

**OREGON OCCUPATIONAL SAFETY AND HEALTH DIVISION  
DEPARTMENT OF CONSUMER AND BUSINESS SERVICES**

**PROGRAM DIRECTIVE**

Program Directive: A-253  
Issued: January 13, 2003  
Revised: October 17, 2008

**SUBJECT:** Silicosis - Local Emphasis Program (LEP)

**AFFECTED CODES/**

**DIRECTIVES:** [437-002-0382 Oregon Rules for Air Contaminants.](#)  
[§1910.1200 Hazard Communication.](#)  
[§1910.134 Respiratory Protection.](#)

See Appendix D for more information on OR-OSHA rules and their applicability to crystalline silica.

**PURPOSE:** This directive describes policies and procedures for implementing a Local Emphasis Program (LEP) to reduce and eliminate the workplace incidence of silicosis resulting from occupational exposure to crystalline silica. This LEP includes inspections conducted in any industry or at any work site where the division determines that there is a potential worker exposure to crystalline silica.

**SCOPE:** This directive applies OR-OSHA-wide.

**REFERENCES:** - [OR-OSHA Field Inspection Reference Manual \(FIRM\)](#)  
- OR-OSHA Occupational Health Laboratory, Manual of Analytical Methods  
- [Preventing Silicosis and Deaths in Construction Workers, NIOSH Alert, DHHS \(NIOSH\) Publication 96-112](#)  
- [Preventing Silicosis and Deaths from Sandblasting, NIOSH Alert, DHHS \(NIOSH\) Publication 92-102](#)  
- DCBS/Oregon Occupational Safety and Health Division, Occupational Health Laboratory: Air Sampling Results for Respirable Fraction of Silica Quartz, Cristobalite, and/or Tridymite

**BACKGROUND:** (Appendix A provides a more detailed review of crystalline silica and silicosis.) Silicosis is an entirely preventable occupational disease. Symptoms generally take years to develop, usually from prolonged exposure. Shortness of breath is a common symptom, with cough and expectoration development with disease progression, especially among cigarette smokers. Other indications of disease progression include fibrotic nodules and fibrosis of lung tissue, wheezing where chronic obstructive bronchitis or asthma is also present, and cancer. Intense exposures to crystalline silica can result in acute silicosis or accelerated health effects.

Crystalline silica is the basic component of sand, quartz and granite rock. It is used or encountered in a wide variety of industries such as electronics; foundries; manufacture of ceramics, clay and pottery, stone, glass; construction; agriculture; manufacture and use of abrasives; mining and quarrying operations; logging; to name a few.

Since 1978, the Oregon Department of Consumer and Business Services has received notification of five accepted disabling claims and 12 denied claims where the nature of injury was primarily silicosis. Other claims, both accepted and denied, included a variety of issues unrelated to the development of silicosis.

**ACTION:** This directive outlines the criteria for inspection scheduling under this emphasis program.

An inspection may be scheduled in non-fixed places of employment when from information available to the Division, recognized health hazards known to be associated with certain processes, are reasonably thought to exist at the place of employment, and the division determines the location of a work-site. (OAR 437-001-0057(7)) Fixed places of employment may also be scheduled. (OAR 437-001-0057(9)).

Recognized Health Hazard: Crystalline silica is a recognized health hazard. A wide variety of published data support the hazard(s) of crystalline silica, primarily the development of silicosis.

Certain Processes: Workers may be exposed to respirable crystalline silica during activities such as:

- demolition of concrete and masonry structures
- crushing, loading, hauling and dumping of rock
- chipping, hammering and drilling of rock
- abrasive blasting using silica sand as an abrasive
- abrasive blasting of concrete (regardless of abrasive used)
- sawing, hammering drilling, grinding and chipping of concrete or masonry

- dry sweeping or pressurized air blowing of concrete, rock or sand dust
- cutting or sanding on silica containing siding
- dry sanding on drywall joint compound
- mixing concrete
- foundry mold work, knock out and manufacture

Places of Employment: This directive identifies certain SIC/ NAICS where information developed by either federal OSHA or OR-OSHA indicates through inspection activity or sampling data that worker exposure to crystalline silica can be reasonably anticipated.

*See Appendix B for a list of Industries with Potential Overexposure to Silica and industries where overexposures to silica have been found.*

**SCHEDULING:** Inspection Scheduling will be based on these criteria:

1. Each field office will do a search of data sources to compile a listing of establishments where these operations are believed to take place.
2. Establishments with fewer than ten employees will be included.
3. Establishments that have received any health inspection in the last three years will be deleted from the inspection list.
  - Each establishment will be prioritized for inspection based on the procedures outlined in Appendix F of this directive.

Joint Safety and Health Inspections: Industrial hygienists conducting construction inspections should consult with safety compliance officers on serious safety hazards such as falls, electrocution, struck-by, or caught-in hazards. Where resources permit, a joint safety and health inspection should be conducted.

OR-OSHA compliance officers can initiate a programmed planned inspection of operations known to create silica overexposures if there is visible dust and employees appear to be inadequately protected.

**APPLICATION:** Inspections under this LEP will address areas of potential crystalline silica dust-related overexposures where there is an increased risk of silicosis. Inspections will include a review of written documentation, i.e., recordkeeping, air monitoring, medical examinations or evaluations, respiratory protection, engineering and/or work practice controls, hazard communication, material safety data sheets, and training. The compliance officer may expand the inspection scope beyond crystalline silica-related activities if serious hazards or violations are observed.

Compliance officers must question employers and employees to determine whether the employer has conducted personal or area sampling for dust containing crystalline silica. Where such data has been collected, copies of the data will be obtained consistent with the requirements of ORS 654.101.

Compliance officers must conduct personal employee monitoring and collect bulk samples where appropriate to document exposures whenever possible.

While evaluating worker exposures to dust containing crystalline silica during abrasive blasting, compliance officers must also be aware of and evaluate potential exposures to noise and metals. Metal exposures often associated with abrasive blasting and other dust creating activities include but are not limited to lead, arsenic, manganese, chromium, cadmium, copper and magnesium.

Compliance officers will also interview the employer and employees to determine whether the employer has conducted any medical surveillance of exposed employees. If such surveillance records exist, copies of the records will be obtained where necessary to support a violation.

Oregon OSHA access to medical records will be conducted consistent with agency policies and procedures. Appendix C contains recommendations for suggestions for a medical monitoring program and should be made available to all employers regardless of the level of exposure to crystalline silica.

