# Residential Air Conveyance System Restoration

ACS cleaning is a new emerging market that is increasingly catching the attention of homeowners everywhere! Let's look at the facts that have prompted all this attention:

- 50% of all illnesses are either caused or aggravated by polluted indoor air
- Children are more likely than adults to be affected by polluted indoor air
- Indoor air has been found to be up to 70 times more polluted than outdoor air
- The average six room house collects over 40 pounds of dust each year

## Common Symptoms of Sick Homes

| | |
|---|---|
| Headaches | Hay Fever |
| Lethargy | Dry Throat |
| Eye Irritations | Nausea |
| Sinusitis | Chronic Upper Respiratory Infections |

Research on deodorants within our industry indicates that the mass median diameter (MMD) of typical smoke particles is approximately 0.1 – 10.0 microns (1 micron = micrometer – 1/1,000,000 of a meter; e.g., the dot over an "i" is approximately 400 microns and the eye of a needle is about 800 microns in size.) The ciliated surfaces on human bronchial passages (small, hair – like structures) are capable of filtering out particles down to ten microns in size. Smaller particles, such as a smoke or soot, can easily by pass the lungs' natural filtering mechanisms (the cilia) and eventually lodge in the lung's alveoli. The alveoli are small sacs within the lung tissue that transfer oxygen from respired air through a thin, delicate membrane into the body's blood circulation system.

At *best*, these smoke particles averaging approximately 4 microns simply irritate delicate lung tissues: at *worst*, when breathed in quantity over prolonged periods, they may cause permanent damage. With impaired respiratory function, the lungs and heart must work harder to convey oxygen to vital organs. This is of great concern in structures occupied by the elderly, or those already suffering from some form of respiratory impairment (bronchitis, asthma, hay fever, emphysema, even heart problems – about 38% of the population: U.S. EPA, 1986). *Of primary concern to health professionals is the effect of these particles on he developing respiratory systems of infants and children (about 9% of the population) who may be exposed for prolonged periods. All the more reason why conscious technicians must apply ACS restoration procedures carefully and meticulously!*

The following defines the type and size of common household airborne particles:

| **Airborne Particle** | **Particle Size in Microns (1 Micron = 1/25,400")** | | |
|---|---|---|---|
| Tobacco Smoke | 0.01 | to | 1.0 |
| Combustion Smoke | 0.1 | to | 4.0 |

| | | | |
|---|---|---|---|
| Atmospheric Dust | 0.01 | to | 1.0 |
| Household Dust | 0.01 | to | 300.0 |
| Skin Flakes | 1.0 | to | 10.0 |
| Animal Dander | .07 | to | 10.0 |
| Cooking Grease and Smoke | 0.02 | to | 10.0 |
| Insecticide Dust | 0.1 | to | 10.0 |
| Coal Dust | 1.0 | to | 100.0 |
| Fumes | 0.1 | to | 1.0 |
| Mold and Mildew Spores | 3.0 | to | 30.0 |
| Bacteria | 0.1 | to | 10.0 |
| Virus | 0.03 | to | 0.25 |
| Pollen | 10.0 | to | 100.0 |
| Hair | 30.0 | to | 120.0 |
| ULV Fogger | 8.0 | to | 15.0 |
| Thermal Fogger | 0.5 | to | 2.0 |

*Particles below 0.2 microns are visible with an electron microscope (0.001 to 0.2 microns).*
*Particles 0.1 to 10 microns are visible with a microscope*
*Particles 10 microns and larger are visible to the naked eye*
*(Source: Stanford Research Institute)*

The single most common denominator surrounding IAQ problems is the **Air Conveyance System!**

In order to fully understand the cleaning of the air conveyance system, we should first outline the components and get some nomenclature down.

**A.** The **Air Conveyance System** within a home or business provides for the circulation of air that may be heated, cooled, or re-circulated and is comprised of all components that deliver the air into the system, condition it, and distribute it to the work/home areas.

This system generally consists of:

**1.** **Intake (Air Return) System**
This is where the system draws in the air and may be large, centrally located in, usually within a hall; or return branch inlets located in several rooms of the structure that feel from a main line.

**2.** **Air Filter**
A filter encased in a frame that is used to remove airborne contamination as it enters the return side of the system. There are several types of filters:

**a.** An expensive bag, panel, or pleated type of disposable is most common. These filters should be removed, disposed of, and replaced with new or preferably high grade filters.

**b.** Permanent (reusable, washable) filters may be installed to trap a higher quantity of particles. Most often called **Electrostatic Filters,** they are

made of plastic media that creates and holds a static charge when air is passed through it. This static charge attracts particles and holds them. This type of filter removes a higher percentage of particles, pollen, and spores, and therefore, is much more efficient.

