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NIOSH HEALTH HAZARD EVALUATION REPORT

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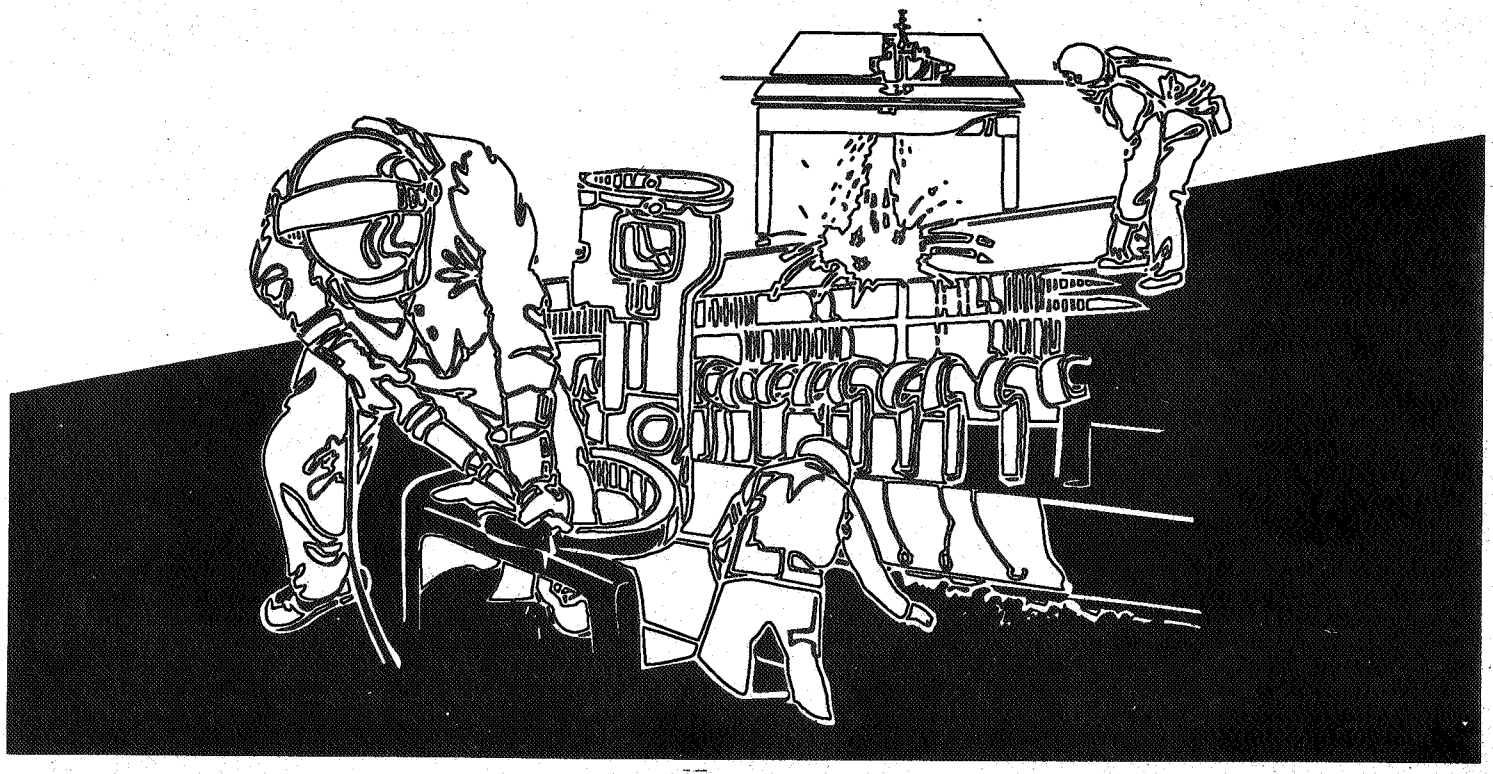
NORFOLK SOUTHERN RAILWAY COMPANY



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer and authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to federal, state, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

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I. Summary

In June 1990, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Virginia Department of Health to investigate silica exposures of individuals working on the Norfolk Southern Railroad. A private physician in Virginia had notified the state health department that one of his patients, a railroad maintenance-of-way employee for Norfolk Southern Railway Company (NSRC), "appeared to have severe (possibly category "C") pneumoconiosis, most likely silicosis." Copies of the individual's chest radiographs were obtained and classified independently by three NIOSH-certified "B" readers. All three readings confirmed category "C" large opacities. It is the position of NIOSH that each case of silicosis represents a sentinel health event indicating a hazardous worksite condition.

Environmental sampling was conducted at three different sites: (1) May 8, 1991, near Front Royal, Virginia, Timber & Surfacing (T&S) Gang #8; (2) July 23-24, 1991, near Raleigh/Durham, North Carolina, T&S Gang #8; and (3) August 27-28, 1991, near Culpeper, Virginia, T&S Gang #2.

Overall, 50 personal breathing zone and 21 area samples were collected for respirable dust and crystalline silica. Twenty-seven (54%) of the personal samples and 10 (48%) of the area sample results equalled or exceeded the NIOSH REL of 0.05 mg/m^3 for respirable quartz. Eight (16%) personal sample and 4 (19%) area sample results equalled or exceeded the Occupational Safety and Health Administration (OSHA) PEL of 0.1 mg/m^3 for respirable quartz; 1 personal and 1 area sample result equalled or exceeded the OSHA PEL, as well as the NIOSH REL of 0.05 mg/m^3, for cristobalite.

During July 22-30, 1991, a medical evaluation was conducted focusing on Track Maintenance (TM) gangs located in three different locations: Manassas, Charlottesville, and Front Royal, Virginia. The medical evaluation consisted of a posterior-anterior (PA) chest radiograph, pulmonary function testing (spirometry), and respiratory and work history questionnaire. A total of 35 individuals participated in the medical survey. Of the participants, two union representatives and one management official who were not currently working on the track at the time of the survey, were not included in the analysis. The remaining 32 participants represent a participation rate of 54% (32/59) based on the list of maintenance-of-way employees, provided by the company, who were working at these three locations in April 1991.

None of the participants had a chest radiograph classified by three out of five "B" readers as profusion category 1/0 or greater. The spirometry results revealed four participants with a mild obstructive pattern; none of the participants had a restrictive pattern. Three of the four were current smokers. Overall, the prevalence of chronic cough was 31%, and the prevalences of chronic phlegm and shortness of breath were each 25%. None of the participants reported being diagnosed with tuberculosis.

Overall, 84% (27) of the participants had a positive work history for possible exposure to silica-containing airborne dust while working for the railroad based on current and past job duties (unloading ballast, member of a T&S gang) and equipment use (tamper, broom, or regulator). The average length of railroad tenure was 17 years. No participant in this survey had a railroad tenure less than 10 years. The average number of years at other dusty jobs was 4 years.

NIOSH investigators have determined that NSRC T&S employees were being overexposed to crystalline silica. In addition, based on the results of this evaluation and the identified sentinel case, the potential for excessive crystalline silica exposure existed for TM employees. Recommendations to reduce exposure and for medical surveillance are presented in Section IX of this report.

KEYWORDS: SIC 4011 (Railroad, Line-haul Operating), Pneumoconiosis, Silicosis, Railroad-industry, Silica, Ballast, Granite.

II. Introduction

In June 1990, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Virginia Department of Health to investigate silica exposures of individuals working on the Norfolk Southern Railroad. A private physician in Virginia had notified the state health department that one of his patients "appeared to have severe (possibly category "C") pneumoconiosis, most likely silicosis." Copies of the individual's chest radiographs were obtained and classified independently by three NIOSH-certified "B" readers. All three readings confirmed category "C" large opacities. The patient was a railroad maintenance-of-way employee for Norfolk Southern Railway Company. He had been employed by the railroad for approximately 20 years as a track laborer on a Track Maintenance (TM) gang. The individual's work history indicated that his source of exposure to silica and/or silica-containing dust was his track maintenance activities. It is the position of NIOSH that each case of silicosis represents a sentinel health event indicating a hazardous worksite condition.

