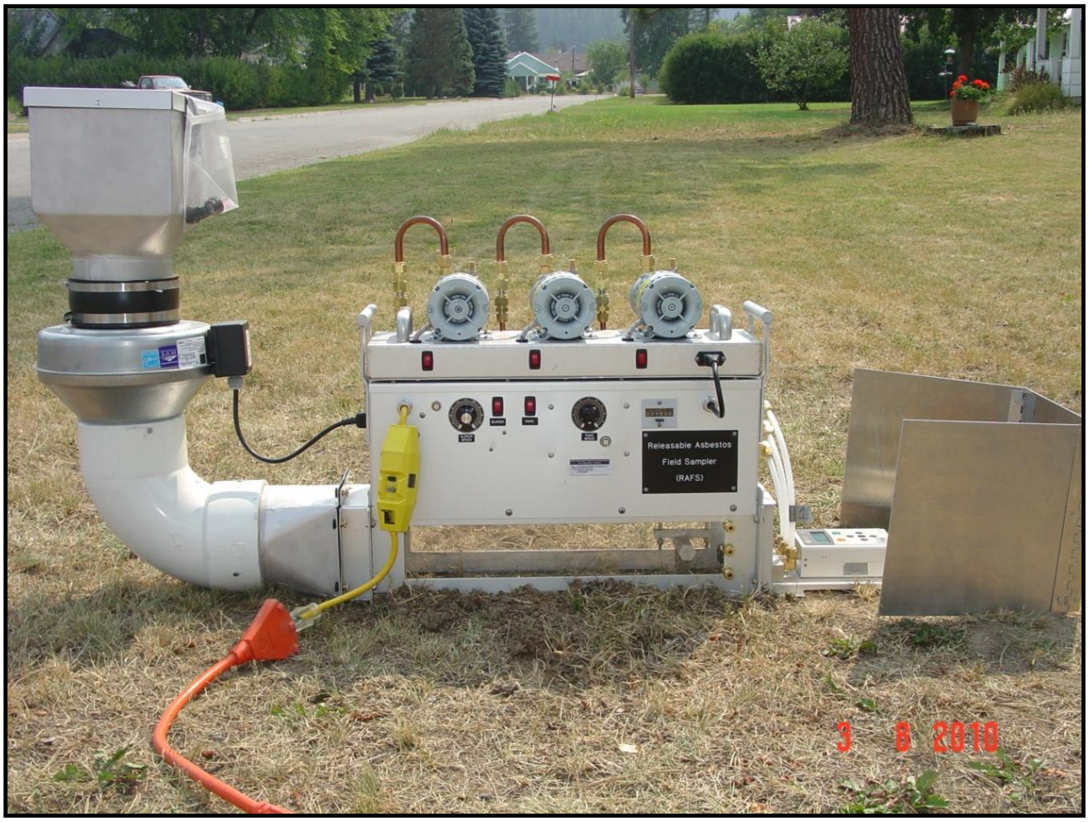
Releasable Asbestos Field Sampler (RAFS) Operation Manual



Releasable Asbestos Field Sampler (RAFS) Operation Manual

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1 RAFS Overview

1.1 Description

The Releasable Asbestos Field Sampler (RAFS)[1] is a field instrument that provides an *in-situ* measurement of asbestos releasability from consistent and reproducible mechanical agitation of the source material such as soil. The RAFS was designed to measure concentration (asbestos structures per cubic centimeter of air) and an emission rate (asbestos structures per second) from soil. The RAFS operates *in situ* under actual soil conditions with representative moisture content and grain size. Kominsky et al. (2010) describes the development and field validation of the RAFS.[(1)]

RAFS utilizes a raking motion to provide the energy that releases particulate material from the soil and aerosolizes the asbestos fibers. A gentle airflow transports the generated aerosol laterally inside a tunnel to one end where filter sampling cassettes or real-time instruments are used to measure asbestos and particulate release.

The RAFS operates as a semi-autonomous instrument with operator-controlled set points such as speed of the raking mechanism and air velocity through the wind tunnel. These set points can be adjusted and optimized by the operator for use in a variety of conditions.

1.2 Theory of Operation

The RAFS consists of a variable-speed HEPA-filtered fan attached to a tunnel (6-inches by 6-inches by 24-inches) with an open bottom for exposure to the test matrix soil (Figures 1 and 2). The fan discharges the air at the tunnel inlet through diffusers to evenly distribute the airflow (Figure 3). A variable-speed motorized rake mechanism inside the tunnel provides consistent and reproducible agitation of the top ½ inch of soil (Figure 4). The rake mechanism has 10 tines that oscillate slightly as it traverses the tunnel back and forth to agitate the soil to aerosolize the asbestos fibers. An attachment at the tunnel exit can support up to three 25-mm-diameter mixed-cellulose ester (MCE) membrane filter cassettes with 50-mm electrically conductive extension cowls for asbestos collection and analysis using direct-transfer transmission electron microscopy (TEM), as well as serves as a platform for positioning an optical particle counter (Figure 5). This aspect of the RAFS design permits collection of concurrent filter samples for different sampling periods with resultant varied air volumes to ensure that a sample is obtained with an acceptable particulate loading for analysis using direct-transfer TEM. A typical sampling period ranges from 10 to 60 minutes, depending on the filter particulate loading.

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1 U.S. Patent No. 7,758, 812 (July 20, 2010), Environmental Quality Management, Inc., 1800 Carillon Boulevard, Cincinnati, OH 45240.

Each filter assembly is attached with rubber and copper tubing to an electric-powered (110-volt alternating current) 1/10-hp vacuum pump operating at an airflow rate of approximately 13.5 liters per minute (lpm). Each pump is equipped with a flow-control critical orifice that maintains the flow rate at approximately 13.5 lpm.

The RAFS collects anisokinetic samples where the freestream velocity is greater than the sample velocity. Anisokinetic sampling does not introduce a positive bias to the measured asbestos concentration because the Stokes number for the aerosolized asbestos fibers is less than 0.01. Under these conditions, inertia effects are negligible and the freestream to sample concentration ratio is unity.(2)

