DEVELOPMENT OF A CRYSTALLINE SILICA MANAGEMENT PLAN FOR A

COAL-FIRED POWER PLANT

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A

PROJECT REPORT

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By

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Abstract

Respirable crystalline silica is a serious occupational health hazard. Exposure can result in the development of silicosis, lung cancer, renal disease, and autoimmune disease. Development of silica-related diseases may take 5-40 years, and there is no cure. The U.S. Occupational Safety and Health Administration (OSHA) recognizes the health burden placed on workers exposed to respirable crystalline silica, and has promulgated a regulatory standard that will protect these workers to a greater extent than in the past. The standard mandates that businesses implement exposure monitoring, engineering and work practice controls to reduce exposures, and training and medical surveillance for employees exposed at the action level (AL) for more than 30 days per year. For this project, a brief epidemiological and knowledge assessment of employees was conducted and initial exposure monitoring for workers was performed. Based on the results, recommendations on work practice controls to reduce exposures were made. To comply with the new OSHA standard, a training program for employees was developed, and requirements for medical surveillance were outlined. The results of this work were used to develop a comprehensive Respirable Crystalline Silica Management Plan for the Golden Valley Electric Association power plant located in Healy, Alaska.

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Chapter 1: Introduction

This paper describes the development of a plan to manage occupational exposures to crystalline silica among workers in a coal-fired power plant. Exposure to crystalline silica dust can lead to a variety of respiratory diseases and other ailments, most of which are incurable and lead to a reduction in both life span and quality of life. Protecting the health of workers is of primary importance, and this management plan helps identify and quantify sources of exposure so that appropriate occupational health measures can be taken.

Silicon is an element that occurs naturally in several forms, including the mineral silicon dioxide (SiO_2). Silicon dioxide, also known as silica, can be found bound to other atoms (combined silica) or may be unbound to other atoms (free silica). With few exceptions, such as asbestos, which is a silicate mineral, combined silica is not a primary concern from a health standpoint. Free silica, in contrast, can be very hazardous, depending on its structural form (Regulations.gov, 2014).

Free silica occurs in two major structural forms: amorphous or crystalline (Regulations.gov, 2014). In amorphous silica, the SiO_2 atoms are bonded together in a random pattern. Amorphous silica is found in substances such as diatomaceous earth, silica gel, and fused silica. In contrast, the SiO_2 atoms in crystalline silica are arranged in a regular, three-dimensional tetrahedron structure (Regulations.gov, 2014). Large amounts of crystalline silica occur in the minerals quartz, granite, flint, chert, opal, and diatomite (Industrial Accident Prevention Association, 2008; Weber and Banks, 1994). The three major forms of crystalline silica are quartz, cristobalite, and tridymite. Cristobalite and tridymite are found in lava or in quartz silica that has been heated to high temperatures (Regulations.gov, 2014).

From a health standpoint, crystalline silica poses a much greater threat than amorphous silica, and this is primarily due to the cytotoxic nature of crystalline silica (Lapp and Castranova, 1993). The Si-O groups on the surface of crystalline silica form hydrogen bonds with phospholipids in the cell membranes of the lung tissue, causing disruption of the cells (Nash et al., 1966). Freshly fractured particles of crystalline silica are more hazardous than older particles, due to the increased surface reactivity in the freshly fractured particles (International Agency for Research on Cancer [IARC], 1997).

Quartz is the form of crystalline silica that is of primary concern from an occupational health standpoint, as it is found in sand and coal, which are widely used in industrial processes. Activities that fracture the coal or rock and generate dust will increase the risk associated with inhalation. Therefore, workers who engage in activities such as mining and/or crushing of coal, and abrasive sandblasting are at particular risk for developing silica-related diseases and need to take protective measures on the job. Recently, hydraulic fracturing has been implicated as a source of occupational exposure to respirable crystalline silica (Esswein, Breitenstein, Snawder, Kiefer, & Sieber, 2013).

Occupational Exposure Limits

The U.S. Occupational Safety and Health Administration (OSHA), the U.S. Centers for Disease Control and Prevention (CDC) National Institute for Occupational Safety and Health (NIOSH), and other professional entities with an interest in occupational health have established occupational exposure limits for hundreds of chemical and particulate contaminants. The occupational exposure limits set by OSHA, which are legally binding, are referred to as permissible exposure levels (PELs). Unfortunately, the majority of PELs were established in the 1970s and are based on out-of-date toxicological data. Changes to the PELs cannot be made by

OSHA without undergoing a lengthy legal and political process, and they must show that complying with a lower value does not pose an unreasonable financial burden on employers.

Recognizing the need for exposure limits that are based on current toxicological studies and epidemiological data, entities such as NIOSH and the American Conference of Governmental Hygienists (ACGIH) have established their own exposure limits based on the best available data. The occupational exposure limits established by NIOSH are called recommended exposure limits (RELs), while those set by ACGIH are termed threshold limit values (TLVs®). Occupational exposure limits are calculated as an average over an eight- or ten-hour work day, although there are ceiling and short-term exposure limits (STEL) for some acutely toxic substances. Ceiling levels are those that should never be exceeded during the working day, while a worker may be exposed at the STEL for up to 15 minutes, no more than four times per day, and with at least one hour between exposure events.

Safe exposure levels are estimated from toxicological and epidemiological data, and are generally believed to be protective of nearly all workers exposed to the substance eight hours per day, 40 hours per week, for their working lifetime (ACGIH, 2012). The permissible exposure limits, RELs, and TLVs® are not hard and fast limits, however. Some workers may be more susceptible to the harmful effects of a given substance. In addition, susceptibility may vary over time as a function of age, or may vary with physical effort and physical condition, e.g., pregnancy (Klonne, 2011).

Particulate contaminants are classified according to their ability to penetrate different regions of the lungs. In addition, the TLV® or PEL for the substance is determined by the location(s) within the respiratory tract where the material is known to have harmful effects on health. The aerodynamic diameter of inhalable and thoracic particles is less than or equal to 100 µm or 25 µm, respectively, while that of respirable particulates is less than or equal to 10 µm (ACGIH, 2012). These terms are used to define TLVs® and PELs for particulate hazardous substances. Those materials for which deposition anywhere in the respiratory tract is harmful are "inhalable", while those materials that cause harm when deposited in the airways or gas-exchange regions form the "thoracic" fraction. If a material is hazardous only when deposited in the gas-exchange region of the lungs, the TLV® is based on the respirable fraction (ACGIH, 2012).

Adverse Health Effects Due to Exposure to Respirable Crystalline Silica

Exposure to respirable crystalline silica dust has been linked to a number of diseases, including silicosis, lung cancer, chronic obstructive pulmonary disease, autoimmune diseases, and renal disease (Calvert, Rice, Boiano, Sheehy, & Sanderson, 2003; Parks, Conrad, & Cooper, 1999; Steenland, Thun, Ferguson, & Port, 1990; Steenland & Goldsmith, 1995; Vupputuri, Park, Nylander-French Owen-Smith, Hogan, & Sandler, 2012). In addition, exposure to crystalline silica increases susceptibility to tuberculosis, an association that has been known since the 16th century (Weber and Banks, 1994).

Silicosis

Silicosis, known since the time of the ancient Greeks, is characterized by fibrosis of the lung tissue. Fibrosis is caused by chronic inflammation of the tissue due to repeated immune system activity. When minerals such as crystalline silica or asbestos that are of respirable size are inhaled into the alveolar regions of the lungs, macrophages are recruited in a (futile) attempt to destroy the material. The chemicals and free radicals released by the macrophages result in inflammation and damage to the lung tissue.

Silicosis may be chronic, accelerated, or acute (Weissman and Wagner, 2005). Chronic silicosis develops after 10 to 30 years of exposure to respirable crystalline silica, while accelerated silicosis develops within 10 years of first exposure. Acute silicosis arises when a worker is exposed to very high concentrations of respirable crystalline silica over a few years, and symptoms begin to appear within four to five years after exposure begins.

Simple silicosis is characterized by the presence of small (<10 mm) opacities in the upper regions of the lungs (Weissman and Wagner, 2005). The small opacities may enlarge or join together to form larger opacities, resulting in conglomerate silicosis or progressive massive fibrosis (Weissman and Wagner, 2005). In acute silicosis, the lower alveolar region fills with fluid and results in the development of small opacities in the upper lungs, followed by the fibrosis when small opacities merge into larger opacities (Weissman and Wagner, 2005).

Chapter 2: Background

Historical Occupational Standards

Crystalline silica has been recognized as an occupational health hazard since the time of the Greeks. The International Agency for Research on Cancer first classified crystalline silica as a probable human carcinogen (class 2A substance) in 1987, and has subsequently classified it as a human carcinogen (class 1 substance) in 1996 (IARC, 1997). Crystalline silica was first regulated by OSHA under the Hazard Communication Standard, and a PEL was set for workers exposed to the substance. There were no requirements for training (other than the general right-to-know provisions that are part of the Hazard Communication Standard) and no requirements for medical surveillance. A Special Emphasis Program for silicosis was developed by OSHA in 1996, which provided guidance for OSHA inspectors in their efforts to focus inspections on worksites where workers were at risk of developing silicosis (OSHA, 1996). In 2008, OSHA issued a National Emphasis Program which expanded the scope of the 1996 Special Emphasis Program and provided additional field guidance to OSHA inspectors (OSHA, 2008).

In 1974, OSHA developed a PEL for respirable crystalline silica dust based on the health effects believed to have been caused by breathing the dust and on epidemiological studies (NIOSH, 1974). The current OSHA PEL for respirable crystalline silica is based on the percentage of silica in the respirable dust, and is calculated as follows: (10 mg respirable crystalline silica dust per cubic meter of air)/(% SiO_2 in the dust + 2). Calculating the PEL is problematic in coal mines and coal-fired power plants where the percentage of silica in the coal and ash can vary depending on the coal, but less problematic in activities such as abrasive sandblasting where the percentage of silica in the material is relatively constant (i.e., sand is 100% quartz).

Other entities, such as ACGIH and the American Society for Testing and Materials (ASTM) have put forth consensus standards for occupational exposure limits for respirable crystalline silica and for medical surveillance, respectively (ACGIH, 2012; ASTM, 2013). The ACGIH TLV® for respirable crystalline silica is 50 μg m^{-3} (ACGIH, 2012). While the use of the ACGIH TLV® is considered "best practice" by industrial hygienists and occupational health physicians, its use is not required by law.

New Occupational Standard

In light of continued evidence for the toxicity of respirable crystalline silica, OSHA proposed a specific rule to regulate occupational exposure to this material. In August 2013, notice of the proposed rulemaking was published in the Federal Register (Federal Register, 2013). The public comment period, which was supposed to close on December 11, 2013, was extended to January 24, 2014 and again to February 11, 2014 (OSHA, 2014). The proposed rule was available on the OSHA website approximately three weeks before it was published in the Federal Register in late August, making the material available for review and comment for 175 days. This is 85 days longer than the typical comment period allotted to rulemaking, and may be the longest public comment period in history (OSHA, personal communication). Public hearings took place from March 18 through April 4, 2014 (OSHA, 2014). The deadline for submitting additional data was set for June 3, 2014, and the deadline for submitting final briefs, arguments, and summations was set for July 18, 2014 and subsequently extended to August 18, 2014 (Regulations.gov, 2014). The final rule was published on March 25, 2016, and will go into effect on June 23, 2016 (Federal Register, 2016). Employers have one to five years to comply with all components of the new rule, depending on the standard to which they must comply (e.g., General Industry/Maritime or Construction).

Some of the pertinent features of the Respirable Crystalline Silica rule are as follows:

Permissible Exposure Level

The rule lowers the PEL to 50 µg m^{-3} and eliminates the problematic formula used to calculate the current PEL. There is still risk associated with exposures at this level, but OSHA believes that it is not feasible for industry to reduce exposure levels below 25 µg m^{-3} using engineering and work practice controls. So in order to reduce risk to workers, they have set the PEL at 50 µg m^{-3}, calculated as an 8-hour time-weighted average. Moreover, they have set the action level (AL) at 25 µg m^{-3}. The AL is the concentration of respirable crystalline silica at which steps must be taken by the employer to reduce the concentration, and below which the standard does not apply as long as the employer has objective data to show that employee exposures will remain below the AL under any foreseeable conditions (29 CFR 1910.1053(a)(2)).

