

# CHAPTER 4: INSPECTION & INSTALLATION

## 4.1 Installation Key Points

**SIZED - Flexible duct shall be properly sized per the requirements of ACCA Manual D or Manual Q as applicable .**

Time should be taken to complete sizing calculations for air distribution systems. This is not specific to flexible duct systems, any ducting system should be properly sized per the requirements of ACCA Manual D (Residential) or Manual Q (Commercial).

**ROUTED - Flexible duct runs shall be properly routed to minimize sagging and “snaking”**

Ducting systems should ALWAYS run in the most direct path from starting point to termination point. Every unnecessary turn or sag in the duct increases friction and reduces air flow.

**EXTENDED - Flexible duct shall be installed fully extended using the minimum length needed to make connections.**

Along with being installed in the most direct path the ducting should be fully extended. Ducting that is not extended can increase pressure drop and reduce air flow.

**BENDED - Flexible duct bends shall be greater than or equal to 1 duct diameter.**

Sharp bends in ducting significantly increase pressure drop. Keep bends to great than or equal to one (1) duct diameter and properly supported.

**SUPPORTED - Flexible ducts shall be properly supported.**

Duct supports shall be a minimum of 1.5” in width with wider supports recommended in installation areas conducive to condensation. Horizontal duct runs shall be supported at maximum 4’ intervals and vertical risers at maximum 6’ intervals.

**SEPARATED - Flexible ducts should be separated in areas conducive to condensation.**

To prevent condensation forming on the outer surface of the duct, a gap should be present to allow free air flow over the outer duct surface. Locations where two duct surfaces are in contact can lead to condensation.

**SEALED - Flexible duct connections shall be properly sealed using listed and labeled sealing materials and methods.**

Care shall be taken to properly seal the ducting using materials listed and labeled to the UL standard. Improper sealing and installation methods can lead to leakage which can reduce system efficiency.

***Note: An Installation Checklist can be found in Appendix E of this manual. This checklist can be used by installers or inspectors to ensure that the ducting is installed properly.***

## 4.2 Air Duct or Air Connector

Flexible ducts are classified by their performance when tested to UL 181 Standard for Safety, Factory-Made Air Ducts and Air Connectors. The standard includes seventeen (17) tests covering fire testing, tests for physical characteristics, and product performance testing. Sixteen (16) test are applicable to Air Ducts and thirteen (13) tests are applicable to Air Connectors. One (1) is reserved for testing Joining Materials. (Refer to Appendix B for testing detail.)

In many cases, Air Ducts and Air Connectors look similar in appearance. The only way to be sure whether a flexible duct is an Air Duct or Air Connector is to examine the listing label on the product.

- Flexible Air Ducts will have a rectangular or square listing label and include the words “Air Duct”.
- Air Connectors will have a circular listing label which identifies it as an “Air Connector”. In addition, Air Connectors will include the words “For installation in lengths not over 14 ft.”

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### 4.3 Bends

When making bends to flexible air ducts or air connectors, the diameter of the bend shall be greater than or equal to one (1) duct diameter (see Figures 8 & 9). If the bends are less than one (1) duct diameter this can significantly increase pressure drop throughout the system resulting in a reduction in the overall system efficiency and performance.

For bends made prior to or after a metal connection, extend the duct straight for at least one duct diameter length before and after the connection points. This avoids potential damage to the duct from the fitting edges while also improving the airflow.

For proper support, place strapping both before and after a 90 degree bend that is made in the middle of a duct run.