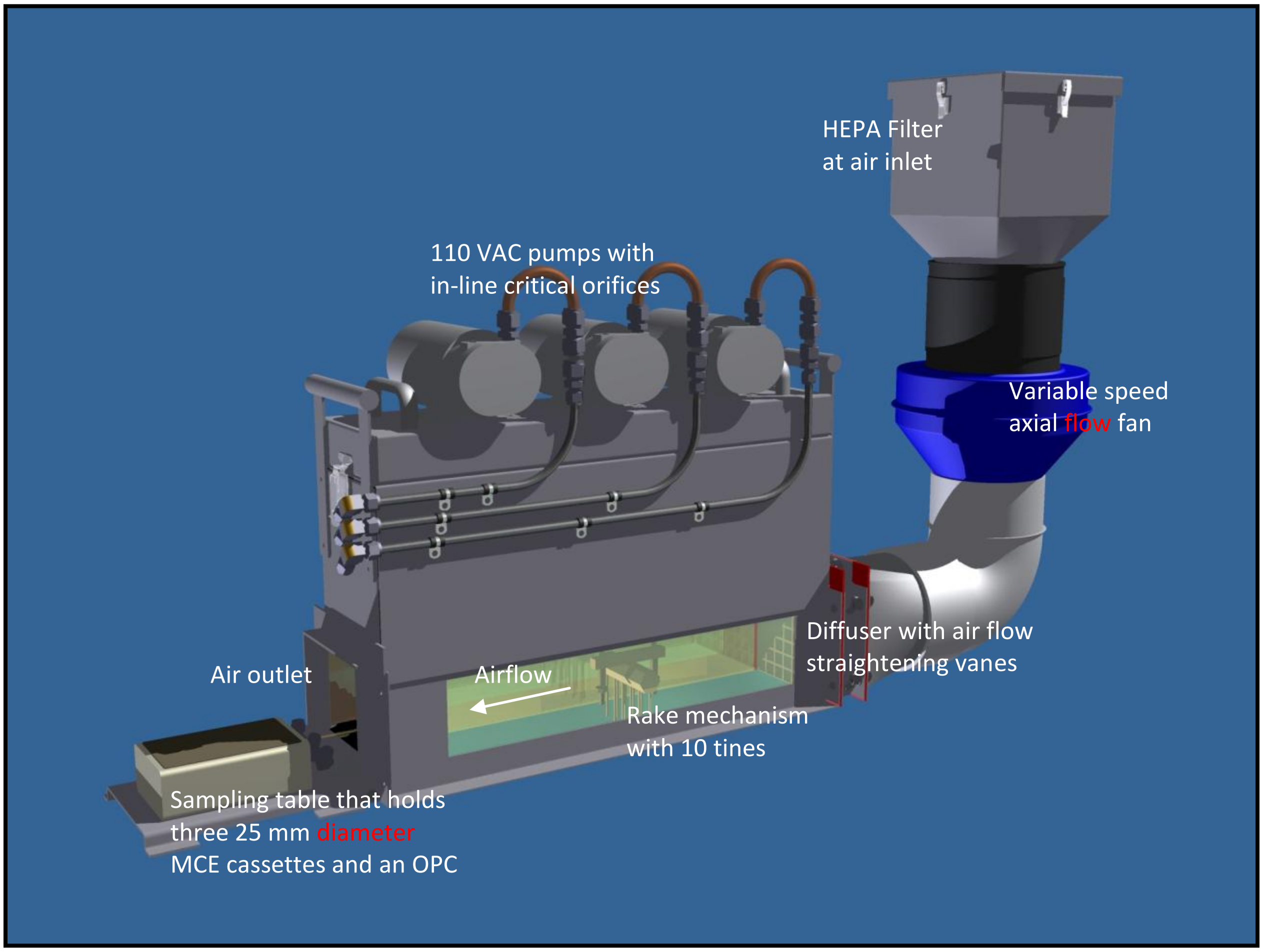


Figure 1. Schematic of the RAFS.

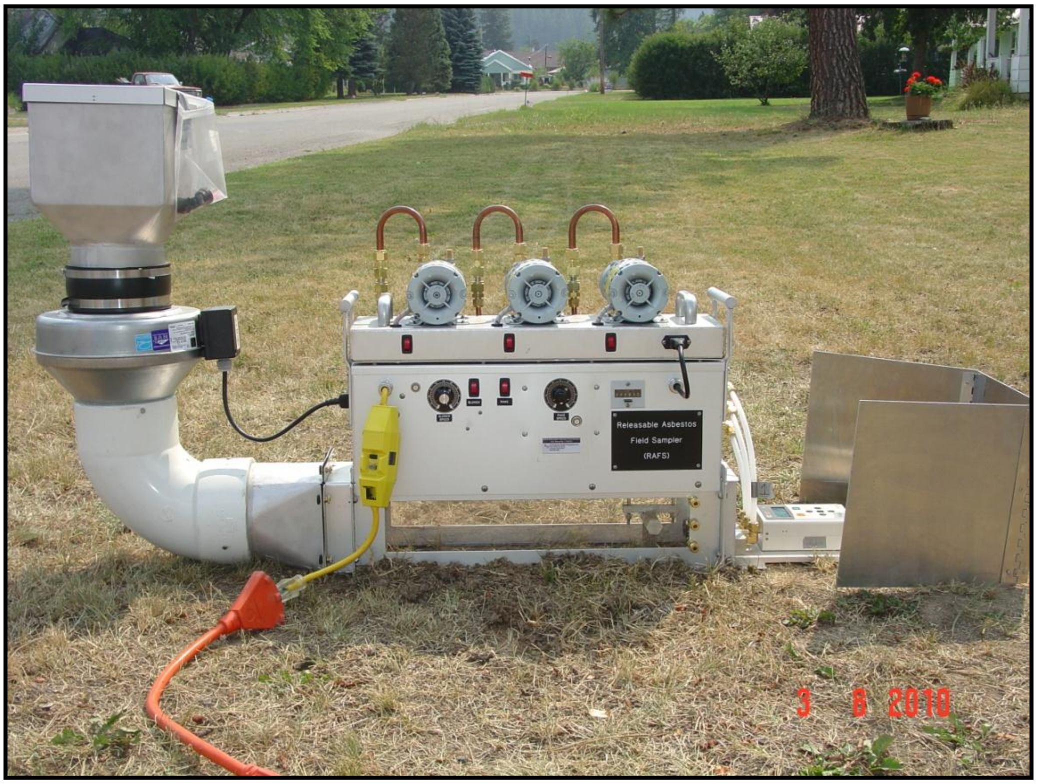


Figure 2. RAFS at Field Evaluation Site.

