

Commercial HVAC 101

Typical System Components & Cleaning Techniques



2023 FALL TECHNICAL CONFERENCE

SEPTEMBER 7-9, 2023 | GRAPEVINE, TEXAS

Embassy Suites by Hilton Grapevine DFW Airport North

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Presenter



Brooks Ingrassia

Brooks Ingrassia has been involved with NADCA for over 10 years. A managing partner of True Cleaning Solutions, has served on a variety of committees and as a member of the Board of Directors.

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Disclaimer

This presentation is not intended to be a comprehensive program covering all aspects of this topic. All technicians are encouraged to read and follow all applicable standards, codes and regulations related to this topic.

- ✓ It is the responsibility of each individual contractor to follow local building codes and licensing requirements and to work safely in accordance with OSHA guidelines.
- ✓ It is the contractor's responsibility to take proper precautions on each project to prevent cross contamination. Always take the health and safety of the building occupants into consideration before you conduct any cleaning procedures.
- ✓ All of the following tips are only general tips. They do not cover every situation and it is your responsibility to adapt these tips to the individual system you are working on.
- ✓ The Instructor is not responsible in any way for the work you perform after viewing this slide show. You are responsible for your own work.
- ✓ The views and opinions following are the instructors' opinions and not necessarily the official position of the National Air Duct Cleaners Association.



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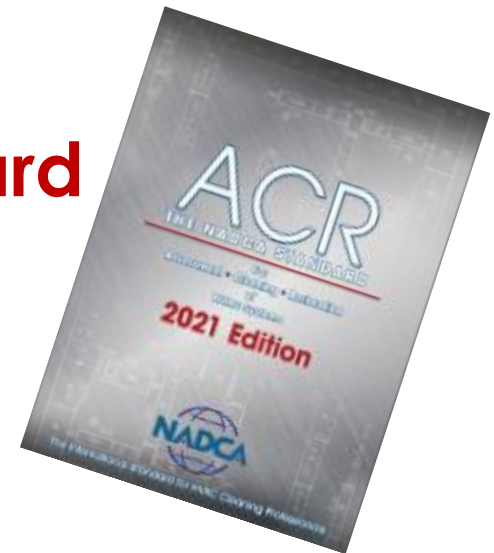
Supplemental Materials

This session covers key points but not every detail.

The tips & techniques presented are for cleaning & restoration procedures.

For a full understanding of this topic, attendees are encouraged to review additional materials including:

ACR, The NADCA Standard 2021 Edition





What We'll Learn

- Types of HVAC Systems
- Typical Components
- Tips for Cleaning These Systems
- Cleaning Requirements



Section 1: Types of Systems

Typical commercial system types:

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- Variable Air Volume
- Constant Volume
- Dual Duct
- Single Zone
- Multiple Zone



Section 1: Types of Systems

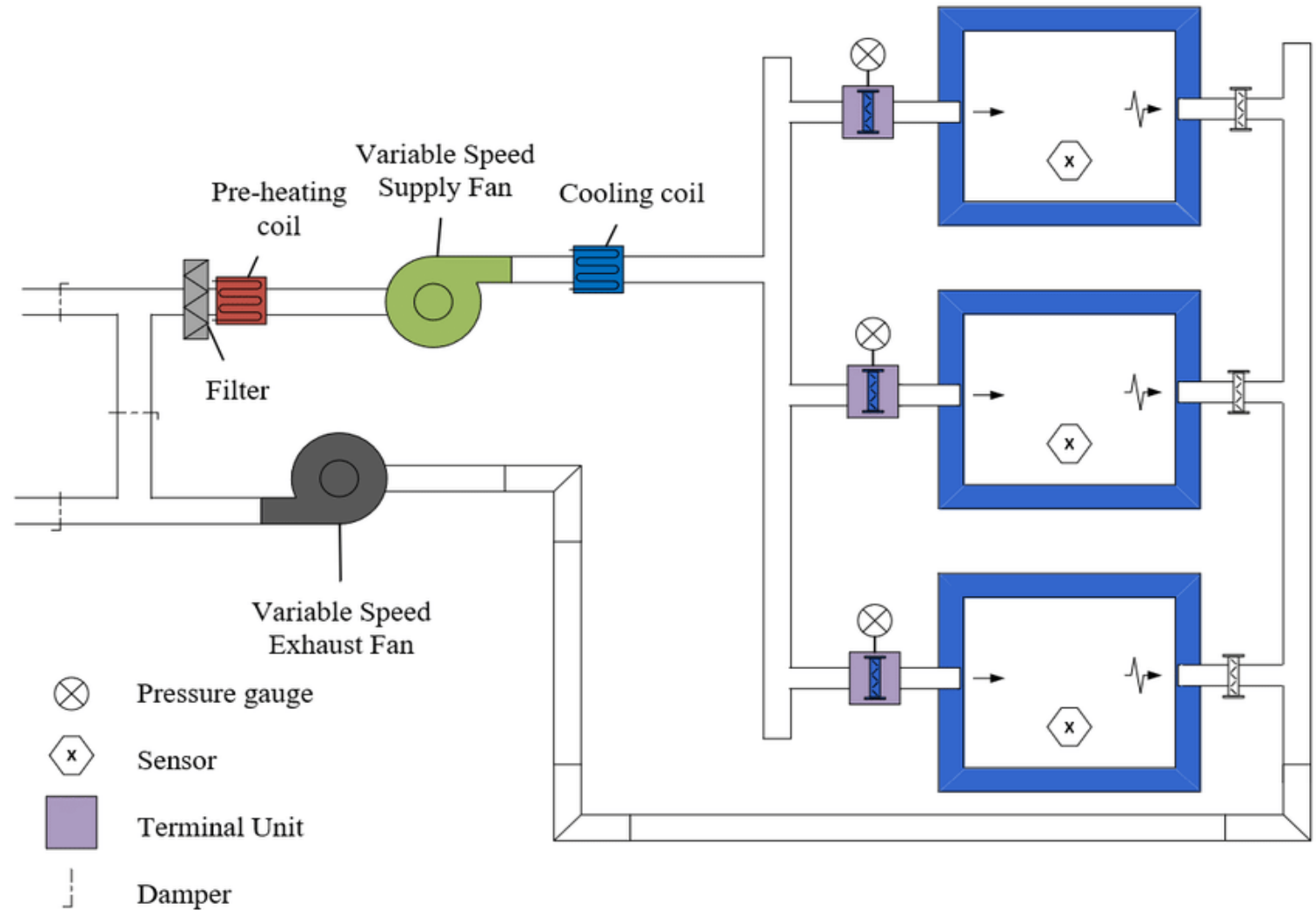
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Key Terms

Variable Air Volume (VAV) System:

Maintains thermal comfort by **varying the amount of heated or cooled air** delivered to each space.

Section 1: Types of Systems - VAV



Section 1: Types of Systems - VAV

Variable Air Volume - Control Boxes



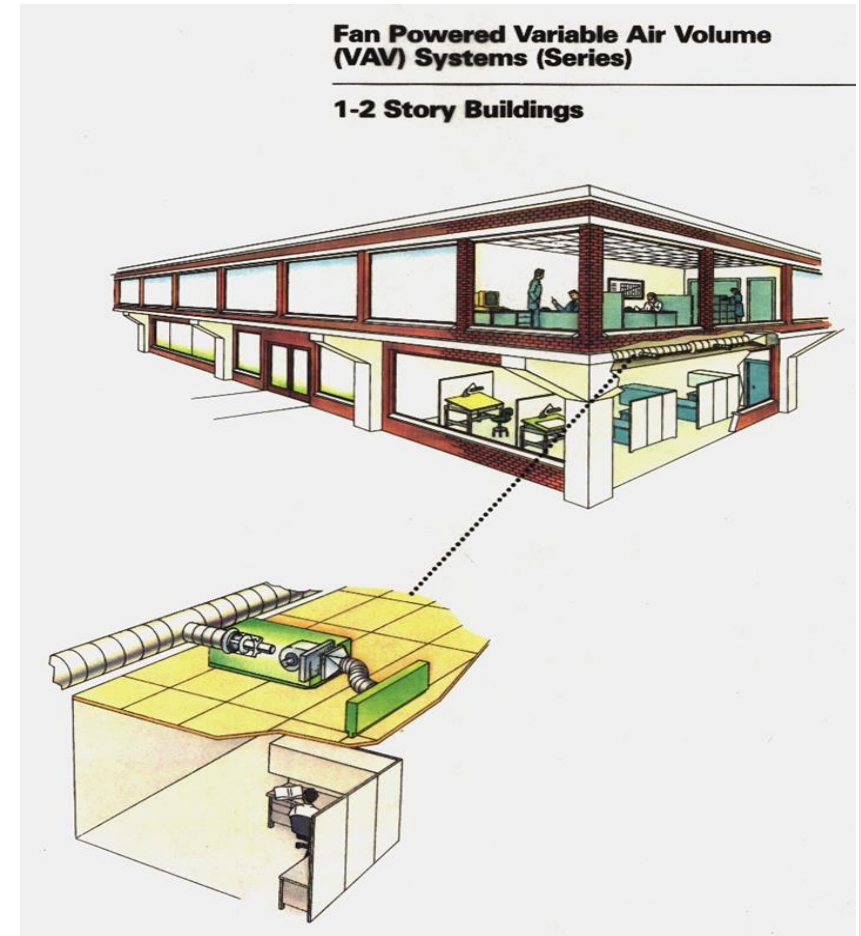
Dampers are the main component to be concerned with during cleaning.



Section 1: Types of Systems - VAV

Variable Air Volume Systems

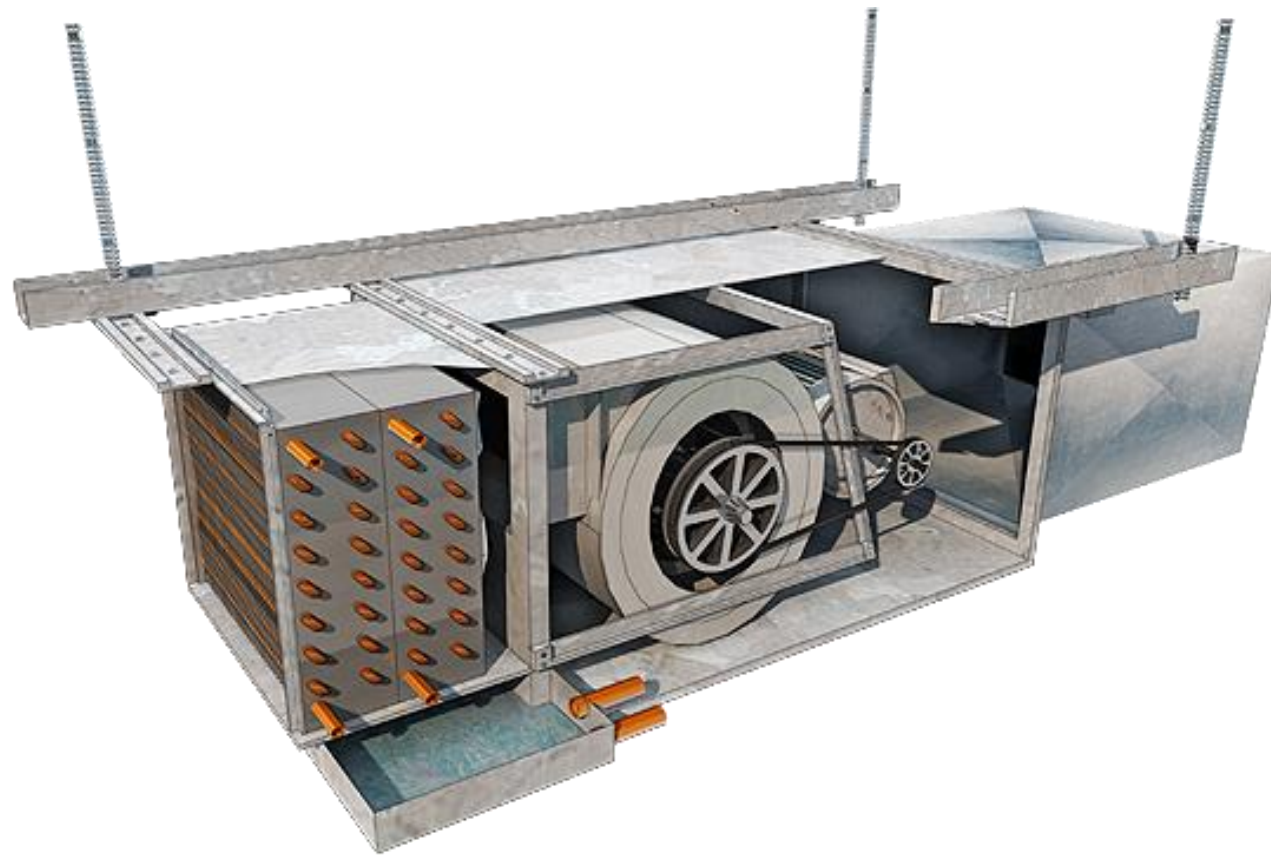
- Spiral duct from AHU to VAV.
- Accessibility to clean VAV boxes plus the clean fan & coil.
- Use slot diffusers or troffers which creates a higher level of difficulty for cleaning or coating.