On November 15, 1990, NIOSH investigators met with representatives of the Norfolk Southern Railway Company, the Federal Railroad Administration (FRA), the Virginia State Health Department, and the Brotherhood of Maintenance of Way Employees at Norfolk Southern offices in Roanoke, Virginia. The purpose of that meeting was to discuss the request and the nature of the evaluation to determine the potential for maintenance-of-way employees to be exposed to crystalline silica. Based on the information obtained during that meeting and subsequent correspondence with the railroad company, we conducted environmental sampling during track maintenance activities conducted by T&S crews. In May, July, and August 1991, environmental surveys were conducted while T&S gangs performed maintenance activities in Front Royal, Virginia; Raleigh/Durham, North Carolina; and Culpeper, Virginia.

In July 1991, a medical evaluation was conducted to determine if maintenance-of-way employees, with similar job duties as that of the sentinel case, may have developed signs or symptoms of disease suggestive of pneumoconiosis and/or adverse respiratory health effects. The evaluation was therefore focused on, but not restricted to, Track Maintenance (TM) gangs. Track Maintenance gangs from Front Royal, Manassas, and Charlottesville, Virginia were evaluated. The evaluation consisted of a respiratory and work history questionnaire, spirometry, and a posterior-anterior (PA) chest x-ray. Each participant was notified of his own spirometry results in September 1991, and of his own chest x-ray results in April 1992.

Preliminary results of the environmental sampling at each site were provided to the company, the union, and the health department shortly after each survey. An interim report presenting all the environmental results was issued February 13, 1992. A revised version was issued March 9, 1992; the precise name of the employer was the singular change made to the interim report.

III. Background

Maintenance-of-way employees are involved in maintaining the ballast, ties, rails, and overall surface of the railroad. Workers are organized into different work crews (gangs) according to duties or operations, which can be differentiated by the degree of mechanization. According to information provided to us by the union, the average employment figure for 1990 was 41,515, based on U.S. membership records for all represented railroads (including passenger operations). This figure represents 15 National Railway Labor Conference (NRLC) Maintenance-of-way and Structures job classifications, not all of which are involved with working on the track bed. According to the union, job mobility is high among maintenance-of-way employees; they move readily through various job classifications based on the number of jobs available, "roster rights" (seniority), and training.

Track Maintenance gangs, or section crews, are considered the 'pick and shovel' crew and are located at permanent work sites, maintaining a specified section of the railroad system and providing support for the large mechanized production gangs traveling through their territory. Mechanized production gangs, such as T&S, are relocated to new sites along the railroad system as maintenance activities progress, staying in camp cars for the duration of time that they are working on a particular section of rail.

Maintenance crews are exposed to the dusts generated during usual maintenance activities, almost all of which involve some manipulation of ballast. Ballast is crushed rock used to provide support, stability, and drainage to the rails and ties. There are three types of rock commonly used for ballast: granite; limestone; and traprock. Granite was used at the survey sites included in this hazard evaluation.

Workers assigned to TM gangs are specifically responsible for unloading ballast from "rock trains," or "stone trains," prior to scheduled track maintenance operations. The ballast is transported in special ballast cars or hopper-bottom revenue cars which dump the load along the track. During maintenance operations, equipment and gangs may stretch out over several miles of track. According to the company, workers on TM gangs may work along with a T&S gang, performing labor with the T&S gang. While TM duties may be performed without powered or automated equipment, according to the union, in addition to unloading rock trains, TM workers will occasionally operate tampers, ballast regulators, brooms, and other equipment (e.g., saws) that can generate large amounts of airborne dust.

IV. Methods

A. Environmental

During the initial meeting in November 1990, NIOSH indicated the desire to conduct environmental sampling of railroad maintenance activities that typically generated large amounts of dust. Based on the information obtained during that meeting and subsequent correspondence with the railroad company, we conducted

environmental sampling during track maintenance activities conducted by the T&S crews. Attempts were made to arrange for environmental sampling during ballast dumping/unloading activities, but because most of the ballast dumping had already occurred for the year and because of scheduling conflicts, we were unable to sample this activity. Environmental sampling was conducted at three different sites which were identified by company officials as being representative of typical maintenance-of-way operations. The dates and sites were as follows: (1) May 8, 1991, near Front Royal, Virginia, T&S Gang #8, (2) July 23-24, 1991, near Raleigh/Durham, North Carolina, T&S Gang #8, and (3) August 27-28, 1991, near Culpeper, Virginia, T&S Gang #2.

Personal and area environmental samples were collected during typical railroad maintenance activities in an attempt to evaluate the workers' actual and potential exposure to respirable crystalline silica. Personal breathing zone samples were obtained on the workers, and area samples were obtained from locations on the equipment (ballast regulators, tampers, brooms) adjacent to or in front of the operators within approximately three feet of their breathing zone. Bulk samples of airborne dust (via a high volume sampler) and settled dust were collected for determination of crystalline silica content.

Respirable dust samples were collected using constant flow samplers with nylon cyclone pre-separators at a flow rate of 1.7 liters per minute (ℓpm). Tared filters were analyzed according to NIOSH Analytical Method 7500[1] to obtain total weight and percent crystalline silica.

B. Medical

All available members of the TM gangs located at each medical survey site were invited to participate. Workers on other maintenance-of-way gangs working out of these sites, who were available, were also invited to participate. Prior to the actual evaluation at each site, we met with the Track Supervisors and crew to describe the evaluation and address questions.

Three methods were used to evaluate workers for possible pneumoconiosis and adverse respiratory health effects: (1) a posterior-anterior (PA) chest radiograph, (2) spirometry, and (3) a respiratory and work history questionnaire.

1. Posterior-Anterior (PA) Chest Radiograph

Each PA chest radiograph was taken on a full size (14 x 17 inch) film and read independently by five NIOSH-certified pneumoconiosis "B" readers who, without knowledge of the participant's age, occupation, or smoking history, classified the films according to the 1980 ILO International Classification of Radiographs of Pneumoconioses.[2] This classification is extensively used internationally for epidemiological research, for the surveillance of those in dusty occupations, and for clinical purposes. Parenchymal and pleural abnormalities were recorded. A chest radiograph was defined as positive (that is, consistent with) pneumoconiosis if at least three of the five "B" readers classified small opacity profusion as 1/0 or greater.

2. Spirometry

Spirometry was performed using a dry rolling-seal spirometer interfaced to a dedicated computer. At least five maximal expiratory maneuvers were recorded for each person. All values were corrected to BTPS (body temperature, ambient pressure, saturated with water vapor). The largest forced vital capacity (FVC), and forced expiratory volume in one second (FEV_1) were the parameters selected for analysis, regardless of the curves on which they occurred. Testing procedures conformed to the American Thoracic Society's recommendations for spirometry.[3] Predicted values were calculated using the Knudson reference equations.[4] Predicted values for blacks were determined by multiplying the value predicted by the Knudson equation by 0.85.[5] Test results were compared to the 95th percentile lower limit of normal (LLN) values obtained from Knudson's reference equations to identify participants with abnormal spirometry patterns of obstruction and restriction.[4] Five percent of the population will have predicted values that fall below the normal range, or LLN, while 95% will have predicted values above the lower limit. However, spirometry has a relatively low sensitivity in detecting diseases like silicosis.

Using this comparison, obstructive and restrictive patterns are defined as:

Obstruction: Observed ratio of FEV_1/FVC% below the LLN.
Restriction: Observed FVC below the LLN; and
FEV_1/FVC% above the LLN.