If OR-OSHA staff find a product that contains crystalline silica and downstream exposure is reasonably anticipated, e.g., sawing or cutting of brick, tiles and concrete block, they should investigate the adequacy of the material safety data sheets (MSDS) and product labeling. For example, concrete blocks have been found with labels stating "Caution, irritant dust," and the MSDS did not address accurately the chronic health hazard.

Worker clothing contaminated with crystalline silica dust can be carried home and potentially expose family members. Work sites where this potential is observed by the compliance officer should be evaluated (including automobiles) and the employer and employee representatives made aware of the hazard of such activity.

Citations and classification of violations for overexposures to crystalline silica dust, respiratory protection, and work practices and/or engineering controls must be issued in accordance with the procedures and requirements of the OR-OSHA Field Inspection Reference Manual (FIRM).

**OUTREACH:** Managers are encouraged to conduct outreach efforts. OR-OSHA encourages the use of its other resources such as publication information available through the internet (<http://www.orosha.org/>) and related links, the audiovisual lending library, the Resource Center, and Consultative Services.

**IMIS CODING:** The instructions which follow are for recording silica inspections under this LEP and the strategic plan. The OSHA-1 and AVD must be coded as follows:

- Choose Box 25d - National Emphasis Program, SILICA - Insp - Presence of Silica/Silicates.
- Code violations with appropriate silica substance codes:

A514 Aluminum Silicate  
C112 Calcium Silicate (Total Dust)  
C122 Calcium Silicate (Respirable Fraction)  
S103 Silica (Quartz, non-respirable)  
S114 Silica, Crystalline Tripoli (as Quartz), Respirable Dust  
S122 Silica, Amorphous, Diatomaceous Earth  
(less than 1% Crystalline Silica)  
S245 Sodium Metasilicate  
1230 Ethyl Silicate  
1777 Methyl Silicate  
1778 Alpha Methyl Silicate  
9010 Silica, Crystalline Quartz (as Quartz), Respirable Dust  
9013 Silica, Fused, Respirable Dust  
9015 Silica, Crystalline Cristobalite, Respirable Dust  
9017 Silica, Crystalline Tridymite, Respirable Dust  
9050 Silica, Amorphous, Precipitated and Gel  
9075 MICA (less than 1% Crystalline Silica)

**EFFECTIVE  
DATE:**

This directive is effective until cancelled or superceded.

## Appendix A

### Background: Crystalline Silica and Silicosis

Crystalline silica is a ubiquitous substance which is the basic component of sand, quartz and granite rock. (9) Airborne crystalline silica occurs commonly in both the work and non-work environments. Occupational exposure to crystalline silica dust has long been known to produce silicosis, a pneumoconiosis or dust disease of the lung. Activities such as sandblasting, rock drilling, roof bolting, foundry work, stonecutting, drilling, quarrying, brick/block/concrete cutting, gunite operations, lead-based paint encapsulant applications, and tunneling through the earth's crust can create an airborne silica exposure hazard. In addition some recently noted exposures to crystalline silica include the following:

- Calcined diatomaceous earth can contain anywhere from <1% to 75% Cristobalite. In addition to use as a filtering media, calcined diatomaceous earth is often used in industries such as food and beverage preparation where only food grade products and equipment can come in contact with foods or beverages being made.
- Asphalt paving manufacturing may also be a source of crystalline silica exposure, due to the mechanical formation of crystalline silica dust when sand and aggregate passes through rotary dryers. The fine dust can have significant amounts of crystalline silica, depending upon the source of the aggregate. For example, rotary drying of gravel from the Willamette River in Oregon was found to generate dust containing approximately 7 to 12% quartz. The waste dust was transferred periodically by front loader, resulting in clouds of visible dust drifting to the operator.
- The repair or replacement of linings of rotary kilns found in pulp and paper mills and in other manufacturing locations as well as the linings in cupola furnaces are potential sources of crystalline silica exposure. This work may not be commonly seen due to the infrequency and less visible nature of the work location. Turnarounds and yearly shutdowns are the time when this work commonly occurs.
- In food processing operations where crops such as potatoes and beans are readied for market, crystalline silica overexposures have been documented in the sorting, grading and washing areas.

Geologically, quartz is the second most common mineral in the earth's crust. Quartz is readily found in both sedimentary and igneous rocks. Quartz content can vary greatly among different rock types, for example: granite can contain anywhere from 10 to 40 percent quartz; shale has been found to average approximately 22 percent quartz; and sandstones can average almost 70 percent quartz. Silica is a general term for the compound silicon dioxide ( $\text{SiO}_2$ ). Silica can be crystalline or amorphous. Different crystalline silica structures exist as polymorphs of silica and include quartz and less common forms such as Cristobalite and Tridymite. The latter two are less stable than quartz which accounts for the dominance of the quartz form. Quartz can exist as two sub-polymorphs, a-quartz or low quartz, and B-quartz or high quartz. Of these two forms, a-quartz is more common as the B-quartz is apparently only stable at temperatures above approximately 570 degrees centigrade. Upon cooling, B-quartz quickly converts to a-quartz. In the literature, crystalline silica is commonly referred to as silica sand,

free-silica, quartz, Cristobalite, and tripoli. When diatomaceous earth is subjected to pressure or is processed (calcined) at temperatures above 1000 degrees C some of the amorphous silica is converted to crystalline silica in the form of Cristobalite.(Appendix G reference -11) Recent articles have documented the creation of Cristobalite in "after-service" refractive ceramic fiber insulation.(Appendix G reference -12-14) Amorphous silica has been found to exist in nature as opal flint, siliceous glass, diatomaceous earth and vitreous silica.(Appendix G reference -15)

Silicosis is one of the world's oldest known occupational diseases with reports dating back to ancient Greece. Since the 1800's, the silicotic health problems associated with crystalline silica dust exposure have been referred to under a variety of common names including: consumption, ganister disease, grinders' asthma, grinders' dust consumption, grinders' rot, grit consumption, masons' disease, miner's asthma, miner's phthisis, potters' rot, sewer disease, stonemason's disease, chalicosis, and shistosis. Silicosis was considered the most serious occupational hazard during the 1930's, and was the focus of major federal, state, and professional attention during this time. (Appendix G reference -10) The hazard is still present 60+ years later. Crystalline silica is commonly found and used in the following industries:

- electronics industry
- foundry industries
- ceramics, clay and pottery, stone, and glass industries
- construction
- agriculture
- maritime
- railroad industry (setting and laying track)
- slate and flint quarrying and flint crushing
- use and manufacture of abrasives
- manufacture of soaps and detergents
- mining industries.