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Section 1: Types of Systems – Fan Coil





Section 1: Types of Systems

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Key Terms

Constant Volume System:

Delivers **constant airflow** to each space.
Changes in temperature are made by heating or cooling the air or switching the AHU on and off.



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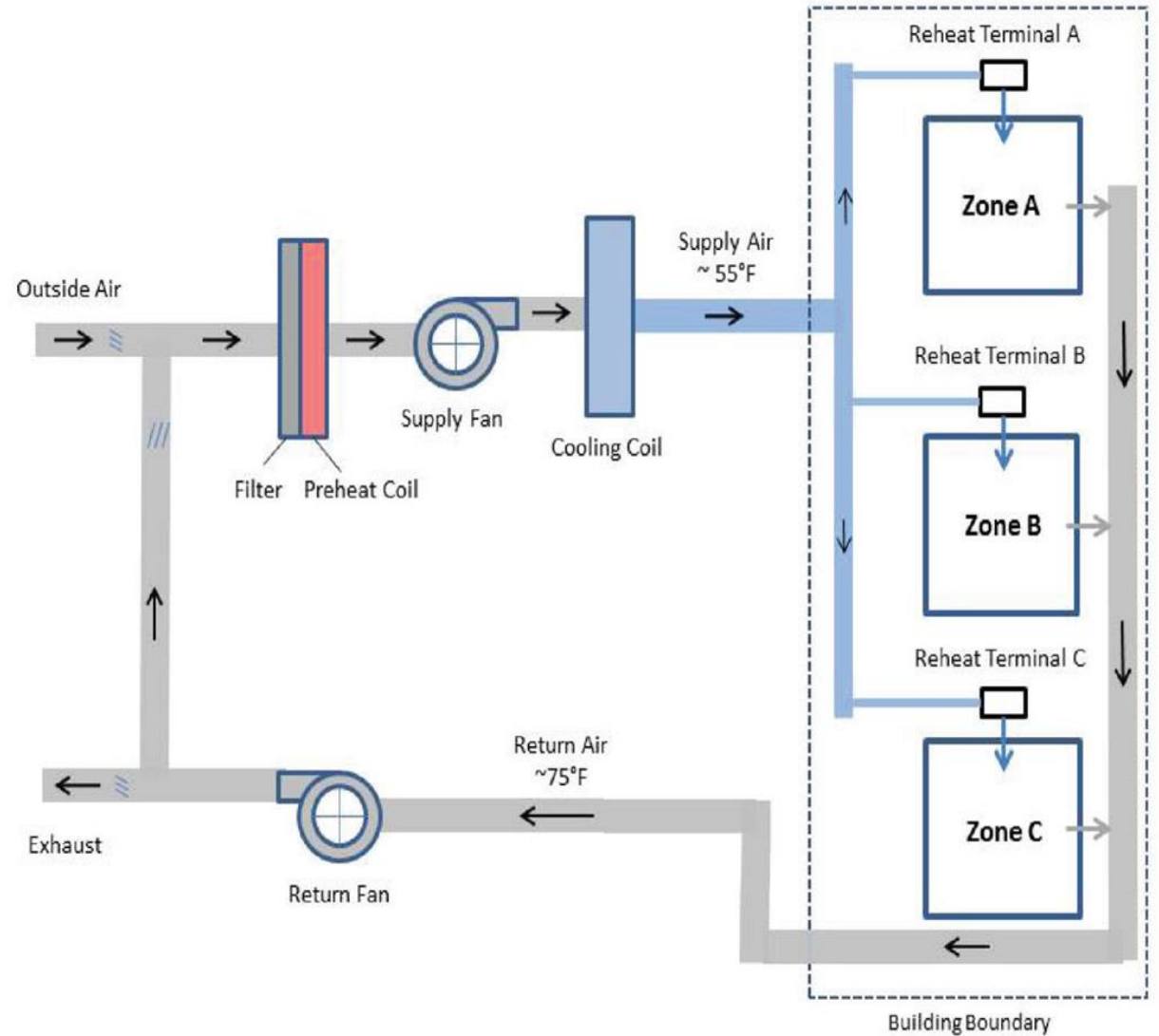
Section 1: Types of Systems - CV

Constant Volume Systems

- Changes in space temperatures are made by heating or cooling the air or switching the air handling unit on and off
- Often operate with a fixed minimum percentage of outdoor air
- CAV systems are less energy-efficient than variable air volume (VAV) systems

Section 1: Types of Systems - CAV

Figure 1
Schematic Diagram of a Typical
Constant Air Volume (CAV) System





Section 1: Types of Systems

Key Terms

Dual Duct:

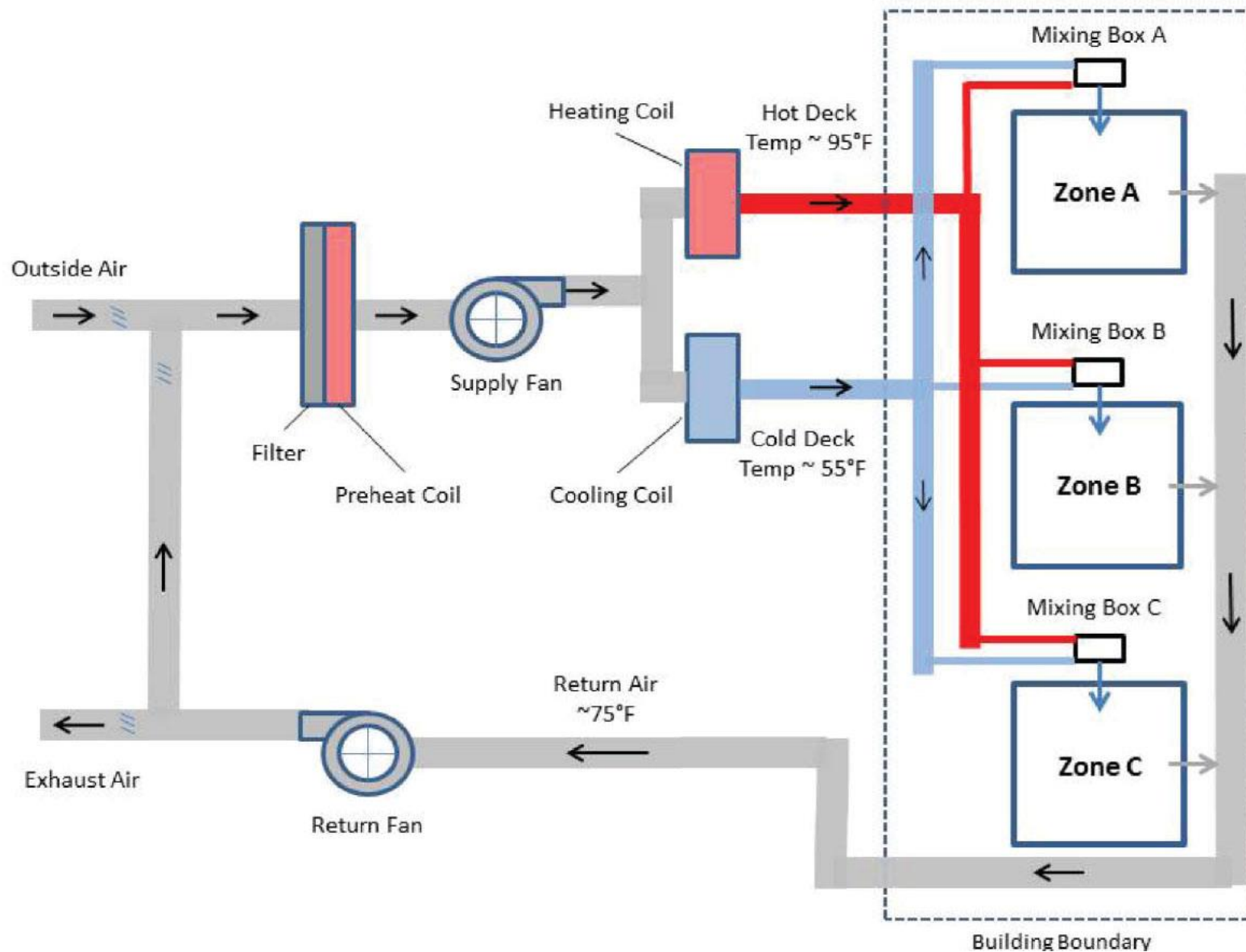
A fan discharges air which is directed through the cooling coil and/or the heating coil. There are **two separate ducts** that **feed hot and cold air** to the same space.

