories, see [NIOSH Impact Sheets](#) and [Program Performance One-Pagers](#).

Impact statements help tell the story of how NIOSH work translates into better practices and standards to protect the health and safety of the workforce. Five major types of impact were identified, and the highlights in each of the five categories are provided below. Appendix A lists almost 200 statements of impact during the second decade of NORA.

NIOSH Standards, Guidance, and Policy Impacts

- NIOSH recommendations to reduce healthcare workers' exposures in preparing and administering hazardous drugs helped healthcare facilities nationally improve their procedures, as well as helped lead to a new law to protect workers in Washington state.
- A NIOSH survey of long-haul truck drivers found unhealthy weights and long work hours. The study results contributed to improved working conditions, including new regulations that limit the number of hours commercial drivers can operate vehicles, by establishing minimum rest times. The study also led some private companies with transportation fleets to adopt wellness programs.

NIOSH Recommendations Impact Manufacturers, Trade Associations, and Others

- To decrease fall-related injuries among construction workers, NIOSH launched the National Construction Falls Campaign with the Occupational Safety and Health Administration and CPWR—The Center for Construction Research and Training.
- The NIOSH "Talking Safety" curriculum helps many organizations and school systems teach working youth (a high-risk age group for job injury) about safety on the job. For example, Oregon State University uses Talking Safety to teach 4H summer school students basic workplace safety and health skills, and the states of Florida and Oklahoma use Talking Safety in their schools.

NIOSH Technology Adopted

- Building on NIOSH partnerships to protect commercial fishermen from entanglement and death in winches on fishing vessels, all three major manufacturers of capstan winches in the Pacific Northwest now provide NIOSH-developed emergency E-Stops as standard safety features on their new seine winches. Captains are also installing the system, and a NIOSH training video with real commercial fishermen promotes winch and deck safety awareness.
- NIOSH developed the Ladder Safety Smartphone Application (more than 50,000 downloads by the end of 2015) so workers with smartphones can easily download the application (app) on the job site, helping them position ladders at the correct angle to prevent serious fall injuries.

NIOSH Research Builds Knowledge Base

- Based on NIOSH studies, several universities collaborated on or conducted independent research on aircraft cabin ventilation and potential disease transmission to better understand and address flight crews' risk for infection.

MOUSE MODEL

The Lawrence Berkeley National Laboratory worked with NIOSH, using NIOSH population and computational genetic studies, to create a transgenic mouse model for laboratory experimental research on chronic beryllium disease. A commercial laboratory made the mouse available to researchers as of 2012.

LEAD ANALYSES

Researchers have used findings from NIOSH lead surveillance analyses to target interventions or conduct further detailed lead analyses.

- Respirator manufacturers and academicians use NIOSH data from advanced computer imaging on face and head sizes and shapes when designing, sizing, and testing new respirator facepieces to fit today's diverse work force.

NIOSH Outputs Widely Disseminated

- The U.S. Department of Veterans Affairs and other veterans' organizations disseminated NIOSH information on return-to-work issues for veterans with Post Traumatic Stress Disorder.
- The American Chemistry Council worked with NIOSH to design and evaluate a medical screening program for workers exposed to toluene diisocyanate (TDI), a chemical associated with acute and chronic health risks, and to assess exposure consistently across facilities.

SECTOR PROGRAMS

During the second decade, NORA sector councils (external to NIOSH) and NIOSH sector programs (internal to NIOSH) contributed to the sector program activities, effectiveness, outcomes, and impact. The NORA sector councils and NIOSH sector programs worked together and independently to achieve the goals established for the decade. This section reviews the activities, effectiveness, outcomes, and impact of the NORA sectors as reported by NORA sector council members and NIOSH sector programs. See the supplement to this report for a more detailed review of each sector's accomplishments during the second decade.

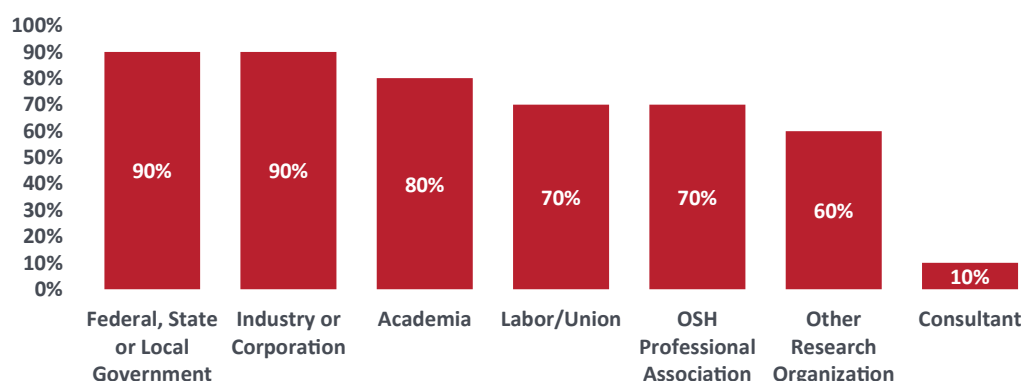
Activities and Outputs

NORA sector council activities included participating in council meetings, developing sector agendas and goals, involving stakeholders, developing products, and creating partnerships. NIOSH sector program activities included participating in NORA sector council activities; conducting research; publishing research findings in peer review and trade journals; and developing communication products, presentations, videos, and social media programs.

NORA sector council members that invested outside of NIOSH further leveraged NIOSH resources to expand the reach of these partnerships. NORA sector council members contributed individual financial resources. This included 33% of council members that contributed up to \$1,000 per year, 29% that contributed \$1,000–\$5,000 per year, and 17% that contributed more than \$5,000 per year.

External partners help a program conduct research and share the results. Seventy percent (70%) of the NIOSH sector programs developed six or more external partnerships during the decade, and 30% had 3–5 external partnerships. Figure 9 shows the percentage of sector programs that engaged partnerships by type of partner agency.

Figure 9. Percentage of sector programs with partnerships



TAXI AIRPLANE SAFETY

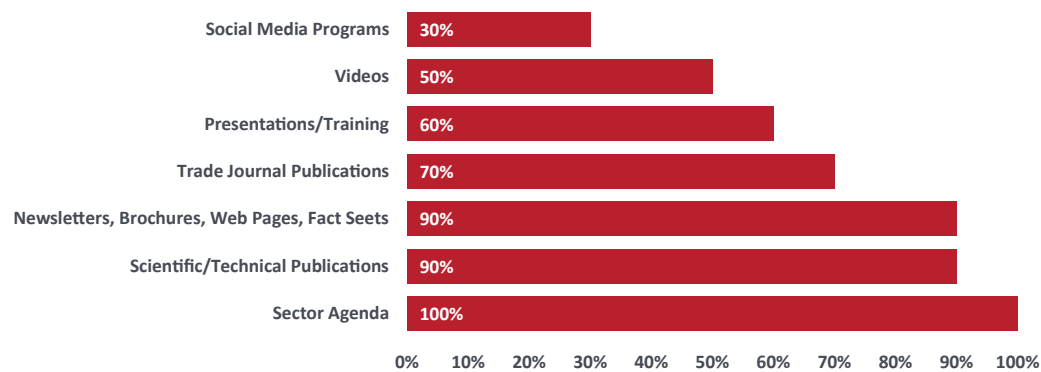
To prevent deaths related to commuter and taxi airplanes in Alaska, NIOSH and partners developed and implemented best-practice guidelines.

AERIAL LIFT FALLS

NIOSH worked with equipment manufacturers and standards committee to protect workers from falls from aerial lifts.

NIOSH sector programs, working with their NORA sector councils, generated a variety of types of products during the second decade (Figure 10). All NIOSH sector programs developed agendas, and almost all (90%) developed scientific or technical publications, and newsletters, brochures, web pages and fact sheets. More than half (70%) of the sector programs developed trade journal publications, 50% developed videos for stakeholder use, and 30% developed social media programs.

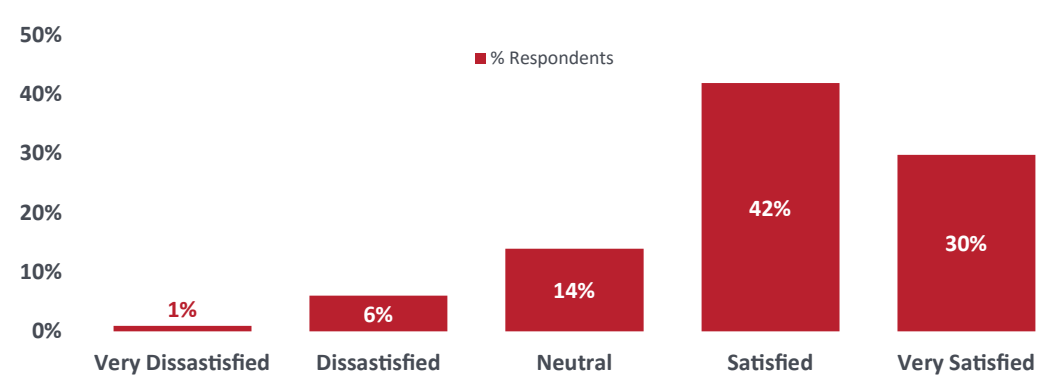
Figure 10. Products developed by sector programs



Effectiveness

Satisfaction items in the sector council survey assessed the effectiveness of the NORA sector councils. NORA sector council members indicated overall satisfaction with effectiveness, ranging from 72% satisfied to very satisfied, to 7% dissatisfied or very dissatisfied.

Figure 11. Satisfaction with sector council effectiveness (percentage of respondents)



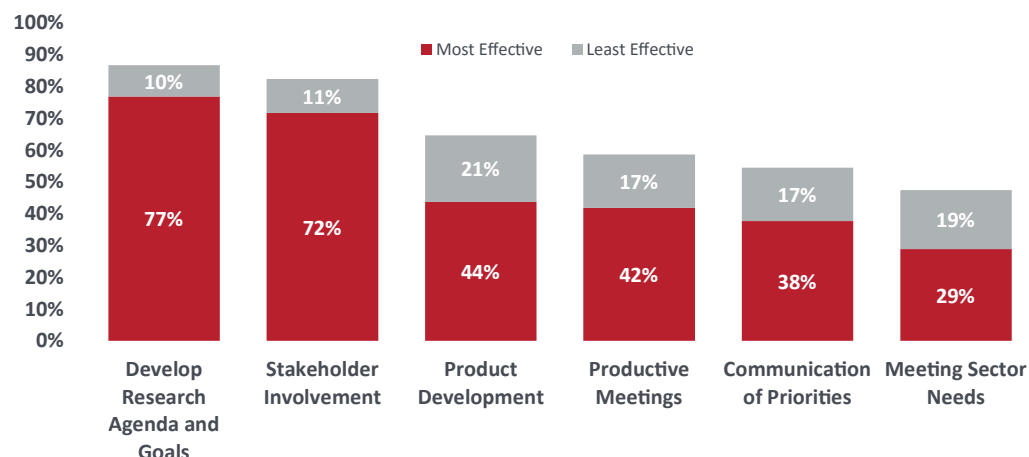
NORA sector council members commented on the most and least effective aspects of the NORA sector councils, as shown in Figure 12. Most respondents chose developing the national research agenda and goals as the most effective aspect (77%), followed by involving stakeholders (72%), developing products (44%), having productive meetings (42%), communicating priorities to stakeholders (38%), and meeting sector needs (29%).

NOISE EXPOSURE

A NIOSH study with boat manufacturers led to several manufacturers reducing styrene and noise exposure with engineering controls.

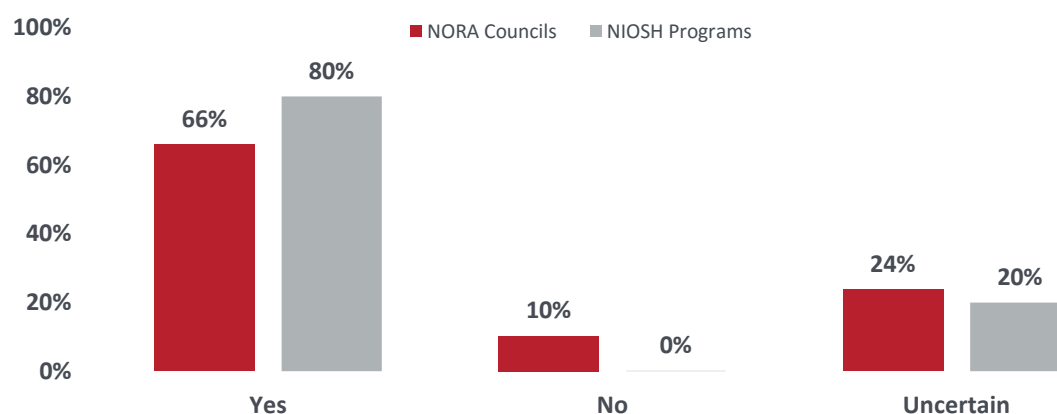
A minority of respondents indicated that the least-effective aspects of the NORA sector councils were developing products (21%), meeting sector needs (19%), communicating priorities to stakeholders (17%) and having productive meetings (17%), followed by involving stakeholders (11%), and developing re-search agenda and goals (10%).

Figure 12. Most and least effective sector activities (percentage of respondents)



NORA sector councils and NIOSH sector programs were asked whether the sector was an effective way to organize the second decade of NORA. Most responding NORA sector council members said "yes" (66%), nearly a quarter were uncertain (24%), and 1 in 10 said "no" (10%). A large majority (80%) of the NIOSH sector programs indicated the sector structure was an effective way to organize the second decade.