Perhaps the most familiar use of quartz sand is as an abrasive blasting agent to remove surface coatings prior to repainting or treating. A recent alert published by the National Institute for Occupational Safety and Health (NIOSH) estimates that there are more than one million American workers that are at risk of developing silicosis. Of these workers, NIOSH further estimates that more than 100,000 are employed as sandblasters. (Appendix G reference -16) In the United States, from 1968 through 1990 the total number of deaths where silicosis was reported anywhere on the death certificate was 13,744. Of these, approximately 6,322 listed silicosis as the underlying cause of the death. (Appendix G reference -17) In this study, deaths in the United States due to silicosis were primarily concentrated in 12 states (California, Colorado, Florida, Illinois, Michigan, New Jersey, New York, Ohio, Pennsylvania, Virginia, West Virginia, and Wisconsin.) The silica-related deaths in these 12 states accounted for 68% of the total silica related deaths in the United States. By industry, construction accounted for 10% of the total silicosis-related deaths. (Appendix G reference -17) Based upon the wide spread occurrence and use of crystalline silica across the major industrial groups (maritime, agriculture, construction, and general industry), and in consideration of the number of silicosis related deaths, the NIOSH estimates for the number of exposed workers, and the health effects of crystalline silica dust exposure (e.g., pulmonary fibrosis, lung and stomach cancer), the Agency is implementing a nationwide Local emphasis program to assure worker protection from over exposure to crystalline silica dust.

## Health Effects of Silica Exposure

Inhalation of crystalline silica-containing dusts has been associated with silicosis, chronic obstructive pulmonary disease, bronchitis, collagen vascular diseases, chronic granulomatous infections such as tuberculosis, and lung cancer. In general, aerosols of particulates can be deposited in the lungs. This can produce rapid or slow local tissue damage, eventual disease or physical plugging. Dust containing crystalline silica can cause formation of fibrosis (scar tissue) in the lungs. (Appendix G reference -9) The inhalation of free crystalline silicon dioxide ( $\text{SiO}_2$ ) can produce a fibrotic lung disease known as silicosis. Particle size, dust concentration and duration of dust exposure are important factors in determining the attack rate, latency period, incidence, rate of progression and outcome of disease. A higher attack rate and severity of silicosis are seen with heating crystalline silica-containing materials too greater than 800 degrees C to transform ( $\text{SiO}_2$ ) into Tridymite and Cristobalite (both of which occur naturally and are also found in synthetic silica preparations). High Cristobalite concentration also results from direct conversion of diatomaceous earth following heat and/or pressure and can be found in the superficial layers of refractory brick which have been repeatedly subjected to contact with molten metal.(Appendix G reference -9)

NIOSH has classified three types of silicosis. These include acute, accelerated, and chronic.

**Acute Health Effects:** Intense crystalline silica exposure has resulted in outbreaks of acute silicosis referred to medically as silico-proteinosis or alveolar lipoproteinosis-like silicosis. Initially, crystalline silica particles produce an alveolitis (inflammation in the gas exchange area of the lung) which is characterized by sustained increases in the total number of alveolar cells, including macrophages, lymphocytes and neutrophils. The alveolitis has been found to progress to the characteristic nodular fibrosis of simple silicosis.

A rapid increase in the rate of synthesis and deposition of lung collagen has also been seen with the inhalation of crystalline silica particles. The collagen formed is unique to silica-induced lung disease and biochemically different from normal lung collagen. (Appendix G reference -18)

**Accelerated Health Effects:** Accelerated silicosis may occur with more intense exposure over 5 to 15 years. Fibrotic nodules are generally smaller and the massive fibrosis often occurs in the mid-zones in the lungs.

Acute and accelerated silicosis have been associated with abrasive blasters.

**Chronic Health Effects:** Chronic silicosis usually takes 20 to 45 years to develop as a result of prolonged exposure to free crystalline silica. Nodular lesions tend to form in the upper lobes. In the simple stage of silicosis, symptoms and impairment of pulmonary function are uncommon. If progressive massive fibrosis (PMF) forms from the coalescence of fibrotic nodules the disease usually progresses, even following removal from exposure. Symptoms of silicosis may not develop for many years. Shortness of breath with exertion is the most common symptom of established silicosis. Cough and expectoration may develop with disease progression, especially in cigarette smokers. Wheezing typically only occurs when conditions such as chronic obstructive bronchitis or asthma are also present. Significant abnormality on a chest x-ray may not be seen until 15 to 20 years of exposure have occurred.

When advanced disease and progressive massive fibrosis are present there is distortion of the normal architecture of the lung. Airway obstruction may occur from contraction of the upper lobes of the lung. Emphysematous changes may develop in the lower lobes of the lung. (Appendix G reference -19)

Cancer: The issue of crystalline silica exposure and cancer is a complicated one with disagreement in the literature. (Appendix G reference -20) In worst case, exposure to respirable crystalline silica dust has been associated with lung cancer. (Appendix G reference -20-26) There also has been the suggestion of stomach cancer associated with ingestion of crystalline silica. (Appendix G reference -7) The International Agency for Research on Cancer (IARC) in examining the carcinogenesis of silica has published monographs regarding silica and some silicates. IARC determined that there is sufficient evidence for carcinogenicity in experimental animals with limited evidence for carcinogenicity in humans and has classified silica as a 2B carcinogen. (Appendix G reference -21) IARC is in the process of revisiting the crystalline silica carcinogen issue based upon recent epidemiological studies.

Studies have demonstrated a statistically significant, dose-related increase in lung cancer in several occupationally exposed groups. Winter (1990) observed that the lung cancer risk for pottery workers increased with estimated cumulative exposure to low levels of silica found in potteries. Another study also found that the risk of lung cancer among pottery workers was related to exposure to silica, although the dose-response gradient was not significant (McLaughlin, et al., 1992). An adjustment for possibly confounding exposure to polycyclic aromatic hydrocarbons slightly raised the odds ratios for exposure to silica. This study also analyzed lung cancer risk in tin miners in China and found a significant trend of increasing risk of lung cancer with increasing cumulative respirable silica exposure. A significant dose-response relationship between death from lung cancer and silica dust particle-years has also been demonstrated for South African gold miners (Hnizdo and Sluis-Cremer, 1991). In this study a synergistic effect on lung cancer risk was found for silica exposure and smoking. Lung cancer risk among workers in the diatomaceous earth industry has been studied by Checkoway, et al. (1993). Results showed increasing risk gradients for lung cancer with cumulative exposure to crystalline silica. The authors felt that this finding indicated a causal relation. Several studies have demonstrated a relationship between the degree of silicosis disability and risk for lung cancer (Goldsmith, 1994). Since severity of silicosis reflects silica exposure, this may also indicate a dose-response relationship for silica exposure and lung cancer (Checkoway, 1993).

