

**Contents**

Introduction ..... 1  
 General descriptions of types of insulated duct systems ..... 2-5  
 How fibrous glass duct insulation improves the indoor environment ..... 6  
 Codes and Standards ..... 7-17  
 Fibrous glass duct systems ..... 18-21  
 Sheet metal ducts with fibrous glass insulation liner ..... 22-25  
 Sheet metal ducts with fibrous glass insulation wrap ..... 26-29  
 Fibrous glass insulation boards ..... 30-33  
 Flexible duct systems ..... 34-36  
 Insulating return air systems, ducted and non-ducted ..... 37  
 Guide Specifications: - 3-Part Masterformat®  
 Fibrous Glass Duct Work - Thermal/Acoustical Insulation ..... 38-40  
 Sheet Metal Ducts - Acoustical Lining Insulation ..... 40-42  
 Sheet Metal Ducts - Thermal Insulation Wrap ..... 42,43  
 Facts on fibrous glass duct insulation ..... 44,45

of fiber glass as “known to the state to cause cancer” was based principally on the old IARC classification.

Fiber glass is now the most thoroughly evaluated insulation material in the market. The data from these evaluations demonstrate that:

**(1)** No causal association has been found between either cancer or non-malignant pulmonary disease and human exposure to glass fibers.

**(2)** Inhalation exposures of animals to massive amounts of biosoluble glass wool fibers, hundreds and even thousands of times greater than human exposures, have not shown a relationship between glass wool fibers and disease.

**(3)** Glass wool fibers are biosoluble and therefore dissolve more rapidly in body fluids than other fibers that have been associated with human disease.

**(4)** Workplace levels of respirable glass fibers in most settings are less than 1 fiber/cc; and airborne levels in insulated buildings are not significantly different than levels outside or in uninsulated buildings.

NAIMA member companies continue to support ongoing scientific investigations into the health and safety aspects of glass wools as part of their comprehensive product stewardship program. NAIMA is dedicated to providing up-to-date information on the results of these studies as they become available.

**Safety of In-Place Duct Products**

When properly designed and installed, fiber glass products for air handling systems improve the indoor environment by controlling heat loss or gain, while reducing condensation and providing acoustical insulation.

The results of several more recent scientific studies demonstrate that fiber glass insulated HVAC systems have no adverse effects on indoor environmental quality.

- The IPCS Environmental Health Criteria 77 on man-made mineral fibers has concluded: “ ... it has generally been concluded that the contribution of fibrous glass lined air transmission systems to the fibre content of indoor air is insignificant.”

- Duke University – A 1997 study showed that mold is no more likely to grow on fiber glass than on any other surface in the duct system. Mold grows in the presence of water. By helping to reduce condensation, fiber glass insulated ducts actually help minimize microbial growth.

- University of Nevada Las Vegas – A 1996 study confirmed the results of numerous earlier studies showing that fiber content in the indoor air from fiber glass lined systems is insignificant and does not adversely affect the health of building occupants.

**Conclusion**

NAIMA members believe fiber glass is safe to manufacture, install, and use when recommended work practices are followed. Complete details on work practices and exposure guidelines are contained in NAIMA’s Health and Safety Partnership Program and can be obtained in written or video form. For more information about quoted references herein contact NAIMA at the following address:



44 Canal Center Plaza, Suite 310  
Alexandria, VA 22314

Phone: (703) 684-0084 Fax: (703) 684-0427  
Or visit us on the internet at [www.naima.org](http://www.naima.org)

The NAIMA Air Handling Committee includes representatives of the following companies involved in the development, manufacture, and marketing of fibrous glass insulations for HVAC duct systems:

- CertainTeed Corp.  
P. O. Box 860, Valley Forge, PA 19482  
800-233-8990
- Johns Manville  
P. O. Box 5108, Denver, CO 80217  
800-654-3103
- Knauf Insulation  
One Knauf Drive, Shelbyville, IN 46176  
800-825-4434
- Owens Corning  
One Owens Corning Parkway, Toledo, OH 43659  
800-GET-PINK

**FACTS ON FIBROUS GLASS DUCT INSULATION**

Fiber glass has been commercially manufactured for more than 75 years. Today, fiber glass is an important component of the nation's economy, providing energy-conserving products that help reduce pollution and preserve the environment.

One of the world's most useful materials, fiber glass can absorb sound, help control heat flow, diminish impurities from liquids and gases, reinforce other materials and, with a vapor retarder, help control condensation. Fiber glass duct insulation does not support the growth of mold when tested in accordance with specifications of the American Society for Testing and Materials (ASTM C 1338) or Underwriters Laboratories Inc. UL 181. In addition, fiber glass duct insulation materials installed internal to the duct system are tested per ASTM G 21-96 and G 22-96 for mold and bacteria.

**Commitment to Product Stewardship**

In May 1999, the North American Insulation Manufacturers Association (NAIMA) began implementing a comprehensive voluntary work practice partnership with the U. S. Occupational Safety & Health Administration (OSHA). This Health and Safety Partnership Program (HSPP) offers safe work practices. The HSPP sets a voluntary permissible exposure limit, or PEL, of 1-fiber-per-cubic-centimeter (1 f/cc).

NAIMA has produced a pamphlet entitled, "Working with Fiber Glass, Rock Wool and Slag Wool Products," that describes the recommended work practices. Included in the pamphlet are recommendations for minimizing dust generation, maintaining adequate ventilation, wearing appropriate clothing and personal protective equipment, and removing fibers from skin and eyes. It also details specific work practices for blowing insulation in attics, installing cavity fill, batt, blanket and roll insulation, fabricating pipe and board, installing ceiling tiles and spray applied fireproofing and handling bulk unbonded products, and removing previously installed products. These recommendations are supported by OSHA as part of the HSPP. The pamphlet, along with a video describing the work practice recommendations, is available [free](#) by contacting NAIMA or visiting the NAIMA web site at [www.naima.org](http://www.naima.org).

**Health and Safety**

NAIMA and its member companies are committed to ensuring that fiber glass products can be safely manufactured, installed and used. NAIMA member companies have funded tens of millions of dollars of research at leading independent laboratories and universities in the United States and abroad. The weight of the scientific research shows no association between exposure to glass fibers and respiratory disease or cancer in humans.

In October 2001, an international expert review by the International Agency for Research on Cancer (IARC) re-evaluated the 1988 IARC assessment of glass fibers and removed glass wools from its list of possible carcinogens by changing the classification of these fibers from Group 2B (possible carcinogen) to Group 3 (not classifiable as to carcinogenicity in humans). Fiber glass wools that are commonly used for thermal and acoustical insulation are included in this classification. IARC noted specifically:

"Epidemiologic studies published during the 15 years since the previous IARC Monographs review of these fibers in 1988 provide no evidence of increased risks of lung cancer or mesothelioma (cancer of the lining of the body cavities) from occupational exposures during manufacture of these materials, and inadequate evidence overall of any cancer risk."

IARC retained its Group 3 classification for continuous glass filaments and the Group 2B "possible carcinogen" classification for certain special purpose glass fibers.

The IARC decision is consistent with the conclusion reached by the U.S. National Academy of Sciences, which in 2000 found "no significant association between fiber exposure and lung cancer or nonmalignant respiratory disease in the MVF [man-made vitreous fiber] manufacturing environment."

IARC's comprehensive review of the extensive studies developed over the past 15 years indicates that some of the prior reviews now need to be updated. Many of these earlier reviews do not account for the new science. For example, the U. S. Department of Health and Human Service (HHS, Shalala 1994) included fiber glass on its list of potential carcinogens based primarily on the 1988 IARC classification. Similarly, the California listing

**FIBROUS GLASS INSULATED HVAC DUCT SYSTEMS and how they provide ...**

- Quiet, efficient air delivery
- Improved indoor environmental quality
- Cost-effective energy conservation
- Enhanced occupant comfort

**Introduction**

Fibrous glass has been used as thermal and acoustical insulation in forced air heating, ventilating, and air-conditioning systems ever since these systems became widely available following World War II. Today, fibrous glass duct systems, duct liners, duct wraps, and commercial insulation boards contribute to indoor environmental quality (IEQ) and occupant comfort in residential, commercial, industrial, and public buildings of all kinds. These include homes, apartments, schools, hotels, motels, medical facilities, theaters, shopping centers, office and government buildings, factories, and many other types of structures where occupant comfort and indoor environmental quality are important criteria.

Fibrous glass insulation is used in air duct systems for four basic reasons:

- Temperature control - Delivery of heated or cooled air at comfort levels suited to building occupancy requirements.
- Acoustical control - Absorption of noise generated by central air handling equipment and movement of air through the ducts, as well as "cross-talk" carried by ducts from one space to another.
- Condensation control – Prevents condensation in or on ducts when installed R-value recommendations are followed, reducing the likelihood of moisture damage to ceilings and other interior finishes.
- Energy conservation - Reduction of HVAC system operating costs by controlling heat loss or gain through air duct walls, helping systems run more efficiently.

HVAC systems typically operate with internal air temperatures between 40°F (4°C) and 250°F (121°C). Systems operating outside this range are not considered in this guide, except that fibrous glass insulation boards may be used in systems operating at internal air temperatures between 0°F (-18°C) and 450°F (232°C).

**Types of insulated air duct systems**

The five types of insulated air duct systems described in this guide can be used to meet all widely used architects' or engineers' specifications, local codes, owners' comfort control requirements, installed and life cycle cost criteria, or the contractor's crew skill levels and shop fabrication resources.

**Combining types of fibrous glass insulation in duct systems**

Often more than one of type of fibrous glass insulation treatment may be specified in a single HVAC duct system. For example, in a variable air volume system, sheet metal ducts with fibrous glass duct liner may be used on the high pressure side if design static pressure exceeds the 2 in. w.g. (500 Pa) limits of the fibrous glass duct system; the fibrous glass duct system may be used on the low pressure side; and insulated flexible ducts may be used as run-outs from trunk ducts to diffusers.

**GENERAL DESCRIPTIONS**

**Fibrous glass duct system**

The fibrous glass duct system is used to conserve heating and cooling energy and to control duct-borne noise in commercial, institutional, or residential heating, ventilating, and air-conditioning ductwork operating in the range of  $\pm 2$  in. w.g. ( $\pm 500$  Pa) static pressure, up to at least 5,000 fpm (25.4 m/sec) internal air velocity, and internal air temperature between 40°F (4°C) and 250°F (121°C). Ducts are only for indoor use and should be located in areas where ambient temperature does not exceed 150°F (66°C).

The fibrous glass duct system is normally made up of nominal four foot (1.2m) sections fabricated from 1, 1 $\frac{1}{2}$ , or 2 in. (25, 38, or 51mm) thick, flat fibrous glass duct board stock having a factory-applied reinforced aluminum exterior air barrier finish. Duct system sections are fabricated using either specially designed hand tools or grooving and closure machines. Duct fittings such as tees, offsets, elbows, and transitions are also fabricated from these modules or from flat duct board stock.

Duct board products are available with coated or faced airstream surfaces. These products permit rigorous cleaning of the duct surface where dust has been allowed to collect in the duct due to lack of filtration or poor maintenance. Additionally, some of these products have higher maximum velocity ratings.

Duct systems fabricated from fibrous glass duct board products qualify under UL 181 as Class 1 Air Ducts, meeting the fire safety requirements of NFPA 90A and 90B including limited combustibility. They also comply with all widely used model codes. Duct board joint closure are sealed using one of three UL 181A listed systems.

the R-value called for in project specifications or drawings. The duct wrap insulation shall consist of a blanket of glass fibers factory-laminated to a scrim reinforced foil kraft vapor retarder facing with a 2 in. (50mm) (min.) stapling and taping flange on one edge.

**PART 3.00 - EXECUTION**

**3.01 Receiving Inspection**

A. The duct wrap shall be inspected to verify that it can be installed in accordance with project drawings and with operating performance parameters and limitations.

**3.02 Insulation of straight duct and fittings**

A. Before applying duct wrap, sheet metal ducts shall be inspected to ensure that they are clean, dry, and tightly sealed at all joints and seams.

B. All portions of duct designated to be externally insulated shall be completely covered with duct wrap.

C. To ensure installed thermal performance, duct wrap shall be cut to “stretch-out” dimensions in Table A below. Remove a 2 in. (50mm) (min.) piece of insulation from the facing at the end of the piece of duct wrap to form an overlapping stapling and taping flap.

