

**Attachment I**

**HVAC Cleaning Procedures**

# **General Procedures for Cleaning WTC-Related Contaminants from Ventilation Systems at 110 Liberty Street, New York, New York**

## **1.0 SCOPE**

The procedures contained in this document provide guidance for cleaning WTC-related dust in two commercial ventilation systems and in a combustion air make-up riser for the residential units within the building located at 110 Liberty Street, New York, New York, and for post-cleaning verification sampling. This document includes performance requirements and post-cleaning verification sampling for cleaning WTC-related dust and debris from ventilation systems consisting of fans, housings, ducts, air control devices, grilles and other components.

## **2.0 PURPOSE**

The purpose of this document is to provide minimum requirements for cleaning ventilation system components that were impacted by airborne dust from the WTC collapse, and to provide procedures for post-cleaning verification sampling following clean-up.

WTC-related dust is generally considered to have common, consistent, and readily observable characteristics visually and tactilely differentiating it from common dust. WTC-related dust generally contains extremely fine particles similar in consistency to talcum powder, is light-colored, contains pulverized concrete and/or gypsum wallboard, and may contain asbestos fibers. Unless otherwise indicated by sampling and analytical testing, the following components shall be assumed to be present in WTC-related dust:

- Man-made Vitreous Fibers
- Crystalline Silica
- Lead
- Asbestos

For this project, all specified ventilation system components shall be assumed to contain WTC-related dust and shall be cleaned accordingly.

Where sampling and analysis indicate that dust and debris in ventilation systems contain only crystalline silica, man-made vitreous fibers, lead, or <1% asbestos contamination, this procedure specifies that duct systems shall be cleaned only while maintained under negative pressure using HEPA-filtered vacuum collection equipment specific to the duct cleaning industry. All cleaning of air handling equipment shall be performed within containment structures that are maintained under negative pressure using HEPA-filtered air filtration devices.

Where sampling and analysis indicate that dust and debris within a ventilation system contains 1% or greater asbestos as determined by standard sampling and analytical techniques, the ventilation system cleaning procedure shall be designed by a New York-licensed Project Designer. The cleaning will be performed in accordance with local, state and federal regulations as specified in the Project Design.

### 3.0 APPLICABLE DOCUMENTS

This section provides full bibliography for references made within this document, or considered in preparation of this document. Cleaning and post-cleaning verification sampling should be conducted in a manner that is fully compliant with the guidance provided in the following documents, to the extent applicable.

1. ACR 2002, *Assessment, Cleaning and Restoration of HVAC Systems*, National Air Duct Cleaning Association, Washington, D.C. (2002).

ACR 2002 specifies procedures for cleaning HVAC systems.

2. NADCA Standard 97-05, *Requirements for the Installation of Service Openings in HVAC Systems*, National Air Duct Cleaning Association, Washington, D.C. (1997).

NADCA 97-05 includes procedures for installing service openings in HVAC systems and construction and material specifications for replacement panels, plates or access doors to cover such openings.

3. *SMACNA HVAC Duct Construction Standards – Metal and Flexible*, Sheet Metal and Air Conditioning Contractors' National Association, Inc., 2<sup>nd</sup> Edition (1995).

The SMACNA standard includes construction and material specifications for access doors for covering service openings as required under 7.5 and 11.1.3 of this document.

4. *SMACNA Fibrous Glass Duct Construction Standards*, Sheet Metal and Air Conditioning Contractors' National Association, Inc., 6<sup>th</sup> Edition (1992).

The SMACNA standard includes construction and material specifications for access doors for covering service openings as required under item 6.5.1.2 of this document.

5. NFPA Standards 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, and 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*, National Fire Protection Association (1999 Edition).

The NFPA standards include construction and material specifications for replacement coverings on service openings as required under item 6.5.1.2 of this document.

6. *Cleaning Fibrous Glass Insulated Air Duct Systems*, North American Insulation Manufacturers Association (NAIMA), 1993

This document provides guidance for cleaning fibrous glass-insulated interior ventilation system surfaces.

7. ASHRAE 33-78, *Methods of Testing Forced Circulation Air Cooling and Air Heating Coils*, American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE), 1978

This document contains procedures for testing air flow through ventilation system thermal coils.

8. ARI 410-91 *Forced-Circulation Air-Cooling and Air-Heating Coils*, Air Conditioning and

Refrigeration Institute (ARI), 1991

This document contains procedures for testing air flow through ventilation system thermal coils.

9. ASHRAE 62-2001, Ventilation for Acceptable Indoor Air Quality, American Society of Heating, Refrigeration, and Air Conditioning Clients (ASHRAE), 2001

This document provides performance and evaluation criteria for acceptable general ventilation system operation.

10. Military Standard 282, United States Department of Defense (DOD), 1956

This document contains leak testing procedures for in-place filters used in air filtration devices, HEPA vacuums and vacuum collection equipment.

11. AMCA 99-86, Standards Handbook, Air Movement and Control Association, 1986

This document contains specifications for air filtration devices.

12. ASHRAE Terminology of Heating, Ventilation, Air Conditioning, and Refrigeration, American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE), 1991

This document defines terminology for use in referring to ventilation systems and components.

13. OSHA Regulations 29 CFR 1910, Occupational Health and Safety Standards

The OSHA regulations specify health and safety requirements for protecting employees during the inspection procedures.

14. Title 15, Chapter 1, Rules of City of New York Asbestos Regulations

This document contains New York City regulations regarding asbestos abatement.

15. NYSDOL – DOSH Regulations – Part 56. ASBESTOS

This document contains New York State regulations regarding asbestos abatement.

16. NYC Guidelines on Assessment and Remediation of Fungi in Indoor Environments

This document contains New York City guidelines regarding microbial remediation.

