



## NIOSH Science Blog

# An Ancient Hazard in a 21st Century Workplace: The Power of Partnerships and Collaboration Investigating Respirable Crystalline Silica in Hydraulic Fracturing

Posted on June 2, 2021 by Eric J. Esswein, MSPH, CIH, FAIHA; CAPT Bradley King, PhD, MPH, CIH; and CAPT Ryan Hill, MPH

In 2013, NIOSH researchers published exposure assessment results for respirable crystalline silica in oil and gas extraction (OGE) workers performing hydraulic fracturing. The results were noteworthy; a previously unidentified but serious occupational exposure hazard was discovered, and risks were significant—in some cases, personal breathing zone exposures exceeded 10 times the occupational exposure limits. This research and resulting engineering and administrative control outcomes would not have happened if not for a devoted group of occupational health and safety (OHS) professionals that comprised the National Occupational Research Agenda (NORA) OGE Sector Council, and the partnerships formed with OHS leaders in the oil and gas industry. The story of this research, these successful partnerships and outcomes are detailed below.

## Background

In 2008, NIOSH began a focused effort to understand occupational hazards and risks for OGE workers, an industry sector rapidly expanding its workforce and advancing its technology.<sup>[1]</sup> The work began with the establishment of [the NIOSH OGE Program](#) and shortly thereafter, the creation of the [NORA OGE Sector Council](#). The U.S. OGE industry is composed of oil and gas operators which are companies that control and manage leased properties (North American Industrial Classification System [NAICS] 211); contractors who drill oil and gas wells [NAICS 213111]; and support contractors who provide numerous services, including hydraulic fracturing, to bring new wells into production and to service existing wells [NAICS 213112]).

The first two meetings of the developing NORA OGE Sector Council were held in Houston and Denver. Representatives from NIOSH, the Occupational Safety and Health Administration (OSHA), the Association of Energy Servicing Companies (AESCC) the International Association of Drilling Contractors (IADC), and executive and field-level representatives from OGE companies attended. Not unexpectedly, some tensions were present during these meetings given uncertainties how the proposed NORA partnership might work. NIOSH representatives explained that the concept of research partnerships between government and industry were not novel; successful partnerships already existed between NIOSH and other industry sectors.

The importance and need for collaborative research were explained and discussed. While NIOSH was uniquely positioned to conduct safety and health research and develop guidance and recommendations to protect workers, the participation of industry representatives was necessary for access to worksites and workers and for industry perspectives on possible research needs. The OGE industry, being required to meet the OSHA general duty clause *that employers shall furnish to employees, employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees*,<sup>[2]</sup> would benefit from NIOSH's expertise and resources.

## Setting Priorities

Despite reservations among some participants, the Council members coalesced to identify research topics and priorities for the nation resulting in the OGE industry's first NORA research agenda. As trust was established, strong relationships were formed, and collaborations began.

The new NORA council's initial focus was on safety, specifically the most frequent fatal events, including motor vehicle crashes, fires and explosions and falls from heights.<sup>[3],[4]</sup> Industrial hygiene scientific research in the literature at the time was negligible and NIOSH researchers pondered the possible long-and-latent consequences of which workplace exposure risks might exist other than the obvious: petroleum hydrocarbons and hydrogen sulfide (H<sub>2</sub>S). The major exposure assessment research question was 'where to begin?' To increase understanding of OGE work practices and processes, field work began in mid-2008, when a large oil and gas company allowed NIOSH to visit oil and gas extraction sites in western Colorado. NIOSH spent time on drilling rigs observing the work, talking to workers, and gaining insights about work practices and process materials. Because workers really are the experts, they were asked what they believed were possible exposure hazards. Hydrogen sulfide in drilling operations was the most common answer.

At a completions site where hydraulic fracturing was occurring, NIOSH noticed large machinery operating in the distance and a "cloud" was being dispersed from a machine the size and shape of a commercial moving van. Despite the company's use of vernacular describing the cloud as "just dirt" NIOSH suspected that it was probably respirable crystalline silica. Similar issues relating to silica exposure hazards in other industries had previously prompted an "**It's not just dust!**" awareness campaign. This observation and the following pivotal conversation between NIOSH and the company representative helped shape NIOSH's OGE research program for years to come:

### NIOSH

### Company representative

"Is that a vapor cloud?"

"No, that's not a vapor cloud."

"What is the cloud?"

"It's just dirt."

"Is the dirt being blown into the air off the ground, from the downward facing exhaust pipes of the trucks?"

"No."

“What was causing the dirt to go into the air?”

“They’re filling the sand mover.”

**“I don’t think that’s dirt, it’s probably respirable crystalline silica.”**

More days were spent in the field, observing drilling, hydraulic fracturing, and simultaneous operations where drilling, completions and servicing all occur on the site at the same time. A list of potential exposure hazards was developed included H<sub>2</sub>S, benzene, lead (Pb) in pipe dope (grease to connect drill pipe), naturally occurring radioactive materials (NORM), diesel exhaust, welding fume, and respirable crystalline silica (RCS) or quartz.

NIOSH considered exposure hazards on five criteria: 1) likelihood of ongoing acute and chronic worker exposure risk, 2) existing occupational exposure limits, 3) occupational disease known to result from exposures, 4) NIOSH or OSHA validated methods for laboratory analytical determination, and 5) potential for implementation of engineering, administrative or other controls if overexposures were identified. Respirable crystalline silica met all the criteria and became the key initial potential exposure to be assessed. However, at the time, the decision to focus on RCS was a surprise to some, including colleagues outside of NIOSH.