#### CORRECT BENDS

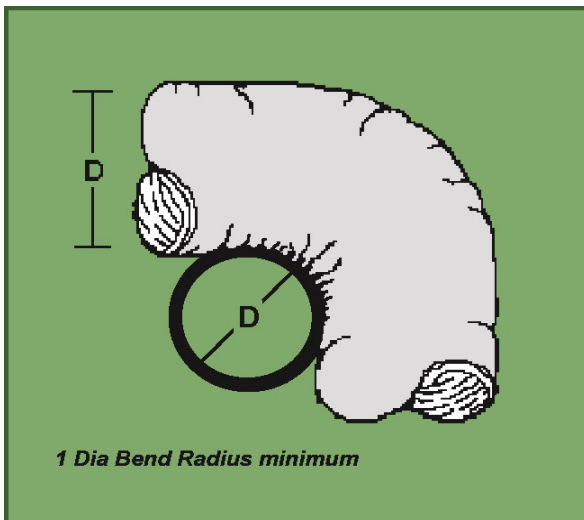


Figure 8

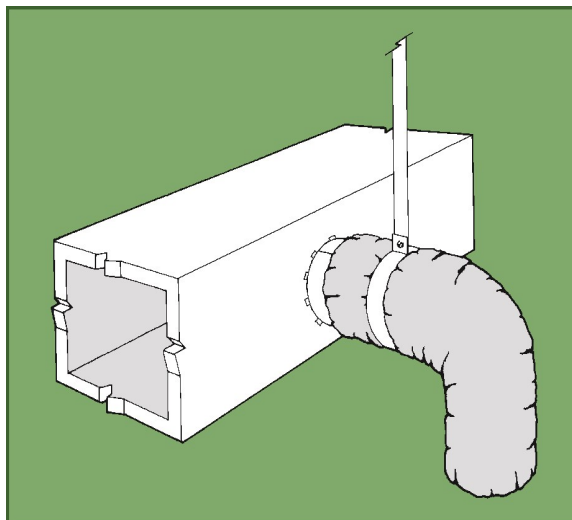


Figure 9

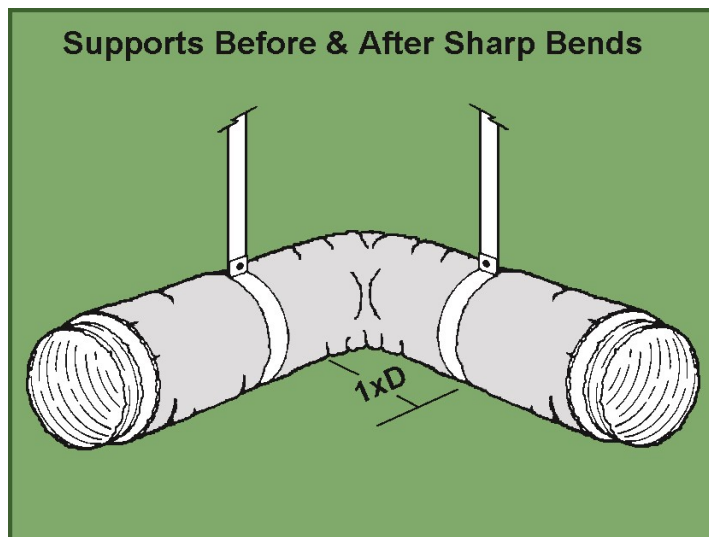


Figure 10

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### INCORRECT BENDS

Ducts shall not be crimped tightly against joist or truss members, or against pipes, wires, and other building materials.

Duct runs shall be made with the minimum practical length needed to make the connection from one fitting to the next. Excessive duct length and bends increase pressure drop and reduce overall system efficiency and performance. Ducts shall not be installed with excess length intended for future building changes.

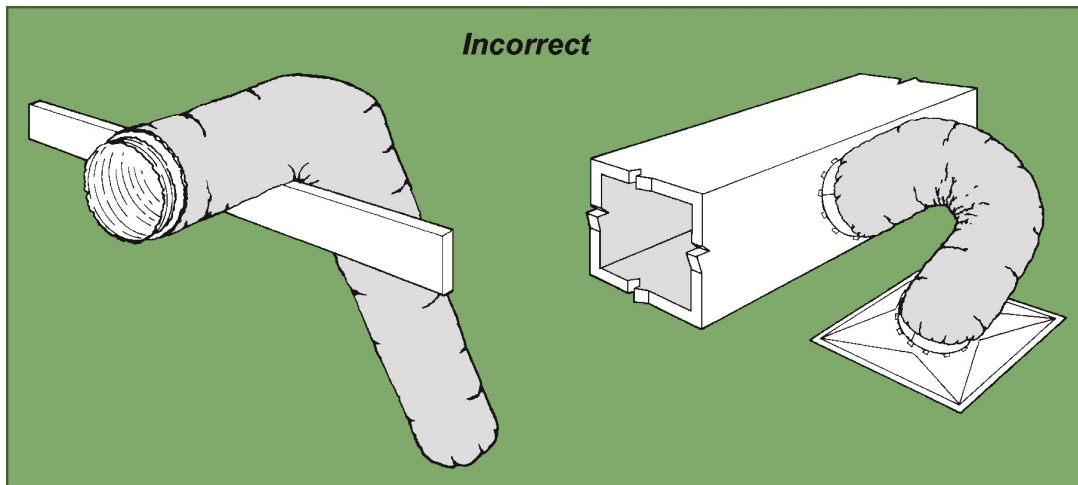


Figure 11

### 4.4 Routing, Sagging, & Snaking

Flexible air ducts and connectors should always be installed in the most direct route possible. Changing directions multiple times will increase the friction rate of the duct thus decreasing the air flow in the HVAC system.

Flexible air ducts and connectors must be installed in the straight condition without sag. Extra supports should be used to prevent sag where 90° bends are made by placing straps both before and after the bend. Excessive sag creates more friction reducing air flow in the air distribution system.

### INCORRECT ROUTING

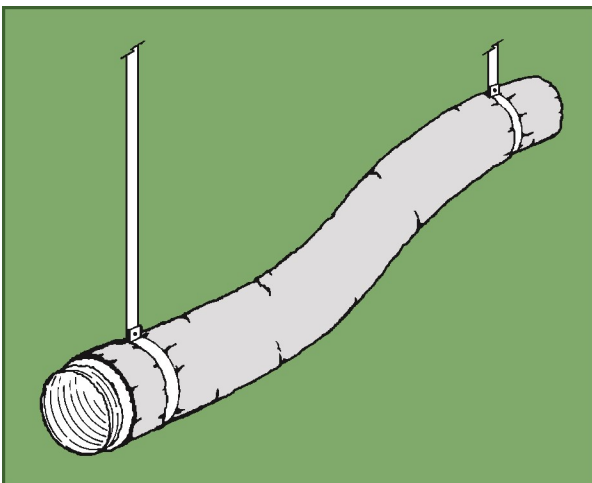


Figure 12

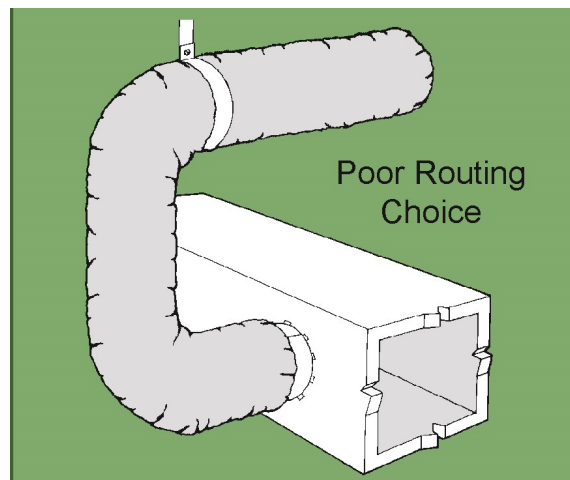


Figure 13

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### 4.5 Supporting Flexible Ducts

#### 4.5.1 Hanger Straps Material & Width.

Various materials are used regionally to hang and support flexible air duct. The ADC does not specify a particular material in our installation instructions. However, ADC does make the following statement:

Hanger or saddle material in contact with Flexible Air Ducts and/or Flexible Air Connectors shall be of sufficient width and rigidity to prevent any restriction of the internal diameter of the duct when the weight of supported sections rests on the hanger or saddle material. In no case will the material contacting the duct or connector be less than 1-1/2" wide.

