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Building Science

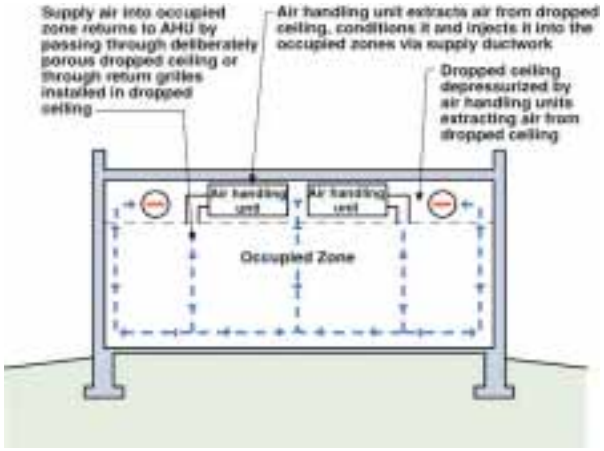
IAQ - Blame It on Star Trek

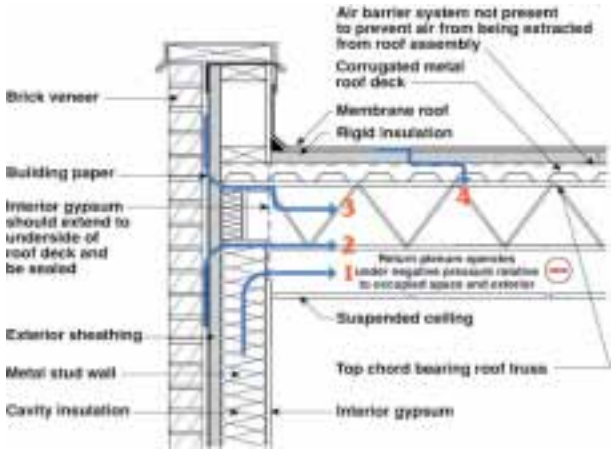
presented by www.buildingscience.com

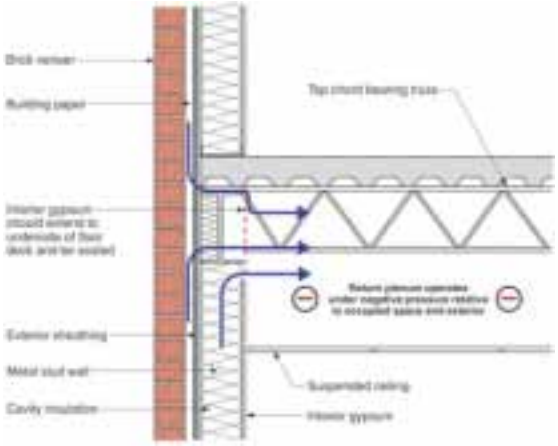
Definition of a Problem

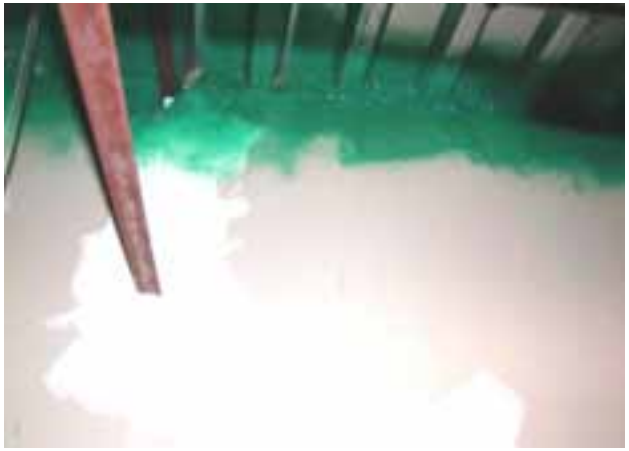
People
Pollutant (hot, wet, UV, ozone)
Path
Pressure

