9 Guidelines for Protecting Worker Health

The following guidelines for protecting worker health and minimizing worker exposures to RCFs are considered minimum precautions that should be adopted as a part of a site-specific safety and health plan to be developed and overseen by appropriate and qualified personnel.

9.1 Informing Workers about Hazards

9.1.1 Safety and Health Training Program

Employers should establish a safety and health training program for all workers who manufacture, use, handle, install, or remove RCF products or perform other activities that bring them into contact with RCFs. As part of this training program, employers should do the following:

- Inform all potentially exposed workers (including contract workers) about RCF-associated health risks such as skin, eye, and respiratory irritation and lung cancer.
- Provide MSDSs on site:
  - Make MSDSs readily available to workers.
  - Instruct workers how to interpret information from MSDSs.
- Teach workers to recognize and report adverse respiratory effects associated with RCFs.
- Train workers to detect hazardous situations.
- Establish procedures for reporting hazards and giving feedback about actions taken to correct them.
- Instruct workers about using safe work practices and appropriate PPE.
- Inform workers about practices or operations that may generate high concentrations of airborne fibers (such as cutting and sanding of RCF boards and other RCF products).
- Make workers who remove refractory insulation materials aware of the following:
  - Their potential for exposure to respirable crystalline silica
  - Health effects related to this exposure
  - Methods for reducing their exposure
  - Types of PPE that may be required (including respirators)

9.1.2 Labeling and Posting

Although workers should have received training about RCF exposure hazards and methods for protecting themselves, labels and signs serve as important reminders and provide warnings to workers who may not ordinarily work in the area. Employers should do the following:

- Post warning labels and signs about RCF-associated health risks at entrances and inside work areas where airborne concentrations of RCFs may exceed the REL.

- State the need to wear appropriate respiratory protection and protective clothing in areas where airborne RCFs may exceed the REL.
- If respiratory protection is required, post the following statement:

RESPIRATORS REQUIRED IN THIS AREA.

- Print all labels and warning signs in both English and the predominant language of workers who do not read English.
- If workers are unable to read the labels and signs, inform them verbally about the hazards and instructions printed on the labels and signs.

9.2 Hazard Prevention and Control

Proper use and maintenance of engineering controls, work practices, and PPE are essential for controlling concentrations of airborne fibers during the manufacturing, use, and handling of RCF products. Minimizing exposure to RCFs may be accomplished through a combination of the following work practices and controls:

- Engineering controls and ventilation
- Product reformulation
- Worker isolation
- PPE (such as protective clothing and equipment and respirators)
- Proper decontamination and waste disposal

9.2.1 Engineering Controls

Engineering controls should be the principal method for minimizing exposure to RCFs in the workplace.

9.2.1.1 Ventilation

Achieving reduced concentrations of airborne RCFs depends on adequate engineering controls such as local exhaust ventilation systems that are properly constructed and maintained. Local exhaust ventilation systems that employ hoods and ductwork to remove fibers from the workplace atmosphere have been used by RCF manufacturers. One example is a slotted-hood dust collection system placed over a mixing tank so that airborne fibers are captured and collected in a bag house with HEPA filters [RCFC 1996]. Other types of local exhaust ventilation or dust collection systems may be used at or near dust-generating systems to capture airborne fibers. Band saws used in RCF manufacturing and finishing operations have been fitted with such engineering controls to capture fibers and dust during cutting operations and thereby reduce exposures for the band saw operator [Venturin 1998]. Disc sanders fitted with similar local exhaust ventilation systems are effective in reducing airborne RCF concentrations during sanding of vacuum-formed RCF products [Dunn et al. 2004]. For quality control laboratories or laboratories where production samples are prepared for analyses, exhaust ventilation systems should be designed to capture and contain dust. For guidance in designing local exhaust ventilation systems, see *Industrial Ventilation—A Manual of Recommended Practice*, 25th edition [ACGIH 2005], *Recommended Industrial Ventilation Guidelines* [Hagopian and Bastress 1976], and the OSHA ventilation standard [29 CFR 1910.94].

Additional engineering controls have been evaluated by the Bureau of Mines for minimizing airborne dust in underground mining operations and at industrial sand plants. These controls may also have applications for RCF finishing, installation, and removal operations. The use of air showers (also known as a canopy air curtain or an overhead air supply island) involves positioning an air supply over the head of a worker to provide a flow of clean, filtered air to the worker's breathing zone [Volkwein et al. 1982, 1988]. Proper design and evaluation are critical for ensuring that filtration is adequate to remove airborne fibers from the air supply. Also, selection of the air supply flow rate is important to make sure that the velocity delivered to the worker's breathing zone is sufficient to overcome cross drafts and maintain a clean air flow.

