



NATIONAL OCCUPATIONAL RESEARCH AGENDA (NORA)

**NATIONAL OCCUPATIONAL RESEARCH AGENDA FOR OIL AND GAS
EXTRACTION**

November 2018

Developed by the NORA Oil and Gas Extraction Sector Council

For more information about the National Occupational Research Agenda (NORA), visit the web site:
<https://www.cdc.gov/niosh/nora/>

For monthly updates on NORA, subscribe to NIOSH eNews at www.cdc.gov/niosh/eNews

Disclaimer

This is a product of the National Occupational Research Agenda (NORA) Oil and Gas Extraction Sector Council. It does not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, or U.S. Department of Health and Human Services.

INTRODUCTION

What is the National Occupational Research Agenda?

The National Occupational Research Agenda (NORA) is a partnership program to stimulate innovative research and workplace interventions. In combination with other initiatives, the products of this program are expected to reduce the occurrence of injuries and illnesses at work. Unveiled in 1996, NORA has become a research framework for the nation and the National Institute for Occupational Safety and Health (NIOSH). Diverse parties collaborate to identify the most critical issues in workplace safety and health and develop research objectives for addressing those needs.

NORA enters its third decade in 2016 with an enhanced structure. The ten industry-based sectors formed for the second decade will continue to prioritize occupational safety and health research by major areas of the U.S. economy. In addition, there are now seven cross-sectors organized according to the major health and safety issues affecting the U.S. working population. While NIOSH is serving as the steward to move this effort forward, it is truly a national effort. NORA is carried out through multi-stakeholder councils, which are developing and implementing research agendas for the occupational safety and health community over the decade (2016-2026). Councils address objectives through information exchange, partnership building, and enhanced dissemination and implementation of evidenced-based solutions.

NORA groups industries into ten sectors using the North American Industry Classification System (NAICS). The exploration and production industry is defined by the North American Industry Classification System (NAICS) as:

Industries in the Oil and Gas Extraction subsector operate and/or develop oil and gas field properties. Such activities may include exploration for crude petroleum and natural gas; drilling, completing, and equipping wells; operating separators, emulsion breakers, desilting equipment, and field gathering lines for crude petroleum and natural gas; and all other activities in the preparation of oil and gas up to the point of shipment from the producing property. This subsector includes the production of crude petroleum, the mining and extraction of oil from oil shale and oil sands, and the production of natural gas, sulfur recovery from natural gas, and recovery of hydrocarbon liquids [OMB 2017].

The Oil and Gas Extraction sector includes three NAICS code groupings: oil and gas operators who control and manage leased areas (NAICS 211), drilling contractors who drill the wells (NAICS 213111), and well servicing companies who provide all other types of support operations that prepare a well for completion and production (NAICS 213112).

What are NORA Councils?

Participation in NORA councils is broad, including stakeholders from universities, large and small businesses, professional societies, government agencies, and worker organizations. Councils are co-chaired by one NIOSH representative and another member from outside NIOSH.

Statement of Purpose

NORA councils are a national venue for individuals and organizations with common interests in occupational safety and health topics to come together. Councils will start the third decade by identifying broad occupational safety and health research objectives for the nation. These research objectives will build from advances in knowledge in the last decade, address emerging issues, and be based on council member and public input. Councils will spend the remainder of the decade working together to address the agenda through information exchange, collaboration, and enhanced dissemination and implementation of solutions that work.

Although NIOSH is the steward of NORA, it is just one of many partners that make NORA possible. Councils are not an opportunity to give consensus advice to NIOSH, but instead provides a way to maximize resources towards improved occupational safety and health nationwide. Councils are platforms that help build close partnerships among members and broader collaborations between other NORA councils and other organizations. The resulting information sharing and leveraging efforts promote widespread adoption of improved workplace practices based on research results.