Exposure Assessment and Sample Analysis

One component of the Respirable Crystalline Silica rule concerns the sampling and analytical methods that must be used when determining employee exposures. Respirable dust is sampled using a cyclone (Figure 1), which fractionates the dust in such a way that the respirable particles are collected while the larger particles are discarded.

Figure 1. An aluminum cyclone with filter attached. The appropriate flow rate for an aluminum cyclone is 2.5 L min^{-1}.

There are different kinds of cyclones, including nylon, aluminum, and Dorr-Oliver. Samples must be collected at a flow rate that is specific for the type of cyclone that is used, otherwise the particles will not be fractionated correctly.

In the rule, OSHA mandates that employers must determine exposures to respirable crystalline silica for employees who are exposed at or above the AL (1910.1053(d)(1)). Samples must be taken from a representative group of workers such that all work shifts and tasks are included. Sampling must be repeated every three or six months, depending on exposure levels (1910.1053(d)(3)), or any time there is a change in process, personnel, or work practices (1910.1053(d)(4)). Analysis of samples must be performed by an accredited analytical laboratory and these laboratories must comply with a series of requirements for quality control purposes (1910.1053(d)(5)). According to the timeline for the implementing the new standard, analytical laboratories will have two years to comply with the new requirements (Federal Register, 2016).

Regulated Areas and Access Control

The standard also designates requirements for establishment of regulated areas and for controlling access to areas where airborne concentrations of respirable crystalline silica are in excess of the PEL (1910.1053(e)). The standard includes requirements for use of respirators (1910.1053(e)(4) and 1910.1053(g)).

Methods of Compliance: Engineering Controls and Work Practice Controls

The rule requires employers to reduce employee exposures to below the PEL using engineering and work practice controls unless the employer can demonstrate that reducing exposures below the PEL is not feasible (29 CFR 1910.1053(f)(1)). Employers must nevertheless use such controls (ventilation, enclosures) to reduce the exposures as much as possible, even if they remain above the PEL, and then implement requirements for respiratory protection. The rule prohibits the use of compressed air and dry sweeping methods to clean areas of respirable crystalline silica dust where such activities could result in exposures that are above the PEL, unless HEPA-filtered vacuuming, wet sweeping, and other alternative methods are not feasible (29 CFR 1910.1053(h)). This will most likely necessitate changes in work practices in many coal-fired power plants, where frequent cleaning is necessary to prevent the build-up of highly combustible coal dust.

The standard requires that the employer establish and implement a written exposure control plan. The plan must include a description of the tasks that could result in exposure to respirable crystalline silica dust, as well as a description of the housekeeping controls that will be used to limit exposures. The plan must also contain a description of the engineering controls, work practices, and respiratory protection used to control exposures. The plan must be readily available to all employees covered by the standard, and must be reviewed and updated annually by the employer (29 CFR 1910.1052(f)(2)).

Medical Surveillance

The standard will require employers to provide medical surveillance at no charge to every employee that is exposed to respirable crystalline silica above the AL for 30 days or more per year (29 CFR 1910.1053(i)(1)(i)). Medical exams must be provided by a physician or other licensed health care provider (PLHCP), and shall be provided at a time and location that is reasonable for the employee. Employees exposed above the PEL must be provided with a baseline examination within 30 days of initial assignment unless the employee has received a similar examination within the last 3 years. The standard outlines the requirements for the exam, including medical and work history, physical examination with emphasis on the respiratory system, a chest x-ray read and classified by a NIOSH-certified “B” reader (or an equivalent diagnostic study), a pulmonary function test administered by a NIOSH-certified spirometry technician, and testing for latent tuberculosis infection. Following the baseline examination, affected employees shall receive periodic reexaminations at least every three years, or more often if recommended by the PLHCP. Employers must provide the PHLCP with a description of the employee’s duties (former, current, and anticipated) as they relate to his or her exposure to respirable crystalline silica, a description of the personal protective equipment (PPE) used by the employee and for how long they have used it, and any other information from medical exams related to the employment that is available to the employer. Upon completion of the exam, the PHLCP shall provide a written opinion within 30 days, including any limitations placed upon the employee with regard to using a respirator. If the employee provides written authorization, the physician’s written opinion shall also contain information regarding any limitations on the employee’s exposure to respirable crystalline silica and/or any recommendation for the employee to be examined by a specialist. The employee must be provided with a copy of the written medical opinion within 30 days of each examination.

Hazard Communication/Employee Training

The rule will require employers to provide training and information to their employees regarding the hazards of respirable crystalline silica (29 CFR 1910.1053(j)(1)). Employees must be told of the health hazards and risks associated with respirable crystalline silica, including cancer and effects on lungs, kidneys, and immune system. Employees must be warned of the specific operations in the facility that can lead to exposures, and must be told of the controls that have been implemented to control these exposures. The employer must post signs to regulated areas where exposures can be expected to exceed the PEL (29 CFR 1910.1053(j)(2)). Finally, employees must be informed of the contents of the rule, as well as of the purpose of the medical surveillance program (29 CFR 1910.1053(j)(3)).

Sources of Occupational Exposure

Exposure to respirable crystalline silica occurs in many industries, including mining, foundry work, construction, and hydraulic fracturing (NIOSH, 2012). Power plants that utilize coal are another industry where exposure to respirable crystalline silica may occur because both bituminous and anthracite coal contain quartz to varying degrees depending on their origin (IARC, 1997). Coal dust and ash produced during burning of coal both contain crystalline silica, some fraction of which is respirable. Workers may be exposed to respirable crystalline silica during operations that generate dust, such as dumping of ash, cleaning of the bag house, and sweeping coal dust that accumulates on surfaces. It is important to keep dust levels to a minimum, as coal dust is combustible and represents a severe fire hazard if housekeeping is not maintained. Common methods for keeping surfaces clean include dry sweeping and using compressed air to blow the dust outside or into a hopper. These methods almost always result in release of the dust to the air, where the dust can be inhaled. Under the new standard, the use of compressed air to clean will be prohibited, unless the employer can show that alternative methods (HEPA vacuuming, wet sweeping) are not feasible (29 CFR 1910.1053(h)(1)).

To summarize, the U.S. Occupational Safety and Health Administration (OSHA) recognizes the health burden placed on workers exposed to respirable crystalline silica, and has promulgated a regulatory standard that will serve to protect these workers to a greater extent than in the past. It is estimated that an additional 688 deaths and 1,585 silica-related illnesses will be prevented annually from adoption of the standard (Federal Register, 2013). The standard mandates businesses to implement exposure monitoring, engineering and work practice controls to reduce exposures, and training and medical surveillance for employees exposed at the AL for more than 30 days per year (Federal Register, 2016).

Chapter 3: Goals and Objectives

Project Goals

This project had two primary goals and one secondary goal. The primary goals were to:

1. Ensure that workers at a coal-fired power plant in rural Alaska are protected against the health hazards of respirable crystalline silica.
2. Ensure that the company is able to comply, at a minimum, with the requirements of the OSHA standard for respirable crystalline silica.

A secondary goal was to collect some preliminary epidemiological data regarding the prevalence of silica-related diseases among the workers at the Golden Valley Electric Association (GVEA) power plant in Healy and among any family members exposed to coal dust in an occupational setting.

Project Objectives

This project had six objectives.

1. Conduct a brief epidemiological and knowledge assessment of the workers.
2. Conduct air sampling for respirable crystalline silica in order to determine employee exposures and develop a sampling program to ensure compliance with the OSHA respirable crystalline silica standard.
3. Determine possible sources of respirable crystalline silica within the plant.
4. Identify possible control measures to reduce exposures, including engineering controls, work practice controls, and selection of personal protective equipment.
5. Develop training for workers on the hazards of crystalline silica and silicosis.
6. Outline a medical surveillance program for workers exposed to respirable crystalline silica.

Chapter 4: Methods

Golden Valley Electric Association owns and manages two coal-fired power plants in Healy, Alaska. Unit #1 was built in 1967, and produces 28 MW of power (GVEA, 2014). The second unit was built in 1999, and purchased by GVEA in 2013. It was brought online in late 2015, but a fire caused by combustible coal dust in March 2016 has led GVEA to shut the unit down until they can repair the damages and thoroughly investigate the cause of the fire. Unit #2 is expected to add 50 MW of power to GVEA's grid (GVEA, 2014).

Study Population

There are 16 different job classifications at the Healy power plant, and approximately 65 employees. Employees at the Healy power plant were assigned by the investigator to similar exposure groups (SEGs) based on their job tasks. Tasks associated with each job classification were considered for their potential to result in exposure to respirable crystalline silica. This enabled the identification of SEGs and allowed for the efficient prioritization of sampling tasks. Workers in some job classifications are expected to have little or no exposure to respirable crystalline silica dust (e.g. office administrative staff, custodians), and only those workers in job classifications that have anticipated exposures were eligible for exposure monitoring. Two of the sixteen job classifications had anticipated exposures.

For the brief epidemiological and knowledge assessment, an attempt was made to include each of the 65 employees at the Healy power plant, regardless of their personal exposure to respirable crystalline silica. Healy is a small rural community with active coal mining. Useful epidemiological information may be gleaned from surveying non-exposed employees at the GVEA power plant because they may have relatives with past exposure to coal dust who may be experiencing silica-related diseases as a result of those exposures.

Data Collection

Epidemiological and Knowledge Assessment

A brief epidemiological and knowledge assessment for current workers was administered with the intent of gathering some basic information about the worker population at the Healy power plant. Assessments were anonymous and participation was voluntary. The assessment (Appendix A) consisted of six questions and was offered to all GVEA employees at the Healy power plant in hardcopy format. The assessment was first provided to GVEA in September 2015, but it took a few months before management was able to distribute it to the employees. This was due to the fact that they were extremely busy trying to bring Unit #2 online, and there was no extra time to spare.

The assessment had four main functions:

1) To determine the self-reported prevalence of respiratory illness, renal disease, and autoimmune diseases among workers.
2) To determine the self-reported prevalence of smoking behaviors among workers.
3) To determine if any family members or relatives had previously worked in either the power plant or at the local coal mine, and whether or not they were known to have been diagnosed with silicosis or other silica-related diseases.
4) To ascertain the level of knowledge with regard to the hazards of respirable crystalline silica.

Sampling Design for Exposure Assessments

The OSHA Crystalline Silica standard requires that employers perform personal air sampling for employees who may be exposed at or above the action level for more than 30 days per year unless they have objective data to support their decision to not sample because exposures are likely to be below the action level for the foreseeable future. The employer need not sample every worker for exposure, but must choose a representative set of employees such that there is at least one employee sampled during every work shift and that all tasks that generate, or have the potential to generate, respirable crystalline silica dust are included in the sampling period(s) (29 CFR 1910.1053(d)).

For this study, employees who are anticipated to have the highest exposures were sampled (N= 4), whereas those without any anticipated exposure were not included in the sampling effort. Sampling occurred over the course of one three-day period in August 2015. Because of the potential for worker-to-worker variation in performing tasks, it is imperative that the person performing the sampling make careful observations of the worker's positioning relative to dusty processes, the types of tasks performed, and the level of care with which dusty tasks are performed. In addition, workers are an excellent source of information about the work processes in the plant and can offer insights into any difficulties associated with performing specific tasks. For this study, this investigator remained with one worker in each of the SEGs during each of the different 12-hour shifts in order to observe their behaviors and the nature of the tasks that they perform.

Exposure Assessment

Personal air sampling was conducted for four employees on August 20-22, 2015. The four employees were chosen from the two job classifications identified as having low to high potential exposures for respirable crystalline silica dust: plant operator and materials handler ("coal crew"). One employee from each of these two job classifications volunteered to participate in monitoring during each of the two work shifts at the plant. Two employees worked during the day shift (7:30 a.m.-7:30 p.m.) and the other two worked the night shift (7:30 p.m.-

7:30 a.m.). In addition, two area samples were taken during the day, one in the safety office and one in the nearby conference room. This was done in order to address concerns voiced by some administrative employees. It should be noted that Unit #2 was not operational during the time period that air sampling was conducted, so the employees of interest were working only in Unit #1. In addition, there had been a significant amount of rain over the summer and the coal piles outside the plant were not particularly dusty. This is somewhat normal for late August in Interior Alaska, but overall the summer of 2015 was a wetter than normal, with over 13.8 inches of rain falling in the months of June through August; normal rainfall for June-August is 5.72 inches (S. Berg, National Oceanic and Atmospheric Administration Weather Service, personal communication).