9.2.1.2 Tool selection and modification

The RCFC has reported that using hand tools instead of powered tools can significantly reduce airborne concentrations of dust. However, hand tools often require additional physical effort and time, and they may increase the risk of musculoskeletal disorders. Employers should therefore use ergonomically correct tools and proper workstation design to avoid ergonomic hazards.

The additional physical effort required to use hand tools may also increase the rate and depth of breathing and may consequently affect the inhalation and deposition of fibers. For operations such as cutting, sawing, grinding, drilling, and sanding, the high level of mechanical energy applied to RCF products with power tools increases the potential for elevated concentrations of airborne fiber. Examples [Carborundum 1992] of how airborne fiber concentrations are affected by the equipment used to process RCF products include the following:

- A test of hand sawing versus the use of a powered jigsaw showed an 81% reduction in concentrations of airborne dust generated.
- A comparison of hand sanding versus power sanding showed a 90% reduction in concentrations of airborne dust generated.
- When a light water mist is applied to the surface of a vacuum-formed board before sanding, airborne dust concentration is reduced by 89% for hand sanding and 88% for powered sanding.
- The use of a cork bore (core drill) versus an electric drill with a twist bit for cutting holes in RCF product forms reduces airborne dust concentrations by about 85%.

9.2.1.3 Engineering controls for RCF finishing operations

Researchers at NIOSH have been working with industrial hygienists at RCFC member facilities to study the effectiveness of engineering controls designed and applied to RCF finishing operations. Because hand tools are not always a practical solution to manufacturing and end-use facilities requirements, engineering controls are being designed and evaluated for use with powered tools.

A joint project between NIOSH and RCFC was initiated in 1998 and involved investigating engineering controls for use with a pedestal belt/disc sander [Dunn et al. 2000, 2004]. These units are frequently used by the manufacturers as well as the customer facilities to produce vacuum-formed boards sized to the required dimensions. A continuous misting nozzle and simple local exhaust ventilation system were integrated for use on the pedestal sanding unit. The mister consisted of a standard atomization nozzle that was set for a low-water flow rate to

minimize part degradation. The local exhaust ventilation system used two hoods or pickup points with a total airflow of 700 ft^3/min.

During production of vacuum-formed boards, these two controls reduced fiber concentrations in the breathing zone as follows:

% decrease in airborne fibers:

Disc sanding using water mist 88

Disc sanding using local exhaust ventilation 99

Belt sanding using water mist 50

Belt sanding using local exhaust ventilation 99

These studies highlight the potential for significant reductions in worker exposure using well designed and maintained engineering controls, but their effectiveness needs to be validated in the field.

9.2.1.4 Wet methods for dust suppression

Fiber counts are lower in more humid atmospheres. Examples of using water to suppress dust concentrations are described as follows:

- At one RCF textile facility, misters have been added above broad looms and tape looms to decrease fiber concentrations.
- Water knives are high-pressure water jets that are used to cut and trim edges of RCF blanket while suppressing dust and limiting the generation of airborne fibers.
- During the installation of RCF modules in a furnace, a procedure called tamping is typically performed. After modules are put in place on the furnace wall, the modules are compressed by placing a 1-ft length of 2- by 4-ft lumber against the modules and tapping it lightly with a hammer. The process helps ensure that the RCF modules are installed tightly in place. When a light water spray is applied to the surface of the modules before tamping, airborne fiber concentration is reduced by about 75% [Carborundum 1993]. The water is applied with a garden-type sprayer that is set on mist using about 1 gal of water/100 ft^2 of surface area. However, caution is advised regarding the dampening of refractory-linings during installation. The introduction of water can damage refractory-lined equipment during heating with explosive spalling from the generation of steam.
- After-service RCF insulation removed from furnaces may be wetted to reduce the release of fibers.

9.2.1.5 Isolation

Some manufacturing processes may be enclosed to keep airborne fibers contained and separated from workers.

- When possible, isolate workers from direct contact with RCFs by using automated equipment operated from a closed control booth or room.
- Maintain the control room at greater air pressure than that surrounding the process equipment so that air flows out rather than in.
- Make sure workers take special precautions (such as using PPE) when they must enter the general work area to perform process checks, adjustments, maintenance, assembly-line tasks, and related operations.

9.2.2 Product Reformulation

One factor that contributes to the toxicity of an inhaled fiber is the durability of the fiber and its resistance to degradation in the respiratory tract. The chemical characteristics of RCFs make them one of the most durable types of SVFs. As a result, an inhaled RCF of specific dimensions will persist longer in the lungs. Modifying the physical characteristics of RCFs or reformulating their chemistry to produce less durable fibers are recommended options for reducing the hazard for exposed workers. Such an approach has been taken by one RCF manufacturer in developing two more soluble types of SVF [Maxim et al. 1999b]. However, caution is advised for developing and distributing such modified fibers. Possible adverse health effects of newly developed fibers should be evaluated before introducing them into commerce. Appropriate testing of these fibers should be performed to provide information about the fiber toxicology and potential adverse health effects associated with exposure to these fibers.