#### **4.0 CHARACTERIZATION OF DUST/ENVIRONMENTAL HAZARDS**

Prior to the start of work, an evaluation of the dust shall be performed by an independent environmental service contractor. The independent environmental service Contractor shall be experienced in performing all necessary sampling procedures for analytical evaluation of the WTC –related dust.

Prior to the start of work, the independent environmental service Contractor shall make a determination

as to whether the following contaminants are present:

- Man-made Vitreous Fibers
- Crystalline Silica
- Lead
- Asbestos

Bulk samples when applicable will be collected for quantitative analysis of the above-referenced analytes. Samples for analysis of man-made vitreous fibers, crystalline silica, lead and Asbestos may only be submitted to an EPA approved laboratory. Wipe samples and air samples may be taken when the quantity of dust to be analyzed is insufficient for bulk collection.

The onsite Environmental Cleaning Contractor shall note any mold growth, rodent droppings, or other biological hazards if observed.

## **5.0 SITE EXAMINATION**

Prior to commencing work, all ventilation system/duct cleaning professionals shall visit the site to examine the conditions under which the work is to be performed in order to identify those conditions that might adversely affect the work. These conditions may include, but may not be limited to the following:

1. Difficulty accessing ventilation system components.
2. Ventilation systems components located in parts of the building that are not included in the scope of ventilation system cleaning, but that may cause the ventilation system components to become re-contaminated following cleaning.
3. Asbestos-containing materials on ventilation system components to be cleaned or damaged asbestos-containing materials in the vicinity of the ventilation system components to be cleaned.
4. Specific scaffolding and/or fall protection requirements.

## **6.0 VENTILATION SYSTEM/DUCT CLEANING FIRM REQUIREMENTS**

- 6.1 The ventilation system/duct cleaning firm shall meet the following minimum health and safety requirements:

Appropriate Respiratory Protection Program as required by 29 CFR 1910.134.

Appropriate Hazard Communication Training as required by 29 CFR 1910.1200, to include health hazards associated with man-made vitreous fibers, crystalline silica, lead, asbestos, and microbiological hazards that may likely be encountered in ventilation systems, in addition to chemicals brought on site to perform the work.

Prior experience in cleaning HVAC systems.

Appropriate personal protective equipment and written program.

An experienced individual to act as a site health and safety supervisor to respond to unanticipated health hazards that may be encountered on the site and to ensure implementation of required health and safety practices.

- 6.2 In addition to the above minimum requirements, the duct cleaning professional shall meet the following contaminant-specific requirements:
  - 6.2.1 Man-made Vitreous Fibers – appropriate Hazard Communication training and personal protective equipment
  - 6.2.2 Crystalline Silica – appropriate Hazard Communication training and personal protective equipment
  - 6.2.3 Lead – appropriate Hazard Communication training, ability to perform personal exposure monitoring for airborne lead, ability to comply with requirements of 29 CFR 1910.1025
  - 6.2.4 Asbestos (< 1%) - – appropriate Hazard Communication training, ability to perform personal exposure monitoring for airborne asbestos, ability to comply with requirements of 29 CFR 1910.1001
- 6.3 All workers shall possess current EPA-accredited training as an Asbestos Worker (32-hour training) or as an Asbestos Supervisor (40-hour training).

## **7.0 GENERAL PERFORMANCE REQUIREMENTS**

In general, all cleaning of air moving equipment and active plenums shall be performed under negative pressure using HEPA-filtered air filtration devices. All ducts that are cleaned shall be maintained under negative pressure using HEPA-filtered vacuum collection equipment specific to the duct cleaning industry. Air filtration devices and vacuum collection equipment shall be exhausted to the outdoors. After cleaning of the ventilation system, any areas that are affected by the work must be as clean or cleaner than their condition prior to the start of work, and must meet post-cleaning verification requirements contained in 8.2 of this document.

- 7.1 **Containment:** WTC-related dust and debris removed by cleaning/remediation process shall be collected and precautions taken to ensure that the debris is not otherwise dispersed outside the ventilation system during cleaning. After cleaning of the ventilation system, any areas that are affected by the work must be as clean or cleaner than their condition prior to the start of work.
  - 7.1.1 When working outside the negative air pressure system the ventilation system/duct cleaning firm shall install plastic sheeting on the floor surface under and at a minimum of 3 feet outside the perimeter of the system. All exposed service tools and equipment shall be free of debris and contamination from the ventilation system. Tools and equipment include (but are not limited to): Vacuum collection equipment, vacuum hoses and attachments, air lines and hoses, brushes, extension rods, cables, ladders, power tools, hand tools, zoning devices, and inspection equipment.
    - 7.1.1.2 Contaminated tools and equipment shall be maintained in poly bags until cleaned in the designated decontamination area at the work site.

7.1.1.3 Hoses, cables, and extension rods shall be cleaned free of visible debris with suitable sanitary damp wipes at the point they are withdrawn from exposed ventilation system components or containment areas into general occupant areas.

7.1.2 Upon removing duct diffusers and grilles prior to cleaning, the ventilation system/duct cleaning firm shall provide adequate containment measures to prevent contaminant exposure from accumulated debris on these devices.

7.2 **Equipment:** All service equipment must operate on standard 110 VAC, 20A circuits.

7.2.1 Vacuum Collection Equipment: All vacuum collection equipment or air filtration devices shall utilize a minimum of HEPA filtration (99.97% at 0.3 micron) final collection efficiency at the device's exhaust. Multi-sectioned equipment must not be opened or detached in occupied areas once contaminated with debris. Vacuum collection equipment shall provide sufficient negative airflow velocity in the ventilation system zone being serviced to draw dislodged debris from the mechanical cleaning device to the vacuum's collection chamber (typically a minimum of 3000 feet per minute (fpm) in the portion of the HVAC system being cleaned.

7.2.2 Pressurized Air Source Used for Cleaning Devices: Must provide a minimum of 175 PSI at a volume of 15 cubic feet per minute. Device must provide pressurized air free of significant moisture, oil and toxic vapors, or be equipped with adequate filtration and dryers to remove such contamination. The ventilation system/duct cleaning firm shall provide ongoing documentation of the device's delivery of contaminant-free pressurized air.