For additional information please refer to Appendix G -references No. 22-26.

Note: Due to the potential association between exposure to dust containing crystalline silica and the development of lung and stomach cancer, one may find facilities where the employer is evaluating or has evaluated this exposure using thoracic samplers. Thoracic dust is defined as that portion of inhaled dust that penetrates the larynx and is available for deposition within the airways of the thorax. Thoracic dust includes the respirable fraction. The collection of thoracic dust samples currently is not a method used by OR-OSHA. Field Offices need to be aware that thoracic sampling devices are currently available and one may run across the use of these samplers during inspections. For more information one can consult with the OR-OSHA Occupational Health Laboratory.

## Appendix B

### Industries with Potential Overexposure to Crystalline Silica, 1996 to 2001; Federal OSHA Data

<b>SIC</b>		<b>NAICS</b>	
1521	General Contractors - Single Family Houses (except remodeling contractors)	236115	New Single-Family Housing Construction (except Operative Builders)
1521	General Contractors - Single-Family Houses (remodeling contractors)	236118	Residential Remodelers
1522	General Contractors - Residential Buildings Other Than Single-Family (except remodeling contractors, hotel and motel construction contractors, and dormitory and barrack construction contractors)	236116	New Multifamily Housing Construction (except Operative Builders)
1522	General Contractors - Residential Buildings Other Than Single-Family (remodeling contractors)	236118	Residential Remodelers
1522	General Contractors - Residential Buildings Other Than Single-Family (dormitory, barrack, hotel, and motel construction contractors)	236220	Commercial and Institutional Building Construction
1541	General Contractors Industrial Buildings and Warehouses (except grain elevators; drycleaning plants; and manufacturing, public, and industrial warehouses)	236210	Industrial Building Construction
1541	General Contractors - Industrial Buildings and Warehouses (general contractors of grain elevators; dry cleaning plants; and manufacturing, industrial, and public warehouses)	236220	Commercial and Institutional Building Construction
1611	Highway and Street Construction	237310	Highway, Street, and Bridge Construction
1622	Bridge, Tunnel, and Elevated Highway Construction bridge and elevated highway construction)	237310	Highway, Street, and Bridge Construction
1622	Bridge, Tunnel, and Elevated Highway Construction (tunnel construction)	237990	Other Heavy and Civil Engineering Construction
1629	Heavy Construction, NEC (Industrial nonbuilding structures [except petrochemical plants and petroleum refineries])	236210	Industrial Building Construction
1629	Heavy Construction NEC (irrigation systems, sewage treatment plants, and water treatment plants)	237110	Water and Sewer Line and Related Structures Construction
1629	Heavy Construction, NEC (petrochemical plants and refineries)	237120	Oil and Gas Pipeline and Related Structures Construction
1629	Heavy Construction, NEC (power generation plants [except hydroelectric dams], transmission stations, and distribution stations)	237130	Power and Communication Line and Related Structures Construction
1629	Heavy Construction, NEC (except industrial nonbuilding structures)	237990	Other Heavy and Civil Engineering Construction
1629	Heavy Construction, NEC (right-of-way clearing and line slashing, blasting, and trenching-and BLS: removal of nonhazardous materials underground storage tanks)	238910	Nonresidential Site Preparation Contractors
1721	Painting and Paper Hanging (traffic lane painting)	237310	Highway, Street, and Bridge Construction
1721	Painting and Paper Hanging (residential)	238320	Residential Paint and Wall Covering Contractors
1721	Painting and Paper Hanging (nonresidential except traffic lane painting)	238320	Nonresidential Paint and Wall Covering Contractors
1741	Masonry, Stone Setting, and Other Stone Work (residential)	238140	Residential Masonry Contractors
1741	Masonry, Stone Setting, and Other Stone Work (nonresidential)	238140	Nonresidential Masonry Contractors
1742	Plastering, Drywall, Acoustical, and Insulation Work (residential)	238310	Residential Drywall and Insulation Contractors
1742	Plastering, Drywall, Acoustical, and Insulation Work (nonresidential)	238310	Nonresidential Drywall and Insulation Contractors
1743	Terrazzo, Tile, Marble, and Mosaic Work ( residential fresco work)	238310	Residential Drywall and Insulation Contractors
1743	Terrazzo, Tile, Marble, and Mosaic Work (nonresidential fresco work)	238310	Nonresidential Drywall and Insulation Contractors
1743	Terrazzo, Tile, Marble, and Mosaic Work (residential except fresco work)	238340	Residential Tile and Terrazzo Contractors