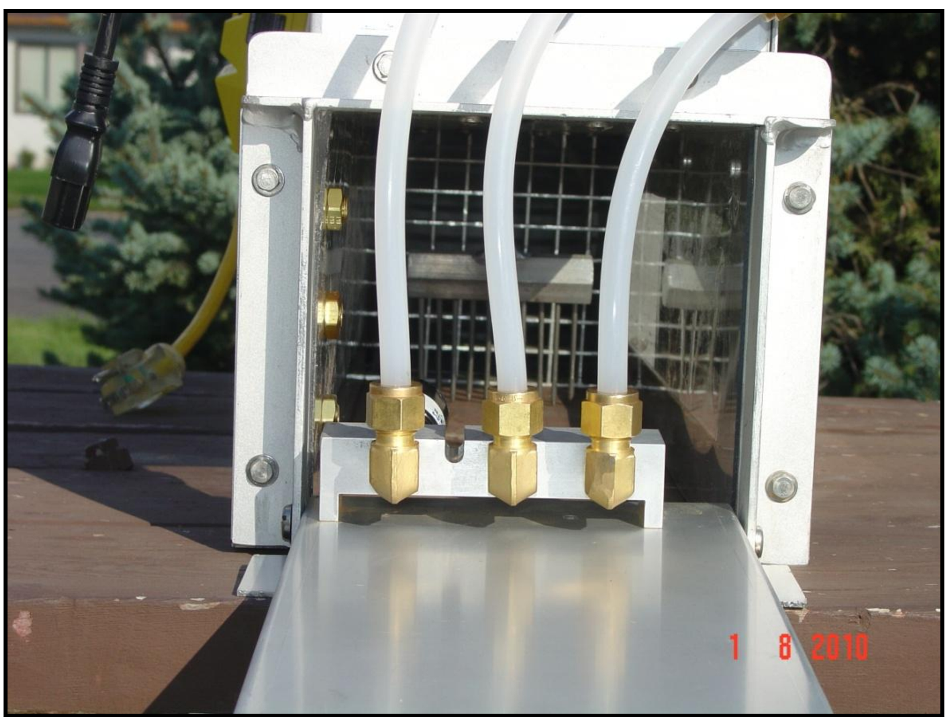
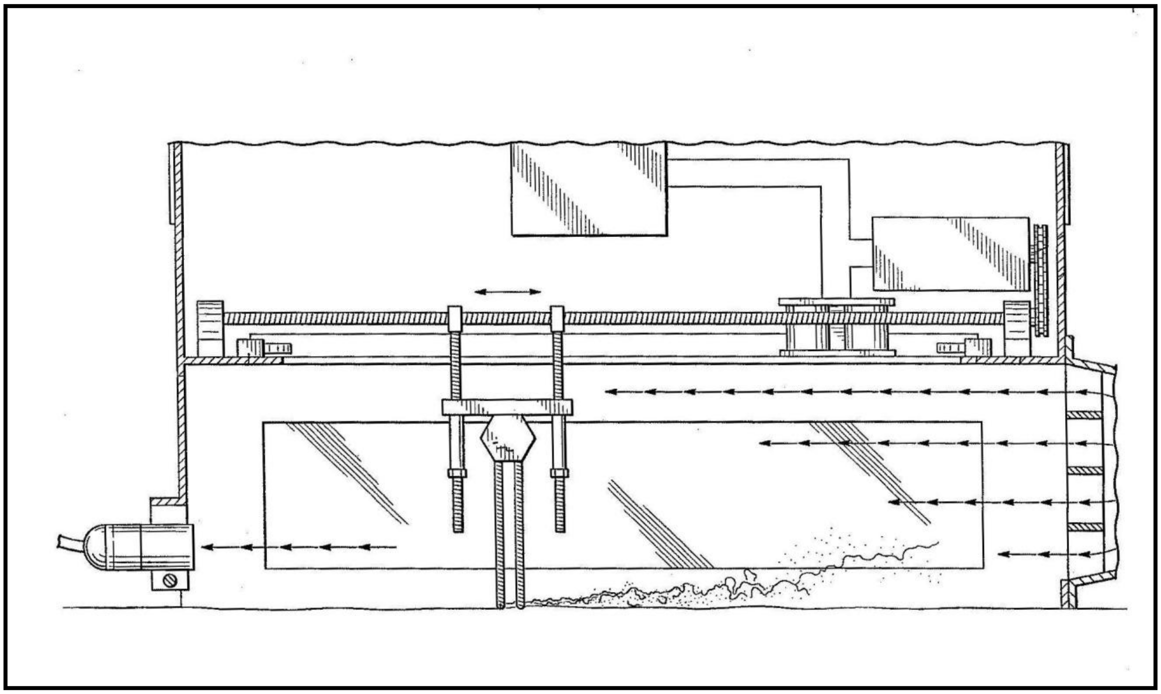


Figure 3. Air flow diffuser at tunnel inlet and filter cassette-mounting assembly at tunnel outlet.



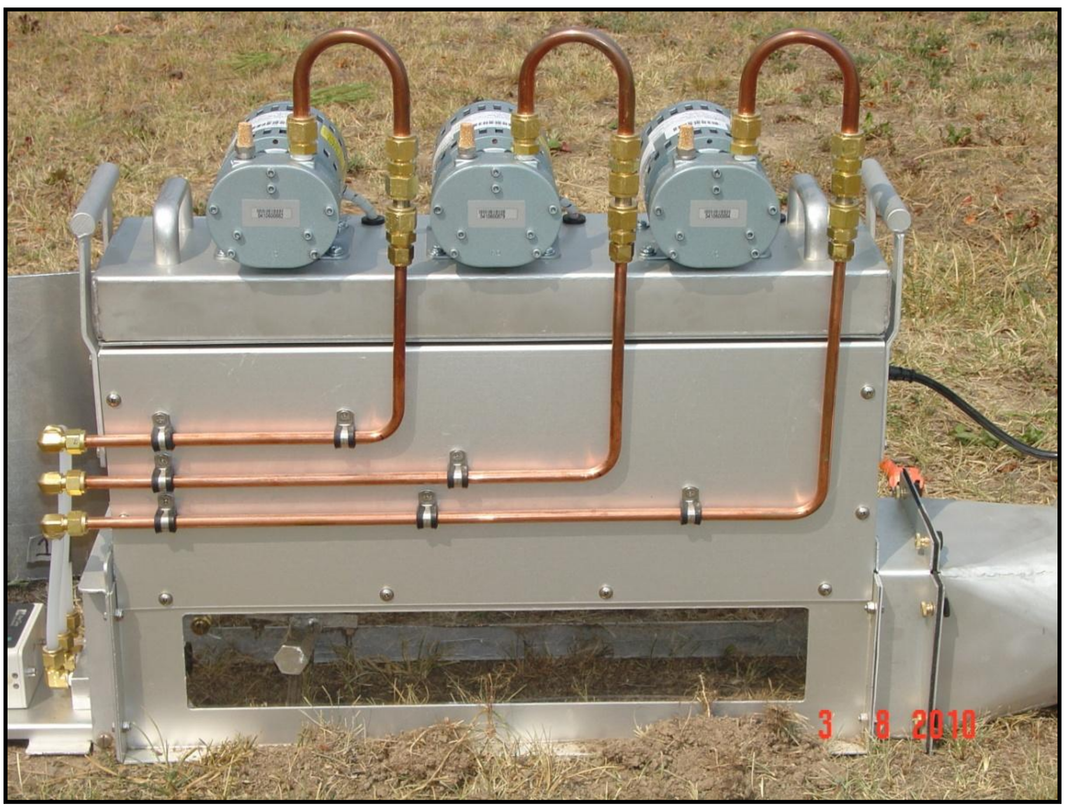


Figure 4. Side view of RAFS showing traverse path of raking mechanism.