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Section 1: Types of Systems – Dual Duct





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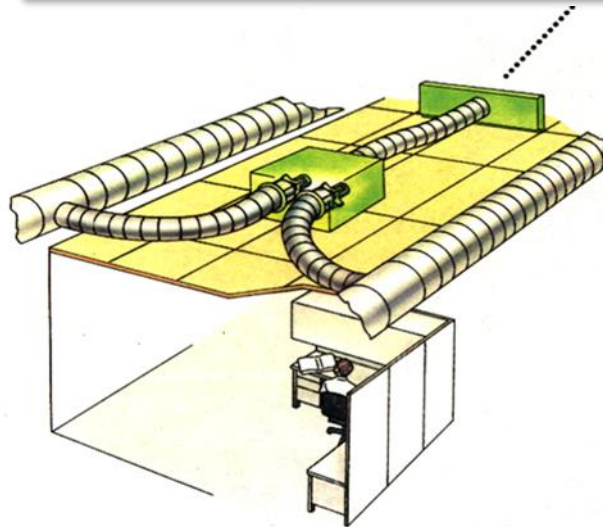
Section 1: Types of Systems – Dual Duct



Section 1: Types of Systems – Dual Duct



- Spiral duct from AHU to VAV.
- Twice as much supply duct from AHU to VAV's



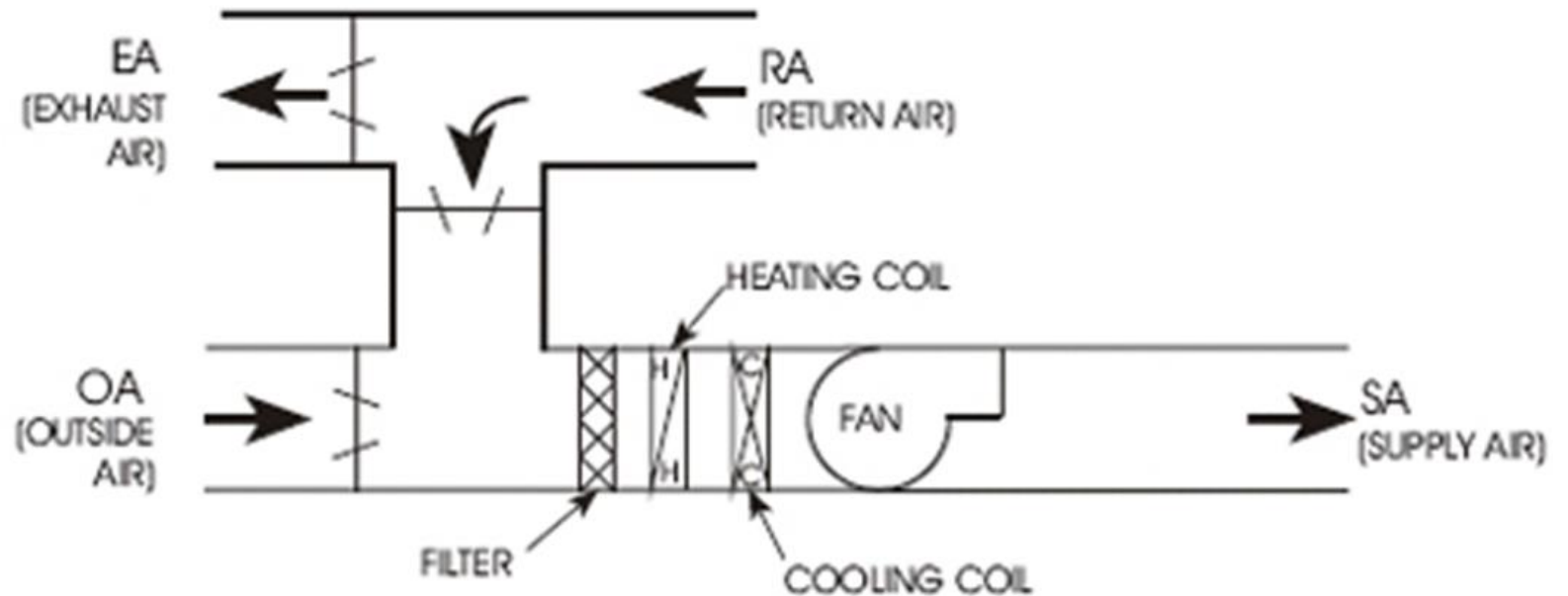
Accessibility to clean VAV boxes & coil.
Use slot diffusers or troffers which creates a higher level of difficulty for cleaning or coating.



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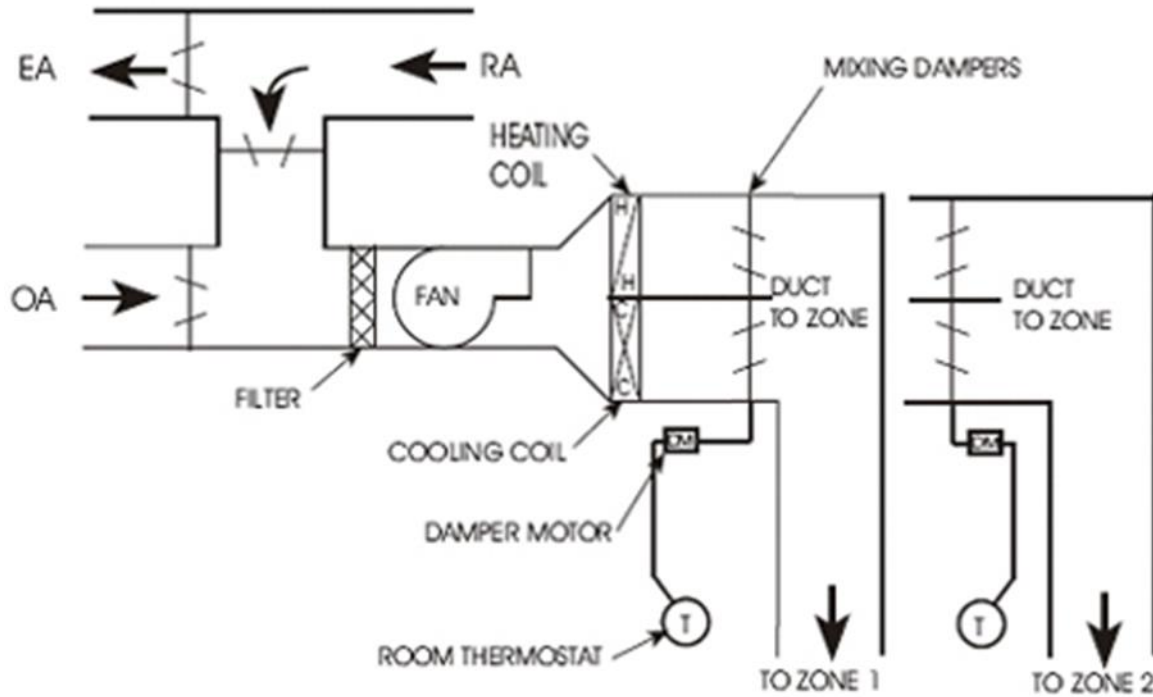
Section 1: Types of Systems – Single Zone

Supplies air at a constant temperature to one complete zone, or area, of a building or to the entire structure all at once. (Has one thermostat)



Section 1: Types of Systems – Multi Zone

Has more than one thermostat and is characterized primarily by two or more supply ducts emanating from the HVAC unit.





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Section 1: Types of Systems – Multi Zone



Section 1: Types of Systems

Daikin Style Mini Split

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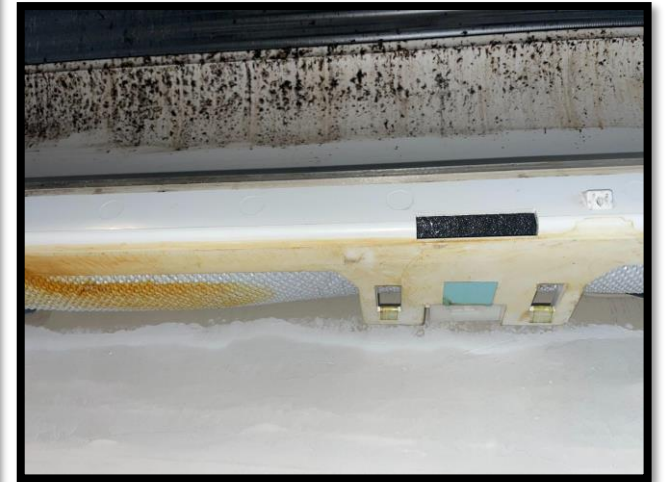


- Integrated supply and return air
- Contains fan, coils, drain pan
- Complete disassembly is needed for complete cleaning
- Found in hospitals and schools



Section 1: Types of Systems

Mini Split - Continued



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Section 1: Types of Systems

PTAC / Ventilators

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Section 1: Types of Systems

Built up AHU on roof cutaway

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Section 1: Types of Systems

Package unit on roof cutaway

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Section 2: HVAC Cleaning & Restoration Methods

NADCA does not endorse or recommend any single method of cleaning or type of equipment.

NADCA recommends the use of source removal methods and equipment designed to clean HVAC systems to the cleanliness levels specified in NADCA Standard ACR.

Each different cleaning method has its advantages and disadvantages



Section 2: HVAC Cleaning & Restoration Methods

Cleaning Methods: Vacuum Collection

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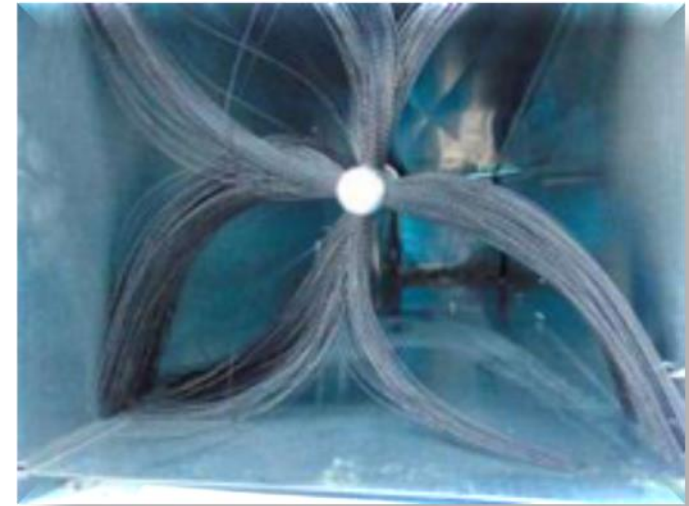
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Section 2: HVAC Cleaning & Restoration Methods

Cleaning Methods: Vacuum Collection

A vacuum collection device alone will not get an HVAC system clean.

Methods and tools designed to agitate debris adhered to surfaces along with use of vacuum collection device(s), is required.

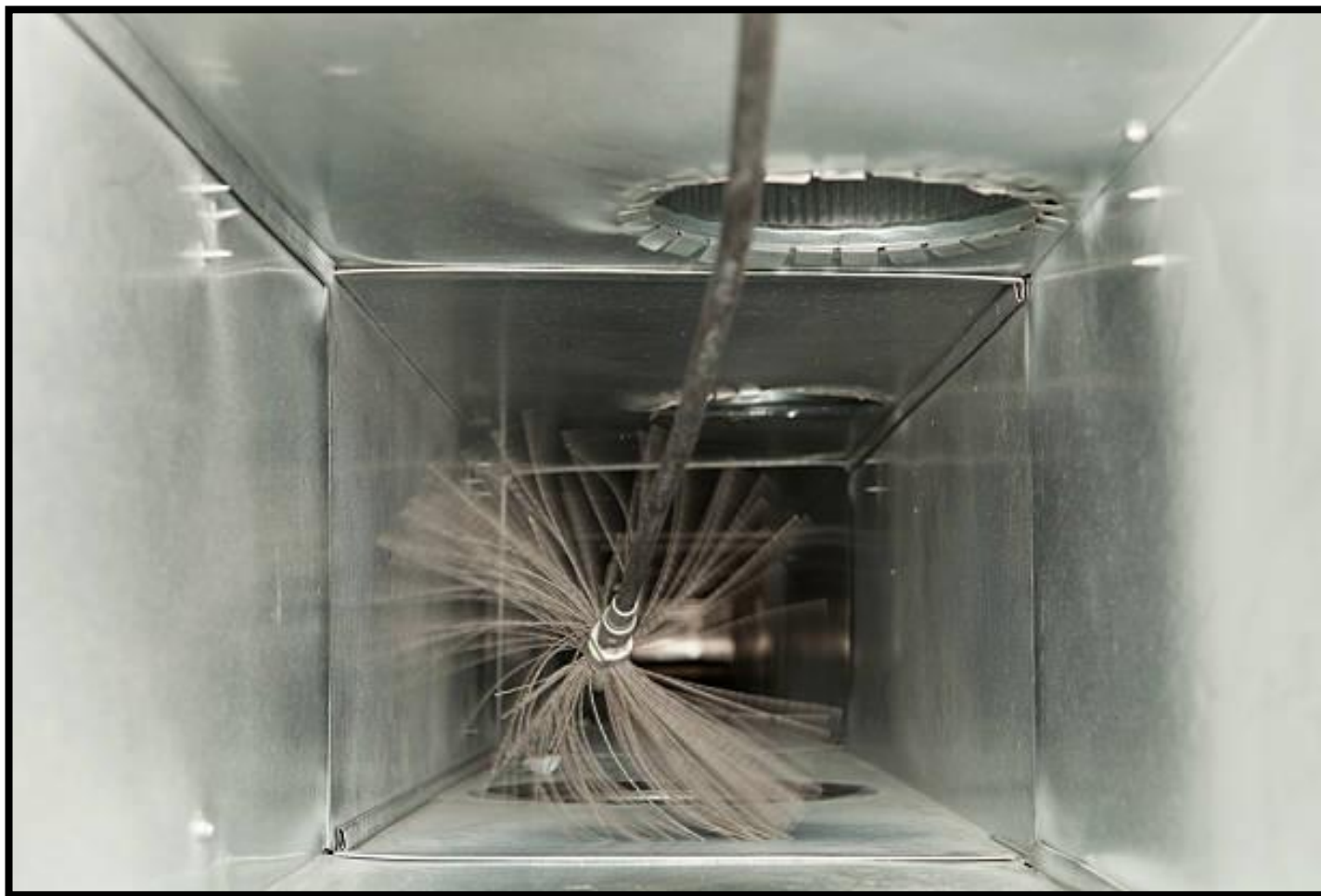




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Section 2: HVAC Cleaning & Restoration Methods