D. Duct wrap insulation shall be installed with facing outside so that the tape flap overlaps the insulation and facing at the other end of the piece of duct wrap. Adjacent sections of duct wrap insulation shall be tightly butted with the 2 in. (50mm) (min.) stapling and taping flap overlapping. If ducts are rectangular or square, insulation

shall be installed so it is not excessively compressed at corners. Seams shall be stapled approximately 6 in. (150mm) on center with  $\frac{1}{4}$  in. (13mm) (min.) steel outward clinching staples.

E. Where a vapor retarder is required, seams shall be sealed with pressure-sensitive tape matching the insulation facing, either plain foil or scrim-reinforced. All tears, punctures, and other penetrations of the duct wrap facing shall be sealed with tape or mastic to provide a vapor-tight system.

**3.03 Final Inspection**

A. Upon completion of installation of duct wrap and before operation is to commence, the system shall be visually inspected to verify that it has been correctly installed.

B. All system dampers shall be opened and fans turned on to blow all scraps and other loose pieces of material out of the duct system. Such material shall be removed.

C. The duct system shall be checked to ensure that there are no air leaks through joints.

**3.04 Safety precautions**

A. All job site operations shall be conducted in compliance with applicable provisions of the Occupational Safety and Health Act, NAIMA’s Health and Safety Partnership Program, and all state and/or local safety and health codes and regulations that may apply to the work. Manufacturer’s Material Safety Data Sheet (MSDS) shall be consulted when appropriate.

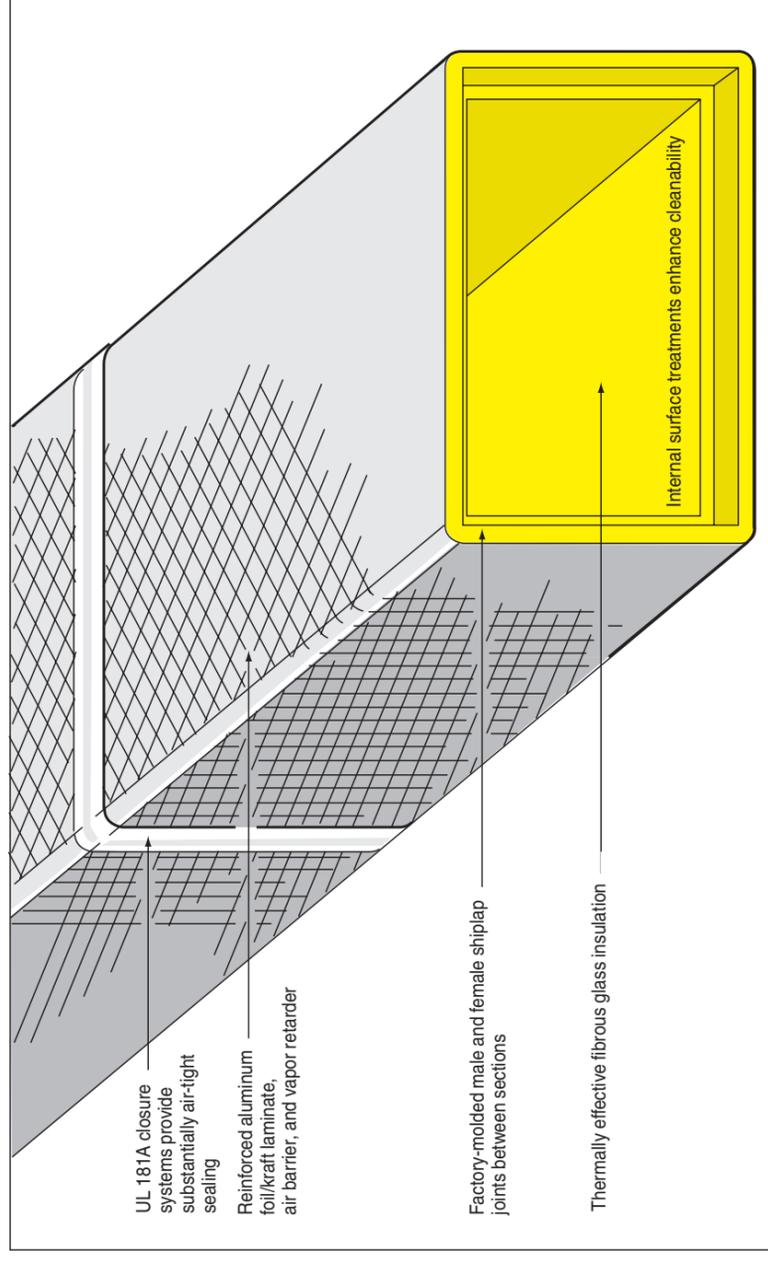


Fig. 1. Fibrous glass duct module

**Table A. Stretch-out dimensions to assure installed thermal performance**

Nominal thickness (as manufactured), in.	Average installed thickness, (mm)		INSULATION STRETCH-OUT DIMENSIONS, P* + in. (mm)	
	in.	(mm)	Round duct, in. (mm)	Square duct, in. (mm) / Rectangular duct, in. (mm)
1	(25)	$\frac{3}{4}$ (19)	P + 7 (178)	P + 6 (152) / P + 5 (127)
1 $\frac{1}{2}$	(38)	$1\frac{1}{8}$ (29)	P + 9 $\frac{1}{2}$ (241)	P + 8 (203) / P + 7 (178)
2	(51)	$1\frac{1}{2}$ (38)	P + 12 (305)	P + 10 (254) / P + 8 (203)
2 $\frac{1}{2}$	(64)	$1\frac{7}{8}$ (48)	P + 14 $\frac{1}{2}$ (368)	P + 12 $\frac{1}{2}$ (318) / P + 9 $\frac{1}{2}$ (241)
3	(76)	$2\frac{1}{4}$ (57)	P + 17 (432)	P + 14 $\frac{1}{2}$ (368) / P + 11 $\frac{1}{2}$ (292)
3 $\frac{1}{2}$	(89)	$2\frac{5}{8}$ (67)	P + 19 $\frac{1}{2}$ (495)	P + 16 $\frac{1}{2}$ (419) / P + 13 (330)
4	(102)	3 (76)	P + 22 (559)	P + 19 (483) / P + 16 (406)

Stretch-out dimension must be followed to achieve labeled installed R-values. \*P = perimeter of sheet metal duct

2. Top layer of duct liner shall be adhered to bottom layer using a minimum of 90% adhesive coverage.
3. Mechanical fasteners shall be of the proper length for the double layer of duct liner.
4. Leading edges of double layer duct linings shall be treated to prevent separation of the two layers in accordance with requirements for single layer applications as determined by air velocity.

1. All ductwork joints and seams shall be sealed in accordance with specification seal class rating.

### 3.03 Final Inspection

A. Upon completing installation of lined duct and before HVAC system start-up, ductwork shall be visually inspected to verify that duct liner has been correctly installed and to confirm that the duct system is free from construction debris.

### 3.04 Commissioning

After the lined duct system is completely installed and ready for service, a final inspection of the entire system shall be conducted. This inspection should include, at minimum, the following steps:

1. All registers, grilles, and diffusers shall be checked to ensure that they are clean and free from construction debris.
2. All filters shall be checked in accordance with their manufacturers' instructions. Specified grade of filters shall be used at all times system is operating.
3. Supply openings shall be covered with filter media prior to system start-up to catch any loose material that may remain inside the ductwork.
4. The HVAC system shall be turned on and allowed to run until steady state operation is reached.
5. Temporary filter media shall be removed from supply openings and, along with it, any loose material blown downstream and caught by the filter media.
6. Air delivery performance shall be checked to ensure that it meets all requirements and complies with SMACNA leakage specifications.

### 3.05 Safety precautions

A. All job site operations shall be conducted in compliance with applicable provisions of the Occupational Safety and Health Act, NAIMA's Health and Safety Partnership Program (HSPP) and all state and/or local safety and health codes and regulations that may apply to the work. Consult manufacturer's Material Safety Data Sheet (MSDS) when appropriate.

## Sheet Metal Ducts - Thermal Insulation Wrap Section 15082, Commercial/Residential Duct Systems

### PART 1.00 - GENERAL

#### 1.01 Scope

A. Work covered by this specification consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for correct fabrication and installation of fibrous glass thermal insulation wrap on exterior surfaces of sheet metal commercial or residential air duct systems, in accordance with applicable project drawings and specifications, subject to terms and conditions of the contract:

1. All air duct systems operating at internal air temperatures not exceeding 250°F (121°C) or lower than 40°F (4°C).
- B. Duct wrap insulation shall meet the requirements of ASTM C 1290, Type II, to maximum service temperature of 250°F (121°C). Facing material shall meet the requirements of ASTM C 1136, Type II, when surface burning characteristics are determined in accordance with ASTM E 84 with the foil surface or polymer surface of the material exposed to the flame as it is in the final composite.

C. Dimensions shown on the plans are finished inside dimensions.

D. Duct wrap shall be installed in accordance with manufacturer's instructions in such a manner that the insulation will provide the installed R-value as published for the product and printed on the facing, thus assuring specified in-place thermal performance.

#### 1.02 Delivery and storage of materials

- A. All insulation materials and fabricated duct sections and fittings shall be delivered to the job site in good condition and stored in a safe, dry place.
- B. All means necessary shall be used at the job site to protect materials from dust, dirt, moisture, and physical abuse before and during installation.

### PART 2.00 - PRODUCTS

#### 2.01 Insulated duct system

A. All supply ducts, return ducts, and related fittings shall be insulated with faced duct wrap insulation meeting

## Sheet metal ducts lined with fibrous glass insulation

Fibrous glass duct liner insulation is designed for application to the interiors of commercial, institutional and residential sheet metal heating, ventilating, and air-conditioning ducts to attenuate noise generated by central air handling equipment, air movement within the ducts, and occupant cross-talk. It also serves to reduce heat loss or gain through sheet metal duct surfaces, and helps to prevent the formation of water vapor condensation both inside the duct and on its exterior surface. Fibrous glass duct liner insulation is fabricated along with the sheet metal work in the shop, providing quality workmanship under controlled conditions.

Fibrous glass duct liner insulations are manufactured from glass fibers bonded with thermosetting resin. They are dimensionally stable, withstand abuse, and provide a cleanable, fire-resistant interior surface designed to minimize friction loss. Two forms are available:

- (1) Flexible blankets, supplied in roll form;
- (2) Rigid boards, supplied in sheet form.

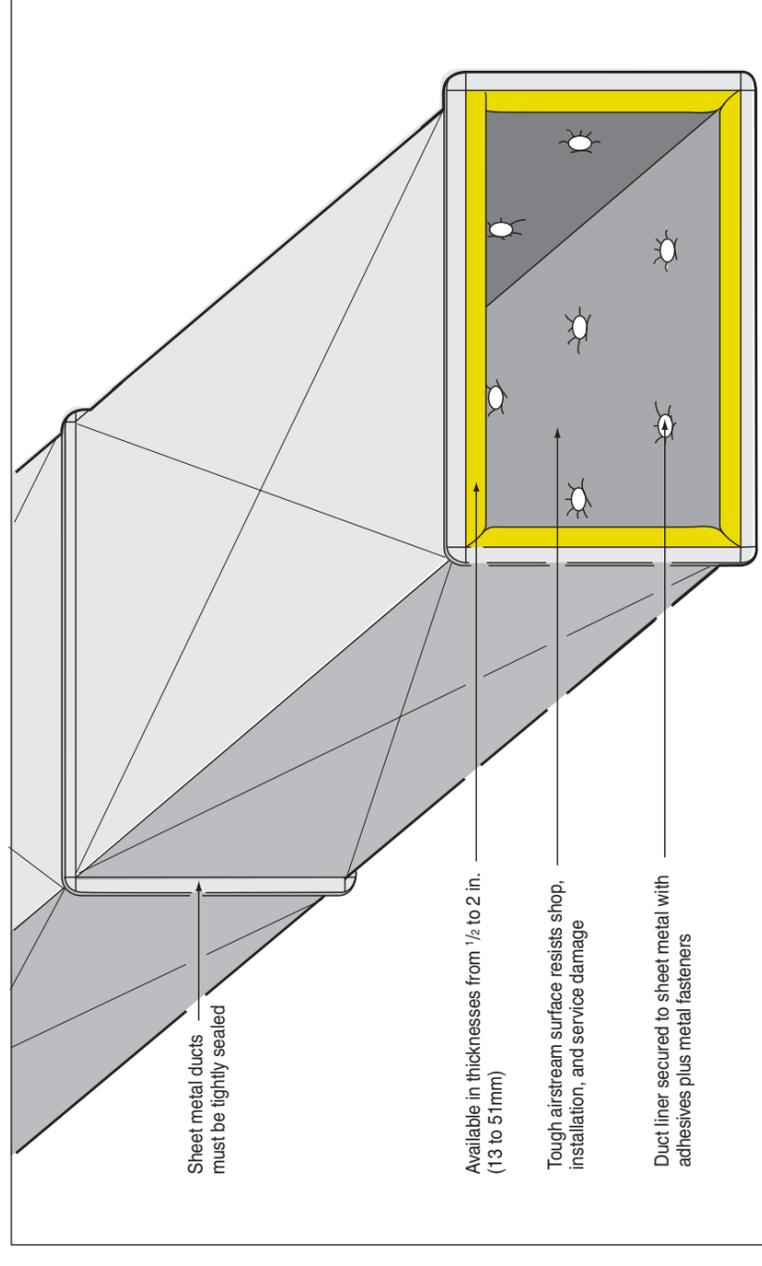


Fig. 2. Sheet metal duct lined with fibrous glass insulation

**GENERAL DESCRIPTIONS**

**Sheet metal ducts with fibrous glass exterior insulation**

**Flexible Blanket**

Fibrous glass duct wrap insulation is designed for application to the exteriors of commercial, institutional, and residential sheet metal heating, ventilating, and air-conditioning ducts and plenums operating at temperatures between 40°F (4°C) and 250°F (121°C). Duct wrap insulation reduces heat loss or gain through duct walls, conserving energy and controlling moisture condensation. Fibrous glass duct wrap insulations are useful in situations where acoustical performance is not an issue. Fibrous glass duct wrap insulations are flexible, resilient, light-density blankets of glass fibers factory-laminated to vapor retarder facings. These products are easily cut and fitted to achieve a neat, thermally effective insulation blanket over the exteriors of rectangular, round, oval, or irregularly shaped ducts.

