

Recommended Medical Screening Protocol for Silica Exposed Workers

Background

There are no legal requirements to perform medical surveillance on individuals exposed to silica. Surveillance for silicosis is the accepted standard of practice for occupational medicine physicians. It should always be kept in mind that medical surveillance is not a substitute for good dust control in the workplace. Controlling exposure is the only effective primary prevention strategy.

In 1974, the National Institute for Occupational Safety and Health (NIOSH) recommended the following medical surveillance protocol in the crystalline silica criteria document (HEW/NIOSH-75-120).

- (1) medical and occupational history with particular attention to signs and symptoms of respiratory disease,
- (2) chest x-ray (1 view, 14 x 17 inch, posterior- anterior),
- (3) pulmonary function tests including forced vital capacity and forced expiratory volume in one second.



The above was recommended for a baseline examination and then at least every three (3) years.

In 1981, in response to the development of cases of acute and accelerated silicosis among workers exposed to a fine mesh silica (silica flour), NIOSH recommended that workers exposed to silica flour be given the above examinations annually (NIOSH Current Intelligence Bulletin #36, June 30, 1981).

In 1992, in response to the development of cases of acute and accelerated silicosis among workers doing sandblasting, NIOSH repeated their 1981 recommendations and added a recommendation for an annual evaluation for tuberculosis (NIOSH Alert, DHHS (NIOSH) publication No. 92-102). In 1996, NIOSH repeated their 1992 recommendations (DHHS (NIOSH) publication No. 96-112). See Appendix I for a summary of the NIOSH recommendations.

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The federal Occupational Safety and Health Administration (OSHA) has recommended examinations every 5 years for workers with less than 20 years of exposure and every 2 years if over 20 years of exposure. OSHA's recommendations are attached in Appendix II.

The National Industrial Sand Association has developed its own guidelines on medical testing. They recommend medical testing every 2 years with x-rays performed every 2-4 years based on the age of the worker and duration of exposure (See Appendix III).

The following protocol was developed after reviewing NIOSH's, OSHA's and the National Industrial Sand Association's recommendations, the medical literature, recommendations on the frequency of chest x-rays and the Center for Disease Control and Prevention's recommendation on screening for tuberculosis.

This protocol assumes that there is industrial hygiene data to indicate that the workers' exposure to silica is less than NIOSH's recommended guideline of $.05 \text{ mg/m}^3$ averaged over a work shift of up to 10 hours a day, 40 hours a week. The following medical testing is recommended if exposure to silica exceeds one half ($.025 \text{ mg/m}^3$) of NIOSH's recommended standard but is less than $.05 \text{ mg/m}^3$. If levels are higher than $.05 \text{ mg/m}^3$ or abrasive blasting with silica is being performed, the frequency of providing a chest x-ray needs to be more often. (See Table I for a recommended protocol summary)

Protocol

- 1) Skin testing for tuberculosis should be done as a baseline and annually for all individuals with x-ray evidence of silicosis. (1/0 or greater using the ILO classification system). Skin testing should be done, using .1 ml of PPD containing 5TU injected subcutaneously into the forearm. If the initial baseline test is negative, it should be repeated 1-3 weeks later, to rule out that any later positive tests are due to a booster effect. Individuals with x-ray evidence of silicosis and a positive PPD should be evaluated for active tuberculosis.

The above test is suggested because of the increased risk of tuberculosis among individuals with silicosis. A recent American Thoracic Society statement recommend TB skin testing for all individuals with 25 years or longer silica exposure even without evidence of silicosis (1).

- 2) The frequency of chest x-rays should be every 5-10 years in the first 20 years of work unless the air levels are above the OSHA standard. For individuals who work in areas where the level of silica is above the OSHA air standard chest x-rays need to be done more frequently (every 1-3 years). If an individual does abrasive blasting with silica than an annual x-ray is recommended even in the first 20 years of work. The first chest x-ray should be done as a baseline before exposure begins. Any worker with 20 or more years of exposure, or x-ray evidence of silicosis should be given an x-ray annually. All x-rays should be interpreted by a NIOSH certified "B" reader. Results should be recorded using the standard ILO classification. A list of the B readers in the state is in Appendix IV. The most up-to-date list of B readers can be obtained at <http://www.cdc.gov/niosh/topics/chestradiography/breader-list.html>.