Samples were collected at a flow rate of 2.5 liters per minute on 5-micron polyvinyl chloride (PVC) filters, according to NIOSH analytical method 7500 (NIOSH, 2013; Appendix B), which is an approved method according to the standard (29 CFR 1910.1053, Appendix A). Due to the length of the work shifts, it was necessary to collect two or three samples per employee, so as not to exceed either the volume limitation of the method (1000 L) or the loading of dust onto the filter (limit of 2 mg). Samples were sent to Bureau Veritas Laboratories, Novi, Michigan, for analysis by x-ray powder diffraction. The sampling parameters are shown in Table 1.

Table 1. Sampling parameters for air sampling at Healy Unit #1, August 20-22, 2015.

Employee	**A**	**B**	**C**	**D**	**Office**
Job title	Materials	Operator	Operator	Materials	N/A
Sample 1 time (minutes)	115	363	358	344	357
Sample 1 flow rate (liters/minute)	2.6	2.4	2.5	2.5	2.5
Sample 1 volume (liters)	300	869	897	867	892
Sample 2 time (minutes)	388	308	299	294	257
Sample 2 flow rate (liters/minute)	2.5	2.5	2.5	2.5	2.5
Sample 2 volume (liters)	967	871	745	741	650
Sample 3 time (minutes)	102				
Sample 3 flow rate (liters/minute)	2.5				
Sample 3 volume (liters)	256				

Identification of Sources of Exposure

In order to control exposures within the plant, it is necessary to understand where and how the respirable crystalline silica dust is generated. The two sources of dust are the coal itself and the ash produced when the coal is burned. The tasks that result in worker exposure to dust were determined by careful observation during exposure monitoring, as well as through discussions with the employees.

Data Analysis

Epidemiological and Knowledge Assessment

Descriptive statistics were used to analyze and report the results of the epidemiological and knowledge assessment.

Calculating the 8-hour Time-weighted Average Exposure to Respirable Crystalline Silica

The laboratory reported the results for respirable crystalline silica in units of milligrams per cubic meter (mg m^{-3}), based on the mass of the respirable dust and the air volume collected for each sample. These concentration data were used to calculate 8-hour time-weighted averages (TWA) for each sampled worker using the following equation:

$$TWA = \frac{(C)\,(t)}{T}$$

Where C is the concentration of respirable crystalline silica in mg m^{-3}, t is the time in minutes for which sampling occurred, and T is the total length of the sampled employee's work day in minutes.

Multiple samples must be taken over the course of the workday for an employee whose work shift or exposure time exceeds the maximum sampling time permitted by the analytical method, or if the environment is so dusty that there is a risk of overloading the filter. The 8-hour TWA for the employee was calculated using the results for all of the samples taken during his shift using the following equation:

$$TWA = \frac{(C_1 t_1) + (C_2 t_2) + \ldots + (C_n t_n)}{T}$$

Where C_1 is the concentration of respirable crystalline silica in mg m^{-3} for sample 1, and t_1 is the length of time in minutes over which sample 1 was collected, and so on, while T is the total length in minutes of the work day for the employee.

Chapter 5: Results

Epidemiological and Knowledge Assessment

A short epidemiological and knowledge assessment was offered to the 65 workers at the GVEA Healy power plants in December 2015. There were 15 assessments returned for this study, which represents a response rate of 23%. At the time of the project my proposal, there were approximately 33 employees in Healy, but the addition of a second power plant to the operation necessitated the hiring of more staff. The raw data from the assessment are included in Appendix C.

In the assessment, employees were asked about the duration of their employment at the GVEA power plant and whether or not they had worked at other coal-fired power plants. The average length of time worked at the GVEA power plant was three years and five months. The range was three months to 19.5 years. Of the 15 respondents, only two had ever worked at another coal-fired power plant. One of these employees had worked for 18 years at another site, and only one and a half years at Healy.

Respondents were asked whether or not they or a family member had ever worked at a coal mine. Only two (13.3%) had worked in a coal mine, but five respondents reported that other family members had worked in a coal mine (33.3%). One individual had a son working in a coal mine and another had an uncle.

The incidence of various respiratory illnesses and silica-related diseases among respondents and their family members was also assessed. Three respondents did not answer the question regarding the incidence of these diseases among family members. The results are shown in Table 2.

Table 2. Incidence of self-reported respiratory illnesses and silica-related diseases among GVEA employees and their family members.

Disease	Employee	Family member*
None	9 (60%)	5 (41.7%)
Asthma	2 (13.3%)	4 (33.3%)
Auto-immune disorder	2 (13.3%)	1 (8.3%)
"Black lung" or "Coal miner's lung"	0	0
Bronchitis	1 (6.7%)	1 (8.3%)
Chronic obstructive pulmonary disorder (COPD)	0	0
Lung cancer	0	1 (8.3%)
Persistent cough	1 (6.7%)	1 (8.3%)
Renal disease	0	1 (8.3%)
Silicosis	0	0
Tuberculosis	0	0
Other: Pneumonia	0	1 (8.3%)

* 3 respondents did not indicate "yes" or "no" for any diseases among family members.

Smoking has a synergistic effect with crystalline silica in the development of silicosis. Respondents were queried about their smoking behavior. Nine of the respondents (60%) had never smoked, and five were former smokers (33.3%). Only one of the respondents is a current smoker (6.7%). Of the six who smoked or were former smokers, four (66.7%) did not provide information regarding the duration of their smoking. The other two reported durations of five years and 12 years.

The last question of the assessment asked respondents to describe their level of awareness regarding the hazards of inhaling coal dust or dust that contains silica. None of the respondents replied "no", however 40% (six) said they were only somewhat familiar, or not sure. The remaining 60% said they were familiar with the risks.

Sources of Crystalline Silica

The two sources of crystalline silica in the power plants at Healy are coal and ash. The percentage of crystalline silica in the coal varies, depending on the particular coal seam from whence it was mined. Preliminary analyses by GVEA indicated that the ash in the plant contains as much as 12% crystalline silica (Phil Newton, personal communication).

Worker exposure to silica-containing ash and coal dust depends on the wetness of the coal, the wind conditions, and the overall cleanliness of the plant. The coal is stored outside in a large pile and bulldozers are used to load the coal into coal-crushing devices. If the weather is rainy or snowy, there will be less coal dust stirred up during these operations. When this investigator visited the Healy power plants in late August, there had been 13.8 inches of rain in the preceding months (normal total for June-August is 5.72 inches; S. Berg, National Oceanic and Atmospheric Administration Weather Service, personal communication). Due to the precipitation, the coal pile was not exceedingly dusty, however, the materials handler and operator both indicated that it could be quite dusty in dry weather and on windy days.

The primary sources of employee exposure to coal ash are during ash handling operations (i.e., ash mixing in Plant #2), during tasks where the house vacuum systems are being cleaned, and when cleaning off the filters in the stand-alone air filtration units.

Job Classifications and Exposure to Crystalline Silica

Employees who work directly with coal and ash are expected to have the highest potential exposure to respirable crystalline silica. Based on job descriptions and investigator observations, the materials handlers technicians (i.e., “coal crew”) have the highest potential for exposure, while the plant operators have a low to high potential, depending on the tasks performed, the wetness of the coal and ash, and the general cleanliness of the power plant. A summary of job classifications and anticipated exposure levels is provided in Table 3.

Table 3. Job classifications and estimated exposure levels for respirable crystalline silica.

Job title	Estimated exposure level
Administrative Staff	Very low
Control room operator	Very low
Electrical & Instrumentation	Low
Maintenance	Low
Mechanic	Low
Plant technician: operator	Low to high
Plant technician: material handling	Low to high

Exposure Monitoring

The analytical results for the sampling conducted August 20-22, 2015 are shown in Table 4.

Table 4. Results of air sampling at Healy Unit #1, August 20-22, 2015.

Employee	A	B	C	D	Office
Sample # 1 quartz (mg m^{-3})	<0.017	<0.0058	<0.0056	<0.0058	<0.0056
Sample #1 time (min)	115	363	358	344	357
Sample #2 quartz (mg m^{-3})	<0.0052	<0.0057	0.035	<0.0067	<0.0077
Sample #2 time (min)	388	308	299	294	257
Sample # 3 quartz (mg m^{-3})	<0.020				
Sample #3 time (min)	102				
Total time (min)	605	671	657	638	614
TWA (mg m^{-3}) for shift	<0.0099	<0.0058	0.016	<0.0062	<0.0065
8-hour TWA (mg m^{-3})	<0.0125	<0.008	0.026	<0.0083	<0.0083
% OSHA 8-hour PEL (0.05 mg m^{-3})	<25	<16	52	<16.5	<16.5
% OSHA 8-hour AL (0.025 mg m^{-3})	<50	<32	104	<33	<33

Note: Samples that contained respirable silica at undetectable levels are shown as being less than the applicable concentration (e.g., <0.017 mg m^{-3}). These values are calculated from the minimum detectable mass (based on the analytical method) and the volume of air collected for the sample, and represent the maximum amount of respirable silica that could be present.

Two field blanks were included with the samples and both filters were below the reporting limit for quartz and cristobalite (Appendix D). None of the samples contained any detectable cristobalite (Appendix D), which is expected since Alaska coal is not known to contain either the cristobalite or tridymite (not analyzed here) forms of crystalline silica. Cristobalite and tridymite occur in nature in small amounts, and can also be formed when quartz is subjected to high temperatures (Regulations.gov, 2014). The author has never observed cristobalite or tridymite in coal and ash samples taken from another coal-fired power plant (personal observation). Thus, the temperatures in a coal-fired boiler do not appear to be sufficiently high to convert quartz to either cristobalite or tridymite.

The majority of the samples had undetectable levels of respirable quartz. In these cases, the concentration of respirable silica is preceded by a less-than sign and is calculated from the analytical limit (5 µg) and the volume of air collected for each sample. In all of these cases, since the actual mass of respirable silica was below the limit of detection for the analytical method, and could have been completely absent in the sample, the TWA values represent the maximum possible exposure for the worker under the sampling conditions.

The first and third samples collected for Employee A were below the reporting limit for the method (5 µg), but the air volumes were low enough to result in a concentration of <0.017 and <0.020 mg m^{-3}, respectively, for respirable quartz. The sample volumes were low in these cases because this investigator was interested in getting some information on task-specific exposures. These concentrations could be significant if the true mass of respirable silica on the filter was close to 5 µg. However, the average of all of the samples collected for Employee A during his work shift results in a shift TWA of <0.0099 mg mg^{-3}, or an 8-hour TWA of <0.0125 mg m^{-3}. Both of these are well below OSHA's AL and PEL.

Based on these results, there was only one job classification with any documented exposure to respirable crystalline silica. This exposure occurred when a plant operator (Employee C) cleaned the house vacuum system in Unit #1. The investigator accompanied Employee C around the plant for the majority of his shift, beginning at 7:45 p.m. up until approximately 5 a.m. At that time, the investigator took a break to organize her notes while Employee C finished his rounds and cleaned the house vacuum system. When he came back at about 6:45 a.m., he was noticeably dusty and there was visible dust on the filter for the air sample. It is clear that virtually all of the dust collected on the filter was accumulated during the task of cleaning the filters. It is estimated that the cleaning task took approximately one hour.

Development of Training Program for Employees

A training program that incorporates the requirements of the OSHA standard was designed so that it can be delivered either in a classroom setting (in-person) or via an online learning platform (See Appendices E and F). GVEA has a learning management system and the training program will reside in that system and be available for employees to review at any time. Per OSHA, the training will be mandatory for all exposed workers (materials handlers and plant operators), and it is strongly recommended for all others. It is estimated that the training will take about an hour, and it must be completed annually. The training can be completed either online or in a classroom setting, depending on the needs of GVEA.

Recommendations for a Medical Surveillance Program

The OSHA standard has specific requirements for medical surveillance, including initial and periodic exams and tests for employees exposed to respirable crystalline silica above the AL for 30 or more days per year. Recommendations for a medical program that meets the requirements of the OSHA standard were included in the Silica Management Plan (Appendix G). The standard specifies that the exam shall include medical and work histories, a physical examination emphasizing the respiratory system, a chest x-ray read and classified by a NIOSH-certified "B" reader (or an equivalent diagnostic study), a pulmonary function test administered by a NIOSH-certified spirometry technician, and testing for latent tuberculosis infection.