Fibrous glass duct wrap insulations are manufactured to comply with ASTM C 1290, *Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts*.

**Insulation Boards**

Fibrous glass insulation boards are also available for application to the outside of sealed sheet metal ducts, housings, and plenums. These are available unfaced, or with reinforced foil (FSK) or all-service jacket (ASJ) vapor retarder facings, in a range of densities and thicknesses. Some are flexible enough to conform to curved surfaces such as large round or oval sheet metal ducts.

Fibrous glass insulation boards can be used in applications operating within the temperature range of 0°F (-18°C) to 450°F (232°C).

Fibrous glass insulation boards are manufactured to comply with ASTM C 612, *Standard Specification for Mineral Fiber Block and Board Thermal Insulation*.

B. Dimensions shown on the plans are finished inside dimensions.

C. Fabrication and installation shall conform to manufacturer's recommendations and to the requirements of the latest edition of North American Insulation Manufacturers Association *Fibrous Glass Duct Liner Standard* (hereinafter referred to as NAIMA FGDLS) or *Standard of Sheet Metal and Air Conditioning Contractors National Association HVAC Duct Construction Standards - Metal and Flexible* (hereinafter referred to as SMACNA HVAC DCS).

**1.02 Delivery and storage of materials**

A. All materials and/or fabricated, insulated duct sections and fittings shall be delivered to the job site in good condition and stored in a safe, dry place.

B. All materials shall be protected from dust, dirt, moisture, and physical abuse before, during, and after installation. Wet or contaminated duct liner shall be replaced.

**PART 2.00 - PRODUCTS**

**2.01 Insulated duct system**

A. All supply ducts, return ducts, and related fittings shall be insulated with duct liner meeting the requirements of ASTM C 1071 as follows:

1. Type I - Flat, in roll form, in thicknesses of 1/2 to 2 in. (13 to 51mm) in 1/2 in. (13mm) increments. Maximum thermal conductivity at 75°F (24°C) mean temperature: 0.31 Btu•in/hr•ft<sup>2</sup>•°F (λ = 0.045 W/m•°C).

2. Type II - Flat, in sheet form, in thicknesses of 1 to 2 in. (25 to 51mm) in 1/2 in. (13mm) increments. Maximum thermal conductivity at 75°F (24°C) mean temperature: 0.27 Btu•in/hr•ft<sup>2</sup>•°F (λ = 0.039 W/m•°C).

**PART 3.00 - EXECUTION**

**3.01 Receiving Inspection**

A. All materials shall be inspected to verify that the duct liner product may be installed in accordance with project drawings, operating performance parameters and limitations, and provisions of NAIMA FGDLS or SMACNA HVAC DCS.

**3.02 Insulation of straight ducts and fittings**

A. All portions of duct designated to receive duct liner shall be fully insulated, with all joints neatly butted and

no interruptions or gaps. Duct liner shall be installed with the surface printing exposed to the air stream.

B. Duct liner shall be adhered to the sheet metal with 90% (minimum) coverage of adhesive complying with requirements of ASTM C 916.

C. If not already coated by the duct liner manufacturer, all transverse edges not receiving sheet metal nosing shall be coated. Longitudinal joints in duct liner should occur at the corners of ducts. If duct size and standard duct liner product dimensions may make exposed longitudinal joints necessary, exposed joints shall be coated with adhesive designed for duct liner application meeting requirements of ASTM C 916. Such joints shall be secured with mechanical fasteners in accordance with NAIMA FGDLS, treated as transverse joints.

D. Duct liner shall be mechanically fastened with weld-secured or impact-driven fasteners so as to compress the insulation no more than 1/8 in. (3 mm) based on nominal insulation thickness, installed perpendicular to the duct surface. Spacing of mechanical fasteners with respect to interior duct dimensions shall be in accordance with NAIMA FGDLS or SMACNA HVAC DCS. Fastener heads or washers shall have a minimum area of 0.75 in.<sup>2</sup> (5cm<sup>2</sup>) with beveled or cupped edges.

E. Metal nosings (channel or zee) shall be securely installed over transverse liner edges facing the airstream at fan discharge and at any point where lined duct is preceded by unlined duct. Also, where air velocities exceed 4,000 fpm (20.3 m/sec), metal nosing shall be installed on upstream edges of all lined duct sections.

F. Flexible duct liner shall be folded and compressed at corners of rectangular duct sections, or shall be cut and fit to assure a lapped, compressed corner joint.

G. Rigid duct liner shall be cut and fit to assure tight, overlapped corner joints. Top pieces of rigid duct liner shall be supported at the edges by side pieces.

H. Installation of two layers of duct liner is not recommended. If the specification forces the use of multiple layers, the following steps shall be taken:

1. First layer of duct liner shall be adhered to the sheet metal in the usual manner.

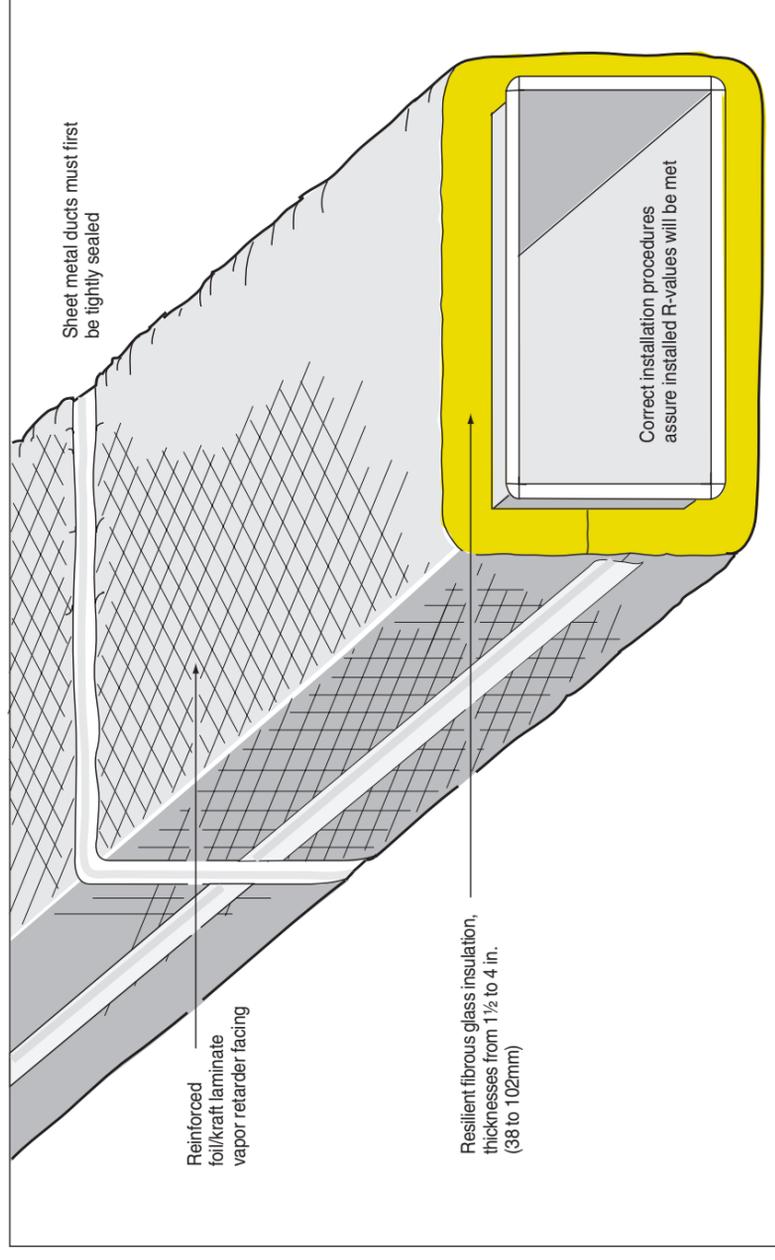


Fig. 3. Metal duct with exterior insulation wrap

**3.06 Accessories**

A. Doors, coils, dampers, registers, grilles, diffusers, air turning vanes, air volume extractors, and other accessory items shall be installed as detailed in NAIMA FGDCS with adequate reinforcement and support to accommodate additional weight without damage to the duct board.

Dampers over 2 square feet (0.19m<sup>2</sup>) shall be supported by sheet metal sleeves with all moving parts shielded with galvanized sheet metal at abrasion points. All 90° elbows shall contain turning vanes spaced at 3 in. (75mm) (max.) intervals, mounted in accordance with the turning vane manufacturer's instructions. Turning vanes shall not be considered as reinforcing members. If air volume extractors or splitter dampers are required on side take-off and split duct connections, these shall be fabricated using appropriate hardware. Slip-in electric heating coils shall be supported independently of the duct system and installed in galvanized sheet metal sleeves extending 6 in. (150mm) (min.) on both sides of the coils.

Accessory items shall be connected to the duct system using 2 1/2 in. (64mm) square or 3 in. (76mm) round galvanized or plated steel washers and #10 sheet metal screws of appropriate length to spread the load to the duct board.

**3.07 Final Inspection**

A. Upon completion of installation of the duct system and before operation is to commence, the system shall be visually inspected to verify that it has been correctly installed using the Inspection Check List in NAIMA FGDCS. Any scraps and loose pieces of material shall be removed from inside the duct system.

B. All dampers shall be opened and fans turned on to blow all remaining loose material out of the duct system.

C. The duct system shall be checked to ensure that there are no air leaks through joints or through tears or punctures of the air barrier facing. If tears or punctures are found, these shall be repaired using procedures as detailed in Section VIII, NAIMA FGDCS.

**3.08 Safety precautions**

A. All job site operations shall be conducted in compliance with applicable provisions of the Occupational Safety and Health Act, NAIMA's Health and Safety Partnership Program (HSP) and all state and/or local safety and health codes and regulations that may apply to the work.

Manufacturer's Material Safety Data Sheets (MSDS) shall be consulted when appropriate.

**Sheet Metal Ducts - Acoustical Lining Insulation Section 15291, Commercial/Residential Duct Systems**

**PART 1.00 - GENERAL**

**1.01 Scope**

A. Work covered by this specification consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for correct fabrication and installation of fibrous glass duct liner in sheet metal commercial or residential air duct systems, in accordance with applicable project drawings and specifications, subject to terms and conditions of the contract:

1. Installation of all air duct systems operating at internal air velocities not exceeding rated duct liner limitations and internal air temperature not exceeding 250°F (121°C).
2. Duct liner products shall conform to the requirements of ASTM C 1071 and shall meet the corrosion requirements of ASTM C 665.
3. Duct liner products shall perform in accordance with the requirements of ASHRAE 62-2001.
4. The manufacturer's product identification, R-value, NFPA 90A/90B, and other required labeling information shall appear on the air stream surface.
5. Duct liner adhesive shall conform to the requirements of ASTM C 916.
6. The finished duct system shall meet the requirements of NFPA 90A and 90B, including
7. Duct liner products shall conform to the requirements of ASTM E 84 with a flame spread index not greater than 25 and a smoke developed index not greater than 50 per NFPA 255, UL 723, and CAN4/ULC-S102.
8. The air stream surface shall have no evidence of flaming, glowing, smoldering, visible smoke, or delamination, cracking, or reduction in thickness when tested in accordance with ASTM C411 at a temperature not less than 250°F (121°C).
9. When tested in accordance with NFPA 259, the insulation shall, have a potential heat value not exceeding 3500 Btu/lb (8141 Kj/kg).
10. Duct liner products shall exhibit no microbiological amplification per ASTM C 1338 when tested per ASTM G 21-96 (fungi test) and ASTM G 22-96 (bacteria test).