In order to reduce radiation exposure, the frequency of chest x-rays should be minimized. When an individual develops an abnormal x-ray, has 20 years of exposure or does abrasive blasting with silica, then there is a need for offering an x-ray on a more frequent basis.

- 3) Pulmonary function tests including forced vital capacity and forced expiratory volume in one second should be done as a baseline and annually. OSHA recommends including diffusion lung capacity. All pulmonary function testing should use equipment and follow recommendations issued by the American Thoracic Society (<http://www.thoracic.org/sections/publications/statements/pages/pfet/pft1.html>). Pulmonary technicians administering the test should have completed a certified training course.

It should be noted that pulmonary functions tests are helpful in evaluation of disability after silicosis has been diagnosed, but should not normally be considered a "screening test" for the diagnosis of silicosis. There have been, however, reports of fibrotic lung disease with normal chest x-rays but abnormal pulmonary function. Individuals with progressive decreases in pulmonary functions beyond that normally associated with age should be closely followed up as to etiology of the pulmonary function decrement.

Treatment

Individuals who develop silicosis should be given the option of transfer to silica free areas. In order for this transfer option to be a realistic alternative, the individuals should be able to maintain his/her pay rate and benefits at the new job.

All individuals should be strongly advised to stop smoking. A plant wide program that combines positive incentives for non-smokers, a phased in non-smoking policy at the facility and programs to help smokers quit is useful.

Symptomatic individuals need to be cared for in a similar manner to the care recommended for other individuals with chronic lung disease.

Individuals with silicosis and positive skin tests for tuberculosis need to be evaluated for active tuberculosis, treated preventively with isoniazid if the disease is not active and followed closely even after treatment. Treatment failure and possible increased susceptibility to atypical mycobacteria suggest that a tuberculosis specialist should be involved in the treatment of those individuals with tuberculosis and silicosis.

⁽¹⁾ American Thoracic Society. Adverse Effects of Crystalline Silica Exposure. American Journal Respiratory and Critical Care Medicine 1997; 155:761-765.

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Table I

Recommended Schedule For Medical Screening Tests Of Silica Exposed Workers

<u>Criteria</u>	<u>Chest X-ray Frequency</u>		<u>Tuberculosis Skin Test Frequency</u>	<u>Breathing Test Frequency</u>
1. Pre-employment	Baseline			Baseline
2. Individuals with normal baseline chest x-ray and exposure levels for silica of:	<20 Years <u>Exposure</u>	>20 Years <u>Exposure</u>		
a. 0.025-0.05 mg/m ³ (Below NIOSH REL)	3-5 years	3-5 years	----	Annually
b. 0.05-0.1 mg/m ³ (Above NIOSH REL; below OSHA PEL)	3-5 years	1-3 years	----	Annually
c. Greater than .1 mg/m ³ (Above OSHA PEL)	1-3 years	1-3 years	----	Annually
3. Individuals with chest x-ray evidence of silicosis ("ILO" results "1/0" or greater):				
a. still working in an area with airborne silica		Annually	Annually	Annually
b. no longer exposed to silica, negative TB skin test		1-3 years	Annually	Annually
c. no longer exposed to silica, positive skin test		Annually	----	Annually
4. Individuals with progressive massive fibrosis ("ILO" results A, B or C large opacities)		Annually	Annually	Annually

APPENDIX I

Medical Monitoring of Workers Exposed to Silica Dust

NIOSH Recommendations

NIOSH Criteria Document on "Crystalline Silica" (1974)

Publication: HEW Publication No. (NIOSH) 75-120

Who: "all workers subject to 'exposure to free silica'" [note: "free silica" = "crystalline silica"]

Timing: "prior to employee placement and at least once every 3 years thereafter"

Content: at a minimum

- 1) "medical and occupational history to elicit data on worker exposure to free silica and signs and symptoms of respiratory disease"
- 2) posteroanterior chest x-ray (CXR) classified using the ILO system (see footnote)
- 3) pulmonary function testing (PFT), including measurement of FVC and FEV₁, ("to provide a baseline for evaluation of pulmonary function and to determine the advisability of the workers using negative- or positive-pressure respirators")
- 4) body weight; 5) height; 6) age

Action: "An employee with or without roentgenographic [i.e., CXR] evidence of silicosis who has respiratory distress and/or pulmonary function impairment should be fully evaluated by a physician qualified to advise the employee whether he should continue working in a dusty trade."