9.2.3 Work Practices and Hygiene

Use good work practices to help reduce exposure to airborne fibers. These practices include the following:

- Limit the use of power tools unless they are equipped with local exhaust or dust collection systems. When possible, use hand tools, which generate less dust and fewer airborne particles.
- Use HEPA-filtered vacuums, wet sweeping, or a properly enclosed wet vacuum system for cleaning up dust containing RCFs.
- During removal of RCF products, dampen insulation with a light water spray to keep fibers and dust from becoming airborne.
- Clean work areas regularly with HEPA-filtered vacuums or with wet sweeping methods to minimize the accumulation of debris.
- Limit access to areas where workers may be exposed to airborne RCFs: permit only workers who are essential to the process or operation.

Use good hygiene and sanitation to protect workers as well as people outside the workplace who might be contaminated with take-home dust and fibers:

- Do not allow workers to smoke, eat, or drink in work areas where they contact RCFs.
- If RCFs get on the skin, wash with warm water and mild soap.
- Apply skin moisturizing cream as needed to avoid dryness or irritation from repeated washing.
- Vacuum contaminated clothes with a HEPA-filtered vacuum before leaving the work area.
  - — Do not use compressed air to clean the work area or clothing.
  - — Do not shake clothes to remove dust.
- Do not wear contaminated clothes outside the work area. Instead, take the following measures to prevent taking contaminants home:
  - — Change into street clothes before going home.
  - — Leave contaminated clothes at the workplace to be laundered by the employer.

— Store street clothes in separate areas of the workplace to keep from contaminating them.

- Provide workers with showers and have them shower before leaving work.
- Prohibit removal of contaminated clothes or other items from the workplace [NIOSH 1995b].

9.2.4 Personal Protective Equipment

Wear long sleeves, gloves, and eye protection when performing dusty activities involving RCFs.

9.2.5 Respiratory Protection

NIOSH recommends using a respirator for any task involving RCF exposures that are unknown or have been documented to be higher than the NIOSH REL of 0.5 f/cm^3 (TWA). Respirators should not be used as the primary means of controlling worker exposures. Instead, NIOSH recommends using other exposure-reduction methods, such as product substitution, engineering controls, and changes in work practices. However, respirators may be necessary when available engineering controls and work practices do not adequately control worker exposures below the REL for RCFs. NIOSH recognizes this control to be a particular challenge in the finishing stages of RCF product manufacturing as well as during the installation and removal of RCF insulation materials.

If respiratory protection is needed, the employer should establish a comprehensive respiratory protection program as described in the OSHA respiratory protection standard [29 CFR 1910.134]. Elements of a respiratory protection program should be established and described in a written plan that is specific to the workplace. This respirator program must include the following:

- Procedures for selecting respirators
- Medical evaluations of workers required to wear respirators
- Fit testing procedures
- Routine use procedures and emergency respirator use procedures
- Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and maintaining respirators
- Procedures for ensuring adequate air quality for supplied-air respirators
- Training in respiratory hazards
- Training in the proper use and maintenance of respirators
- Program evaluation procedures
- Procedures for ensuring that workers who voluntarily wear respirators (excluding filtering facepiece respirators known as dust masks) comply with the medical evaluation and cleaning, storing, and maintenance requirements contained in Appendix D of the OSHA respiratory protection standard
- A designated program administrator who is qualified to administer the respiratory protection program

The written respiratory protection program should be updated as necessary to account for changes in the workplace that affect respirator use. All equipment, training, and medical evaluations required under the respiratory protection program should be provided at no cost to workers. Workers should use only respirators that have been certified by NIOSH [2002].

When airborne RCF concentrations exceed the REL, NIOSH recommends the following respiratory protection:

- At a minimum, use a half-mask, air-purifying respirator equipped with a 100 series particulate filter (this respirator has an assigned protection factor (APF) of 10.

- For a higher level of protection and for prevention of facial or eye irritation, use a full-facepiece, air-purifying respirator (equipped with a 100 series filter) or any powered, air-purifying respirator equipped with a tight-fitting full facepiece.

- For greater respiratory protection when the work involves potentially high airborne fiber concentrations (such as removal of after-service RCF insulation such as furnace insulation), use a supplied-air respirator equipped with a full facepiece, since airborne exposure to RCFs can be high and unpredictable.