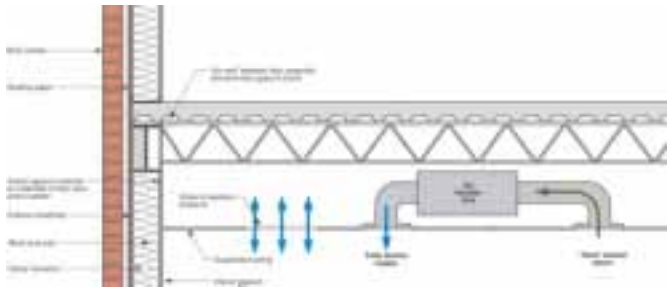

EXIT

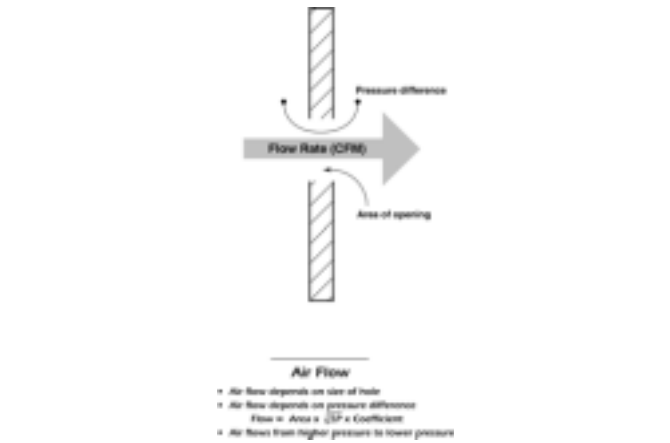

Supply air into occupied zone returns to AHU by passing through deliberately porous dropped ceiling or through return grilles installed in dropped ceiling
Air handling unit extracts air from dropped ceiling, conditions it and injects it into the occupied zones via supply ductwork
Dropped ceiling depressurized by air handling units extracting air from dropped ceiling
Air handling unit
Air handling unit
Occupied Zone




Brick veneer
Building paper
Top chord bearing truss
Interior gypsum
Exterior sheathing
Metal stud wall
Cavity insulation
Suspended ceiling
Interior gypsum

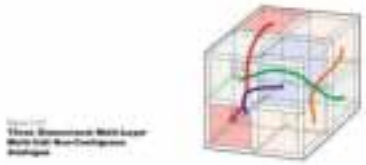


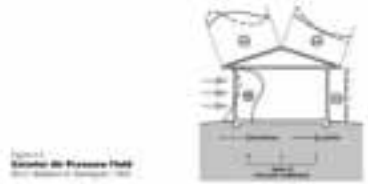


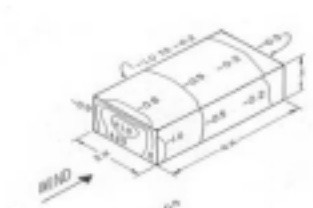


Air Flow

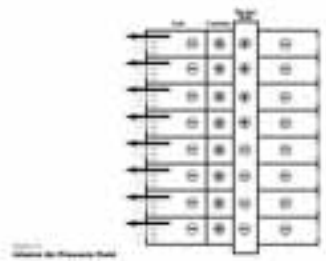
- Air flow depends on size of hole
- Air flow depends on pressure difference
  Flow = Area x $\sqrt{\Delta P}$ x Coefficient
- Air flows from higher pressure to lower pressure