Records: should be available to medical representatives of OSHA, NIOSH, the employee or former employee, and the employer; also, should be maintained for at least 30 years following employee's termination of employment.

NIOSH Current Intelligence Bulletin # 36 on "Silica Flour: Silicosis" (1981)

Publication: DHHS (NIOSH) Publication No. 81-137

Who: "all who manufacture, use, or handle silica flour or materials containing silica flour"

Timing: preplacement and then **annually**

Content: At a minimum

- 1) "comprehensive work and medical histories to evaluate exposure and signs and symptoms of respiratory disease"
- 2) posteroanterior CXR, "preferably" classified using the ILO system
- 4) PFTs, including measurement of FVC and FEV₁, and calculation of FEV₁/FVC

Action: "Workers with radiographic [i.e. CXR] evidence of silicosis should be given the opportunity to transfer to jobs without silica exposure (defined as exposure at concentrations less than half of the NIOSH-recommended standard)." "Workers should be informed of ... the results of workplace monitoring and medical test results."

Records: not mentioned (see 1974 Criteria Document recommendations, above)

1997 National Conference To Eliminate Silicosis
March 25 and 26, 1997
Washington, D.C.

NIOSH ALERTS on Preventing Silicosis associated with Sandblasting (1992), with Rock Drilling (1992), and with Construction Work (1996)

Publication: DHHS (NIOSH) Publication No. 92-102
Publication: DHHS (NIOSH) Publication No. 92-107
Publication: DHHS (NIOSH) Publication No. 96-112

Who: "all workers who may be exposed to respirable silica dust"

Timing: "before job placement and at least once every 3 years thereafter"; "more frequent examinations (for example, annual) may be necessary for workers at risk of acute or accelerated silicosis"

Content: at a minimum

- 1) "a medical and occupational history to collect data on crystalline silica exposure and signs and symptoms of respiratory disease"
- 2) posteroanterior CXR classified using the ILO system

3) PFT (spirometry)
4) **annual evaluation for tuberculosis** (*American Review of Respiratory Disease* 1986;134:355-63)*
Action: **"encourages reporting of all cases of silicosis to the appropriate State health department and to OSHA or MSHA** (see guidelines in accompanying table)
Records: not mentioned (see 1974 Criteria Document recommendations, above)
Other: "Examinations should always supplement effective dust monitoring and controls-never substitute for them."

*See also:

1) Screening for tuberculosis and tuberculous infection in high-risk populations; Recommendations of the Advisory Council for the Elimination of Tuberculosis. *Morbidity and Mortality Weekly Report* 1995;44(No. RR- 11): 19-34. [*Offers specifics on TB screening,- defines individuals with silicosis as "high risk."*]

2) American Thoracic Society statement: Adverse effects of crystalline silica exposure. *American Journal of Respiratory Care and Critical Care Medicine* 1997.. [**Recommends TB screening for those who have been occupationally exposed to crystalline silica for 2 years or longer, even without clinical evidence of silicosis.**]

Footnote: Additional resources include the following:

ILO (International Labour Office). Classification of radiographs of the pneumoconioses. *Medical Radiography and Photography* 1981 ;57:2-17. [*Presents clear description of the most recent IL 0 classification system, including photographs of the standard reference radiographs and where to purchase sets of these standard films.*]

ATS (American Thoracic Society). Standardization of spirometry-1994 update. *American Journal of Respiratory and Critical Care Medicine*. 1995;152: 1107-1136. [*Presents detailed guidelines for conducting spirometric testing as recommended by the highly regarded medical section of the American Lung Association.*]

The following Appendix is excerpted from OSHA's Special Emphasis Program (SEP) on Crystalline Silica. A copy of the entire SEP can be downloaded from the internet at <http://www.OSHA.gov>

Appendix C

Medical protocol recommendations for exposure to crystalline silica: (2848)

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 respiratory 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 1980 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 1910.2.0, 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 II

NATIONAL INDUSTRIAL SAND ASSOCIATION

Respiratory Medical Surveillance for Silicosis

Purpose

The objective of the medical surveillance program is to prescribe baseline and periodic health evaluations of workers exposed to crystalline silica. The guidance is modeled after an official American Thoracic Society (ATS) statement, adopted in June 1982. The complete program, including guidance on dust surveillance can be found in the NISA "Occupational Health Program for Exposure to Crystalline Silica in the Industrial Sand Industry," available from NISA; 4041 Powder Mill Road; Suite 402; Calverton, MD 20705; Phone (301) 595-5550.