Figure 13. Effectiveness of sector structure (percentage of respondents)

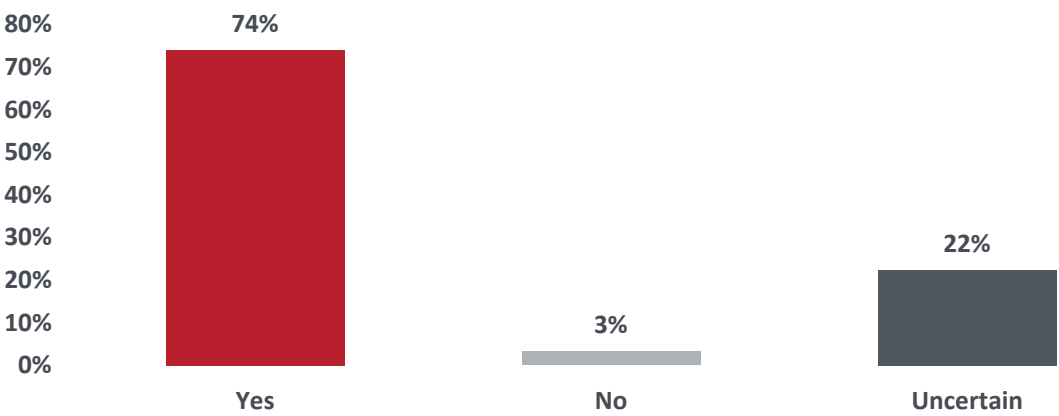


NORA sector council members were asked if the work of the council addressed the most pressing needs, resulted in improved workplace safety, or led to adopting improved workplace practices. Most council members indicated that their research agenda targeted the most critical issues within their sectors.

CROSSING GUARDS

NIOSH and partners developed educational materials to prevent injury among New Jersey crossing guards, and state police departments and employers requested additional copies and reported taking steps to provide required personal protective equipment.

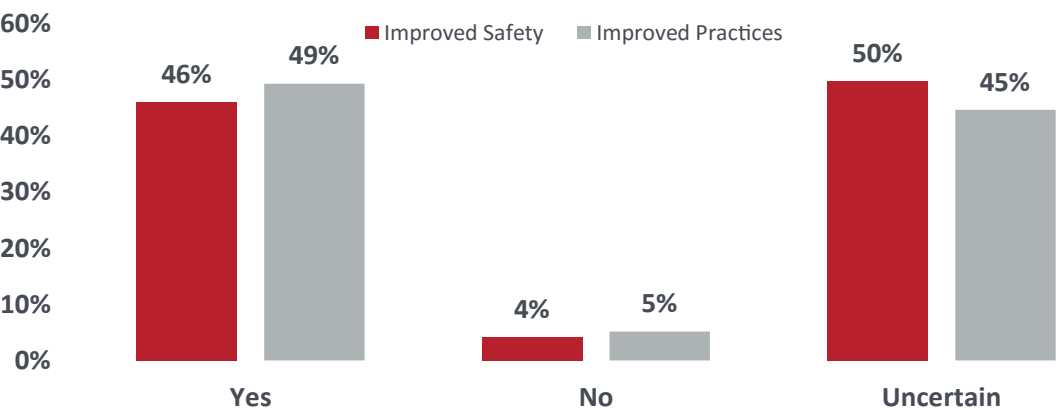
Figure 14. NORA sector councils addressed most pressing needs (percentage of respondents)



Outcomes and Impact

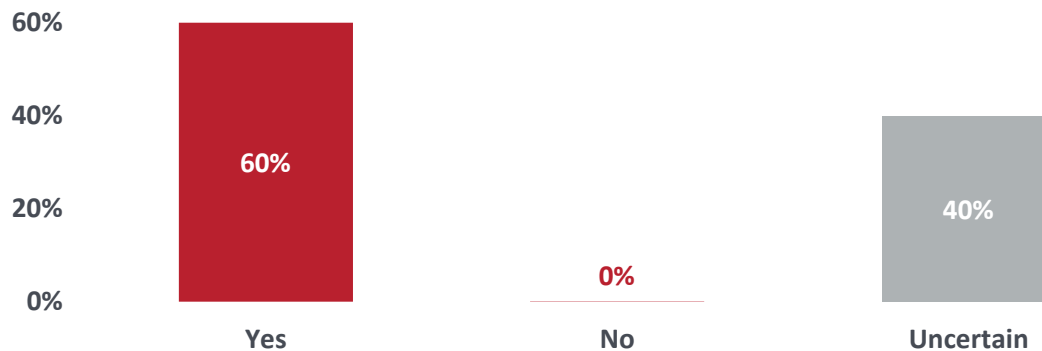
Two measures of outcomes of sector activities are the degree to which the NORA sector agenda improved workplace safety and practices, and whether the NORA sector agenda led to research conducted by others outside of NIOSH. NORA sector councils were split on whether the NORA sector agendas improved workplace safety and practices. Improving workplace and safety practices is the final and most difficult step in moving research results into practice, requiring actions by stakeholders, such as industry, labor, professional associations, safety and health practitioners, and other government agencies. Figure 15 shows the level of agreement that the NORA sector agenda improved workplace health and safety and practices: 46% and 49% reported that the NORA sector agenda resulted in improved safety or improved practices, while 50% and 45% were uncertain the NORA sector agenda resulted in improved safety or improved practices. The challenges of tracking and reporting impact may have contributed to the uncertainty reported in Figure 15. NIOSH is addressing these challenges in the third decade of NORA through new approaches to tracking council achievements and other efforts.

Figure 15. Sector agenda improved workplace safety and practices (percentage of respondents)



Another outcome measure of sector activities is whether the work for the sector led to research by others outside of NIOSH. Most NIOSH sector programs (60%) reported that their NORA sector agenda led to follow-on research by others outside of NIOSH.

Figure 16. Sector agenda led to research by others outside of NIOSH (percentage of respondents)



Evidence of the impact sector programs achieved during the second decade of NORA is illustrated through selected impact stories featured in the supplement to this report. Impact stories were selected based on the recommendation of the NORA program leadership and the strength of the evidence that impact had been achieved.

PATHOGEN SAFETY

The NIOSH and partners' program, "Preventing Occupational Transmission of Blood borne Pathogens Among Healthcare Workers," helped improve worker safety internationally by instructing more than 20,000 trainers and leading to new regulations.

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PARTNERSHIPS AND RESEARCH TO PRACTICE (R2P)

Partnerships and r2p is the third evaluation domain. Partnerships are fundamental to NIOSH work. The NIOSH emphasis on r2p includes partners collaborating in planning and conducting research, and NIOSH partnering with others who use NIOSH outputs to improve safety and health in workplaces.

Activities and Outputs

Partnerships

Partnerships can help support, enhance, and advance research, and they are important in accomplishing the NIOSH mission. To ensure continued relevance and impact of its science, NIOSH is committed to engaging partners throughout the entire research process [NIOSH 2010].

A partner is defined as an individual, group, or organization actively involved in NIOSH research activities. Partners may engage in and contribute to advancing research efforts in various ways, such as the following: (1) identifying an occupational safety and health issue; (2) planning projects; (3) providing access to worker populations; (4) collecting data, implementing, and assessing recommended work practices; (5) disseminating research findings, and (6) evaluating the impact of the research on improving the safety and health of workers.

Throughout the second decade of NORA, NIOSH had both formal and informal partnerships. Table 7 shows the breakdown of partners listed in the NIOSH Partnership Database by type of organization. Formal partnerships within NIOSH are those that require a documented agreement, such as a letter of agreement (LOA), or memorandum of understanding (MOU). A review of documented formal partnerships between FY2007 and FY2014 indicated that NIOSH had 285 formal collaborations with 232 organizations.

Table 7. NIOSH partners by type and number of formal agreements

Type of Partner	Total Number of Partner Organizations	Number of Formal Agreements
Industry or corporation	534	80
Federal, state, or local government agency	328	80
International organizations	273	30
Nongovernment organizations	314	27
Academia	308	27
Professional associations	134	24
Trade	73	14
Labor or union	52	3
Total	2,016	285

Note: Many more informal and functional partnerships during the decade are described under Sector Activities and Sector Program Review. The data presented here represent only formal partnerships and do not represent the full scope of NIOSH partners during the second decade of NORA. Please see the sections on Sector Programs for additional information on the breadth of partners during the decade.

RETAIL WORKER SAFETY

NIOSH and partner-sponsored workshops introducing retailers to equipment manufacturers led to efforts to prevent muscle and bone injuries among retail workers.

ASPHALT MILLING

Resulting from a major collaboration by NIOSH and diverse partners, asphalt milling manufacturers signed an agreement promising that all new asphalt milling machines sold to the U.S. market will have controls in place to keep silica dust levels below occupational exposure limits by January 1, 2017.

Research to Practice (r2p)

NIOSH launched the Research to Practice (r2p) initiative in 2003 as a way to strategically conduct and support relevant and impactful research efforts on worker safety and health. The r2p initiative is fundamental to all NIOSH research and focuses on translating and transferring NIOSH research findings, technologies, and information into effective practices to prevent injury and illness. Additionally, it emphasizes that research conducted or funded by NIOSH should be relevant for recognized evidence-based policy and practice, effectively diffuse research outputs to individuals or groups most likely to adopt them, and ensure that outputs are usable by organizations with the power to improve workplace safety and health.

All NIOSH activities involve some aspect of r2p. This section presents measures of the effectiveness and impact of r2p activities during the decade. Effectiveness was evaluated by assessing the reach of NIOSH activities and products. Reach refers to the number of stakeholders who are exposed to NIOSH information and outputs. Making stakeholders aware of NIOSH results is the first step in having results used to improve safety and health in workplaces, but reach is not sufficient to facilitate change. Impact was assessed by the parameters of research to practice activities beyond reach in the logic model (Figure 1). As with Partnerships, r2p is embedded throughout the review of research and sector programs. Please see the sections on Sector Programs for more information on the breadth of research to practice during the decade.

Conferences and Workshops

During the second decade, NIOSH and nonfederal partners supported high quality, scientific conferences and meetings relevant to the NIOSH scientific mission and to the public health. A scientific conference or meeting is a gathering, symposium, seminar, scientific meeting, workshop, or any other organized and formal meeting—whether conducted face-to-face or via the Internet. These meetings are held to coordinate, exchange, and disseminate information. They may also explore or clarify a defined subject, problem, area of knowledge, gaps in science, prevention, intervention, or policies.

During the second decade, NIOSH sponsored 119 conferences with 4,745 attendees. NIOSH sponsored travel to these conferences for 2,348 (49%) federal attendees and 1,107 (23%) non-federal attendees. The remaining 1,290 (27%) attendees were supported by non-federal funding. Conferences were cosponsored with a variety of stakeholder groups representing the breadth of partnerships developed over the decade. Cosponsoring agencies included professional associations; nongovernment organizations; federal, state, or local government agencies; international organizations; academia; industry or corporations; labor or union groups; and other research organizations.

Conference outputs during the decade included conference proceedings; new or updated research methods; training materials; recommendations; and newsletters, brochures, web pages, and fact sheets. Selected highlights of the outcomes of these conferences are provided in the [Outcomes and Impact](#) section below.

NIOSH Membership in Consensus Standards Committees

One of the partnership and r2p activities of the third decade was NIOSH membership on consensus standards committees. Annual reports from NIOSH staff contributing to such efforts were analyzed to identify how many different standards NIOSH contributed to, and how many standards NIOSH completed and published. Annual reports received during fiscal years 2012–2014 were analyzed to determine how many different consensus standards a NIOSH member reported working on, and how many completed and published standards resulted. Writing or revising a consensus standard often requires work over multiple years.

Table 8 shows how many different standards organizations NIOSH worked with between FY2012 and FY2014. Many standards organizations oversee multiple consensus standards committees. The reported outcomes are counts of different standards worked on by the NIOSH members and completed by the committees. Data available for the FY2012 to FY2014 period show NIOSH staff reported working on a total of 81 committees and 151 standards; 6 of these committees establish international standards. A subset of 5 committees published a total of 20 standards. Standards often take years to complete and publish.

TRAINING TRAINERS

The NIOSH and partners' program, "Preventing Occupational Transmission of Blood borne Pathogens Among Healthcare Workers," helped improve worker safety internationally by instructing more than 20,000 trainers and leading to new regulations.

SILICA HAZARD ALERT

A NIOSH Science Blog with New Jersey state partners about silica exposure from fabricating engineered stone countertops led to increased protection for workers. For example, NIOSH and the Occupational Safety and Health Administration published a hazard alert, and the state of Texas identified a silica case, which NIOSH investigated on request.

Table 8. Summary of NIOSH memberships on consensus standards committees and reported outcomes (FY2012–FY2014)

Organization	Number of committees	Number of Standards NIOSH worked on	Number of Published Standards
ANSI*	28	52	6
ASTM	14	25	0
NFPA	13	19	2
ISO†	7	14	1
ASABE	4	16	0
AIHA	2	—‡	—
UL	2	—	—
AAMI	1	0	1
AATCC	1	—	—
ACOEM	1	1	1
ASHRAE	1	2	0
IEC†	1	2	0
IEEE†	1	1	0
ISA†	1	0	7
NTEA	1	18	2
OECD†	1	—	—
TAPPI	1	—	—
WHO†	1	1	0
Total	81	151	20

*Includes ANSI Technical Advisory Groups and ANSI committees sponsored by other organizations, including AIHA and ASSE (American Society of Safety Engineers)

†Establishes international standards.

‡Fields marked “—” indicate data not available.