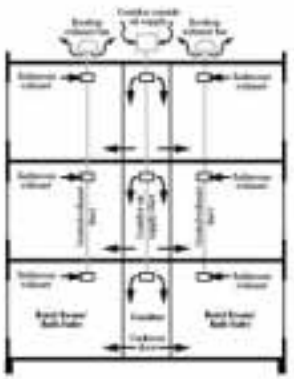


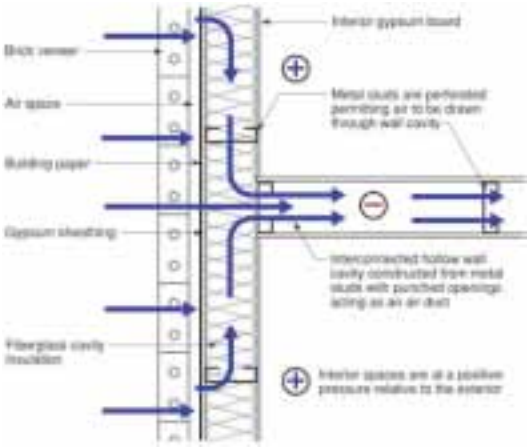


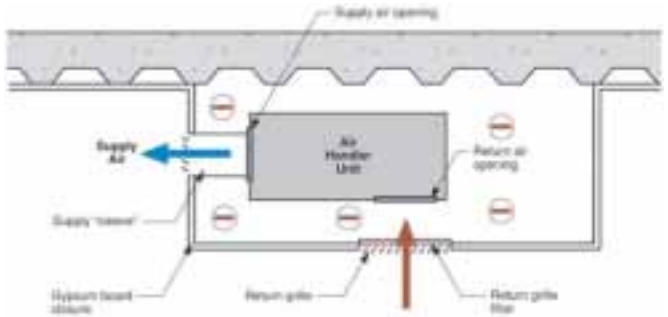


Pressure coefficients on walls and roof of rectangular buildings without parapets

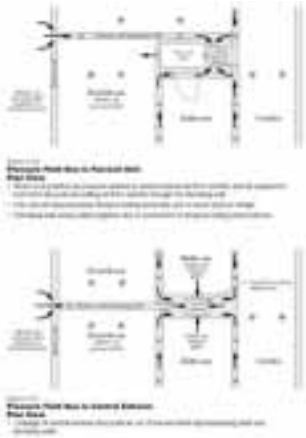


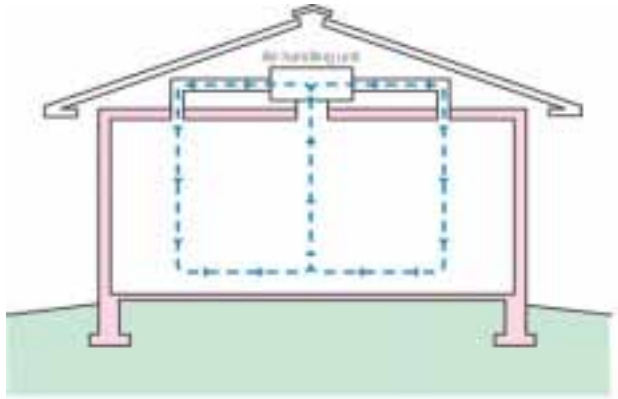



Brick veneer
Air space
Building paper
Gypsum sheathing
Fiberglass cavity insulation
Interior gypsum board
Metal studs are perforated permitting air to be drawn through wall cavity
Interconnected hollow wall cavity constructed from metal studs with punched openings acting as an air duct
Interior spaces are at a positive pressure relative to the exterior

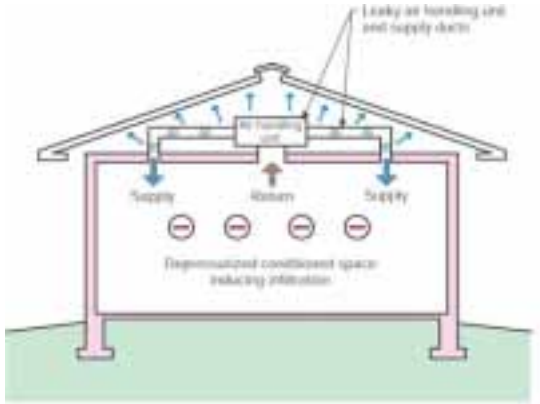

Supply Air
Air Handler Unit
Return air opening
Gypsum board
Return grille
Return grille filter


Adjacent Hotel Room
Exterior Air
Hotel Room
Bathroom
Interior Corridor





Note: Colored shading depicts the building's thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.