Figure 5. Filter cassette mounting holder and optical particle counter platform at tunnel exit.

1.3 Safety

Inhalation of any type of asbestos will increase the risk of lung cancer, mesothelioma, and non-malignant lung and pleural disorders including asbestosis, pleural plaques, pleural thickening, and pleural effusions. Exercise sufficient precautions to avoid inhalation exposures when handling materials suspected of containing asbestos such as soil. Avoid generating dust during cleaning of the wind tunnel. Use of pressurized air duster or dry wiping may generate airborne asbestos fibers. The surfaces should be damp wiped using a lint free cloth moistened with a standard all-purpose surface cleaner. Exercise sufficient precautions to prevent potential electrical hazards associated the 110-VAC power cords. Operators should strictly follow the site-specific Health and Safety Plan. If a Health and Safety Plan is not available, consult an American Board of Industrial Hygiene (ABIH) certified industrial hygienist to identify the personal protective equipment that should be used.

2 Unpacking Instructions

2.1 Unpacking

Before removing any RAFS components from the carrying cases (Figure 6), the arrangement of the various items should be noted, so that repacking can be done easily. To prevent damage to the RAFS, use the handles at each end of the RAFS main body when carrying the instrument. The main body is constructed of lightweight aluminum with clear-plastic side panels and is susceptible to damage.

Figure 6. RAFS components in packing cases.

2.2 Packing Inventory

Table 1 lists the main components of the RAFS. Refer to Figures 1 and 2 for an explanation and diagram of each item in Table 1. Table 2 lists the RAFS auxiliary equipment. Figure 7 shows examples of the auxiliary equipment. Other manufacturers produce equivalent equipment; the user should decide what manufacturer and instrument model is best for their needs. Of the equipment listed in Table 2, only the meteorological station and the optical particle counter are considered optional. The meteorological station and particle counter are not required if the RAFS is to be used independently; if RAFS releasability data are to be compared with activity-based sampling data, the both instruments are highly recommended. Table 3 lists the filters and the specific accessories required to run each test. Example data collection forms are located in Appendix A. The user should create labels and forms to suit their specific needs.

Table 1. Main Components of the RAFS (see Figures 1 and 2)

Quantity	Description
1	RAFS assembly (control panel, wind tunnel, raking mechanism, air flow diffuser, and filter cassette holder and platform).
1	Axial flow fan and 90^{o} supply air duct.
1	HEPA filter with rubber connection assembly.
3	110-VAC rotary vane, pulsation-free oiless vacuum pump (1.1 cfm free air flow, 20” Hg max vacuum, 10 psi max pressure.
3	1.4 mm orifices (“A”) to provide 13.5 Lpm at altitudes less than 2650 feet.
3	1.5 mm orifices (“B”) to provide 13.5 Lpm at altitudes between 2650 and 6900 feet.
1	Wind direction indicator.
1	Wind Screen.

Table 2. RAFS Auxiliary Equipment

Quantity	Description
1	Primary standard air flow meter; flow range 0 – 20 Lpm.
1	Thermal anemometer (30 – 1,000 fpm) or rotating vane anemometer (30 – 1,000 fpm).
1	Hand-held optical particle counter.
1	Soil Moisture Meter.
1	Aluminum (non-porous equivalent surface) approximately 1-ft by 3-ft for collection of equipment blank quality control sample (see Figure 8).
1	110-VAC power supply or (portable generator, 1000W, minimum).
1	Hand-held meteorological station to measure temperature, wind speed, % relative humidity, and barometric pressure (optional).

1 Hand-held optical particle counter (optional).

Table 3. Sampling Filters and Support Materials.[1]

Quantity	Description
3	25 mm diameter, 0.8µm pore size mixed cellulose ester (MCE) membrane filters with 50 mm electrically-conductive extension cowl to reduce static charge.
3	Filter labels with unique sample identification code.
1	Field sampling and instrument data collection form.
1	Chain-of-custody form.
1	Lint free wipes and surface cleaner in spray bottle for RAFS decontamination.

[1] This listed materials are those needed for a single test. These materials are provided by the RAFS user.

Figure 7. Photographs of RAFS auxiliary equipment listed in Table 3. (From left to right, primary air flow calibrator, vane anemometer, gasoline generator, soil moisture meter, optical particle counter, and meteorological station).

Figure 8. Aluminum (or equivalent non-porous surface) for collection quality assurance equipment blank.

3 RAFS Setup

3.1 Hardware Inspection

Electrical Connections

Power connections for the blower and the agitator mechanism are on the RAFS main body (Figure 9). The vacuum pump power connections are wired into the pump platform that is connected to the RAFS main body via a standard plug. Inspect these connections making sure the fittings are snug before applying power to the system. A GFIC switch is located on the control panel (Figure 9).

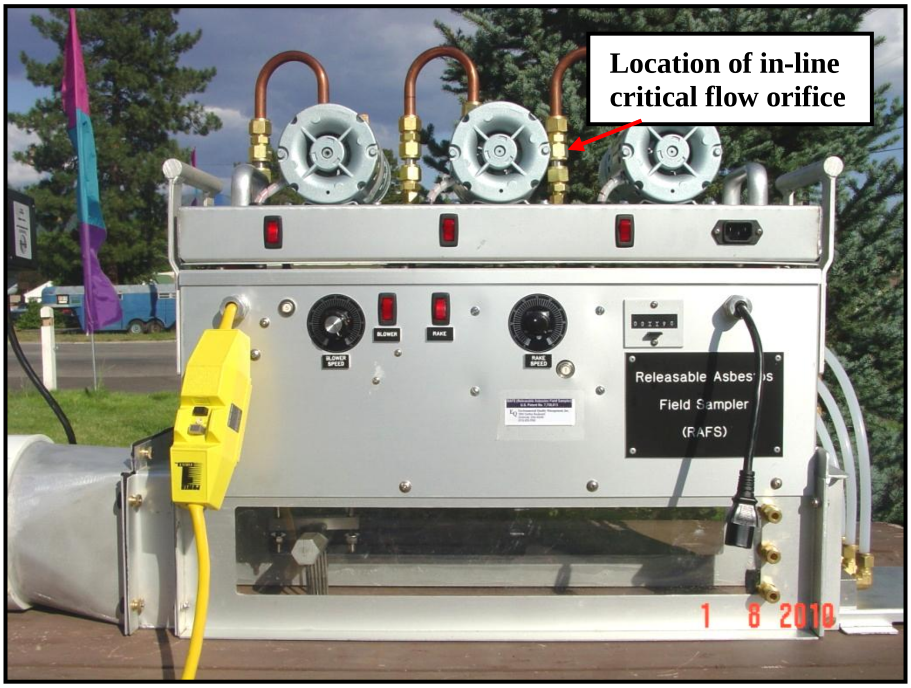


Figure 9. RAFS electrical connections and GFCI.
Note: Location of in-line critical flow orifice.