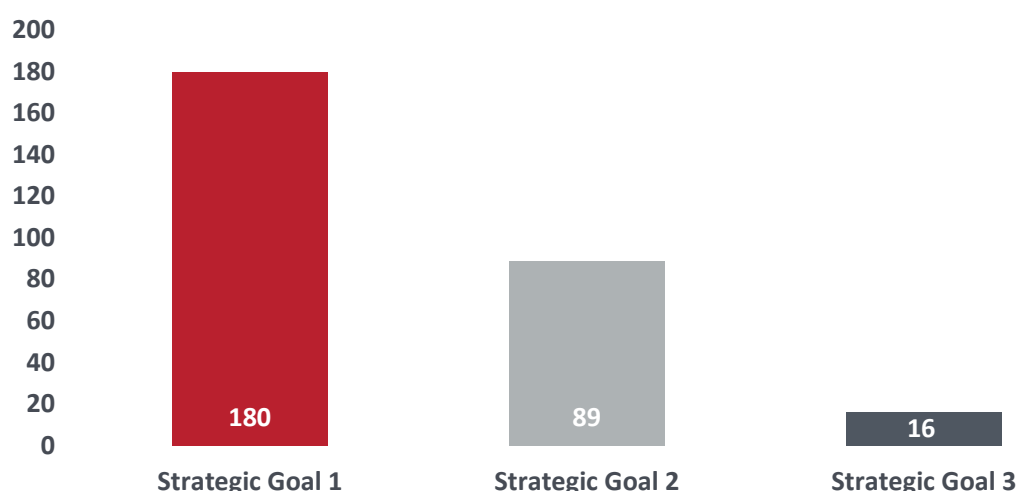
Effectiveness

Effectiveness of partnerships and Research to Practice (r2p) was measured in terms of the reach of NIOSH work in developing new knowledge.

Effectiveness of formal partnership collaborations was assessed by how they align with the NIOSH strategic goals (FY2007–FY2015) that are detailed online [NIOSH 2014]. Figure 17 shows the number of formal partnership agreements developed during the decade by NIOSH strategic goal. Most agreements (180) related to Strategic Goal 1: “Conduct research to reduce work-related illnesses and injuries.” A total of 89 formal agreements supported Strategic Goal 2: “Promote safe and healthy workplaces through interventions, recommendations, and capacity building,” and 16 formal agreements supported Strategic Goal 3: “Enhance international workplace safety and health through global collaborations.”

Resulting from a major collaboration by NIOSH and diverse partners, asphalt milling manufacturers signed an agreement promising that all new asphalt milling machines sold to the U.S. market will have controls in place to keep silica dust levels below occupational exposure limits by January 1, 2017.

Figure 17. Number of formal partnership agreements by NIOSH strategic goal (FY2007–FY2014)



Types of organizations that engaged NIOSH during the decade are described in Table 9 by the strategic goal they supported. Industry and federal, state, or local government agencies were the most frequent partners.

Table 9. Organizations engaging NIOSH, by strategic goal

Goal 1: “Conduct research to reduce work-related illnesses and injuries”

Type of Partner	Formal Agreements (N=180)
Industry or corporation	65
Federal, state, or local government agency	55
International organizations	13
Nongovernment organizations	11
Academia	20
Professional associations	10
Trade	5
Labor or union	1

Goal 2: “Promote safe and healthy workplaces through interventions, recommendations, and capacity building”

Type of Partner	Formal Agreements (N=89)
Industry or corporation	15
Federal, state, or local government agency	25
International organizations	1
Nongovernment organizations	16
Academia	7
Professional associations	14
Trade	9
Labor or union	2

STATE USES NIOSH WORK

Maryland’s local occupational health faculty members use the new NIOSH-funded state-based Occupational Health and Safety Surveillance Program indicators website to teach about occupational safety and health.

Goal 3: Enhance international workplace safety and health through global collaborations

Type of Partner	Formal Agreements (N=16)
International Organizations	16

The international agreements reflect NIOSH’s commitment to working with international partners on knowledge, technology, and practice issues. Additionally, NIOSH provides leadership on occupational safety and health with United Nations agencies, such as the World Health Organization (WHO) and International Labour Organization; along with international associations, such as the International Social Security Association, and U.S. programs that support global occupational health initiatives, such as the National Institute of Health John E. Fogarty International Center. NIOSH leads the coordination group for the WHO Collaborating Centers for Occupational Health, which currently includes 55 WHO collaborating centers in occupational health.

Another measure of reach is nonscientific publications that mention NIOSH work. The number of news articles, in general, and the number of articles in trade publications, specifically, show that NIOSH information and outputs reach the public. A search of the Lexis Nexis database found 15,007 articles mentioning NIOSH. Table 10 shows the number of articles by sector.

Table 10. News Mentions of NIOSH (2007–2014)

Sector	News Articles	Trade Publications	Articles Citing NIOSH Products
Agriculture, Forestry and Fishing	7	0	6
Construction	65	18	26
Healthcare and Social Assistance	92	9	25
Manufacturing	755	109	325
Mining	424	63	124
Oil and Gas Extraction	122	17	37
Public Safety	24	6	12
Services	863	92	360
Transportation, Warehousing and Utilities	136	17	13
Wholesale and Retail Trade	259	35	53
Totals	2,747	366	981

Outcomes and Impact

Outcomes and impact of partnerships and r2p use measures that go beyond reach, describing the use, adoption, or adaptation of NIOSH information, as well as how that knowledge transferred into practice. One measure of NIOSH impact is how often other federal agencies cite NIOSH recommendations or specific NIOSH-funded outputs in their official notices and rule-making publications in the *Federal Register*. Every federal agency must post final regulations and requests for comments on pending rules in the *Federal Register*.

Federal Register References to NIOSH Science and Recommendations

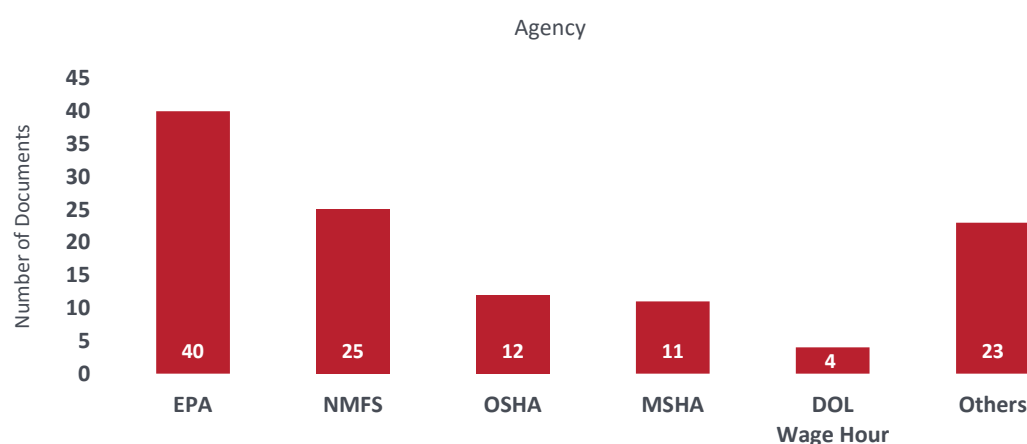
A public database of *Federal Register* articles was searched by fiscal year for references to NIOSH between FY2011–FY2014. Each article was analyzed to identify the NIOSH-funded program or product that was cited. A total of 21 federal agencies published 115 *Federal Register* documents that referenced

HEARING STANDARDS

NIOSH research on noise-related hearing loss contributed to standards from the U.S. Department of Defense, American National Standards Institute, and the U.S. Department of the Interior.

NIOSH outputs. The distribution of these documents by agency is shown in Figure 18. The EPA had the highest number of documents (40) that cited NIOSH, followed by NMFS, the National Marine Fisheries Service (25), OSHA (12), MSHA (11) and DOL Wage and Hour Division (4). A total of 16 other agencies collectively cited NIOSH in 23 documents.

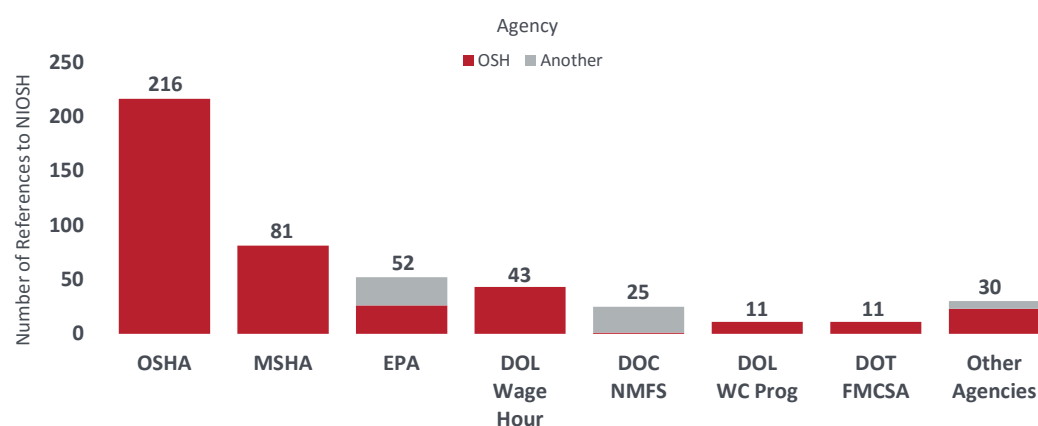
Figure 18. Number of *Federal Register* documents citing NIOSH by various Federal agencies (FY2011–FY2014)



Agency documents may contain many references to different NIOSH recommendations and outputs. A more specific measure of NIOSH impact is the number of references to NIOSH recommendations and outputs by another agency in the context of improving occupational safety and health. Sometimes, NIOSH guidance or research results are cited by agencies working in other contexts, for example, environmental hazards for the general public.

The following chart shows that most references to NIOSH work in the *Federal Register* are related to occupational safety and health. The largest exception is the National Marine Fisheries Service (NMFS) citing the 1998 criteria document *Occupational Noise Exposure* in the discussion of allowable noise levels for marine mammals near marine construction sites and during military exercises.

Figure 19. Number of references to NIOSH in occupational safety and health or another context (FY2011–FY2014)



The type of outcome was also noted for each citation. In some cases, the citation of NIOSH or a specific NIOSH-funded output was a significant factor in

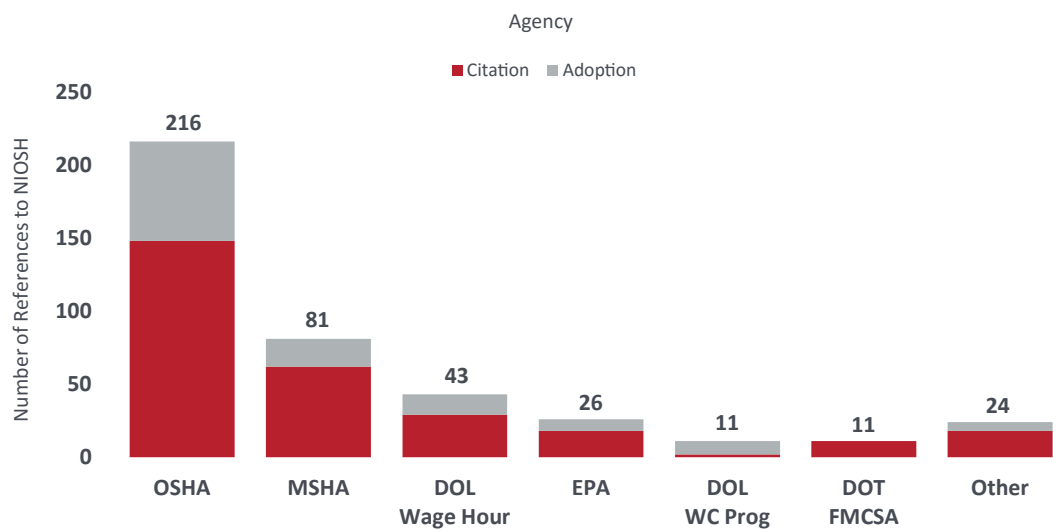
ROAD CONFERENCE

NIOSH helped sponsor the first International Conference on Workers on Roads, held in Washington, DC, in 2009, leading to new United Nations clauses about road safety for workers.

guiding a decision of the citing agency. In other cases, the NIOSH program or output was cited mainly for information purposes.

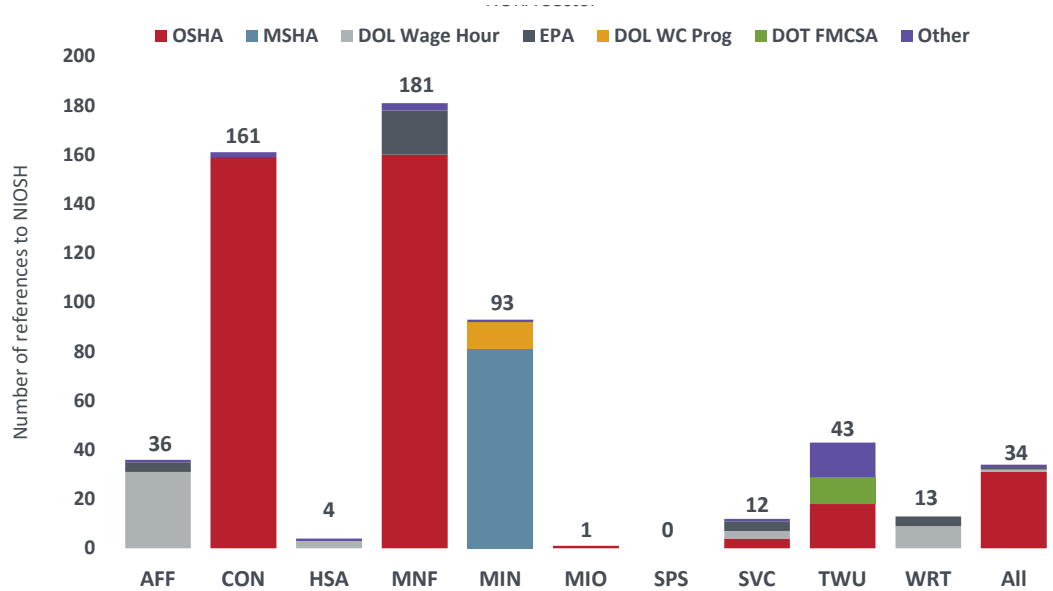
The 412 references to NIOSH in the occupational safety and health context were further analyzed to identify the type of outcome. NIOSH typically considers the following four categories of outcomes when evaluating impact: (1) citations of project work by others, (2) adoption or changes in policies, practices and procedures or workplace environment in which project activity likely contributed, (3) dissemination of outputs by those outside NIOSH, and (4) other. None of the 412 references to NIOSH was identified in the dissemination of outputs category. Documents that mentioned NIOSH in a less significant way, the “other” category, were excluded from the analysis.