**Fibrous glass insulated flexible ducts**

Flexible ducts insulated with fibrous glass are an efficient, economical way to install connections between trunk ducts and room diffusers or registers. A spiral wire-reinforced inner air conduit is wrapped with resilient fibrous glass and jacketed with a flexible vapor retarder of reinforced foil or plastic film. These flexible products can conform to bends when connecting trunk ducts to diffusers, or when routing ductwork through obstructed areas. (NAIMA members do not manufacture flexible ducts, but do supply the flexible duct industry with fibrous glass insulation.)

Fibrous glass insulated flexible ducts can be used in applications where internal air temperatures do not exceed 250°F (121°C).

Fibrous glass insulated flexible duct systems are manufactured to comply with Air Diffusion Council Test Code FD-72-R1. They also meet requirements of UL181, and comply with all widely used model building codes.

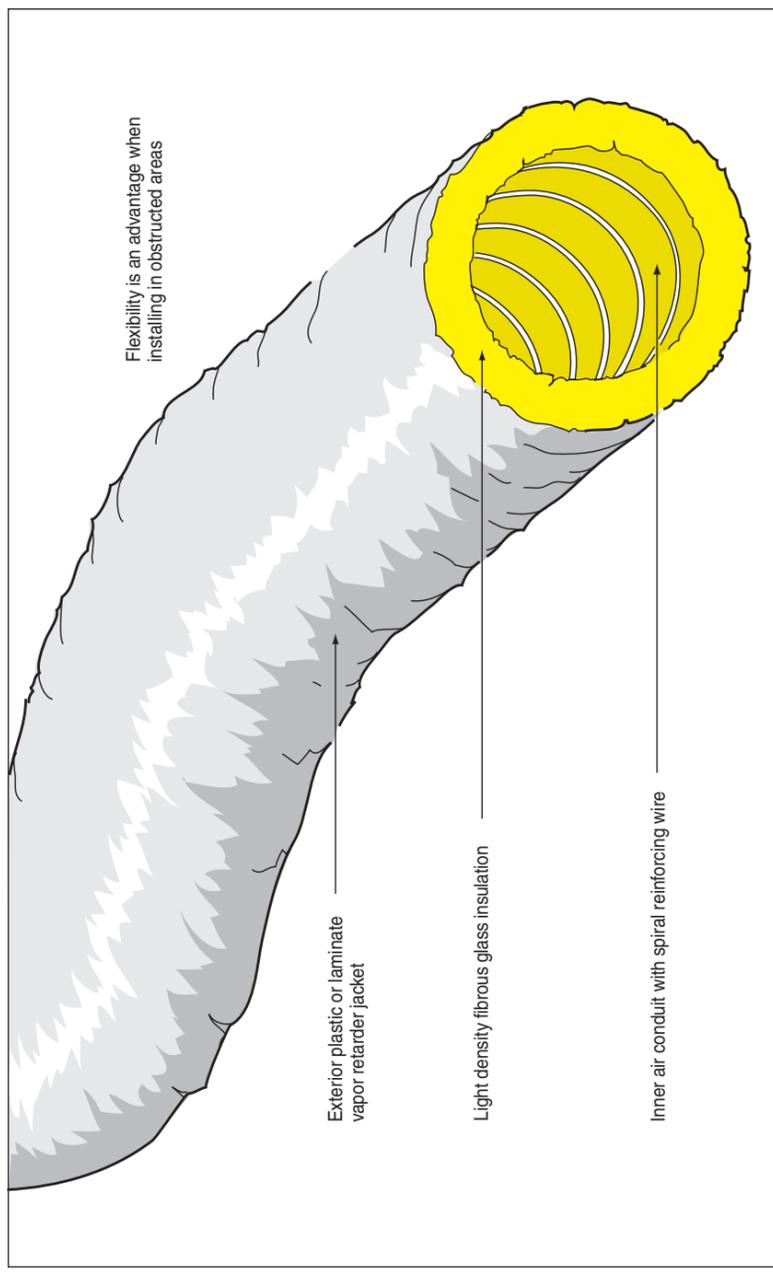


Fig. 4. Insulated flexible duct

## HOW FIBROUS GLASS DUCT INSULATION IMPROVES THE INDOOR ENVIRONMENT

### Temperature control:

Fibrous glass duct insulation means enhanced comfort. It helps to ensure that heated or cooled air will be transmitted from central air equipment to working and living spaces at comfort levels suited to occupants' needs. Increased occupant comfort in commercial buildings contributes to increased productivity; in residential buildings, to an enhanced sense of well-being. In either case, fibrous glass duct insulation allows the building owner to utilize central equipment effectively—or, in many instances, to provide desired comfort levels with central equipment of less capacity and cost than would be required when ducts are not thermally insulated.

### Acoustical control:

Fibrous glass duct insulation means peace and quiet. It is a key contributor to the creation of an acoustically satisfying indoor environment by absorbing noise generated by central air equipment, by expansion and contraction of duct components, and from air movement noise within the ducts. It also contributes to personal privacy and productivity by preventing the ductwork from transmitting unwanted conversations from room to room in the home or workplace. No other forms of duct insulation, including elastomeric foams and reflective products, can match the acoustical effectiveness of fibrous glass insulation applied to control noise in air handling systems.

### Energy conservation:

Fibrous glass duct insulation means energy saved. The same thermal performance properties that contribute to occupant comfort also enable fibrous glass duct insulation to control heat loss or gain through duct walls with efficiency not equaled by other forms of duct insulation. By enabling ducts to transmit heated or cooled air to occupied spaces at design temperatures, building operating cost is reduced—sparing the environment from additional greenhouse gases released into the air.

### Condensation control:

Fibrous glass duct insulation means dry ductwork. When warm, humid air comes in contact with the surfaces of uninsulated cold air ductwork, water vapor will condense and result in dripping of liquid water from duct surfaces onto other building components. Installing insulation with sufficient R-value along with a low permeance vapor retarder will minimize, and in most cases prevent, condensation problems and consequent damage to

building materials. Adding insulation is the best way to control surface condensation.

### Mold and fungus resistance:

Fibrous glass duct insulation will not support the growth of mold when tested in accordance with applicable ASTM and UL specifications. Furthermore, fibrous glass duct insulation products designed for installation inside air ducts are tested for mold and bacteria resistance in accordance with ASTM test procedures. Fibrous glass insulation installed in clean, dry, well-maintained air duct systems will not contribute to mold, fungal, or bacterial amplification and consequent contamination of the indoor environment.

### Fire safety:

Fibrous glass duct insulation means fire safety. ASTM, UL, and NFPA fire safety test methods all show fibrous glass to resist flame spread from external or internal fire sources. Fibrous glass duct insulations are tested to withstand flame penetration. They resist ignition by small, low-energy flames and will not spread fire from such sources.

### Durability and integrity:

Fibrous glass duct insulation means durability. Their consistent resin-bonded fiber structures and tough, abuse-resistant, mat-faced or coated airstream surfaces provide long-term thermal, acoustical, and condensation control performance without deterioration and with no measurable fiber erosion. They resist damage both during installation and in service. Fibrous glass insulation products installed within the ducts may be readily cleaned in situations where dust has been allowed to enter the duct system due to absence of filtration or poor maintenance.

### Proven performance:

Fibrous glass duct insulation means proven performance. These products are manufactured to meet exacting physical property and performance requirements set forth in ASTM, UL, and NFPA standards and test procedures. The design, fabrication, and installation of air duct systems insulated with fibrous glass are all accomplished by skilled, trained contractors supported by comprehensive industry standards, including NAIMAs "Work Smart" program which covers recommended practices for the handling and installation of all kinds of fibrous glass insulation products.

C. Mastic as listed under UL181A, Part III (M) and applied in conjunction with 3 in. (76mm) wide glass fabric tape. This closure system may be used as an alternative to either pressure-sensitive or heat-activated tapes for all closure applications, and must be used to bond duct board to sheet metal when system operating pressure is greater than 1 in. w.g. (125 Pa). It may also be required in some fire-rated assemblies.

## PART 3.00 - EXECUTION

### 3.01 Receiving Inspection

A. All materials shall be inspected to verify that the duct system may be installed in accordance with project drawings, operating performance parameters, limitations, and standards published in NAIMA FGDCS.

### 3.02 Fabrication, straight duct and fittings

A. All straight duct sections shall be fabricated in accordance with NAIMA FGDCS, Section II, and all fittings shall be fabricated in accordance with NAIMA FGDCS, Section III, using proper machinery, tools, and techniques.

### 3.03 Closure

A. Mechanical fasteners of the types shown in NAIMA FGDCS, Section IV, shall be used to connect the duct board to sheet metal before application of closure material.

B. Flaps on all field joints shall be stapled approximately 2 in. (50mm) on centers with 1/2 in. (13mm) (min.) outward clinching steel staples near the edge of the flap. On fitting joints where stapling flaps cannot be included as part of the construction, tape tabs 8 in. (200mm) (min.) in length shall be applied. Tape tabs shall be centered over the joint, a minimum of one tab per duct side and/or 12 in. (300mm) (max.) on centers.

C. On field joints, all taping surfaces shall be wiped clean before sealing. If the surface is contaminated with grease or oil, it shall be cleaned with a solvent recommended by the tape manufacturer.

D. Pressure-sensitive tape shall be firmly rubbed in place immediately after application using a squeegee tool. When the duct surface temperature is below 50°F (10°C), a heat-sealing tool shall be used to assure bonding. Pressure-sensitive tapes may be used to seal to properly cleaned sheet metal when system operating pressure is less than 1 in. w.g. (125 Pa).

E. Heat-activated tape closures shall be sealed with an iron (a heat gun may not be used) using a smearing action. Heat-sealing equipment must be capable of maintaining a sufficient temperature at the duct surface to assure an adequate bond. Colored dots on tape surface shall become darkened, indicating that satisfactory bonding temperature has been reached. Staples may be omitted when closures are made by machine using heat-activated tape. Joint shall be allowed to cool before stressing.

F. Mastic shall be brushed onto joint and glass fabric imbedded in it. A second coat of mastic shall be brushed over the glass fabric until the fabric is filled. Mastic shall be applied in accordance with application instructions on the container, and allowed to cure before stressing.

### 3.04 Reinforcement

A. All straight ducts and fittings shall be reinforced to prevent ballooning, collapsing, or sagging using either the formed sheet metal system or the tie rod system in accordance with the provisions of Section V of NAIMA FGDCS. Tie rod washers shall be 2 1/2 in. (64mm) square or 3 in. (76mm) diameter and shall be made of plated or galvanized sheet metal of at least 0.028 in. (0.7mm) thickness, with turned edges to prevent cutting into the facing of the duct board. Hole size shall be approximately 0.150 in. (4mm) to allow the tie rod to move freely through the washer.

B. To prevent sagging of top panels of supply ducts over 48 in. (1200mm) wide reinforced with formed sheet metal channel, #10 plated sheet metal screws with 2 1/2 in. (64mm) square or 3 in. (76mm) diameter galvanized steel washers shall be installed inside the duct on the longitudinal centerline of the duct. When tie rod reinforcement is used, sag support shall consist of 1/2 in. (13mm) rigid galvanized steel conduit and 2 1/2 in. (64mm) square or 3 in. (76mm) diameter galvanized steel washers inside the duct on the longitudinal centerline 3 in. (76mm) from the male shiplap edge. For all negative pressure systems, refer to NAIMA FGDCS for proper spacing of reinforcement and proper attachment to the duct board.

### 3.05 Hanging and support

A. The duct system shall be supported in accordance with the provisions of Section VI of NAIMA FGDCS.

B. All hangers, supports, and attachments to the structure must be capable of withstanding three times the anticipated load.