Rake Mechanism

Figures 1 and 9 show an illustration of the rake mechanism. With the RAFS slightly tilted upward, observe the rake travel through a full cycle to determine that it is working properly. There should be free and consistent movement of the rake mechanism. *Caution: Obstruction of rake mechanism movement can overload the electrical circuit causing the fuse to blow.*

HEPA Filter and Axial Flow Fan Assembly

Fasten the axial flow fan and 90^o air supply duct with air diffuser grate assembly to the RAFS. Inspect the fan to ensure there is free movement of fan blades. Securely fasten each of the six fasteners (Figure 9) to ensure an airtight connection.

3.2 Connect Auxiliary Components

Vacuum Pumps

Position the platform with the three vacuum pumps on the top of the RAFS main body (Figure 9). Secure the pump platform with the latches (Figure 9). Connect the power cord to the electrical outlet box on the RAFS (Figure 9). *Note: Each pump has an initial startup power requirement of approximately 4-5 amps.* The vacuum pumps should be started in sequence to minimize the possibility of over loading a 15 amp power supply circuit. During operation, the power requirement is reduced to approximately 4.5 amps (1.5 amps per pump). Install the in-line critical flow control orifice for each pump (Figure 9).

Filter Sampling Cassettes

Install the sampling table at the outlet of the RAFS (Figures 5 and 8). Slide the hooks at the end of the sampling table over the two pins located immediately inside the RAFS wind tunnel. The pins and latches are designed to insert the sample cassettes the proper distance inside the RAFS wind tunnel. The open-face, 25 mm diameter, 0.8 µm pore size, mixed-cellulose ester (MCE) membrane filters in cassettes with a 50 mm extension cowl are positioned in the three rubber grommets at the end of the sampling table. The tension provided by the grommets properly aligns the cassettes to the airflow inside the tunnel (Figure 5). Typically, three filter cassettes are mounted concurrently. However, the user can use only one or two cassettes, if desired.

3.3 Power Supply

The RAFS can operate from either 110-VAC line power or from a gasoline-powered portable generator (≥15 amps). The generator should not be positioned closer than 50 ft from the operating RAFS unit (Figure 7).

4 Operation and Sampling Conditions

4.1 Parameters and Values

Table 4 lists the required operating parameters and values for proper operation of the RAFS. Typical operation has the fan operating at maximum speed. The user can decrease the fan speed to increase the sample collection time. This step is desired if additional air volume is needed to achieve the desired analytical sensitivity. The rake speed is typically operated at full power. The user can decrease the rake speed when operating in sandy, loose soil to increase sample collection time to provide additional air volume to increase analytical sensitivity.

Table 4. Recommended Operating Settings

Item	Target Setting	Adjustment Location
Fan (Air Velocity)	280-380 fpm	RAFS Control Panel
Rake (Traverse Speed)	1 cyc/20-30 sec	RAFS Control Panel
Sampling Pump (Flow Rate)	13 - 14 Lpm	Fixed Value

Figures 9 and 10 show the RAFS control panel. The blower (wind) and agitator (rake) mechanisms are powered on and adjusted (slow to fast) independently. Bulb lights provide a visual signal the respective systems are powered-on.

The flow control orifice installed in-line with each pump fixes the sampling flow at approximately 13.5 Lpm. It is recommended the user confirm the actual sample flow rate with a primary air flow calibrator (Figure 7).

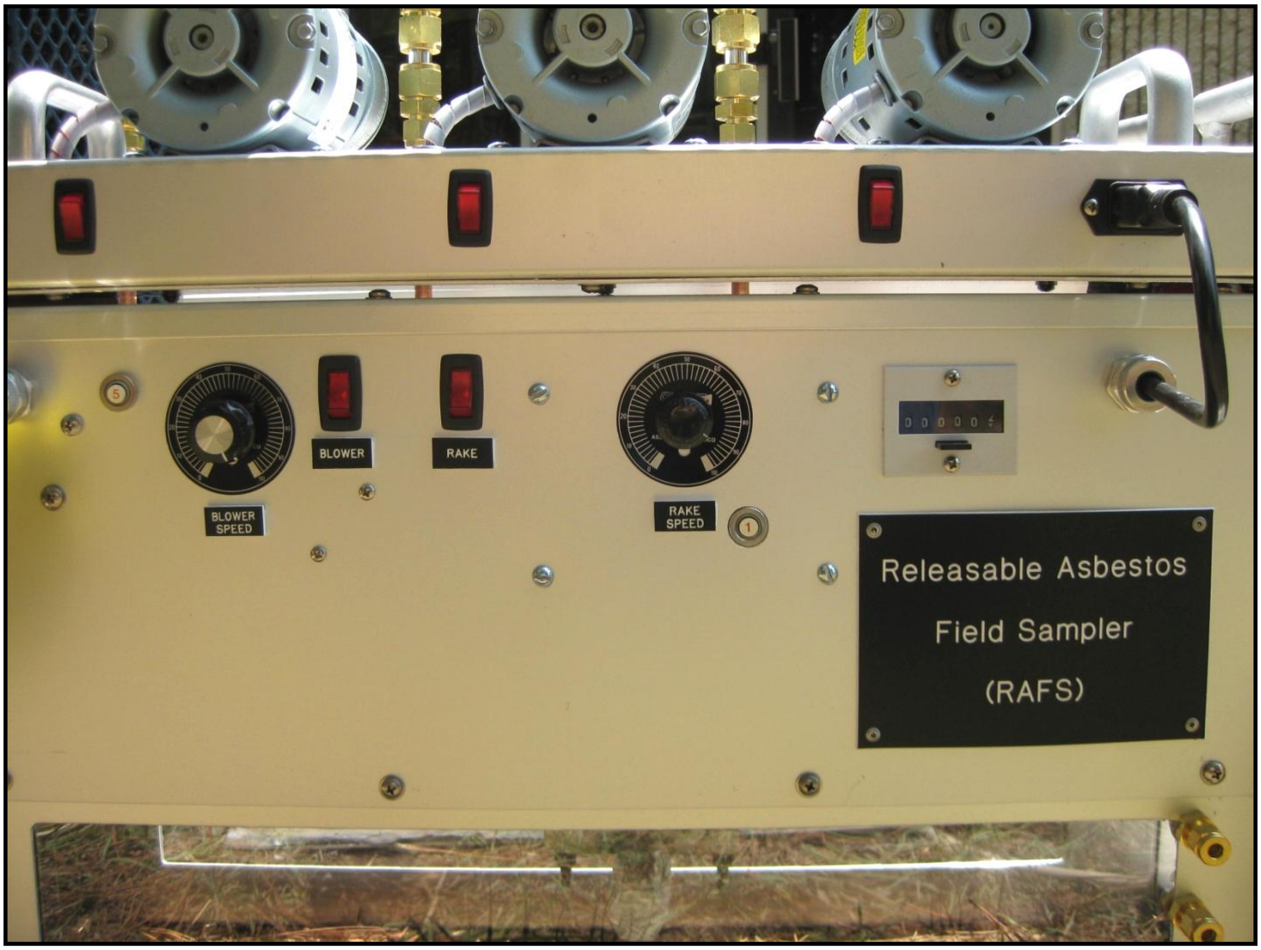


Figure 10. RAFS control panel.