Objectives

The respiratory medical surveillance program has the following objectives:

1. To establish a baseline from which to assess changes that may develop in the individual at a future date. Thus, each worker serves as his or her own control, and the ability to recognize early change is greatly enhanced.
2. To detect abnormalities that might be consistent with silicosis in an early stage, when corrective measures are most likely to be beneficial.
3. To prevent the development of silicosis that could produce pulmonary impairment in the worker.
4. To disclose to the worker occupationally and nonoccupationally related abnormalities for appropriate medical follow-up.
5. To identify potentially hazardous working conditions and underscore the need for improvements in control measures.
6. To develop data on which epidemiological studies of crystalline silica exposure can be based.

Respiratory Surveillance Program

The NISA respiratory surveillance program for silicosis consists of the following components:

1. A medical history that focuses on the presence of respiratory symptoms and smoking.
2. A comprehensive occupational history that details prior exposure to potentially harmful dusts, chemicals, and other physical agents. Any adverse effects related to these exposures must be recorded.
3. A medical examination of the thorax, as indicated.
4. A 14-by-17-inch posteroanterior (PA) chest X-ray, preferably obtained using a high-kilovoltage technique. For pneumoconioses, films should be interpreted by qualified board-certified radiologists who are NIOSH-certified B readers. Films should be classified in accordance with the 1980 *Guidelines for the Use of ILO International Classification of Radiographs of Pneumoconioses*.
5. Pulmonary function tests that include spirometric measurements of forced expiratory volume in 1 second (FEV₁) and forced vital capacity (FVC). Such tests should be performed, calculated, and interpreted in accordance with the 1994 ATS standards (optional).
6. Baseline medical evaluations of new hires that include a tuberculosis skin test (optional). The major complication of silicosis is pulmonary tuberculosis. The tuberculosis test should be an intradermal skin test using purified protein derivative (PPD). Administering the test requires skill, since the injection needle must stop between layers of the skin.

Chest X-rays

1. Radiographic changes in workers exposed to crystalline silica are the most sensitive means of early detection of silicosis; that is, abnormalities are usually seen radiographically before pulmonary function loss can be detected spirometrically or before symptoms appear. Periodic chest X-rays are therefore a vital part of medical surveillance.

2. Although other X-rays may be ordered by an examining physician, a PA projection on 2

a film no less than 14 by 17 inches and no more than 16 by 17 inches at full inspiration is essential to the program for detection of the pneumoconioses.