The criteria for interpretation of the level of severity for obstruction and restriction, as assessed by spirometry, is based on the NIOSH classification scheme (available upon request from the Division of Respiratory Disease Studies). For those persons with values below the LLN, the criteria are:

	Obstruction (FEV_1/FVC x 100)	Restriction (% Predicted FVC)
Mild	>60	>65
Moderate	≥ 45 to ≤ 60	≥ 51 to ≤ 65
Severe	<45	<51

3. Respiratory and Work History Questionnaire

A modified version of the Medical Research Council (MRC) questionnaire[6] (Appendix I) on respiratory symptoms, supplemented with questions concerning smoking habits, demographic information, information on physician-diagnosed respiratory illnesses, and occupational history, was administered by trained interviewers. In addition, specific questions were asked regarding the average number of ballast or stone trains unloaded a year, and prior use of any special equipment or machines.

The following definitions were established for the purposes of analysis:

"Chronic cough" - a cough on most days for as much as three months during the year.

"Chronic phlegm" - the production of phlegm on most days for as much as three months during the year.

"Chronic shortness of breath" - becoming short of breath when walking with others the same age on level ground.

"Rhinitis" - nasal drainage on most days for as much as three months each year.

"Hemoptysis" - coughing up blood.

Wheezing and chest illness were both defined as an affirmative response to the initial question in each of these sections. Non-diagnosed asthma was defined as attacks of shortness of breath with wheezing and normal breathing between attacks.

V. Evaluation Criteria and Toxicology

A. Evaluation Criteria

Evaluation criteria are used as guidelines to assess the potential health effects of occupational exposures to substances and conditions found in the work environment. These criteria are generally established at levels that can be tolerated by most healthy workers occupationally exposed day after day for a working lifetime without adverse effects. Because of variation in individual susceptibility, a small percentage of workers may experience health problems or discomfort at exposure levels below these existing criteria. Consequently, it is important to understand that these evaluation criteria are guidelines, not absolute limits between safe and dangerous levels of exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria considered in this report are: 1) NIOSH recommended exposure limits (RELs)[7,8,9], 2) the 1991-1992 American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs)[10], and 3) the U.S. Department of Labor (OSHA) Permissible Exposure Limits (PELs).[11] The OSHA PELs may be required to take into account the economic feasibility of controlling exposures in various industries where the agents are used. By contrast, the NIOSH RELs are based primarily on concerns relating to the prevention of occupational disease. Both NIOSH RELs and OSHA PELs are presented in the tables summarizing the environmental data.

NIOSH recommends that exposure to respirable crystalline silica (cristobalite, quartz, tridymite, tripoli) be controlled so that no worker is exposed to a time-weighted average (TWA) concentration greater than 0.05 milligrams per cubic meter (mg/m^3). The OSHA standards and ACGIH TLVs are 0.05 mg/m^3 for cristobalite and tridymite, and 0.1 mg/m^3 for quartz and tripoli.[10,11]

B. Toxicology

Crystalline silica, also referred to as free silica, is silicon dioxide (SiO_2). The three most common forms are quartz, tridymite, and cristobalite. Cristobalite is the most biologically active, followed by tridymite and quartz.[12] The chief concern of excessive crystalline silica exposure is the development of silicosis, a form of pneumoconiosis. Silicosis is a fibrotic pulmonary disease caused by the inhalation, deposition, and retention of dust containing silicon dioxide.[13] Silicosis is usually diagnosed through chest radiograph, occupational exposure history, and spirometry. Lung tissue reacts to the presence of silica dust in the lung by forming nodules, which on chest radiograph may appear discrete, round, and more prominent in the upper lobes.[14,15] Such radiographic abnormalities are often the first sign of silicosis.

The three clinical forms of the disease -- chronic, accelerated, and acute silicosis -- are differentiated by intensity of exposure, time to onset of disease after initial exposure (induction period), and the rate at which the disease progresses.[13,15,16,17] The percentage of crystalline silica in the dust, size of the dust particle, and form of crystalline silica may also affect disease onset and progression.[9,15,18]

Chronic manifestations of the disease encompass both the "simple" (the presence of detectable, discrete, silicotic nodules <1 cm in diameter on chest radiograph) and accelerated forms of silicosis, with a continuum thought to exist between the two. Factors determining the progression of disease are unclear.[14] Both "simple" and accelerated forms can become complicated by the development of infection and/or progressive massive fibrosis (PMF). Infections (i.e. tuberculosis and/or fungal infections) are believed to result from the inability of the overwhelmed lung scavenger cells (macrophages) to kill the organisms that cause these diseases.[19,20]

Progressive massive fibrosis has at times been called "complicated" silicosis, and is equated with the occurrence of large (>1 cm) opacities; the result of silicotic nodules fusing into large masses. PMF profoundly affects both the structure and function of the lungs.[13,14,16,17]

The ILO radiographic classification of pneumoconioses uses three categories to define large opacities according to size: A, B, and C.[2,21] Category A is specified as an opacity >1 cm but <5 cm, or several opacities >1 cm whose combined diameters are <5 cm; Category B is one or more opacities >5 cm whose combined area is less than the equivalent area of the right upper lung zone; Category C is one or more opacities whose combined area is greater than the equivalent area of the right upper lung zone.[2,21]

"Simple" silicosis is the most common form of chronic silicosis and usually becomes evident after 20 years or more of exposure to dust containing <30% crystalline silica.[13,14,17] There may be few clinical symptoms: a cough, with or without sputum; and shortness of breath. There may be little or no decrement in pulmonary function. While opinion on the frequency of progression of "simple" silicosis after cessation of exposure varies[16,22], there is widespread support for the concept of progression after exposure has ceased.[9,12,13,18,23]

Accelerated silicosis is associated with higher exposures to crystalline silica and has a shorter induction period than simple silicosis. Radiographic abnormalities usually appear within 5-15 years.[15,16,17] This form of silicosis often progresses after exposure has been discontinued. A rapid decline and mixed obstructive-restrictive pattern of impairment may be seen on spirometry.[12,18,22]

Acute silicosis, or silico-proteinosis, may develop within six months to two years following exposure to extremely high concentrations of crystalline silica.[17] It is characterized by the presence of fluid within the alveoli containing an amorphous proteinaceous material and inflammatory cells.[13,15,22,24] Symptoms include shortness of breath, fever, and cyanosis. Radiographically, its appearance is different from that of "simple" nodular silicosis, with few, diffuse nodules.[15,18] Consequently, it may often be misdiagnosed as pulmonary edema, pneumonia, or tuberculosis. Respiratory impairment is severe with acute silicosis, and the disease is usually fatal.[13,15,16,18]

The National Toxicology Program (NTP) lists respirable crystalline silica (quartz, crystobalite, and tridymite) as a group of substances which "may reasonably be anticipated to be carcinogens."[25] The NTP defines "reasonably anticipated to be carcinogens" as:

> "those substances for which there is limited evidence of carcinogenicity in humans and/or sufficient evidence of carcinogenicity in experimental animals"(p.viii).

In addition, the International Agency for Research on Cancer (IARC) considers there to be "sufficient evidence" for carcinogenicity in experimental animals and "limited evidence" in humans.[26] NIOSH considers crystalline silica to be a potential occupational carcinogen.[8]

VI. Results

A. Environmental

Samples were collected over the length of a normal work day. In many instances, the sampling period was less than eight hours; however, a zero value was not assigned to the unsampled portion of the work shift in computing the concentrations (TWAs) because we judged that exposures during the unsampled portion of the work shift were similar to those during the sampled portion. There were also periods of operational downtime when ballast was not being disturbed; when the crews were breaking for lunches, waiting in a siding for

passing trains, and repairing failed equipment. Sampling pumps continued to run throughout these periods, so actual exposures representative of downtime, as well as the day's range of tasks, were measured on those days. If periods of downtime were reduced, and workers spent more time performing maintenance activities, it is most likely that higher exposures would have been measured.

Tables 1, 2, and 3 summarize the results of respirable dust samples collected for the various job categories at each of the three worksites. A total of 50 personal breathing zone and 21 area samples were collected. These samples were analyzed both gravimetrically and for crystalline silica content by x-ray diffraction. Both quartz and cristobalite were detected. The limit of detection (LOD) for both quartz and cristobalite was 0.02 mg/m^3 and the limit of quantitation (LOQ) was 0.04 mg/m^3.