7.3 **Component Cleaning:** Mechanical Cleaning procedures include the dislodging of WTC-related dust and debris on the interior surfaces of the ventilation system by manual, mechanical, pneumatic, or hydro-agitation. Loosened debris shall be collected and removed from the ventilation system using suitable vacuum collection equipment and/or HEPA vacuuming methods, as specified.

7.3.1 **Cleaning Non-Porous ventilation system components:** Cleaning methods shall be used that will render the ventilation system components visibly clean. No cleaning method shall be used which will damage components of the ventilation system or significantly alter the integrity of the system.

7.3.2 **Cleaning Porous Ventilation System Components:** Cleaning method shall be used that will render the ventilation system components visibly clean and minimize fiber release from the porous ventilation system component surface. No cleaning method should be used which will damage components of the ventilation system or significantly alter the integrity of the system. Porous ventilation system components which exhibit increased potential for fiber release (i.e. damaged internal surface bond or coating, and open internal seams and joints) shall be replaced or encapsulated with a product approved for that purpose upon completion of Mechanical Cleaning procedures.

7.4 **Encapsulation of Ventilation System Components:** Encapsulation of porous or degraded porous ventilation system components shall be employed only after cleaning and successful

completion of post-cleaning verification procedures by the Environmental Cleaning Contractor (see 8.2 of this document).

7.4.1 Encapsulant coatings shall be applied directly to the interior porous surfaces of ventilation system components by hand brushing, rolling, or troweling, or via spray system, with a maximum distance of 24" from the spray discharge tip to the surface being treated. Encapsulant coatings may not be fogged into the system. A continuous film thickness should be achieved in treated areas, as per manufacturer's instructions.

7.4.2 Ventilation system control devices, heating elements, sensing equipment, grilles, and fans must be adequately blocked off or masked so that they will remain free from over-spray from the Encapsulation process.

7.5 **Service openings:** All access ways cut in the ventilation system for inspection and/or cleaning must be repaired so that they shall not significantly alter the airflow or adversely impact the facility's indoor air quality. All openings made in the ventilation system must be sealed in accordance with industry standards and local codes, using materials acceptable under those standards and codes (see Appendix B).

7.6 **Disposal of Debris:** All waste and debris removed from the ventilation system shall be double-bagged in 6-mil polyethylene bags and disposed of in accordance with all applicable federal, state, and local requirements.

## 8.0 QUALITY ASSURANCE

8.1 **Health and Safety:** The ventilation system/duct cleaning firm shall comply with all applicable federal, state, and local requirements for protecting the safety of the ventilation system/duct cleaning firm's employees, building occupants, and the environment. No processes or materials shall be employed in such a manner that they will create adverse health effects to the building occupants, the ventilation system/duct cleaning firm's employees, or the general public.

8.1.1 The ventilation system/duct cleaning firm shall perform initial exposure monitoring of its employees for asbestos and lead in accordance with 29 CFR 1910.1001 and 29 CFR 1910.1025, respectively.

8.1.2 Ventilation system/duct cleaning firm's employees shall use respiratory protection in compliance with OSHA 1910.134

8.1.3 Regardless of exposure assessment results, at minimum the ventilation system/duct cleaning firm's employees shall wear properly fitted, HEPA-filtered (P-100) negative half-mask respirators when performing any work related tasks on site which might expose them to elevated levels of airborne particulate.

8.2 **Post-cleaning Verification:** Prior to re-commissioning a cleaned section of the ventilation system (at the end of the work shift, etc.), the ventilation system/duct cleaning firm will obtain cleanliness clearance from the Environmental Cleaning Contractor. Ventilation system cleanliness will be determined after mechanical cleaning and before the application of any surface treatment or introduction of any treatment-related substance to the ventilation system. Verification shall be conducted before the ventilation system is restored to normal operation.

Ventilation system components may be evaluated by the Environmental Cleaning Contractor for visible cleanliness via direct visual inspection or with a visual inspection system (i.e., mirrors, boroscope, remote camera). The Environmental Cleaning Contractor may direct the ventilation system/duct cleaning firm to provide additional access openings into the ventilation system, as deemed necessary to thoroughly verify cleanliness.

8.2.1 All porous and non-porous ventilation system surfaces must be visibly clean and capable of passing a visual inspection.

8.2.2 Cleaning of non-porous ventilation system surfaces shall be verified by surface wipe sampling performed by the Environmental Cleaning Contractor using specified methods. Surface wipe sampling for man-made vitreous fibers, crystalline silica, lead and asbestos will be performed. Wipe sample results must meet the following criteria to established that cleaning has been adequate:

- Lead – less than 25 micrograms of lead per square foot using the specified method
- Asbestos – no asbestos detected using the specified method

8.2.3 Pre-occupancy air testing: After successful completion of 8.2.1 and 8.2.2, and removal all polyethylene sheeting, containments and any remaining visible debris, the ventilation system shall be started up and air sampling for man-made vitreous fibers, crystalline silica, lead and asbestos will be performed performed by the Environmental Cleaning Contractor using specified methods. Airborne concentrations of these contaminants shall be within recommended guidelines for acceptable indoor air quality. Occupants may re-enter the building only after successful completion of air monitoring.

### 8.3 **Materials and Workmanship:**

8.3.1 Work shall be executed by skilled persons who are thoroughly trained, experienced and completely familiar with the specified requirements and the methods needed for proper performance of the project, and shall be in conformance with the best practices of each trade involved.