Duct Leakage Should Be Less Than 5% of Rated Flow As

Tested By Pressurization To 25 Pascals

Pollutants

Principle Damage Functions
Heat
Water
Ultra-Violet Radiation

Ozone

If You Want To Find The Pollutant Source
Look For the Hot Spot or the Wet Spot or the

Spot That Sees Ultra-Violet Light or the Spot That is Sensitive to Ozone

Damage Functions are Exponential and Synergistic

Arrhanius Equation of Free Energy: Every 10 degree Kelvin rise in temperature yields a doubling of available energy for reactions to occur

Heat: every 10 degree K or 18 degree F results in a 50 percent reduction in the useful service life of a material

Water: every 18 percent increase in relative humidity results in a doubling of the vapor pressure and a 50 percent reduction in the useful service life of a material

Ultra-Violet Radiation: every 10 percent increase in intensity results in a 50 percent reduction in the useful service life of a material

Ozone: every 10 percent increase in intensity results in a 50 percent reduction in the useful service life of a material

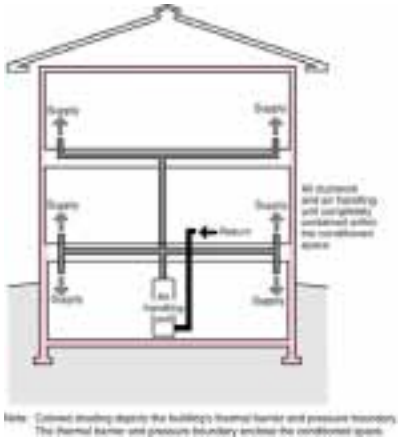
If You Want Things To Last A Long Time:

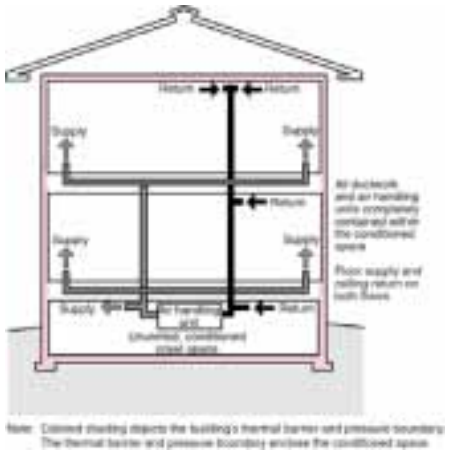
Keep Them Cold
Keep Them Dry
Keep Them Out of The Sunlight

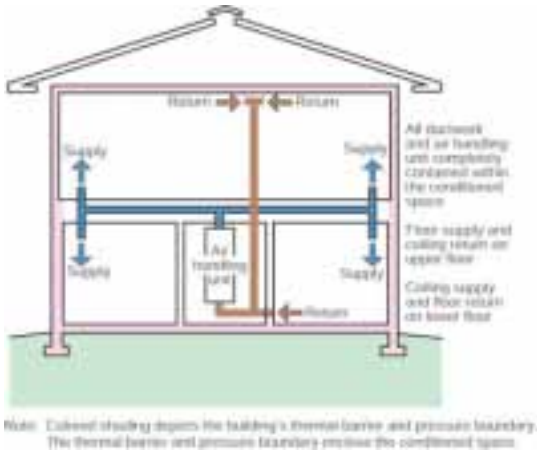
And Don't Expose Them To Ozone

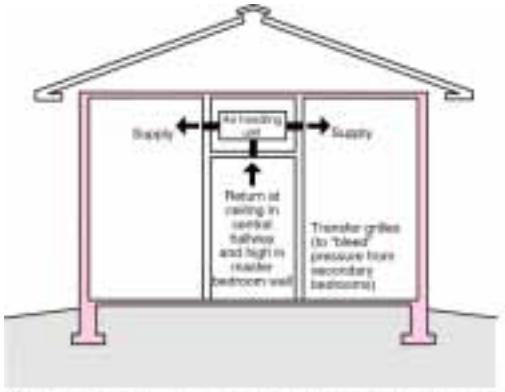
The Principle Damage Functions Result in the Breakdown of Materials
Breakdown Products are Often Gaseous and Particulate