Cleaning Methods: Brushing

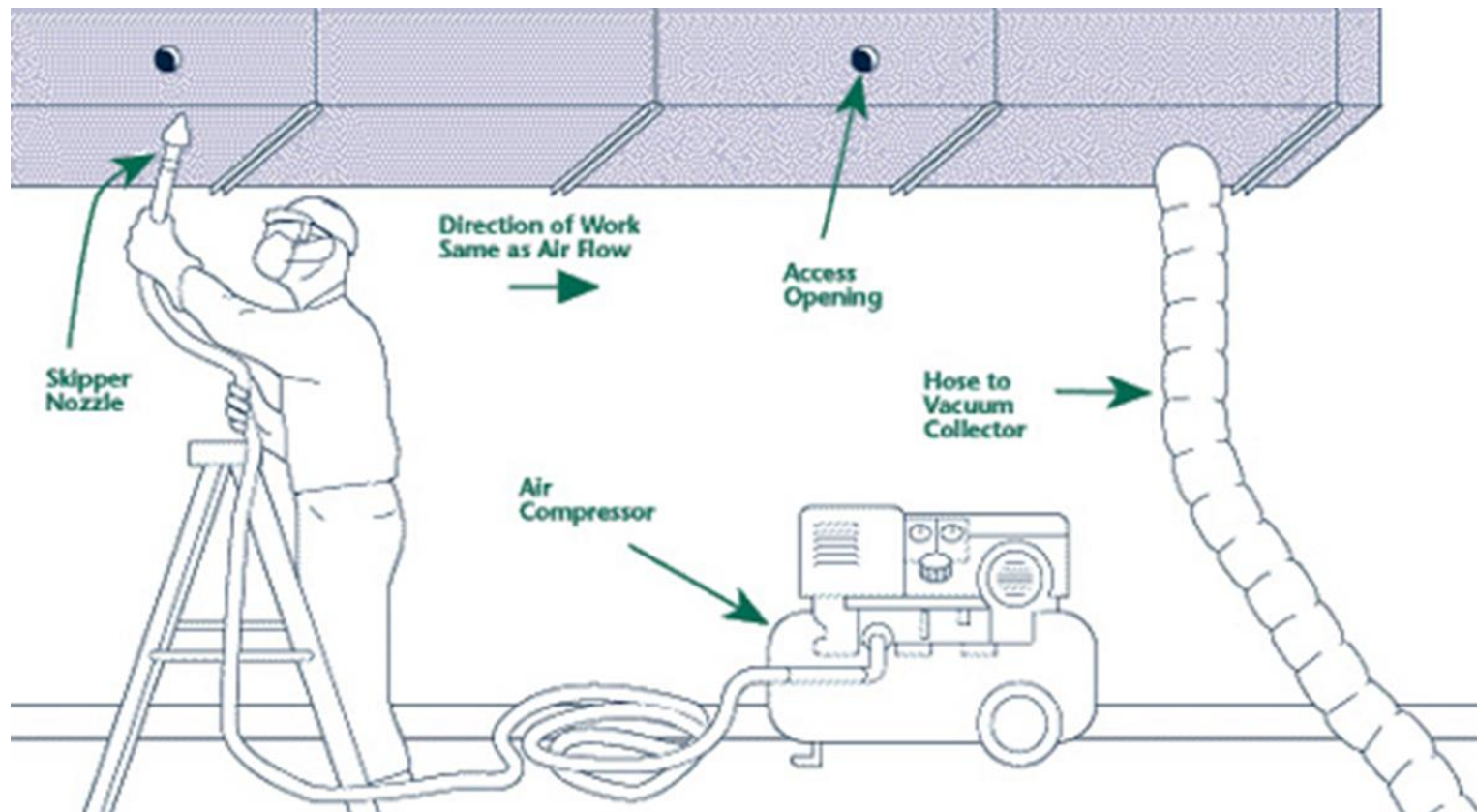




Section 2: HVAC Cleaning & Restoration Methods

Cleaning Methods: Air Washing

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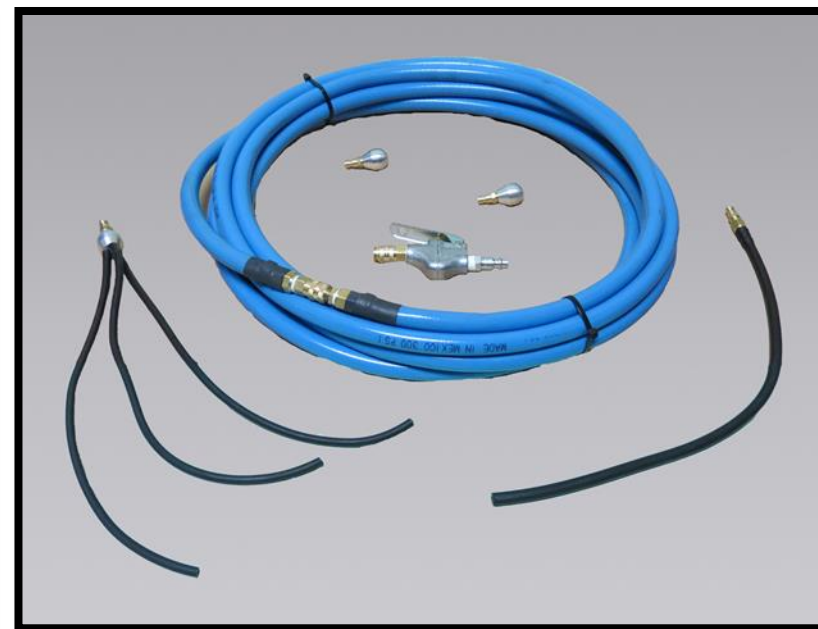


Section 2: HVAC Cleaning & Restoration Methods

Cleaning Methods: Air Washing

Whips, Rods, Blast Nozzles

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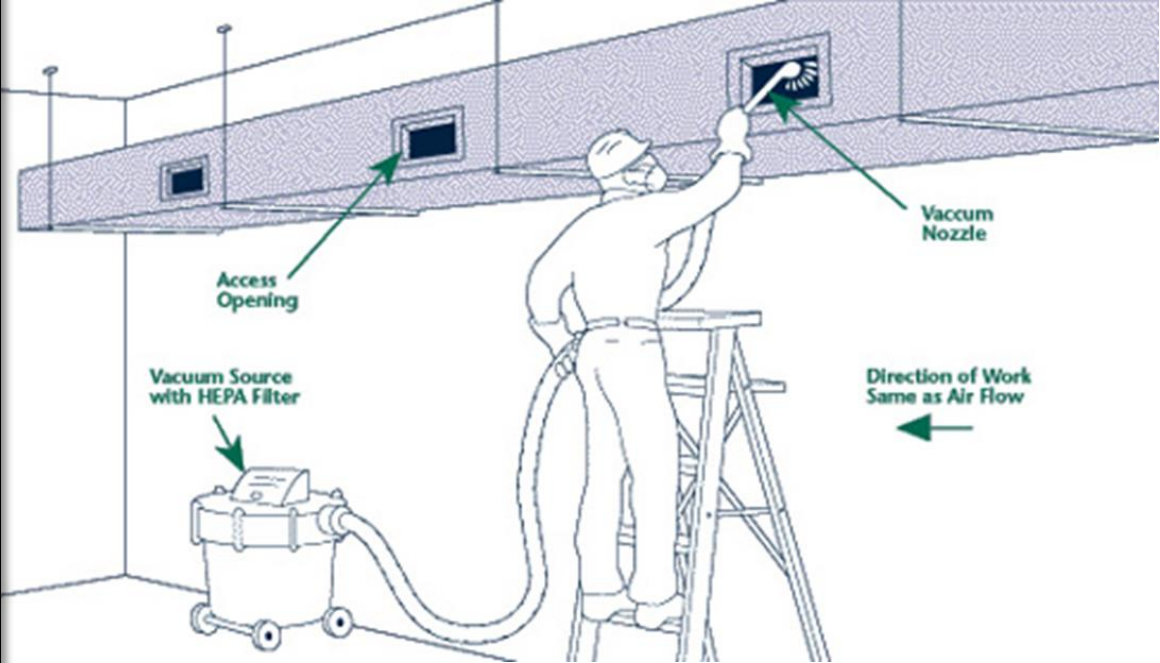




Section 2: HVAC Cleaning & Restoration Methods

Cleaning Methods: Contact Vacuuming

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Section 2: HVAC Cleaning & Restoration Methods

Cleaning Methods: Handing Washing / Wet Wiping

This procedure is just what its name implies- washing components by hand.

Involves hand tools such as brushes, sponges or damp cloths to wipe clean a designated area.



Liquids cannot be applied to porous components such as fibrous glass. Make sure that no chemical residues are left in the system during hand washing.



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Section 2: HVAC Cleaning & Restoration Methods

Cleaning Methods: Power Washing

Power Washing

Power washing involves the use of mechanical equipment able to spray a jet of water onto a specific area.

Components frequently cleaned by power washing:

- Cooling and reheat coils
- Blower wheels, fans and their housings
- Evaporator and condensing coils
- Condensate drain pan
- Some types of filters
- Grills, registers, and diffusers





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Section 2: HVAC Cleaning & Restoration Methods

Why clean in this order?



Reduces likelihood of cleaned portions becoming re-contaminated.