1743	Terrazzo, Tile, Marble, and Mosaic Work (nonresidential except fresco work)	238340	Nonresidential Tile and Terrazzo Contractors
1771	Concrete Work (residential concrete work except stucco work and residential asphalt, brick, and paving)	238110	Residential Poured Concrete Foundation and Structure Contractors
1771	Concrete Work (nonresidential concrete work except stucco work and commercial asphalt, brick, and paving)	238110	Nonresidential Poured Concrete Foundation and Structure Contractors
1771	Concrete Work (residential stucco work)	238140	Residential Masonry Contractors
1771	Concrete Work (nonresidential stucco work)	238140	Nonresidential Masonry Contractors
1771	Concrete Work (residential asphalt, brick, and concrete paving)	238990	All Other Residential Specialty Trade Contractors
1771	Concrete Work (commercial asphalt, brick, and concrete paving)	238990	All Other Nonresidential Specialty Trade Contractors
1799	Special Trade Contractors, NEC (indoor swimming pool construction contractors)	236220	Commercial and Institutional Building Construction
1799	Special Trade Contractors, NEC (anchored earth retention contractors)	237990	Other Heavy and Civil Engineering Construction
1799	Special Trade Contractors, NEC (residential glass tinting work)	238150	Residential Glass and Glazing Contractors
1799	Special Trade Contractors, NEC (nonresidential glass tinting work)	238150	Nonresidential Glass and Glazing Contractors
1799	Special Trade Contractors, NEC (residential forming contractors and ornamental metal work contractors)	238190	Other Residential Foundation, Structure, and Building Exterior Contractors
1799	Special Trade Contractors, NEC (nonresidential forming contractors and ornamental metal work contractors)	238190	Other Nonresidential Foundation, Structure and Building Exterior Contractors
1799	Special Trade Contractors, NEC (residential antenna installation, boiler, duct, and pipe insulation; lightning rod installation)	238290	Other Residential Building Equipment Contractors
1799	Special Trade Contractors, NEC (building equipment installation contractors for service station equipment; boiler, duct, and pipe insulation; lightning rod installation; bowling alley equipment installation; church bell installation; and clock tower installation)	238290	Other Nonresidential Building Equipment Contractors
1799	Special Trade Contractors, NEC (residential paint and wallpaper stripping and removing contractors)	238320	Residential Paint and Wall Covering Contractors
1799	Special Trade Contractors, NEC (nonresidential paint and wallpaper stripping and removing contractors)	238320	Nonresidential Paint and Wall Covering Contractors
1799	Special Trade Contractors, NEC (residential building finishing contractors for weather stripping and damp proofing, window covering fixture installation, and bathtub refinishing)	238390	Other Residential Building Finishing Contractors
1799	Special Trade Contractors, NEC (nonresidential building finishing contractors for weather stripping and damp proofing, modular furniture installation, trade show exhibit installation and removal, and spectator seating installation)	238390	Other Nonresidential Building Finishing Contractors
1799	Special Trade Contractors, NEC (residential dewatering contractors, test drilling for construction, and core drilling for construction)	238910	Residential Site Preparation Contractors
1799	Special Trade Contractors, NEC (nonresidential dewatering contractors, test drilling for construction, and core drilling for construction)	238910	Nonresidential Site Preparation Contractors
1799	Special Trade Contractors, NEC (residential except indoor swimming pool contractors, anchored earth retention contractors, glass tinting work, forming contractors, ornamental metal work contractors, lightning rod installation contractors)	238990	All Other Residential Specialty Trade Contractors
1799	Special Trade Contractors, NEC (nonresidential except indoor swimming pool contractors, anchored earth retention contractors, glass tinting work, forming contractors, ornamental metal work contractors, service station equipment installation)	238990	All Other Nonresidential Specialty Trade Contractors
1799	Special Trade Contractors, NEC (power washing building exteriors, not associated with construction)	561790	Other Services to Buildings and Dwellings
1799	Special Trade Contractors, NEC (asbestos abatement and lead paint removal contractors)	562910	Remediation Services
3251	Brick and Structural Clay Tile (except slumped brick)	327121	Brick and Structural Clay Tile Manufacturing
3251	Brick and Structural Clay Tile (slumped brick)	327331	Concrete Block and Brick Manufacturing
3253	Ceramic Wall and Floor Tile	327122	Ceramic Wall and Floor Tile Manufacturing
3255	Clay Refractories	327124	Clay Refractory Manufacturing

3259	Structural Clay Products, NEC	327123	Other Structural Clay Product Manufacturing
3261	Vitreous China Plumbing Fixtures and China and Earthenware Fittings and Bathroom Accessories	327111	Vitreous China Plumbing Fixture and China and Earthenware Bathroom Accessories Manufacturing
3262	Vitreous China Table and Kitchen Articles	327112	Vitreous China, Fine Earthenware, and Other Pottery Product Manufacturing
3269	Pottery Products, NEC	327112	Vitreous China, Fine Earthenware, and Other Pottery Product Manufacturing
3271	Concrete Block and Brick	327331	Concrete Block and Brick Manufacturing
3272	Concrete Products, Except Block and Brick (concrete pipe)	327332	Concrete Pipe Manufacturing
3272	Concrete Products, Except Block and Brick (concrete products, except dry mix concrete and pipe)	327390	Other Concrete Product Manufacturing
3272	Concrete Products, Except Block and Brick (dry mixture concrete)	327999	All Other Miscellaneous Nonmetallic Mineral Product Manufacturing
3273	Ready-Mixed Concrete	327320	Ready-Mix Concrete Manufacturing
3281	Cut Stone and Stone Products	327991	Cut Stone and Stone Product Manufacturing
3291	Abrasive Products (except steel wool with or without soap)	327910	Abrasive Product Manufacturing
3291	Abrasive Products (steel wool with or without soap)	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing
3321	Gray and Ductile Iron Foundries	331511	Iron Foundries
3322	Malleable Iron Foundries	331511	Iron Foundries
3325	Steel Foundries, NEC	331513	Steel Foundries (except Investment)
3365	Aluminum Foundries	331524	Aluminum Foundries (except Die-Casting)
3366	Copper Foundries	331525	Copper Foundries (except Die-Casting)
3431	Enameled Iron and Metal Sanitary Ware	332998	Enameled Iron and Metal Sanitary Ware Manufacturing
3441	Fabricated Structural Metal	332312	Fabricated Structural Metal Manufacturing
3442	Metal Doors, Sash, Frames, Molding and Trim	332321	Metal Window and Door Manufacturing
3443	Fabricated Plate Work (Boiler Shops) (fabricated plate work and metal weldments)	332313	Plate Work Manufacturing
3443	Fabricated Plate Work (Boiler Shops) (power boilers and heat exchangers)	332410	Power Boiler and Heat Exchanger Manufacturing
3443	Fabricated Plate Work (Boiler Shops) (heavy gauge tanks)	332420	Metal Tank (Heavy Gauge) Manufacturing
3443	Fabricated Plate Work (Boiler Shops) (metal cooling towers)	333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing
3444	Sheet Metal Work (stamped metal skylights)	332321	Metal Window and Door Manufacturing
3444	Sheet Metal Work (except sheet metal bins and vats, skylights, and sheet metal cooling towers)	332322	Sheet Metal Work Manufacturing
3444	Sheet Metal Work (metal bins and vats)	332439	Other Metal Container Manufacturing
3444	Sheet Metal Work (cooling towers, sheet metal)	333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing
3471	Electroplating, Plating, Polishing, Anodizing, and Coloring	332813	Electroplating, Plating, Polishing, Anodizing and Coloring
3479	Coating, Engraving, and Allied Services, NEC (except jewelry, silverware, and flatware engraving and etching)	332812	Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers
3479	Coating, Engraving, and Allied Services, NEC (precious metal jewelry engraving and etching)	339911	Jewelry (except Costume) Manufacturing
3479	Coating, Engraving, and Allied Services, NEC (silver and plated ware engraving and etching)	339912	Silverware and Plated Ware Manufacturing

Since 1997, from available data, Oregon OSHA has found overexposures in the following.