A comprehensive assessment of workplace exposures should always be performed to determine the presence of other possible contaminants (such as silica) and to ensure that the proper respiratory protection is used. Table 9–1 provides additional guidance for selecting appropriate respiratory protection with regard to airborne fiber concentrations and the NIOSH REL for RCFs.

Workers may voluntarily choose to use respiratory protection even when airborne fiber concentrations are below the NIOSH REL or other applicable Federal or State standards. When respirators are used voluntarily by workers, employers need to establish only those respiratory protection program elements necessary to assure that the respirator itself is not a hazard [29 CFR 1910.134]. The exception is that filtering-facepiece respirators (for example, any 95 or 100 series filter) can be used without a respirator protection program when they are used voluntarily.

For information and assistance in establishing a respiratory protection program and selecting appropriate respirators, see the OSHA Respiratory Protection Advisor on the OSHA Web site at http://www.osha.gov. Additional information is available from the *NIOSH Respirator Selection Logic* [NIOSH 2004] document at http://www.cdc.gov/niosh/docs/2005–100 and the *NIOSH Guide to the Selection and Use of Particulate Respirators Certified under 42 CFR 84* [NIOSH 1996].

9.3 Exposure Monitoring

9.3.1 Workplace Exposure Monitoring Program

The workplace exposure monitoring program for worksites where RCFs or RCF products are manufactured, handled, or used should include routine environmental and personal monitoring of airborne fiber concentrations. The monitoring strategy should be designed to assess the effectiveness of engineering controls, work practices, PPE, training, and other factors in controlling airborne fiber concentrations. The monitoring program should also be used to identify areas or tasks that are associated with higher exposures to RCFs and that therefore require additional efforts to reduce them.

The goal of an RCF exposure monitoring program is to ensure a more healthful work environment where worker exposure (measured by full-shift samples) does not exceed the REL. Because adverse respiratory health effects can occur at the REL for RCFs, achieving lower concentrations is desirable whenever possible. For work involving potential

Table 9–1. Respiratory protection for exposure to RCFs*

Airborne concentration of RCFs or conditions of use	Minimum respiratory protection options
≤5.0 f/cm^3 (10 × REL)	Any air-purifying, elastomeric half-mask respirator equipped with a 100 series (N†, R, or P) filter‡
	Any negative pressure (demand), suppled-air respirator equipped with a half mask
≤12.5 f/cm^3 (25 × REL)	Any powered, air-purifying respirator equipped with a hood or helmet and a high-efficiency particulate air filter (HEPA filter)
	Any continuous-flow, supplied-air respirator equipped with a hood or helmet
≤25 f/cm^3 (50 × REL)	Any air-purifying, full-facepiece respirator equipped with a 100 series (N†, R, or P) filter‡
	Any powered, air-purifying respirator equipped with a tight-fitting facepiece (half or full facepiece) and a HEPA filter
	Any negative pressure (demand), supplied-air respirator equipped with a full facepiece
	Any continuous flow, supplied-air respirator equipped with a tight-fitting facepiece (half or full facepiece)
	Any negative pressure (demand), self-contained respirator equipped with a full facepiece
≤500 f/cm^3 (1,000 × REL)	Any pressure demand, supplied-air respirator equipped with a half-mask

*Abbreviations: APFs=assigned protection factors; HEPA=high-efficiency particulate air; NIOSH=National Institue for Occupational Safety and Health; RCFs=refractory ceramic fibers.
†N-100 series particulate filters should not be used in environments where there is potential for exposure to oil mists.
‡Assigned protection factors (APFs) for other half-mask and full-facepiece particulate respirators certified under 42 CFR Part 84 are being studied by NIOSH. Recommended APFs for these respirators will be revised accordingly.

exposure to airborne RCFs, perform the exposure sampling survey as follows:

- Collect representative personal samples for the entire work shift using NIOSH Method 7400 (B rules) [NIOSH 1977a, 1998].
- Perform periodic sampling at least annually and whenever any major process change takes place or another reason exists to suspect that exposure concentrations may have changed.
- Collect all routine personal samples in the breathing zones of the workers.
- For workers exposed to concentrations above the REL, perform more frequent exposure monitoring until at least two consecutive samples indicate that the worker's exposures no longer exceed the REL.
- Notify all workers about monitoring results and any actions taken to reduce their exposures.
- Make sure that any sampling strategy considers variations in work and production schedules as well as the inherent exposure variability in most workplaces [NIOSH 1995a].