Councils are diverse and dynamic, and are open to anyone with an interest in occupational safety and health. Members benefit by hearing about cutting-edge research findings, learning about evidence-based ways to improve safety and health efforts in their organization, and forming new partnerships. In turn, members share their knowledge and experiences with others and reciprocate partnerships.

Oil and Gas Extraction Council

Beginning in 2008, NIOSH has worked with partners and stakeholders in the oil and gas extraction industry as well as the Occupational Safety and Health Administration (OSHA), academia, trade associations, insurance companies and state and local groups to set forth a research agenda for the nation within the NORA council framework. Some of our members have been with us since the beginning while others have participated based on their subject matter expertise or the timeliness of a particular issue.

What does the National Occupational Research Agenda for Oil and Gas Extraction represent?

The National Occupational Research Agenda for Oil and Gas Extraction is intended to identify the research, information, and actions most urgently needed to prevent occupational injuries and illnesses in the Oil and Gas Extraction sector. This agenda provides a vehicle for oil and gas extraction stakeholders to describe the most relevant issues, gaps, and safety and health needs for the sector. Each NORA research agenda is meant to guide or promote high priority research efforts on a national level, conducted by various entities, including: government, higher education, and the private sector.

Because the agenda is intended to guide national occupational health and safety efforts for the Oil and Gas Extraction Sector, it cannot at the same time be an inventory of all issues worthy of attention. The omission of a topic does not mean that topic was viewed as unimportant. Those who developed this agenda did, however, believe that the number of topics should be small enough so that resources could be focused on a manageable set of objectives, thereby increasing the likelihood of substantial impact in the workplace.

NIOSH used the draft agendas created by the sector and cross-sector NORA Councils to help inform the [NIOSH Strategic Plan](#). NIOSH programs used the [burden, need and impact \(BNI\) method](#) to write research goals that

articulate and operationalize the components of the NORA Sector and Cross-Sector Agendas that NIOSH will take up. NORA Agendas and the NIOSH Strategic Plan are separate but linked.

Who are the target audiences?

The National Occupational Research Agenda for Oil and Gas Extraction provides guidance on important occupational safety and health issues to those in industry, government, academia, insurance, and trade associations along with concerned professionals in related disciplines (safety, industrial hygiene, engineering, training, epidemiology and surveillance). It is the Oil and Gas Extraction Sector Council's hope that it can be used to inform research at all levels and in all domains for the duration of the third decade of NORA. It also identifies perceived gaps where new or continuing activities are necessary to improve or maintain safe and healthy work environments for all upstream oil and gas extraction workers in the U.S.

How was the research agenda developed?

In September 2016, the NORA Oil and Gas Extraction Sector Council met and began the process of developing a national research agenda for the third decade of NORA. As a starting point, council members were invited to respond to a brief questionnaire where they selected priority occupational safety and health issues for the nation. The survey responses were analyzed and then grouped into four categories: motor vehicle safety, worker safety (other than motor vehicle), health, and cross-cutting issues. A workgroup was formed for each of the four areas, and each workgroup met to discuss and identify the priority occupational safety and health issues related to their topic. At the end of the meeting, the workgroups returned their worksheets to the council coordinator, who used the information to develop the first draft of the research agenda.

In April 2017, the council met again with the goals of finalizing the objectives and providing supporting information for each. To do this, the council workgroups met in person with a template that asked them to respond to two questions for each objective: 1) Why is this important? and 2) What needs to be done? Because occupational safety and health resources are limited, this agenda focuses on priority occupational safety and health operations, workers, and issues based on what is currently known about safety and health risks in industries within the oil and gas extraction industry. The workgroups identified the priority sub-objectives within their group and reported their summaries back to the full council.

The council is action-oriented, so plans to begin addressing the highest priority goals began shortly after the April 2017 meeting. To help guide this work, the NORA Oil and Gas Extraction Council leadership coordinated a series of virtual meetings to develop action plans for the highest priority research objectives. These action plans were intended to provide a guide for the council and other stakeholders. While the sub-objectives within each objective are listed below in priority order, the objectives themselves are not presented in any particular order. The numbering conventions are used only to facilitate the tracking of implementation efforts.