4.2 Operating Settings

Air Velocity

The air velocity through the RAFS tunnel must be measured both before and after sampling event. The measurement before sample collection is necessary to determine the air velocity is within the specified operating range (Table 4). *Note: Since variations in the test matrix surface characteristics may influence the air velocity exiting the tunnel, this measurement should be on a surface that is representative of the test location.*

Place the RAFS on the test surface with the tunnel exit facing downwind; i.e., the wind is not blowing into the tunnel exit. Adjust the fan control knob to full speed and then turn on both the fan and rake agitator.

The air speed through the RAFS is measured using a calibrated vane anemometer (e.g., Davis Anemometer 4-inch or equivalent) or a thermal anemometer (e.g. TSI Model 9535 or equivalent). The instrument must be calibrated against a NIST-traceable standard and operated in accordance with the operating manual. The air velocity measurements are made at approximately 2 inches inside the exit face of the wind tunnel. The average air velocity is reported as feet per minute.

Vane Anemometer—The vane anemometer is positioned inside the tunnel and air flow is measured for exactly one minute. This yields average air velocity in the tunnel over the 1 minute period.

Thermal anemometer—The instrument probe is inserted through each of the three openings at the tunnel exit (Figure 9 and 10). Three equal-distance velocity measurements are made at each vertical height yielding nine measurements. (Note: There should be no movement of the probe during the measurement period (ACGIH Ventilation Manual, 2005). To determine the velocity a straight numerical average of nine individual point velocities is calculated.

Rake Speed Cycle

One full cycle consists of two lengths of the tunnel; i.e., back and forth once. The test should begin with the rake mechanism at the tunnel outlet and the control knob set at full power. The counter should be reset to zero before beginning each test. An automatic counter connected to the mechanism is mounted on the control panel (Figure 10). The RAFS rake speed (time for one full cycle) is measured with a stopwatch. The rake speed is the traverse length (36 inches per full cycle) divided by the measured time.

Unobstructed, the rake will complete one full cycle approximately every 20 seconds. However, the rake speed may be slower due to factors such as depth and the physical characteristics of the soil (i.e., moisture, porosity, grain size, and presence of vegetation and aggregate).

4.3 Test Location Preparation

Preparation of the test location for RAFS sample collection is required. The terrain must be relatively even (e.g., flat) and be approximately 1 ft wide and 3 ft long so the RAFS tunnel frame base maintains solid contact with the soil. The RAFS tunnel has a footprint of 6-inches wide by 24-inches length. The RAFS tunnel edges should firmly contact the soil. An uneven surface beneath the tunnel walls must be evened to prevent the release of air beneath the walls (Figure 11). Small gaps between the RAFS walls and the soil can be filled with extra soil (Figure 12).

Level the surface beneath the tunnel walls to ensure the rake tines can reach a depth of between ¼-inch to ¾-inch. The rake tines must maintain consistent contact with the soil along the entire length of traverse during sample collection. Failure to maintain consistent contact of the rake tines with the soil will reduce the quantity of asbestos fibers aerosolized from the soil.

Figure 11. Uneven surface beneath tunnel wall must be relatively even to eliminate the release of air from beneath the frame.

Figure 12. Air gap beneath tunnel wall is sealed with soil.

The test area soil must be free of rocks, twigs, roots, and other objects larger than ≈½-inch in any dimension to prevent the rake mechanism from snagging and stalling. The RAFS can operate on soil with light to medium vegetation. A general rule, the location is acceptable if the bare soil to vegetation ratio is 1:1 with even coverage. Heavy vegetation, like a lawn, will require removal of vegetation to achieve the 1:1 ratio (Figure 13). Extremely compacted soil may be gently loosened with a hand-held pickax if the RAFS rake tines are unable to penetrate the soil.

Figure 13. RAFS operating in soil with vegetation.

The rake is mounted to a shaft, which is attached to a motorized screw-drive. The mounting connection allows for a moderate degree of lateral motion as the rake traverses the tunnel. The lateral motion of the rake increases the surface area of the soil that is mechanically disturbed. As the rake traverses the tunnel, grooves are created in the soil and the rake mechanism is lowered by its weight to accommodate the soil plane. Typically, the rake reaches a depth of no less than approximately ½ -inch (Figure 14).

If precipitation is forecasted, the test locations should be covered with approximately a 6-ft by 6-ft plastic tarp, which is held in place with tent stakes to maintain the soil moisture content. Measurable particle aerosolization by the RAFS does not occur when soil moisture content is greater than 35%. At this moisture content, the soil particles remained agglomerates because the capillary force induced by the thin water layer between individual particles exceeded the disturbance force induced by the RAFS.

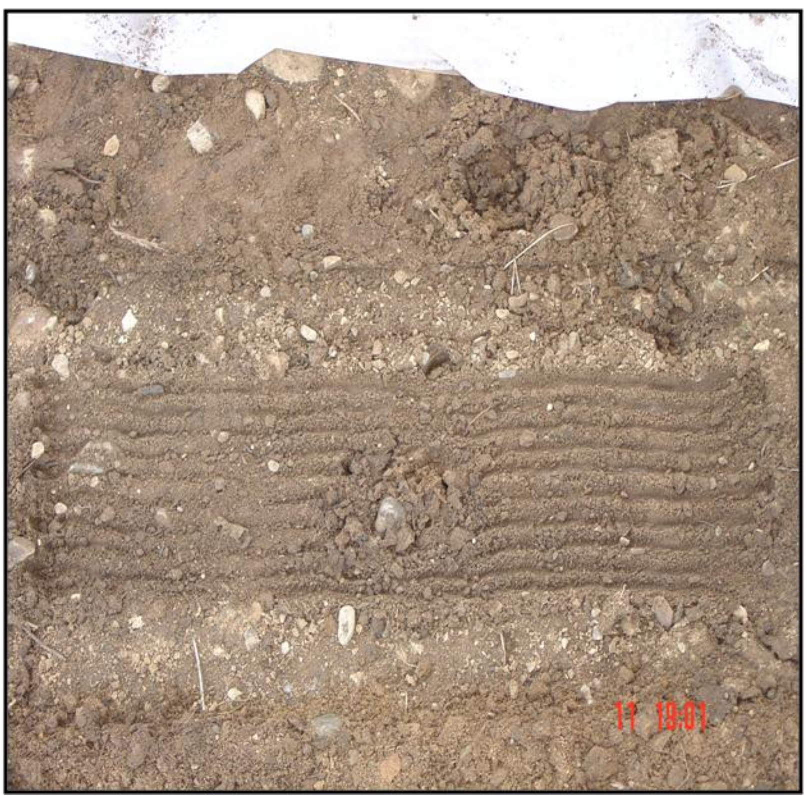


Figure 14. Proper contact of rake tines with soil resulting in grooves (~½-inch depth).