Depending on the exposure dose and duration, inhalation of RCS can cause silicosis, an incurable, sometimes fatal (but preventable) lung disease that typically develops after long periods of exposure and progresses gradually. However, rapidly fatal cases of acute silicosis can result from very intense exposures over only a few months or years are well documented among sandblasters, tunnelers, miners, and some other occupational groups.<sup>[5]</sup> Crystalline silica has also been determined to be an occupational lung carcinogen<sup>[6]</sup> and there is evidence that inhaling respirable silica dust causes chronic obstructive pulmonary disease (COPD), chronic renal (kidney) disease and various autoimmune diseases. Individuals with silicosis are known to be at higher risk of tuberculosis and several other respiratory infections.

## The Power of Partnerships and Collaboration

The first Memorandum of Understanding (a NIOSH-industry partnership agreement) focused on conducting exposure assessments for RCS and understanding other point sources of emissions for RCS. That partnership was renewed, and more MOUs were signed with other companies operating in multiple states. As more exposure data were obtained, the magnitude of RCS exposure risks became apparent; the problem was industry wide. The next step was to communicate the results regarding the magnitude of exposure risks and importance of implementing engineering and administrative controls.

In 2010 a NIOSH Fact Sheet ([NIOSH Field Effort to Assess Chemical Exposure Risks to Gas and Oil Workers<sup>\[7\]</sup>](#)) was developed and circulated on the internet, at conferences and with the help of industry partners and the NORA OGE Sector Council which was now an effective, collaborative partnership success due to participation of industry partners and the diligence of the Council and the National Service, Transmission, Exploration and Production Safety (STEPS) Network and its Chairperson, Mr. Rick Ingram who was also Co-Chair of the NORA OGE Council.

The National STEPS Network created the Respirable Crystalline Silica Focus Group and NIOSH was a participating member. The group was dedicated to understanding and communicating risks for RCS exposures in the OGE industry and implementing meetings to discuss how the hierarchy of controls could be implemented on an industry-wide basis.

NIOSH research results describing occupational exposure risks for RCS (and some proposed controls) were formally presented at a 2012 workshop entitled: *Health Impact Assessment of Shale Gas Extraction* convened by the Institute of Medicine (IOM) Roundtable on Environmental Health Sciences, Research to discuss the human health impact of shale gas extraction through the lens of a health impact assessment.[8] In 2013, NIOSH published results of the study in the *Journal of Occupational and Environmental Hygiene*. [9] The study was extensively cited, and results were presented by invitation at numerous conferences throughout the nation and in South Africa.

In years following, additional industry partners signed MOUs with NIOSH allowing NIOSH researchers to visit sites, meet with management and workers and conduct exposure assessment research. In turn, the OGE industry responded by taking the results and recommendations of NIOSH research and implementing a wide range of engineering and administrative controls (training and policies and procedures) and personal protective equipment to help limit exposures to RCS. NIOSH also invented and field tested a mini baghouse retrofit assembly, an engineering control for sand moving machinery to control RCS emissions. Over time, the design was improved, and further field tested in several states through additional MOUs signed with operating and servicing companies. [10],[11]

Industry-wide accomplishments in engineering and administrative controls for exposures to RCS were showcased at two Silica in the Oilfield Summits. The first in 2018, in Denver, Colorado was organized by industry, with proceedings published in a [journal article](#). The second, a virtual Summit, was organized by the NORA OGE Sector Council and held in April 2021, with outputs now under development. Neither Summit would have been possible without the commitment and dedication of OHS professionals from industry and government, including NIOSH. Additionally, NIOSH worked with our industry partners and the NORA OGE Council to get controls for RCS in OGE included in [Work Safely with Silica](#) (Silica Safe.org) an on-line resource for understanding the hazards and risks of exposures to RCS and how to control exposure risks.[12]

Today the same commitment to workplace health and safety continues as NIOSH celebrates its *50<sup>th</sup> Anniversary* and highlights the value of government and industry partnerships that contributed to the success of the NORA OGE Sector Council and other NORA Councils. NIOSH and our current industry partners and the NORA OGE Sector Council members continue to work together to address the priorities contained in the NORA OGE research agenda for the third decade of NORA. NIOSH welcomes additional partners interested in participating in the NORA OGE Sector Council. Please e-mail [nioshoilandgas@cdc.gov](mailto:nioshoilandgas@cdc.gov) for more information.

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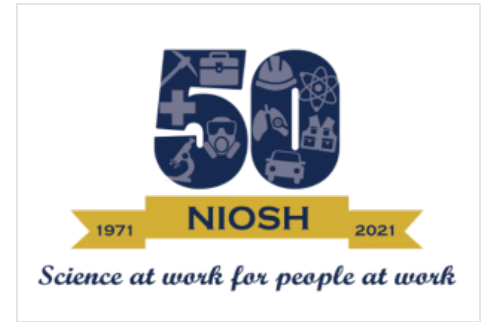
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Read more about NORA in a recent [blog](#).

*This blog is part of a [series](#) for the NIOSH 50th Anniversary. Stay up to date on how we're celebrating NIOSH's 50<sup>th</sup> Anniversary on our [website](#).*

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Nice update, Folks! NIOSH continues to be a high point on the landscape of worker health and safety, as we begin the second half of your (our) First Century. Thanks, Larry

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This is the model of how industry and government can coalesce together in a partnership of mutual trust and respect to further safety for the “workers on the ground” . A very worthwhile endeavor deserving of further support and positioned for solving future problems unknown to us at present.

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