Chapter 6: Discussion

Analysis of Epidemiological and Knowledge Assessment Data

Results of the assessment, while limited in scope, suggest that coal-related and silica-related lung diseases are not common among this population. Approximately 60% of the respondents indicated that they had none of the illnesses or conditions listed on the assessment. It is important to note, however, that the low response rate (23%) may mean that the results are not indicative of the true status of the population. On the other hand, it seems likely that a person who has family members suffering from coal-related lung disease might be more apt to participate in an anonymous assessment as a means of telling someone their personal story.

It was encouraging to find that 60% of the respondents had never smoked. Smoking may increase the risk of developing silica-related lung disease (Rosenman, Reilly, Rice, Hertzberg, Tseng, & Anderson, 1996). Again, the low response rate for the assessment makes interpretation of these results problematic. In contrast to the willingness to report silica-related lung disease, however, it seems reasonable to expect that workers who smoke are less likely to want to complete an assessment asking them about their smoking behaviors. Thus, the assessment may have underestimated the percentage of workers at the GVEA power plants who smoke.

The last question of the assessment asked respondents to describe their level of awareness regarding the hazards of inhaling coal dust or dust that contains silica. None of the respondents replied “no”, however 40% (6) said they were only somewhat familiar, or not sure. The remaining 60% said they were familiar with the risks. This shows that adding a training program on the hazards of respirable crystalline silica may be of benefit to the GVEA workers.

Sources of Silica and Tasks with Potential Exposure

As noted, the two sources of respirable crystalline silica in the Healy power plants are coal dust and ash. In order to keep exposures to a minimum, it is imperative to keep the plants as clean as possible. This includes working carefully around dust-generating equipment and regularly washing down surfaces with water to reduce dust accumulation. There are several stand-alone air filtration units used on Levels 5-7 of Unit #1. These units help remove dust from the air in the plant, thus reducing exposures. In addition, there is a vacuum system in the plant that contains filters. These filters need to be changed and/or cleaned periodically, and thus represent a major source of potential exposure for the employee(s) charged with this task. The only exposure to respirable crystalline silica in this study occurred during such a task.

The ash handling systems are a distinct source of silica-containing dust. In talking with the workers, it was learned that the ash handling systems are different in Unit #1 and Unit #2. In Unit #1, the ash from the bag house is mixed with water in a closed system of pipes and transported to an outdoor settling pond. In Unit #2, the ash will be sent into a mixer to be mixed with water before being taken to the settling pond. This latter system of handling can result in releases of ash into the building area if the mixer is not sealed well, or if it is over-pressurized for any reason. This is a major source of exposure at the University of Alaska Fairbanks power plant (personal observations). Extra precautions will need to be taken in the ash handling area of Unit #2, and employees may need to wear respiratory protection and protective coveralls while working in that area.

A third source of potential exposure occurs during the coal loading process. Coal is heaped in large piles outside the plant and a dozer is used to scoop it up and dump it into the coal crushing unit. Depending on the weather, the coal piles may be dry or wet, and this has implications for the quantity of dust that is stirred up during the loading operation. In addition, one of the workers indicated that the cab of one of the dozers is leaky. When it is dusty and windy, a lot of coal dust gets into the cab of the dozer, thus exposing the worker. It is recommended that the newer (less leaky) dozer be used whenever the coal pile is dry. In addition, the operator should consider wearing a respirator for added protection.

Some administrative employees were concerned that silica-containing dust could be entering administrative spaces at the plant. To address these questions, air samples were taken in the administrative office and in the conference room. Both of these samples were below the limit of detection for respirable crystalline silica.

To help clarify the steps involved in managing silica exposures at GVEA, the following process map/flow chart was created (Figure 2).

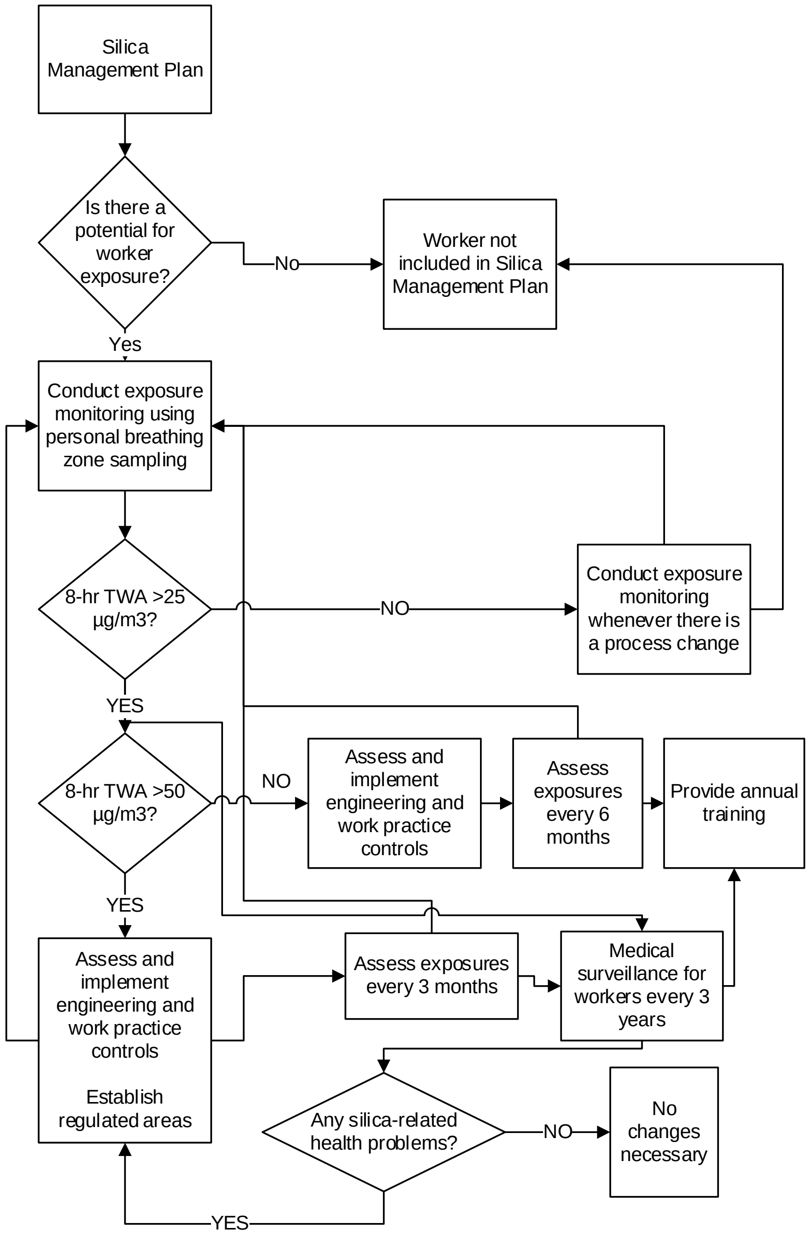

Figure 2. Flow chart for managing respirable crystalline silica exposures at the GVEA Power Plants.

Chapter 7: Strengths and Limitations

One limitation of this study was that the air sampling was performed after a particularly wet summer, when dust levels were noticeably lower. It is possible that the dust levels could be high during the other seasons of the year, depending on snow cover, relative humidity, and the amount of wind. Another limitation is that Unit #2 was not operational during the sampling effort. This unit has a number of different features that may increase potential exposures to workers, such as the ash handling system. It will be important for GVEA to look carefully at the conditions in Unit #2 when it is fully operational and implement any necessary controls. On the positive side, exposures for workers in Unit #1 were almost all below the detection levels for the analytical method; the one exposure occurred while cleaning filters. This suggests that exposures in Unit #2 could be kept below the AL and PEL if the work areas are kept clean and steps are taken to mitigate any release of ash from the ash handling system.

A second limitation of the study was the small response rate and the self-reporting nature of the epidemiological and knowledge assessment. The assessment was offered to all employees, but only 23% of them responded. This may be due to the fact that the primary focus of all of the workers during the months of September-December was in getting Unit #2 operational. The assessment was not anticipated to take more than five to ten minutes to complete, but in the round-the-clock environment of the Healy power plants, it was easy to overlook. In addition, there may have been workers who did not wish to fill out the assessment even though it was anonymous.

The primary strength of this study was the detailed visual observations made during exposure monitoring. During sampling, the investigator worked closely with two employees (one plant operator and one materials handler), and they showed her the details of the operation of the plant.

By spending the vast majority of the 12-hour work shift with each of them, the investigator was able to see which tasks could result in exposure and which ones would not result in any exposure. An additional benefit of this was that it encouraged the development of relationships between the plant workers and health and safety staff. Workers may feel more connected with safety staff and thus feel that their health and safety is taken seriously by management. Workers who feel that this is the case are more likely to be engaged in protecting their own health and safety as well as that of their co-workers.

Chapter 8: Public Health Implications

Reducing the incidence of occupational lung disease is an important public health goal. This is especially true for situations where the disease-causing agent is a particulate. Particulates can be carried home by workers on their clothing, in their hair, and on the interior surfaces of their vehicles. This can result in exposure to family members, including children. And while there does not seem to be strong relationship between casual exposure to low levels of crystalline silica and the development of silicosis in the general public, chronic silicosis has been observed among people living in areas where soil silica content is high and it is frequently very dusty (Norboo, Angchuk, Yahya, Kamat, Pooley, Corrin, Herr, Bruce, and Ball, 1991). Healy is often very windy, and there is active coal mining in the area. By increasing the knowledge of the GVEA workers with regard to the hazards of inhaling coal dust (and ash), it may be possible to improve the knowledge of their family members and acquaintances as well.

There are limited studies on environmental and non-occupational exposures to respirable crystalline silica dust (Bhagia, 2012). Environmental exposure can occur via natural sources, such as wind storms and sand storms. Non-occupational exposure can occur among those living in the vicinity of silica dust-generating industries, such as quartz crushing, agate grinding, and ceramics, or even from farming activities (Bhagia, 2012). In addition, non-occupational exposures can occur through hobbies and activities such as pottery and ceramics (Cooper, Wither, Bernatsky, Claudio, Clarke, Rioux, CaNIOS GenES Investigators, & Fortin, 2010). The limited data obtained from the epidemiological assessment could suggest that exposure to respirable silica from environmental coal dust (from the nearby coal mine) is not a big concern in Healy. However, the assessment was very limited in scope and environmental monitoring would be of interest from a public health standpoint.

Chapter 9: Conclusions and Recommendations

Routine Air Monitoring

The OSHA Respirable Crystalline Silica Standard requires that employees exposed to respirable crystalline silica concentrations greater than 0.025 mg m^{-3} averaged over an 8-hour day be trained on the hazards of respirable silica and be provided with medical surveillance for silica-related diseases. In addition, employers must perform personal exposure monitoring (air sampling) for a representative set of employees during each work shift. Such exposure monitoring must be performed every six months for employee groups who are exposed over the AL (0.025 mg m^{-3}) or every three months for those exposed to respirable crystalline silica over the PEL (0.05 mg m^{-3}).

Based on the data collected here and observations made during the sampling, it was recommended that all Plant Technicians (operators and materials handlers) be considered 'silica workers' from an OSHA standpoint. These are the employees who work directly with coal and ash, or frequent areas where there may be a lot of coal dust or ash present. Although the few employees sampled in August had minimal to no exposure to respirable crystalline silica, it was clear that the possibility for exposure exists and that working conditions are variable. When the air sampling was conducted, environmental conditions were quite wet. In contrast, a materials handler said that it was often quite dusty in the cab of the dozer when environmental conditions are drier. In addition, one of the operators performed a task (cleaning out the vacuum system) that resulted in measureable exposure. This task took approximately one hour and resulted in a total of 0.035 mg of respirable crystalline silica being collected on the filter. The ash handling system for Plant #1 results in less exposure to airborne ash relative to the system used in Plant #2, which is in the process of being brought online. Thus, additional measurements will likely be necessary to assess exposures for plant technicians working in that area once it is up and running at full capacity.

Based on the exposures measured here, routine exposure monitoring may be necessary every six months, or at least during filter-cleaning operations. None of the workers were exposed above the PEL, however, one worker was exposed over the AL. This was due to a particular cleaning task that provided essentially all of the exposure to respirable crystalline silica. The worker's exposure was just barely in excess of the AL, however, and this suggests that steps could be taken to reduce the exposure below the AL and thus eliminate the need for exposure monitoring every six months. Possible options include using a HEPA vacuum to clean the filter, cleaning the filters more frequently so that there is less dust accumulation on the filter, and ensuring that the work is performed slowly and carefully so as to minimize the amount of airborne dust. This task was the one task that was not observed directly by the investigator, so there is some uncertainty with regard to the details of how the work was performed.