SIC		NAICS	
1542	General Contractors - Nonresidential Buildings, Other than Industrial Buildings and Warehouses	236220	Commercial and Institutional Building Construction
1622	Bridge, Tunnel, and Elevated Highway Construction bridge and elevated highway construction)	237310	Highway, Street, and Bridge Construction
1622	Bridge, Tunnel, and Elevated Highway Construction (tunnel construction)	237990	Other Heavy and Civil Engineering Construction
1623	Water, Sewer, Pipeline, and Communications and Power Line Construction (water and sewer pipelines and related construction)	237110	Water and Sewer Line and Related Structures Construction
1623	Water, Sewer, Pipeline, and Communications and Power Line Construction (gas and oil pipelines, mains, and pumping stations)	237120	Oil and Gas Pipeline and Related Structures Construction
1623	Water, Sewer, Pipeline, and Communications and Power Line Construction (power and communications transmission lines)	237130	Power and Communication Line and Related Structures Construction
1711	Plumbing, Heating, and Air-Conditioning (residential environmental control installation contractors)	238210	Residential Electrical Contractors
1711	Plumbing, Heating, and Air-Conditioning (nonresidential environmental control installation contractors)	238210	Nonresidential Electrical Contractors
1711	Plumbing, Heating, and Air-Conditioning (residential except environmental controls installation; and septic tank, cesspool, and dry well construction)	238220	Residential Plumbing, Heating, and Air-Conditioning Contractors
1711	Plumbing, Heating, and Air-Conditioning (nonresidential except environmental controls installation; and septic tank, cesspool, and dry well construction)	238220	Nonresidential Plumbing, Heating, and Air-Conditioning Contractors
1711	Plumbing, Heating, and Air-Conditioning (residential septic tank, cesspool, and dry well construction contractors)	238910	Residential Site Preparation Contractors
1711	Plumbing, Heating, and Air-Conditioning (residential septic tank, cesspool, and dry well construction contractors)	238910	Nonresidential Site Preparation Contractors
1741	Masonry, Stone Setting, and Other Stone Work (residential)	238140	Residential Masonry Contractors
1741	Masonry, Stone Setting, and Other Stone Work (nonresidential)	238140	Nonresidential Masonry Contractors
1743	Terrazzo, Tile, Marble, and Mosaic Work (residential fresco work)	238310	Residential Drywall and Insulation Contractors
1743	Terrazzo, Tile, Marble, and Mosaic Work (nonresidential fresco work)	238310	Nonresidential Drywall and Insulation Contractors
1743	Terrazzo, Tile, Marble, and Mosaic Work (residential except fresco work)	238340	Residential Tile and Terrazzo Contractors
1743	Terrazzo, Tile, Marble, and Mosaic Work (nonresidential except fresco work)	238340	Nonresidential Tile and Terrazzo Contractors
1761	Roofing, Siding, and Sheet Metal Work (residential roofing contractors)	238160	Residential Roofing Contractors
1761	Roofing, Siding, and Sheet Metal Work (nonresidential roofing contractors)	238160	Nonresidential Roofing Contractors
1761	Roofing, Siding, and Sheet Metal Work (residential siding contractors)	238170	Residential Siding Contractors
1761	Roofing, Siding, and Sheet Metal Work (nonresidential siding contractors)	238170	Nonresidential Siding Contractors
1761	Roofing, Siding, and Sheet Metal Work (residential except roofing and siding work)	238390	Other Residential Building Finishing Contractors
1761	Roofing, Siding, and Sheet Metal Work (nonresidential except roofing and siding work)	238390	Other Nonresidential Building Finishing Contractors
1771	Concrete Work (commercial asphalt, brick, and concrete paving)	238990	All Other Nonresidential Specialty Trade Contractors
1799	Special Trade Contractors, NEC (indoor swimming pool construction contractors)	236220	Commercial and Institutional Building Construction
1799	Special Trade Contractors, NEC (anchored earth retention contractors)	237990	Other Heavy and Civil Engineering Construction
1799	Special Trade Contractors, NEC (residential glass tinting work)	238150	Residential Glass and Glazing Contractors
1799	Special Trade Contractors, NEC (nonresidential glass tinting work)	238150	Nonresidential Glass and Glazing Contractors