9.3.2 Action Level

NIOSH has recommended an action level (AL) of 0.25 f/cm^3 for determining when additional controls are needed or when administrative actions should be taken to reduce RCF exposures. The purpose of the AL is to indicate when worker exposures to RCFs may be approaching the REL. Measurement of exposure concentrations at or above the AL indicate that there is a high degree of certainty that RCF concentrations exceed the REL. The AL is a statistically derived concept permitting the employer to have confidence (for example, 95%) that if the measured exposure concentration is below the AL, only a small probability exists that the exposure concentration is above the REL. NIOSH has concluded that the use of an AL permits employers to monitor RCF exposures in the workplace without devoting unnecessary resources to conducting daily exposure measurements. The AL concept has served as the basis for defining the elements of an occupational standard in NIOSH criteria documents and in comprehensive standards promulgated by OSHA and MSHA. Employers should determine whether the use of an AL of 0.25 f/cm^3 provides adequate assurance that worker exposures are being maintained below the REL. In some work environments, the high degree of exposure variability for certain job tasks may require a lower AL to assure that exposures are being maintained below the REL. Similar exposure monitoring strategies have been espoused by the American Industrial Hygiene Association, which recommends that if measured exposures are less than 10% of the designated exposure limit (for example, REL or PEL), there is a high degree of certainty that the exposure limit will not be exceeded.

9.3.3 Sampling Strategies

When sampling to determine whether worker exposures are below the REL, a focused sampling strategy may be more practical than random sampling. A focused sampling strategy targets workers perceived to have the highest exposure concentrations [Leidel and Busch 1994]. A focused strategy is most efficient for identifying exposures above the REL if maximum-risk workers and time periods are accurately identified. Focused sampling may help identify short-duration tasks involving high airborne fiber concentrations that could result in elevated exposures over a full work shift.

Sampling strategies such as those used by Corn and Esmen [1979], Rice et al. [1997], and Maxim et al. [1997] have been derived and used in RCF manufacturing facilities to monitor airborne fiber concentrations by selecting representative workers for sampling. The representative workers are grouped according to dust zones, uniform job titles, or functional job categories. These approaches are intended to reduce the number of required samples while increasing the confidence of identifying workers at similar risk.

Area sampling may also be useful in exposure monitoring for determining sources of airborne RCF exposures and assessing the effectiveness of engineering controls.

9.4 Medical Monitoring

NIOSH recommends periodic medical evaluation, or medical monitoring, of RCF-exposed workers to identify potential health effects and symptoms that may be related to contact with airborne fibers. The following sections describe the objectives of medical monitoring and the elements of a medical monitoring program for workers exposed to RCFs.

The primary goals of a workplace medical monitoring program are (1) early identification of adverse health effects that may be related to exposures at work and (2) possible health trends within groups of exposed workers. These goals are based on the premise that early detection, subsequent treatment, and workplace interventions will ensure the continued health of the affected workforce.

9.4.1 Objectives of Medical Monitoring

Medical monitoring and resulting interventions represent secondary prevention and should not replace primary prevention efforts to minimize worker exposures to RCFs. In the case of RCFs, medical monitoring is especially important because achieving compliance with the REL of 0.5 f/cm^3 does not assure that all workers will be free from the risk of respiratory irritation or chronic respiratory disease caused by occupational exposure. Early identification of respiratory system changes and symptoms associated with RCF exposures (such as decreased pulmonary function, irritation, dyspnea, chronic cough, wheezing, and pleural plaques) may signal the need for more intensive medical monitoring and the assessment of existing controls to minimize the risk of long-term adverse health effects. An ongoing medical monitoring program also serves to inform workers of potential health risks and promotes an understanding of the need for and support of exposure control activities.

A medical monitoring program serves as an effective secondary prevention method on two levels—screening and surveillance. Medical screening in the workplace focuses on the early detection of health outcomes for individual workers and may involve an occupational history, medical examination, and application of specific medical tests to detect the presence of toxicants or early pathologic changes before the worker would normally seek clinical care for symptomatic disease. By contrast, medical surveillance (described in Section 9.5) involves the ongoing evaluation of the health status of a group of workers through the collection and aggregate analysis of health data for the purpose of preventing disease and evaluating the effectiveness of intervention programs.

9.4.2 Criteria for Medical Screening

To determine whether tests or procedures for medical screening are appropriate and relevant to a given hazard (in this case, exposure to airborne RCFs), the following factors should be considered:

- Prevalence of an associated disease or symptoms in the population
- Risk of toxicity associated with the exposure
- Consequences of false positive test results
- Sensitivity, specificity, and predictive value of the screening test(s) to be used
- Reliability and validity of the screening test(s)
- Ability of the screening test(s) to identify disease early so that effective treatment or intervention may be used to impede disease progression
- Availability, accessibility, and acceptability of followup, further diagnostic tests, and effective management of the disease
- Benefits of the screening program compared with the costs [Wagner 1996].