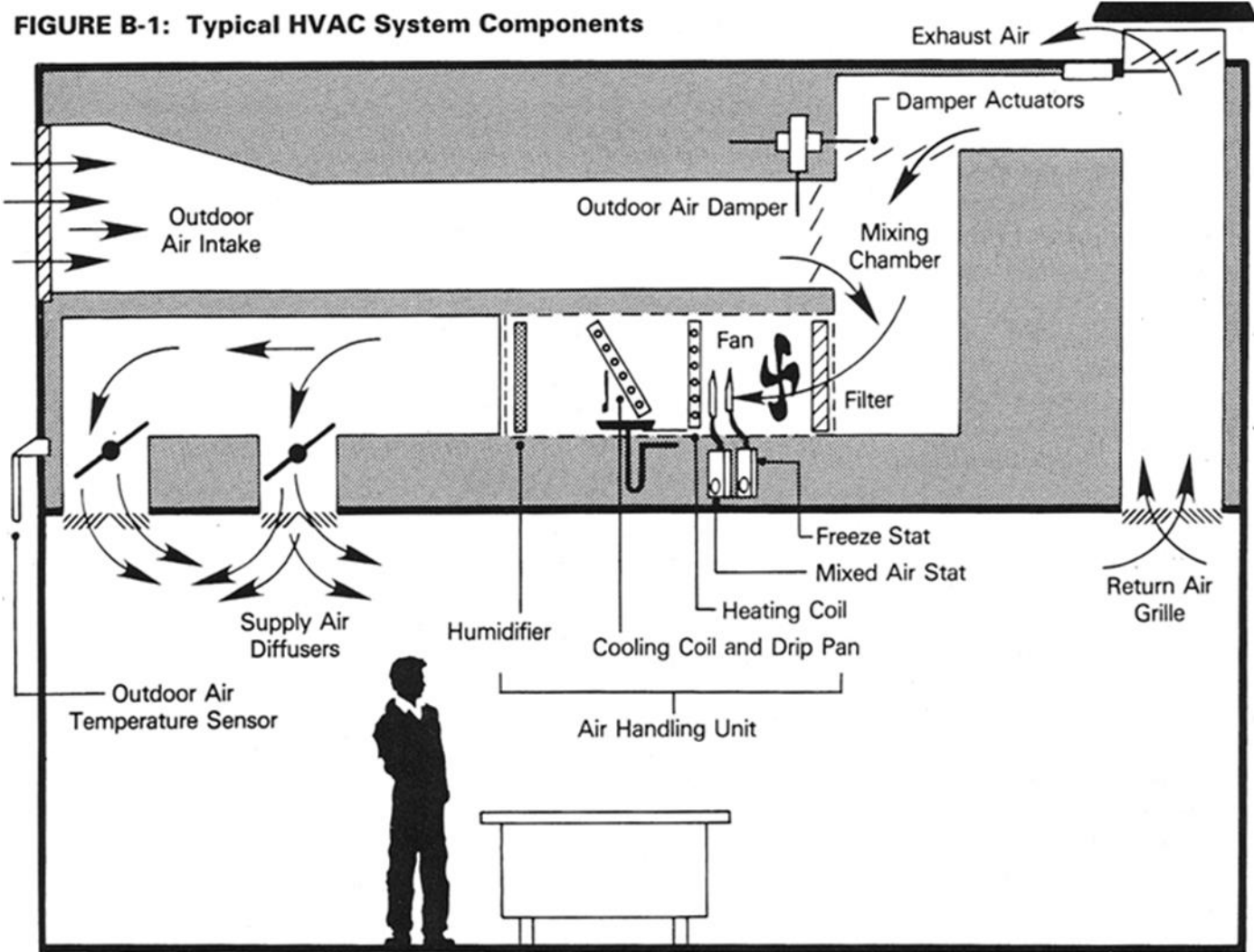


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Section 3: Component Cleaning

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Section 3: Component Cleaning

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Section 3: Component Cleaning

Air Handling Unit (AHU)

Air handling units, terminal units (VAV, Dual duct boxes, etc.), blowers and exhaust fans:

Ensure that supply, return, and exhaust fans and blowers are thoroughly cleaned. Areas to be cleaned include:

- ✓ Fan & Fan Housings
- ✓ Fan compartments
- ✓ Plenums (except ceiling supply and return plenums)
- ✓ Coil sets
- ✓ Blades or Vanes
- ✓ Shafts
- ✓ Baffles
- ✓ Dampers
- ✓ Drive assemblies



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Section 3: Component Cleaning

AHU Types

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Small RTU

Built in place AHU





Section 3: Component Cleaning

AHU Types

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Section 3: Component Cleaning

AHU Types

Rooftop Unit (RTU)

Packaged Unitary Equipment

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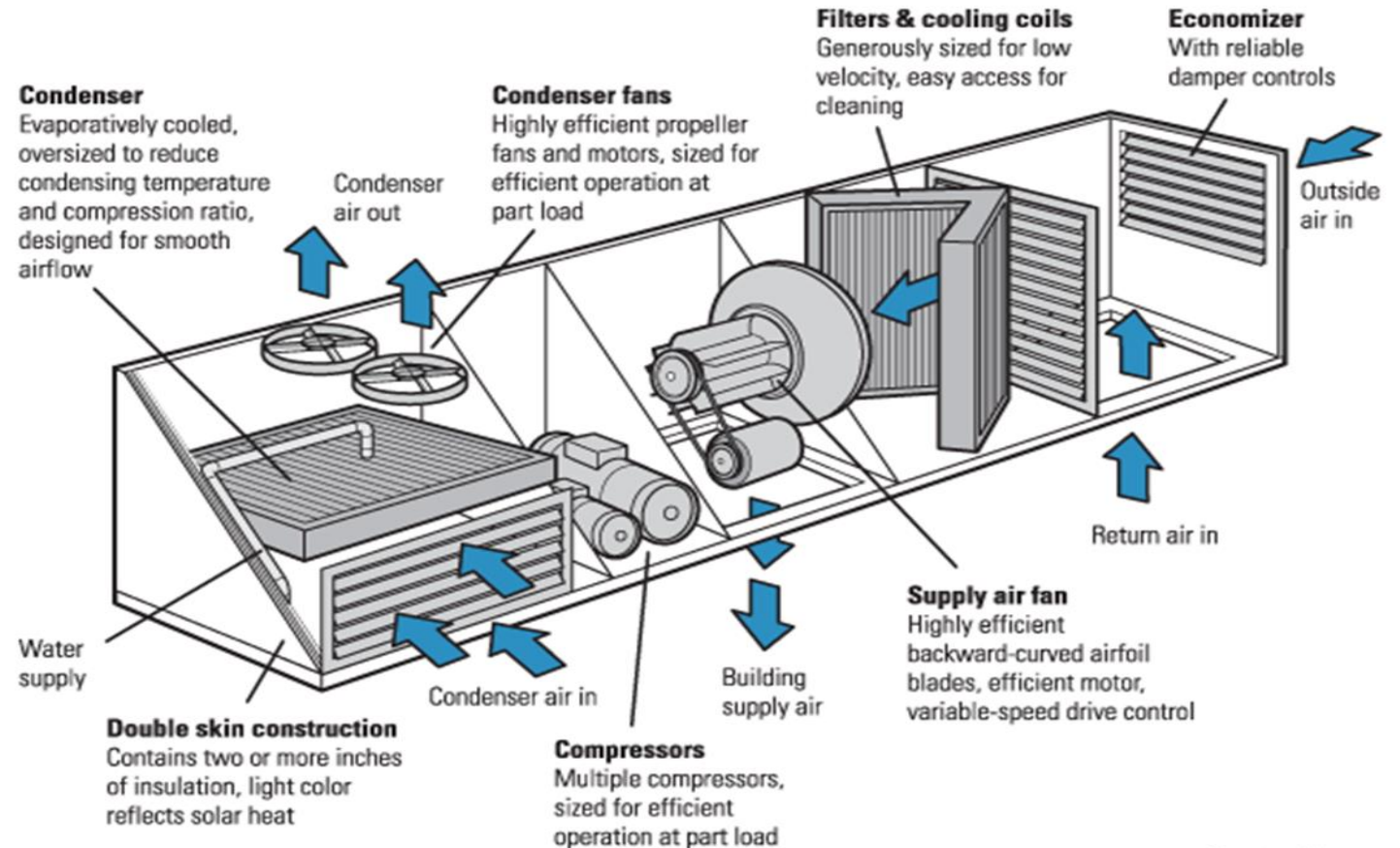
Section 3: Component Cleaning

AHU Types

Rooftop Unit (RTU)

Packaged Unitary Equipment

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Here's a Tip...

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Section 3: Component Cleaning

AHU

- ✓ Clean all AHU internal surfaces, components, condensate collectors & drains.
- ✓ Assure that suitable operative drainage system is in place prior to beginning wash down procedures.
- ✓ Clean all coils and related components, including evaporator fins.



Section 3: Component Cleaning

Fan Types

Forward Curved fans transfer large volumes of air for a minimum wheel diameter. They're used when space requirements are a primary consideration.

- Blades commonly lose **balance clips**.
- Are by far the **most common** and are in **most residential units**



Section 3: Component Cleaning

Fan Types

Backward Inclined Flat fan has some of the characteristics of the airfoil fan. Has relatively high efficiency.



A backward inclined fan has a non-overloading characteristic.

The horsepower required by the fan actually decreases when the flow rate increases past a certain point.

Section 3: Component Cleaning

Fan Types

Axial fans are suitable for large quantities of air at low pressures.

- Produce very little noise
- Found in return air ducts.

When compared with centrifugal fans, the axial fans are the easiest to clean, but can easily become unbalanced while cleaning.

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Section 3: Component Cleaning

Fan Types – Fan Wall

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Section 3: Component Cleaning

Fan Cleaning

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Sometimes the only way to clean is to go inside!

Section 3: Component Cleaning

Coils

- ✓ Reheat coils – Evaporator coils – Condensing coils
- ✓ Heating and cooling coils are placed in the airstream to **regulate the temperature of the air** delivered to the space
- ✓ In general, the **copper rows** determine the coil depth for cleaning
- ✓ Not all coils are cleanable
- ✓ When cleaning electrical resistance coils in a duct system, it's important to make sure the power source is de-energized!





Section 3: Component Cleaning

Coils

All portions of each coil assembly must be cleaned.

- Both upstream and downstream sides of each coil section *shall* be accessed for cleaning.
- When both sides of a coil are not accessible for cleaning then removal and/or replacement *may* be required.
- Visual inspection of the coil and drain pan will determine whether Type 1 or Type 2 cleaning is required.

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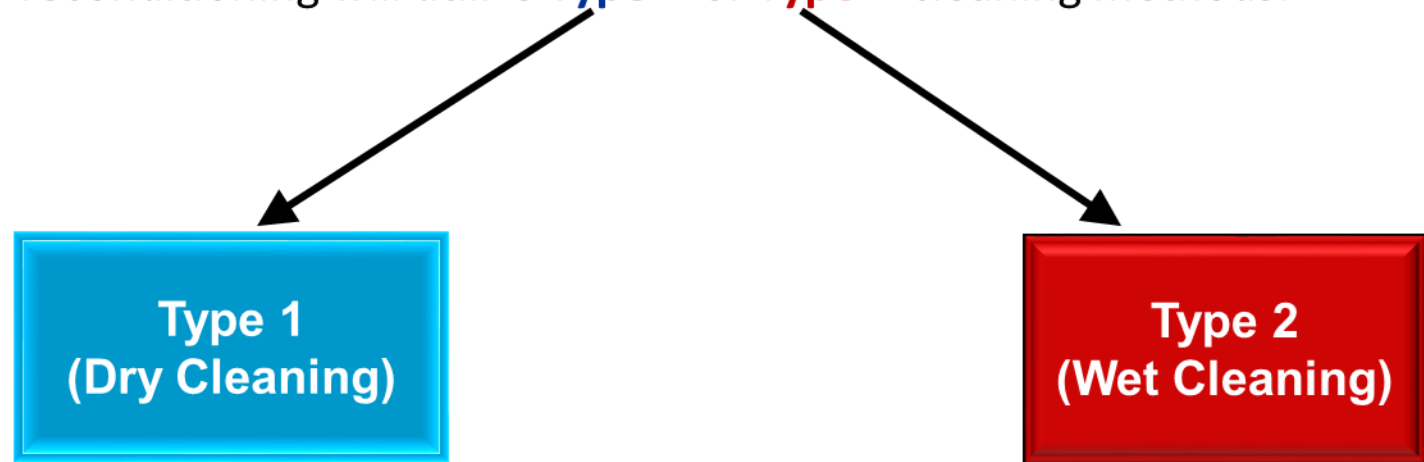




Section 3: Component Cleaning

Coils

The substances impacted on the evaporator coil help determine the initial cleaning protocol. Evaporator coil cleaning is broken into two (2) categories known as **Types**. Evaporator coil reconditioning will utilize **Type-1** or **Type-2** cleaning methods.