For flexible duct installed in Climate Zones 1A, 2A, and 3A (refer to the IECC US Climate Zone Map) where higher levels of heat and humidity are likely it is recommended that a hanger or saddle material be not less than 3" wide to support the flexible duct. This recommendation is to reduce the likelihood of condensation at the point of contact with the hanging material and flexible duct due to compression of the fiberglass insulation potentially caused by the supporting material and the weight of the duct.

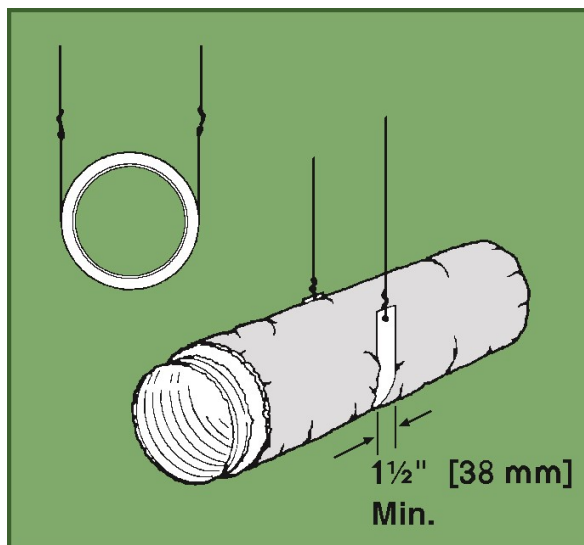


Figure 14

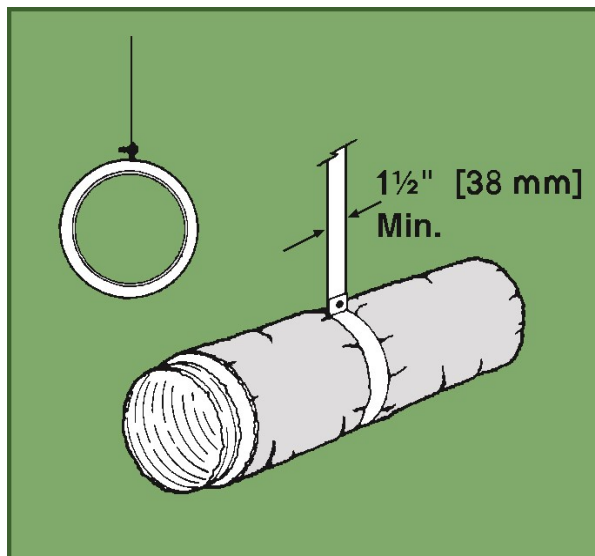


Figure 15

## INSPECTION & INSTALLATION

### 4.5.2 Support Spacing

Flexible duct shall be supported at maximum 4' intervals horizontally and 6' intervals for vertical risers.

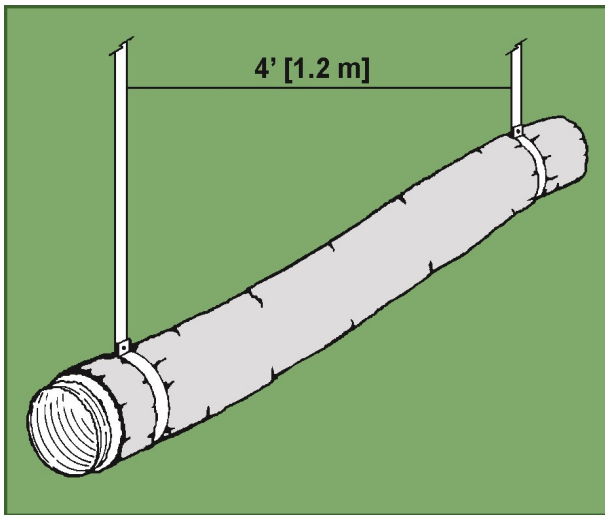


Figure 16

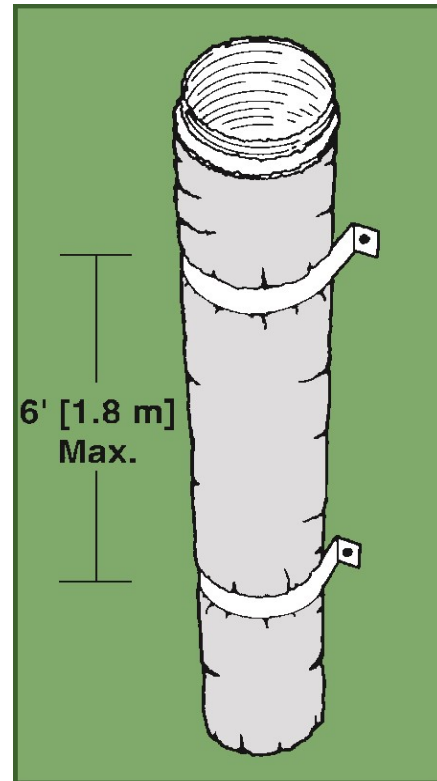


Figure 17

### 4.5.3 Ceiling or Truss Supports

Ceiling beams or truss members may be used to support flexible duct provided they do not exceed 4' intervals, and are at least 1 1/2" wide.