On the basis of these criteria, NIOSH recommends a medical screening program for RCF-exposed workers that require initial and periodic medical examinations. The elements of the program should include a physical examination, occupational history, respiratory symptom questionnaire, spirometric testing, and chest radiograph when warranted. If a particular medical screening test indicates the presence of exposure-related disease or the increased probability that disease will develop, further evaluation and diagnostic testing may be needed. Recommended guidelines and schedules for specific medical tests are described in Section 9.4.5 (Recommended Program Elements).

9.4.3 Worker Participation

All workers potentially exposed to RCFs, in both manufacturing and end-use industries, may benefit by being included in an occupational medical monitoring program. Workers should be provided with information about the purposes of medical monitoring, the health benefits of the program, and the procedures involved. The following hierarchy describes workers who should be included in a medical monitoring program and who could receive the greatest benefit from medical screening:

- Workers exposed to elevated fiber concentrations (for example, all workers exposed to airborne RCFs at concentrations above the AL of 0.25 f/cm^3 [described in Section 9.3])
- Workers in areas or in jobs and activities in which, regardless of airborne fiber concentration, one or more workers have recently developed symptoms or respiratory changes apparently related to RCF exposure
- Workers who may have been previously exposed to asbestos or other respiratory hazards that place them at an increased risk of respiratory disease
- Workers with potential exposure to airborne RCFs who also smoke cigarettes or other tobacco products (see Section 9.6, Smoking Cessation).

9.4.4 Medical Monitoring Program Director

Oversight of the medical monitoring program should be assigned by the employer to a qualified physician or other qualified health care provider (as determined by appropriate State laws and regulations) who is informed and knowledgeable about the following:

- The administration and management of a medical monitoring program for occupational hazards

- The establishment of a respiratory protection program based on an understanding of the requirements of the OSHA respiratory protection standard and types of respiratory protection devices available at the workplace
- The identification and management of work-related respiratory effects or illnesses
- The identification and management of work-related skin diseases

9.4.5 Recommended Program Elements

Recommended elements of a medical monitoring program for workers exposed to RCFs include provisions for an initial medical examination and periodic medical examinations at regularly scheduled intervals. Depending on the findings from these examinations, more frequent and detailed medical examinations may be necessary. Worker education should also be included as a component of the medical monitoring program. Specific elements of the examinations and scheduling are described below and illustrated in the flow chart diagram in Figure 9–1.

9.4.5.1 Initial medical examination

An initial (baseline) examination should be performed as near as possible to the date of beginning employment (within 3 months). The initial medical examination should include the following:

- A physical examination of all systems, with emphasis on the respiratory system and the skin
- A spirometric test (Anyone administering spirometric testing as part of the medical monitoring program should have completed a NIOSH-approved training course in spirometry or other equivalent training.)
- A chest X-ray (All chest X-ray films should be interpreted by a NIOSH-certified B reader using the standard International Classification of Radiographs of Pneumoconioses [ILO 2000 or the most recent equivalent].)
- Other medical tests as deemed appropriate by the attending health care professional
- A standardized respiratory symptom questionnaire such as the American Thoracic Society Respiratory Questionnaire [Ferris 1978 or the most recent equivalent] with additional questions to address symptoms of pleuritic chest pain and pleurisy
- A standardized occupational history questionnaire that gathers (1) information about all past jobs (with special emphasis on those with potential exposure to dust), (2) a description of all duties and potential exposures for each job, and (3) a description of all protective equipment the worker has used

9.4.5.2 Periodic medical examinations

Periodic examinations (including a physical examination of the respiratory system and the skin, spirometric testing, a respiratory symptom update questionnaire, and an occupational history update questionnaire) should be administered at regular intervals determined by the medical monitoring program director. The frequency of the periodic medical examinations should be determined according to the following guidelines:

- For workers with fewer than 10 years since first exposure to RCFs, periodic examinations should be conducted at least once every 5 years.