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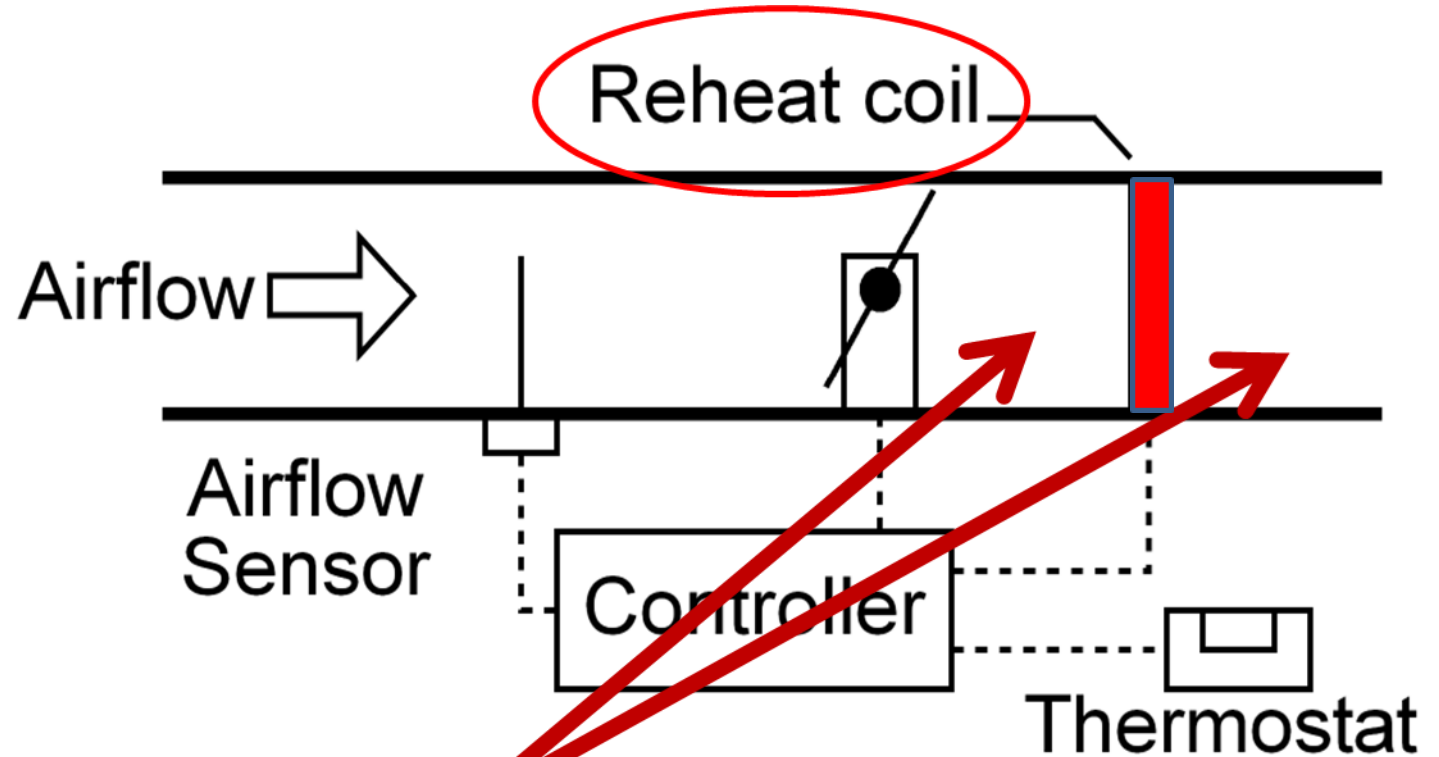




Section 3: Component Cleaning

Inline Coils

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Install Service Openings



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Section 3: Component Cleaning Inline Coils





Section 3: Component Cleaning

Reheat Coils

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Reheat Coils:

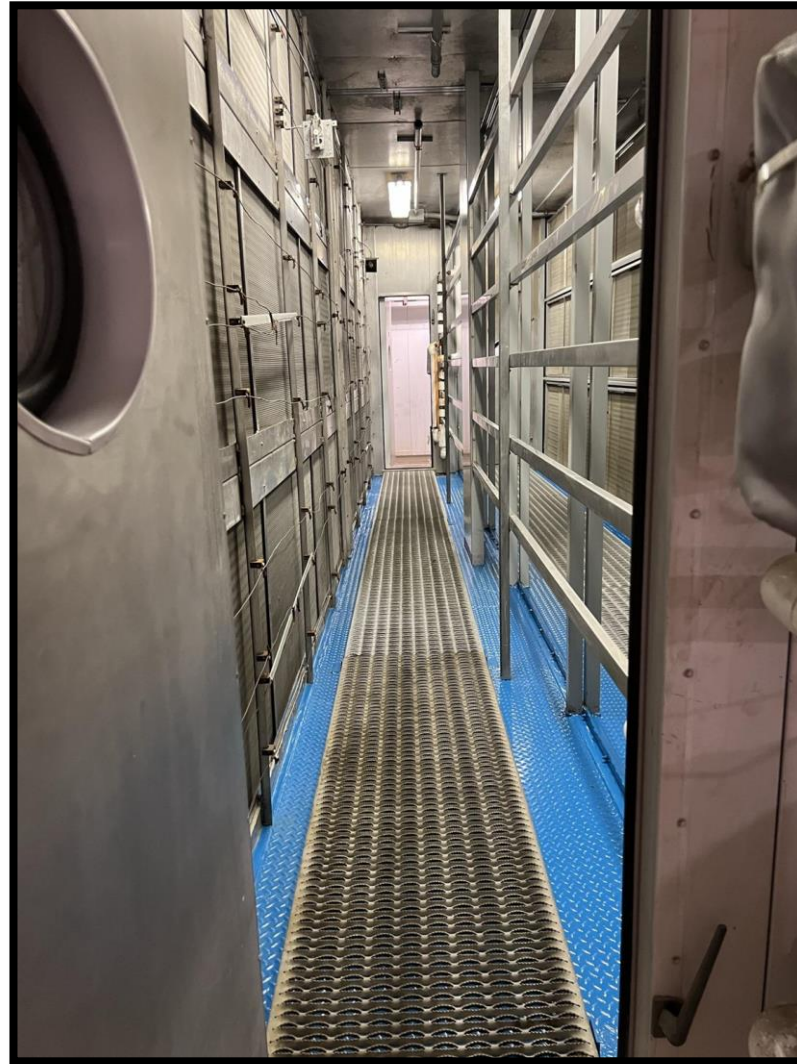
- ✓ Need access on both sides
- ✓ No condensate drain
- ✓ Need to set up water control





Section 3: Component Cleaning AHU Located Heat & Cooling Coils

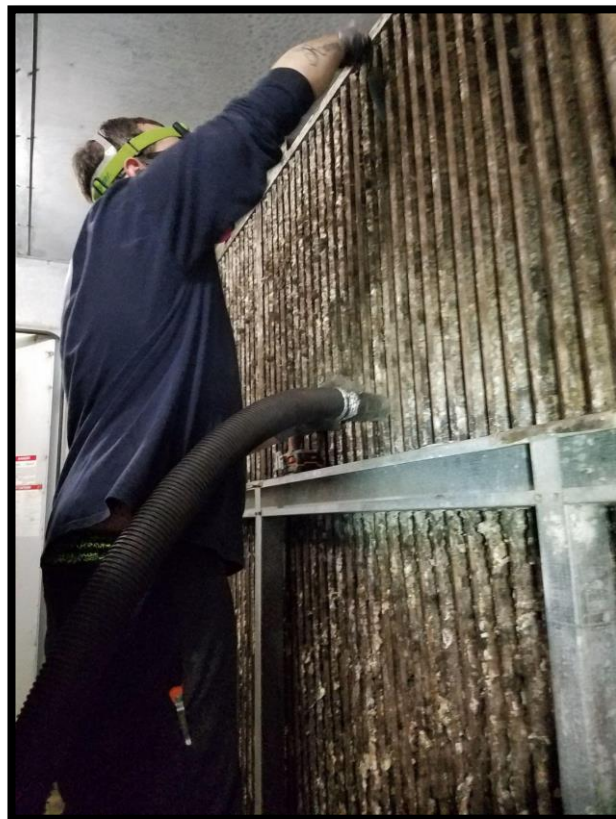
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Section 3: Component Cleaning Coils - Mist/Cary Over Eliminators

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Team of 4 was able to remove the top mist eliminator. It was a lot heavier than appeared.

Removing it allowed access to the CW Coil

We were unable to the design of the unit to remove the bottom one. **Pro Tip: Should have brought in a Mechanical for assistance**

Built containment in place near a large drain to pressure wash and sterilize the top mist eliminator





Section 3: Component Cleaning

Drain Lines & Pans

The condensate drain pan and drain line *shall* be cleaned and flushed. The condensate drain pan *shall* be inspected to verify proper drainage operation before and after cleaning.