8.3.2 Work shall present a neat and workmanlike appearance when completed.

8.3.3 Finish of materials and components shall be consistent with industry good practice.

8.4 **Cleaning:** Work and storage areas shall be maintained and kept clean on a daily basis. The ventilation system/duct cleaning firm shall final clean the immediate work area(s) with a HEPA-filtered vacuum cleaner to be free of any residual visible WTC-related dust. Materials removed and debris resulting from the ventilation system/duct cleaning firm's work shall become the property of the ventilation system/duct cleaning firm and shall be removed for appropriate disposal (see 7.6 of this document).

## 9.0 **WORK SEQUENCE AND SCHEDULING**

9.1 As a general procedure, cleaning work should follow the ventilation system airflow, beginning at the system's return air intakes. Cleaning should proceed from those points to the air handling unit (AHU), then out through the air discharge points. This work sequence will reduce the

likelihood of cleaned portions of the ventilation system being re-contaminated if the system is reactivated at the end of the work shift.

- 9.2 Additional precautions that may be used to protect cleaned surfaces of the ventilation system from being re-contaminated by uncleaned ventilation system surfaces. These may include: 1) the installation of temporary duct blanks or zoning devices to separate cleaned sections, and 2) installation of temporary air filters.

## 10.0 PRODUCTS

- 10.1 **Encapsulants:** Ventilation system encapsulation products shall be for specific use in ventilation systems and applied per manufacturer's instructions. Encapsulants shall be water-based, with low VOC (volatile organic compound) emissions, and meet NFPA smoke development and flame spread requirements for HVAC system products.

10.1.1 Ventilation system/duct cleaning firm shall maintain on-site MSDS copies for any encapsulant product used in the ventilation system.

10.1.2 Ventilation system/duct cleaning firm will apply product in strict compliance with manufacturer's recommended safety precautions for Ventilation system/duct cleaning firm's personnel and building occupants.

10.1.3 Ventilation system/duct cleaning firm shall comply with any applicable federal, state, or local regulations regarding the use of such products.

- 10.2 **Cleaning Chemicals:** Any chemicals used in cleaning ventilation system components (i.e. chemical cleaners, degreasers, etc.) shall be applied per manufacturer's instructions.

10.2.1 Ventilation system/duct cleaning firm shall maintain on-site MSDS copies for any cleaning chemical used in the ventilation system.

10.2.2 Ventilation system/duct cleaning firm shall comply with any applicable federal, state, or local regulations regarding the use of such products.

## 11.0 EXECUTION

- 11.1 Preparation - General

11.1.1 **Project Orientation/Preparation:** Ensure that a site examination has been performed in accordance with Section 5.0 of this document.

11.1.1.1 **Task Coordination:** A pre-task performance meeting shall be conducted for the project.

11.1.1.2 **Walk-through:** Visually inspect the ventilation system prior to the start of work and note any mechanical modifications. Note location of all electrical panels for fuse reset. Note condition of fans, visible buildups, and accessible ductwork.

- 11.1.2 **Site Preparation:** To minimize possible contamination and damage, the ventilation system/duct cleaning firm shall provide a negative pressure work area containment as necessary during ventilation system remediation.
- 11.1.2.1 Negative pressure must be maintained by way of an attached external HEPA-filtered air filtration device. The vacuum must provide at least eight (8) air-changes in the containment per hour.
  - 11.1.2.2 The AHU servicing the area being cleaned must be shut down or zoned-off and remain so during the cleaning process.
  - 11.1.2.3 Only properly trained, authorized individuals may enter the work area while cleaning is being performed.
- 11.1.3 **System Access:** Provide necessary access for cleaning and inspection of the ventilation system.
- 11.1.3.1 Remove and poly bag diffusers if transport to decontamination area will be through non-containment areas. Clean all grilles and diffusers. Thoroughly dry grilles and diffusers prior to re-installing after cleaning.
  - 11.1.3.2 Install service openings as specified in Appendix B in return air handling systems as necessary to facilitate inspection and cleaning procedures. Access points should not exceed fifty (50) foot intervals to accommodate procedures and final inspection, unless otherwise deemed acceptable by the building management or Environmental Cleaning Contractor.
  - 11.1.3.3 The structural integrity of the ductwork shall not be significantly altered by the installation of service openings (See APPENDIX B).
- 11.1.4 **Duct Zoning:** Ventilation system/duct cleaning firm will isolate sections of the ventilation system if needed to facilitate cleaning.
- 11.1.4.1 Prior to cleaning, ventilation system airflow control devices may be repositioned and zoning devices installed in diffusers and ductwork as necessary to facilitate negative airflow from vacuum collection equipment and to avoid contamination from entering the conditioned air spaces.
  - 11.1.4.2 All zoning devices shall be removed and airflow control devices reset to their pre-cleaning positions upon completion of cleaning in the work area they serve.
  - 11.1.4.3 Zoning devices must be disposed of or cleaned free of contaminant debris or other suitable measures employed to prevent cross-contamination prior to reuse in other ventilation system areas.

## 11.2 General Cleaning Procedures

- 11.2.1 Hand wet-wiping: Wiping may be performed in cases where dry cleaning methods such as HEPA vacuuming or mechanical brushing, cannot successfully remove contaminants of concern. Damp wiping should be performed with disposable towels or rags properly wetted with Simple Green or a similarly environmentally friendly degreasing agent. If disinfection is required, a Foster Products 40-80 HVAC and Wall Disinfectant or equivalent quarternary ammonium compound cleaning solution may be used.

It is not necessary to establish negative pressure in locations where wet wiping is the only cleaning performed. If possible, the components to be cleaned should be removed, placed in a 6-mil polyethylene bag, and cleaned outside of the occupant space. If removal of the components is not possible, use of a disposable drop cloth in the work area is recommended.