They are Typically Transported by Air

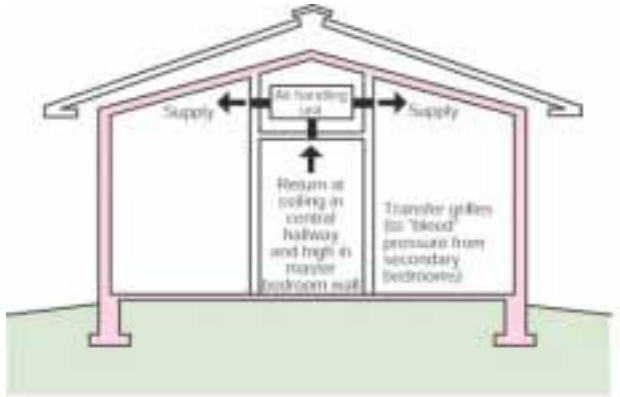



Return
Return
Supply
Supply
Return
Supply
Supply
Supply
Return
All ductwork and air handling units completely contained within the conditioned space
Floor supply and ceiling return on both floors


Return
Return
Supply
Supply
Supply
Supply
Air handling unit
Return
All ductwork and air handling unit completely contained within the conditioned space
Floor supply and ceiling return on upper floor
Ceiling supply and floor return on lower floor



Note: Colored shading depicts the building's thermal barrier and pressure boundary. The thermal barrier and pressure boundary enclose the conditioned space.



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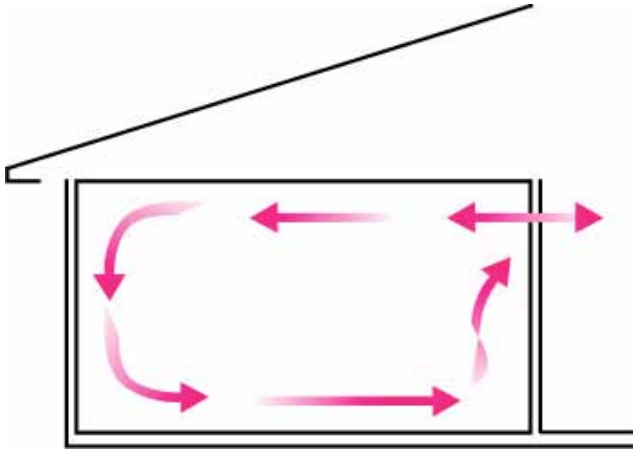
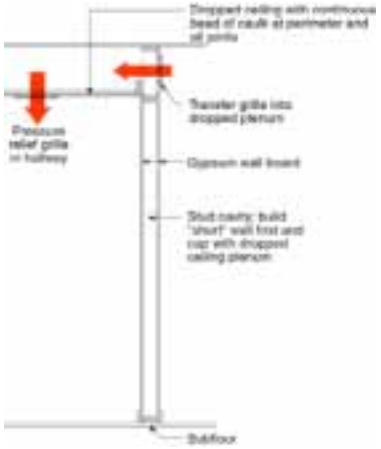
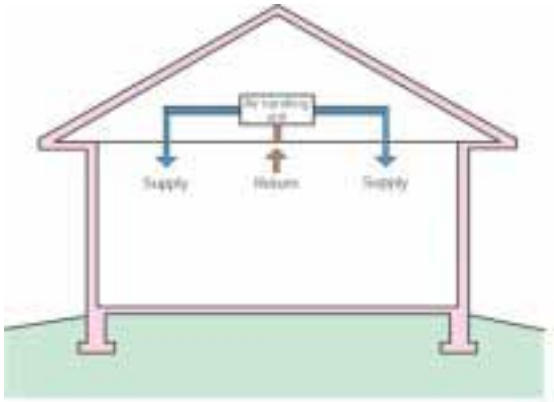
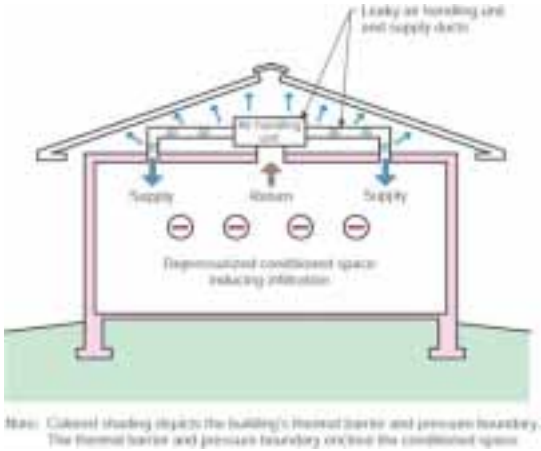
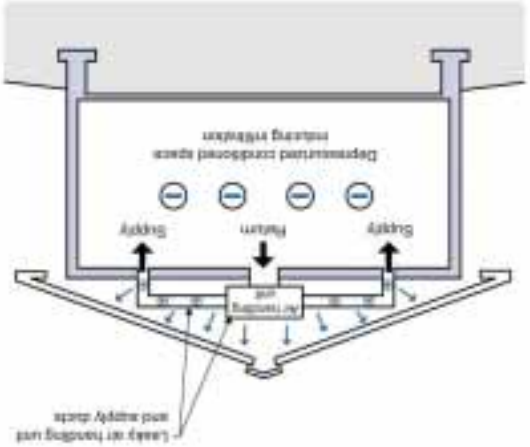
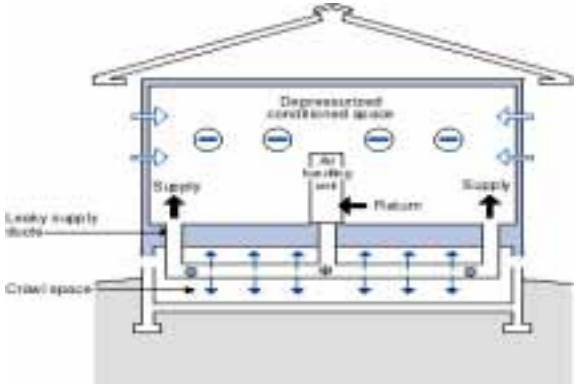