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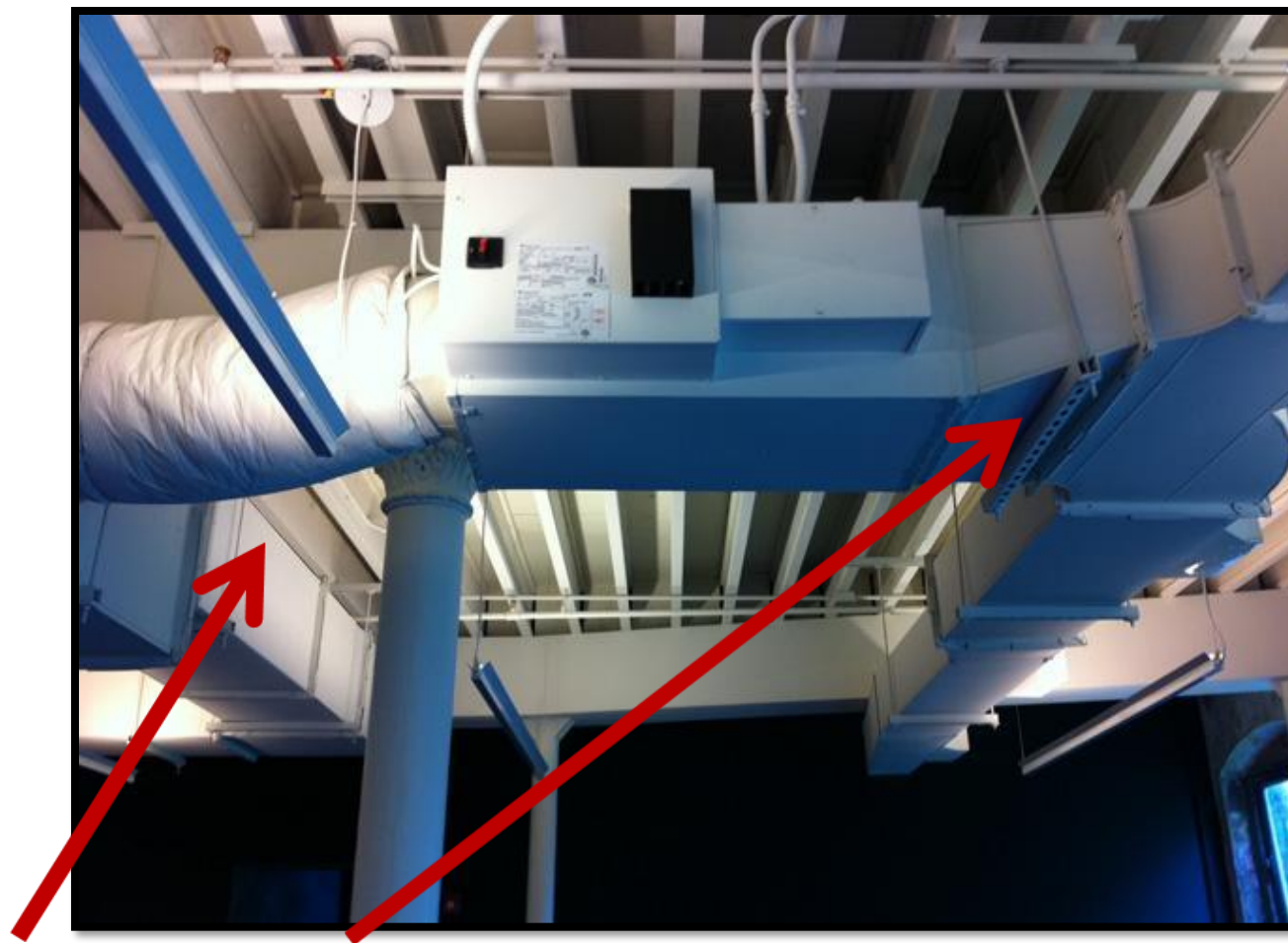
Usually a **drain pan** and **line** have the **highest amounts of contamination** when compared to all other system components.



Section 3: Component Cleaning

VAV/Mixing Box

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Install Service Opening



Section 3: Component Cleaning

VAV/Mixing Box

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Clean VAV

Dirty VAV





Section 3: Component Cleaning

VAV/Mixing Box

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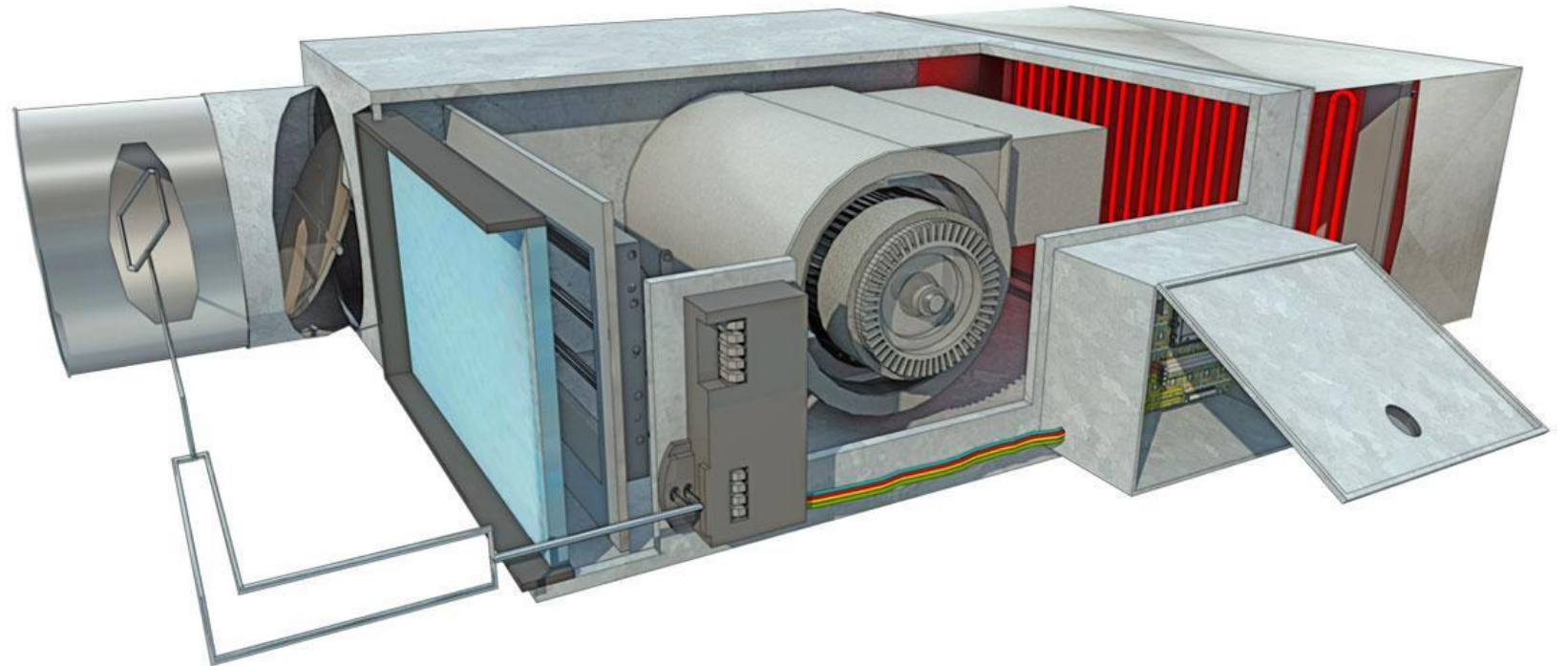
Here's a Tip...

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Section 3: Component Cleaning

VAV/Mixing Box

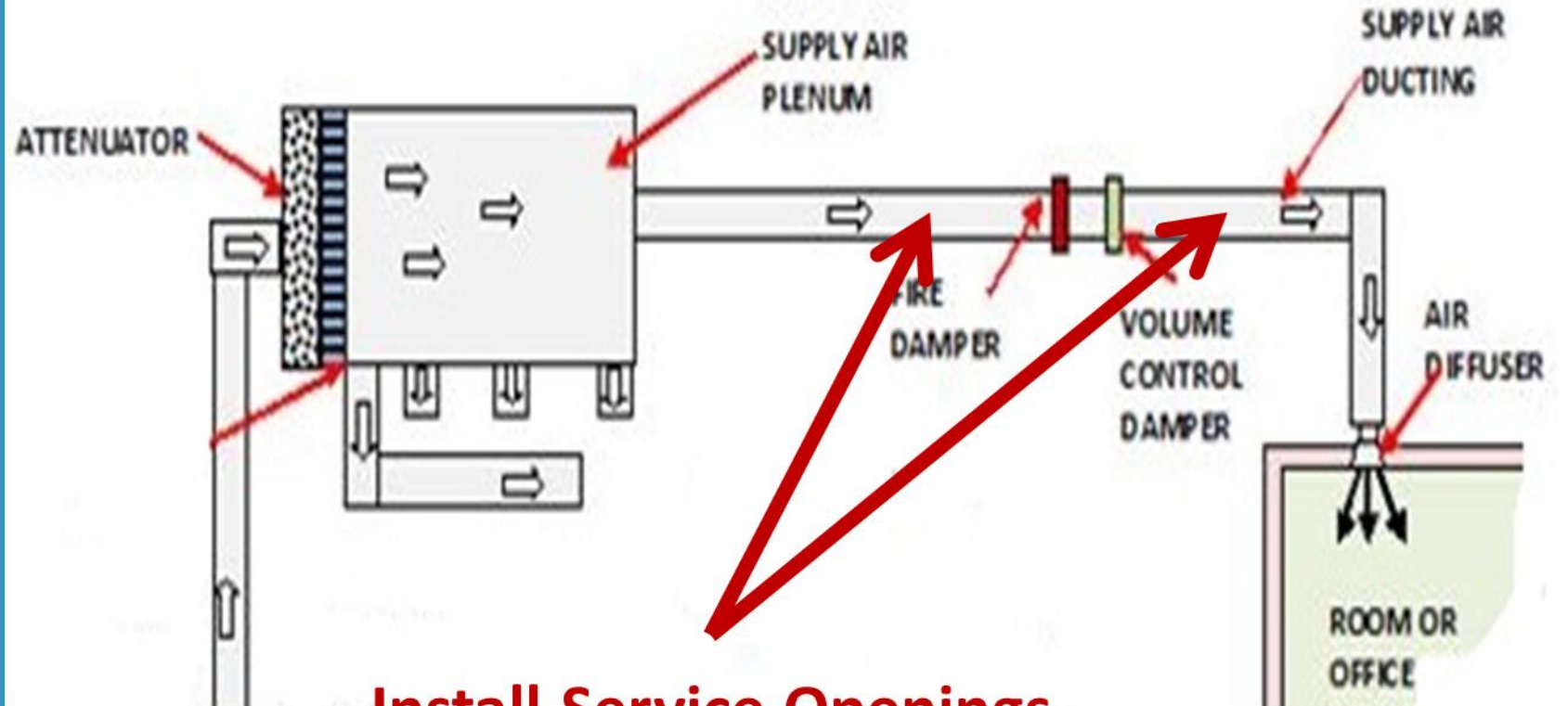
- ✓ Electric Coil – be sure to disconnect power & follow Lock Out/Tag Out
- ✓ Pay attention to fiberglass insulation inside of component



Section 3: Component Cleaning

VAV/Mixing Box

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Install Service Openings



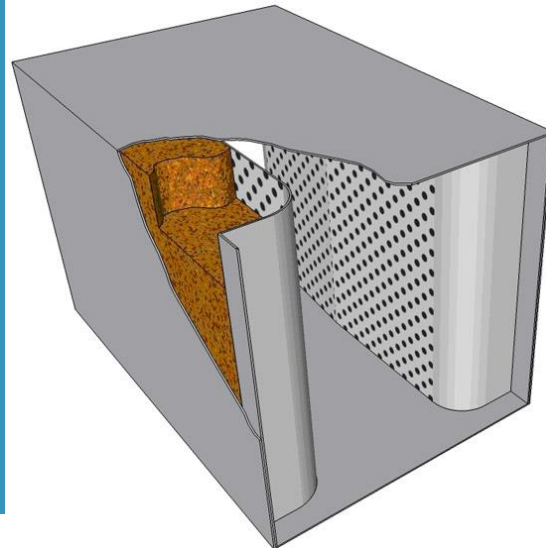
Section 3: Component Cleaning

Sound Attenuators

Designed to reduce noise in the ducts.

A water pressure washer should not be used for cleaning a perforated sound attenuator and the internal components of perforated sound attenuators are not cleanable.