Quartz was detected on 34 of the 50 personal samples and was quantifiable on 30 of the 34. The maximum personal quartz exposure was 0.16 mg/m^3. The average quartz exposure for the 30 samples with quantifiable amounts was 0.08 mg/m^3. The median quartz exposure for all the samples was .05 mg/m^3. The average percentage of quartz by weight on the personal samples was approximately 18 percent.

Cristobalite was detected on 8 of the 50 personal samples and was quantifiable only on one sample. That sample was collected on a ballast regulator operator and indicated an exposure of 0.05 mg/m^3.

Of the 21 area samples collected, quartz was detected on 15 and was quantifiable on 13 of the 15. Quartz concentrations were found as high as 2.04 mg/m^3. Cristobalite was detected on 6 of the samples and quantifiable on 4. The highest cristobalite concentration was 0.44 mg/m^3.

B. Medical

A total of 35 individuals participated in the medical survey. Three of them, two union representatives and one management official, not currently working on the track at the time of the survey, were not included in the analysis. The following results describe data from 32 participants who were currently working on the tracks. This represents a participation rate of 54% (32/59) based on the list of maintenance-of-way employees, provided by the company, who were working at these three locations in April 1991.

The mean age of participants was 42 years; the standard deviation (SD) was 7 years and the range was 31-56 years. All participants were male. Sixty-nine percent (22) were white and 31% (10) were black. Participants were evenly distributed among the three smoking categories: 34% (11) were current smokers, 31% (10) were former smokers, and 34% (11) were never smokers. The mean number of pack-years of cigarette use was 28 years for current smokers and 26 years for formers smokers.

The gangs represented in the survey were: TM (Track Maintenance); T&S (Timber & Surfacing); TR (Track Repair), Track Patrol; TLB (Tractor Load Backhoe); GR (Grade-All); and CTC (Crane Operator). Sixty-three percent (20) of the participants were members of a TM gang. Overall, 69% (22) of the participants reported their job title as Laborer or Foreman. The remaining participants indicated working primarily as machine operators, heavy equipment operators, welders, and track supervisors. Some of these individuals also reported performing general track maintenance duties as needed, such as unloading ballast.

The average job tenure with Norfolk Southern was 17 years. No participant in this survey had a tenure less than 10 years. Twenty-five (78%) participants worked between 10 and 19 years, and seven (22%) participants worked between 20 to 22 years. When reported tenure in previous gangs was examined (Appendix I, pg. 3), the information proved to be inconsistent with total railroad tenure and therefore was not used.

The distribution of reported prior employment tenure in other dusty jobs was examined and revealed 66% (21) of the participants had worked less than 5 years in other dusty jobs -- ten of whom reported no work in other dusty jobs; 16% (five) worked between five and 10 years; and 19% (six) worked 10 years or more. The median number of years at other dusty jobs was 3.75 years and the average was 4 years (Range: 0-18).

Based on anecdotal descriptions of dusty work conditions obtained during interviews and discussions with workers, questions regarding the number of ballast trains unloaded per year, as well as information on prior gang experience and special equipment use, were asked in an attempt to examine qualitatively the extent to which participants may have been exposed to large amounts of airborne dust containing crystalline silica. The reported number of ballast or stone trains unloaded per year ranged from one to 30, with a median of six. Forty-seven percent (15) of the participants reported previous work on a T&S gang, one of whom indicated running a ballast regulator and tamper, and one of whom reported using a broom and a tamper. Of the participants who did not report prior T&S tenure, two reported using a ballast regulator and one reported using a tamper.

The prevalence of chronic symptoms by smoking status is reported in Table 4. The overall prevalence of chronic cough was 31%, and for chronic phlegm and shortness of breath, 25% each. Higher prevalences of chronic cough and chronic phlegm are seen in current smokers than in former and never smokers. The prevalence of chronic shortness of breath is essentially the same for all three smoking categories. Two participants who reported chronic shortness of breath experienced other physical symptoms such as back and leg pain, and arthritis; one was a current smoker and the other never smoked.

When chronic cough, phlegm, and shortness of breath were examined by total railroad tenure (10-19 years and 20+ years), these symptoms occurred only in those with less than 20 years of tenure.

Table 5 presents the prevalence of upper and lower respiratory symptoms and chest illness by smoking status. Higher overall prevalences are seen for wheeze (47%) and rhinitis (38%), and none of the symptoms appear to be associated with smoking status (except that former smokers appear to have lower prevalences than either current or never smokers).

Pneumonia, chronic bronchitis, and pleurisy were the only respiratory illnesses diagnosed in the past among these participants. Pneumonia was the most frequently reported illness (22%), particularly among non-smokers (4/11). A diagnosis of chronic bronchitis was reported by two participants, one current smoker and one former smoker. A single, non-smoking participant reported pleurisy. None of the participants reported being diagnosed with tuberculosis.

Table 6 contains the mean spirometry results by cigarette smoking status. As might be expected, FEV_1, percent predicted FEV_1, and $FEV_1/FVC\%$ were lower for current and former smokers. The spirometry results revealed four participants with a mild obstructive lung disease pattern. Three of the four were current smokers. The one non-smoking participant reported unloading an average of three ballast trains a year, prior T&S experience, but no prior work in other dusty jobs. This individual reported symptoms of chronic cough and chronic phlegm.

Initially, two independent "B" readings were obtained which varied widely. The second reader's classifications were "high," i.e. markedly positive. A third "B" reading was obtained to reach an agreement, and the first and the third reader did agree. However, to ensure that disease was not being overlooked, two additional independent "B" readings were obtained. None of the participants had a chest radiograph classified by three or more "B" readers as profusion category 1/0 or greater. One participant had a chest radiograph classified as 0/1 by two readers and 1/1 by a third.

VII. Discussion

A. Environmental

Environmental sampling conducted as early as 1984 by Norfolk Southern indicated that maintenance-of-way employees were exposed to silica-containing dust. In June 1984, the company monitored a slave broom operator and 2 ballast regulator operators in T&S gang #2. The percentages of respirable quartz by weight on their samples were 16.5%, 20.2%, and 17.2%. Two of their samples were more than twice the 1984 OSHA PEL {10 milligrams of dust per cubic meter of air divided by (% SiO_2 + 2)} for respirable mineral dust containing quartz. Their sample results indicated that the workers were exposed to respirable dust concentrations of 0.43 mg/m^3, 1.18 mg/m^3, and 1.05 mg/m^3. Based on the percentage of quartz on each sample, the workers were exposed to quartz concentrations of approximately 0.07 mg/m^3, 0.24 mg/m^3, and 0.18 mg/m^3.

Other information provided by Norfolk Southern indicated that in 1990, they had conducted sampling to determine the silica content of ballast samples from the various quarries used. Samples of the granites used had silica (all as quartz) content (by weight) ranging from <2% to 38%, and limestone samples had silica content ranging from <2% to 9%.

NIOSH sampling results indicated that 27 (54%) of the 50 personal samples, and 10 (48%) of the 21 area samples, had results that equalled or exceeded the NIOSH REL of 0.05 mg/m^3 for respirable crystalline silica. Eight (16%) personal samples and 4 (19%) area samples had results that equalled or exceeded the OSHA PEL of 0.1 mg/m^3 for respirable quartz; results of 1 personal and 1 area sample equalled or exceeded the OSHA PEL, as well as the NIOSH REL of 0.05 mg/m^3 for cristobalite.

Personal breathing zone sampling is the preferred method of contaminant measurement used to evaluate actual worker exposures. Area sampling is not a direct measurement of worker exposure, but rather representative of potential exposure. Information from area sampling may be useful in determining contaminant sources in order to implement an effective control strategy. For example, one fixed machine mounted area sample collected on a back broom showed a time-weighted average respirable quartz concentration of 2.04 mg/m^3, 20 times the OSHA PEL or 40 times the NIOSH REL. In contrast, the corresponding personal sample collected on the broom operator show a much lower, but still excessive, respirable quartz concentration of 0.11 mg/m^3. The reason for this difference in exposure is that the broom operator attempted to stay upwind of the broom and out of the dust cloud during operation, thereby reducing his overall exposure. The utility of that fixed machine mounted area sample shows that the operators potential for excessive exposure to respirable quartz would be much greater if he were working on the machine rather than upwind or away from the machine.