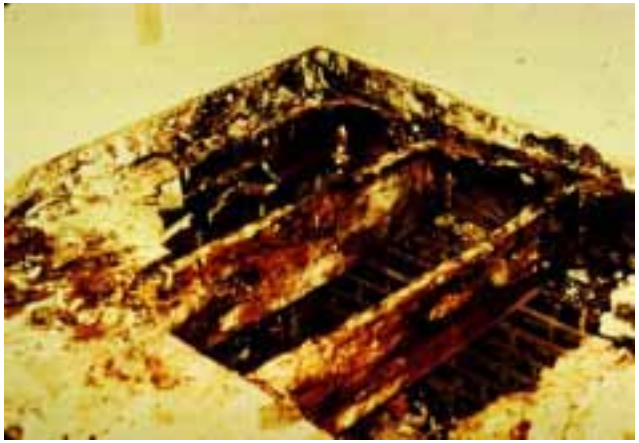

Transfer grille into dropped plenum
Pressure relief grille in hallway
Gypsum wall board
Subfloor

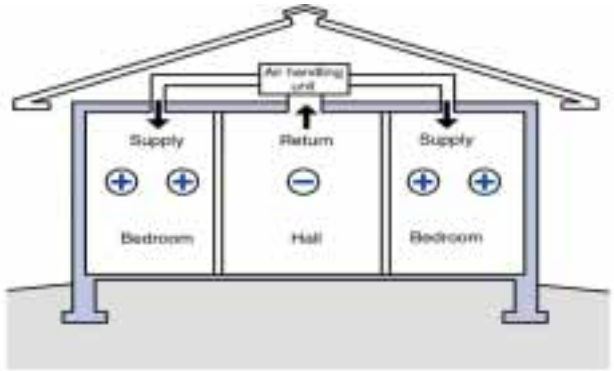

Supply
Return
Supply


Supply
Return
Supply


Supply
Return
Supply

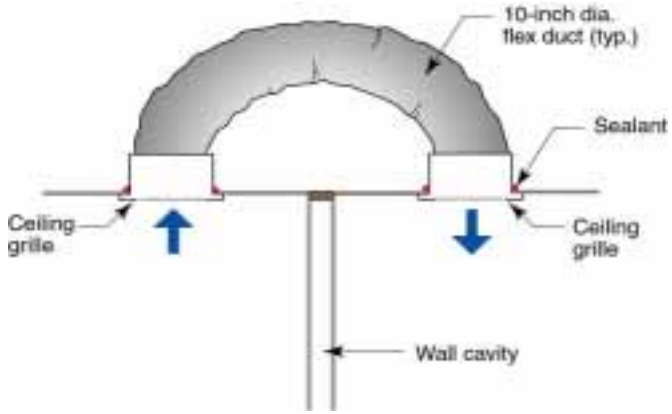

Supply
Return
Supply
Leaky supply ducts
Crawl space

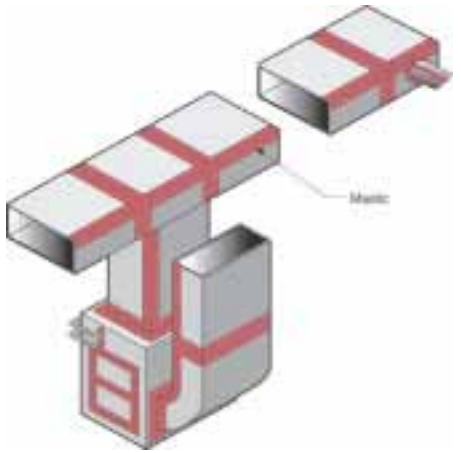


