EDUCATION AND TRAINING FOR THE MINING WORKFORCE

Statement of

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before the

Subcommittee on Energy and Mineral Resources
Committee on Natural Resources
U.S. House of Representatives

December 14, 2015

Chairman Lamborn, Ranking Member Lowenthal, and members of the Committee, I would like to thank you for the invitation to address you on the subject of education, training, and workforce issues related to the U.S. mining industry. My name is Leigh Freeman and I am the Principal at Leigh Freeman Consultancy. I have more than forty years of experience in the private sector of the mining industry. I am a Geological Engineering graduate of the University of Montana at Montana Tech. I am deeply involved in minerals education and talent development. To this end, I currently serve on industry advisory boards for the geological engineering department of the University of Montana at Montana Tech, the Profession Land & Resource Management program for the Western State University here in Colorado, and the mining engineering advisory boards for the South Dakota School of Mines and the University of Arizona. For much of my professional career I have been active on committees for the Society of Mining, Metallurgy & Exploration (SME), particularly those committees involving minerals education and sustainability. Relevant to this proceeding, I served as a member of the Committee on Emerging Workforce Trends in the U.S. Energy and Mining Industries of the National Academies of Sciences, Engineering, and Medicine. The National Academy of Sciences was chartered by Congress in 1863 to advise the government on matters of science and technology and later expanded to include the National Academies of Engineering and Medicine.

In 2013, the Academies' committee of which I was a member published a consensus report titled "Emerging Workforce Trends in the U.S. Energy and Mining Industries: A Call to Action" which was sponsored by the Department of Energy's National Energy Technology Laboratory. The report examined the U.S. mining and energy workforce, and proposed approaches to address crucial, emerging needs to meet the nation's requirements

for skilled workers in most mining and energy sectors, spanning the workforce in private industry, at universities, and in the federal government. The report task originated as a congressional mandate in the Energy Policy Act of 2005.

Specifically, the report analyzed the need for and availability of workers for the hardrock and coal mining, and oil and gas, geothermal, nuclear, solar, and wind energy industries. In each of these sectors, the committee examined the availability of skilled labor at both entry and senior levels; the historical and current trends in the size, growth, and demographics of the workforce; labor market characteristics; future demand for and supply of workers; job health and safety impacts of potential labor shortages; and, particularly relevant to today's discussion, the availability and need for education and training programs for workers in these sectors. The report recognized that creation of a skilled workforce begins early, that the nation will depend on these workers to be capable in science, technology, engineering, and mathematics (STEM) disciplines, and that this STEM prerequisite creates a parallel requirement for an educational system that can effectively teach these subjects.

I will focus my remarks primarily on those aspects of the Academies report that are relevant for mining and the topic of today's hearing. However, the broader scope of the report provides useful context to the mining information and I will share some of the overarching recommendations from the report. I will also add some personal observations from my own professional experience about what has taken place in academia and industry to address mining education at the university level over the last 15 years.

Two major factors impact the workforce across all mining and energy sectors. The first is Demographic. Approximately one-third of the U.S. workforce comprises baby

boomers—the generation born between 1946 and 1964—and they are poised to retire in great numbers by the end of this decade. Moreover, there are too few younger workers currently available and prepared to replace them. The second major crosscutting factor impacting the workforce is Competencies. Specifically, the application of STEM principles in the workplace has increased the skill and competency requirements of the mining and energy workers. A strong foundation in STEM skills is therefore needed for many mining and energy jobs, and the need is growing at all levels as innovation and new technologies are increasingly applied in the workplace. The current pipeline of STEM-capable students and workers is inadequate to meet these workforce needs. The report outlined seven recommendations to address the shortfalls of the current education pipeline and I will review those briefly.

In its recommendations to address challenges presented by Demographics and Competencies, the committee highlighted the importance of collaborative efforts among government, industry, and educational institutions to create and support new approaches to develop multiple pathways in higher education that can lead to a range of mining and energy jobs. To ensure that there are enough faculty now and in the pipeline who qualify to work and teach at the cutting edge of technology, the committee also recommended that the government and industry consider public-private partnerships to provide joint support for mining and energy research programs at U.S. universities, with the goal of attracting and better preparing students and faculty, promoting innovation, and helping to insure the relevance of university programs. Recognizing that industry's ability to financially support these critical efforts is subject to market price cyclicity in the commodity sectors

underscored the importance of government-industry partnerships in providing consistent financial support for mining and energy education.