Much of the discussion during the development of these research objectives focused on the profound changes in the oil and gas extraction industry as a result of the prolonged downturn in oil prices and extraction activities. In the current operating environment, companies may be less likely to invest in newer technologies that improve health and safety workplace conditions or implement other safety and health programs. There are also safety and health implications once the level of activity increases; workers who join the industry may lack relevant experience and training, which may increase their risk of being injured on the job. These uncertainties could affect the ability of this council and others to conduct the research activities described below.

THE OBJECTIVES

Because occupational safety and health resources are limited, this agenda focuses on priority occupational safety and health operations, workers, and issues based on what is currently known about safety and health risks in industries within the oil and gas extraction industry. Previous council discussions on leading causes of fatalities, injuries and hazardous exposures, along with industry experience and expertise were all brought to bear on the selection of priorities contained within these objectives. These priority operations, workers, and issues include:

- Onshore exploration and production activities;
- Workers employed by small companies;
- Short service employees (workers with one-year or less of experience in this industry);
- Organizational practices that may influence safety and health in this industry; and
- Emerging safety and health issues.

Objective 1: Reduce Motor Vehicle Injuries and Fatalities

Transportation incidents were the leading cause of death in this industry, accounting for 40% of all fatalities during 2003-2013. The majority (80%) of these incidents were motor vehicle crashes. The largest proportion of workers (51.5%) who die are occupants of light-duty vehicles (e.g. pickup trucks), and more than one third of workers fatally injured in these crashes were not wearing their seat belt [Retzer et al. 2013]. The most current data from the Bureau of Labor Statistics found that motor vehicle crashes accounted for 44% of all fatal injuries in the industry during 2016 [BLS 2017].

- 1.1. Identify and promote effective strategies to increase safety belt use in the oil and gas extraction industry.

Previous research has shown that lack of seatbelt use is a contributing factor in more than one third of the motor vehicle fatalities in the oil and gas extraction industry [Retzer et al. 2013]. The council encourages more research to identify and promote strategies to increase seat belt use among oil and gas extraction workers.

- 1.2. Identify, evaluate, and promote effective strategies to improve driver performance in the oil and gas extraction industry, such as in-vehicle technology and driver coaching.

The council identified the need for more research to improve driver performance and the development of industry-specific best practices (including but not limited to in-vehicle technology and driver coaching). A recent NIOSH study found that supervisory coaching in combination with in-vehicle monitoring systems can be an effective strategy to improve driver performance in the workplace [Bell et al. 2017].

- 1.3. Identify and evaluate effective organizational strategies (policies, programs, organizational culture) to reduce driver fatigue and driver distraction in the oil and gas extraction industry.

Many workers within this industry drive long distances to remote well sites on rural roads, which may lack safety features such as lighting, guard rails, and adequate road grading. Commuting long distances to and between well sites may also place oil and gas extraction workers at increased risk of being involved in a fatigue-related incident. Research to determine the effectiveness of journey management and other administrative policies and programs in preventing incidents related to fatigue and distraction should be conducted and promoted.

- 1.4. Enhance existing surveillance systems and data sets to increase what is known about motor vehicle injuries and fatalities in the oil and gas extraction industry.

The council identified the need for more detailed information on fatal work injuries during the second decade of NORA. In response, council members worked with NIOSH to develop Fatalities in Oil and Gas (FOG) [NIOSH 2015a], an industry-specific database that collects information from a number of sources and is maintained by NIOSH. Partnerships and research are needed to more completely identify and collect detailed information on fatal and non-fatal motor vehicle crashes in the oil and gas extraction industry to enhance what is known about these events and to identify effective prevention strategies.