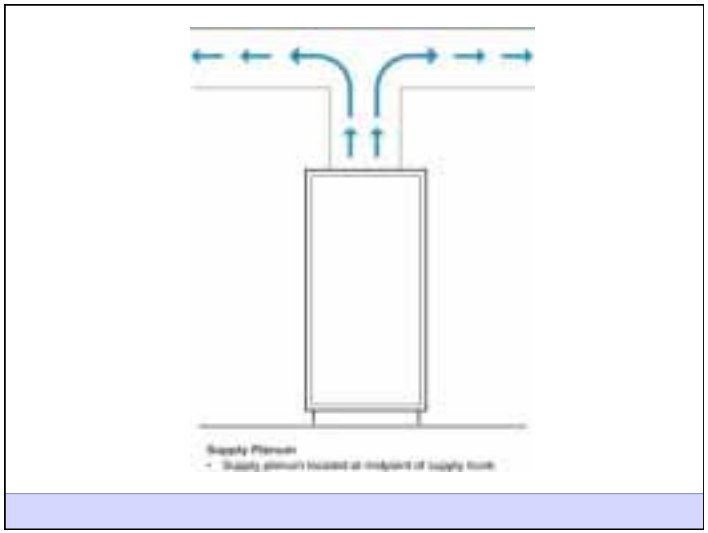

Air handling unit
Supply
Return
Supply
Bedroom
Hall
Bedroom

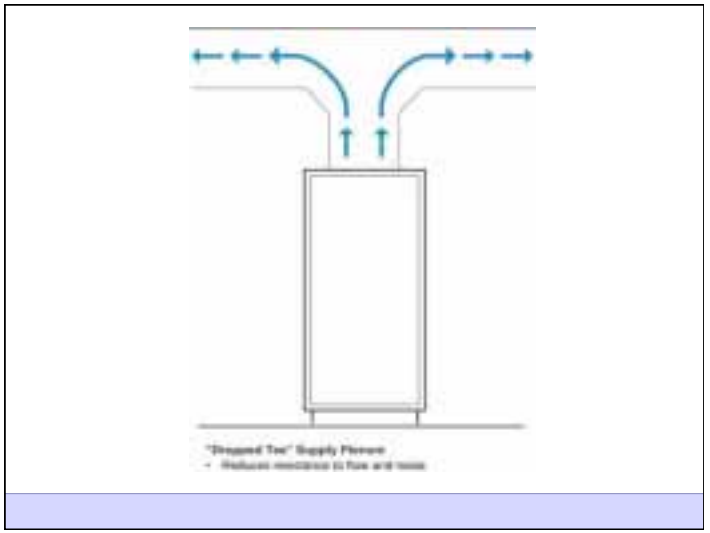

RULE

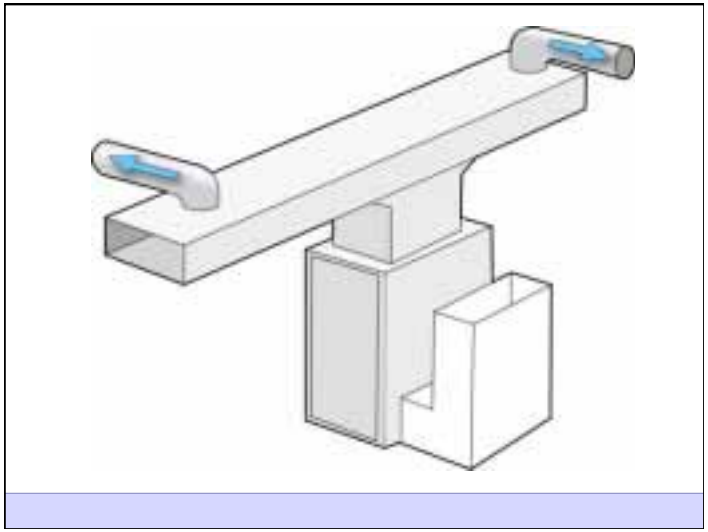

Grille located high in wall on bedroom side to avoid blockage by furniture
Cavity is sealed tight, drywall glued to studs and plates on both sides
Grille located low in wall on hallway side