Maintaining exposures below the PEL is heavily dependent upon maintaining good work practices and upon keeping the plant as clean as possible. If dust builds up in the plant work areas, workers will be exposed to higher concentrations of respirable silica dust and their exposures may exceed the PEL. In this case, GVEA would need to conduct personal air sampling for a representative group of materials handlers and/or operators every three months. A basic sampling plan would include an operator and a materials handler for each of the two shifts. The estimated financial cost for this is a minimum of $1000 per sampling effort, not including sampling equipment and industrial hygiene expertise. If sampling is only needed for filter-cleaning operations, the cost will be considerably less (approximately $150 per worker for sample analysis). If a GVEA staff member can be trained to perform sampling and interpret sampling results, it is possible to rent sampling equipment. Alternatively, an industrial hygienist will need to be contracted to go to Healy and perform sampling for one or three days every three to six months.

Engineering Controls and Cleaning Methods

The Occupational Safety and Health Administration's silica rule requires employers to reduce employee exposures to below the PEL using engineering and work practice controls unless the employer can demonstrate that reducing exposures below the PEL is not feasible (29 CFR 1910.1053(f)(1)). Employers must nevertheless use such controls (ventilation, enclosures) to reduce the exposures as much as possible, even if they remain above the PEL, and then implement requirements for respiratory protection. The rule prohibits the use of compressed air and dry sweeping methods to clean areas of respirable crystalline silica dust where such activities could result in exposures that are above the PEL, unless other cleaning methods (high efficiency particulate air filters (HEPA) and/or wet sweeping) are not feasible (29 CFR 1910.1053(h)(1)).

It is recommended that GVEA continue to use HEPA air filters to reduce airborne dust loads in dusty areas, and that respiratory protection be worn when plant operators clean the filters or the house vacuum system. Moreover, if HEPA vacuuming or other controls could be implemented during filter cleaning processes, that would help reduce exposures to below the AL, thus reducing the need for routine exposure monitoring.

A material handlers indicated that one of the dozers tends to fill up with coal dust when the coal pile is dry. Therefore, another recommendation is that during dry and dusty conditions, the dozer with the more tightly sealed cab be used for coal-loading operations. The other option is to keep the coal piles damp, but wet coal causes other problems in the operation of the plant.

Medical Surveillance

The Respirable Crystalline Silica rule requires that employers provide medical surveillance at no charge to every employee that is exposed to respirable crystalline silica above the AL for 30 days or more per year (29 CFR 1910.1053(i)(1)(i)). Medical exams shall be performed by a physician or other licensed health care provider (PLHCP), and shall be provided at a time and location that is reasonable for the employee. Employees exposed above the AL must be provided with a baseline examination within 30 days of initial assignment unless the employee has received a similar examination within the last 3 years. The standard outlines the requirements for the exam, including medical and work history, physical examination with emphasis on the respiratory system, a chest x-ray read and classified by a NIOSH-certified "B" reader (or an equivalent diagnostic study), a pulmonary function test administered by a NIOSH-certified spirometry technician, and testing for latent tuberculosis infection.

Following the baseline examination, affected employees shall receive periodic reexaminations at least every three years, or more often if recommended by the PLHCP. Employers must provide the PHLCP with a description of the employee's duties (former, current, and anticipated) as they relate to his or her exposure to respirable crystalline silica, a description of the personal protective equipment (PPE) used by the employee and for how long they have used it, and any other information from medical exams related to the employment that is available to the employer.

Upon completion of the exam (baseline or periodic), the PHLCP shall provide a written opinion within 30 days, including any limitations placed upon the employee with regard to using a respirator. If the employee provides written authorization, the medical opinion can include information on whether the employee has any medical conditions that might preclude him or her from working with respirable crystalline silica, and/or needs to see a specialist.

Hazard Communication/Employee Training

The Respirable Crystalline Silica rule requires employers to provide training and information to their employees regarding the hazards of respirable crystalline silica (29 CFR 1910.1053(j)). Employees must be told of the health hazards and risks associated with respirable crystalline silica, including cancer and effects on lungs, kidneys, and immune system. Employees must be warned of the specific operations in the facility that can lead to exposures, and must be told of the controls that have been implemented to control these exposures. In addition, signs must be posted at the entrance to regulated areas, where the concentration of respirable crystalline silica could exceed the PEL (29 CFR 1910.1053(j)(2)). Finally, employees must be informed of the contents of the rule, as well as of the purpose of the medical surveillance program (29 CFR 1910.1053(j)(3)).

This Crystalline Silica Management Plan (Appendix G) includes a training program designed specifically for GVEA's coal-fired power plants in Healy, Alaska (Appendices E and F). The training should be provided upon initial hire and a refresher provided annually thereafter. It is recommended that all employees at the power plant be provided with this training since they have the potential to be around coal dust and ash even if they do not work with it directly.

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Appendices

Appendix A
Epidemiological and Knowledge Assessment

1. How long have you worked at the GVEA power plant? _____ years _______ months

2. Have you worked at other coal-fired power plants? _____ yes _______ no
    a. If so, for how long (totally) at other site(s)? _____ years _____ months

3. Have you ever worked in a coal mine? _____ yes _____ no

4. Have any family members worked in a coal-fired power plant or in a coal mine?
    _____ yes _____ no

    a. If yes, which family members (check all that apply)?

    _____father _____grandfather _____uncle
    _____mother _____grandmother _____aunt
    _____sister _____brother _____son or daughter

5. Have you or a family member ever been diagnosed with or experienced any of the following?

	Self		Family member	
	Yes	**No**	**Yes**	**No**
Asthma				
Autoimmune disorder (lupus, rheumatoid arthritis, etc.)				
"Black lung" or "Coal miner's lung"				
Bronchitis				
Chronic obstructive pulmonary disorder (COPD)				
Lung cancer				
Persistent cough				
Renal (kidney) disease				
Silicosis				
Tuberculosis				
Other respiratory disease (*specify:*)				

6. Are you a smoker? _____yes _____no _____formerly
    a. If so, for how long? ____ years _____ months

7. Are you familiar with the hazards of inhaling coal dust or dust that contains silica?

    _____yes _____no _____somewhat/not sure

Appendix B
NIOSH Analytical Method 7500

The analytical method is available for download free of charge at

http://www.cdc.gov/niosh/docs/2003-154/pdfs/7500.pdf.

Appendix C
Epidemiological and Knowledge Assessment Raw Data

Length of Time Working at Healy or in other Coal-fired Power Plants

Respondent	GVEA Years	GVEA Months	GVEA Total (years)	Other (years)	Total (years)
1	1	5	1.42		1.42
2	1	0	1.00		1.00
3	1	6	1.50	18.00	19.50
4	3	1	3.08		3.08
5	1	8	1.67		1.67
6	6	2	6.17	5	11.17
7	19	6	19.5		19.50
8	0	7	0.58		0.58
9	1	1	1.08		1.08
10	0	9	0.75		0.75
11	0	3	0.25		0.25
12	1	6	1.5		1.5
13	1	2	1.17		1.17
14	8	2	8.17		8.2
15	3	0	3		3
		Average	3.39		4.92
	Total respondents	15			
	Total workers	65			
	% response	23.08			

Coal mine work	# Yes	# No	% Yes
Self	2	13	13.33
Others	5	10	33.33

Illnesses/conditions	# Self	# Others	% Self	% Other
None	9	5	60.00	41.67
Asthma	2	4	13.33	33.33
Pneumonia	1		6.67	0.00
Bronchitis	1	1	6.67	8.33
Autoimmune	2	1	13.33	8.33
Persistent cough	1	1	6.67	8.33
Lung cancer		1	0.00	8.33
Renal disease		1	0.00	8.33
# with no response	0	3		

# Smoker Yes	# Smoker No	# Former	% Yes	% Former	% Never
1	9	5	6.67	33.33	60.00

# Knowledge yes	# Knowledge no	# Knowledge somewhat	% yes	% no	%somewhat
9		6	60.00	0.00	40.00

Respondent	# Smoking years	Smoking months	Total (years)	Not reported
1	5		5	4
2	12		12	
	Average		8.5	
		Percent not reported		66.67

Appendix D
Lab Results from Bureau Veritas

BUREAU VERITAS

September 21, 2015

Tracey Martinson
UNIV. OF ALASKA FAIRBANKS
P.O. Box 758145
Fairbanks, AK 99775

Bureau Veritas Work Order No. 15090671

Reference:

Dear Tracey Martinson:

Bureau Veritas North America, Inc. received 13 samples on September 10, 2015 for the analyses presented in the following report.

Enclosed is a copy of the Chain-of-Custody record, acknowledging receipt of these samples. Please note that any unused portion of the samples will be discarded 30 days after the date of this report, unless you have requested otherwise.

This material is confidential and is intended solely for the person to whom it is addressed. If this is received in error, please contact the number provided below.

We appreciate the opportunity to assist you. If you have any questions concerning this report, please contact a Client Services Representative at (800) 806-5887.

Sincerely,

Karen Coonan

Karen Coonan
Client Services Representative
Electronic signature authorized through password protection

Bureau Veritas North America, Inc.
Health, Safety, and Environmental Services
22345 Roethel Drive
Novi, MI 48375
Main: (248) 344-1770
Fax: (248) 344-2655
www.us.bureauveritas.com

CASE NARRATIVE

Date: *21-Sep-15*

CLIENT: UNIV. OF ALASKA FAIRBANKS

Project:

Work Order No 15090671

The results of this report relate only to the samples listed in the body of this report.

Unless otherwise noted below, the following statements apply: 1) all samples were received in acceptable condition, 2) all quality control results associated with this sample set were within acceptable limits and/or do not adversely affect the reported results, and 3) the industrial hygiene results have not been blank corrected.

ANALYTICAL RESULTS

Date: *21-Sep-15*

Client: UNIV. OF ALASKA FAIRBANKS

Project:

Work Order No: 15090671

Client ID: #1 | **Date Sampled:** 8/20/2015
Lab ID: 001A | **DateReceived:** 9/10/2015
Matrix: PVC 5 Filter | **Air Vol.(L):** 300

Analyte	Concentration (µg)	Concentration (mg/m³)	Reporting Limit (µg)	Test Method	Date Analyzed	Analyst
Cristobalite	<5	<0.017	5	NIOSH 7500	09/17/2015	AJP
Quartz	<5	<0.017	5	NIOSH 7500	09/17/2015	AJP

Client ID: #2 | **Date Sampled:** 8/20/2015
Lab ID: 002A | **DateReceived:** 9/10/2015
Matrix: PVC 5 Filter | **Air Vol.(L):** 869

Analyte	Concentration (µg)	Concentration (mg/m³)	Reporting Limit (µg)	Test Method	Date Analyzed	Analyst
Cristobalite	<5	<0.0058	5	NIOSH 7500	09/17/2015	AJP
Quartz	<5	<0.0058	5	NIOSH 7500	09/17/2015	AJP

Client ID: #3 | **Date Sampled:** 8/20/2015
Lab ID: 003A | **DateReceived:** 9/10/2015
Matrix: PVC 5 Filter | **Air Vol.(L):** 967

Analyte	Concentration (µg)	Concentration (mg/m³)	Reporting Limit (µg)	Test Method	Date Analyzed	Analyst
Cristobalite	<5	<0.0052	5	NIOSH 7500	09/17/2015	AJP
Quartz	<5	<0.0052	5	NIOSH 7500	09/17/2015	AJP

Client ID: #4 | **Date Sampled:** 8/20/2015
Lab ID: 004A | **DateReceived:** 9/10/2015
Matrix: PVC 5 Filter | **Air Vol.(L):** 871

Analyte	Concentration (µg)	Concentration (mg/m³)	Reporting Limit (µg)	Test Method	Date Analyzed	Analyst
Cristobalite	<5	<0.0057	5	NIOSH 7500	09/17/2015	AJP
Quartz	<5	<0.0057	5	NIOSH 7500	09/17/2015	AJP

General Notes:
<: Less than the indicated reporting limit (RL).
--: Information not available or not applicable.