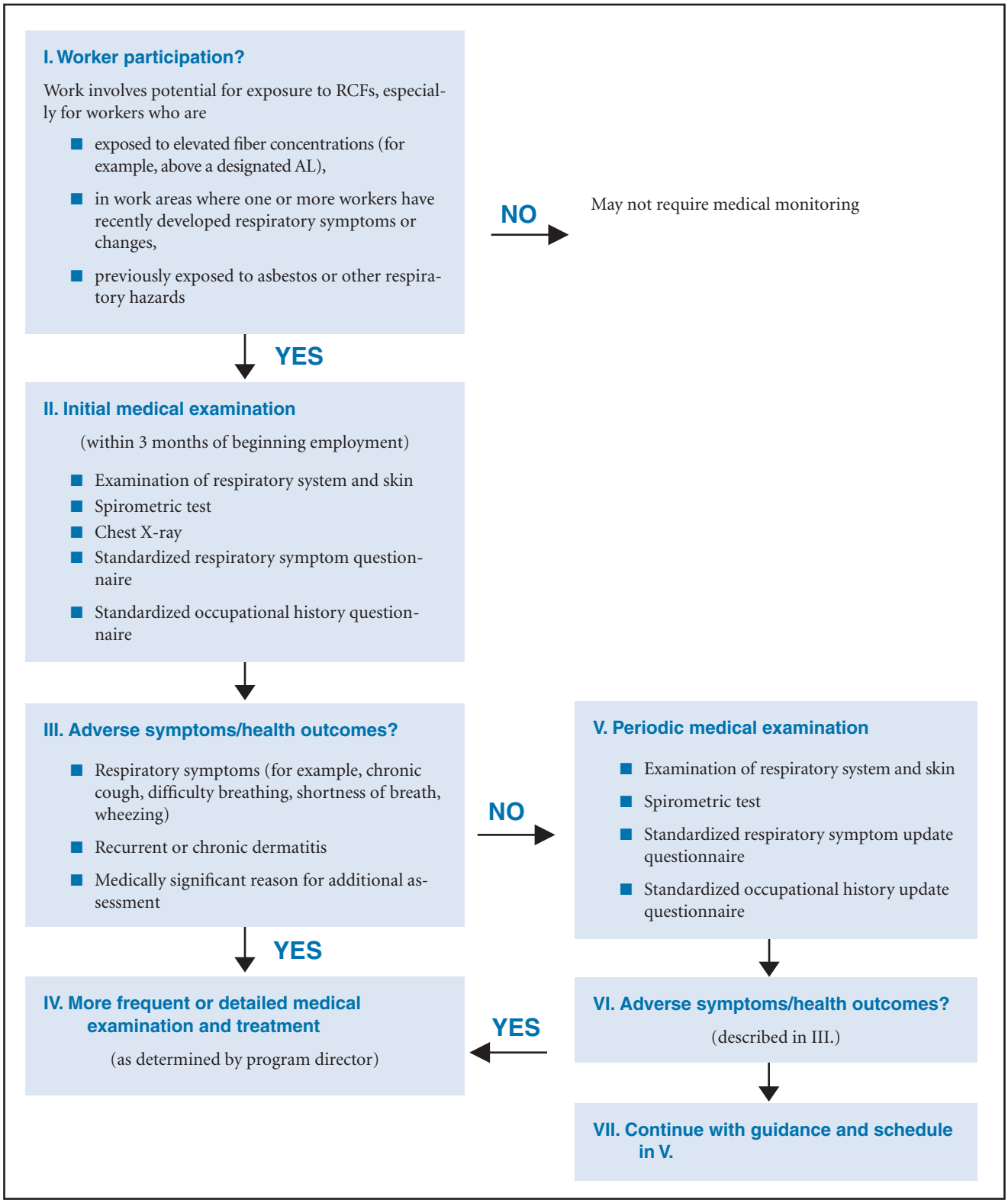

Figure 9–1. Flow chart of medical monitoring guidelines for workers exposed to RCFs. This flow chart is intended as a simplified representation of the minimum requirements of the recommended medical monitoring program guidelines. Administration and management of the program should ultimately rely on the judgment of the medical monitoring program director. Frequency of periodic medical examinations are as follows:

- If time since first RCF exposure is <10 years, examinations should be conducted at least every 5 years.
- If time since first RCF exposure is ≥10 years, then examinations should be conducted at least every 2 years.

- For workers with 10 or more years since first exposure to RCFs, periodic examinations should be conducted at least once every 2 years.

A chest X-ray and spirometric testing are important upon initial examination and may also be appropriate medical screening tests during periodic examinations for detecting respiratory system changes—especially in workers with more than 10 years since first exposure to RCFs. The value of periodic chest X-rays in a medical monitoring program should be evaluated by a qualified health care provider in consultation with the worker to assess whether the benefits of testing warrant the additional exposure to radiation. As with the frequency of periodic examinations, the utility of the chest X-ray as a medical test becomes greater for workers with more than 10 years since first exposure to RCFs (based on the latency period between first exposure and appearance of noticeable respiratory system changes). Because persons with advanced fiber-related pleural changes experience difficulty in breathing as the parietal and visceral surfaces become adherent and lose flexibility, it may prove beneficial to detect fibrotic changes in the early stages so steps may be taken to prevent further lung damage. Similar recommendations have been made for asbestos-exposed workers diagnosed with pleural fibrosis or pleural plaques to prevent more serious types of respiratory disease [Balmes 1990].