The ballast was dry at all the survey sites. No wetting of the ballast to reduce generation of dust was observed during our surveys.

Company officials stated that following their 1984 air sampling results, maintenance-of-way supervisors were instructed to make NIOSH-approved respirators available to their workers for voluntary use. In 1990, the company mandated respirator use by ballast regulator operators and track broom operators and continued to make them available for voluntary use by all other maintenance-of-way workers.

During our first environmental survey in May 1991, some workers were observed wearing non-approved paper masks, which were inconsistent with respirators selected for protection from crystalline silica exposure under the company's 1987 Respiratory Protection Program. Labels on the masks clearly warned against their use for lung protection. Company officials were informed of the inadequacy of the masks. Paper masks were still being provided for use during subsequent surveys. NIOSH-approved respirators were not seen being worn by workers during any of our surveys. Following our surveys, Norfolk Southern mandated respirator use by all maintenance-of-way workers operating or working in the immediate vicinity of ballast-disturbing or dumping equipment.

The company's respiratory protection program incorrectly classifies silica as a nuisance dust. OSHA and ACGIH currently use the terms "Particulates Not Otherwise Regulated" and "Particulates Not Otherwise Classified," respectively, for substances which were previously designated "nuisance dusts." To be classified under these categories, substances must have no established standards and they must contain no asbestos and less than 1% free silica. Exposure to such substances is considered to cause adverse "nuisance" effects, including interference with vision, irritation of the upper respiratory tract and skin, and deposits of these substances in the eyes, ears, and nasal passages. Reactions of lung tissue to these substances are considered to be reversible when exposure ceases.[8]

OSHA has established exposure limits for silica. It is a hazardous dust. NIOSH and ACGIH have also recommended exposure limits for silica. It is misleading to apply the term "nuisance dust" to silica.

B. Medical

The purpose of the medical portion of this hazard evaluation was to determine if maintenance-of-way employees, with similar job duties as that of the sentinel case, may have developed signs or symptoms of disease suggestive of pneumoconiosis and/or adverse respiratory health effects. Silicosis, a type of pneumoconiosis, is usually diagnosed by chest radiograph, occupational exposure history, and spirometry. Three methods were used to evaluate workers for respiratory health effects: posterior-anterior (PA) chest radiograph, spirometry, and respiratory work history and questionnaire.

None of the participants had a chest radiograph classified by 3 or more "B" readers as profusion category 1/0 or greater. However, the absence of radiographic abnormalities does not preclude the possibility of current or future pathological findings.[13,14]

Factors such as the particular focus on the TM gang (as the referent group), the long latency of chronic silicosis, and the small number of workers evaluated may have reduced the likelihood of finding the disease. The small number of participants limits the generalizability of the medical results and would not necessarily apply to those maintenance-of-way employees who may have greater silica exposures.

Spirometry revealed four individuals (12%) with an obstructive spirometry pattern. In a group of 944 non-exposed blue-collar workers[27], 8.1% were observed to have an obstructive (FEV_1/FVC <70%) spirometric pattern. Occupational exposures to mineral dust have been associated with airflow limitation and chronic obstructive pulmonary disease.[28,29] Three out of the four participants with obstructive abnormalities were current smokers. However, smokers are often more susceptible to the effects of workplace exposures, and changes in lung function may be potentiated by occupational dust exposure.[30]

In addition, spirometry is limited by its lack of specificity as to the etiology of any abnormality. Furthermore, because of its wide range of normal, spirometry as a one-time screening test is most effectively used for confirmation, rather than exclusion, of pulmonary disease.[31,32,33]

The cause of the chronic symptoms reported on the questionnaires are non-specific and may be related to dust exposure, smoking, or other causes. The chronic symptoms of cough, phlegm, shortness of breath, and the abnormal spirometry patterns occurred only in those with less than 20 years of railroad tenure, probably a reflection of the larger proportion (78%) of workers in this group among those who were evaluated.

Overall, 84% (27) of the participants had a history of possible exposure to silica-containing airborne dust while working for the railroad, based on current and past job duties (unloading ballast, member of a T&S gang) and equipment use (tamper, broom, or regulator). This, coupled with the environmental data, provides strong evidence that the potential for excessive crystalline silica exposure existed. Although there were no confirmed cases of silicosis among those evaluated, the development of dust-induced disease in these workers remains a serious concern. Intervention, primarily in the form of exposure reduction, is of greater benefit in the preclinical phase than in the clinical phase (i.e. detectable disease). Early intervention will often limit permanent lung damage.

Five out of the 15 maintenance-of-way job classifications have been identified through the occupational history and/or environmental data collected as having the potential for exposure to respirable crystalline silica. These five classifications: Extra Gang Foreman, Gang/Section Foreman, Extra Gang Laborer, Section Laborer, and Machine Operator may represent an average of over 32,000 workers based on all union-represented railroads in 1990, according to the union.

C. Other Findings

Our investigation was unable to confirm that either the Federal Railroad Administration (FRA) or OSHA had ever attempted to evaluate maintenance-of-way employees' exposure to crystalline silica in the past. Differences in interpretation of the jurisdictional relationship between OSHA and FRA contributed to this situation.

VIII. Conclusions

As stated previously, the primary purpose of this study was to determine the potential for exposure to respirable crystalline silica and whether maintenance-of-way workers may have developed signs or symptoms suggestive of pneumoconiosis and/or adverse respiratory health effects. Although the medical survey found no evidence of silicosis among a small sample of primarily TM employees, the environmental sampling data indicated that T&S employees were being overexposed to crystalline silica. In addition, the potential for excessive crystalline silica exposure existed for TM employees.

IX. Recommendations

1. The Norfolk Southern Railway Company should conduct additional on-going environmental monitoring to determine which maintenance-of-way job classifications are subject to crystalline silica exposure and evaluate efforts made to control these exposures.

2. Investigate engineering controls to reduce worker exposure. Whenever a hazard can be reduced by reasonable substitution of other less toxic materials, the substitution should be made. Wetting the ballast before and during track maintenance operations would probably reduce the exposure to airborne respirable crystalline silica dust.

3. Until accepted engineering control measures have been developed to reduce dust exposures, or while engineering controls are being established, NIOSH-approved respiratory protective equipment should be used. The current respiratory protection program should be reviewed to assure it is consistent with the requirements of ANSI Z88.2-1980, OSHA standard 29 CFR 1910.134, and the NIOSH Respirator Decision Logic.[34,35,36] In order for a respiratory protection program to be effective, it is extremely important that the program be properly administered and kept up to date.

4. Amend the Medical Standards Guide to include pre-placement chest radiographs, spirometry testing, and tuberculosis skin testing for all maintenance-of-way employees potentially exposed to crystalline silica dust. This will provide a baseline for future evaluation. Out of the 32 participants, six (19%) reported never having a chest radiograph, either company provided or through routine medical care.

5. Provide periodic medical examinations at least once every three years[9] for all maintenance-of-way employees with exposure to crystalline silica dust. These examinations should include at a minimum:

   A. A medical and occupational history to collect data on worker exposure to crystalline silica dust, and signs and symptoms of respiratory disease.

   B. A chest radiograph (posterior-anterior 14" x 17") classified according to the ILO International Classification of Radiographs of Pneumoconioses.

   C. Pulmonary function testing (spirometry) including Forced Vital Capacity (FVC) and Forced Expiratory Volume at one second (FEV_1) using equipment and methods consistent with ATS recommendations.[3]

   D. An annual evaluation for tuberculosis.[18,37]

6. As part of established hazard communication[38] and respiratory protection programs, workers should receive training regarding the potential health effects of crystalline silica exposure and necessary work practices needed to reduce exposures.