Figure 20. Number of references to NIOSH in the occupational safety and health context by outcome type (FY2011–FY2014)



For each mention of NIOSH in the occupational safety and health context, up to two NORA sectors or All Sectors were noted as the focus of the federal agency’s action. Figure 21 presents the results by sector and agency.

Figure 21. Number of references to NIOSH in the occupational safety and health context, categorized by NORA sector and agency (FY2011–FY2014)

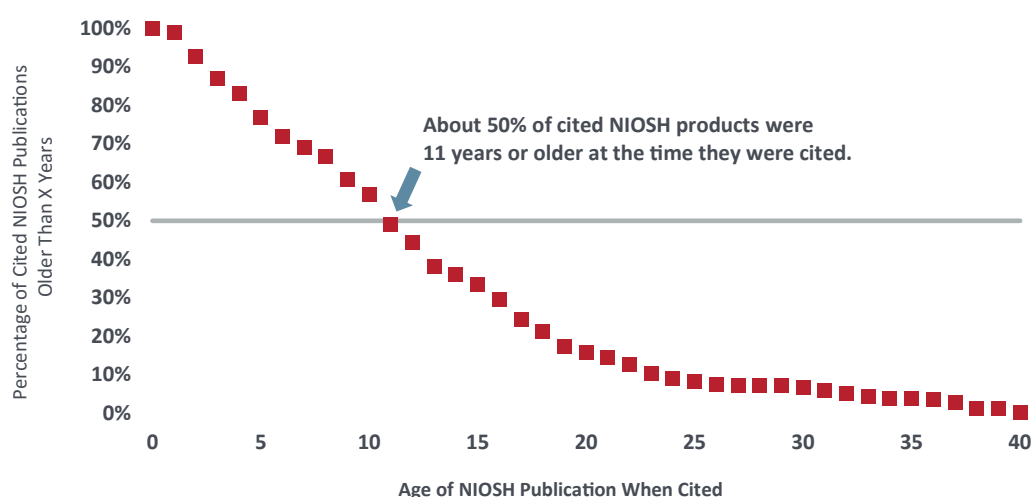


A NIOSH-developed cost-collection strategy helps businesses like Ford Motor Company to determine costs of work-related injuries and illnesses.

As expected, MSHA issues regulations related to mining and OSHA regulations cover many sectors. In particular, OSHA referenced many different NIOSH-funded outputs in documents promulgating the silica standard, which affects the largest numbers of workers in the construction and manufacturing sectors. OSHA and agencies in the Department of Transportation promulgate rules related to TWU workers.

A measure of the relevance and longevity of the impact of NIOSH products is how old the document is when cited. Approximately 50% of the cited NIOSH products were 11 years old or older when they were cited by another federal agency in a *Federal Register* document. This suggests that NIOSH documents have a sustained relevance and impact well beyond their publication date.

Figure 22. Percentage of cited NIOSH products older than the indicated age



Conferences and Scientific Meetings

Outcomes and impact of partnerships and r2p can be found in the results of conferences and workshops NIOSH sponsored during the decade that involved the transfer of new knowledge into practice, NIOSH recommendations being adopted by external stakeholders, other researchers building on NIOSH knowledge, and external organizations disseminating outputs. Here are selected impacts that resulted from NORA-related conferences and meetings during the second decade.

Construction

Largest construction project insurer in the United States uses NIOSH safety climate rating tool. AIG, the largest insurer of construction projects in the United States, helped by testing the worksheets with selected clients and encouraging their clients to use the modified worksheets. The workbook is designed to help construction managers and safety professionals strengthen their workplace safety climate. Workshop products include the workshop report, worksheets used by industry, rating tools used by industry ([“Safety Culture and Climate in Construction: Bridging the Gap Between Research and Practice,”](#) Washington, DC, June 2013).

NICOTINE STUDY

NIOSH responded to a request from the Occupational Safety and Health Administration (OSHA) to clarify how the skin absorbs nicotine from electronic cigarettes, contributing scientific information to OSHA developing a compliance action with an electronic-cigarette manufacturer.

Workshop results in research partnerships in construction safety. This study, examining the safety culture spectrum in the construction industry, was produced by Dodge Data & Analytics in partnership with the CPWR—The Center for Construction Research and Training, United Rentals, and 12 other supporting and contributing organizations. Dodge Data & Analytics is the leading provider of data and analytics for construction in North America. (“Safety Culture and Climate in Construction: Bridging the Gap Between Research and Practice,” Washington, DC, June 2013.)

Economics of Occupational Safety and Health

NIOSH workshop moves closer to standardized methods to estimate the societal burden of occupational safety and health injury, illness, and fatality. The NIOSH surveillance and economics programs partnered to discuss the methods, advantages, and challenges of developing burden estimates by using health-related quality-of-life metrics, as well as applications of such burden estimates. The workshop brought researchers from different disciplines together to describe, discuss, and illustrate the use of relevant methods and data. (“Toward the Development of Comprehensive Measures of the Burden of Morbidity and Mortality Among Workers: the use of Health-related Quality of Life (HRQL) metrics,” Washington, DC, June 2012.)

NIOSH partners with Canada to identify emerging issues in occupational safety and health economic studies. This workshop brought researchers from Canada and the United States together to discuss current and emerging issues relating to occupational safety and health economic studies. The result was a better understanding of how economic studies contribute to worker safety and health, and the methodological issues in economics studies. Researchers identified opportunities for future collaborative research. (Workshop on the Economics of Occupational Safety and Health, Montreal, Canada, September 2016.)

Injury Prevention

The National Occupational Injury Research Symposium (NOIRS) advances partnerships in injury prevention. NIOSH partnered with the National Safety Council, the American Society of Safety Engineers, Liberty Mutual Research Institute for Safety, and the Society for Advancement of Violence and Injury Research to bring more than 250 researchers, safety professionals, and students from six countries, representing government, universities, research institutes, the private sector, labor, and non-profit or nongovernmental organizations together to discuss research needs, fostering information sharing and discussions across disciplines, encouraging student participation, and promoting dialogue between researchers and practitioners. (NOIRS, Kingwood, WV, May 2015.)

Exposure Assessment

NIOSH workshop on direct-reading exposure assessment methods leads to identified gaps in science and research priorities. This NIOSH workshop, which focused on research needs related to direct reading methods for assessing occupational exposures, resulted in gaps being identified in currently available technology for real-time exposure methods. Additionally, research

priorities were identified for direct-reading method research by occupational agent hazard class. (The Direct-Reading Exposure Assessment Methods (DREAM) Workshop. Arlington, VA. November 2008.)

Total Worker Health®

International symposium partners with more than 17 organizations to ignite follow-on research. This symposium built on past meetings to advance the research and translation of Total Worker Health® concepts and best practices. This meeting advanced the science and translation of total worker health integration, resulting in a well-informed community of scientists and practitioners in occupational health, health promotion, and numerous others fields. Survey results demonstrated the meeting also increased the collaboration and partnerships of this diverse audience. (1st International Symposium to Advance Total Worker Health. Bethesda, MD. October 2014.)

Workshop evaluates state of the science in total worker health and future research direction. NIOSH partnered with the National Board of Industrial Hygiene and the National Heart, Lung and Blood Institute to convene a workshop to evaluate the current state of knowledge on integrated approaches to worker safety, health, and well-being. The workshop also plotted the direction for future research. A federal stakeholders meeting will identify next steps. (National Institute of Health Pathways to Prevention Workshop: Total Worker Health—What's Work Got to Do With It?, Bethesda, MD, December 2015.)

Worker's Compensation

Partnership workshops on workers' compensation result in new direction and new research center. These workshops fostered closer collaboration among partners in workers' compensation, including many economists from and outside NIOSH. The workshops ultimately created the NIOSH Center for Workers' Compensation Studies (CWCS). Because of the workshop interactions, a closer collaboration of economists and epidemiologists was achieved that has benefited several areas of research, including updating and improving burden estimates. Workers' compensation workshops established the direction for new NIOSH Workers' Compensation Studies and generated renewed interest in using workers compensation data for prevention purposes. (Workshop on Use of Workers' Compensation Data for Occupational Injury and Illness Prevention, Washington, DC, September 2009; Workshop on the Use of Workers' Compensation Data for Occupational Safety and Health, Washington, DC, June 2012; and NIOSH Workers' Compensation Leaders Research Colloquium, Washington DC, December 2014.)

Work Stress and Health

International conference series on work stress and health build research partnerships and ignite research. During the second decade of NORA, NIOSH cosponsored a premier international conference series on work organization and stress with the American Psychological Association (APA) and the Society for Occupational Health Psychology (SOHP). These conferences have been

FLOOR FINISHER SAFETY

NIOSH-funded research contributed to Massachusetts adopting a law to reduce the risk of serious or fatal burns for floor-finishing workers from flammable chemicals.

ROAD WORKER SAFETY

NIOSH work contributed to a new standard from the American National Standards Institute to protect highway construction workers (Standard A10.47, Work Zone Safety for Highway Construction).

influential in moving forward the field of occupational stress research. Conferences have led to publishing and disseminating conference abstracts on work organization and stress interventions, as well as dissemination studies. Much of the work presented at these conferences is later published in the scientific literature. (*Work, Stress, and Health* 2006, 2008, 2009, 2011, 2013, 2015, www.apa.org/wsh.)

THIRD DECADE OF NORA (2016–2026)

The third decade of NORA was launched on October 1, 2016, building on the many successes and lessons learned from the first two decades of this unique partnership approach to setting the research course for occupational safety and health. These guiding questions will frame the work of the third decade:

What research should be done in 2020 and beyond?

Can an efficient and effective structure be found to identify and integrate research priorities?

NORA enters the third decade with an enhanced structure. The 10 sectors formed for the second decade will continue to prioritize occupational safety and health research by major areas of the U.S. economy. Seven cross-sectors will also be organized according to the major health and safety issues affecting the U.S. working population.

NIOSH and its partners will form [NORA councils](#) for sectors and cross-sectors, including participants from academia, industry, labor, and government. Each council will draft strategic objectives for the nation in NORA agendas. These agendas will give guidance to the entire occupational safety and health community for moving research to practice in workplaces.

More will be revealed as the decade unfolds. This review of the second decade of NORA will help inform the direction and scope of the next 10 years of doing the most important work to protect the health and safety of the workforce.

METH RESIDUE

NIOSH worked with the state health departments in Cincinnati and Colorado, as well as SKC, Inc., the National Jewish Medical and Research Center, and Colorado law enforcement agencies, to develop a method to detect methamphetamine residues and toxins contaminating surfaces often found in the labs during and after cleanup. A company successfully licensed and commercialized the product for release to first responders and other agencies.



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APPENDIX A: SELECTED IMPACTS OF THE SECOND DECADE OF NORA

Impact stories collected from the NIOSH sector and cross-sector programs, NORA sector councils, and public comments provide insight into the work accomplished during the NORA second decade. Additional impact stories were collected from NIOSH impact sheets, [Bullard-Sherwood Awards](#) and intramural and extramural research projects.

These impact statements show five major types of impact:

- NIOSH research used in setting standards, guidance, or policy
- NIOSH recommendations adopted by manufacturers, trade associations, or others
- NIOSH technology adopted
- Other researchers build on knowledge to pursue additional research or service
- External organizations disseminate outputs

Most impacts fall into the first two categories: NIOSH research used in setting standards, guidance or policy (30%), and NIOSH recommendations adopted by manufacturers, trade associations, or others (47%). Other impacts were evenly distributed across the other three categories (8–9% each). These data are evidence that NIOSH work is translated into better practices and standards to protect the health and safety of the workforce. Individual impact statements in all of these categories are described below.

NIOSH Standards, Guidance, and Policy Impacts

Impact Stories

NIOSH research with other organizations provided science-based evidence for the American Society of Agricultural and Biological Engineers (ASABE) to develop a consensus document (Performance Standard X-599) to protect farmworkers from serious injury or death in tractor rollovers. ASABE developed the document in 2010 and reaffirmed it in 2014.

NIOSH research led the International Organization for Standardization to develop an international standard to protect forest-machinery operators from thrown objects. The standard calls for improving the machinery's window glazing.

Impact Stories

The NIOSH state-based SENSOR-Pesticide program provided the U.S. Environmental Protection Agency with information to improve worker protection from harmful pesticides. In addition, SENSOR and another NIOSH project to prevent pesticide contamination in workers' homes contributed to the North Carolina Pesticide Board's decision to continue surveillance for pesticide poisoning and to veto a proposal that would ease restrictions on aerial pesticide application.

NIOSH work contributed to a new standard from the American National Standards Institute to protect highway construction workers (Standard A10.47, Work Zone Safety for Highway Construction).

NIOSH research on construction-related hearing loss helped the Occupational Safety and Health Administration develop an interactive, web-based training site to protect workers.

NIOSH-funded research contributed to Massachusetts adopting a law to reduce the risk of serious or fatal burns for floor-finishing workers from flammable chemicals.

NIOSH research to protect healthcare workers contributed to needle-stick regulations in 21 states, new regulations on safe patient handling in 11 states, and new standards on safe patient handling at the American Nurses Association.

NIOSH-developed training modules on preventing workplace violence help protect workers by instructing nursing students on how to prevent workplace violence and contributing to the state of New Jersey enacting a law to help protect workers.

NIOSH recommendations to reduce healthcare workers' exposures in preparing and administering hazardous drugs helped healthcare facilities improve their procedures, as well as helped lead to a new law to protect workers in Washington state.