9.4.5.3 More frequent medical examinations

Any worker should undergo more frequent and detailed medical evaluation if he or she has any of the following indications:

- New or worsening respiratory symptoms or findings (for example, chronic cough, difficulty breathing, wheezing, reduced lung function, or radiographic evidence of pleural plaques or fibrosis)
- History of exposure to other respiratory hazards (for example, asbestos)
- Recurrent or chronic dermatitis
- Other medically significant reason(s) for more detailed assessment

9.4.5.4 Worker education

Workers should be provided with sufficient training to recognize symptoms associated with RCF exposures (such as chronic cough, difficulty breathing, wheezing, and skin irritation). Workers should also be instructed to report these symptoms to designated safety and health personnel and a physician or other qualified health care provider for appropriate diagnosis and treatment.

9.4.6 Written Reports to the Worker

Following initial and periodic medical examinations, the physician or other qualified health care provider should provide each worker with a written report containing the following:

- Results of any medical tests performed on the worker
- Medical opinion in plain language about any medical condition that would increase the worker's risk of impairment from exposure to airborne RCFs
- Recommendations for limiting the worker's exposure to RCFs, which may include the use of appropriate PPE, as warranted
- Recommendations for further evaluation and treatment of medical conditions detected

9.4.7 Written Reports to the Employer

Following initial and periodic medical examinations, the physician or other qualified health care provider should provide a written report to the employer containing the following:

- Occupationally pertinent results of the medical evaluation
- A medical opinion about any medical condition that would increase the worker's risk of impairment from exposure to airborne RCFs
- Recommendations for limiting the worker's exposure to RCFs (or other agents in the workplace), which may include the use of appropriate PPE or reassignment to another job, as warranted
- A statement to indicate that the worker has been informed about results of the medical examination and about the medical condition(s) that should have further evaluation or treatment

Findings, test results, or diagnoses that have no bearing on the worker's ability to work with RCFs should not be included in the report to the employer. Safeguards to protect the confidentiality of the worker's medical records should be enforced in accordance with all applicable regulations and guidelines.

9.4.8 Employer Actions

The employer should assure that the qualified health care provider's recommended restrictions of a worker's exposure to RCFs or to other workplace hazards are followed and that the REL for RCFs is not exceeded without requiring the use of PPE. Efforts to encourage worker participation in the medical monitoring program and to report symptoms promptly to the program director are essential for the program's success. Medical evaluations performed as part of the medical monitoring program should be provided by the employer at no cost to the participating workers. If the recommended restrictions determined by the medical program director include job reassignment, such reassignment should be implemented with the assurance of economic protection for the worker. When medical removal or job reassignment is indicated, the affected worker should not suffer loss of wages, benefits, or seniority.

The employer should ensure that the medical monitoring program director communicates regularly with the employer's safety and health personnel (such as industrial hygienists), employee representatives, and safety and health committees to identify work areas that may require evaluation and implementation of control measures to minimize the risk from exposure to hazards.

9.5 Surveillance of Health Outcomes

Standardized medical screening data should be periodically aggregated and evaluated by an epidemiologist or other knowledgeable person to identify patterns of worker health that may be linked to work activities and practices that require additional primary prevention efforts. Routine aggregate assessments of medical screening data should be used in combination with evaluations of exposure monitoring data to identify changes needed in work areas or exposure conditions.

One example of surveillance using analyses of medical screening data is the ongoing epidemiologic study of RCF workers described in the RCFC product stewardship plan referred to as PSP 2000 [RCFC 2001]. Elements of this plan may be adapted and modified by other employers to develop medical surveillance programs for workers who are potentially exposed to RCFs.

9.6 Smoking Cessation

NIOSH recognizes a synergistic effect between exposure to RCFs and cigarette smoking that increases the risk of adverse respiratory health effects. The combined effects of smoking and dust exposures have been recognized as contributing to the increased risk of respiratory diseases, including chronic bronchitis, emphysema, and lung cancer. NIOSH urges employers to establish smoking cessation programs that (1) inform workers about the increased hazards of cigarette smoking and exposure to RCFs and (2) provide assistance and encouragement for workers who want to quit smoking. NIOSH recommends that all workers who are potentially exposed to airborne RCF fibers and who also smoke should participate in a smoking cessation program. With regard to smoking in the workplace, NIOSH recommends that employers do the following:

- Prohibit workers from smoking in the workplace.
- Disseminate information about health promotion and the harmful effects of smoking.
- Offer smoking cessation programs to workers at no cost to participants.
- Collect detailed smoking histories as part of the medical monitoring program.
- Use training, employee assistance programs, or health education campaigns to encourage activities promoting physical fitness and other healthy lifestyle practices that affect respiratory and cardiovascular health.