Objective 2: Reduce Non-vehicle Related Worker Injuries and Fatalities

In 2016, 422,000 workers were employed by the oil and gas extraction industry [BLS 2016]. In addition, thousands more contractors from the transportation, construction, and other industries work at oil and gas worksites, completing tasks such as hauling water used in the hydraulic fracturing process, constructing roads and new oil and gas well pads, and servicing existing wells. During 2003–2016, 1,485 oil and gas extraction workers were killed on the job, resulting in an annual fatality rate more than six times higher than the rate among all U.S. workers [BLS 2016]. The most frequent non-vehicle related worker fatalities during this time period were the result of contact with objects and equipment (25%), fires and explosions (14%), exposure to harmful substances and environments (9%), falls (8%), and all other event types (3%).

- 2.1 Improve training and communication resources for all field personnel to recognize and control safety and health hazards.

In an effort to avoid injuries and exposures before they occur, workers and their supervisors need to be able to recognize hazards that exist in the oil and gas extraction workplace. While much training exists, the council believes that research to improve training or implement it more effectively would be beneficial.

- 2.2 Increase the use of effective controls to reduce injuries and fatalities resulting from contact-related incidents.

Injuries resulting from contact with objects and equipment were the second most frequent fatal event in the oil and gas extraction industry resulting in 369 worker deaths during 2003-2016 [BLS 2016]. Contact injuries are the leading cause of death for workers employed by drilling contractors, making this research a high priority for that workforce. More research is needed to evaluate the available controls and to develop new controls that will reduce contact injuries among oil and gas extraction workers.

- 2.3 Increase the use of gas monitors and educate employers and employees to respond appropriately to fixed and portable monitoring of flammable gases.

The industry has identified a need to better understand how gas monitors are selected, used, and maintained. Additional research is needed to examine what information the monitor provides to the person wearing it and how it could be used for better decision-making. Recommendations are also needed for how companies can use the data collected by the monitors worn by their employees in the field to provide a healthier workplace.

- 2.4 Increase awareness of the importance of well control/reduce loss of well control, resulting in incidents.

A priority issue for stakeholders is well control, which the International Association of Drilling Contractors (IADC) calls “the industry’s highest process safety challenge” [IADC 2018]. Well control is needed to prevent the uncontrolled release of gas and oil from the well during drilling, well-completion, well-workover, abandonment, and well-servicing operations. Properly trained personnel are essential for safe well control activities.

2.5 Increase root cause analysis of injury and near-miss incidents.

By conducting a thorough investigation that identifies root causes, employers and workers can identify causes of accidents and produce information that can be used to reduce risks and prevent similar events from recurring. Research is needed to identify barriers to the use of root cause analysis and how to effectively promote the dissemination of lessons learned.

2.6 Enhance existing surveillance systems and data sets for oil and gas extraction worker injuries and fatalities.

The NIOSH Fatalities in Oil and Gas (FOG) database currently collects industry-specific information on oil and gas extraction worker fatalities; adding severe non-fatal injury data reported to OSHA will allow researchers to examine trends of non-fatal injuries. The in-depth case review of both fatalities and severe injuries will allow researchers to identify root (underlying) causes of these events.

Objective 3: Reduce Exposures to Hazards and Their Health Effects in Workers

While fatal injuries to oil and gas extraction workers have been identified and described, significant gaps exist in what is known about hazardous exposures to chemical or physical agents among this workforce. Field studies have identified several significant exposure hazards to this workforce including respirable crystalline silica during hydraulic fracturing [Esswein et al. 2013], and hydrocarbon gases and vapors during tank gauging operations [NIOSH 2015b]. While field studies are ongoing, much work remains to fully characterize occupational health hazards to workers in the oil and gas extraction industry and to identify and characterize substances that can cause inflammation, allergy, infectious disease or other immune responses following exposure in the work environment. In addition, dermal exposures to toxic chemicals used within the industry present a broadly recognized but difficult to quantify burden related to the ability of these chemicals to be dermally absorbed into the body and contribute to systemic toxicity.