**GUIDE SPECIFICATIONS - 3-Part Masterformat®**

**Fibrous Glass Duct Work - Thermal/Acoustical Insulation, Section 15082, Commercial / Residential Duct Systems**

**PART 1.00 - GENERAL**

**1.01 Scope**

A. Work covered by this specification consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for correct fabrication and installation of air duct systems using fibrous glass duct board, in accordance with applicable project drawings and specifications, subject to terms and conditions of the contract:

1. All air duct systems operating at internal static pressures not exceeding  $\pm$  2 in. w.g. ( $\pm$  500 Pa), internal air velocities not exceeding 5,000 fpm and 12 m / sec to 25.4 m / sec and internal air temperatures not exceeding 250°F (121°C) and not lower than 40°F (4°C).

B. The finished duct system shall meet the requirements of NFPA 90A and 90B by complying with the requirements of Underwriters Laboratories Standard for Safety UL 181 for Class 1 Air Duct.

C. Dimensions shown on the plans are finished inside dimensions. Fabrication and installation shall conform to the manufacturer's recommendations and to the requirements of the latest edition of the North American Insulation Manufacturers Association's *Fibrous Glass Duct Construction Standard* (hereinafter referred to as NAIMA FGDCS).

D. Grooves and shiplaps shall be made using specific tools and/or machines designed for that purpose. Ends shall meet so that shiplaps fit without ridges or rough edges.

**1.02 Delivery and storage of materials**

A. All materials and/or fabricated duct sections and fittings shall be delivered to the job site in good condition and stored in a safe dry place.

B. All means necessary shall be used at the job site to protect materials from dust, dirt, moisture, and physical abuse before and during installation.

**PART 2.00 - PRODUCTS**

**2.01 Insulated duct system**

A. All rectangular supply ducts, return ducts, and related fittings of 96 in. (2400mm) span or less operating at  $\pm$  2 in. w.g.

( $\pm$  500 Pa) shall be fabricated from one of the following:

1. Type 475-EI or Type 800-EI fibrous glass duct board 1 in. (25mm) thick having an R-value of 4.3 (RSI, 0.76).
2. Type 800-EI duct board 1½ in. (38mm) thick having an R-value of 6.5 (RSI, 1.14).
3. Type 800-EI or Type 1400-EI duct board 2 in. (51mm) thick having an R-value of 8.7 (RSI, 1.53).

B. Duct board shall be imprinted with the manufacturer's name, board type, and R-value in a repeat pattern. Additionally, each full duct board sheet shall have a UL Class 1 Air Duct label adhered to the facing of the board. Flexible ducts shall be identified in a similar manner.

C. The duct board shall have an air barrier/vapor retarder facing of aluminum foil/kraft laminate reinforced with scrim.

**2.01 Alternate material specification**

A. Lined or coated duct board products are available for use where it is desired to have the airstream surface coated or faced to (1) isolate the glass fiber substrate, (2) inhibit penetration of the insulation by dust, dirt or other pollutants, and (3) provide a surface that is easily cleanable. These products may be rated for internal air velocities exceeding 2,400 fpm (12 m/s).

**2.02 Closure materials**

Closure materials shall be one of the following:

A. Pressure-sensitive aluminum foil tapes listed and labeled under UL 181A, Part I (P), identified by name, date of manufacture, product name/number, and UL 181A-P. Minimum width of pressure-sensitive tape for 1 in. (25mm) duct board is 2½ in. (64mm). 3 in. (76mm) pressure-sensitive tape is recommended for 1½ in. (38mm) duct board and required for 2 in. (51mm) duct board.

B. Heat-activated tapes listed and labeled under UL 181A, Part II (H), identified by name, date of manufacture, product name/ number, and UL 181A-H, may be used in all applications except for bonding to sheet metal. Tapes shall be at least 3 in. (76mm) wide.

**CODES AND STANDARDS**

Any building project, whether new construction or retrofit, is first subject to state laws and/or local ordinances.

These laws and ordinances in turn reference codes governing a number of issues that affect the design and construction of HVAC duct systems, among them building safety, indoor environmental quality and energy conservation. These building codes, in turn, reference standards that set forth how building materials and systems shall be manufactured, fabricated, installed, and tested to ensure compliance with code requirements. Incorporated into state laws and local ordinances, these codes and standards thus have the force of law.

**1. INTERNATIONAL CODE COUNCIL (ICC)**

From early in the last century there existed three major code authorities, each of which had established and was maintaining its own set of model building codes in different parts of the United States. These three authorities were:

- Building Officials and Code Administrators International (BOCA)
- International Conference of Building Officials (ICBO)
- Southern Building Code Congress International (SBCCI)

In 1994, recognizing the need for a single set of codes without regional limitations, these three groups established The International Code Council (ICC). Its mission: "To promulgate a comprehensive and compatible regulatory system for the built environment, through consistent performance-based regulations that are effective, efficient and meet government, industry and public needs."

While the ordinances of some local jurisdictions may still reference BOCA, ICBO, and SBCCI codes, nation-wide acceptance of the ICC set of codes is fast becoming a reality. This makes it possible for architects, engineers, manufacturers of building materials and systems, contractors, and code enforcement officials to work with the same regulatory system anywhere in the United States.

It should be noted that some states have established their own building, energy or environmental codes, and that these codes do not necessarily relate to the ICC set of codes. Some state codes may be more or less stringent than the ICC codes.

Among the codes developed by ICC, the following most directly relate to HVAC duct systems in commercial construction:

- International Mechanical Code
- International Energy Conservation Code

**These codes supersede:**

- BOCA National Code, 1996 Edition and National Mechanical Code, 1996 Edition
- ICBO Uniform Building Code, 1997 Edition and Uniform Mechanical Code, 1997 Edition
- SBCCI Standard Building Code, 1997 Edition and Standard Mechanical Code, 1997 Edition
- CABO (Council of American Building Officials) Model Energy Code, 1997 Edition

ICC codes relating to HVAC duct systems in residential or light commercial construction include:

- International Residential Code
- International Energy Conservation Code

**These codes supersede:**

- CABO One and Two Family Dwelling Code, 1995 Edition

Although these codes also deal with issues such as fire safety, indoor environmental quality, and acoustics (among others), the key concerns relative to HVAC duct system insulation can be summed up as follows:

Mechanical codes answer the question, "What physical properties are required of the insulation?"

Energy codes answer the question, "How much insulation is needed in this particular application?"

**2. MECHANICAL, ENVIRONMENTAL, AND OTHER STANDARDS**

ICC codes incorporate by reference the mechanical, fire safety, indoor environmental quality, and other standards promulgated by the following organizations:

- National Fire Protection Association (NFPA)
- Underwriters Laboratories, Inc. (UL) and its Canadian affiliate (ULC)
- American Society for Testing and Materials (ASTM)

Following is a summary of Standards promulgated by the above authorities which are most important to the design, fabrication, and installation of HVAC duct systems incorporating fibrous glass insulation.

**A. National Fire Protection Association (NFPA)**

- i. NFPA Standard 90A, *Standard for the Installation of Air Conditioning/Ventilating Systems*, 2002 Edition  
This Standard states that “Class 1 rigid or flexible air ducts tested in accordance with UL 181 *Standard for Safety, Factory-Made Air Ducts and Air Connectors*, and installed in conformance with the conditions of listing, shall be permitted to be used for ducts when the air temperature in the duct does not exceed 121°C (250°F) or when used as vertical ducts up to two stories in height.”

This Standard also requires that supplementary materials including duct coverings, duct linings, vapor retarder facings, adhesives, fasteners, and tapes “shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.” The Standard further requires that air duct, panel, and plenum coverings and linings “shall not flame, glow, smolder, or smoke” when tested in accordance with ASTM C 411, *Standard Test Method for Hot-Surface Performance of High Temperature Thermal Insulation*, “at the temperature to which they are exposed in service.” In no case shall the test temperature be below 121°C (250°F).

The Standard defines a limited combustible material as one “that does not comply with the definition of non-combustible material that, in the form in which it is used, has a potential heat value not exceeding 8141 kJ/kg (3500 Btu/lb) (see NFPA 259, *Standard Test Method for Potential Heat of Building Materials*), and that complies with either of the following (a) or (b). Materials subject to increase in combustibility or flame spread rating beyond the limits herein established through the effects of age, moisture, or other atmospheric condition shall be considered combustible. (a) Materials having a structural base of noncombustible material, with a surfacing not exceeding a thickness of 3.2 mm (1/8 in.) and with a flame spread rating not greater than 50. (b) Materials in the form and thickness used, other than as described in (a), having neither a flame spread rating greater than 25 nor evidence of continued combustion and of such composition that

surfaces that would be exposed by cutting through the material on any plane would have neither a flame spread rating greater than 25 nor evidence of continued progressive combustion.”

- ii. NFPA Standard 90B, *Standard for the Installation of Warm Air Heating/Air Conditioning Systems*, 1999 Edition

With respect to fire safety of air duct systems, the requirements and definitions of this Standard are identical to those of NFPA Standard 90A.

These two companion standards serve as the basis for many other codes, standards and specifications. They encompass all of the fibrous glass duct insulation systems discussed herein.

- iii. NFPA 255, *Method of Test of Surface Burning Characteristics of Building Materials*

This Standard sets forth test methods for determining the surface burning characteristics of building materials, including those used in HVAC duct systems. This Standard is considered by most building code officials to be equivalent to the following:

- ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*
- UL 723, *Tests for Surface Burning Characteristics of Building Materials*
- CAN/ULC-S102, *Tests for Surface Burning Characteristics of Building Materials (Canada)*

- iv. NFPA 259, *Standard Test Method for Potential Heat of Building Materials*

This Standard, referenced in NFPA 90A, sets forth methods of establishing the limited combustibility classification of thermal insulating materials.

**INSULATING RETURN AIR SYSTEMS, DUCTED AND NON-DUCTED**

**General:**

Provisions must be made for the return of conditioned air from occupied spaces to central air equipment. Without adequate provisions for return air flow, the system may deliver insufficient air to occupied spaces and may also lose overall thermal efficiency. This is an especially critical factor in today’s tight, energy-efficient construction.

There are two basic approaches to providing for return air: ducted and non-ducted. (Many systems are combinations of these two approaches.)

**Ducted return systems**

Ducted return systems are preferable because ducts provide the most thermally and acoustically efficient path for air to return to central units. Ideally, every room or space should have a return air register ducted into the return system. This makes it unnecessary to resort to such expedients as placing grilles in doors, under-cutting doors so return air can flow under them, or (in worst cases) simply leaving doors open and suffering the resulting lack of privacy.

It is often important that return ducts be acoustically treated to prevent central equipment noise from reaching occupied spaces. Fibrous glass ducts, insulated flexible ducts, and sheet metal ducts with fibrous glass duct liners can all be used to provide acceptable noise control. Duct wraps provide no acoustical benefit.

Thermal insulation is also important on return systems because the temperature differential between the ambient air and the return air in the duct is often large.

**Non-ducted return systems**

Stud cavities and spaces between floor joists are often used as return air paths. Unless these paths are tightly sealed, return air may be drawn into central equipment from unconditioned spaces such as hot or cold attics, basements, and crawl spaces, and supplied to occupied spaces. Such unwanted air can easily enter a non-ducted return system through numerous construction openings such as wiring conduits and chases.

Fig. 33 shows ways in which leakage can be minimized when stud and joist cavities are used as return ducts.

The builder and the HVAC contractor should work together in the early stages of construction to ensure opportunities to provide for return air systems when it can still be done right - before interior walls, ceilings, and other construction block access to potential locations for return air paths.