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Section 3: Component Cleaning

Turning Vanes

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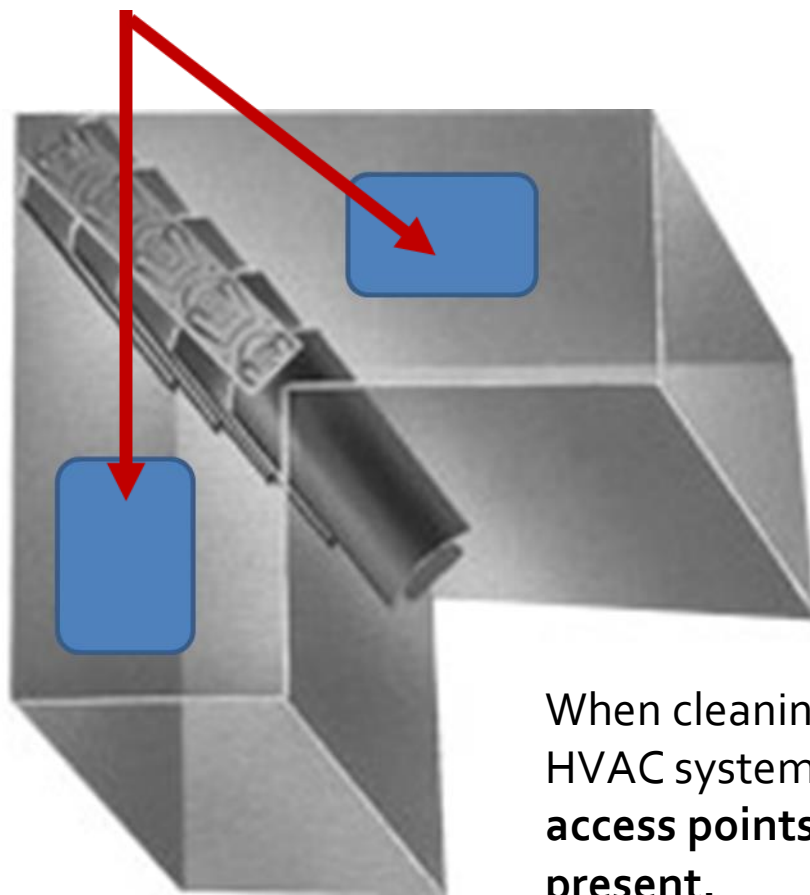
- ✓ Primary function is to reduce static pressure loss in a duct system
- ✓ Require multiple access points and care in cleaning
- ✓ Fiberglass vanes can be very fragile
- ✓ Rarely found in high pressure systems



Section 3: Component Cleaning

Turning Vanes

Service Openings



When cleaning a **90-degree turn** in a commercial HVAC system, it is recommended to **put two (2) access points per turn when turning vanes are present.**

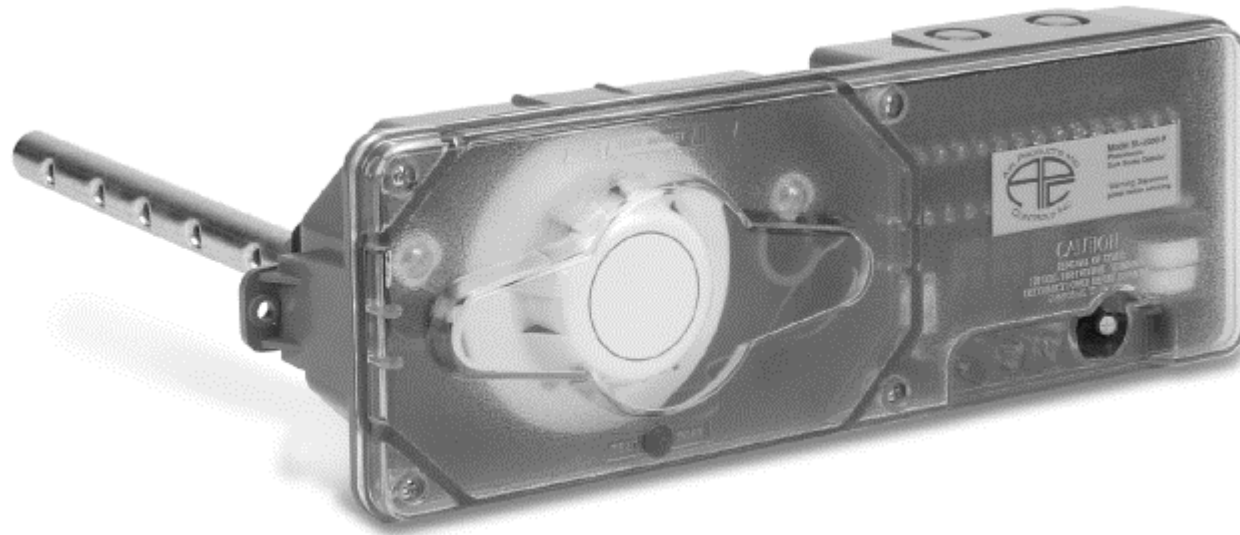
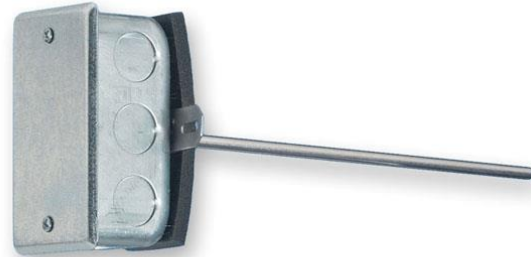
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Section 3: Component Cleaning

Sensors

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Section 3: Component Cleaning

Vents, Grills, Registers & Diffusers

Air distribution devices (registers, grilles & diffusers):

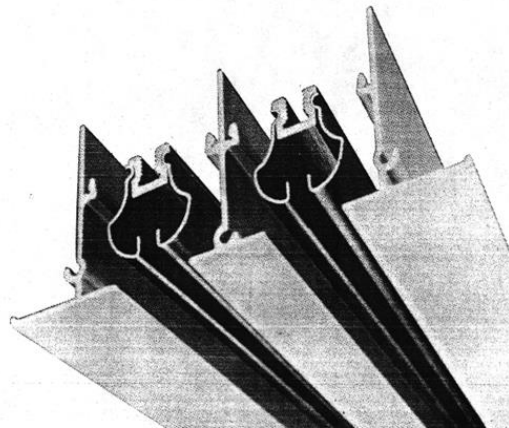
- Remove, if possible, for proper cleaning.
- Make sure they are restored to their previous position.

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Section 3: Component Cleaning

Slot Diffusers



- Not easily removed
- Rubber bladder
- Air wash

Most of these are connected to the ceiling or ceiling grid.



Here's a Tip...

Always check the inside of these for damaged or friable insulation.



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Section 3: Component Cleaning Sheet Metal Ducts With Interior Insulation

- Microbial issues
- Reasons for insulation in duct
- Coatings



If you can't properly clean it, you can't coat it!

Section 3: Component Cleaning

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Duct Board

- Microbial issues
- Reasons for using this type
- Coatings



Here's a Tip...

If you can't properly clean it, you can't coat it!

Be sure to use mechanical cleaning methods that will not create abrasions, breaks, or tears to fibrous glass liner or duct board surfaces!



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Section 3: Component Cleaning

Externally Insulated Duct

- Reasons for insulation
- Thermal value only
- Carefully create access
- Reinstall insulation after access openings are made.





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Section 3: Component Cleaning Fiberglass and Insulated Duct Work

Thoroughly clean
with HEPA
vacuuming
equipment, while
system is under
constant negative
pressure

Do not get fibrous
glass components
wet

Do not cause
damage to fibrous
glass components



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Section 3: Component Cleaning Fiberglass and Insulated Duct Work



When physically entering lined ductwork, caution must be taken not to damage the lining.





Section 3: Component Cleaning

Fiberglass and Insulated Duct Work

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Component Cleaning





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Section 4: Standards



- Visibly Clean
- Source Removal
- Negative Duct Pressurization
- Service Openings
- Containment



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Section 4: Standards

Selecting the HVAC cleaning method to be employed on any given project is an important factor for successful cleaning.

- Vacuum Collection
- Brushing
- Air Washing
- Hand or Contact Vacuuming
- Hand Washing
- Power Washing





Section 4: Standards

Visibly Clean Standard

Key Terms

Visibly Clean:

An interior surface is considered visibly clean when it is free from **“non-adhered”** substances and debris.



Definition: What does non-adhered mean?

Any material not intended or designed to be present in an HVAC system, and which can be removed by contact vacuuming.



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Section 4: Standards

Source Removal

Key Terms

Source Removal

The mechanical cleaning of system components to remove dirt and debris.

Requires two key elements to be effective:

1. **Agitation** of dust and debris within the HVAC system.
2. **Extraction** of contaminants from the HVAC system



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Section 4: Cleaning Requirements & Standards

Negative Duct Pressurization

Key Terms

Negative Pressure

Used to prevent debris from entering the occupied space or leaving the contained area.



Prior to and throughout the duration of the cleaning process, the HVAC system and associated air duct *shall* be kept at an appropriate negative pressure differential relative to the indoor non-work area.



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Section 4: Cleaning Requirements & Standards

Service Openings

Minimum Requirements for Service Openings

Service openings shall:

not degrade the structural, thermal, or functional integrity of the system;

not hinder, restrict, or alter the airflow within the air duct;

not be made in flexible ductwork;

be created in a manner that allows for proper closure;

comply with applicable UL, SMACNA and NFPA standards, as well as local, regional, state and federal codes.





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Section 4: Cleaning Requirements & Standards

Effective
negative pressure
containment
requires:

- Physical barrier around work area
- Sealing off HVAC return air grills
- Continuously pulling air through a HEPA filtration device to reduce airborne particles.
- Exhausting more cubic feet per minute of clean, HEPA-filtered air out of the space than is supplied into it.



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Section 4: Cleaning Requirements & Standards

Service Openings

Service Panels

- *Shall* be of an equivalent gauge or heavier
- *Shall* be mechanically fastened (screwed or riveted) at minimum every 4" on center.
- *Shall* overlap the ductwork surfaces by a minimum of 1" on all sides.
- *Recommended* to be sealed with gaskets, duct sealants, mastic or tape.





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Section 4: Cleaning Requirements & Standards

Containment





Section 4: Cleaning Requirements & Standards

Containment

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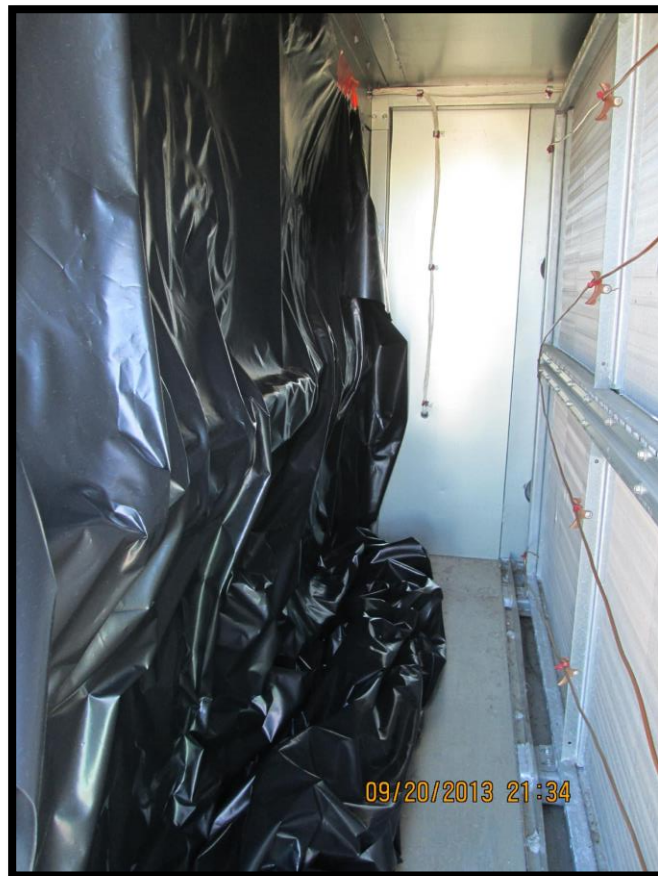


Section 4:

Cleaning Requirements & Standards

Containment

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Section 4: Cleaning Requirements & Standards Containment





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Thank you
for
Participating!