ANALYTICAL RESULTS

Date: *21-Sep-15*

Client: UNIV. OF ALASKA FAIRBANKS

Project:

Work Order No: 15090671

Client ID: #5 **Date Sampled:** 8/20/2015

Lab ID: 005A **DateReceived:** 9/10/2015

Matrix: PVC 5 Filter **Air Vol.(L):** 256

Analyte	Concentration (µg)	Concentration (mg/m³)	Reporting Limit (µg)	Test Method	Date Analyzed	Analyst
Cristobalite	<5	<0.020	5	NIOSH 7500	09/17/2015	AJP
Quartz	<5	<0.020	5	NIOSH 7500	09/17/2015	AJP

Client ID: #6 **Date Sampled:** 8/21/2015

Lab ID: 006A **DateReceived:** 9/10/2015

Matrix: PVC 5 Filter **Air Vol.(L):** 892

Analyte	Concentration (µg)	Concentration (mg/m³)	Reporting Limit (µg)	Test Method	Date Analyzed	Analyst
Cristobalite	<5	<0.0056	5	NIOSH 7500	09/17/2015	AJP
Quartz	<5	<0.0056	5	NIOSH 7500	09/17/2015	AJP

Client ID: #7 **Date Sampled:** 8/21/2015

Lab ID: 007A **DateReceived:** 9/10/2015

Matrix: PVC 5 Filter **Air Vol.(L):** 650

Analyte	Concentration (µg)	Concentration (mg/m³)	Reporting Limit (µg)	Test Method	Date Analyzed	Analyst
Cristobalite	<5	<0.0077	5	NIOSH 7500	09/17/2015	AJP
Quartz	<5	<0.0077	5	NIOSH 7500	09/17/2015	AJP

Client ID: #8 **Date Sampled:** 8/21/2015

Lab ID: 008A **DateReceived:** 9/10/2015

Matrix: PVC 5 Filter **Air Vol.(L):** 897

Analyte	Concentration (µg)	Concentration (mg/m³)	Reporting Limit (µg)	Test Method	Date Analyzed	Analyst
Cristobalite	<5	<0.0056	5	NIOSH 7500	09/17/2015	AJP
Quartz	<5	<0.0056	5	NIOSH 7500	09/17/2015	AJP

General Notes:
<: Less than the indicated reporting limit (RL).
--: Information not available or not applicable.

BUREAU VERITAS

ANALYTICAL RESULTS

Date: *21-Sep-15*

Client: UNIV. OF ALASKA FAIRBANKS

Project:

Work Order No: 15090671

Client ID: #9 | **Date Sampled:** 8/21/2015
Lab ID: 009A | **DateReceived:** 9/10/2015
Matrix: PVC 5 Filter | **Air Vol.(L):** 867

Analyte	Concentration (µg)	Concentration (mg/m³)	Reporting Limit (µg)	Test Method	Date Analyzed / Analyst
Cristobalite	<5	<0.0058	5	NIOSH 7500	09/17/2015 AJP
Quartz	<5	<0.0058	5	NIOSH 7500	09/17/2015 AJP

Client ID: #10 | **Date Sampled:** 8/22/2015
Lab ID: 010A | **DateReceived:** 9/10/2015
Matrix: PVC 5 Filter | **Air Vol.(L):** 745

Analyte	Concentration (µg)	Concentration (mg/m³)	Reporting Limit (µg)	Test Method	Date Analyzed / Analyst
Cristobalite	<5	<0.0067	5	NIOSH 7500	09/17/2015 AJP
Quartz	26	0.035	5	NIOSH 7500	09/17/2015 AJP

Client ID: #11 | **Date Sampled:** 8/22/2015
Lab ID: 011A | **DateReceived:** 9/10/2015
Matrix: PVC 5 Filter | **Air Vol.(L):** 741

Analyte	Concentration (µg)	Concentration (mg/m³)	Reporting Limit (µg)	Test Method	Date Analyzed / Analyst
Cristobalite	<5	<0.0067	5	NIOSH 7500	09/17/2015 AJP
Quartz	<5	<0.0067	5	NIOSH 7500	09/17/2015 AJP

Client ID: BLANK #1 | **Date Sampled:** 8/20/2015
Lab ID: 012A | **DateReceived:** 9/10/2015
Matrix: PVC 5 Filter | **Air Vol.(L):** NA

Analyte	Concentration (µg)	Concentration (mg/m³)	Reporting Limit (µg)	Test Method	Date Analyzed / Analyst
Cristobalite	<5	--	5	NIOSH 7500	09/17/2015 AJP
Quartz	<5	--	5	NIOSH 7500	09/17/2015 AJP

General Notes:
<: Less than the indicated reporting limit (RL).
--: Information not available or not applicable.

ANALYTICAL RESULTS

Date: *21-Sep-15*

Client: UNIV. OF ALASKA FAIRBANKS

Project:

Work Order No: 15090671

Client ID: BLANK #2

Lab ID: 013A

Matrix: PVC 5 Filter

Date Sampled: 8/21/2015

DateReceived: 9/10/2015

Air Vol.(L): NA

Analyte	Concentration (µg)	Concentration (mg/m³)	Reporting Limit (µg)	Test Method	Date Analyzed / Analyst
Cristobalite	<5	--	5	NIOSH 7500	09/17/2015 AJP
Quartz	<5	--	5	NIOSH 7500	09/17/2015 AJP

General Notes:
<: Less than the indicated reporting limit (RL).
--: Information not available or not applicable.

REQUEST FOR LABORATORY ANALYTICAL SERVICES

For Bureau Veritas Use Only
Bureau Veritas Lab Project No. 15090671

BUREAU VERITAS

Bureau Veritas North America, Inc.

Detroit Lab
22345 Roethel Drive
Novi, MI 48375
(800) 806-5887
(248) 344-1770
Fax (248) 344-2655

Atlanta Lab
3380 Chastain Meadows Pky. Ste 300
Kennesaw, GA 30144
(800) 252-9919
(770) 499-7500
Fax (770) 499-7511

Chicago Lab
95 Oakwood Road
Lake Zurich, IL 60047
(888) 576-7522
(847) 726-3320
Fax (847) 726-3323

RUSH ANALYSIS
CONTACT LAB IN ADVANCE
Need Results by: __/__/__
Charges Authorized? ☐ Yes ☐ No
(If yes, initial here) ____
☐ Email Results ☐ Fax

REPORT RESULTS TO
Name: TraceyMartinson
Company:
Mailing Address: PO Box 758145
City, State, Zip: Fairbanks AK 99775-8145
Telephone No.: (907) 474-6771
Client Job. No.:
Dept.:
Fax No.:

SEND INVOICE INFORMATION
☐ PO #
☐ Call for Credit Card Information
☐ Direct Bill
Name: Dan Maynor
Company: GVEA
Address:
City, State, Zip:

Special instructions and/or specific regulatory requirements: (method, limit of detection, etc.)
email: tamartinson@alaska.edu

* Explanation of Preservation

Soils: Which state are these from? ____
Water: ☐ Drinking Water ☐ Groundwater ☐ Wastewater

ANALYSIS REQUESTED (Enter an "X" in the box below to indicate request. Enter a "P" if Preservative added.*)

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	MATRIX/MEDIA	AIR VOLUME (specify units)	Number of Containers	NIOSH 7500 Quartz & Cristobalite								FOR LAB USE ONLY
#1 ✓	8/20/15	8am	5μPVC	300 L	1	X								
#2 ✓	8/20/15	8am	5μPVC	869 L	1	X								
#3 ✓	8/20/15	11am	5μPVC	967 L	1	X								
#4 ✓	8/20/15	2pm	5μPVC	871 L	1	X								
#5 ✓	8/20/15	5:30pm	5μPVC	256 L	1	X								
#6 ✓	8/21/15	8:30am	5μPVC	892 L	1	X								
#7 ✓	8/21/15	2:30pm	5μPVC	650 L	1	X								
#8 ✓	8/21/15	7:45p	5μPVC	897 L	1	X								
#9 ✓	8/21/15	7:45p	5μPVC	867 L	1	X								
#10 ✓	8/22/15	1:50am	5μPVC	745 L	1	X								
#11 ✓	8/22/15	1:40am	5μPVC	741 L	1	X								

CHAIN OF CUSTODY
Collected by: TraceyMartinson (print) Collector's Signature: TraceyMartinson
Relinquished by: TraceyMartinson Date/Time 9/4/15 3p Received by: Date/Time
Relinquished by: Date/Time Received by: Date/Time
Method of Shipment: Received at Lab by: Kristin Bunnons Date/Time 9/10/15 3:30pm
Sample Condition Upon Receipt: ☒ Acceptable ☐ Other (explain)

Authorized by: Dal W. Maynor Date 9-4-15
(Client Signature MUST Accompany Request)

LABORATORY COPY

Page 1 of 2

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REQUEST FOR LABORATORY ANALYTICAL SERVICES

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Bureau Veritas Lab Project No. 5090671

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(800) 806-5887
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Fax (248) 344-2655

Atlanta Lab
3380 Chastain Meadows Pky, Ste 300
Kennesaw, GA 30144
(800) 252-9919
(770) 499-7500
Fax (770) 499-7511

Chicago Lab
55 Oakwood Road
Lake Zurich, IL 60047
(888) 576-7522
(847) 726-3320
Fax (847) 726-3323

RUSH ANALYSIS
CONTACT LAB IN ADVANCE
Need Results by: ___/___/___
Charges Authorized? ☐ Yes ☐ No
(If yes, initial here) ____
☐ Email Results ☐ Fax

REPORT RESULTS TO
Name: Tracey Martinson — Client Job. No.:
Company: — Dept.:
Mailing Address:
City, State, Zip:
Telephone No.: — Fax No.:

BILLING INFORMATION
☐ PO # ____ ☐ Call for Credit Card Information ☐ Direct Bill
Name: Don Maynor
Company: GVEA
Address:
City, State, Zip:

Special instructions and/or specific regulatory requirements: (method, limit of detection, etc.)
email: tamartinson@alaska.edu

* Explanation of Preservative

Soils: Which state are these from? ____
Waters: ☐ Drinking Water ☐ Groundwater ☐ Wastewater

ANALYSIS REQUESTED
(Enter an "X" in the box below to indicate request. Enter a "P" if Preservative added.*)

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	MATRIX/MEDIA	AIR VOLUME (specify units)	Number of Containers	NIOSH 7500 Quartz + Cristobalite								FOR LAB USE ONLY
Blank #1 ✓	8/20/15	10am	5u PVC	Ø L	1	X								
Blank #2 ✓	8/21/15	9pm	5u PVC	Ø L	1	X								

CHAIN OF CUSTODY
Collected by: Tracey Martinson (print) — Collector's Signature: Tracey Martinson
Relinquished by: Tracey Martinson — Date/Time 9/4/15 3pm — Received by: — Date/Time
Relinquished by: — Date/Time — Received by: — Date/Time
Method of Shipment: — Received at Lab by: Kristin Barons — Date/Time 9/10/15 3:30pm
Sample Condition Upon Receipt ☐ Acceptable ☐ Other (explain)

Authorized by: Dale W. Maynor — Date 9-4-15
(Client Signature MUST Accompany Request)

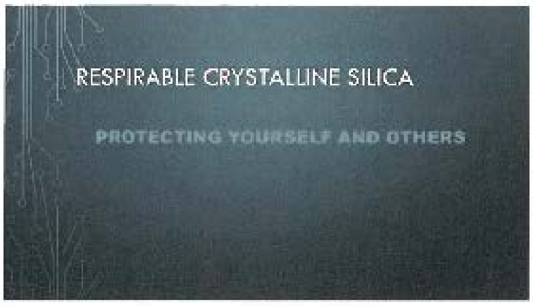
LABORATORY COPY

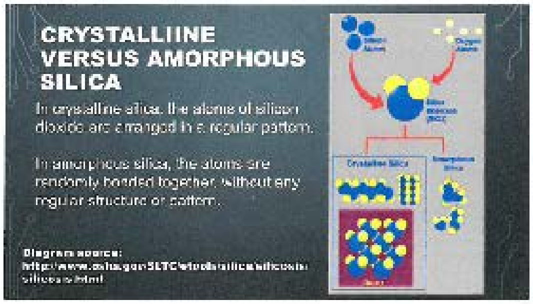
Page 2 of 2

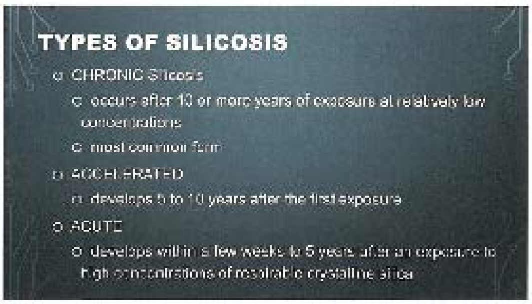
8 of 8

Appendix E
Crystalline Silica Training PowerPoint

This Powerpoint presentation was developed and can be added to the Learning Management System used by GVEA for providing employee access to other required training. If desired, a voice-over can be added to the module.