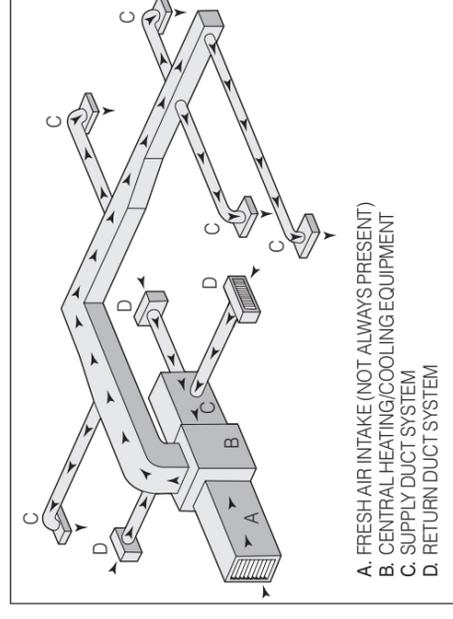


Fig. 32. Air distribution system including ducted return

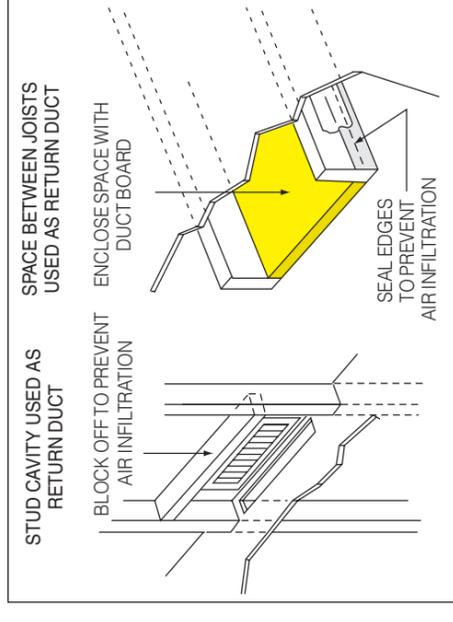


Fig. 33. Ways to provide non-ducted air return

**FLEXIBLE DUCT SYSTEMS**



Fig. 31. Applying plastic closure strap to flexible duct

**Short Form Field Inspection Check List**

(Refer to ADC Flexible Duct Installation Manual for details)

	YES	NO
• Is duct system static pressure within product limits?	<input type="checkbox"/>	<input type="checkbox"/>
• Does insulation R-value meet code requirements?	<input type="checkbox"/>	<input type="checkbox"/>
• Is the UL 181B label attached to flexible duct material?	<input type="checkbox"/>	<input type="checkbox"/>
• Is the UL label attached to the flexible duct jacket?	<input type="checkbox"/>	<input type="checkbox"/>
• Are connections to trunk ducts air-tight and insulated?	<input type="checkbox"/>	<input type="checkbox"/>
• Do closures otherwise meet ADC manual requirements?	<input type="checkbox"/>	<input type="checkbox"/>
• Does flexible duct support meet ADC manual requirements?	<input type="checkbox"/>	<input type="checkbox"/>
• Is the duct system free from sharp bends or kinks?	<input type="checkbox"/>	<input type="checkbox"/>
• Are vertical flexible duct runs correctly supported?	<input type="checkbox"/>	<input type="checkbox"/>

**B. Underwriters Laboratories Inc. (UL)**

- i. UL 181, *Standard for Safety, Factory-Made Air Ducts and Air Connectors*

This Standard specifies requirements for materials used in the manufacture of factory-made air ducts and air connector systems for use in accordance with NFPA Standards 90A and 90B and the ICC International Mechanical Code. Fibrous glass duct products and systems are classified as Class 1, having a flame spread index not exceeding 25 without evidence of continued progressive combustion and a smoke developed index not exceeding 50. This Standard also establishes a test program applicable to both rigid and flexible fibrous glass duct products and systems as shown in the table below.

	RIGID	FLEXIBLE
Surface burning characteristics	•	•
Flame Penetration	•	•
Burning	•	•
Corrosion (a)	•	•
Mold Growth and Humidity	•	•
Temperature	•	•
Puncture	•	•
Static Load	•	•(b)
Impact	•	•
Erosion	•	•
Pressure	•	•
Collapse	•	•
Tension	•	•
Torsion	•	•
Bending	•	•
Leakage	•	•

(a) Applicable to parts of metals not inherently corrosion resistant.

(b) Test applicable for flexible air ducts and air connectors that incorporate vapor retarders supported by grommets or other means of field support.

- ii. UL 181A, *Standard for Closure Systems for Use with Rigid Air Ducts* (2nd Edition, 1994)

This standard specifies materials and techniques used in making the following listed closures in rigid duct systems:

- Pressure-sensitive aluminum foil tape UL 181A, Part I (P)
- Heat-activated aluminum foil tape UL 181A, Part II (H)
- Glass fiber fabric and mastic UL 181A, Part III (M)

Under the UL 181A listing procedures an individual closure system may be qualified for use on all manufacturers' fibrous glass duct materials which meet the UL 181 requirement. Use of any non-listed closure system voids the UL 181 Class 1 Air Duct Rating.

- iii. UL 181B, *Standard for Closure Systems for Use with Flexible Air Ducts and Connectors* (1st Edition, 1995)

This standard specifies materials and techniques used in making closures in flexible duct systems by means of plastic or metal closure straps, tapes, and mastics. Under the UL 181B listing procedures an individual closure system may be qualified for use on all manufacturers' flexible duct products which meet the UL 181 requirement. Use of any non-listed closure system voids the UL 181 Class 1 Air Duct Rating.

- iv. UL 723, *Tests for Surface Burning Characteristics of Building Materials*

As noted, this Standard is considered by most building code officials to be equivalent to the surface burning characteristics tests set forth in ASTM E 84, NFPA 255, and CAN/ULC-S102.

**C. ASTM International**

- i. ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*

As noted, this Standard is considered by most building code officials to be equivalent to the surface burning characteristics tests set forth in UL 723, NFPA 255, and CAN/ULC-S102.

- ii. ASTM C 411, *Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation*

This Test Method covers determination of the performance of block and pipe forms of thermal insulating materials when exposed to simulated hot-surface application conditions. The term "hot-surface performance" refers to a simulated use-temperature test in which the heated testing surface is in a horizontal position. This test method refers primarily to high-temperature insulations applicable to hot-side temperatures in excess of 200°F (93°C). It may be used for materials such as preformed insulations, blanket insulations, and insulating cements.

- iii. ASTM C 423, *Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method*

This Standard establishes methods of determining sound absorption properties of fibrous glass duct board and duct liner.

- iv. ASTM C 518, *Test Method for Steady-State Heat Flux Measurement and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus*

This Standard establishes methods of determining thermal performance properties of fibrous glass duct board, duct liner, duct wrap, and insulation boards described in this Guide.

- v. ASTM C 612, *Standard Specification for Mineral Fiber Block and Board Thermal Insulation*

This Specification covers the composition, physical properties, and dimensions of rigid and semi-rigid mineral fiber block and board for use as thermal insulation as described on pages 30-33 of this Guide.

- vi. ASTM C 1071, *Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)*

This Specification covers the composition, physical properties, and dimensions of fibrous glass duct liners (both flexible and rigid) as described on pages 22-25 of this Guide. This Specification in turn references the following additional ASTM Standards:

- ASTM G 21-96, *Practice for Determining Resistance of Synthetic Polymer Materials to Fungi*
- ASTM G 22-96, *Practice for Determining Resistance of Plastics to Bacteria*
- ASTM C 916, *Standard Specification for Adhesives for Duct Liner Insulation*
- vii. ASTM C 1290, *Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts*

This Specification covers the composition, physical properties, and dimensions of fibrous glass duct wrap insulation as described on pages 26-29 of this Guide.

**D. Manufacturing, Fabrication, and Installation Standards**

Standards governing the design, fabrication, and installation of HVAC duct systems include those of the following organizations:

- North American Insulation Manufacturers Association (NAIMA). Members of this association include the four manufacturers of fibrous glass air duct insulation products.
- Sheet Metal & Air Conditioning Contractors National Association (SMACNA). As the name implies, this association includes companies that fabricate and install air duct systems incorporating fibrous glass insulation products.
- Air Diffusion Council (ADC). This organization includes manufacturers of various classes of flexible duct materials including those which incorporate fibrous glass insulation.
- Midwest Insulation Contractors Association (MICA). This organization is chiefly concerned with mechanical and industrial insulation, but air duct and plenum insulation is included.

- i. North American Insulation Manufacturers Association (NAIMA)

- a. *Fibrous Glass Duct Construction Standard*, Fifth Edition, 2002, Publication AH 116

This Standard contains recommended methods of fabricating and installing air handling ducts using fibrous glass duct board material as defined herein. It covers duct board performance criteria, assembly, fabrication, fittings, approved closures, reinforcement, hanging, support

**Acoustical performance:**

Acoustical performance is determined in accordance with ASTM E 477 and/or Air Diffusion Council Test Code FD-72-R1.

**Static pressure / temperature performance:**

These properties are determined in accordance with Air Diffusion Council Test Code FD-72-R1 under conditions of 140°F (60°C) for 160 hours and 180°F (82°F) for 4 hours.

**Leakage:**

Leakage is determined in accordance with Air Diffusion Council Test Code FD-72-R1 for flexible duct only; leakage including connections is determined in accordance with UL 181 requirements

**Connections:**

Insulated flexible ducts are connected to fiber glass or sheet metal trunk ducts using standard sheet metal dove-tail or spin-in collars. The flexible duct is mechanically attached either with plastic closure straps, metal clamp straps, or approved tape. Connections should be made without bends in excess of 90 degrees, using the shortest possible lengths of flexible duct material.

**Support:**

Insulated flexible ducts are supported at intervals as recommended by manufacturers, but at a distance not greater than 5 feet (1.5 m), with maximum permissible sag of 1/2 in. per foot (15mm per 300 mm) of spacing between support points.

Details of flexible duct connection and support are available in Air Diffusion Council (ADC) *Flexible Duct Performance & Installation Standards*, 4<sup>th</sup> edition, 2003.

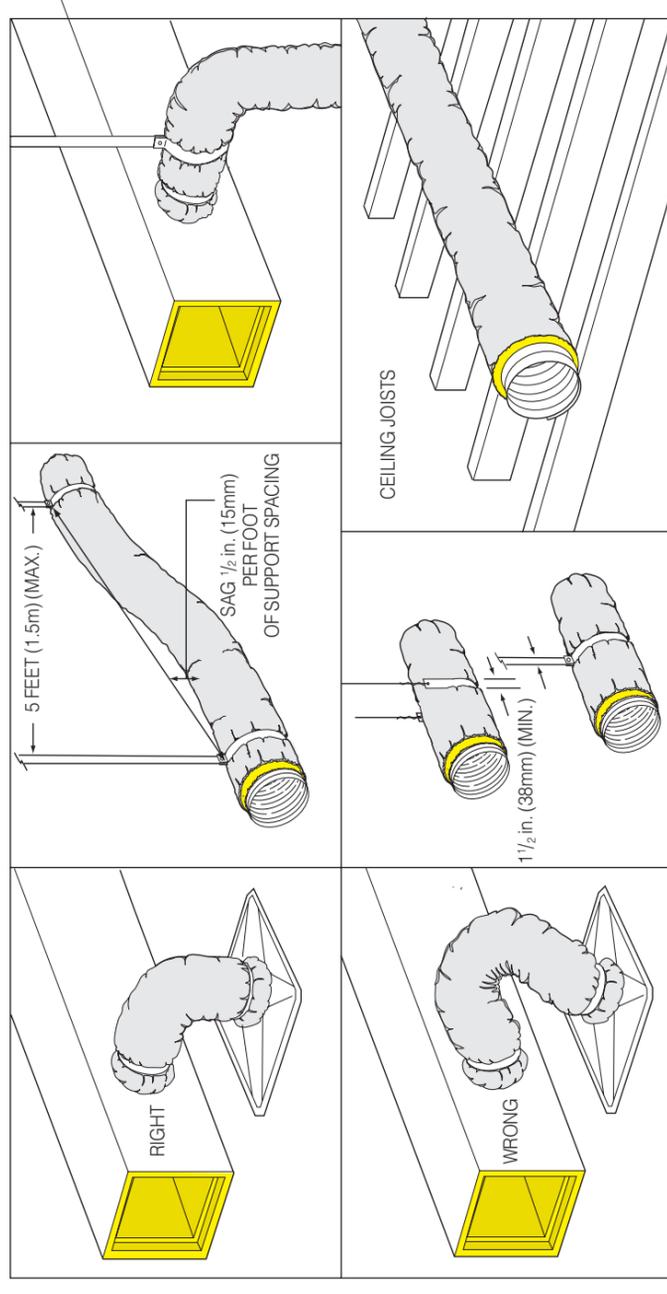


Fig. 30. Correct ways to connect and support flexible duct

**FLEXIBLE DUCT SYSTEMS**



Fig. 29. Flexible duct

**Uses:**

Fibrous glass insulated flexible ducts are used in residential and commercial heating, ventilating, and air conditioning systems operating at static pressures from 1/2 to 10 in. w.g. (125 to 2500 Pa), 6 000 fpm (30.5 m/sec) maximum air velocity, and 250°F (121°C) maximum internal air temperature. Flexible ducts are designed for use as run-outs from trunk ducts to room registers, diffusers, and mixing boxes. They may also be used as supply and return air ducts when the product's flexibility is an advantage in routing ducts through spaces with obstructions.

**Description:**

Fibrous glass insulated flexible ducts consist of a spiral wire reinforced inner air barrier core wrapped with resilient fibrous glass insulation and jacketed with an exterior vapor retarder of reinforced foil or plastic film. The light density fibrous glass insulation provides both thermal efficiency and effective noise control. Insulated flexible ducts are available in sizes encompassing most residential and commercial system requirements. (NAIMA members do not manufacture flexible ducts, but do supply the flexible duct industry with fibrous glass insulation.)