**c.** An electronic precipitator is a filtering device that uses not only a prefilter to catch particles, pollen, and some microorganisms, but it also uses electrical current (tungsten ionizing wires) to charge particles positively, along with negatively charged collector plates to attract particles down to 0.01 microns MMD. Although the prefilter and collector plates are designed to be removed and cleaned periodically, to properly clean and service an electronic filter system subjected to intense smoke damage may require the services of a qualified ACS service technician to properly disconnect, clean and reconnect the entire system to its electrical circuitry.

The **Air Filter** may be located at the return air entrance to the system or in the air handler near the fan.

**3. <u>Air Conveyance Ducts</u>**

These are the pathways that direct the air to the air handler and then distribute the conditioned air. These ducts can be made of several materials and be constructed in a variety of shapes and sizes:

**a.** Sheetmetal (round, square or rectangular)
**b.** Ductboard (square or rectangular)
**c.** Flexible (plastic) Wire Spiral Bound (round) – Flex Duct
**d.** An integral part of the structure (studs, joists, sheetwork)

Sheetmetal duct may be plain, internally insulated, or externally insulated. Flex duct is typically externally wrapped with insulation material. Ductboard is simply compressed fiberglass formed to created a stiff board material approximately _" – 1" thick. These sheets are cut and made into various square or rectangular shapes. This insulation has a two-fold purpose. First, it serves as a sound absorption medium to dampen vibrations and the noise generated by the air handler and the air flow. Second, it prevents temperature loss as the air moves down the system. *The internal sound/insulation liner complicates restoration/cleaning in that it absorbs contaminants during use, and it makes it difficult to remove those contaminants once they have been absorbed.*

The **Main Air Duct** or **Central Trunk Line** extends down the central portion of the structure. Typically sheetmetal or ductboard, it is progressively reduced in size as it extends away from the air handler in order to maintain uniform flow and pressure to all outlets.

**Branch (Feeder) Lines** convey forced air from the central trunk line to individual rooms. Branch outlets may be located within the ceiling wall or floors depending on the overall construction of the structure.

**4.** **Fresh Air Intake Ducts**

Normally found in commercial buildings, and in some residential structures, this portion of the ACS provides fresh air mixing (air exchange) to prevent the build-up of stale contaminated air. Dampers, motors, and linkage may be present to vary the amount of fresh air mixed with return air within the ACS.

**5.** The **Air Handler** of the ACS does the job of conditioning the air and moving it throughout the system. It generally has several components:

**a.** (Possible Location) **Air Filter** for trapping pollutants (Section 2)

**b.** **Blower Motor and Fan –** Mechanical components may include a blower (usually a squirrel-cage) operated by an electrical motor, turning approximately 12 – 1500 cfm (residential). The purpose of the blower is to increase air pressure and air flow through the ACS.

**c.** **Heat Components –** A heat generation (oil, gas, or electric) and transfer unit will be found in most ACSs. Circulating air that enters the system passes over electrical coils where heat transfer takes place; or it passes around baffles that are heated by fuel oil or LP gas. Fresh air enters the combustion chamber through a fresh air intake and combusted gases escape from the system through as separate exhaust.

**d.** **Cooling Components -** The cooling system generally consists of a compressor, aluminum or copper coils and a condensation collection tray (drip pan). The compressor unit compresses a gas (Freon or an equivalent) and forces it through the cooling coils in a continuously re-circulating cycle. As intake air passes over the cooling coils, the air is chilled and then blown into the structure. Humidity in the intake air will condense on the cool metal coils, causing moisture droplets to form. These droplets will drip into a pan under the coils and be channeled through copper or PVC tubing to the exterior of the structure. *In warm, humid weather, algae and other fungi may form in the drip pan or within the drain tubes, causing a backup of water that eventually can overflow into the structure, causing considerable damage!*

**6.** **Plenum Box** may be used when a central trunk line in to present. The Plenum is the chamber immediately after the air handler from which each supply duct branches out to the individual rooms.

**7.** **Diffusers, Registers (Inlet and Outlet Covers)**
These louvered covers are designed to be opened or closed to allow greater or lesser quantities of air to enter an individual room based on occupant preference. The outlet covers also direct the flow of air to a specific portion of that room.

**8. Thermostat**

The thermostat controls the level of temperature (and in some cases humidity) within the structure

**B.** Proper ACS restoration/cleaning is called **Source Removal** meaning that the entire ACS system is accessed and all interior surfaces are addressed to remove as best as possible all contaminants both *particulate* and *microbial.*

Restoration contractors will require several items of equipment in order to undertake professional ACS restoration. This equipment generally includes:

**1. Power Tools**

An electrical or battery powered, _" variable-speed hand drill will be required for cutting holes (up to 12" diameter) for the flex duct attachment collar, or for drilling access holes in main duct lines into which nozzles and air lines may be inserted. Obviously, a few hand tools will be required for removing and replacing vent and compartment access covers. Safety glasses, various sizes of drill bits and extension cords may be needed as well.