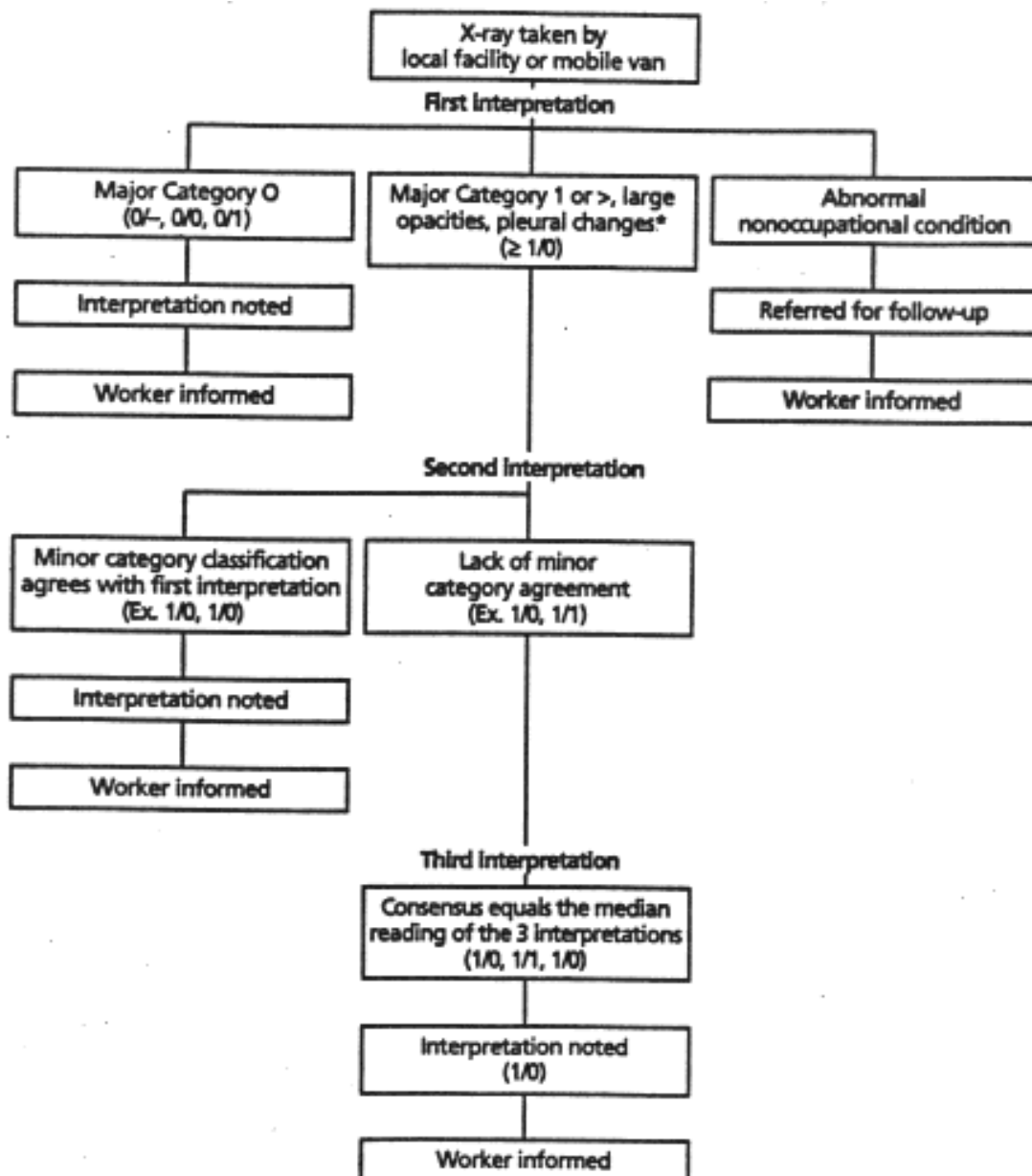
3. The radiographic changes associated with pneumoconioses must be classified according to the 1980 *Guidelines for the Use of ILO International Classification of Radiographs of Pneumoconioses*.

4. All X-rays should be interpreted by a physician who is certified by NIOSH as a B

reader, is board-certified in radiology, and has considerable experience in occupational lung diseases.

5. Multiple interpretations of all films 1/0 or greater should be obtained and 5-10 percent of the films interpreted as 0/1 receive multiple interpretations, according to the decision logic shown below. Such a system will allow a consensus interpretation or median reading to be noted.

NISA Consensus Procedure for X-Ray Interpretations



APPENDIX III

Spirometry Testing

Spirometry is an optional component of the NISA respiratory medical surveillance program. The reasoning for making spirometry an option for NISA member companies include:

1. Pulmonary function tests are nonspecific; one can seldom make a diagnosis based on spirometric findings alone. The total clinical presentation, including medical history, physical examination, chest X-ray, and appropriate ancillary laboratory studies, must be considered.
2. Experience has shown that most abnormalities on screening spirometry are not due to work-related disorders.
3. Many technicians, nurses, and physicians have been inadequately trained and perform or analyze tests incorrectly.
4. Certain spirometers have been demonstrated to be technically unsatisfactory.
5. Test methodology and procedure have lacked standardization, rendering difficult the comparison of results obtained at different facilities.
6. Surprisingly, physicians without adequate training lack the necessary knowledge to interpret the results of pulmonary function tests properly.
7. Surveillance information obtained under these circumstances can be worse than no information at all.

It is imperative that if spirometry is part of medical surveillance, it be conducted to meet stringent quality control parameters.

1. The physician or health professional performing spirometry for a member company should be thoroughly familiar with and meet the guidelines and the criteria of the ATS.
2. Properly conducted, spirometry is regarded as a useful component of respiratory medical surveillance programs for baseline evaluation and periodic monitoring. Routine follow-up studies of workers exposed to respirable crystalline silica can detect

pulmonary function loss in its earliest stages, although radiographic changes consistent with silicosis will normally precede losses detected by spirometry that result from the inhalation of respirable crystalline silica.