- 11.2.2 Manual HEPA vacuum with soft bristle brush attachment: Manually vacuum internal HVAC surfaces from top to bottom to remove all visible debris. Maintain the cleaning zone under negative pressure (minimum -0.02 inches water gauge) using a HEPA filtered air filtration device during manual vacuuming
- 11.2.3 Power driven mechanical or pneumatic brush system for duct runs: This type of equipment may only be used in ducts where negative pressure has been established using a HEPA filtered vacuum collection device (minimum of 3000 fpm air velocity in cleaning zone of the duct). Always work in the direction of the air flow. Apply the mechanical brushing equipment to dislodge debris from the interior surfaces of the duct. Following mechanical brushing, all surfaces of the cleaning zone shall be air washed with a pressurized air source to transport all dislodged debris to the vacuum collection device. *Note that air washing alone is not a sufficient cleaning method and will not be considered acceptable for proper duct cleaning.*
- 11.2.4 Chemical wet cleaning of evaporator or chilled water coils: Wet cleaning of the coils and drip pan shall be performed using commercially available coil cleaner, subject to approval of Environmental Professional. Saturate the coils with a pump sprayer and thoroughly rinse with clean water. Cleaning solution and rinse water will collect in the condensate drain pan; if significant lead or asbestos contamination has been identified in the dust on the coils and/or in the drain pan, the water must be collected and tested for proper disposal.

Maintain the cleaning zone under negative pressure using a HEPA filtered air filtration device. If odors are present and it is not possible to exhaust the HEPA filtered air filtration device outside the building, it may be necessary to use an activated carbon bed in air filtration device to eliminate odors.

- 11.2.5 Electric Heating and Reheat coils: Clean electric heating and reheat coils using only dry methods. No water or encapsulant may come into contact with electric heating or re-heat coils. Dry clean using one or more of the following methods:

- 11.2.6 Manual HEPA vacuum
- 11.2.7 Pressurized air cleaning (only if cleaning zone is maintained under negative pressure)
- 11.2.8 Manual brushing using manual HEPA vacuum to collect dust

Maintain the cleaning zone under negative pressure using a HEPA filtered air filtration device whenever possible.

### 11.3 Site-specific Cleaning Procedures

#### 11.3.1 Lemon Grass Restaurant

This is a 2,351 sq ft space with variable ceiling height. One air handling unit is located above the ceiling toward the south end of the floor. This is a recirculating air unit with no outdoor air supply. Return air enters the unit through a grille located in the side of the unit. The air handling unit is accessible and is provided with access doors. The air handling unit distributes supply air through a main supply air duct and several branch ducts. Supply air diffuser openings are located on the underside of the supply duct (most of the diffusers have been removed). The supply diffuser openings extend in a line to the north of the air handling units and are spaced approximately 15' apart. There are approximately four 18" supply diffuser openings located to the north of the air handling unit. There is a separate ducted make-up air system that delivers outdoor air to the cooking stations. The make-up air system consists of a single duct with diffuser openings on the underside of the duct, and a blower assembly that is located in-line with the duct. Outdoor air is provided to the make-up air system through a ducted outdoor air intake located in an exterior wall of the building approximately 10' above ground level.

#### VENTILATION SYSTEM COMPONENTS TO BE CLEANED

The following system components will be cleaned in the Lemon Grass Restaurant:

- a. Air handling unit and components
- b. Reheat Coil
- c. Supply air ducts and terminal diffusers
- d. Makeup Air System
- e. Dissembled Duct Sections on Floor

#### CLEANING PROCEDURES

General: Any interior surfaces of the air handling unit or ventilation system that are porous shall be cleaned using manual HEPA vacuuming methods. After successful completion of visual inspection and verification sampling, a lockdown encapsulant shall be applied to the porous surfaces using a hand-operated sprayer or brush, using care not to coat electrical or mechanical components.

Note that if any disassembly of the air handling units is required to complete the work, the air handling unit shall be reassembled by a qualified HVAC professional after all parts are dry and are verified clean.

Note that all HEPA air filtration devices and HEPA-filtered vacuum collection devices shall be exhausted to the outdoors.

## Air Handling Unit

1. Ensure that the air handling unit motor is locked out and is electrically isolated, and place the air handling unit and its components under containment prior to beginning work. A temporary Zip-wall containment of 6-mil, fire retardant polyethylene sheeting extending from the floor to the ceiling deck, and maintained under negative pressure using a HEPA-filtered air filtration device is sufficient. The footprint of the containment should be large enough to accommodate a ladder or scaffolding. Note that WRS Infrastructure and Environment, Inc. may construct the containment prior to the start of ventilation system cleaning. In addition, WRS Infrastructure and Environment, Inc. shall install a service opening to facilitate cleaning of interior components. The access panel shall be installed in the supply air duct between the blower and the reheat coil.
2. Clean the filter racks at the return air side of the unit by damp wiping.
3. Prior to cleaning, place polyethylene sheeting underneath the coils. Wet clean the upstream and downstream sides of cooling coils. Apply manufacturer-approved cleaning solution to the coils using low pressure methods (i.e., airless sprayer, hand operated pump).
4. Clean the blower assembly and blower housing in place. The blower assembly and blower housing shall be cleaned by a combination of hand vacuuming, damp wiping and air washing. As required in this document, air washing shall only be performed after a vacuum collection device has been installed.
5. HEPA vacuum remaining interior surfaces and components (e.g., condenser equipment and compartment, controls, outside air vent to condenser compartment) to remove all visible debris. No encapsulant materials may be used inside the condenser compartment.
6. Perform a final cleaning by wet-wiping and/or HEPA vacuuming methods of the interior work area containment surfaces, ladders, equipment etc. prior to final visual inspection and wipe sampling.

## Reheat Coils

1. Clean the electric reheat coil (located inside the supply air duct) by dry vacuuming or air washing. No liquids may come into contact with the electric reheat coil.