SYMPTOMS OF SILICOSIS

- Symptoms of silicosis include:
  - Shortness of breath following physical exertion
  - chest pain
  - fatigue
  - severe cough
  - loss of appetite
  - cyanosis (skin turns bluish due to lack of oxygen)

WHAT OSHA REGULATIONS ARE THERE?

Occupational safety and health administration (OSHA) regulates exposure to crystalline silica with the following features:

- Permissible exposure level (PEL) is dependent on the percent silica in the dust
- No requirements for medical surveillance or specific training for employees

DEVELOPMENT OF NEW REGULATIONS

- There is still significant morbidity and mortality from silica-related lung diseases
- Thus, OSHA has proposed a stricter, more comprehensive standard that is in the process of being finalized
- The general consensus is that the PEL was not protective enough
- Sets requirements for medical surveillance and monitoring for exposed employees
- Requires specific training for employees

WORKER EXPOSURES

- Workers in coal-fired power plants may be exposed to dust containing crystalline silica
  - Some (but not all) of the dust is respirable (< 10 micron)
  - Sources include coal and ash
- Proposed OSHA standard will mandate that specific actions be taken to assess and control exposures for workers, as well as specify requirements for medical surveillance and training

CRYSTALLINE SILICA EXPOSURE AT GVEA

Jobs at the Healy Power Plants that have potential exposure to respirable crystalline silica dust:

- Plant technicians: operators
- Plant technicians: materials handlers

Jobs at the Healy Power Plants with little or no exposure to respirable crystalline silica dust:

- Control room operators
- Electricians and maintenance personnel
- Administrative staff

CRYSTALLINE SILICA EXPOSURE AT GVEA (CONT.)

Tasks at the Healy Power Plants with potential exposure to respirable crystalline silica dust include:

- Loading ash and/or coal
- Cleaning house vacuum lines
- Cleaning filter units
- Cleaning up ash and/or coal dust

MEASURING CRYSTALLINE SILICA EXPOSURE

Airborne concentrations of respirable crystalline silica are measured using a filter and a small pump. The filter is attached to a device called a cyclone, which separates the small respirable dust particles from larger particles.

PURPOSE OF EXPOSURE MONITORING

Exposure monitoring, or personal air sampling:

- measures the concentration of respirable crystalline silica that you are breathing during your work
- helps GVEA determine if exposures are in excess of the PEL
- helps GVEA identify proper respiratory protection (i.e., half-face respirator or full-face powered air-purifying respirator)
- may be performed if an employee is experiencing adverse health effects that may be related to silica

REDUCING EXPOSURES TO CRYSTALLINE SILICA

GVEA employees can reduce exposures to respirable crystalline silica by:

- avoid stirring up coal dust and coal ash
- use HEPA vacuums to clean filters and other dusty areas in the power plants—never dry sweep!
- when the coal piles are dry, use the dozer with the cab that is not as leaky
- keep the plant as clean as possible
- wear respiratory protection when performing dusty tasks

MEDICAL SURVEILLANCE

GVEA employees who are materials handlers and plant operators are the most likely to be exposed to respirable crystalline silica dust while working.

The OSHA standard will require that these employees be provided with a physical exam at least every 3 years, at no cost to the employee.

The purpose of the exam is to check the employee's respiratory health and lung function and look for signs of silica-related lung disease.

The medical provider must provide a written opinion to GVEA within 30 days of the exam, and medical records must be retained for the duration of employment plus 30 years.

MEDICAL SURVEILLANCE

The medical exam includes:

- a physical exam
- a chest x-ray
  - given at first exam and every 5 years thereafter
  - may be given more frequently for those who have worked around respirable crystalline silica for longer periods of time
- a pulmonary function test (spirometry)
- a Tuberculosis screen test

Appendix F
Crystalline Silica Quiz (Key)

1. Crystalline silica is found in all of the following, EXCEPT:
    a. Sand
    b. Coal
    c. Fiberglass
    d. Granite

2. True or **false** (circle one):

    Respirable particles are readily removed from the lungs and do not pose any health hazard.

3. Respirable silica can cause:
    a. Silicosis and /or lung cancer
    b. Increased risk of tuberculosis
    c. Rheumatoid arthritis
    d. All of the above

4. Chronic silicosis occurs after ____ of exposure, while acute silicosis develops after ___ years of exposure.
    a. A few weeks-5 years/10+ years
    b. 10+ years/a few weeks-5 years
    c. 10+ years/20+ years
    d. A few weeks-5 years/20+ years

5. True or **false** (circle one):

    There is a cure for silicosis.

6. Sources of respirable crystalline silica in the GVEA power plants include:
    a. Coal
    b. Ash
    c. Bicarbonate
    d. Both a & b

7. Tasks at the Healy power plants with potential exposure to respirable crystalline silica include:
    a. Loading ash
    b. Working in the control room
    c. Cleaning house vacuum lines and air filters
    d. Both a & c

8. Areas in the plant that have a lot of coal or ash dust should:
    a. Be swept up regularly with a broom
    b. Never be cleaned because that stirs up the dust too much
    c. Be cleaned using compressed air
    d. Be cleaned using a vacuum with a HEPA filter

9. Medical surveillance (physicals) will be provided every 3 years to:
    a. Control room operators
    b. Administrative staff
    c. Materials handlers and plant operators
    d. All of the above

10. **True** or false (circle one):

    Medical exams include annual testing for tuberculosis and a chest x-ray every 5 years.

Appendix G
GVEA Silica Management Plan

Background

Respirable crystalline silica is a serious occupational health hazard. Exposure can result in the development of silicosis, lung cancer, renal disease, and autoimmune disease. Development of silica-related diseases may take five-40 years, and there is no cure. The U.S. Occupational Safety and Health Administration (OSHA) recognizes the health burden placed on workers exposed to respirable crystalline silica, and has promulgated a regulatory standard (29 CFR 1910.1053) that will serve to protect these workers to a greater extent than in the past. The standard mandates that businesses implement exposure monitoring, engineering and work practice controls to reduce exposures, and training and medical surveillance for employees exposed at the action level (AL) for more than 30 days per year. The standard sets a permissible exposure level (PEL) of 0.05 mg m^{-3} as an 8-hour time-weighted average, and an action level (AL) of 0.025 mg m^{-3}.

The purpose of this Crystalline Silica Management Plan is to describe the sources of respirable crystalline silica within the coal-fired power plants located in Healy, Alaska, and to identify the job classifications with exposure to respirable crystalline silica. In addition, requirements for medical surveillance and employee training will be outlined, as well as any ongoing requirements for routine exposure monitoring. This will enable GVEA to comply with most of the components of the OSHA Respirable Crystalline Silica standard. The standard also requires the development of a written exposure control plan that outlines the specific work practices that are required to control exposures. This Management Plan will help facilitate the development of the exposure control plan for GVEA.

Sources of Crystalline Silica

The primary sources of crystalline silica in the power plants at Healy are coal and ash. The percentage of crystalline silica in the coal varies, depending on the particular coal seam from whence it was mined. Preliminary analysis of the ash by GVEA has shown that the ash in the plant contains as much as 12% crystalline silica (Phil Newton, personal communication).

Worker exposure to silica-containing ash and coal dust depends on the wetness of the coal, the wind conditions, and the overall cleanliness of the plant. The coal is stored outside in a large pile and bulldozers are used to load the coal into coal-crushing devices. If the weather is rainy or snowy, there will be less coal dust stirred up during these operations. When I visited the Healy power plants in late August, there had been a significant amount of rain in the preceding months. The coal pile was not exceedingly dusty, however, the materials handler and operator both told me that it could be quite dusty in dry weather and on windy days.

The primary sources of employee exposure to coal ash are during ash handling operations (i.e., ash mixing in Plant #2 when it comes online), during tasks where the house vacuum systems are being cleaned, and when cleaning the filters in the air filtration units located on Levels 5-7 of Plant #1.

Job Classifications and Exposure to Crystalline Silica

Employees who work directly with coal and ash are expected to have the highest potential exposure to respirable crystalline silica. Based on job descriptions and observations, the materials handlers technicians (i.e., "coal crew") have the highest potential for exposure, while the plant operators have a low to high potential, depending on the tasks performed, the wetness of the coal and ash, and the general cleanliness of the power plant. A summary of job classifications and anticipated exposure levels is provided in Table 1.

Table 1. Job classifications and estimated exposure levels for respirable crystalline silica.

Job title	Estimated exposure level
Administrative Staff	Very low
Control room operator	Very low
Electrical & Instrumentation	Low
Maintenance	Low
Mechanic	Low
Plant technician: operator	Low to high
Plant technician: material handling	Low to high

Exposure Monitoring

The OSHA Crystalline Silica standard requires that employers perform personal air sampling for employees who may be exposed at or above the action level for more than 30 days per year unless they have objective data to support their decision to not sample because exposures are likely to be below the action level. Personal air sampling was conducted in order to assist GVEA with complying with the new standard when it is implemented.

Personal air sampling was conducted for four employees on August 20-22, 2015. The four employees were chosen from the two job classifications identified as having low to high potential exposures for respirable crystalline silica dust: plant operator and materials handler ("coal crew"). One employee from each of these two job classifications volunteered to participate in monitoring during each of the two work shifts at the plant. Two employees worked during the day shift (7:30 a.m.-7:30 p.m.) and the other two worked the night shift (7:30 p.m.-7:30 a.m.). In addition, two area samples were taken during the day, one in the safety office and one in the nearby conference room. It should be noted that Unit #2 was not operational during the time period that air sampling was conducted, so the employees were working only in Unit #1. In addition, there had been a great deal of rain and the coal piles outside the plant were not particularly dusty.

Samples were collected at a flow rate of 2.5 liters per minute on 5 micron polyvinyl chloride (PVC) filters, according to NIOSH analytical method 7500 (Appendix D). Due to the length of the work shifts, it was necessary to collect two or three samples per employee, so as not to exceed either the volume limitation of the method (1000 L) or the loading of dust onto the filter (limit of 2 mg). Samples were sent to Bureau Veritas Laboratories, Novi, Michigan, for analysis by x-ray powder diffraction.

The sampling parameters are shown in Table 2, and analytical results are shown in Table 3. Two field blanks were included with the samples and both filters were below the reporting limit for quartz and cristobalite (data not shown; see Appendix E). None of the samples contained any detectable cristobalite (Appendix E) or tridymite (not analyzed) which is expected since Alaska coal is not known to contain either of those two forms of crystalline silica (personal observations).

Table 2. Sampling parameters for air sampling at Healy Unit #1, August 20-22, 2015.

Employee	[redacted]	[redacted]	[redacted]	[redacted]	**Office**
Job title	Materials	Operator	Operator	Materials	N/A
Sample 1 time (minutes)	115	363	358	344	357
Sample 1 flow rate (liters/minute)	2.6	2.4	2.5	2.5	2.5
Sample 1 volume (liters)	300	869	897	867	892
Sample 2 time (minutes)	388	308	299	294	257

Sample 2 flow rate (liters/minute)	2.5	2.5	2.5	2.5	2.5
Sample 2 volume (liters)	967	871	745	741	650
Sample 3 time (minutes)	102				
Sample 3 flow rate (liters/minute)	2.5				
Sample 3 volume (liters)	256				

Table 3. Results of air sampling at Healy Unit #1, August 20-22, 2015.

Employee	[redacted]	[redacted]	[redacted]	[redacted]	**Office**
Sample # 1 quartz (mg/m^3)	<0.017	<0.0058	<0.0056	<0.0058	<0.0056
Sample #1 time (min)	115	363	358	344	357
Sample #2 quartz (mg/m^3)	<0.0052	<0.0057	0.035	<0.0067	<0.0077
Sample #2 time (min)	388	308	299	294	257
Sample # 3 quartz (mg/m^3)	<0.020				
Sample #3 time (min)	102				
Total time (min)	605	671	657	638	614
TWA (mg/m^3) for shift	<0.0099	<0.0058	0.016	<0.0062	<0.0065
8-hour TWA (mg/m^3)	<0.0125	<0.008	0.026	<0.0083	<0.0083
% OSHA 8-hour PEL (0.05 mg/m^3)	<25	<16	52	<16.5	<16.5
% OSHA 8-hour AL (0.025 mg/m^3)	<50	<32	104	<33	<33

Note: Samples that contained respirable silica at undetectable levels are shown as being less than the applicable concentration (e.g., <0.017 mg m^{-3}). These values are calculated from the minimum detectable mass (based on the analytical method) and the volume of air collected for the sample, and represent the maximum amount of respirable silica that could be present.