1799	Special Trade Contractors, NEC (residential forming contractors and ornamental metal work contractors)	238190	Other Residential Foundation, Structure and Building Exterior Contractors
1799	Special Trade Contractors, NEC (nonresidential forming contractors and ornamental metal work contractors)	238190	Other Nonresidential Foundation, Structure and Building Exterior Contractors
1799	Special Trade Contractors, NEC (residential antenna installation, boiler, duct, and pipe insulation; lightning rod installation)	238290	Other Residential Building Equipment Contractors
1799	Special Trade Contractors, NEC (building equipment installation contractors for service station equipment; boiler, duct, and pipe insulation; lightning rod installation; bowling alley equipment installation; church bell installation; and clock tower installation)	238290	Other Nonresidential Building Equipment Contractors
1799	Special Trade Contractors, NEC (residential paint and wallpaper stripping and removing contractors)	238320	Residential Paint and Wall Covering Contractors
1799	Special Trade Contractors, NEC (nonresidential paint and wallpaper stripping and removing contractors)	238320	Nonresidential Paint and Wall Covering Contractors
1799	Special Trade Contractors, NEC (residential building finishing contractors for weather stripping and damp proofing, window covering fixture installation, and bathtub refinishing)	238390	Other Residential Building Finishing Contractors
1799	Special Trade Contractors, NEC (nonresidential building finishing contractors for weather stripping and damp proofing, modular furniture installation, trade show exhibit installation and removal, and spectator seating installation)	238390	Other Nonresidential Building Finishing Contractors
1799	Special Trade Contractors, NEC (residential dewatering contractors, test drilling for construction, and core drilling for construction)	238910	Residential Site Preparation Contractors
1799	Special Trade Contractors, NEC (nonresidential dewatering contractors, test drilling for construction, and core drilling for construction)	238910	Nonresidential Site Preparation Contractors
1799	Special Trade Contractors, NEC (residential except indoor swimming pool contractors, anchored earth retention contractors, glass tinting work, forming contractors, ornamental metal work contractors, lightning rod installation contractors)	238990	All Other Residential Specialty Trade Contractors
1799	Special Trade Contractors, NEC (nonresidential except indoor swimming pool contractors, anchored earth retention contractors, glass tinting work, forming contractors, ornamental metal work contractors, service station equipment installation)	238990	All Other Nonresidential Specialty Trade Contractors
1799	Special Trade Contractors, NEC (power washing building exteriors, not associated with construction)	561790	Other Services to Buildings and Dwellings
1799	Special Trade Contractors, NEC (asbestos abatement and lead paint removal contractors)	562910	Remediation Services
2411	Logging	113310	Logging
2851	Paints, Varnishes, Lacquers, Enamels and Allied Products	325510	Paint and Coating Manufacturing
2952	Asphalt Felts and Coatings	324122	Asphalt Shingle and Coating Materials Manufacturing
3253	Ceramic Wall and Floor Tile	327122	Ceramic Wall and Floor Tile Manufacturing
3281	Cut Stone and Stone Products	327991	Cut Stone and Stone Product Manufacturing
3295	Minerals and Earths, Ground or Otherwise Treated (grinding, washing, separating, etc. of kaolin and ball clay)	212324	Kaolin and Ball Clay Mining
3295	Minerals and Earths, Ground or Otherwise Treated (grinding, washing, separating, etc. of clay, ceramic, and refractory minerals nec)	212325	Clay and Ceramic and Refractory Minerals Mining
3295	Minerals and Earths, Ground or Otherwise Treated (grinding, washing, separating, etc. of chemical and fertilizer minerals, nec)	212393	Other Chemical and Fertilizer Mineral Mining
3295	Minerals and Earths, Ground or Otherwise Treated (grinding, washing, separating, etc. of nonmetallic minerals, nec)	212399	All Other Nonmetallic Mineral Mining
3295	Minerals and Earths, Ground or Otherwise Treated (except grinding, washing, separating, etc. of nonmetallic minerals)	327992	Ground or Treated Mineral and Earth Manufacturing
3325	Steel Foundries, NEC	331513	Steel Foundries (except Investment)
3421	Cutlery (except hedge shears and trimmers, tinnerns' snips, and similar nonelectric hand tools)	332211	Cutlery and Flatware (except Precious) Manufacturing
3421	Cutlery (hedge shears and trimmers, tinnerns snips, and similar nonelectric hand tools)	332212	Hand and Edge Tool Manufacturing
3441	Fabricated Structural Metal	332312	Fabricated Structural Metal Manufacturing
3555	Printing Trades Machinery and Equipment	333293	Printing Machinery and Equipment Manufacturing
5719	Miscellaneous Home furnishings (manufacturing and selling pottery on site)	327112	Vitreous China, Fine Earthenware, and Other Pottery Product Manufacturing

5719	Miscellaneous Home furnishings Stores (blinds and shades)	442291	Window Treatment Stores
5719	Miscellaneous Home furnishings Stores (except pottery and crafts made and sold on site and window furnishings)	442299	All Other Home Furnishings Stores
5945	Hobby, Toy, and Game Stores	451120	Hobby, Toy, and Game Stores

## Appendix C

Medical protocol recommendations for exposure to crystalline silica are listed in Appendix G – references 28-48.

**A. MEDICAL EXAMINATIONS** The following are the recommended medical procedures for individuals chronically exposed to crystalline silica or for individuals who have received one or more severe acute exposures to crystalline silica.

1. A baseline examination which includes a medical and occupational history to elicit data on signs and symptoms of respiratory disease prior to exposure to crystalline silica. The medical examination emphasizing the respiratory system, should be repeated every five (5) years if under 20 years of exposure and every two (2) years if over 20 years of exposure. The medical examination should be repeated more frequently if respiratory symptoms develop or upon the recommendation of the examining physician.
2. A baseline chest x-ray should be obtained prior to employment with a follow-up every 5 years if under 20 years of exposure and every 2 years if over 20 years of exposure. A chest x-ray may be required more frequently if determined by the examining physician.
3. Pulmonary Function Tests (PFT): Should include FEV1 (forced expiratory volume in 1 second), FVC (forced vital capacity) and DLCO (diffusion lung capacity). PFTs should be obtained for a baseline examination with PFTs repeated every 5 years if under 20 years of exposure and every 2 years if over 20 years of exposure. PFTs may be required more frequently if respirable symptoms develop or if recommended by the examining physician.
4. A chest x-ray should be obtained on employment termination.

**B. MEDICAL MANAGEMENT** The chest x-ray should be a chest roentgenogram (posteroanterior 14" x 17" or 14" x 14") classified according to the 1970 ILO International Classification of radiographs of Pneumoconiosis by a certified class "B" reader. The medical follow-up should include the following procedures:

1. With a positive chest x-ray (1/0 or greater) the worker should be placed in mandatory respiratory protection, or if already wearing a respirator, the program should be reevaluated to assure proper fit and that the elements of 29 CFR 1910.134 are being met.
2. The worker should be referred to a physician specializing in lung diseases for a medical evaluation and medical monitoring as warranted by the examining physician. A written opinion from the examining physician as to whether the employee has any detected condition that would place the worker at an increased risk should be provided to the employer and employee, while specific medical findings remain confidential.
3. All medical test results should be discussed with the worker by the physician.
4. In accordance with 29 CFR 1910.1020, medical records shall be maintained for at least 30 years following the employee's termination of employment, unless the employee is employed for less than one year and the records are provided to the employee upon termination.

## Appendix D

The standards listed below may be cited for crystalline silica overexposure identified under this LEP, consistent with enforcement policy and procedure:

<b>OR-OSHA Requirement</b>	<b>General Industry</b>	<b>Construction</b>
Employer Responsibilities	437-001-0760	
Safety Committee	437-001-0765	437-001-0765
Safety & Health Program	none required	1926.20
General Training		1926.21
Recordkeeping (OSHA 300)	OAR 437-001-0700 to 0750	OAR 437-001-0700 to 0750
Abrasive Blasting, breathing air, enclosures, controls	1910.94	1926.28, 55, 95, 100, 101, 102, 103, 300
General PPE	1910.132	1926.28, 95, 100-105
Respiratory Protection	1910.134	1926.103
Hygiene	1910.141	1926.27 and 51
Accident Prevention & Warning Signs	1910.145	1926.200
Permissible Exposure Limits & Controls	OAR 437-002-0382	OAR 437-003-1000
Access to Employee Exposure & Medical Records	1910.1020	1926.33 references 1910.1020
Hazard Communication	1910.1200	1926.59

Note: Such reviews provide an excellent opportunity to address themes consistent with OR-OSHA's Strategic Plan.