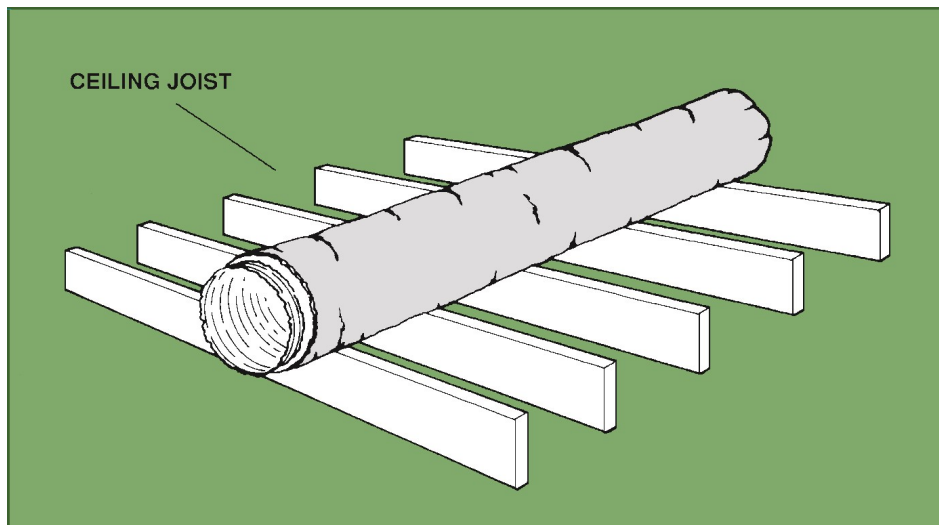


Figure 18

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### 4.6 Compression

Unnecessary longitudinal and circumferential compression of flexible duct significantly increases pressure drop resulting in reduced air flow and loss of system efficiency. Care should be taken to insure flexible ducts are installed fully extended and not compressed.

A simplified, yet easily understood, comparison can be made by looking at the common garden water hose. Kinking a garden hose reduces or chokes off the water flow. Also, a long garden hose will have lower water pressure than a much shorter one. Movement of air through ducts is effected in the same manner.

#### 4.6.1 Longitudinal Compression.

Flexible air ducts and air connectors should always be installed to their fullest length without longitudinal compression. Due to the helical configuration of flex duct inner cores, excess longitudinal compression significantly increases pressure drop and reduces performance. (See Figure 19)

#### 4.6.2 Circumferential Compression.

Flexible air ducts and air connectors are intended to be installed in their original round configuration. For optimal air flow, care should be taken to avoid compressing the duct circumferentially along its length. Ducts should not be forced into small building cavity areas that result in compression of the duct wall and/or the duct inner liner diameter. Incidental compression when connecting to oval pipe or fittings is acceptable. Compressing the duct vapor barrier and insulation can reduce the duct thermal performance characteristics and could also result in localized condensation. (See Figure 20)

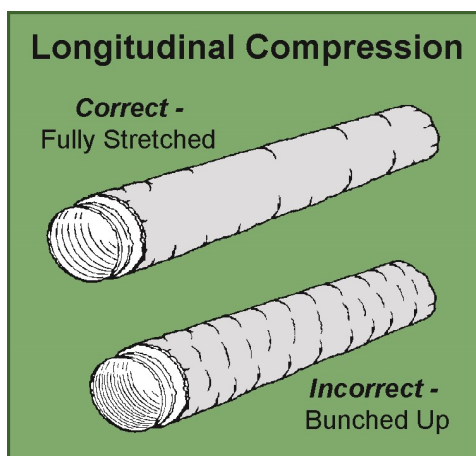


Figure 19

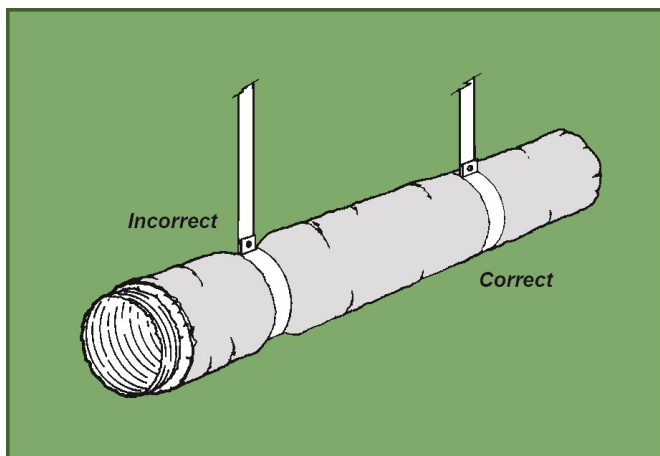


Figure 20

### 4.7 Installation Instructions

All connections, joints and splices shall be made in accordance with the manufacturer's installation instructions. Always reference the manufacturer's installation instructions for more detailed requirements.

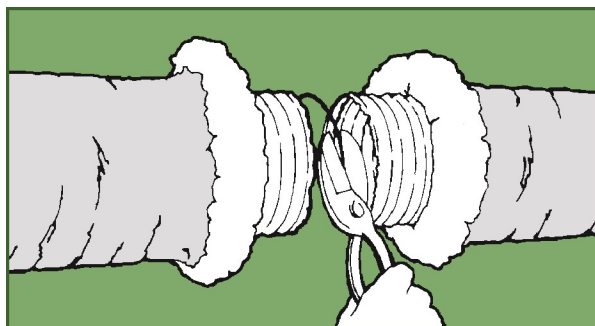
Due to the wide variety of ducts and duct assemblies with special end treatments (factory installed fittings, taped ends, crimped metal ends, etc.), only the standardized installation instructions were shown.