**Features and benefits:**

**Acoustically effective**

The fiber glass insulation absorbs fan and vibration noise from central air equipment and eliminates the popping noises caused by expansion and contraction of sheet metal ducts.

**Thermally efficient**

The fiber glass insulation helps the flexible duct system to deliver to occupied spaces conditioned air at or close to design temperatures, saving energy and contributing to comfort.

**Fast installation**

Flexible duct is easily cut to required lengths and quickly attached to trunk ducts and room registers using sheet metal collars and closure straps, tapes, or glass fiber fabric and mastic.

**Flexibility**

This characteristic simplifies completion of the system, especially when ducts must be routed through spaces with obstructions such as attics or above suspended ceilings.

**Code compliance**

Fibrous glass insulated flexible duct systems meet requirements of UL 181, and comply with all widely used model codes including ICC, BOCA, CABO, ICBO, and SBCCI.

**Thermal performance:**

Commonly available R-values range from 4.1 to 8.0. Consult manufacturers' literature for their products' R-values, as well as for the following performance properties.

**Friction loss:**

Friction loss is determined in accordance with Air Diffusion Council Test Code FD-72-R1.

and damage repair. This standard was developed using reliable engineering principles and research, plus information obtained from manufacturers, contractors, testing laboratories, and others with specialized experience. A 3-part CSI Masterformat® specification is included.

- b. *Fibrous Glass Residential Duct Construction Standard*, Third Edition, 2001, Publication AH 119

This Standard is based on the Fibrous Glass Duct Construction Standard cited above, but focuses on recommended methods of fabricating and installing air handling ducts in residential and light commercial structures. A 3-part CSI Masterformat® specification is included.

- c. *Fibrous Glass Duct Liner Standard*, Third Edition, 2002, Publication AH 124

This standard sets forth important properties of fibrous glass duct liner materials, acoustical and thermal performance, contribution to indoor environmental quality, and installation procedures. A 3-part CSI Masterformat® specification is included.

- ii. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

- a. *Fibrous Glass Duct Construction Standards*, Seventh Edition, 2003

This standard served as a basis for the scope and content of the above cited NAIMA standard.

- b. *HVAC Duct Construction Standards*, Second Edition, 1995

This standard includes sections on installation of fibrous glass duct liner materials and insulated flexible duct systems.

- iii. Air Diffusion Council (ADC)

- a. *Flexible Duct Performance and Installation Standards*, Fourth Edition, 2003

This standard sets forth specific methods of classifying, testing, marking, and installing flexible ducts in air distribution systems. It references ADC Test Code FD-72R1, which establishes values and procedures for testing insulated flexible ducts in terms of air friction loss.

acoustical performance, static pressure/ temperature performance, and leakage. Fabrication and installation guidelines are included.

- iv. Midwest Insulation Contractors Association (MICA)

- a. *National Commercial and Industrial Insulation Standards*, Fifth Edition, 1999

This standard includes installation and fabrication specifications for fibrous glass duct wrap and duct liner, as well as for rigid fibrous glass exterior board insulation over metal ducts.

**3. ENERGY CONSERVATION STANDARDS**

The Department of Energy's Federal Energy Policy Act of 1992 required states to certify that their commercial building energy codes meet or exceed the energy conservation requirements of ASHRAE/IESNA 90.1-1989, an energy standard promulgated by ASHRAE, the American Society of Heating, Refrigerating, and Air-Conditioning Engineers. This act also required states' residential building energy codes to meet or exceed the energy conservation requirements of CABO's Model Energy Code.

DOE conducts ongoing review of subsequent versions of these and other energy codes to determine whether these might be the basis for a better national energy policy. In 2002, for commercial construction DOE updated the Federal Energy Policy Act to recognize a later version of the ASHRAE energy standard, ASHRAE/IESNA 90.1-1999. DOE is also currently reviewing another ASHRAE energy standard, ANSI/ASHRAE/IESNA 90.1 2001. For energy conservation in residential construction, DOE now recognizes the ICC's International Energy Conservation Code (IECC), 2003 Edition.

Most State energy conservation codes are currently being updated to reflect DOE recognition of these more recent ASHRAE and ICC energy standards and to maintain compliance with the Federal Energy Policy Act.

Insulation R-values required by these standards are given on the following four pages.

**A. ASHRAE/IESNA 90.1-1989, Energy Efficient Design of New Buildings Except Low Rise Residential Buildings**

This widely accepted National Voluntary Consensus Standard was developed under the auspices of ASHRAE, the American Society of Heating, Refrigerating, and Air-Conditioning Engineers; it was co-sponsored by the Illuminating Engineering Society of North America. This standard includes energy-efficient design requirements for HVAC systems and equipment intended to improve utilization of energy in buildings. It provides minimum required thermal resistance (R) values for air ducts, plenums, and enclosures based on the temperature differential (TD) at design conditions between the space within which the duct is located and the design air temperature in the duct. The table below shows these required minimum R-values related to duct insulation thickness.

As required by the Energy Policy Act of 1992, each State must certify that its commercial building code energy provisions meet or exceed the requirements of this ASHRAE Standard. Some states have their own energy codes and/or amendments to these codes which provide greater R-values.

**TABLE 9-2 (ASHRAE/IESNA 90.1-1989). Minimum duct insulation <sup>(a)</sup>**

DUCT LOCATION BUILDING EXTERIOR	COOLING <sup>(b)</sup>		HEATING <sup>(c)</sup>	
	ANNUAL COOLING DEGREE DAYS Base 65°F (18°C)	INSULATION R-VALUE <sup>(d)</sup> (RSI value)	ANNUAL HEATING DEGREE DAYS Base 65°F (18°C)	INSULATION R-VALUE <sup>(d)</sup> (RSI value)
Below 500 (Below 278)	3.3 (0.58)		Below 2,500 (Below 833)	3.3 (0.58)
500 - 1,150 (278 - 638)	5.0 (0.88)		1,500 - 4,500 (833 - 2,500)	5.0 (0.88)
1,151 - 2,000 (639-1,111)	6.5 (1.15)		4,501 - 7,500 (2,501 - 4,167)	6.5 (1.15)
Above 2,000 (Above 1,111)	8.0 (1.41)		Above 7,500 (Above 4,167)	8.0 (1.41)

**DUCT LOCATION INSIDE OF BUILDING ENVELOPE OR IN UNCONDITIONED SPACES: <sup>(e)</sup>**

TD <sup>(e)</sup> < 15°F (TD <sup>(e)</sup> < 8.3°C)	Not required	Not required
40°F > TD, > 15°F (22°C > TD, > 8.3°C)	3.3 (0.58)	3.3 (0.58)
TD > 40°F (TD > 22°C)	5.0 (0.88) <sup>(f)</sup>	5.0 (0.88) <sup>(f)</sup>

(a) Insulation R-values shown are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and condensation. Additional insulation, vapor retarders, or both, may be required to limit vapor transmission and condensation. For ducts which are designed to convey both heated and cooled air, duct insulation shall be as required by the most restrictive condition. Where exterior walls are used as plenum walls, wall insulation shall be as required by the most restrictive condition of this section or Section 8 of ASHRAE/IESNA 90.1-1989.

(b) Cooling ducts are those designed to convey mechanically cooled air or return ducts in such systems.

(c) Heating ducts are those designed to convey mechanically heated air or return ducts in such systems.

(d) Insulation resistance measured on a horizontal plane in accordance with ASTM C 518-85 at a mean temperature of 75°F (24°C) at the installed thickness.

(e) TD is defined as the temperature difference at design conditions (see ASHRAE Standard 9.4.1) between the space within which the duct is located and the design air temperature in the duct.

(f) Insulation thermal resistance for run-outs to terminal devices less than 10 feet (3.05m) in length need not exceed R-value of 3.3 (RSI = 0.58).

(g) Unconditioned spaces include crawl spaces and attics.

**Insulating for personnel protection:**

Insulation thickness is considered sufficient to provide personnel protection when its surface temperature does not exceed 140°F (60°C). Table 9, based on the NAIMA 3E Plus<sup>®</sup> Program, gives the thicknesses of fibrous glass insulation boards that will achieve such protection at operating temperatures to 450°F (232°C).

**Table 9. Thickness required for personnel protection**

System Operating Temperature °F (°C)	Insulation Thickness (FSK facing) in. (mm)	Insulation Thickness (ASJ or bare) in. (mm)
150 (66)	1/2 (13)	1/2 (13)
200 (93)	1/2 (13)	1/2 (13)
250 (121)	1 (25)	1/2 (13)
300 (149)	1 (25)	1/2 (13)
350 (177)	1 1/2 (38)	1 (25)
400 (204)	2 (51)	1 (25)
450 (232)	2 1/2 (64)	1 (25)

Conditions: Vertical flat surface, average ambient temperature: 75°F (24°C), no air movement at exterior surface.

**Short Form Field Inspection Check List**

	YES	NO
• Are insulation boards certified to comply with ASTM C 612?	<input type="checkbox"/>	<input type="checkbox"/>
• Were all joints in sheet metal ductwork tightly sealed before installing insulation?	<input type="checkbox"/>	<input type="checkbox"/>
• Are mechanical fasteners spaced on 16" to 18" (400mm to 450mm) centers starting no more than 3' (76mm) from joints?	<input type="checkbox"/>	<input type="checkbox"/>
• Are mechanical fasteners spaced at the correct intervals?	<input type="checkbox"/>	<input type="checkbox"/>
• Where a vapor retarder is required, are seams of insulation boards tightly taped or sealed with glass fabric and mastic?	<input type="checkbox"/>	<input type="checkbox"/>
• Is pressure-sensitive tape at least 3 in. (76mm) wide over all seams and joints?	<input type="checkbox"/>	<input type="checkbox"/>
• Is field-jacketing material evenly and uniformly applied, with no gaps or seams?	<input type="checkbox"/>	<input type="checkbox"/>
• Where a vapor retarder is required, are all fasteners tightly sealed with pressure-sensitive tape matching the insulation facing?	<input type="checkbox"/>	<input type="checkbox"/>

**FIBROUS GLASS INSULATION BOARDS**

**Installation:**

On exterior duct surfaces, insulation is installed by impaling it on weld pins and securing with speed clips or washers, or using special weld pins with integral cupped head washers. Unfaced boards can then be finished with reinforced insulating cement, canvas, or weatherproof mastic, or with sheet metal, depending upon the application. See Figure 28. Faced boards can be installed in the same way. Joints between boards are sealed with pressure-sensitive tape or glass fabric and mastic.

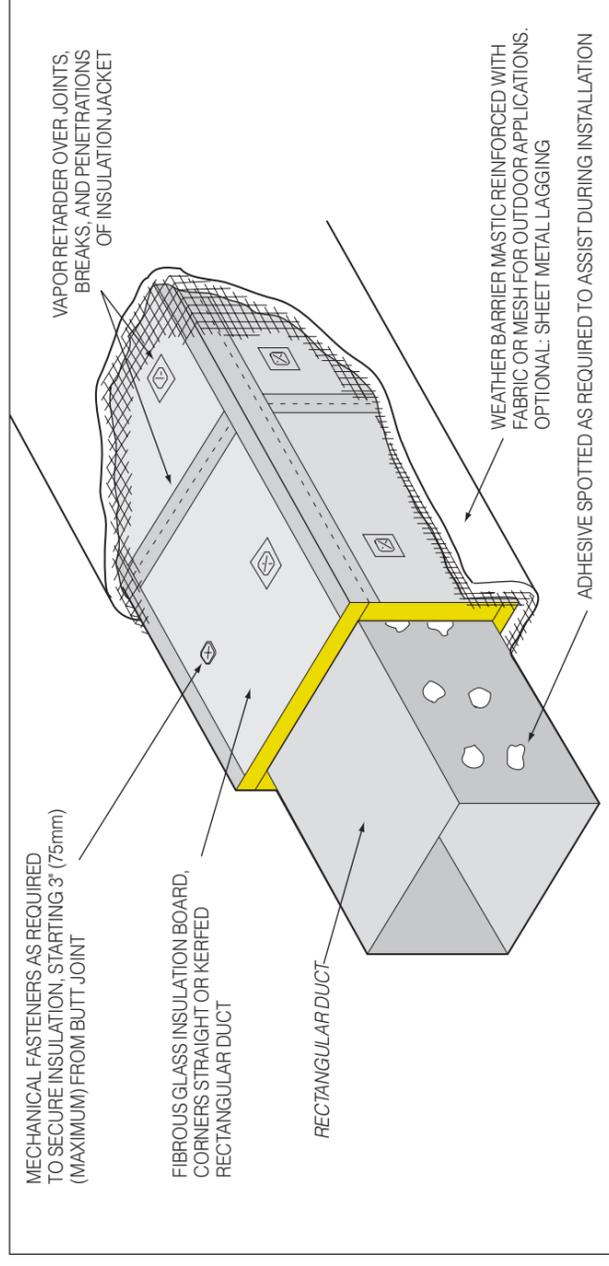


Fig. 28. Installation of fibrous glass insulation board on duct or plenum exterior (From National Commercial & Industrial Insulation Standards, Midwest Insulation Contractors Association)

**B. ANSI/ASHRAE/IESNA 90.1-2001, Energy Standard for Buildings Except Low Rise Residential Buildings**

This National Voluntary Consensus Standard was developed under the auspices of ASHRAE. It was co-sponsored by both the American National Standards Institute (ANSI) and the Illuminating Engineering Society of North America; it supersedes ASHRAE/IESNA 90.1-1989 and is recognized by DOE as the minimum energy conservation standard in commercial

construction. Minimum duct system R-values are keyed to building envelope criteria tables found in Appendix B of the Standard, and to climate zone conditions found in Appendix D. Minimum R-values are given in Tables 6.2.4.2A and 6.2.4.2B below.