A NIOSH device that better predicts the risk of coal dust explosion from coal mine dust samples led to improved safety for coal miners. The Mine Safety and Health Administration increased the fireproof requirement for rock dust in mine-intake airways, and rock-dust manufacturers, suppliers, and mine operators made changes to ensure that the rock dust used to prevent explosions meets size specifications.

NIOSH research and development of an LED Cap Lamp led to the International Electrotechnical Commission updating its standards to ensure that future cap lamps provide greater visibility and safety for miners.

Impact Stories

The NIOSH Coal Workers Health Surveillance Program, which offers free chest X-rays and lung testing for black lung disease to all coal miners, found that former miners were significantly more likely than current miners to have the disease. These findings prompted the Mine Safety and Health Administration to expand its prevention efforts.

A NIOSH study on reducing diesel exhaust and particulate matter emitted by mining equipment led to a new 2013 document, "Hazard Alerts for Diesel Exhaust/Diesel Particulate Matter," from the Mine Safety and Health Administration and the Occupational Safety and Health Administration.

NIOSH work contributed to the Mine Safety and Health Administration's updated policy on specific methods, including scrubber use and deep cutting, to reduce airborne coal mine dust during the mining process known as continuous mining.

NIOSH investigations contributed to the Food and Drug Administration's proposed rule (72 FR 8643) that would require testing of portable medical oxygen-delivery systems to ensure the devices are not flammable.

NIOSH fire investigations led to increased fire fighter safety:

- State and local regulations cited a NIOSH alert to require clear marking of lightweight roof and floor trusses.

- Fire departments improved training.

NIOSH research contributed to National Fire Prevention Association updated standards in several areas of fire-fighter safety, including Structural Fire Fighting and Proximity Fire Fighting, Protective Clothing and Equipment, and Electronic Safety Equipment for Emergency Responders.

NIOSH studies provided the methodology for a new American Society for Testing and Materials standard for preventing risk of fire fighters suffering burns from heat building up in their protective clothing.

NIOSH research contributed to new standards and improved ambulance design to protect emergency medical workers.

NIOSH studies of emergency-room injuries found that protective lock out/tag out devices improve safety, leading to the U.S. Department of Labor's proposed revisions to child labor regulations.

NIOSH research on the hazardous chemical isocyanate improved safety for auto workers by informing new ISO methods and standards.

Impact Stories

A NIOSH analysis of data from the Bureau of Labor Statistics contributed to the Occupational Safety and Health Administration removing a previous exemption that allowed injuries and illnesses among school caterers to go unreported.

NIOSH surveyed long-haul truck drivers, finding unhealthy weights and long work hours. The research contributed to improved work conditions, including updated Hours of Service regulations at the Federal Motor Carriers' Administration and wellness programs at private companies.

NIOSH research found that in-cab cameras help protect taxi cab drivers from assault and robbery. The research contributed to improved regulations within some municipalities.

NIOSH information on preventing work-related silica exposure provided scientific information for the Occupational Safety and Health Administration's silica dust rule making.

NIOSH studies of work-related cancer deaths provided information that helped the International Agency for Research on Cancer to classify additional chemicals as known human carcinogens.

NIOSH work contributed to an American Society for Testing and Materials standard for using a technique, called ICP-MS, to measure toxic metals in airborne substances.

A NIOSH document, "Components for Direct Reading Instruments for Gases and Vapors," contributed to a new ISO standard to improve monitoring for dangerous airborne substances.

The NIOSH and partners' program, "Preventing Occupational Transmission of Blood borne Pathogens Among Healthcare Workers," helped improve worker safety internationally by instructing more than 20,000 trainers and leading to new regulations.

NIOSH helped the National Health and Nutrition Examination Survey improve surveillance of work-related hearing loss, which contributed to a new ISO standard.

NIOSH research on chemicals that can damage hearing contributed to actions by several organizations, including the American Conference of Governmental Industrial Hygienists, the American College of Occupational and Environmental Medicine, and the U.S. Army Center for Health Promotion and Preventive Medicine.

Impact Stories

NIOSH research with collaborators on hearing-protection devices contributed to a proposed rule by the U.S. Environmental Protection Agency.

NIOSH research on noise-related hearing loss contributed to standards from the U.S. Department of Defense, American National Standards Institute, and the U.S. Department of the Interior.

A NIOSH study on hand-arm vibration syndrome contributed scientific information to the revisions of national standards by the American National Standards Institute and the International Organization for Standardization.

A NIOSH study on work-related arm disorders contributed to WorkSafe British Columbia's new policy on musculoskeletal disorders (#27.00–27.40).

NIOSH recommended exposure levels for carbon nanotubes and titanium dioxide provided the U.S. Environmental Protection Agency with information to develop regulations to protect workers who handle engineered nanomaterials.

NIOSH work contributed to several groups issuing improved standards for respirators and respirator equipment. These groups include the Mine Safety and Health Administration, the National Fire Protection Association, the International Organization for Standardization, the American National Standards Institute, and the American Society for Testing and Materials.

A NIOSH calculator that helps analyze personal protective equipment's protection against chemicals contributed to a new standard from the American Society for Testing and Materials.

NIOSH study results are included in an American Industrial Hygiene Association guideline for decontaminating personal protective clothing and equipment after use.

NIOSH research contributed to a 2008 standard from the American Society for Testing and Materials for determining physiological stresses from wearing personal protective clothing ensembles.

NIOSH methods to measure protective clothing's resistance to nanoparticles contributed to new guidance documents, requirements, and test methods from other government agencies, organizations, and manufacturers.

Impact Stories

NIOSH work contributed to several organizations developing new methods to measure the effectiveness of respirator decontamination. These organizations include the International Organization for Standardization, the American National Standards Institute, and the American Society for Testing and Materials (ASTM E2720-10 and E2721-10).

NIOSH findings contributed to the Occupational Safety and Health Administration reforming its respiratory protection standard.

NIOSH principles to protect workers through workplace design are included in a revised standard from the American National Standards Institute.

NIOSH research to protect workers from coal mine dust significantly contributed to a final rule from the Mine Safety and Health Administration.

NIOSH Recommendations Impact Manufacturers, Trade Associations and Others

Impact Stories

NIOSH research on using digital lung X-rays to classify occupational dust diseases significantly contributed to new standards and rules from the International Labour Organization and the U.S. Department of Labor's Office of Workers' Compensation Programs.

NIOSH research and recognition that occupational exposure to the butter flavorings diacetyl and 2,3 pentanedione are associated with significant risk for a serious, irreversible lung disease increased public awareness and efforts to improve worker protection. For example, the Occupational Safety and Health Administration started a special emphasis program on diacetyl in 2009, and then proposed rulemaking, and the state of California adopted standards in 2010.

NIOSH work on the leakage of contaminants into enclosed tractor cabs contributed to the American Society of Safety Engineers revising a standard to remove all statements regarding the use of enclosed tractor cabs in lieu of more protective respirators.

NIOSH studies of beryllium's health effects led to Materion and the United Steelworkers' union adopting and recommending to the Occupational Safety and Health Administration a consensus standard for a lowered permissible exposure limit for the metal.

Impact Stories

A NIOSH Science Blog with New Jersey state partners about silica exposure from fabricating engineered stone countertops led to increased protection for workers. For example, NIOSH and the Occupational Safety and Health Administration published a hazard alert, and the state of Texas identified a silica case, which NIOSH investigated on request.

Results from the NIOSH SENSOR-Pesticides program contributed to the U.S. Environmental Protection Agency updating its pesticide Worker Protection Standard.

NIOSH released a health hazard alert with the Occupational Safety and Health Administration to bring national attention to an issue, based on a Michigan report, of worker deaths from overexposure to the chemical methylene chloride while stripping bathtubs.

A NIOSH evaluation and other information about fatal falls from telecommunication towers contributed to the North Carolina Department of Labor releasing a new standard.

NIOSH research and expertise contributed to the National Fire Protection Association and other groups adopting improved standards for safer products, including firefighter self-contained breathing apparatus, ambulances, and truck cabs.

NIOSH science contributed to new federal, state, and municipal regulations to protect workers, including federal child labor law revisions, state workplace violence prevention laws, city ordinances for taxicab cameras, and the Occupational Safety and Health Administration's new recordkeeping rule, Youthbuild.

NIOSH information on baler hazards informed the American National Standards Institute when revising its standard on baling equipment safety.

Concepts from the NIOSH Prevention through Design (PtD) initiative have been added to more than 25 consensus standards. Among the groups developing these consensus standards are the American National Standards Institute (ANSI), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), American Society of Safety Engineers (ASSE), American Industrial Hygiene Association (AIHA), Underwriters Laboratory (UL), Semiconductor Equipment and Materials International (SEMI), and the International Organization for Standardization (ISO).

The NIOSH-funded New York Fatality Assessment and Control Evaluation program led to new worker protections in the state.

Impact Stories

A NIOSH collaboration with the U.S. Coast Guard led to the fishing industry improving practices for personal flotation devices and hatch monitors.

NIOSH research led to the National Marine Fisheries Service opening a Notice of Proposed Rulemaking in April 2011 to protect workers at sea (Standard 10 Guidelines).

NIOSH work contributed to a drug manufacturer's improved product labeling for veterinarians, livestock farmers, and other workers to avoid unintended, potentially lethal self-injection when administering an animal antibiotic.

NIOSH sample traffic-control plans for road-construction areas contributed to federal and state training modules and best practice guidelines.

NIOSH diagrams for blind areas in road construction areas helped improve worker safety.

NIOSH launched the National Construction Falls Campaign with the Occupational Safety and Health Administration and CPWR — The Center for Construction Research and Training to decrease fall-related injuries among construction workers.

NIOSH work contributed scientific information to training and literature designed to prevent nail-gun injuries among construction workers.

NIOSH work with the U.S. Green Building Council to improve worker safety during and after building construction led to the Council adopting the Prevention through Design approach.

NIOSH work contributed to a New Jersey mandate that state-funded contractors improve fall-protection measures.

NIOSH worked with equipment manufacturers and standards committee to protect workers from falls from aerial lifts.

NIOSH research to prevent construction-related falls contributed scientific information to better worker protection when two manufacturers modified harness designs and developed new harnesses to prevent falls, and the American National Standards Institute updated its fall prevention and protection standards.

Impact Stories

NIOSH work to protect school-renovation workers from exposure to the chemical polychlorinated biphenyl, or PCB, contributed to efforts by companies to reduce workers' exposure.

NIOSH recommendations adopted by healthcare facilities help protect workers by reducing exposure to disinfectants that can cause health problems.

NIOSH recommendations adopted by the Occupational Safety and Health Administration help improve the health and safety of home healthcare workers.

NIOSH studies of health effects related to filtering face-piece respirators contributed to new guidance from national and international groups, including the World Health Organization, the Food and Drug Administration, and the Institute of Medicine.

NIOSH suggestions contributed to an American Nurses Association's position statement to improve health and safety for nurses ("Addressing Nurse Fatigue to Promote Safety and Health: Joint Responsibilities of Registered Nurses and Employers to Reduce Risks").

A NIOSH training resource led to mining companies implementing accommodations to reduce hazards for older miners.

NIOSH diesel-emissions control strategies and technologies have been widely implemented by U.S. underground mining companies.

NIOSH work led to a mining stakeholder implementing the Institute's buffer design, which increases safety when rock blasting.

NIOSH and the Industrial Minerals Association–North America developed a handbook for reducing miners' silica exposures.

NIOSH research to improve mine safety led to industry using three different methods to check mine ventilation, well test analyses, and protocol development.

NIOSH findings of potential silica exposure during hydraulic fracturing led to a joint workgroup between NIOSH and industry partners to develop ways to control this hazard.

NIOSH and partners developed a guide for reducing motor vehicle fatalities that the International Oil and Gas Producers adopted.

Impact Stories

A NIOSH project to protect workers from hearing loss led to the shipbuilding industry using its training and recommendations.

NIOSH work to protect workers from exposure to the chemical styrene led a wind blade manufacturer to change its design, reducing exposure during a procedure known as glue wiping.

NIOSH and partners developed educational materials to prevent injury among New Jersey crossing guards, and state police departments and employers requested additional copies and reported taking steps to provide required personal protective equipment.

NIOSH worked with several police departments on a study that found fewer sexual and reproductive problems among patrol officers using no-nose bicycle seats compared to traditional seats. Based on these results, one police department ordered 400 no-nose seats for its patrol officers.

A NIOSH pilot project led to the National Highway Traffic Safety Administration improving surveillance of emergency medical services crashes.

NIOSH studies of firefighter exposures to gases, vapors, and particles led fire crews to require self-contained breathing apparatus worn throughout firefighting.

A NIOSH study of the size of current firefighters provided fire apparatus and personal protective equipment manufacturers with data for updating their designs.

A NIOSH study of a restaurant-safety e-tool led the Occupational Safety and Health Administration to revise it to improve its relevance to young Hispanic and African-American restaurant workers.

The NIOSH safety checklist program improved protections for school workers after adoption by the Massachusetts Department of Education, the state of Michigan, and the World Health Organization.

The “NIOSH School Chemistry Laboratory Safety Guide” protects more chemistry teachers and students after adoption by the Occupational Safety and Health Administration, the American Industrial Hygiene Association, the National Science Teachers Association, and high school programs.

A NIOSH-funded, state-based Fatality Assessment and Control Evaluation improved safety for mechanics who work on vehicles with left-accelerator pedals. For example, a manufacturer changed its design to prevent auto mechanics from accidentally depressing the left accelerator instead of the brake, and a car dealership instituted administrative controls to protect personnel servicing a car with a left-accelerator pedal.

Impact Stories

Protecting more than half a million postal workers, NIOSH developed engineering controls implemented by the U.S. Postal Center to reduce the risk of anthrax exposure from contaminated mail in processing centers.

NIOSH research on radiation safety led to the U.S. Customs and Border Protection Agency adopting Institute-developed training materials, and to the Transportation Security Administration accepting NIOSH risk information.