## Supply Air Ducts and Terminal Diffusers

1. Remove all terminal diffusers into 6-mil polyethylene bags and proceed to the enclosure constructed for cleaning of the air handling unit. Terminal diffusers shall be wet-cleaned. The diffusers should be sprayed with Simple Green or a similar environmentally safe degreaser and hand washed as needed to remove adhered materials.
2. Seal the diffuser openings using 6-mil polyethylene sheeting to be secured with duct tape.
3. Install a vacuum collection device at the terminal end of the duct section to be cleaned. If the entire duct is not cleaned as one unit, then isolate the section of the duct to be cleaned using a zoning device.
4. The supply air duct shall be cleaned using a pressurized air/mechanical brush system in combination with a vacuum collection device. The direction of cleaning shall be from the air handler toward the terminal end of the duct. (It is permissible to use a mechanical brush followed by application of pressurized air in lieu of combination style equipment.) The

vacuum collection equipment shall be configured to maintain a minimum of 3000 feet per minute air velocity in the cleaning zone.

#### Make –Up Air System

1. All non-porous surfaces of the outdoor air intake located on the exterior of the building shall be cleaned using manual wet-wiping and HEPA vacuuming methods as needed to remove adhered materials. Note that the air intake for the condenser compartment of the air handling unit is located adjacent to the outdoor air intake for the makeup air system and should be cleaned concurrently.
2. The section of the duct from the outdoor air intake through the blower unit shall be cleaned using HEPA vacuum methods. It may be necessary to install a service opening in order to perform this cleaning.
3. Clean blower assembly and blower housing in place by a combination of hand vacuuming, damp wiping and air washing. As required in this document, air washing shall only be performed after a vacuum collection device has been installed.
4. Seal the diffuser openings using 6-mil ethylene sheeting to be secured with duct tape.
5. The makeup air duct shall be cleaned using a pressurized air mechanical brush system in combination with a vacuum collection device. The direction of cleaning shall be from the blower assembly toward the terminal end of the duct. (It is permissible to use a mechanical brush followed by application of pressurized air in lieu of combination style equipment.) It may be necessary to install a service opening in order to perform the duct cleaning. The vacuum collection equipment shall be configured to maintain a minimum of 3000 feet per minute air velocity in the cleaning zone.

#### Dissembled Duct Sections on Floor

1. Transport dissembled duct sections to the enclosure constructed for cleaning of the air handling unit for wet cleaning. The dissembled duct sections should be sprayed with Simple Green or a similar environmentally safe degreaser and hand washed as needed to remove adhered materials.

#### 11.3.2 Food Exchange Restaurant

This is a 2,324 sq ft space with 10' high suspended acoustical ceiling on the south side and a solid gypsum drywall suspended ceiling on the north side. An older tin ceiling is present on the deck of the south side and an additional layer of gypsum is attached to the deck on the north side. Prior to the start of work, the suspended acoustical ceiling on the south side will be removed by WRS Infrastructure and Environment, Inc.

Two nearly side-by-side air handling units are located above the ceiling. These are recirculating air units with no outdoor air supply. Return air enters the ceiling plenum through passive return grilles located in the false ceiling below each unit. The air handling units draw return air from the ceiling plenum through grilles in the sides of the units. The air handling units distribute supply air to supply air ducts that extend to the north and to the south of the units. The ducts are approximately 50' long (north-south dimension). Supply air is distributed to the occupant space through supply diffusers off of the supply duct; the diffusers are flush with the false ceiling. There are supply grilles off the supply air duct that extend in a line to the north and to the south

of the air handling units; these are spaced approximately 15' apart. There are 5 supply grilles each located to the north and south of the air handling units.. The air handling unit is not provided with access doors and is difficult to access.

## VENTILATION SYSTEM COMPONENTS TO BE CLEANED

The following system components in the Food Exchange Restaurant will be cleaned:

- a. Air handling units and components
- b. Supply air ducts and terminal diffusers

## CLEANING PROCEDURES

General: Any interior surfaces of the air handling unit or ventilation system that are porous shall be cleaned using manual HEPA vacuuming methods. After successful completion of visual inspection and verification sampling, a lockdown encapsulant shall be applied to the porous surfaces using a hand-operated sprayer or brush, using care not to coat electrical or mechanical components.

Note that if any disassembly of the air handling units is required to complete the work, the air handling unit shall be reassembled by a qualified HVAC professional after all parts are dry and are verified clean.

Note that all HEPA air filtration devices and HEPA-filtered vacuum collection devices shall be exhausted to the outdoors.

### Air Handling Units

1. Ensure that the air handling unit motors are locked out and is electrically isolated, and place the air handling units and their components under containment prior to beginning work. A temporary Zip-wall containment of 6-mil, fire retardant polyethylene sheeting extending from the floor to the ceiling deck, and maintained under negative pressure using a HEPA-filtered air filtration device is sufficient. The footprint of the containment should be large enough to accommodate a ladder or scaffolding. Note that WRS Infrastructure and Environment, Inc. may construct the containment prior to the start of ventilation system cleaning.
2. Clean the filter racks at the return air sides of the units by damp wiping.
3. Prior to cleaning, place polyethylene sheeting underneath the coils. Wet clean the upstream and downstream sides of cooling coils. Apply manufacturer-approved cleaning solution to the coils using low pressure methods (i.e., airless sprayer, hand operated pump).
4. Clean the blower assembly and blower housing in place. The blower assembly and blower housing shall be cleaned by a combination of hand vacuuming, damp wiping and air washing. As required in this document, air washing shall only be performed after a vacuum collection device has been installed.
5. HEPA vacuum remaining interior surfaces and components to remove all visible debris. No encapsulant materials may be used inside the condenser compartment.

## Reheat Coils

1. Note that if reheat coils are present, by dry vacuuming or air washing. No liquids may come into contact with the electric reheat coil.