3.1 Develop, implement, and evaluate controls for known and well-characterized exposures in the oil and gas extraction industry.

Respirable crystalline silica, hydrocarbon gases and vapors, hydrogen sulfide (H₂S) and toxic metals are known exposures in the oil and gas extraction workplace. Research is needed to develop new and evaluate existing controls that prevent exposures to these known hazards. The results of the research and evaluation of these controls will be promoted within the industry to encourage adoption and effective control of known hazards.

3.2 Evaluate anticipated but poorly characterized exposures in the oil and gas extraction industry.

There are many uncharacterized exposure hazards in the oil and gas extraction industry. Exposure assessment studies to identify and characterize unknown exposures are urgently needed. By gathering exposure monitoring data and publishing the results, the industry will better understand potential exposure hazards and how to address them using the hierarchy of controls.

- 3.3 Prevent noise-induced hearing loss due to noise exposures and combined exposure to noise and chemicals in the oil and gas extraction industry.

Working in noisy environments and around noise-generating equipment is understood to be a common condition in the oil and gas extraction industry, but surveillance information is lacking. Noise sources should be identified and characterized, and ototoxic chemicals identified. Noise should be reduced as feasible via elimination, substitution, engineering and administrative control solutions.

- 3.4 Develop programs, systems, and tools to better track work exposure history and long-term health impacts for workers.

Because the oil and gas extraction industry workforce expands and contracts with the price of crude oil and operates in some of the more remote and less populated areas of the United States, much of the workforce is transient. As a result, monitoring exposures and health status of workers over time is difficult. Research is needed to identify methods for following oil and gas extraction workers over time, to collect exposure and health outcome information which may allow for epidemiologic studies and/or the timely identification and prevention of long-term adverse health effects in this worker population.

Objective 4: Identify and Promote Proactive Strategies to Improve Oil and Gas Worker Safety and Health

This objective includes “cross-cutting issues,” which address additional areas of need identified by the council members.

- 4.1 Identify and promote the most effective leading indicators for the oil and gas extraction industry.

Many safety and health professionals in the oil and gas extraction industry seek to use leading indicators as a means to proactively improve safety and health within the workforce. The Campbell Institute of the National Safety Council has recently published extensively on this topic [NSC 2018]. Leadership time in the field and training are examples of leading indicators which could be tracked alongside the required lagging indicators like recordable incidents. Research should be conducted to identify and evaluate the leading indicators of injuries and illnesses.

- 4.2 Identify and promote the critical elements of safety management at multi-employer worksites.

On an oil and gas extraction worksite (well pad) each crew has their own supervisor, however they often work alongside other crews on the same location. The operating company representative (known as the “company man”) has responsibility for all workers while they are on the worksite. One example of this is simultaneous operations, which the American Petroleum Institute (API) defines as two or more independent operations (such as drilling, workover, wireline, facilities construction, etc.) conducted under common operational control in which the activities of any one operation may impact the safety of personnel, equipment and/or the environment of the other(s). In a 2013 bulletin they also note: failure to coordinate can result in the potential clash of activities that can cause an undesired event or set of circumstances [API 2013]. Research evaluating how operators implement best practice guidance for simultaneous operations, including effective organization and communication to and among parties working on site at the same time or in sequence, should be undertaken and shared with the industry.

4.3 Develop and promote communication products that describe the business case for safety.

Given the economic conditions that have affected the oil and gas extraction industry over the past few years, this sub-objective could help employers make decisions where return on investment data is sometimes difficult to obtain. Much of the oil and gas extraction industry uses the National Safety Council's Journey to Safety Excellence [NSC 2013] as their baseline for making financial decisions regarding safety programs. Using the [OSHA Safety Pays](#) tool as a model, new research could provide a better understanding of the drivers that determine an organization's decision to fund workplace safety and health initiatives in various economic circumstances. Tools could be developed if needed or existing ones could be modified to provide clearer explanations of the benefits that come from proactive investments in safety and health programs (compared to the costs of paying for insurance claims or higher premiums). Work would most likely involve operators and company owners working in partnership with insurance providers or state workers compensation offices to gather data and make the necessary comparisons.