4.4 Aerosol Concentration/Sample Volume

Collection of valid air samples with the RAFS depends on the soil emission rate and RAFS filter sample volume (sampling flow rate times sampling time). The sample collection time must be sufficiently long to maximize the sample volume collected without overloading the filter with particles. A high sample volume will reduce the cost of achieving the transmission electron microscopy (TEM) analytical detection limit (e.g., 0.005 structures/cm^3). However, the filter sample volume must be balanced against the particle emission rate so the filters are not overloaded. Filters overloaded with particles cannot be analyzed by direct-transfer TEM analysis; an indirect transfer method must be used instead.

Two approaches are used to determine the particulate loading on the filter sample is acceptable for analysis of asbestos using direct-transfer TEM.

> *Approach 1*—first approach involves on-site examination of filter samples using a phase contrast microscope (PCM) in accordance with NIOSH Method 7400 to determine whether the particulate loading would be acceptable for subsequent analysis by direct transfer TEM. Note: This approach may not be cost reasonable unless the RAFS user is a trained optical microscopist.
>
> *Approach 2*—second approach involves on-site visual examination of the filter particulate loading with the unaided eye.

Both approaches use the same basic steps to determine the sample volume that will result in an acceptable particulate loading. These steps are outlined below:

1. Use a hand-held optical particle counter (e.g., MetOne GT-521) to determine the particulate air concentration (i.e., number particles/cm^3) generated by the RAFS. Generally, the highest concentrations are generated within first 5-minutes of sample collection. *Hence, the information should be used to determine the minimum sample volume for the first of the three samples.*

   Table 5 presents guidance to determine a target sampling time (minutes) based on the RAFS generated number concentration (number of particles/cm^3) to obtain an acceptable filter loading for asbestos analysis using direct transfer specimen preparation for TEM analysis. This guidance is based on observing the number concentration profile over the initial 5-minutes of sampling.

Table 5. Guidance to Determine Target Sampling Time based on RAFS Generated Particulate Number Concentration and Sample Flow of 13.5 Lpm.

Aerosol Concentration, #/cm^3	Sampling Time, Minutes	Sample Volume, Liters[a]
>25	5 or less	< 68
~ 10	5 to 10	68 to 135
~ 5	10 to 20	135 to 270
~ 2	15 to 40	203 to 540
~ 1	30 to 75	400 to 1000
<1	45 to 110	600 to 1500

2. Typically, a minimum sampling period of 10 minutes is obtained, though depending on the soil condition it can be as short as 5 minutes. After achieving the target sampling period, pause all three sampling pumps and remove the filter cassette from location #1 for observation by either on-site optical microscopy (NIOSH Method 7400) or by visual examination by unaided eye.

   Photographs of particulate loading on 25 mm diameter, 0.8µm pore size MCE filters is presented in Figure 15. Three categories of particulate loadings relative to an unused filter are presented: Range of Acceptable (three filter images); Questionable (two filter images); and Overloaded (one filter image).

3. Based on the optical or visual examination of the filter particulate loading either terminate the sampling and remove the remaining two filter cassettes or proceed with the sampling on filter cassettes #2 and #3. *Note: Filter cassette #1 should be properly stored for potential subsequent TEM analysis in the laboratory*.

4. Proceed with the sampling. Typically, the sampling period for the second filter cassette will extend 5, 10, or 15-minutes (or even longer) depending on the visual particulate loading on the filter and the current aerosol concentration observed on the optical particle counter display.

   After achieving the target sampling period, pause the two sampling pumps and remove the filter cassette from location #2. Based on the optical or visual examination of the filter particulate loading either terminate the sampling and remove the third filter cassette or proceed with the sampling on filter cassette #3. *Note: Filter cassette #2 should be properly stored for potential subsequent TEM analysis in the laboratory*.

5. Proceed with the sampling. Typically, the sampling period for the third filter cassette will extend 5, 10, or 15-minutes (or even longer) depending on the visual particulate loading on the filter and the current aerosol concentration observed on the optical particle display.

After achieving the target sampling period, stop the sampling pump and remove the filter cassette from location #3. *Properly store the filter cassette for potential subsequent TEM analysis in the laboratory*.

6. Sample collection is now complete.

Figure 15. Photographs of 25 mm dia. 0.8 µm pore MCE filters to assess proper loading of particles for direct-transfer TEM analysis. a) unused filter, b) lightly loaded filter, c) ideal, properly loaded filter, d) overloaded filter, e) very overloaded filter.

4.5 Loading/Unloading Filter Cassettes

Loading

Install the site-specific labeled filter cassettes in the holder located at the exit of the RAFS tunnel. The holder supports up to three filter cassettes with the centerline of each cassette positioned at 1.5-inches above the test surface (Figure 5). The leading edge of the filter cassette should be placed approximately 2 inches inside the tunnel face. Remove the face cap and outlet plug from the filter cassette. Attach the vacuum hose to the outlet ferrule of the cassette. Secure the filter cassette in the mounting bracket with the screw clamp. Repeat for each cassette.

Unloading

Loosen the screw clamp and remove the filter cassette. Install face cap and outlet plug. Disconnect the vacuum hose from the filter cassette. Exercise sufficient caution during disconnecting the filter from the filter cassette not to separate the base of the filter cassette from the 50 mm extension cowl. It this occurs, the filter sample should be discarded.

5 Step-By-Step RAFS Operation

1. Assemble the RAFS unit.

2. Set the RAFS operating settings; see Section 4.2. Variations in test matrix surface characteristics may directly influence the air flow velocity exit the tunnel. Therefore, set the fan speed operating setting on a surface as representative of the test locations.

3. Clean the RAFS unit; see Section 6.

4. If necessary, collect an equipment blank and field blanks; see Section 6.

5. Select/prepare a test location; see Section 4.3.

6. Place the RAFS on the test location; see Section 4.3.

7. Remove face cap and outlet plug from three site-specific labeled 25 mm diameter, 0.8 µm pore size MCE filter cassettes with 50 mm extension cowls. Install the filter cassettes in the RAFS sampling table.