## INSPECTION & INSTALLATION

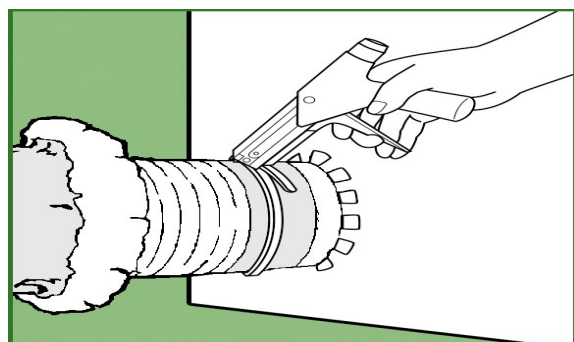
### 4.7.1 Installation Instructions for Air Ducts and Air Connectors - Nonmetallic with Plain Ends

#### Connections - Using Tape and Fasteners

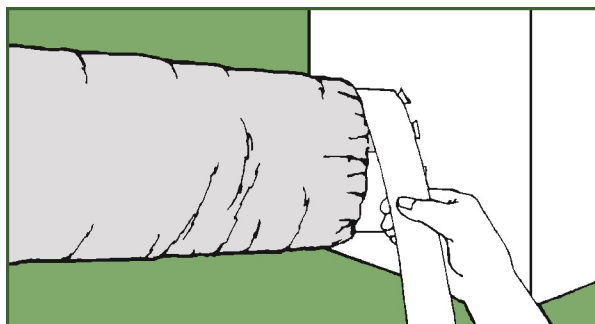
1. After desired length is determined, cut completely around and through duct with knife or scissors. Cut wire with wire cutters. Fold back jacket and insulation.



2. Slide at least 1" [25 mm] of core over fitting and past the bead. Seal core to collar with at least 2 wraps of duct tape. Secure connection with clamp placed over the core and tape and past the bead.

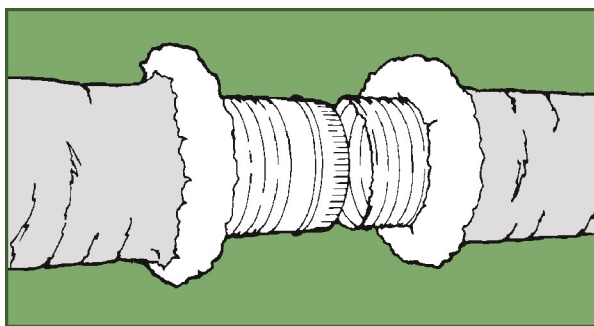


3. Pull jacket and insulation back over core. Tape jacket with at least 2 wraps of duct tape. A clamp may be used in place of or in combination with the duct tape.

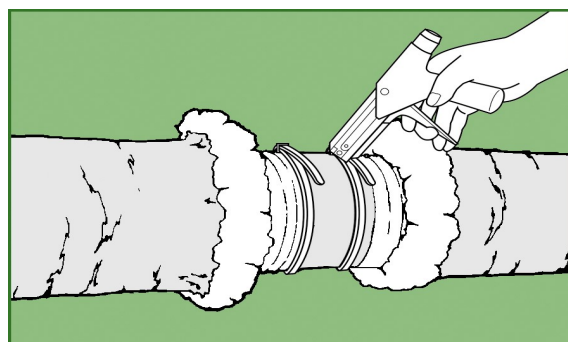


#### Splices - Using Tape and Fasteners

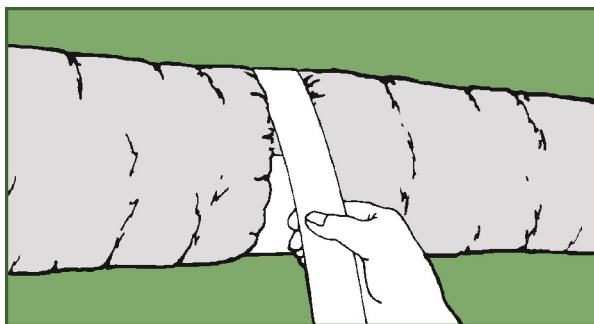
1. Fold back jacket and insulation from core. Butt two cores together on a 4" [100 mm] min. length metal sleeve.



2. Tape cores together with at least 2 wraps of duct tape. Secure connection with 2 clamps placed over the taped core ends and past the beads.



3. Pull jacket and insulation back over cores. Tape jackets together with at least 2 wraps of duct tape.



#### NOTES:

1. For uninsulated air ducts and air connectors, disregard references to insulation and jacket.
2. Use beaded sheet metal fittings and sleeves when using nonmetallic clamps.
3. Use tapes listed and labeled in accordance with Standard UL 181B and marked "181B-FX".
4. Nonmetallic clamps shall be listed and labeled in accordance with Standard UL 181B and marked "181B-C". Use of nonmetallic clamps shall be limited to 6 in. w.g. [1500 Pa] positive pressure.



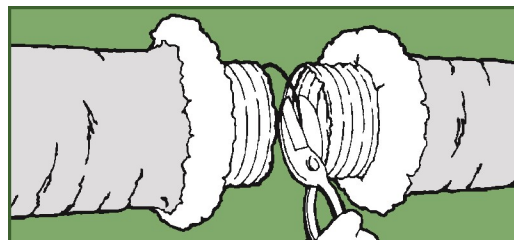
## INSPECTION & INSTALLATION

### 4.7.2 Alternate Installation Instructions for Air Ducts and Air Connectors - Nonmetallic with Plain Ends

#### Connections and Splices - Using Mastic and Fasteners

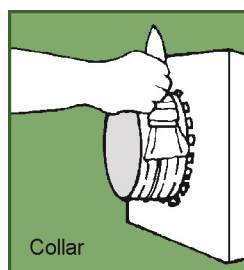
##### Step 1

After desired length is determined, cut completely around and through duct with knife or scissors. Cut wire with wire cutters. Pull back jacket and insulation from core.

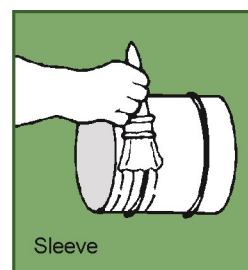


##### Step 2

Apply mastic approximately 2" [50 mm] wide uniformly around the collar of the metal fitting or over the ends of a 4" [100 mm] min. length metal sleeve. Reference data on mastic container for application rate, application thickness, cure times and handling information.