4.4 Identify work organization factors that contribute to occupational stress, anxiety, depression, fatigue, and adverse health outcomes for oil and gas extraction workers.

Job stress has significant adverse effects across the spectrum of well-being (e.g., physical and mental health, behavior, productivity, social, non-work outcomes), and has been linked to a range of adverse physical, mental, cognitive, behavioral, safety, and performance outcomes [NIOSH 2017]. Job stress is an important issue for the oil and gas extraction industry and should be investigated further. Research to better characterize how organizational factors influence job stress, and interventions to address those organizational factors, is necessary. This may include surveillance on work practices, work factors (psychosocial and safety climate), and health outcomes among oil and gas extraction workers. Innovative surveillance approaches are especially needed for certain groups such as those in contingent work arrangements. Work organization interventions from other industries could provide solutions applicable to oil and gas extraction.

REFERENCES

- API [2013]. Well Construction Interface Document Guidelines, First Edition. Washington, DC: American Petroleum Institute, API Bulletin 97.
- Bell JL, Taylor MA, Chen G-X, Kirk RD, Leatherman ER [2017]. Evaluation of an in-vehicle monitoring system (IVMS) to reduce risky driving behaviors in commercial drivers: Comparison of in-cab warning lights and supervisory coaching with videos of driving behavior. *J Safety Res* 60:125-136.
- BLS [2016]. Census of Fatal Occupational Injuries. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, <https://www.bls.gov/iif/oshcfoi1.htm>.
- BLS [2017] Census of Fatal Occupational Injuries (CFOI) fatal injuries in oil and gas extraction 2003-2016 (Data table generated by BLS for NORA Oil and Gas Extraction sector). Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics.
- Esswein EJ, Breitenstein M, Snawder J, Kiefer M, Sieber WK [2013]. Exposures to respirable crystalline silica during hydraulic fracturing. *J Occup Environ Hyg* 10(7):347-356.
- IADC [2018]. Well Control Institute. Washington, DC: International Association of Drilling Contractors, <http://www.iadc.org/well-control-institute/>.
- NIOSH [2015a]. Fatalities in the Oil and Gas Extraction Industry (FOG). Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease control and Prevention, National Institute for Occupational Safety and Health, <https://www.cdc.gov/niosh/topics/fog/default.html>.
- NIOSH [2015b]. Suspected inhalation fatalities involving workers during manual tank gauging, sampling, and fluid transfer operations on oil and gas well sites, 2010-2014. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease control and Prevention, National Institute for Occupational Safety and Health, <https://www.cdc.gov/niosh/topics/fog/data.html>.
- NIOSH [2017]. Healthy Work Design and Well-Being Program. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease control and Prevention, National Institute for Occupational Safety and Health, <https://www.cdc.gov/niosh/programs/hwd>.
- NSC [2013]. Journey to safety excellence: the business case for investment in safety – a guide for executives. Itasca, IL: National Safety Council, <http://www.nsc.org/JSEWorkplaceDocuments/Journey-to-Safety-Excellence-Safety-Business-Case-Executives.pdf>.
- NSC [2018]. Campbell Institute: Leading Indicators. Itasca, IL: National Safety Council, <http://www.nsc.org/Measure/Pages/campbell-institute-leading-indicators.aspx>.
- OMB [2017]. North American Industry Classification System. Washington DC: U.S. Office of Management and Budget, National Technical Information Service, <https://www.census.gov/eos/www/naics/>.
- Retzer KD, Hill RD, Pratt SG [2013]. Motor vehicle fatalities among oil and gas extraction workers. *Accid Anal Prev* 51(1):168-174.