The availability of current, accurate mining and energy information was also highlighted by the committee as being important. The report stressed the need for industry and educational institutions to provide timely and accurate information about career opportunities in mining and energy fields, and educational and career navigation resources targeted toward students, educators, and policy makers. In a related way, the report called upon the federal government to work with industry to develop more agile and responsive workforce data that reflect the fast-paced change of jobs and occupations and allow students, educators, and employers to understand and take advantage of changing job opportunities.

Finally, the report found a critical, pending shortage of federal employees involved in mineral and energy fields due to high, ongoing retirement rates in the federal government sector. These federal employees play an important role in data gathering and advising, as well as in oversight of mining and energy activities for an increasingly involved and concerned citizenry. The committee recommended several approaches for the agencies to attract and retain qualified workers to meet current and future needs in mineral and energy policy, permitting, extraction methods, production oversight, reclamation, and research and data provision. The committee noted the challenges faced by the federal sector in hiring qualified employees both because of the high retirement rates and competition from the higher compensation offered by industry.

The balance of my remarks will focus on the mining component of the report. Mineral and energy resources are essential for the nation's fundamental functions, its

economy, and its security and are essential for the existence and operation of products that are used by people every day**.** The committee defined mining to include metals such as copper and iron—basic materials for all industrial nations—as well as rare earths and other metals necessary for high tech, national defense, and energy applications; industrial minerals such as potash used for fertilizer and sodium carbonate (trona) for glass production; coal for energy; and building materials including sand, gravel and crushed rock for infrastructure including houses, highways, and airport construction. In addition to the convenience and security offered by these kinds of products, minerals also support the economic standard of living in the United States. The USGS estimated that the overall value added to the U.S. gross domestic product (GDP) in 2014 by major industries that consumed processed nonfuel mineral materials was $2.5 trillion. This contribution represented about 14.4 percent of the total U.S. GDP of $17.4 trillion in 2014.

Although the committee's recommendations were applied across the broad array of mining and energy sectors, the study committee noted a particularly acute situation regarding age demographics in the workforce and an accompanying shortage of STEM-capable, younger people to fill upcoming and current openings in mining and mining engineering. The USGS has monitored import reliance for decades and these data have shown an increase in the number of minerals for which the United States depends primarily or completely on foreign suppliers of the raw material. Whether or not the minerals used every day in the United States are mined domestically or abroad, the capacity to conduct research and foster technological innovation are important. Without them, the committee suggested, the nation may not be able to anticipate and react to potential restrictions in the mineral markets. A talent crisis for professionals and workers is

pending, and already exists for faculty in mining and mining engineering, driven by an aging workforce and international competition for talent. Both will precipitate fundamental changes in the cost of talent at all skill and education levels, but particularly for those positions requiring the most highly trained or educated practitioners.

Mining disciplines in higher education were broadly defined in the committee's report to include fields such as mining exploration, mineral extraction and processing, metallurgy, extractive metallurgy, economic geology, exploration geophysics, and geochemistry, among others. The committee underscored the advantages of disciplinary diversity whereby students could be trained and educated across disciplinary lines to increase innovation and educate people with a breadth of skills to address career challenges in a cyclical commodity business.

Although the need for sustaining highly qualified university faculty and graduates in mining and mining engineering is evident, the capacity of U.S. universities to meet this need is severely challenged. Some of the data available from the committee's report—and updated, where possible, for this testimony—illustrate the nature of these challenges. First, the number of accredited mining and mineral engineering programs has declined from 25 in 1982 to 14 in 2007. The number of faculty has also declined, from approximately 120 in 1984 to 70 in 2007. This translates into an average of 5 faculty at each of the 14 programs, each awarding 9 B.S. degrees per year per school. Over the last 10 years U.S. universities have produced fewer than 200 mining engineers per year for employment across the full range of metals, coal, industrial minerals, and building materials sectors, and in academia and federal and state agencies. Relative to other engineering disciplines, these mining and mineral engineering programs are small and may be more vulnerable to financial pressures experienced by

universities. Furthermore, the major proportion of the current technological leadership in U.S. institutions of higher education is approaching retirement without an obvious source of qualified replacements. The study committee identified a critical role for U.S. universities to develop graduate research programs in mining with a goal of establishing global technological leadership.