## Supply Air Ducts and Terminal Diffusers

1. Remove all terminal diffusers into 6-mil polyethylene bags and proceed to the enclosure constructed for cleaning of the air handling unit. Terminal diffusers shall be wet-cleaned. The diffusers should be sprayed with Simple Green or a similar environmentally safe degreaser and hand washed as needed to remove adhered materials.
2. Seal the diffuser openings using 6-mil polyethylene sheeting to be secured with duct tape.
3. Install a vacuum collection device at the terminal end of the duct section to be cleaned. If the entire duct is not cleaned as one unit, then isolate the section of the duct to be cleaned using a zoning device.
4. The supply air duct shall be cleaned using a pressurized air/mechanical brush system in combination with a vacuum collection device. The direction of cleaning shall be from the air handler toward the terminal end of the duct. (It is permissible to use a mechanical brush followed by application of pressurized air in lieu of combination style equipment.) The vacuum collection equipment shall be configured to maintain a minimum of 3000 feet per minute air velocity in the cleaning zone. (See Requirements Section for use of this equipment.)

### 11.3.3 Combustion Make-up Air Riser

The combustion make-up air riser extends from the ceiling of a second floor mechanical closet to the roof of the building.

## VENTILATION SYSTEM COMPONENTS TO BE CLEANED

The following system components will be cleaned:

- a. Combustion riser
- b. Associated vents
- c. Roof cap

## CLEANING PROCEDURES

Note that the HEPA-filtered vacuum collection devices shall be exhausted to the outdoors.

### Combustion riser, associated vents and roof cap

1. Remove all vents into 6-mil polyethylene bags and proceed to work area appropriate for cleaning the vents. The vents shall be wet-cleaned. The vents should be sprayed with Simple Green or a similar environmentally safe degreaser and hand washed as needed to remove adhered materials.
2. Seal the vent openings using 6-mil polyethylene sheeting to be secured with duct tape.
3. Install a vacuum collection device at the bottom of the riser on the second floor.

4. The combustion riser shall be cleaned using a pressurized air/mechanical brush system in combination with a vacuum collection device. The direction of cleaning shall be from the roof down toward the second floor. (It is permissible to use a mechanical brush followed by application of pressurized air in lieu of combination style equipment.) The vacuum collection equipment shall be configured to maintain a minimum of 3000 feet per minute air velocity in the cleaning zone. (See Requirements Section for use of this equipment.)
5. Remove the roof cap if possible and place on a polyethylene sheet. Wet-clean by damp wiping in place or if removed, spray with Simple Green or a similar environmentally safe degreaser and hand wash as needed to remove adhered materials.

## APPENDIX A DEFINITIONS

1. **Access Doors:** Covers for service openings consisting of pre-fabricated operable or removable entry panels, which are installed in a ventilation system to facilitate inspection and maintenance services.
2. **Air Conveyance System, Air Handling System, HVAC System, Ventilation System:** The ventilation system is any interior surface of a building's air distribution system for conditioned spaces and/or occupied zones (See definition of air handling system, ASHRAE 62-1989). This includes the entire air distribution system from the points that the air enters the system to the points that air is discharged from the system. The return air grilles, air ducts (except ceiling plenums) to the air handling unit (AHU), the interior surface of the AHU, mixing box, coil compartment, condensate drain pans, humidifiers, and dehumidifiers, supply air ducts, fans, fan housing, fan blades, spray eliminators, turning vanes, filters, filter housings, reheat coils, and supply diffusers are all considered part of the ventilation system.
3. **Air Filtration Device (also referred to as Negative Air Machine):** An external air moving device which can be temporarily connected to a section or sections of an ventilation system to create negative airflow for cleaning and remediation procedures, employing a minimum of DOP-tested HEPA final filtration if exhausted indoors.
4. **Air Washing:** For duct cleaning, this term applies to the use of pressurized air, in combination with a Vacuum Collection Device, for transporting dislodged debris into the vacuum collection equipment.
5. **Ceiling Plenum:** A non-ducted area between the ceiling over a conditioned building space and the floor above, through which air is transported to a conditioned space from an ventilation system (ceiling supply air plenum), or from a conditioned space to an ventilation system (ceiling return air plenum).
6. **Coils:** Devices inside the ventilation system, which temper and/or dehumidify the air transported by the ventilation system. These include heat exchangers, with or without extended surfaces, through which either water, ethylene glycol solution, brine, volatile refrigerant, steam, or electricity is circulated for the purpose of total cooling (sensible cooling plus latent cooling) or sensible heating of a forced-circulation air stream (See ASHRAE 33-78 and ARI 410-91).
7. **Debris:** Any solid materials, including particulate substances, in the ventilation system not intended to be present.
8. **DOP Testing:** The percentage of removal of 0.3 micrometer particles of dioctylphthalate (DOP) is used to rate high efficiency air filters, those with efficiencies above about 98 percent (See Military Standard 282, U.S. Department of Defense, 1956).
9. **Ductwork (Ducts):** A system of passageways for distribution and extraction of air (See ASHRAE Terminology of Heating, Ventilation, Air Conditioning, and Refrigeration, 1991).