The majority of the samples had undetectable levels of respirable quartz. In these cases, the concentration of respirable silica is preceded by a less-than sign and is calculated from the analytical limit (5 µg) and the volume of air collected for each sample. In all of these cases, since the actual mass of respirable silica was below the limit of detection for the analytical method, and could have been completely absent in the sample, the TWA values represent the maximum possible exposure for the worker under the sampling conditions.

The first and third samples collected for the first employee in the table were below the reporting limit for the method (5 µg), but the air volumes were low enough to result in a concentration of <0.017 and <0.020 mg m^{-3}, respectively, for respirable quartz. The sample volumes were low in these cases because one of the goals was to get some information on task-specific exposures. These concentrations could be significant if the true mass of respirable silica on the filter was close to 5 µg. However, the average of all of the samples collected for this employee during his work shift results in a shift TWA of <0.0099 mg m^{-3}, or an 8-hour TWA of <0.0125 mg m^{-3}. Both of these are well below OSHA's AL and PEL.

Based on these sampling results, there was only one job classification with any documented exposure to respirable crystalline silica. This exposure occurred when a plant operator cleaned the house vacuum system in Unit #1. I accompanied this employee (listed third in the table) around the plant for the majority of his shift, beginning at 7:45 p.m. up until approximately 5 a.m. At that time, I took a break to organize my notes while the employee finished his rounds and cleaned the house vacuum system. When he came back at about 6:45 a.m., he was noticeably dusty and there was visible dust on the filter for the air sample. It is clear that virtually all of the dust collected on the filter was accumulated during the task of cleaning the vacuum system. It is estimated that the cleaning task took approximately one hour.

OSHA Requirements and Recommendations

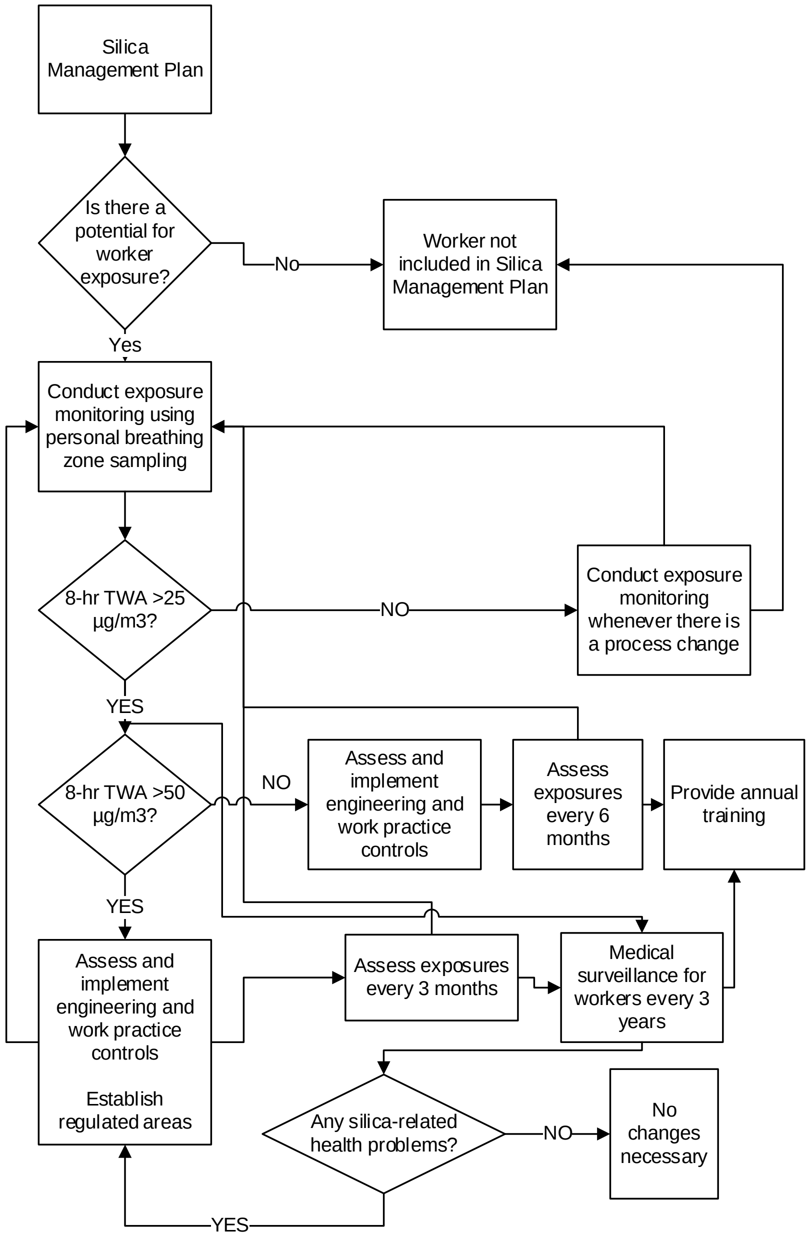
Routine Air Monitoring

The OSHA Crystalline Silica Standard requires that employees exposed to respirable crystalline silica concentrations greater than 0.025 mg m^{-3} averaged over an 8-hour day be trained on the hazards of respirable silica and be provided with medical surveillance for silica-related diseases. In addition, employers must perform personal exposure monitoring (air sampling) for a representative set of employees during each work shift. Such exposure monitoring must be performed every six months for employee groups who are exposed over the AL (0.025 mg m^{-3}) or every three months for those exposed to respirable crystalline silica over the PEL (0.05 mg m^{-3}). The task of cleaning the filters in the vacuum system released sufficient respirable crystalline silica dust that the AL was exceeded for the employee who performed this task. The standard requires that exposure monitoring be performed every six months for employees exposed at the AL. Alternatively, a performance-based option may be utilized (29 CFR 1910.1053(d)(2)). Since it is clear that the exposure occurred during a specific task, my recommendation is that exposure monitoring be performed when the filter-cleaning operations are performed. In addition, I strongly recommend that methods for reducing exposure while performing this task be considered (e.g., HEPA-vacuuming, bag-in/bag-out methods, ventilation). Another option for reducing exposure is to clean the filters more frequently. The worker was just barely over the AL. More frequent cleaning of the filters would result in less dust accumulation on the filters, and therefore will help reduce exposure to respirable crystalline silica dust.

Based on the data collected here and observations made during the sampling, I recommend that all Plant Technicians (operators and materials handlers) be considered silica workers. These are the employees who work directly with coal and ash, or frequent areas where there may be a lot of coal dust or ash present. Although the employees sampled in August had minimal to no exposure to respirable crystalline silica, it was clear that the possibility for exposure exists and that working conditions are variable. When I sampled, the coal was quite wet, but a materials handler told me that it is often quite dusty in the cab of the dozer when environmental conditions are drier. In addition, one employee performed a task (cleaning out the vacuum system) that resulted in measureable exposure. This task took approximately one hour and resulted in a total of 0.035 mg of respirable crystalline silica being collected on the filter. The ash handling system for Plant #1 results in less exposure to airborne ash relative to the system used in Plant #2 (which was not yet operational). Thus, additional measurements may be necessary to assess exposures for plant technicians working in that area once it is up and running.

Based on the exposures measured here, routine exposure monitoring may be necessary every six months, or any time air or vacuum system filters are cleaned. None of the workers were exposed above the PEL, however, one worker was exposed over the AL. This was due to a particular cleaning task that provided essentially all of the exposure to respirable crystalline silica. If sampling only needs to be performed during filter-cleaning tasks, the cost would be approximately $150 per worker performing the task, but monitored over the entire work shift).

Maintaining exposures below the AL and PEL is heavily dependent upon maintaining good work practices and upon keeping the plant as clean as possible. If dust builds up in the plant work areas, workers will be exposed to higher concentrations of respirable silica dust and may exceed the PEL. In this case, GVEA would need to conduct personal air sampling for a representative group of materials handlers and/or operators every three months. A basic sampling plan would include an operator and a materials handler for each of the two shifts. The estimated financial cost for this is a minimum of $1000 per sampling effort, not including sampling equipment and industrial hygiene expertise. If a GVEA staff member can be trained to perform sampling and interpret sampling results, it is possible to rent sampling equipment. Alternatively, an industrial hygienist will need to be contracted to go to Healy and perform sampling for two or three days every three to six months. To help clarify the steps involved in managing silica exposures at GVEA, the following process map/flow chart was created.



Engineering Controls and Cleaning Methods

The Occupational Safety and Health Administration's Respirable Crystalline Silica rule requires employers to reduced employee exposures to below the PEL using engineering and work practice controls unless the employer can demonstrate that reducing exposures below the PEL is not feasible (29 CFR 1910.1053(f)(1)). Employers must nevertheless use such controls (ventilation, enclosures) to reduce the exposures as much as possible, even if they remain above the PEL, and then implement requirements for respiratory protection. The rule prohibits the use of compressed air and dry sweeping methods to clean areas of respirable crystalline silica dust where such activities could result in exposures that are above the PEL, unless other cleaning methods (high efficiency particulate air filters (HEPA) and/or wet sweeping) are not feasible (29 CFR 1910.1053(h)(1)).

It is recommended that GVEA continue to use HEPA air filters in dusty areas, and that respiratory protection be worn when plant operators clean the filters or the house vacuum system. Moreover, if HEPA vacuuming or other controls could be implemented during filter cleaning processes, that would help reduce exposures to below the AL, thus reducing the need for routine exposure monitoring. Another recommendation is that, during coal loading operations, if the coal is dry and dusty, then the dozer with the more tightly-sealed cab should be used. One of the materials handlers indicated that one of the dozers tends to fill up with coal dust when the coal pile is dry. The other option is to keep the coal piles damp, but wet coal causes other problems in the operation of the plant.

Medical Surveillance

The Respirable Crystalline Silica rule requires that employers provide medical surveillance at no charge to every employee that is exposed to respirable crystalline silica above the AL for 30 days or more per year (29 CFR 1910.1053(i)(1)(i)). Medical exams must be provided by a physician or other licensed health care provider (PLHCP), and shall be provided at a time and location that is reasonable for the employee. Employees exposed above the AL must be provided with a baseline examination within 30 days of initial assignment unless the employee has received a similar examination within the last 3 years. The standard outlines the requirements for the exam, including medical and work history, physical examination with emphasis on the respiratory system, a chest x-ray read and classified by a NIOSH-certified "B" reader (or an equivalent diagnostic study), a pulmonary function test administered by a NIOSH-certified spirometry technician, and testing for latent tuberculosis infection.

Following the baseline examination, affected employees shall receive periodic reexaminations at least every three years, or more often if recommended by the PLHCP. Employers must provide the PHLCP with a description of the employee's duties (former, current, and anticipated) as they relate to his or her exposure to respirable crystalline silica, a description of the personal protective equipment (PPE) used by the employee and for how long they have used it, and any other information from medical exams related to the employment that is available to the employer.

Upon completion of the exam (baseline or periodic), the PHLCP shall provide a written opinion within 30 days, including any limitations placed upon the employee with regard to using a respirator. If the employee provides written authorization, the medical opinion can include information on whether the employee has any medical conditions that might preclude him or her from working with respirable crystalline silica, and/or needs to see a specialist.

Hazard Communication/Employee Training

The Respirable Crystalline Silica rule requires employers to provide training and information to their employees regarding the hazards of respirable crystalline silica (29 CFR 1910.1053(j)). Employees must be told of the health hazards and risks associated with respirable crystalline silica, including cancer and effects on lungs, kidneys, and immune system. Employees must be warned of the specific operations in the facility that can lead to exposures, and must be told of the controls that have been implemented to control these exposures. In addition, signs must be posted at the entrance to regulated areas, where the concentration of respirable crystalline silica could exceed the PEL (29 CFR 1910.1053(j)(2)). Finally, employees must be informed of the contents of the rule, as well as of the purpose of the medical surveillance program (29 CFR 1910.1053(j)(3)).

This Crystalline Silica Management Plan includes a training program designed specifically for GVEA's coal-fired power plants in Healy, Alaska. The training should be provided upon initial hire and a refresher provided annually thereafter. It is recommended that all employees at the power plant be provided with this training since they have the potential to be around coal dust and ash even if they do not work with it directly.