7. If positive findings are found on the chest radiograph or spirometry or both, the employee should be notified and referred for further clinical evaluation. All cases of silicosis should be reported to State health departments as required, and recorded as required by OSHA. To enhance the uniformity of reporting, NIOSH has developed reporting guidelines and a surveillance case definition for silicosis (Appendix II). This definition and guidelines are recommended for surveillance of work-related silicosis by State health department and regulatory agencies receiving reports of cases from physicians and other health care providers.[17]

8. NIOSH recommends that exposure to respirable crystalline silica (cristobalite, quartz, tridymite, tripoli) be controlled so that no worker is exposed to a time-weighted average (TWA) concentration greater than 0.05 milligrams per cubic meter (mg/m^3). According to recent congressional testimony[39,40], OSHA has retained the authority and exercised jurisdiction regarding this working condition (that is, exposure to crystalline silica). Norfolk Southern Railway Company should adhere to the crystalline silica standard along the right-of-way until a final rule has been adopted by the FRA. Ultimately, NSRC is responsible for the occupational safety and health of all its employees.

9. Silica exposure is a previously un-characterized health hazard amongst railroad right-of-way workers. It is unlikely that the potential for exposure to respirable crystalline silica exists on Norfolk Southern Railway properties alone. This, in addition to the number of maintenance-of-way employees possibly at risk for developing silicosis and other lung disease related to silica dust exposures, warrants a thorough evaluation of this potential hazard and preventable disease.

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1. Norfolk Southern Railway Company
2. Brotherhood of Maintenance of Way Employees
3. Federal Railroad Administration, Department of Transportation
4. Virginia Department of Health
5. OSHA Region III

For the purpose of informing affected employees, copies of this report should be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1
RESULTS OF RESPIRABLE DUST SAMPLING[a]
T&S Gang, No. 8, Front Royal, VA
May 8, 1991
Norfolk Southern Railway Company
HETA 90-341

Job	Sample Type	Sampling Time (minutes)	Quartz %	Cristobalite %	Resp. Dust (mg/m^3)	Resp. Quartz (mg/m^3)	Resp. Cristobalite (mg/m^3)
Tamper	P	410	<LOQ	ND	0.16	<LOQ	ND
Tamper	P	402	ND	ND	0.18	ND	ND
Foreman	P	400	ND	ND	0.07	ND	ND
Ballast Regulator	P	400	16	<LOQ	0.53	0.08	<LOQ
Scrap Buggy	P	395	ND	<LOQ	0.15	ND	<LOQ
Spike Puller	P	360	ND	ND	0.08	ND	ND
Ballast Regulator	P	394	8.3	ND	0.90	0.07	ND
Plate Jack	P	413	ND	ND	0.01	ND	ND
Plate Jack	P	394	ND	ND	0.04	ND	ND
Tamper	P	400	ND	ND	0.07	ND	ND
Plate Broom	P	390	14.3	ND	0.32	0.05	ND
Tamper	A	388	ND	ND	0.01	ND	ND
Scrap Buggy	A	367	ND	ND	0.13	ND	ND
Tamper	A	382	30	ND	0.16	0.05	ND
Ballast Regulator	A	391	12.8	7.7	0.59	0.07	0.04

[a]All samples were collected at a flow rate of 1.7 liters per minute in accordance with NIOSH Analytical Method 7500[(1)].

TABLE 1 (CONTINUED)

Job	Sample Type	Sampling Time (minutes)	Quartz %	Cristobalite %	Resp. Dust (mg/m^3)	Resp. Quartz (mg/m^3)	Resp. Cristobalite (mg/m^3)
Ballast Regulator	A	390	12.9	<LOQ	0.47	0.06	<LOQ
Tamper	A	385	ND	ND	0.08	ND	ND
Plate Broom	A	375	7.8	2.6	1.80	0.14	0.04
Plate Broom	A	371	<LOQ	ND	0.17	<LOQ	ND
Limit of Detection (LOD)			0.75	0.75	0.01	0.02	0.02
Limit of Quantitation (LOQ)			1.5	1.5		0.04	0.04
NIOSH REL						0.05	0.05
OSHA PEL						0.10	0.05

NOTES: Sample Type - (P) Personal, (A) Area
mg/m^3 - milligrams per cubic meter of air
<LOQ - Substance was detected but below The Limit of Quantitation
ND - None Detected

TABLE 2
RESULTS OF RESPIRABLE DUST SAMPLING[a]
T&S Gang No.8, Raleigh/Durham, NC
Norfolk Southern Railway Company
HETA 90-341

Date	Job	Sample Type	Sampling Time (minutes)	Quartz %	Cristobalite %	Resp. Dust (mg/m^3)	Resp. Quartz (mg/m^3)	Resp. Cristobalite (mg/m^3)
7/23	Spike Puller	P	440	ND	ND	0.04	ND	ND
	Tamper	P	445	ND	ND	0.16	ND	ND
	Tamper	P	445	16	ND	0.33	0.05	ND
	Ballast Regulator	P	491	14.8	ND	0.32	0.05	ND
	Ballast Regulator	P	430	12	ND	0.34	0.04	ND
	Back Broom	P	477	15	ND	0.90	0.14	ND
	Plate Broom	P	462	17	ND	0.37	0.06	ND
	Plate Broom and Tie Binder	P	459	31	ND	0.21	0.06	ND
	Scrap Buggy	P	440	ND	ND	0.13	ND	ND
	Plate Broom	P	456	25	ND	0.15	0.04	ND
	Ballast Regulator	A	476	12.2	ND	0.51	0.06	ND
	Ballast Regulator	A	410	<LOQ	ND	1.40	<LOQ	ND
	Tamper	A	438	11	ND	0.36	0.04	ND
	Tamper	A	435	<LOQ	ND	0.26	<LOQ	ND

[a]All samples were collected at a flow rate of 1.7 liters per minute in accordance with NIOSH Analytical Method 7500[(1)].

TABLE 2 (CONTINUED)

Date	Job	Sample Type	Sampling Time (minutes)	Quartz %	Cristobalite %	Resp. Dust (mg/m^3)	Resp. Quartz (mg/m^3)	Resp. Cristobalite (mg/m^3)
7/24	TM Crew	P	480	ND	ND	0.04	ND	ND
	Ballast Regulator	P	475	8.5	ND	1.00	0.09	ND
	Ballast Regulator	P	449	10	5.8	0.89	0.09	0.05
	Back Broom	P	475	20.5	ND	0.42	0.09	ND
	Spike Puller	P	435	ND	ND	0.15	ND	ND
	Plate Broom	P	453	<LOQ	ND	0.27	<LOQ	ND
	Scrap Buggy	P	440	ND	ND	0.06	ND	ND
	Plate Broom	P	454	12.7	<LOQ	0.60	0.08	<LOQ
	Tamper	P	477	<LOQ	ND	0.32	<LOQ	ND
	Tamper	P	476	25	ND	0.19	0.05	ND
	Tamper	A	465	15.6	ND	0.40	0.06	ND
	Tamper	A	465	<LOQ	ND	0.21	<LOQ	ND
	Ballast Regulator	A	424	16	<LOQ	0.76	0.12	<LOQ
	Ballast Regulator	A	470	11	<LOQ	1.10	0.12	<LOQ
Limit of Detection (LOD)				0.75	0.75	0.01	0.02	0.02
Limit of Quantitation (LOQ)				1.5	1.5		0.04	0.04
NIOSH REL							0.05	0.05
OSHA PEL							0.10	0.05

NOTES: Sample Type - (P) Personal, (A) Area
mg/m^3 - milligram per cubic meter of air
<LOQ - Substance was detected but below The Limit of Quantitation
ND - None Detected

TABLE 3
RESULTS OF RESPIRABLE DUST SAMPLING[a]
T&S Gang No.2, Culpeper, VA
Norfolk Southern Railway Company
HETA 90-341