One approach to reasserting U.S. leadership in mining fields suggested by the committee was the establishment of several interdisciplinary graduate Centers of Excellence in Earth Resources Engineering at leading U.S. research universities. These kinds of centers could help focus attention on the science and engineering challenges presented by the mining industries and develop the professional expertise that will be needed. These Centers could efficiently coordinate the work of faculty and research facilities at multiple universities and would complement the more classical programs of the U.S. schools of mines. In addition, Centers of Excellence could create an education system that responds to changes in the economy more quickly and produces a more flexible, STEM-competent workforce. The immediate goal in addressing the shortfalls of the current education pipeline would be to re-establish the pipeline of talent and particularly of qualified faculty in the 14 remaining mining schools in the disciplines deemed to be 'professions at risk': mining, extractive metallurgy/mineral processing, and economic geology. The outcome from such an approach was envisioned by the committee to develop students equipped with multiple skills, who are prepared to adjust quickly to industry requirements and job availability.

In my own professional experience, I have participated in a consistent industry-academic initiative since 2002 to try to develop more robust mining education programs

and I'd like to briefly discuss a few of these here as complements to the work done by the Academies committee**.** In 2002, industry and the academic community recognized the pending talent crisis in the U.S. mining sector. This realization led to the formation of an Education Sustainability Task Force, where I served as co-chairman under the auspices of the SME. At subsequent workshops and symposia, leaders from industry and the academic community, with participation from federal agencies, established plans to stabilize and advance minerals education at U.S. universities with a special focus on funding to re-establish the 'the pipeline for qualified faculty.' These efforts continued in support of the aforementioned congressional mandate in the Energy Policy Act of 2005 as well as the Academies report presented here. Consistent with recommendations in the Academies report to "provide financial and leadership support to sustain critical teaching capacity until medium- and long-term solutions can be developed and implemented," the effort led to the formation and subsequent funding by industry of the SME Education Sustainability Committee (ESC).

Since its inception in fall 2013, the ESC has sought to develop actionable items to address the long-term challenges to the sustainability of U.S. degree granting programs in Mining Engineering and Mineral Processing/Extractive Metallurgy. Given its mission and the implications of faculty shortages on the future viability of these academic programs, the ESC has focused its efforts on ways of rebuilding the faculty pipeline in order to address the growing absence of viable tenure-track candidates to replace the aging workforce of existing faculty at U.S. universities. The actionable items facilitated by the ESC culminated in two complimentary initiatives; (1) the development of 4-year graduate fellowships for qualified Ph.D. students who are committed to pursuing careers in academia and (2) the

awarding of Career Grants to assist new faculty in establishing research and publication records necessary to achieve tenure and promotion. Thus far, 3 Ph.D. Fellowships and 2 Career Development Grants have been distributed and the solicitation for 2016 has been recently released. When full participation of the Grant Program is reached in 2018, the total financial commitment will be $1.477 million annually. This program, chaired by Dr. Hugh Miller of the Colorado School of Mines, will be discussed by others at this proceeding. The Academies report recommended industry-funded programs such as ESC as a short-term solution to a longer-term, stable solution realized by private-public funding.

In summary, with a direct alignment to industry education and skill requirements, the Academies report suggested that the success of mining education programs can be measured by attainment of employment and advancement opportunities in the mining industries. Expansion of research programs at universities, with matching funding from industry, could be directed toward specific outcomes such as: (1) advancing technology or business processes to drive innovation and enrich graduate and undergraduate education; and (2) developing university faculty who work on the cutting edge of research to enhance the quality of higher education. For mining and mining engineering, where the supply of STEM-capable younger workers is inadequate to replace or sustain requirements for workers in the private sector, in academia, and in the federal government, establishing Centers of Excellence in Earth Resources Engineering or similar technology- and innovation-focused research and education programs could help re-establish a U.S. leadership role in mining.

I would like to thank the Committee for its time and interest in this subject and I look forward to questions.