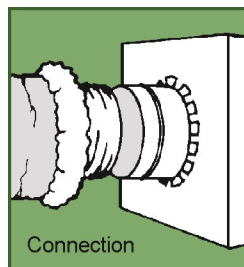
Collar



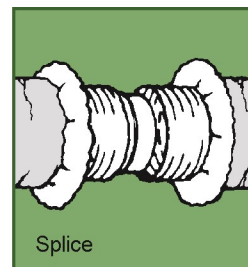
Sleeve

##### Step 3

Slide at least 2" [50 mm] of core over the fitting or sleeve ends and past the bead.



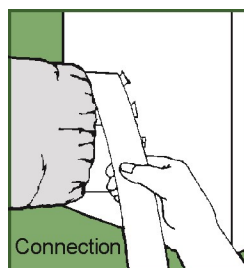
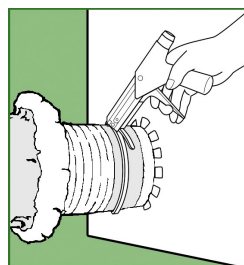
Connection



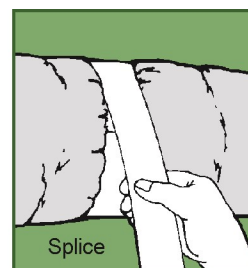
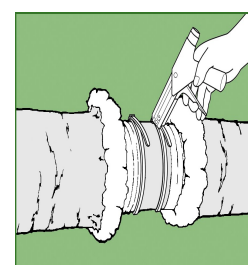
Splice

##### Step 4

Secure core to collar with a clamp applied past the bead. Secure cores to sleeve ends with 2 clamps applied past the beads.



Connection



Splice

##### Step 5

Pull jacket and insulation back over core ends. Tape jacket(s) with at least 2 wraps of duct tape. A clamp may be used in place of or in combination with the duct tape.

#### NOTES:

1. For uninsulated air ducts and air connectors, disregard references to insulation and jacket.
2. Use beaded sheet metal fittings and sleeves when using nonmetallic clamps.
3. Use mastics listed and labeled in accordance with Standard UL 181B and marked "181B-M" on container.
4. Use tapes listed and labeled in accordance with Standard UL 181B and marked "181B-FX".
5. Nonmetallic clamps shall be listed and labeled in accordance with standard UL 181B and marked "181B-C". Use of nonmetallic clamps shall be limited to 6 in. w.g. [1500 Pa] positive pressure.

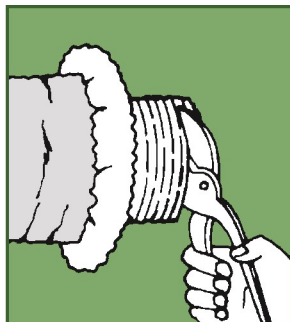
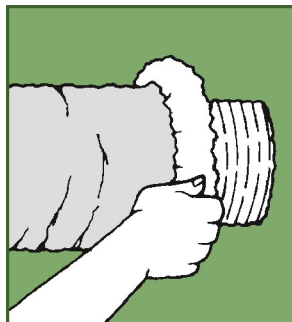


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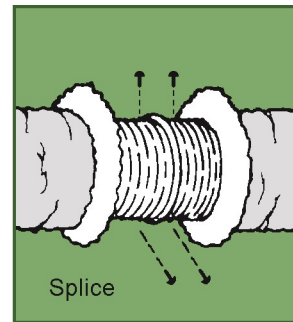
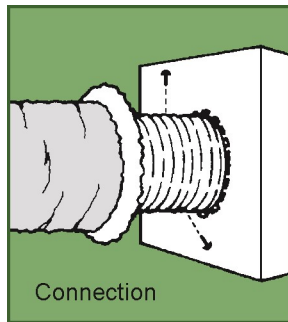
### 4.7.3 Installation Instruction for Air Ducts and Air Connectors - Metallic with Plain Ends

#### Connections and Splices - Using Tape or Mastic and Sheet Metal Screws

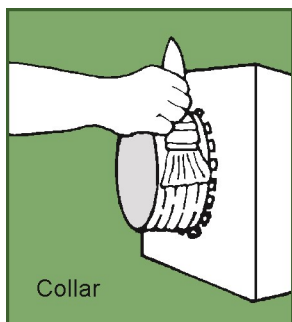
1. After cutting duct to desired length, fold back jacket and insulation exposing core. Trim core ends squarely using suitable metal shears. Determine optional sealing method (Steps 2 or 5) before proceeding.



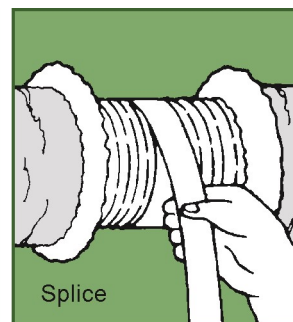
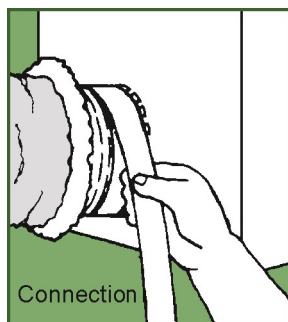
4. Secure to collar/sleeve using #8 sheet metal screws spaced equally around circumference. Use 3 screws for diameters under 12" [300 mm] and 5 screws for diameters 12" [300 mm] and over.



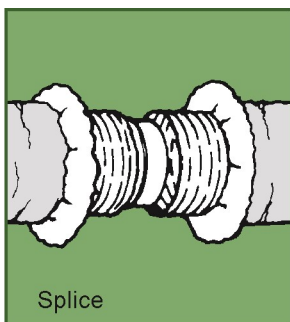
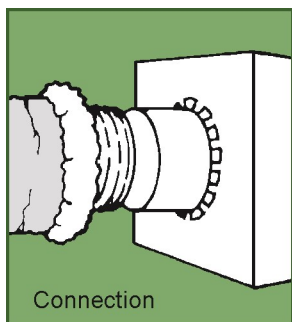
2. When mastics are required and for pressures 4" w.g. [1000 Pa] and over, seal joint with mastic applied uniformly to the outside surface of collar/sleeve. (Disregard this step when not using mastics and proceed to Step 3).