Date	Job	Sample Type	Sampling Time (minutes)	Quartz %	Cristobalite %	Resp. Dust (mg/m^3)	Resp. Quartz (mg/m^3)	Resp. Cristobalite (mg/m^3)
8/27	TM Crew	P	411	27.2	ND	0.11	0.04	ND
	Tamper	P	412	26.3	ND	0.27	0.07	ND
	Tie Handler	P	420	ND	ND	0.04	ND	ND
	Ballast Regulator	P	412	19	<LOQ	0.30	0.06	<LOQ
	Ballast Regulator	P	411	12.8	ND	0.56	0.07	ND
	Plate Broom	P	418	28.6	<LOQ	0.30	0.08	<LOQ
	Plate Broom	P	415	20.5	ND	0.55	0.11	ND
	Tamper	P	414	<LOQ	ND	0.18	<LOQ	ND
	Back Broom	P	410	25	<LOQ	0.57	0.14	<LOQ
	Ballast Regulator	A	412	9.1	ND	0.33	0.04	ND
	Ballast Regulator	A	410	9.4	ND	0.53	0.07	ND
	Switch Tamper	A	410	25	ND	0.17	0.04	ND
	Switch Tamper	A	409	ND	ND	0.04	ND	ND

[a]All samples were collected at a flow rate of 1.7 liters per minute in accordance with NIOSH Analytical Method 7500[(1)].

TABLE 3 (CONTINUED)

Date	Job	Sample Type	Sampling Time (minutes)	Quartz %	Cristobalite %	Resp. Dust (mg/m^3)	Resp. Quartz (mg/m^3)	Resp. Cristobalite (mg/m^3)
8/28	Plate Broom	P	360	12.5	<LOQ	1.31	0.16	<LOQ
	Plate Broom	P	363	13.6	ND	0.71	0.10	ND
	Tamper	P	369	25.8	ND	0.49	0.13	ND
	Back Broom	P	369	20.6	ND	0.54	0.11	ND
	Ballast Regulator	P	368	14.3	ND	0.34	0.05	ND
	Ballast Regulator	P	367	13.6	ND	0.70	0.10	ND
	Tamper	P	361	36.4	ND	0.18	0.07	ND
	Scrap Buggy	P	364	4.9	ND	0.99	0.05	ND
	Tie Handler	P	357	ND	ND	0.07	ND	ND
	TM Crew	P	360	ND	ND	0.03	ND	ND
	Back Broom	A	225	13.4	2.9	15.24	2.04	0.44
Limit of Detection (LOD)				0.75	0.75	0.01	0.02	0.02
Limit of Quantitation (LOQ)				1.5	1.5		0.04	0.04
NIOSH REL							0.05	0.05
OSHA PEL							0.10	0.05

NOTES: Sample Type - (P) Personal, (A) Area
mg/m^3 - milligram per cubic meter of air
<LOQ - Substance was detected but below The Limit of Quantitation
ND - None Detected

TABLE 4
PREVALENCE OF CHRONIC SYMPTOMS[a] BY CIGARETTE SMOKING STATUS
Norfolk Southern Railway Company
HETA 90-341

	11 CURRENT SMOKERS		10 FORMER SMOKERS		11 NEVER SMOKERS		TOTAL NUMBER = 32	
	Number	%	Number	%	Number	%	Number	%
Chronic Cough	5	45	2	20	3	27	10	31
Chronic Phlegm	5	45	1	10	2	18	8	25
Chronic Shortness of Breath	3	27	2	20	3	27	8	25

[a]See text for definitions

TABLE 5
PREVALENCE OF UPPER AND LOWER RESPIRATORY SYMPTOMS[a]
AND CHEST ILLNESS BY CIGARETTE SMOKING STATUS
Norfolk Southern Railway Company
HETA 90-341

	Smoking Status							
	CURRENT N=11		FORMER N=10		NEVER N=11		TOTAL N=32	
	Number	%	Number	%	Number	%	Number	%
Rhinitis	4	36	2	20	6	55	12	38
Wheeze	6	55	3	30	6	55	15	47
Asthma	1	9	2	20	2	18	5	16
Hemoptysis	1	9	1	11	1	9	3	10
Chest Illness	1	9	2	20	1	9	4	12

[a]See text for definitions

TABLE 6
PULMONARY FUNCTION TEST RESULTS
vs
SMOKING STATUS
Norfolk Southern Railway Company
HETA 90-341

	Smoking status					
	CURRENT N=11		FORMER N=10		NEVER N=11	
	Mean	(SD)	Mean	(SD)	Mean	(SD)
FVC (ℓ)	4.53	(1.00)	4.51	(0.86)	4.90	(0.83)
Percent predicted FVC	106.8	(15.3)	100.8	(10.4)	102.3	(13.4)
FEV_1 (ℓ)	3.34	(0.76)	3.56	(0.65)	4.00	(0.79)
Percent Predicted FEV_1	95.9	(14.3)	97.6	(9.9)	101.0	(15.8)
FEV_1/FVC ratio (%)	73.9	(3.9)	79.2	(4.7)	81.5	(6.9)

Appendix I

DATE ___/___/___
LOCATION _____

RDHETA 90-341
(Do not write in this box.)

A. IDENTIFICATION

1. NAME _____
(Last First Middle Initial)

2. CURRENT ADDRESS _____
(Number, Street, or Rural Route)

_____
(City or Town, County, State, Zip Code)

3. HOME PHONE: (_____) _____

4. SSN ____-____-_____

5. BIRTHDATE _____/_____/_____
Month, Day, Year

6. AGE AT LAST BIRTHDAY _____

7. SEX 1☐ Male
2☐ Female

8. RACE 0.☐ White 1.☐Black 2.☐Asian/Pacific Islander
3.☐ American Indian/Eskimo 4.☐ Other

8a. Are you of Hispanic origin? 1.☐ YES 2.☐ NO

STANDING HEIGHT _____(inches) WEIGHT _____(lbs.)

B. OCCUPATIONAL HISTORY

1. What is your present job status?

Employed, full time	1.☐
Employed, but not full time	2.☐
Retired	3.☐
Sick or disabled	4.☐

1a. **If retired or sick and disabled:**

When did you STOP working? Month ____ Year ____

THESE NEXT QUESTIONS ARE ABOUT YOUR **CURRENT** JOB OR **LAST JOB** YOU HELD.

2. When did you start to work on the railroad?

Year 19____

3. Which railroad do/did you work for?

Southern	1.☐
Norfolk & Western	2.☐
Norfolk & Southern	3.☐

4. What type of gang or crew do/did you work on?

TM (Track Maintenance)	1.☐
TS (Timber & Surfacing)	2.☐
RTG (Rail transposing Gang)	3.☐
B&B (Bridge & Building)	4.☐
Other _____	5.☐

IF TM GANG:

4a. What section does/did your crew cover?

_____

4b. How many ballast or stone trains a year do/did you unload (on average)?

Number _____

5. When did you begin work on this particular gang?

Month ____ Year 19_____

6. What is/was the name and number of your gang (ex. TM-2)? _____

7. What is/was your job title?_____

Briefly describe your work duties. (Special duties/equipment)

_____

_____

8. How many days per week do/did you work? _____ days/week

9. How many hours per day do/did you work? _____ hours/day

10. What other gangs have you worked on? For how long?

Railroad _____ Gang _____ No. Yrs. _____

Railroad _____ Gang _____ No. Yrs. _____

Railroad _____ Gang _____ No. Yrs. _____

10a. Did you run any special equipment while working on these other gangs? (ex. ballast regulator)

1.☐ YES 2.☐ NO

---

11. Have you ever worked:

* in a foundry? 1.☐ YES 2.☐ NO No. Yrs. _____

* in a mine? 1.☐ YES 2.☐ NO No. Yrs. _____

* in a quarry? 1.☐ YES 2.☐ NO No. Yrs. _____

* in a pottery? 1.☐ YES 2.☐ NO No. Yrs. _____

* in a cotton, flax, or hemp mill? 1.☐ YES 2.☐ NO No. Yrs. _____

* with asbestos? 1.☐ YES 2.☐ NO No. Yrs. _____

* sandblasting? 1.☐ YES 2.☐ NO No. Yrs. _____

* road work? 1.☐ YES 2.☐ NO No. Yrs. _____

* shipbuilding or repair? 1.☐ YES 2.☐ NO No. Yrs. _____

* in any other dusty jobs? 1.☐ YES 2.☐ NO No. Yrs. _____

OCCUPATIONAL HISTORY TABLE- [*Complete the following table showing the entire work history of the individual from present to initial employment. Sporadic, part time periods of employment, each of no significant duration, should be grouped if possible.*]

INDUSTRY AND FIRM	TENURE OF EMPLOYMENT		SPECIFIC OCCUPATION	HAZARDOUS HEALTH EXPOSURE ASSOCIATED WITH WORK		
	FROM	TO		YES	NO	IF YES, DESCRIBE

C. SYMPTOMS

Please answer **YES** or **NO** to the following questions.