Silicosis Prevention Program B The following is a list of elements which may be included in an effective program:

- ongoing personal air monitoring program
- ongoing medical surveillance program
- training and information to workers on crystalline silica\*\*
- availability of air and medical surveillance data to workers\*
- an effective respiratory protection program\*
- hygiene facilities and clothing change areas

- appropriate recordkeeping\*
- personal exposures below the PEL or the facility has an abatement program that also provides for interim worker protection
- housekeeping program\*
- in construction: a safety and health program\*
- regulated areas

\*Required by specific OR-OSHA standards if an overexposure to crystalline silica exists.

\*\*Hazard Communication training is required if potential exposure exists.

## **Appendix E**

### **Checklist for Conducting Silica-Related Inspections**

#### **Employee Exposure Monitoring**

- sample for respirable silica
- leak test filters/cyclones
- bulk samples of settled dust
- employer's monitoring records

#### **Engineering and Work Practice Controls**

- location of employees
- ventilation
- wet methods

#### **Respiratory Protection**

- written program
- medical and fit test records
- cartridge selection and change-out schedule
- breathing air quality and use

#### **Hazard Communication**

- written program
- MSDS
- training
- bulk samples of products

#### **Symptoms of Silicosis in Workplace**

- survey/interview employees
- employees obtaining medical evaluations

#### **Medical Surveillance**

- employer awareness of silicosis risk
- employer identifying possible cases
- employer referring cases to physician

#### **Housekeeping and Hygiene Facilities**

- facility cleanliness
- clean-up methods (compressed air, dry sweeping?)
- change rooms/PPE storage
- separate break areas

#### **Employee Exposure and Medical Records**

- employer monitoring and medical records
- employee access and confidentiality

#### **Abrasive Blasting**

- sample for silica and metals
- sample for noise
- ventilation and dust control
- PPE and respirators
- carbon monoxide alarm on respirator
- manual control of blast nozzle operating valve
- electrical grounding

## **Appendix F**

### **Inspection Scheduling Lists**

This appendix outlines the method by which an inspection list is created using random numbers. The table of random numbers provided is designed to order randomly a list of establishments which contains 50 or fewer establishments.

The following table has been produced by ordering the integers from 1 to 50 randomly and displaying the results. There are ten sets of independently derived random numbers (50 numbers: the integers from 1 to 50 listed in ten columns).

An inspection cycle will consist of no more than ten establishments. Within the cycle, the establishments may be scheduled and inspected in any order that makes efficient use of resources. All establishments in a cycle must have inspections initiated before any establishments in a new cycle may be inspected.

Health Enforcement Managers are responsible for the creation and administration of the regional lists under their jurisdiction.

The procedure to be used is as follows:

1. Make all modifications to the establishment list.
2. Number the establishment list sequentially; i.e., assign "1" to the first establishment on the list, "2" to the second, etc.
3. Cross out all numbers on the random number set that has been selected which are greater than the number of establishments on the establishment list.
4. Include all establishments in the inspection cycle whose sequence number is listed in the number set.
5. Draw a line after the last random number used; this will be the starting point for the next inspection cycle.

**EXAMPLE:** Suppose there are 40 establishments on the establishment list and an inspection cycle containing 10 establishments is needed. Random number Set 1 is the one selected and all numbers greater than 40 are crossed out. The first inspection cycle would then contain establishments with the following sequence numbers: 36, 37, 29, 40, 19, 32, 3, 34, 1, 15. Draw a line under the number 15 and start the next cycle with the numbers 30, 10, 18 etc.

Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10
36	2	49	46	17	50	27	45	24	26
47	21	19	35	19	34	32	1	21	7
37	46	24	42	47	1	48	37	2	13
29	12	23	44	30	24	21	18	48	41
40	22	10	32	26	21	39	7	1	4
43	30	7	5	21	16	34	25	49	30
19	28	32	40	29	43	6	27	20	34
32	1	28	33	33	15	8	4	46	16
3	44	26	29	4	25	15	42	7	27
34	49	42	1	31	22	31	16	6	28
1	29	29	31	22	9	29	35	28	8
15	23	18	27	44	2	36	26	26	38
30	16	2	17	49	3	28	15	27	39
10	38	43	12	14	46	46	31	4	19
18	24	15	28	11	42	30	39	33	35
8	10	31	37	48	7	10	46	35	46
23	34	22	11	35	8	25	36	10	37
9	50	39	50	28	20	16	38	43	50
33	6	50	4	15	12	12	30	39	36
46	40	48	34	18	37	2	24	16	44
35	42	30	2	20	13	17	17	37	32
12	15	4	18	45	35	20	19	44	6
2	45	9	10	38	5	4	2	34	49
38	41	3	3	42	38	50	34	36	25
16	47	11	25	39	39	26	3	9	20
24	27	46	23	6	6	42	22	13	1
27	17	8	9	37	11	37	48	32	18
25	7	47	26	5	29	14	43	25	24
39	26	13	24	40	26	3	13	5	5
22	14	40	16	12	41	43	41	40	21
17	37	34	48	50	23	45	49	42	17
20	48	27	22	43	27	18	23	12	29
28	13	16	8	7	28	11	40	14	12
41	5	21	19	1	33	33	28	23	11
4	8	33	36	2	14	7	21	50	40
42	31	36	14	27	10	23	33	29	33
45	36	6	45	8	49	40	5	11	14
50	4	38	13	46	47	41	10	45	10
11	3	5	20	9	17	5	9	41	43
26	11	25	6	24	48	22	14	18	2
44	19	45	15	23	45	1	47	30	47
49	35	37	49	34	44	47	6	19	31
6	33	17	7	16	40	49	50	38	48
7	39	12	47	13	18	35	11	47	45
14	9	41	39	36	30	44	8	15	3
48	18	35	38	3	19	9	12	31	15

## Appendix G

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