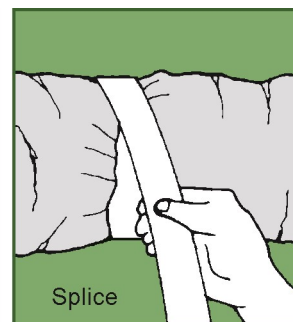
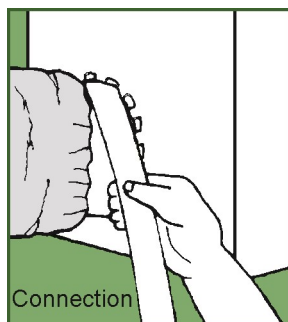
5. For pressures under 4" w.g. [1000 Pa] seal joint using 2 wraps of duct tape applied over screw heads and spirally lapping tape to collar/sleeve. (Disregard this step when using mastics per Step 2).



3. Slide at least 1" [25 mm] of core over metal collar for attaching duct to take off or over ends of a 4" [100 mm] metal sleeve for splicing 2 lengths of duct.



6. Pull jacket and insulation back over core. Tape jacket with 2 wraps of duct tape. A clamp may be used in place of or in combination with the duct tape.



#### NOTES:

1. For uninsulated air ducts and air connectors, disregard references to insulation and jacket.
2. Use mastics listed and labeled to Standard UL 181B and marked "181B-M" on container.
3. Use tapes listed and labeled to Standard UL 181B and marked "181B-FX".
4. Nonmetallic clamps shall be listed and labeled in accordance with Standard UL 181B and marked "181B-C".

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### 4.8 Fittings, Fasteners & Sealants

#### 4.8.1 Fittings

Sheet metal fittings to which flexible ducts with plain ends are attached shall be beaded and have a minimum of 2 inches [50 mm] collar length. Beads are optional for fitting when using metal worm-gear clamps or when attaching metallic flexible ducts using sheet metal screws.

Sheet metal sleeves used for joining two sections of flexible duct with plain ends shall be a minimum of 4 inches [100 mm] in length and beaded on each end. Beads are optional for sleeves when using metal worm gear clamps or when joining metallic flexible ducts using sheet metal screws.

#### 4.8.2 Mastic

Mastic shall be listed and marked "UL181B-M".

#### 4.8.3 Tapes

Tape shall be listed and marked "UL181B-FX".

#### 4.8.4 Nonmetallic Fastener (Plastic ties)

Plastic ties often called zip ties shall be listed and marked "UL 181 B-C".

Flexible duct secured with nonmetallic fasteners shall be limited to 6 inches W.G. [1500 Pa] positive pressure.

#### 4.8.5 Metallic Fasteners

Metallic fasteners are not required to be listed.

#### 4.8.6 Screws

ADC does not recommend the use of metal screws for making connections and splices with non-metallic flexible air ducts. Procedures and materials (tapes, mastic, fasteners) for connecting and splicing non-metallic flexible ducts are evaluated using UL181B Standard which does not address the use of metal screws. Potentially, metal screws can damage the components in some non-metallic flexible ducts.

ADC allows the use of sheet metal screws for making connections and splices with metallic flexible air ducts.

### 4.9 Typical Installation Locations

#### 4.9.1 Ducts in Attics

When installing flexible ducting in attics, the ducts can be suspended from the rafters using an appropriate strap material and proper spacing. Flexible ducts can also rest on ceiling joists or truss supports provided the support centerline spacing does not exceed four (4) feet and the support surface is at least 1-1/2" in width. (Refer to Section 4.5 Supporting Flexible Ducts)

Avoid installing ducts in areas where exposure to direct sunlight will occur (e.g. turbine vents, sky lights canopy windows, etc.). As most flexible ducts are intended for Indoor Use Only, this exposure to UV radiation can lead to eventual deterioration of the outer vapor barrier. (Refer to 3.7 UV Light)

Avoid running ducts unnecessarily high up against the roof line. Attic spaces are generally significantly hotter closer to the roof line and this elevated temperature can significantly affect the energy efficiency of the duct system and potentially increase the occurrence of condensation.

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### 4.9.2 Ducts in Crawl Spaces

In accordance with the building codes, ducts installed under a building structure shall not be in contact with the ground. All duct surfaces shall be at least 4" above the earth (i.e. not sitting directly on dirt, rocks etc.). In addition, the crawl space shall shield the ducting from environment exposure. For installations where the duct may be exposed, such as a mobile home crossover duct, only ducts designed and intended for use under exposed conditions shall be used.

Care must also be taken to ensure that the area under the structure is free from potential flooding. Flexible duct vapor barriers offer protection to the insulation from normal moisture vapor transfer; however, ducts sitting in standing water from flooding will deteriorate and not perform as designed.

### 4.9.3 Ducts in Walls and Between Floors

Flexible air ducts can be installed in walls and between floors. When installed vertically in walls the ducts shall be supported by straps at six (6) feet maximum intervals (Refer to Section 4.5 Supporting Flexible Ducts). For exterior walls refer to the appropriate energy code for the minimum insulation required between the ducts and the exterior space.

### 4.9.4 Ducts in Plenums

The building codes require that materials installed in plenums have a Flame Spread Index of 25 or less and a Smoke Developed Index of 50 or less when tested in accordance with ASTM E84. All listed and labeled Class 1 or Class 0 Flexible Air Ducts and Air Connectors meet this requirement and therefore may be installed within a plenum.

### 4.9.5 Ducts in Fire Resistant Rated Assemblies

Refer to Section 3.7 for materials allowed in Fire Resistant Rated Assemblies.

### 4.9.6 Ducts Exposed to the Elements

Unless specifically designed and labeled for outdoor use, flexible air ducts and air connectors shall not be used outdoors. Refer to the appropriate energy code for specific duct insulation requirements when ducts are installed outdoors.