COUGH

1. Do you usually cough on getting up, or first thing in the morning in the winter?

   (Count a cough with first smoke or on first going out-of-doors. Exclude clearing throat or a single cough. "Usually" means 4 or more days per week.)

   1.☐ YES 2.☐ NO

2. Do you usually cough during the day (or at night) in the winter?

   (Ignore an occasional cough. "Usually" means 4 or more days per week.)

   1.☐ YES 2.☐ NO

IF NO TO BOTH QUESTIONS 1 AND 2, GO TO "PHLEGM."
IF YES TO EITHER QUESTION 1 OR 2:

2a. Do you cough like this on most days (or nights) for as much as three months during the year?

   1.☐ YES 2.☐ NO

2b. How many years have you coughed like this? _____ years

PHLEGM

1. Do you usually bring up any phlegm from your chest on getting up, or first thing in the morning in the winter?

   (Count phlegm with first smoke or on first going out of doors. Exclude phlegm from the nose. Count swallowed phlegm. "Usually" means 4 or more days per week.)

   1.☐ YES 2.☐ NO

2. Do you usually bring up any phlegm from your chest during the day (or at night) in the winter?

   ("Usually" means 4 or more days per week. Accept twice or more)

   1.☐ YES 2.☐ NO

IF NO TO BOTH QUESTIONS 1 AND 2, SKIP TO QUESTION #3.
IF YES TO EITHER QUESTION 1 or 2:

2a. Do you bring up phlegm like this on most days (or nights) for as much as three months during the year?

1.☐ YES 2.☐ NO

2b. How many years have you brought up phlegm like this?

_____ years

3. Have you ever coughed up blood? 1.☐ YES 2.☐ NO

If **YES**,
3a. Was this in the past year? 1.☐ YES 2.☐ NO

BREATHLESSNESS

1. Do you have any nerve, muscle, or bone problem that makes walking quite difficult for you?

1.☐ YES 2.☐ NO

If **YES**, please specify _____

2. Are you short of breath when hurrying on level ground or walking up a slight hill? 1.☐ YES 2.☐ NO

If **YES**,
2a. Do you get short of breath walking with other people of your own age on level ground?

1.☐ YES 2.☐ NO

If **YES**,
2b. Do you have to stop for breath when walking at your own pace on level ground?

1.☐ YES 2.☐ NO

WHEEZING

1. Does your chest ever sound wheezing or whistling?

1.☐ YES 2.☐ NO

IF **YES**:
1a. Do you get this most days or nights each week?

1.☐ YES 2.☐ NO

1b. Does the wheezing always clear after you cough?

1.☐ YES 2.☐ NO

2. Have you ever had attacks of shortness of breath with wheezing or whistling?

1.☐ YES 2.☐ NO

IF YES:

2a. Was your breathing absolutely normal between attacks?

1.☐ YES 2.☐ NO

WEATHER

1. Does the weather affect your chest? 1.☐ YES 2.☐ NO

(Record YES if adverse weather definitely and regularly causes chest symptoms.)

IF NO TO QUESTION 1, GO TO "NASAL DRAINAGE".
IF YES TO QUESTION 1:

1a. Does the weather make you short of breath? 1.☐ YES 2.☐ NO

1b. What kind of weather? _____

NASAL DRAINAGE

1. Do you usually have a stuffy nose, or drainage at the back of your nose in the winter?

1.☐ YES 2.☐ NO

2. Do you have this in the summer?

1.☐ YES 2.☐ NO

IF NO TO BOTH QUESTIONS 1 AND 2, SKIP TO "CHEST ILLNESS".
IF YES TO EITHER QUESTION 1 or 2:

2a. Do you have this on most days for as much as three months each year?

1.☐ YES 2.☐ NO

CHEST ILLNESSES

1. During the past three years have you had any chest illness which has kept you from your usual activities for as much as a week?

1.☐ YES 2.☐ NO

If YES:

1a. Did you bring up more phlegm than usual in any of these illnesses?

1.☐ YES 2.☐ NO

1b. Have you had more than one illness like this in the past three years?

1.☐ YES 2.☐ NO

D. SMOKING HISTORY

1. Have you ever smoked cigarettes regularly?

1.☐ YES 2.☐ NO

IF NO TO QUESTION 1, SKIP TO QUESTION 2 BELOW.
IF YES TO QUESTION 1:

1a. How old were you when you first started smoking cigarettes regularly?
_____years old (age)

1b. Do you still smoke cigarettes?

1.☐ YES 2.☐ NO

If NO, how old were you when you last gave up smoking?

_____years old (age)

1c. During the years that you smoked, did you ever quit for 6 months or more?

1.☐ YES 2.☐ NO

If YES, how long did you quit for altogether?

_____years

1d. Over the years that you smoked, on the average, approximately how many cigarettes per day did you smoke?

_____ Cigarettes per day.

2. Do you now smoke a pipe or cigar?

1.☐ YES 2.☐ NO

E. GENERAL QUESTIONS

1. Have you ever been told by a doctor that you had:

A.	Chronic bronchitis	1.☐ YES 2.☐ NO
B.	Emphysema	1.☐ YES 2.☐ NO
C.	Asthma	1.☐ YES 2.☐ NO
D.	Pneumonia	1.☐ YES 2.☐ NO
E.	Tuberculosis	1.☐ YES 2.☐ NO
F.	Other lung conditions (specify)	1.☐ YES 2.☐ NO

_____

2. Have you ever had a chest x-ray? 1.☐ YES 2.☐ NO

If **YES**,

2a. Have you ever been told that your chest x-ray was abnormal?

1.☐ YES 2.☐ NO

What were you told? _____

_____

_____

2b. What year was your most recent chest x-ray?

19____

MAY WE HAVE YOUR PERMISSION TO LOOK AT ANY CHEST X-RAYS AND MEDICAL RECORDS FROM THE PAST TO COMPARE WITH THE X-RAY WE TAKE TODAY? WE NEED THE NAMES AND ADDRESSES OF THE DOCTOR'S OFFICE, CLINIC, OR HOSPITAL WHERE YOUR X-RAYS AND RECORDS ARE STORED.

1.☐ YES 2.☐ NO

(Have worker fill out and sign release form on next page)

Appendix II[17]

SURVEILLANCE GUIDELINES: SILICOSIS

Reporting Guidelines

State health departments and regulatory agencies should encourage physicians (including radiologists, pathologists, and other healthcare providers) to report all diagnosed or suspected cases of silicosis. These reports should include persons with

-- a physician's provisional or working diagnosis of silicosis, **OR**

-- a chest radiograph interpreted as consistent with silicosis, **OR**

-- pathologic findings consistent with silicosis

To set priorities for workplace investigations, State health departments and regulatory agencies should collect appropriate clinical, epidemiologic, and workplace information about persons reported to have silicosis.

Surveillance Case Definition

A. 1. History of occupational exposure to airborne silica dust

AND

2. Chest radiograph or other imaging technique interpreted as consistent with silicosis

OR

B. Pathologic findings characteristic of silicosis.