**2. Auxiliary Filtration/Collector Unit**

A high-velocity (around 2500 cfm) auxiliary blower unit (operating on household current) is attached to the ACS to provide continuous air movement throughout cleaning and restoration procedures. Various gauges enable the technician to monitor the condition (blockage) of the filters during operation. This auxiliary blower/filtration unit may be used simply as an extremely efficient air purification unit to provide healthier breathing air directly to soot contaminated areas where workers must spend prolonged periods in the restoration process (e.g. kitchen pack-outs). This unit may incorporate up to four filtration systems:

**a.** A **bag or screen prefilter** is designed to collect large clumps of solid debris that is removed from extremely soiled, usually older systems.
**b.** A **bag house filter** is used to collect a high percentage (up to 85%) of all particles down to ten microns in size, and to prolong the life of the more expensive HEPA filter.
**c.** A **high efficiency particle attracting HEPA) filter** is used to attract 99.97% of all particles down to0.3 microns in size (including molds, pollen, and most bacteria.)
**d.** An **activated charcoal filter** may be used to remove most volatile organic compounds (VOCs), in situations where these VOCs may create health or odor problems.

**3. Flexible Ducting**

As a minimum, 25 foot sections of 8", 12", or 14" flexible plastic ducting is used to attach the auxiliary blower/filtration unit to the structure's ACS. Metal collars (8", 12", 14") that can be attached to sheet metal ductwork, are included in this equipment classification. A 14" reducing collar may be attached to the auxiliary

blower unit to provide airflow from two 8" lines connected to separate points on the ductwork.

**4. Compressor**

A portable, gas (8 – 10 hp) or electric powered (typically 220V), light duty compressor that generates at least 150 psi is required to operate various cleaning devices that are used for "air washing" ACS components, and are fed into individual room supply ducts to dislodge soot and accumulated soil.

**5. Air Lines and Compressed Air Cleaning (Blowdown) Nozzles)**

Either semi-rigid or flexible, non-marking compressed air lines are quick-coupled to the compressor and to various blowdown nozzles. If the compressor is gasoline powered and must remain outside the structure, several extra lengths of air hose will be needed. A variety of nozzles serve different purposes in ACS restoration.

- **a.** **A Compressed Air Gun** (with extension) is required for "air washing" louvered vent diffusers, cooling coils, and other mechanical components.
- **b.** **A Forward Blowdown Air Nozzle** may be attached to a semi-rigid line and fed into the ACS to air wash rust off interior surfaces and into the air stream provided by the auxiliary blower unit.
- **c.** **A Reverse Thrust Air Nozzle** or "skipper" may be used to propel flexible air lines into the ACS, knocking loose contaminants as it enters; and further cleaning interior surfaces as it is pulled out of the system.
- **d.** **A Whip Cleaning Device** is made of a flexible piece of plastic or latex hose that is fed into the ACS on the end of the semi-rigid air hose. The rapid whipping action uses a combination of physical contact and compressed air to knock or blow loose debris into the air stream generated by the auxiliary blower unit.

**6. Brushes**

Brushes of varying diameters with long, flexible bristles (chimney sweep brushes: 6", 8", 10", 12") are used in very heavily soiled air duct systems to physically brush contaminants from interior walls. These brush heads are normally attached to the ends of semi-rigid extension rods that enable technicians to reach far within individual air ducts.

**7. Auger**

An electrically powered or drill driven unit is often used to power the flexible cable (25' – 35' length) that attaches to the brushes mentioned above. A power nylon strap can also be used on the auger unit to scrub a variety of duct shapes, sizes, and possibly even internally insulated ducts.

**8. Miscellaneous Supplies**

Various knockout plugs (1 or 2"), metal plates and self-tapping screws will be required to reseal the ACS when restoration is complete. Assorted rivets, along

with a rivet gun, also may be useful for sheet metal repair. Also, anticipate the need for a tape measurer and heavy duty flashlight.

**9. Pump Sprayer**

A hand pump spray or fogger and appropriate EPA registered air duct sanitizer may be needed for complete restoration of an ACS that displays considerable biocontamination, or when prolonged exposure to excess moisture is experienced – floor ducts exposed to water damage, for example.

**10. Video Monitoring Equipment**

This equipment is used to evaluate ACS internal surfaces both before and after restoration. It consists of a small portable monitor and a camera with an optical probe that can easily fit into holes drilled in the ductwork at various intervals.