## 4.10 Contact with Fixtures

### 4.10.1 Hot Equipment

Flexible air ducts shall be installed with a minimum clearance to an appliance as specified in the appliance manufacturer's installation instructions. They shall not be installed in contact with boilers, steam pipes, or other equipment that exceeds the duct manufacturer's maximum recommended use temperature.

### 4.10.2 Pipes

Contact with pipes, both metal and plastic, should be avoided when possible, but incidental contact with pipes should not cause damage to the flexible duct. Pipe manufactures instructions must be used to determine if contact with the flexible ducting will lead to degradation in the piping material.

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### 4.11 Leakage

Flexible duct has inherently low leakage properties due to the impervious nature of the materials used as the air barrier. These give the flexible duct itself leakage rates less than 0.5% of air volume when proper connections are made to the other systems.

A higher than expected leakage rate can occur at connections if improper materials or careless work practices are used. To assure a low leakage rate for flexible duct systems, the following is required:

- Reference applicable industry manuals (SMACNA, NAIMA) for making round tap-ins into and sealing fitting joints to rigid ducts, plenums, etc.
- Make flexible duct connections/splices in accordance with the manufacture's recommended installation instructions for this Standard.
- Seal flexible duct connections with sealing materials listed and labeled to Standard UL 181B. Mechanically secure connections with approved clamping material.
- Repair any rip, tear or hole in the air barrier using materials listed and labeled to Standard UL 181B and methods recommended by the manufacturer.

### 4.12 Condensation

In areas with high humidity, it is possible for condensation to form on flexible duct surfaces. Condensation will form when the temperature of any surface is lower than the dew point temperature of the surrounding air. This phenomenon is commonly observed on a glass of ice water placed in a warm, humid environment.

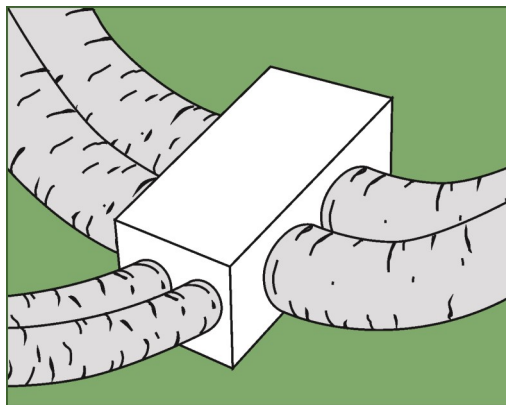
It is important to note that ducts with high R-value insulation can decrease the likelihood of condensation. For correct thermal performance, the duct needs to be exposed to ambient air on all sides without insulation compression.

To reduce condensation there are several installation practices to avoid when working in areas prone to condensation.

#### 4.12.1 Practices to Avoid

##### 4.12.1.1 Duct Contact

When ducts make contact, the temperature between the ducts could easily drop below the dew point temperature. (Figure 21)



**Figure 21**

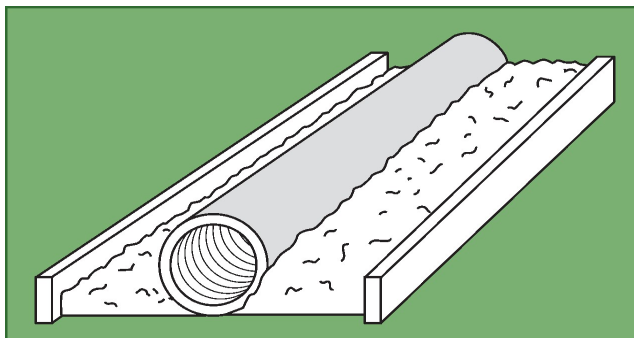
##### 4.12.1.2 Insulation Compression

Compressing the thickness of duct insulation significantly impacts duct thermal performance resulting in surface condensation. Avoid compressing the duct insulation.

## INSPECTION & INSTALLATION

### 4.12.1.3 Insulation Contact

Avoid laying duct directly on attic insulation in areas conducive to condensation.. Ducts should be properly suspended to allow free circulation of ambient air around all surfaces of the duct. See section 4.5 for proper duct support.



**Figure 22**

### 4.12.1.4 Adding External Insulation

Avoid adding extra insulation to the outside of the duct. Encapsulating or burying ducts that already contain an outer vapor barrier can potentially lead to moisture problems when the ducts are installed in areas of the country conducive to condensation. In addition, encapsulating flexible ducts may invalidate the manufacturers listing to the UL181 Standard and/or the warranty. Care should be taken when considering the practice of encapsulating or burying a flexible duct system in this manner.

### 4.12.1.5 Tight Strapping

Avoid installing duct supports too tightly this can lead to surface condensation.

### 4.12.1.6 Exposed Metal Fittings

Exposed metal fittings lead to condensation. All metal fittings should be insulated per the requirements in the building code.

### 4.12.1.7 Improper Sealed Inner Core

Avoid air leakage from flexible duct inner cores. Unconditioned air permeating the surround insulation leads to surface condensation.

### 4.12.1.8 Porous Inner Core

The use of porous inner liners should be avoided in areas conducive to condensation. (i.e. Perforated Acoustical Products)

### 4.12.1.9 Torn or Unsealed Vapor Barriers

Air infiltration through the exterior vapor barrier can result in condensation formation on the exterior of the inner liner.

## 4.13 Field Alterations

Alterations made in the field, such as applying additional overwraps of insulation or barriers, adding spray-foam insulation, surface painting, applying internal sanitizers or spray sealants, etc. may compromise the fire safety performance of the duct and void the manufacturer's listing and/or product warranty.

## 4.14 Personal Protective Equipment

Insulated flexible air ducts generally contain fiberglass insulation and steel wire. Where necessary, wear eye protection, use a properly fitted approved respirator, and wear long-sleeve loose fitting clothing and gloves during installation.