8. Position the optical particle counter at the same location as the MCE filter cassettes.

9. In the following immediate sequential order start the sampling pumps, optical particle counter, RAFS fan, and RAFS rake mechanism to collect a test sample.

10. Sample duration varies with each test location; see Section 4.4.

11. Record the sampling data and conditions.

12. Repeatedly check the RAFS system during the sampling period to verify operation of the raking mechanism, as well as fan and sampling pumps.

13. In the following immediate sequential order stop the equipment when the test is being stopped or paused (see Section 4.4): sampling pumps, optical particle counter, fan, and rake mechanism.

14. Record the sampling data and conditions.

15. After removing the sample filter cassettes but prior to moving the RAFS measure the air velocity through the tunnel; see Section 4.2. Prior to measuring the air velocity, carefully redistribute any soil that has accumulated “piled” at the exit end of the tunnel.

16. Clean the RAFS with pre-moistened lint free cloth (or lint free cloth moistened with a surface cleaner). Pay particular attention to the inside of the RAFS tunnel, rake mechanism, and filter cassette bracket.

17. Repeat steps 3 through 16 for collection of the next sample.

6 Maintenance, Quality Control, and Calibration

6.1 Cleaning the RAFS

The RAFS must be thoroughly cleaned both immediately before and after use to remove all asbestos and non-asbestos particulate surface contamination. Particular attention should be paid to the tunnel, raking mechanism, and filter cassette support bracket. The entire RAFS unit should be thoroughly wiped with pre-moistened lint free cloth (or lint free cloth moistened with a surface cleaner). Change the cloth frequently to prevent cross-contamination of the surfaces; e.g., interior of tunnel vs. exterior.

6.2 Quality Control

RAFS Field Blank

A field blank is collected to check for accidental contamination of samples by the operator. Follow standard procedures for collection, handling, and processing of the field blank.

RAFS Equipment Blank

An equipment blank is a quality control sample used to detect asbestos fibers introduced to samples during the measurement process; i.e., it determines the cleanliness and decontamination effectiveness of the RAFS. Immediately prior to collection of field samples a RAFS equipment blank sample should be collected to demonstrate the cleanliness of the RAFS equipment.

Place the RAFS unit on a clean aluminum (or equivalent non-porous surface) sheet. An equipment blank (open-face, 25 mm dia., 0.8 µm pore size MCE filter with 50 mm extension cowl) is collected using exactly the same procedure as used to collect a test sample (Figure 8). Operate the fan at maximum speed during the sampling period of 5 minutes (minimum). During the sampling period determine the emission of any particles using a optical particle counter. If the concentration on the optical particle counter exceeds 100 number of particles/cm^3, re-clean the unit. Replace the MCE filter and begin the test again.

6.3 Equipment Performance Check and Calibration

RAFS Unit

The RAFS requires a performance check of its primary operating settings: fan speed and rake speed. See Section 4.2 "Operating Settings."

Auxiliary Equipment

A performance check and/or calibration should be performed on each piece of primary auxiliary equipment in accordance with the respective operation manual. This includes the vacuum sampling pumps and optical particle counter, and air flow meter.

7 Troubleshooting

Table 6 lists the symptoms, possible causes, and recommended solutions for common problems that may occur with the RAFS.

Table 6. Troubleshooting for RAFS

Symptom	Possible Cause(s)	Corrective Action
No power to RAFS	No power	Check generator or 110 VAC outlet
No movement of rake mechanism	No power to RAFS	Check power source; switch on
	Rake power switch off	Switch on
	GFI tripped	Reset GFI switch
	Rake mechanism jammed	Inspect mechanism for obstruction. Remove obstruction
Fan does not operate	No power to RAFS	Check power source; switch on
	Fan power switch off	Switch on
	GFI tripped	Reset GFI switch
Vacuum pumps not on	No power	Check power cords
		Check power switch
		Check power source

8 References

1. Kominsky, J., Thornburg, J, Shaul, G., Barrett, W., and Hall, F. Development of the Releasable Asbestos Field Sampler. *J. Air Waste Management Assoc.* in press.

2. Hinds, W. Aerosol Technology. 2nd Ed., John Wiley & Sons. 1999.

3. International Organization for Standardization. ISO Method 10312:1995. Ambient Air-Determination of Asbestos Fibres—Direct Transfer Transmission Electron Microscopy Method (1995).

Appendix A: Example Forms

Example RAFS Filter Sample Label

RAFS-A#-L#-X-#	RAFS-O = Outdoor RAFS
	A# = Area Number (e.g., A1)
	L# = Location # in that Area (e.g., L1)
	X = Type of sample (S = Sample, B = Field blank, E = Equipment blank, D = Duplicate)
	# = Location in RAFS sample manifold (1, 2, or 3)

AIR SAMPLE CUSTODY FORM

RELEASABLE ASBESTOS FIELD SAMPLER (RAFS)

Tampa, FL: GAO08 and GAO108

Sample ID	Sample Type	Volume (L)	Shipper ID	Date	Receipt ID	Date
GAO08-I-RAFS-A1-L1-01	Sample	100	AD	9/14/2009		
GAO08-I-RAFS-A1-L1-02	Field Blank	0	AD	9/14/2009		
GAO08-I-RAFS-A1-L3-01	Sample	50	AD	9/14/2009		
GAO08-I-RAFS-A1-L3-02	Duplicate	50	AD	9/14/2009		

RAFS Datasheet

AIR SAMPLING AND INSTRUMENT DATA COLLECTION FORM

RELEASABLE ASBESTOS FIELD SAMPLER (RAFS)

Date:
Tech:
GPS: N
W
Altitude: *feet*

Sampling Condition Parameters

Area: **Location:** **RH:** % **Temp:** ºF **Wind Vel:** *miles/hr* **Bar Press:** *inches of Hg*
Weather Phenomena (e.g. rain, wind gusts): **Direction:** **Dew Pt:** ºF
Location Description (e.g. vegetation, soil consistency): **Test Qualifier:**

Sample ID	RAFS Unit №	Pump №	Flow Rate		Agitator Data				Time		Comments	RTI Filter ID
			Start (L/m)	Stop (L/m)	Start Count	Stop Count	Cycle Time (s)	Depth (inches)	Start	Stop		

MetOne GT 521 Filename	Start	Stop	Flow Rate (L/m)	Comments	Vane Anemometer
					feet/minute

Soil Moisture Readings

Reading 1	Reading 2	Reading 3	Reading 4	Reading 5

Additional Sample Period Comments

Soil Sample Tracking

Split #	Sample ID	Comments
1		
2		
3		
4		
5		