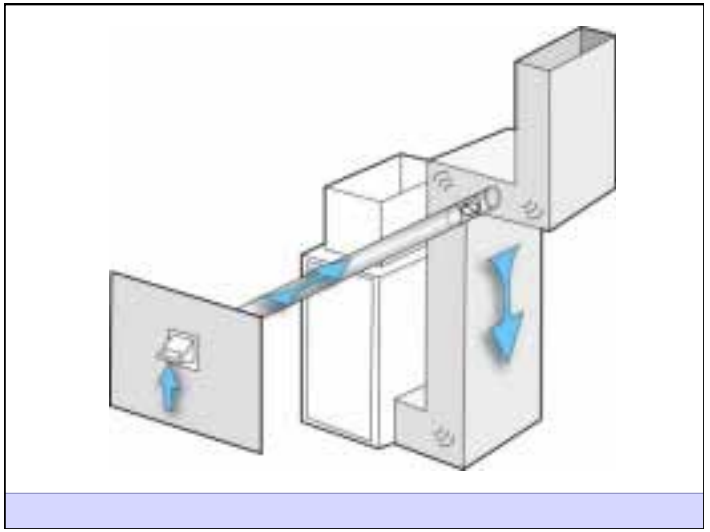

10-inch dia. flex duct (typ.)
Sealant
Ceiling grille
Ceiling grille
Wall cavity

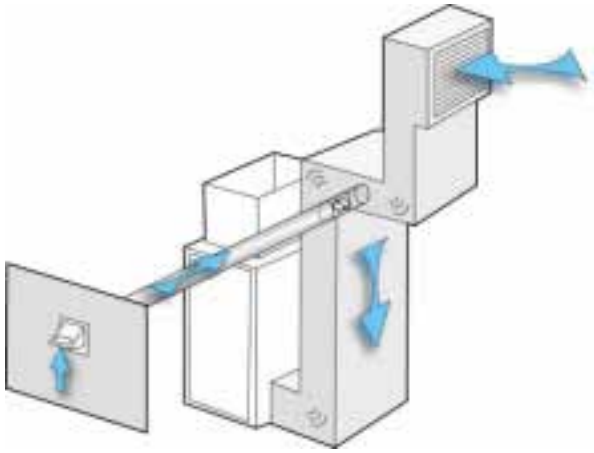


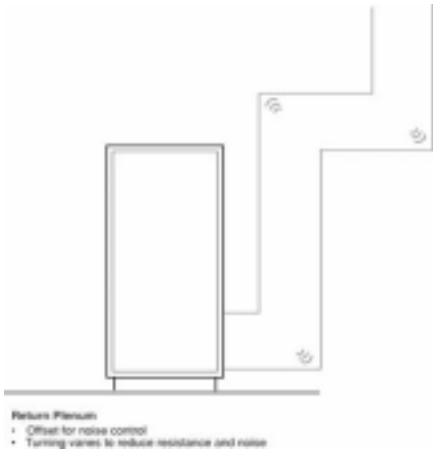











Return Plenum
• Offset for noise control
• Turning vanes to reduce resistance and noise


Radius Return Plenum
• Offset for noise control
• Radius return to reduce resistance and noise