3. The ATS criteria should be cited in procurement agreements between the member company and the spirometry provider.
4. A checklist, developed from the ATS criteria, of some of the items to assess in choosing a spirometry provider is provided at the end of this handout.
5. Manufacturers should provide documentation that their instruments have been tested by an independent laboratory. If such documentation is not available, the equipment should be approached with caution-it probably does not meet the ATS criteria.

Record Keeping and Worker Notification

All medical records obtained on workers should be retained for at least 30 years after the worker ceases employment. This is necessary because of the chronic nature and long latency of silicosis, and the records may also be useful in assessing the adequacy of occupational standards.

The examining physician or other health professional should provide the employer with the results of the examination of the respiratory system. Any abnormalities detected, whether occupational or nonoccupational, should be disclosed to the employee with an appropriate recommendation for medical follow-up. The opinion should be prepared to:

1. Assist the company in developing baseline measurements on the employees.
2. Inform the company about any medical condition or change in an employee's condition from exposure to silica or other job related factor.
3. Recommend restrictions regarding a worker's exposure to silica.
4. Advise the company regarding the worker's ability to wear a respirator or other protective equipment.
5. The worker should be provided a copy of the examination results, and evidence that this has been done should be obtained.

Frequency of Examinations

Baseline Examinations

Before a worker is assigned to a job with potential exposure to crystalline silica, a medical examination should be completed to establish a baseline on the worker's respiratory health status.

Periodic Examinations

With the exception of chest X-rays, medical evaluations should be administered at least every 2 years and should be comprehensive examinations that include the elements of the baseline examination.

The frequency of X-ray examinations depends on the number of years since first exposure to silica dust, the age of the worker, and whether any signs or symptoms are present as outlined in the following table:

Frequency Of Chest X-Rays

Years Since First Silica Exposure	<u>Age of Employee</u>	
	15-35	>35
0-8	Every 4 years	Every 4 years
>8	Every 4 years	Every 2 years

Note: Workers experiencing signs or symptoms should be x-rayed as determined by a physician.

NISA Occupational Health Program Checklist for Evaluating Spirometry Testing Services

Though not a comprehensive listing, this checklist can assist in evaluating the proficiency of a spirometry testing provider.

Standardization

- Does the spirometry testing provided meet the requirements of the ATS "Standardization of Spirometry-1994 Update"?
- Are the criteria of the ATS "Standardization of Spirometry-1994 Update" specific in any agreement for services or cited by the contractor in a discussion of services provided?

Technicians

- Have spirometry technicians successfully completed a NIOSH-approved course in spirometry? Many providers advertise that their technicians are NIOSH-approved or certified, but NIOSH approves only the course, not individuals.
- Does the technician elicit vigorous subject effort in performing the forced expiratory maneuver?
- Does the technician observe the subject and instruments to detect faulty technique during testing?
- Does the technician obtain a minimum of three acceptable forced expiratory volume maneuvers on each subject?

Spirometer

- Does the provider use a dry-rolling-seal spirometer?
- Has the instrument been independently tested at the University of Utah in the laboratory of Drs. Gardner and Crapo?
- Does the provider have a copy of the results of the tests by Drs. Gardner and Crapo on the instrument being used?
- Does the provider calibrate the spirometer daily, using a 3-liter syringe according to ATS recommendations?

Measurements

- Does the provider measure FVC and FEV₁ and express their ratio (FEV₁/FVC%)?

Note: Some providers report mean forced expiratory flow at the middle portion of the FVC (FEF_{25%-75%}). FEF_{25%-75%} has much larger intrasubject variability, has a wider normal range, and is less sensitive than FEV₁/FVC%. For these and other reasons, FEF_{25%-75%} not generally recommended for occupational surveillance programs.

- Are the spirometry results corrected to BTPS?
- Are predicted FVC and FEV₁ corrected for non-Caucasians by multiplying results by 0.85?
- Are observed values compared with predicted values from Knudson's equations in accordance with ATS standards?

Reports

- In addition to comparison with predicted normals, does the provider compare serial results (repeat testing) from an individual and report significant changes?
- Are the spirometry results reported to the company in an understandable manner?
- Does the provider or company notify individual workers of results and answer questions satisfactorily?

APPENDIX IV

NIOSH B Reader List MI Michigan, United States of America

6 reader(s) were found.
Report generated on 6/30/2012

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