NIOSH work to protect truck drivers led to some trucking companies adopting the Institute's fatigue-training webpage for driver education.

NIOSH work with industry partners to improve truck-driver safety by compiling accurate body measurements of truck drivers led to some manufacturers using these measurements to redesign their truck cabs.

To prevent deaths related to commuter and taxi airplanes in Alaska, NIOSH and partners developed and implemented best-practice guidelines.

NIOSH research on commuter and taxi airplane accidents in Alaska led the National Oceanic and Atmospheric Administration to place weather cameras throughout the state.

NIOSH research on reducing boat workers' exposure to carbon monoxide led some boat manufacturers to improve their vessel design.

NIOSH and partner-sponsored workshops introducing retailers to equipment manufacturers led to efforts to prevent muscle and bone injuries among retail workers.

NIOSH research to protect young and inexperienced workers led to a curriculum that stakeholders use to help these workers stay safe on the job.

NIOSH research on radiation exposure at work led to the Occupational Safety and Health Administration's request for the risk-assessment information.

A NIOSH publication on a technique, known as control banding, that manages workplace risks was the basis of the American Industrial Hygiene Association's 5-year strategic plan, which identifies control banding as a top priority.

The NIOSH-developed control-banding process of workplace-risk management informs some stakeholders' emergency-preparedness plans.

A NIOSH software model helps the U.S. Environmental Protection Agency identify work-related risks.

Impact Stories

The NIOSH “Talking Safety” curriculum helps many organizations and school systems teach students about work safety. For example, Oregon State University uses Talking Safety to teach 4-H summer school students basic workplace safety and health skills, and Florida and Oklahoma use Talking Safety in their schools.

NIOSH compiled findings identifying hazardous chemical exposure levels in its *Current Intelligence Bulletin 66: Derivation of Immediately Dangerous to Life or Health*. Stakeholders such as the American Industrial Hygiene Association, the American Society of Safety Engineers, and the World Health Organization adopted these findings to protect workers.

A NIOSH study with three companies that identified sources of acrylamide exposure led to the companies changing their operation procedures to lower workers’ exposures.

NIOSH research that found fewer sexual and reproductive problems among patrol officers using no-nose bicycle seats compared with traditional seats led police departments in Seattle, WA; San Antonio, TX; Miami, FL; and Chicago, IL; to offer no-nose saddles as standard equipment for bicycle patrols.

A NIOSH-developed cost-collection strategy helps businesses like Ford Motor Company to determine costs of work-related injuries and illnesses.

NIOSH developed the “Emergency Responder Health Monitoring and Surveillance” document, leading to the National Response Team adopting and implementing it based on NIOSH training.

A NIOSH environmental sampling toolkit and training materials help employers train emergency first responders.

The *NIOSH Manual of Analytical Methods* continues to provide practitioners in the United States and internationally with new ways to monitor work-related exposures.

A NIOSH method, validated by other laboratories, provides industrial hygienists with a tool to assess exposure to beryllium oxide.

NIOSH research validated the Occupational Safety and Health Administration’s way of sampling for the flavoring diacetyl. More researchers and industrial hygienists are now using that approach.

Impact Stories

NIOSH and other agencies used the Institute's environmental-sampling software in a full-scale Idaho National Laboratory bioterrorism-response exercise.

NIOSH recommendations for sampling wood dust led to the American Forest & Paper Association accepting this methodology.

NIOSH and other organizations helped Chile establish its National Program to Eliminate Silicosis by starting a regional silica analytic laboratory, assessing silica-related risks in workplaces, and giving trainings in reading X-rays, testing lung function, and assessing workplace risks.

NIOSH helped sponsor the first International Conference on Workers on Roads, held in Washington, DC, in 2009, leading to new United Nations clauses about road safety for workers.

A NIOSH study with boat manufacturers led to several manufacturers reducing styrene and noise exposure with engineering controls.

NIOSH studies and its Buy Quiet campaign contributed to an expanding market for quieter tools.

NIOSH efforts to prevent work-related hearing loss led to the American College of Occupational and Environmental Medicine and the Department of the Interior adopting the Institute's recommendation to use the 8 kHz frequency to monitor workers.

NIOSH developed a new strategy to prevent work-related chemical exposure of skin (*Current Intelligence Bulletin 61: A Strategy for Assigning New NIOSH Skin Notations*), which the American Industrial Hygiene Association, U.S. Navy, and the World Health Organization adopted.

A NIOSH web-based calculator is a tool that industrial hygienists use to estimate absorption after brief exposure to the skin of workplace chemicals.

NIOSH responded to a request from the Occupational Safety and Health Administration (OSHA) to clarify how the skin absorbs nicotine from electronic cigarettes, contributing scientific information to OSHA developing a compliance action with an electronic-cigarette manufacturer.

Impact Stories

NIOSH research on preventing hand-arm vibration syndrome contributed scientific information to new national standards for testing and certifying anti-vibration gloves, which led to the General Services Administration recommending that gloves be certified and to the LeBlanc Building Co. incorporating a hand-tool document in its employee training.

The NIOSH model for work-related biomechanics (6DHAND) provided information that the company BioMotion of America used to develop protocols for when workers can return to work after an injury.

NIOSH work led to the Occupational Safety and Health Administration and the Environmental Protection Agency developing recommendations for working with multi-walled carbon nanotubes.

The NIOSH virtual Nanotechnology Research Center has supported or influenced more than 90 researchers in pioneering studies to better understand potential occupational health and safety risks in the nanotechnology industry, and to incorporate effective precautions as the industry grows.

NIOSH research to improve the design and fit of personal protective equipment informs manufacturers of respirators for healthcare workers, gear for firefighters, and fall protection harnesses for construction workers.

NIOSH work provided the basis for parts of a respirator-safety video from the Occupational Safety and Health Administration to show workers how to properly put on and take off a respirator.

NIOSH work to measure nanoparticles penetrating respirators informs researchers and organizations developing new or revised standards in this area.

NIOSH software helps universities, manufacturers, and occupational-safety workers develop training programs to identify when a respirator cartridge stops working.

NIOSH efforts led, in part, to three dry-cleaning companies adopting a “wet cleaning” process to reduce worker exposures to chemicals in dry cleaning.

NIOSH research with Brush Wellman Inc. to protect workers from exposure to beryllium led to the company implementing a comprehensive exposure-prevention program.

NIOSH work, in part, led to the U.S. Air Force commissioning a National Academies review of beryllium.

Impact Stories

NIOSH research on dust-exposure biomarkers led to the U.S. Department of Defense developing ways to assess risk and prevent exposure in Iraq.

NIOSH research led to the American Thoracic Society starting a workgroup and publishing an official statement on work-related asthma.

The NIOSH blood-lead surveillance program, ABLES, identified unsafe conditions and industries, and the Occupational Safety and Health Administration used this information to update its “National Emphasis Program–Lead” to reduce work-related lead exposure.

NIOSH and the states coordinate procedures to help compile national work-related data for death certificates.

The NIOSH National Occupational Mortality Surveillance system, which emphasizes the importance of including occupation on death certificates, contributed to the Colleges of Mortuary Science modified curriculum.

NIOSH recommendations for preventing diseases identified through medical claims data provide information that health insurers use to develop reports and that employers use to develop priorities and prevention plans.

Maryland’s local occupational health faculty members use the new NIOSH-funded state-based Occupational Health and Safety Surveillance Program indicators website to teach about occupational safety and health.

Several states added Industry/Occupation questions to their state’s version of the Behavioral Risk Factor Surveillance System (BRFSS) in 2012 based on NIOSH recommendations.

Academic, state, federal and other groups use the NIOSH online Occupational Injury and Illness Classification System to interpret occupational injury statistics and assign codes in occupational injury surveillance systems.

NIOSH created training materials for law enforcement agencies to reduce workplace violence and related injuries in the retail industry. Police agencies in at least five cities are already using the materials.

NIOSH consulted with and assisted federal agency partners, such as Office of Personnel Management and Veterans Health Administration, to incorporate and advance the policies, programs, and practices of the NIOSH initiative known as Total Worker Health®.

NIOSH Technology Adopted

Impact Stories

NIOSH, states, manufacturers, farm organizations, and individuals partnered to test, validate, and increase farmers' awareness of cost-effective roll-over protection systems to reduce risk of serious injury or death in a tractor overturn. NIOSH and partners also encouraged market incentives to install the systems.

Building on NIOSH partnerships to protect commercial fishermen from entanglement and death in winches on fishing vessels, all three major manufacturers of capstan winches in the Pacific Northwest now provide NIOSH-developed emergency E-Stops as standard safety features on their new seine winches. Captains are installing the system, and NIOSH has created a training video with real commercial fishermen who promote winch and deck safety awareness.

NIOSH developed the Ladder Safety Smartphone Application (more than 50,000 downloads by the end of 2015). Workers with smartphones can easily download the application (app) on the job site and use it to help them position ladders at the correct angle to prevent serious fall injuries.

Manufacturers have shown interest in commercializing the patented NIOSH roof-bracket guard-rail system, and the Roofers' Union requested more than 100 additional brochures describing the system to distribute to instructors in the union's apprenticeship program.

Resulting from a major collaboration by NIOSH and diverse partners, asphalt milling manufacturers signed an agreement promising that all new asphalt milling machines sold to the U.S. market will have controls in place to keep silica dust levels below occupational exposure limits by January 1, 2017.

In 2007, a U.S. company offered a simple, reliable, NIOSH-developed wipe method to the healthcare market for removing lead contamination from the skin before collecting blood samples to measure blood lead levels. The method was also offered to the industrial market for removing lead contamination from skin and workplace surfaces.

An instrument company commercialized the NIOSH Coal Dust Explosibility Meter (CDEM) to evaluate coal mine dust samples in real-time to help keep coal dust levels below concentrations that can pose the risk of combusting and propagating a methane explosion. The Mine Safety and Health Administration's approved this meter in 2011.

Impact Stories

Government, industry, and labor representatives collaborated to assess the challenges of improving underground mine communications and tracking technologies that are vital for locating and rescuing miners trapped after a mine cave-in. Systems developed through NIOSH funding and research account for a significant percentage of installed communications systems, and NIOSH funding of fundamental research stimulated the development of additional systems, which have also been accepted by the Mine Safety and Health Administration and installed by mining companies.

NIOSH and public sector mining partners created the Collapsible Drill Steel Enclosure (CDSE), which absorbs sound to reduce roof-bolting machine noise, reduces time-weighted noise exposures during 8-hour work shifts, and reduces the potential for noise-induced hearing loss for miners.

The NIOSH Personal Dust Monitor led to increased efforts to protect mine workers from coal-dust exposure. The Mine Safety and Health Administration's updated regulations specify the monitor's use for compliance dust sampling, and a private company commercialized the monitor.

After NIOSH developed a real-time instrument for measuring diesel engine particulates in an effort to reduce metal and non-metal mining workers' exposures, companies began using it to analyze working conditions and improve exposure control.

Coal mining companies have embraced an in-mine nitrogen gas generation system that a commercial seller of gas generation equipment developed with NIOSH funding.

At least one company commercialized NIOSH technology to allow multiple air sources to be attached to a self-rescuer respirator without breaking the seal and compromising performance.

NIOSH worked with the state health departments in Cincinnati and Colorado, as well as SKC, Inc., the National Jewish Medical and Research Center, and Colorado law enforcement agencies, to develop a method to detect methamphetamine residues and toxins contaminating surfaces often found in the labs during and after cleanup. A company successfully licensed and commercialized the product for release to first responders and other agencies.

NIOSH developed a Hearing Loss Simulator (HLS), a software training and communication tool that demonstrates the effects of noise exposure on a worker's hearing without exposure to harmful noise levels. The real-life scenarios of this software are designed to raise awareness, increase motivation for hearing loss prevention, and reduce the number of people who suffer from hearing loss. OSHA and other organizations are utilizing and recommending the HLS.

Impact Stories

NIOSH's new web-based Industry and Occupation Computerized Coding System (NIOCCS) speeds the standardized coding of industry and occupation into vital records, cancer registries, healthcare records, and other record systems. NIOCCS vastly improves the use of these sources for identifying the toll of work-related illnesses and injuries and identifying trends in types, numbers, and rates of occupational injury and illness for better prevention.

NIOSH Research Builds Knowledge Base and Impacts New Research by Others

Impact Stories

The University of Iowa initiated further research on take-home pesticide exposure, with a study protocol largely developed based on the results from a NIOSH study.

Researchers and professional societies used NIOSH-generated knowledge and simulation methods to develop innovative and practical strategies to prevent falls. These strategies include developing and deploying graded lumber and the incorporating of a plywood/sheeting overlay on the planks to provide the minimum weight protection as required by OSHA. The New Jersey Turnpike Authority adopted the method in 2009 and has since added contract language specifications for temporary catch platforms for contractors bidding on related projects.

NIOSH, OSHA, CPWR—the Center for Construction Research and Training, labor, and industry partnered on a National Safety Stand-Down To Prevent Falls in Construction in 2014 and again in 2015. These events gave guidance and resources for preventing painful, disabling, or fatal fall injuries. About 1 million workers and 25,000 businesses participated.

Researchers and practitioners furthered injury and illness prevention in the wholesale and retail trade sector, based on several key NIOSH publications that outlined key threats to and solutions for worker safety and health in the sector.

Evaluation of a NIOSH human lung dosimetry model by independent researchers in the United Kingdom and European Union found substantial improvement in fit to two new data sets on long-term clearance and retention of respirable particles in humans. Subsequently, the NIOSH computer model is being incorporated into the next revision of the International System of Radiological Protection to inform future versions of national standards and guidance worldwide.

Impact Stories

Based on NIOSH studies, several universities collaborated on or conducted independent research on aircraft cabin ventilation and potential disease transmission to better understand and address flight crews' risk for infection.

Researchers use NIOSH's two-stage personal cyclone sampler to measure airborne viruses in pig barns, to sample grain dust mycotoxin, and to assess exposures on chicken farms.