10. **Encapsulation:** The application of a bridging (resurfacing) or penetrating compound on internal ventilation system surfaces to bond, mechanically resurface, or lock-down fibrous and other ventilation system components which have deteriorated or been damaged, to control the entrainment of particulates from these components into the airstream.
11. **Environmental Cleaning Contractor:** The Environmental Cleaning Contractor at 110 Liberty Street is WRS Infrastructure and Environment, Inc., as the authorized by the USEPA .
12. **Environmental Service Contractor:** An independent environmental contractor performing an initial assessment of the WTC-related dust, as authorized by the USEPA
13. **Fan:** A power driven machine that moves a volume of air by converting rotational mechanical energy to an increase in the total pressure of the moving air (See AMCA 99-86).
14. **HEPA Filter:** High efficiency particulate air filter capable of a 99.97% collection efficiency for a 0.3 micron size particle as per DOP testing.
15. **Mechanical Cleaning:** Physical removal of debris and other foreign matter from ventilation system surfaces.
16. **Negative Air (Vacuum Collection) Cleaning:** Procedure for removal of debris from a ventilation system using a HEPA-filtered Vacuum Collection Device for particulate control and capture.
17. **Non-Porous Surface:** Any surface of the ventilation system in contact with the air stream which cannot be penetrated by either solutions or air. This would exclude ventilation system materials such as wood, fiberboard, thermal/acoustic insulation, and concrete.
18. **Porous Surface:** Any surface of the ventilation system in contact with the air stream which can be penetrated by either solutions or air, including but not limited to ventilation system materials such as wood, fiberboard (ductboard), fibrous thermal/acoustic insulation, and concrete.
19. **Pressure Drop:** (1) Loss in pressure, as from one end of a refrigerant line to the other, from friction, static, heat, etc. (2) Difference in pressure between two points in a flow system, usually caused by frictional resistance to fluid flow in a conduit, filter, or other flow system (See ASHRAE Terminology of Heating, Ventilation, Air Conditioning, and Refrigeration, 1991).
20. **Sanitization:** A process to reduce the proliferation of microbial growth in an ventilation system, usually involving the application of a biocide agent.
21. **Source Removal:** An HVAC hygiene mitigation process, which involves the physical capture, removal, and controlled containment of foreign matter from an ventilation system.
22. **Static Pressure:** The normal force per unit area that is exerted on the interior surfaces of the ventilation system by the air.

23. **ULPA Filter:** High efficiency particulate air filter capable of a 99.99% collection efficiency for a 0.1 micron size particle.
24. **Vacuum Collection Device or Equipment:** a HEPA-filtered device for duct cleaning used to place a duct system or sections of a duct system under negative pressure and to collect and transport dust and debris that has been dislodged by mechanical cleaning. This device overcomes greater static pressures than those typical of air filtration devices.
25. **Ventilation system/duct cleaning firm:** Service firm contracted to provide ventilation system cleaning and/or hygiene remediation for a facility.
26. **Visibly Clean:** Determined by internal visual inspection, that all portions or components of the ventilation system are free of any visible debris.
27. **Visual Inspection:** Examination of ventilation system components to evaluate the presence of visible contamination using the human eye or other optical instrument. Visual inspection may be aided by the use of telescoping inspection mirrors and flashlights inserted through service openings.
28. **Visual Inspection System (VIS):** Optical device such as a still camera, borescope, or CCTV (closed circuit television) video camera system employed to perform a visual hygiene evaluation and/or documentation of internal areas in an HVAC system.
29. **Zoning Device:** A physical barrier consisting of a balloon or other device for blocking/segregating a ventilation duct.

## **APPENDIX B**

### **INSTALLATION OF SERVICE OPENINGS IN AIR HANDLING SYSTEMS**

- [B.1] Service openings in Sheet Metal Ventilation System Components: Any Service openings shall be made in such a way as to not significantly weaken the structural integrity of the metal ventilation system component and provide an air tight seal once secured. Ventilation system/duct cleaning firm must provide a finished surface deemed visually acceptable by the Client and in the opinion of the Client, not reduce the building's aesthetic qualities. Work cut and patched in an unsatisfactory manner shall be removed and replaced by the Ventilation system/duct cleaning firm at no additional cost to the Client. Upon completion of inspection and/or cleaning services, the Service openings shall be sealed in accordance with job specifications, with one of the following closure techniques:
- (1) Install gasketed removable Access Doors.
  - (2) Install sheet metal panels fastened with sheet metal screws and sealed with silicone chalk, mastic or duct sealant.
- [B.2] Service openings in Externally Insulated Sheet Metal Ventilation System Components: (See [C.1] Service openings in Sheet Metal Ventilation System Components) Upon closure of Access Hole, external insulation must be replaced as necessary and the edges secured with either an approved water-based bridging encapsulant for canvas-wrapped insulated duct exteriors or reinforced 4" wide foil tape on foil-faced insulated duct exteriors.
- [B.3] Service openings in Fibrous Lined Sheet Metal Ventilation System Components: Any Service openings shall be made in such a way as to not significantly weaken the structural integrity of the metal ventilation system component or create fiber shed from the internal insulation at the cut area once the Access Hole is closed. Upon completion of inspection and/or cleaning services, the Service openings shall be sealed in accordance with the following closure techniques:
- (1) Install gasketed, insulated Access Doors. The cut edge of the internal insulation lining at the Access Hole must be sealed with an approved Bridging Encapsulant to prevent fiber shed, and the insulation on the cover plate should fit securely in the cut-out area.
  - (2) Pressure fitting round hole plugs (for Service openings 3" diameter or smaller in low/medium positive air pressure applications) after an approved ventilation system Bridging Encapsulant has been applied to the cut edge of the internal insulation to prevent fibershed.
  - (3) Install sheet metal panels affixed with similar insulation to match the removed portion of insulation from the service opening, fastened with sheet metal screws and sealed with silicone chalk, mastic or duct sealant. The cut edge of the internal insulation lining at the Access Hole must be sealed with an approved bridging encapsulant to prevent fiber shed, and the insulation on the cover plate should fit securely in the cut-out area.

[B.4] Service openings in Fibrous Glass Ventilation System Components (Duct board): Any Service openings shall be made in such a way as to not significantly weaken the structural integrity of the Fibrous Glass Ventilation System Component or create fiber shed from the product at the cut area once the Access Hole is closed. Upon completion of inspection and/or cleaning services, the Service openings shall be sealed in accordance with job specifications, with one of the following closure techniques:

- (1) Install gasketed, insulated Access Doors which will seal the internal cut edge to prevent fibershed, or after an approved ventilation system Bridging Encapsulant has been applied to the cut edge of the internal insulation to prevent fibershed
- (2) Make a shiplap or a 45 degree inward "pumpkin" access cut in the ductboard, and reinstall the cut piece after inspection and/or cleaning with a tape that complies with UL 181 or UL 181A closure systems (See NAIMA's Cleaning Fibrous Glass Insulated Air Duct Systems - Recommended Practice, 1993).