Researchers adopted methods developed in a NIOSH study of bakery workers' sensitization to flour dust.

NIOSH scientists invented a way to suspend carbon nanotubes in air while controlling the concentration of particles. This was a true breakthrough because it was the first time a well-characterized controlled aerosol of a carbon nanotube had been generated, providing a resource for studies on these minute particles, whose properties and characteristics are not well understood.

Academics and researchers are using NIOSH findings to improve tuberculosis risk and prevention education in workplaces.

Respirator manufacturers and academics use NIOSH data on representative face and head sizes and shapes in the modern workforce when designing, sizing, and testing new respirator facepieces.

Other researchers utilize the findings from NIOSH studies to initiate new research on physiological countermeasures for firefighter personal protective equipment.

Researchers use NIOSH methods and information on developing, testing and evaluating end-of-service-life sensors for respirators.

The Lawrence Berkeley National Laboratory worked with NIOSH, using NIOSH population and computational genetic studies, to create a transgenic mouse model for laboratory experimental research on chronic beryllium disease. A commercial laboratory made the mouse available to researchers as of 2012.

Researchers have used findings from NIOSH lead surveillance analyses to target interventions or conduct further detailed lead analyses.

NIOSH Outputs Widely Disseminated by External Organizations

Impact Stories

Multiple influential organizations worked with NIOSH to develop and disseminate brochures and other educational materials to promote hearing conservation on farms.

The American Society of Safety Engineers and other construction partners and stakeholders disseminated a NIOSH trade journal article on culturally meaningful and effective safety training of Latino immigrant workers.

Healthcare professional practice organizations partnered with NIOSH to develop and market a web-based survey of healthcare workers. This gave respondents FAQs, tabular, and chart presentations of example results, and links to health and safety information germane to the healthcare sector.

The National Safety Council (NSC) collaborated on an r2p (research to practice) track at the annual NSC conference and on other efforts to disseminate NIOSH products and information.

The Occupational Safety and Health Administration, Department of Homeland Security, Environmental Protection Agency, World Health Organization, and other stakeholders have adopted or promoted use of many NIOSH products, including Fast Facts cards, Alerts, Workplace Solutions documents, and topic pages covering different hazards.

Industries shared their innovative noise programs with NIOSH and partners as part of the Safe-in-Sound award to identify and disseminate best practices.

Stakeholders learned about NIOSH guidance from other organizations, including the Occupational Safety and Health Administration, National Nanotechnology Initiative, National Institutes of Health, Massachusetts Labor and Workforce Development, Safe Work Australia, National Institute of Environmental Health Sciences, and American Chemistry Council.

Other organizations, including the Occupational Safety and Health Administration, National Institutes of Health and American College of Occupational and Environmental Medicine (ACOEM) helped disseminate information about NIOSH research and recommendations for minimizing exposures in the manufacturing and industrial use of nanomaterials, as well as conducting health surveillance of workers.

Impact Stories

Mexican consulates partner with NIOSH to provide improved occupational safety and health information to U.S. immigrants.

NIOSH recommendations for prevention through design were promoted by textbook publishers, the Occupational Safety and Health Administration, the American Industrial Hygiene Association, the American Society of Safety Engineers, the Transportation Research Board, and others in textbooks and engineering education modules.

The U.S. Department of Veterans Affairs and other veterans' organizations disseminated NIOSH information on return-to-work issues for veterans with Post Traumatic Stress Disorder.

The American Chemistry Council worked with NIOSH to design and evaluate a medical screening program for workers exposed to toluene diisocyanate (TDI), a chemical associated with acute and chronic health risks, and to assess exposure consistently across facilities where these chemicals are present.

OSHA collaborated with NIOSH to develop and disseminate information on choosing and using cleaning chemicals to reduce risks of chemical burns, rashes, asthma, and other adverse effects.

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APPENDIX B: NIOSH PROGRAM LEADERSHIP (2006–2016)

NIOSH Sector Program Leadership

Agriculture, Forestry, and Fishing

Pietra Check	Brian Curwin
George Conway	Brad Husberg

Construction

James Albers	Matthew Gillen
David Bang	Frank Hearl
Christine Branche	Jeffery Kohler
Scott Earnest	Nancy Romano
Elizabeth Garza	Nancy Stout

Healthcare and Social Assistance

Jim Boiano	Teri Palermo
Megan Casey	Eileen Storey
John Decker	David Weissman
Susan McCrone	

Manufacturing

Michael Baskett	Lynn Jenkins
Gayle DeBord	Greg Lotz
Rebecca Carlo	Thais Morata
Alberto Garcia	Mary Lynn Woebkenberg
Mike Gressel	

Mining

Pam Drake	Susan Moore
Gerry Finfinger	Drew Potts
Anthony Iannacchione	Randy Reed
Mike Jenkins	Adam Smith
Jeffery Kohler	David Snyder
Eric Lutz	Jeff Welsh
R.J. Matetic	Mike Werner

Oil and Gas Extraction

Tricia Boyles	Ryan Hill
David Caruso	Nicole Mode
George Conway	Kyla Retzer

Public Safety

Les Boord	Bill Haskell
Corey Butler	Jeff Palcic
Maryann D'Alessandro	Terri Schnorr
Renee Funk	David Utterback

Services

Luenda Charles	Hope Tiesman
Cherie Estill	David Utterback
Terri Schnorr	

Transportation, Warehousing and Utilities

Jan Birdsey	Jennifer E. Lincoln
Dawn Castillo	Stephanie Pratt
Elizabeth Dalsey	Audrey Reichard
Jim Helmkamp	Karl Sieber
Max Kiefer	Nancy Stout

Wholesale and Retail Trade

Vern Anderson	Donna Pfirmman
Anasua Bhattacharya	Rashaun Roberts
Long Nguyen	Paul Schulte

NIOSH Cross-sector Program Leadership

Health Outcome Cross-Sectors

Cancer, Reproductive, and Cardiovascular Diseases

Terri Schnorr	Doug Trout
Mary Schubauer-Berigan	

Hearing Loss Prevention

Amanda Azman	Mark Stephenson
Guner Gurtunca	Jim Thompson
R.J. Matetic	Dave Yantek
Bill Murphy	

Immune and Dermal Diseases

Stacey Anderson	Fred Frasch
Don Beezhold	Mike Luster
Scott Dotson	Al Munson

Musculoskeletal Disorders

Frank Buczek	Jessica Ramsey
Stephen Hudock	Dan S. Sharp
Thomas McDowell	Oliver Wirth
Albert E. Munson	

Respiratory Diseases

Jay Colinet	David Weissman
Paul Henneberger	Ainsley Weston
Steven Mischler	

Traumatic Injury

Dawn Castillo	Dan Hartley
Cammie Chaumont Menéndez	Christine Schuler
Jim Collins	Nancy Stout

Work Organization and Stress Related Disorders

Greg Lotz	Jessica Streit
Jeannie Nigam	Naomi Swanson
Steve Sauter	

Non-Health Outcome Cross-Sector Programs

Authoritative Recommendations

T.J. Lentz	Christine Whittaker
Paul Schulte	

Economics

Tim Bushnell	DeLon Hull
Frank Hearl	Rene Pana-Cryan
Steve Huddock	Tapas Ray

Emergency Preparedness and Response

John Decker	Joe Little
Lisa Delaney	Jim Spahr
Renee Funk	Ken Martinez
Margaret Kitt	Angela Weber

Engineering Controls

Gayle DeBord	Deborah Hirst
Ron Hall	Greg Lotz
Duane Hammond	

Exposure Assessment

Gayle DeBord	Cindy Striley
Mark Hoover	David Weissman

Global Collaborations

Marilyn Fingerhut	Leslie Nickels
Deborah Hoyer	Andrea Okun
Margaret Kitt	

Health Hazard Evaluations

Terri Schnorr	Allison Tepper
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Nanotechnology

Chuck Geraci	Paul Schulte
Laura Hodson	Aleksandr Stefanik

Occupational Health Disparities

Sherry Baron	Paul Schulte
Michael Flynn	Andrea Steege

Personal Protective Technology

Les Boord	Ed Fries
Chris Coffey	Colleen Miller
Maryann D'Alessandro	

Prevention through Design

Jonathan Bach	T.J. Lentz
Pamela Heckel	Rick Rhinehart
Donna Heidel	Paul Schulte
Laura Hodson	

Small Business Assistance

Garrett Burnett	Ray Sinclair
Tom Cunningham	Carol Stephenson
Amanda Harney	
Brenda Jacklitsch	
Paul Schulte	

Surveillance

Yvonne Boudreau

Corey Butler

Dawn Castillo

Margaret Filios

Renee Funk

Sara Luckhaupt

Jacek Mazurek

Linda McWilliams

John Myers

Terri Schnorr

Lee Sanderson

John Sestito

Eileen Storey

Marie Sweeney

Total Worker Health

Casey Chosewood

Heidi Hudson

Jeannie Nigam

Kelli Pierson

Anita Schill

Sara Tamers

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APPENDIX C: NORA SECTOR COUNCIL MEMBERS (2006–2016)

Agriculture, Forestry and Fishing Council

Marilyn Adams, Farm Safety for Just Kids

Noemi Avalos, NIOSH

Don Boswick, University of Utah

Ralph Bredl, Wisconsin dairy farmer

Chuck Brundage, AGCO Corporation

Roy Buchan, AIHA

Shari Burgus, Farm Safety for Just Kids

Geoff Calvert, NIOSH

Pietra Check, NIOSH

Marsha Cheyney, University of Iowa

George Conway, NIOSH

Brian Curwin, NIOSH

Steve Dearwent, NIOSH

Cornelius de Hoop, Louisiana State University

Michael DeSpain, John Deere & Company

Allison DeVries, Colorado State University

Howard Douglas, AGCO Corporation

Darrin Drollinger, Association of Equipment Manufacturers

Ellen Duysen, University of Nebraska

Jerry Dzugan, Alaska Marine Safety Education Association

Giulia Earle-Richardson, New York Center for Agricultural Medicine and Health

Janet Ehlers, NIOSH

Kimberly Faulkner, NIOSH

Sandy Freeland, University of California Davis

Deliana Garcia, Migrant Clinicians Network

John Garland, Garland and Associates

Brett Green, NIOSH

Mark Greskevitch, NIOSH

Paul D. Gunderson, Dakota Center for Technology-Optimized Agriculture

Dan Hair, Workers Compensation Fund Utah

David Hard, NIOSH

Bill Haskell, NIOSH

Dolores Huerta, Dolores Huerta Foundation

Sharon Hughes, National Council of Agricultural Employers

Bradley Husberg, NIOSH

Matt Keifer, National Farm Medicine Center

Karl W. Klotzbach, Case New Holland

Jennifer Koeman, National Pork Board

William Krycia, State of California Department of Industrial Relations

Greg Kullman, NIOSH

Kerry Leedom Larson, National Pork Board

Barbara Lee, Marshfield Clinic Research Foundation

Lurilla Lee, Trident Seafoods

Jennifer M. Lincoln, NIOSH

Devin Lucas, NIOSH

Dennis Lynch, NIOSH

Kathleen MacMahon, NIOSH

Murray Madsen, National Institute for Farm Safety

Jacek Mazurek, NIOSH

John Miles, University of California Davis

Mary Miller, Washington State Department of Labor and Industries

Dennis Murphy, Penn State University	James Antonini, NIOSH
Mel Myers, University of Kentucky	Charles Austin, Sheet Metal Occupational Health Institute Trust
John Myers, NIOSH	Robin Baker, CPWR–The Center for Construction Research and Training
Matt Nonnenmann, University of Iowa	David Bang, NIOSH
Risto Rautiainen, University of Nebraska Medical Center	Ki Moon Bang, NIOSH
Brad Rein, U.S. Department of Agriculture	Mike Behm, East Carolina University
Stephen J. Reynolds, Colorado State University	Tom Bobick, NIOSH
Allen Robison, NIOSH	Christine Branche, NIOSH
Mike Rosecrans, National Transportation Safety Board and U.S. Coast Guard	Tom Broderick, Construction Safety Council
Robert Rummer, U.S. Forest Service	Mike Buchet, OSHA
Ted Scharf, NIOSH	S. C. Burkhammer, Burkhammer Consulting Services
Marc Schenker, University of California, Davis	Alberto J. Cabán-Martinez, Harvard University
Pedro Serrano, Washington Department of Labor and Industries	Kevin Cannon, Associated General Contractors of America
Dan Sharp, NIOSH	Jim Cawley, NIOSH
Matt Sheaff, Association of Farmworker Opportunity Programs	Pat Coleman, NIOSH
Joel H. Sherman, Grimmway Enterprises, Inc.	Theodore K. Courtney, Liberty Mutual Research Institute for Safety
Mathew Smidt, Auburn University	Justin Crandol, Associated General Contractors of America
Julie Sorensen, Bassett Memorial Hospital	Wayne Creasap, The Association of Union Contractors
Bruce Stone, Virginia Farm Bureau	Greg Cutlip, NIOSH
David Strauss, Association of Farmworker Opportunity Programs	Shelia Davidson, U.S. Navy Naval Facilities Engineering Command
Liz Wagstrom, National Pork Board	Letitia Davis, Massachusetts Department of Public Health
Michael Weber, Association of Equipment Manufacturers	Donald Elisburg, National Asphalt Paving Association
Jon Williams, NIOSH	Michael Fiore, Massachusetts Department of Public Health
Amy Wolfe, AgSafe	Gary Fore, National Asphalt Pavement Association
Construction Council	Mark Fullen, West Virginia University
Walter Alarcon, NIOSH	Elizabeth Garza, NIOSH
James Albers, NIOSH	Matthew Gillen, NIOSH
Henry A. Anderson, Wisconsin Department of Health Services	Janie Gittleman, U.S. Department of Defense
Dan Anton, Eastern Washington University	Daniel Glucksman, International Safety Equipment Association

Linda Goldenhar, CPWR—The Center for Construction Research and Training	Edgar Reyes, NIOSH
Michael Hayslip, National Excavation and Safety Training Institute	Jerry Rivera, National Electrical Contractors Association
Frank Hearl, NIOSH	Nancy Romano, NIOSH
Carl Heinlein, AIHA; American Contractors Insurance Group	Emmett Russell, International Union of Operating Engineers
Palmer Hickman, National Joint Apprenticeship and Training Committee for the Electrical Industry	Gerald Ryan, Operative Plasterers' and Cement Masons' International Association of the United States and Canada
Russ Hutchison, Association of Equipment Manufacturers	Brad Sant, American Road & Transportation Builders Association
Steve Inserra, NIOSH	Eugene Satrun, AIHA
Vicki Kaskutas, Washington University in St. Louis	Paul Satti, Construction Safety Council
Richard King, American Society of Safety Engineers	Scott Schneider, Laborers' Health and Safety Fund of North America
Brian Kleiner, Virginia Tech	Thomas Shanahan, National Roofing Contractors Association
Jeff Kohler, NIOSH	Tonya Smith-Jackson, North Carolina A & T State University
T.J. Lentz, NIOSH	Ron Sokol, American Society of Safety Engineers
Ken Lynch, NIOSH	Christina Spring, NIOSH
Hester J. Lipscomb, Duke University	Pete Stafford, CPWR—The Center for Construction Research and Training
Brian Lowe, NIOSH	Nancy Stout, NIOSH
Jim Maddux, OSHA	Charles N. Stribling, Jr., Kentucky Department of Labor
Howard Marks, National Asphalt Pavement Association	Aaron Sussell, NIOSH
Robert Matuga, National Association of Home Builders	George (Don) Tolbert, Liberty Mutual Group
Barbara McCabe, International Union of Operating Engineers	Michael Toole, American Society of Civil Engineers
Robert E. McCleery, NIOSH	Chris Trahan, CPWR—The Center for Construction Research and Training
Frank Migliaccio, International Association of Bridge, Structural, Ornamental and Reinforcing Iron Workers	Richard Unger, NIOSH
Andrew Morral, RAND	Val Vallyathan, NIOSH
Daniel J. Moss, Association of Equipment Manufacturers	Jeff Vincent, International Union of Operating Engineers
Michelle Myers Mihelic, Associated General Contractors of America	Stephen Wiltshire, Forrester Construction Company
Jim Newhall, NIOSH	
Christopher Pan, NIOSH	
William Piispanen, Washington Group International	
Tim Rehak, NIOSH	

Healthcare and Social Assistance Council

Amy Bahruth, American Federation of Teachers

David Beach, Kentucky Office of Vocational Rehabilitation	Kathy Gerwig, Kaiser Permanente
Richard Bennett, AIHA	MaryAnn Gruden, Association of Occupational Health Professionals
Ann Berry, NIOSH	Suzy Harrington, American Nurses Association
Roland BerryAnn, NIOSH	Robert Harrison, University of California, San Francisco
Carrie Blakeway, The Lewin Group, on behalf of the National Direct Service Workforce Resource Center	Michael J. Hodgson, U.S. Department of Veterans Affairs
Jim Boiano, NIOSH	Nancy Hughes, American Nurses Association
Bill Borwegen, Service Employees International Union	Janice Huy, NIOSH
Yvonne Boudreau, NIOSH	Lisa Iverson-Leirmo, AIHA
Janise Brassell, NIOSH	Katherine Kany, American Federation of Teachers
Barbara Braun, The Joint Commission	Margaret Kitt, NIOSH
Frank Buczek, NIOSH	David Kuhar, CDC Division of Healthcare Quality Promotion
Shelley Rae Carry, Kaiser Permanente	Kevin Landkrohn, OSHA
Claire Caruso, NIOSH	Angela Laramie, Commonwealth of Massachusetts
Megan Casey, NIOSH	Melissa M. Leone, Apria Healthcare
Mark Catlin, Service Employees International Union	Maria Lioce, NIOSH
Jennifer Lynn Cleveland, CDC Division of Oral Health	Therese M. Long, Organization for Safety and Asepsis Procedures
Amy Collins, CDC Division of Oral Health	Tara MacCannell, CDC Division of Healthcare Quality Promotion
Jim Collins, NIOSH	Kathryn A. E. Maher, University of Washington Harborview Medical Center
Marian Condon, American Nurses Association	Susan McCrone, NIOSH
Eve J. Cuny, Organization for Safety and Asepsis Procedures; University of the Pacific	Melissa A. McDiarmid, University of Maryland
Jamie Murphy Dawson, American Nurses Association	Kate McPhaul, U.S. Department of Veterans Affairs
John Decker, NIOSH	Jean Meade, NIOSH
Dave DeJoy, University of Georgia	Amber Hogan Mitchell, Johnson & Johnson
Lisa Delaney, NIOSH	Thomas Nerad, OSHA
Brigid Elchos, State of Mississippi	Peter Orris, University of Illinois at Chicago Medical Center
June M. Fisher, San Francisco General Hospital	Teri Palermo, NIOSH
Ruth Francis, American Nurses Association	Lisa Panlilio, CDC Division of Healthcare Quality Promotion
Linda Frederick, NIOSH	Barbara (Joene) Patterson, NIOSH
Renee Funk, NIOSH	
Robyn RM Gershon, University of California, San Francisco	

A. Ray Pentecost III, Clark Nexsen
Architecture & Engineering

John Piacentino, NIOSH

Margaret M. Quinn, University of
Massachusetts Lowell

Lewis Radonovich, Veterans Health
Administration

Carol Y. Rao, CDC Division of
Healthcare Quality Promotion

W. Allen Robison, NIOSH

Bonnie Rogers, University of North
Carolina at Chapel Hill

Joni Scheftel, Minnesota Department
of Health

Anita Schill, NIOSH

Ronald Shaffer, NIOSH

Barbara Silverstein, Washington State
Department of Labor & Industries

Ray Sinclair, NIOSH

Ron Smith, The American Institute of
Architects Academy of Architecture
for Health

Rosemary K. Sokas, Georgetown
University

Beverlee Stafford, National
Rehabilitation Association

Laura Stock, University of California,
Berkeley

Eileen Storey, NIOSH

Richard Warburton, ChemDAQ

Tracy Whitaker, National Association
of Social Workers

Marcy Whitebook, Center for the
Study of Childcare Employment

Susan Wilburn, World
Health Organization

David Weissman, NIOSH

Dale Woodin, American Society for
Healthcare Engineering

Bernadette Wright, The Lewin Group,
representing National Direct Service
Workforce Resource Center

Manufacturing Council

Alfred A. Amendola, NIOSH

Henry A. Anderson, Wisconsin
Department of Health Services

David Ayers, National Ready Mix
Concrete Association

Ann Barr, Pacific University Oregon

Michael E. Barsan, NIOSH

Michael Baskett, NIOSH

Tom Beardsley, United Auto Workers

William S. Beckett, Mount
Auburn Hospital

Theodore Braun, Liberty Mutual
Insurance Company

Janice Camp, University
of Washington

Rebecca Carlo, NIOSH

Tania Carreon-Valencia, NIOSH

George Chelovich, CNA
Insurance Company

Lilia Chen, NIOSH

Alberto M. Colombi, PPG Industries, Inc.

Greg Day, NIOSH

Renguang Dong, NIOSH

Scott Dotson, NIOSH

Michael Douglas, General Motors

Linda Frederick, NIOSH

Edward Fries, NIOSH

Alberto Garcia, NIOSH

Charles Geraci, NIOSH

Manuel Gomez, US Chemical Safety
and Hazard Investigation Board

Mike Gressel, NIOSH

Lee Hager, Self-employed consultant
to 3M

James Harris, NIOSH

Donna S. Heidel, NIOSH

Bill Horsford, Toyota Motor
Engineering & Manufacturing North
America, Inc.

Phillip R. Hunt, United Biosource
Corporation

Kevin J. Igli, Tyson Foods, Inc.

Robert, Jr. Isiminger, OSHA

Lynn Jenkins, NIOSH

James R. Johnson, National Safety Council
 Kristine Krajnak, NIOSH
 Kathleen Kreiss, NIOSH
 Bernadine Kuchinski, NIOSH
 Wendy Laing, North Carolina State University
 Greg Lotz, NIOSH
 Dan McCausland, American Meat Institute
 Trudi Zimmerman McCleery, NIOSH
 Brian McGuire, Heico Wire Group
 John Mendeloff, RAND Corporation
 Paul Middendorf, NIOSH
 Thais Morata, NIOSH
 John S. Morawetz, International Chemical Workers Union Council
 Mike Morgan, University of Washington
 Ivan Most, Strategic Occupational Health Management
 Jack Nunes, Ingersoll Rand
 John L. O'Donoghue, University of Rochester
 David Parker, Park Nicollet Institute
 Tapas Ray, NIOSH
 Gordon R. Reeve, Arkansas Department of Health
 Frank M. Renshaw, Bayberry EHS Consulting, LLC
 Robyn Robbins, United Food and Commercial Workers International Union
 Cynthia Robinson, NIOSH
 William (Allen) Robison, NIOSH
 Donald Schill, State of New Jersey Department of Health
 Christine Schuler, NIOSH
 Darius D. Sivin, United Automobile, Aerospace, and Agricultural Implement Workers of America (UAW)
 Mark J. Skripol, Pratt & Whitney
 Thomas J. Slavin, Slavin OSH Group, LLC
 Kenneth Stevanus, OSHA

Patricia Sullivan, NIOSH
 Aaron Sussell, NIOSH
 Glenn Talaska, University of Cincinnati
 Julie Tremblay, 3M
 Ronald Tubby, Intel Corporation
 Ken Wengert, Kraft Foods North America
 Elizabeth A. Whelan, NIOSH
 Mary Lynn Woebkenberg, NIOSH
 Monica Laing Workman, Lincoln Electric Company
 Michael J. Wright, United Steelworkers
 Steve Wurzelbacher, NIOSH

Mining Council

Sukumar Bandopadhyay, University of Alaska
 Christopher Bise, West Virginia University
 Jefferey Burgess, University of Arizona
 Alberto Caban-Martinez, University of Miami
 Joe Casper, National Sand, Stone and Gravel Association
 Mark Ellis, Industrial Minerals Association–North America
 Arthur Frank, Drexel University
 Samuel Frimpong, Missouri University of Science and Technology
 John M. Gallick, Alpha Natural Resources
 R. Larry Grayson, Penn State University
 John S. Hayden, Society for Mining, Metallurgy, and Exploration
 Keith A. Heasley, West Virginia University
 Thomas A. Hethmon, University of Utah
 William Hustrulid, Consultant
 Anthony Iannacchione, NIOSH
 Mike Jenkins, NIOSH
 David Kanagy, Society for Mining, Metallurgy, and Exploration
 Jeffery Kohler, NIOSH
 Jeffery H. Kravitz, MSHA
 Eric Lutz, University of Arizona

George Luxbacher, Society for Mining,
Metallurgy, and Exploration

Matt Main, Climax Molybdenum
Company

Richard Maxwell, Freeport McMoRan
Copper and Gold, Inc.

Hugh Miller, Colorado School of Mines

Thomas Novak, University of Kentucky

Dennis O'Dell, United Mine Workers
of America

Susan Patton, Agapito Associates

Drew Potts, NIOSH

Mary Poulton, University of Arizona

Randy Reed, NIOSH

Lee Saperstein, Missouri University of
Science and Technology

James Sharpe, Sharpe Media

Madan Singh, U.S. Geological Survey

Joseph Sottile, University of Kentucky

Bob Stein, NIOSH

Larry Stolarczyk, Stolar, Inc.

Eileen Storey, NIOSH

Stanley Suboleski, Consultant

Richard Sweigard, University
of Kentucky

Janet Torma-Krajewski, Colorado
School of Mines

James L. Weeks, MSHA

Mike Werner, NIOSH

Linda Zeiler, MSHA

Joe Zelanko, Rosebud Mining
Company

Oil and Gas Extraction Council

Barbara Alexander, NIOSH

Linda Berryman, Devon Energy

Mike Betts, John L. Wortham and Sons

Eric Bourquin, Texas Mutual
Insurance Company

Tricia Boyles, NIOSH

Paul Breaux, International Association
of Drilling Contractors

Mike Breitenstein, NIOSH

Jason Burton, NIOSH

Darrel Canada, Canada and Associates
Safety Training, LLC

Halina Caravello, Baker Hughes
Incorporated

David Caruso, NIOSH

Richard Cerenzio, ISNetworld

George Conway, NIOSH

Elaine Cullen, NIOSH

JD Danni, OSHA

Mitchell Davis, National Oilwell Varco

Joe Eastin, ISNetworld

Eric Esswein, NIOSH

Pete Flatten, Encana Oil and Gas

Joel Haight, University of Pittsburgh

Elizabeth Haley, PEC Premier

Wendy Harris, Baker Hughes Inc.

Nancy Hauter, OSHA

Ryan Hill, NIOSH

George Hillas, Halliburton

Holly Hopkins, American
Petroleum Institute

Warren Hubler, Helmerich & Payne
International Drilling Company

Joe Hurt, International Association of
Drilling Contractors

Rick Ingram, BP/STEPS

Kenny Jordan, Association of Energy
Service Companies

Adam Kickish, CalFrac Well Services

Bradley King, NIOSH

William Knight, Pioneer
Natural Resources

Elizabeth Lawhorn, Exxon Mobil

Guy Lombardo, Schlumberger

Teresa Madden-Thompson, University
of Texas Arlington

Marianne McGee, OSHA

Nicolle Mode, NIOSH

Robert H. Montgomery, Exponent, Inc.

Christopher L. Nielsen, EnCana Oil
and Gas

Bob Nocco, Chevron
 Kurt Papenfus, Safety Management Systems
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Public Safety Council

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