**TABLE 6.2.4.2A (ANSI/ASHRAE/IESNA 90.1-2001). Minimum Duct Insulation R-Value, (a) Cooling and Heating Only Supply Ducts and Return Ducts**

Climate Zone	Duct Location				
	Unvented Attic with Ventilated Attic	Unvented Attic with Backloaded Ceiling	Roof Insulation	Unconditioned Space <sup>(b)</sup>	Indirectly conditioned Space <sup>(c)</sup>
Envelope Criteria Table	HDD65	CDD50 Exterior	Attic	Attic	Attic
B-1 to B-7	0-1800	all	none	none	none
B-8 to B-12	1801-3600	all	R-3.5	none	none
B-13 to B-15	3601-5400	all	R-3.5	none	none
B-16 to B-18	5401-7200	all	R-6	R-3.5	R-3.5
B-19 to B-20	7201-9000	all	R-6	R-3.5	R-3.5
B-21 to B-22	9001-10800	all	R-8	R-6	R-3.5
B-23	10801-12600	all	R-8	R-6	R-6
B-24	12601-16200	all	R-8	R-6	R-6
B-25	16201-19800	all	R-10	R-8	R-6
B-26	19801+	all	R-10	R-8	R-6
<b>Heating Only Ducts</b>					
			none	none	none
			none	none	none
			none	none	none
			R-3.5	R-3.5	R-3.5
			R-6	R-6	R-6
			R-8	R-8	R-6
			R-10	R-8	R-6
			R-10	R-8	R-6
<b>Cooling Only Ducts</b>					
B-15, 18, 20, 22 to 26	all	0 – 1800	R-1.9	R-1.9	none
B-12, 14, 17, 19, 21	all	1801-3600	R-3.5	R-1.9	none
B-7, 9, 11, 13, 16	all	3601-5400	R-3.5	R-1.9	none
B-4, 6, 8, 10	all	5401-7200	R-6	R-1.9	none
B-3, B-5	all	7201-9000	R-6	R-3.5	R-3.5
B-2	all	9001-10800	R-6	R-3.5	R-3.5
B-1	all	10801+	R-8	R-3.5	R-3.5
<b>Return Ducts</b>					
B-1 to B-26	all climates	R-3.5	R-3.5	none	none

(a) Insulation R-values, measured in (hr•ft<sup>2</sup>•F)/Btu, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Where exterior walls are used as plenum walls, wall insulation shall be as required by the most restrictive condition of 6.2.4.2 or Section 5 of ANSI/ASHRAE/IES 90.1-2001. Insulation resistance measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 75°F at the installed thickness.

(b) Includes crawl spaces, both ventilated and non-ventilated.

(c) Includes return air plenums with or without exposed roofs above.

**TABLE 6.2.4.2B. Minimum Duct Insulation R-Value,<sup>(a)</sup> Combined Heating and Cooling Ducts**

Climate Zone	Duct Location									
	Envelope Criteria Table	HDD65	CDD50	Exterior	Ventilated Attic	Unvented Attic with Backloaded Ceiling Insulation	Unvented Attic with Roof Insulation	Unconditioned Space <sup>(b)</sup>	Indirectly Conditioned Space <sup>(c)</sup>	Buried
B-1	0 - 900	10801+	R-8	R-6	R-6	R-8	R-3.5	R-3.5	none	R-3.5
B-2	0 - 900	9001-10800	R-6	R-6	R-6	R-8	R-3.5	R-3.5	none	R-3.5
B-3	0 - 900	7201-9000	R-6	R-6	R-6	R-6	R-3.5	R-3.5	none	R-3.5
B-4	0 - 900	0 - 7200	R-6	R-6	R-3.5	R-6	R-1.9	R-1.9	none	R-3.5
B-5	901-1800	7201+	R-6	R-6	R-6	R-6	R-3.5	R-3.5	none	R-3.5
B-6	901-1800	5401-7200	R-6	R-6	R-6	R-6	R-3.5	R-3.5	none	R-3.5
B-7	901-1800	0-5400	R-3.5	R-6	R-3.5	R-6	R-1.9	R-1.9	none	R-1.9
B-8	1801-2700	5401+	R-6	R-6	R-3.5	R-6	R-3.5	R-3.5	none	R-3.5
B-9	1801-2700	0-5400	R-6	R-6	R-3.5	R-6	R-1.9	R-1.9	none	R-1.9
B-10	2701-3600	5401+	R-6	R-6	R-6	R-6	R-3.5	R-3.5	none	R-3.5
B-11	2701-3600	3601-5400	R-6	R-6	R-6	R-6	R-3.5	R-3.5	none	R-1.9
B-12	2701-3600	0-3600	R-3.5	R-3.5	R-3.5	R-3.5	R-1.9	R-1.9	none	R-1.9
B-13	3601-5400	3601+	R-6	R-6	R-6	R-6	R-3.5	R-3.5	none	R-3.5
B-14	3601-5400	1801-3600	R-6	R-6	R-3.5	R-6	R-1.9	R-3.5	none	R-1.9
B-15	3601-5400	0-1800	R-3.5	R-3.5	R-3.5	R-3.5	R-1.9	R-1.9	none	R-1.9
B-16	5401-7200	3601+	R-6	R-6	R-6	R-6	R-3.5	R-3.5	none	R-3.5
B-17	5401-7200	1801-3600	R-6	R-6	R-6	R-6	R-1.9	R-3.5	none	R-3.5
B-18	5401-7200	0-1800	R-6	R-6	R-3.5	R-3.5	R-1.9	R-3.5	none	R-3.5
B-19	7201-9000	1801+	R-8	R-6	R-6	R-6	R-1.9	R-3.5	none	R-3.5
B-20	7201-9000	0-1800	R-6	R-6	R-6	R-6	R-1.9	R-3.5	none	R-3.5
B-21	9001-10800	1801+	R-8	R-8	R-6	R-6	R-1.9	R-6	none	R-3.5
B-22	9001-10800	0-1800	R-8	R-8	R-6	R-6	R-1.9	R-3.5	none	R-3.5
B-23	10801-12600	all	R-8	R-6	R-6	R-6	R-1.9	R-6	none	R-6
B-24	12601-16200	all	R-8	R-8	R-1.9	R-8	R-1.9	R-6	none	R-6
B-25	16201-19800	all	R-10	R-8	R-8	R-8	R-3.5	R-6	none	R-6
B-26	19801+	all	R-10	R-10	R-10	R-8	R-3.5	R-8	R-3.5	R-6

(a) Insulation R-values, measured in (hr•ft<sup>2</sup>•°F)/Btu, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Where exterior walls are used as plenum walls, wall insulation shall be as required by the most restrictive condition of 6.2.4.2 or Section 5 of ANSI/ASHRAE/IES 90.1-2001. Insulation resistance measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 75°F at the installed thickness.

(b) Includes crawl spaces, both ventilated and non-ventilated.

(c) Includes return air plenums with or without exposed roofs above.



Fig. 25. Seams and joints of faced boards are sealed with glass fabric and mastic or with pressure sensitive tape.

**SBCCI.**

**Thermal performance:**

Manufacturers' published literature shows these products to perform in the following R-value ranges shown in Table 8, depending on product type and density:

**Table 8. Commonly available R-values**

Thickness, in. (mm)	R-value, hr•ft <sup>2</sup> •°F/Btu	(RSI, m <sup>2</sup> •°C/W)
1 (25)	4.0 - 4.5	(0.70-0.79)
1 1/2 (38)	6.0 - 6.8	(1.06-1.20)
2 (51)	8.0 - 9.0	(1.41-1.58)
2 1/2 (64)	10.0 - 11.4	(1.75-2.01)
3 (76)	12.0 - 13.6	(2.11-2.39)
3 1/2 (89)	14.0 - 16.0	(2.46-2.82)
4 (102)	16.0 - 18.0	(2.82-3.17)

Thermal values above are for insulation only as determined by ASTM C 518 at 75°F (24°C) and do not include air films or reflective surfaces. Values are subject to normal manufacturing and testing tolerances.

**Condensation control:**

Figures 26 and 27 show the installed R-values of fibrous glass insulation boards required to prevent moisture condensation on the vapor retarder surface under varying conditions of ambient temperature and relative humidity. Curves are based on internal air temperatures of 55°F (13°C) and no air movement on the exterior surface.

NOTE: R-values as required by ASHRAE 90.1-1989 may not be sufficient for condensation control, as may be seen in the figures below.

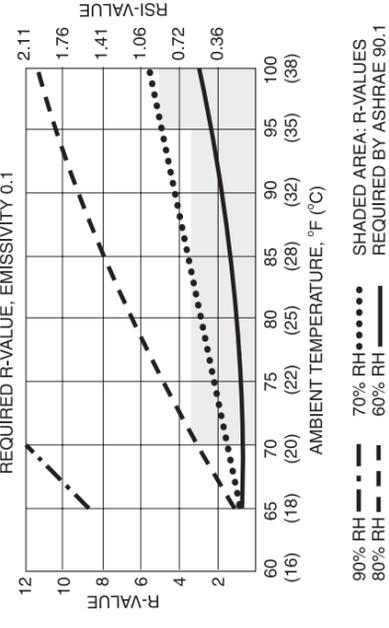


Fig. 26. Required R-value, emissivity 0.1 (FSK)

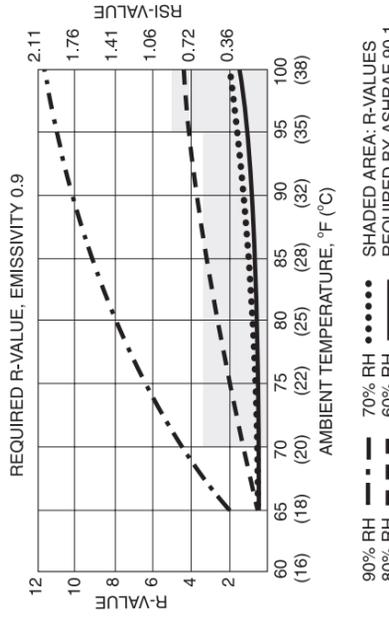


Fig. 27. Required R-value, emissivity 0.9 (ASJ)

**FIBROUS GLASS INSULATION BOARDS**

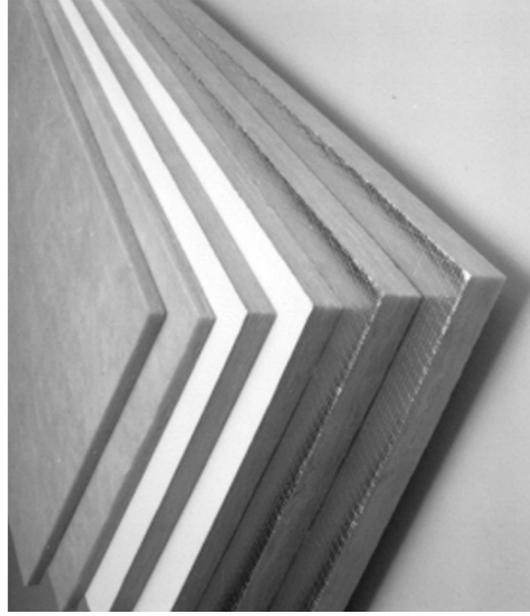


Fig. 24. *Fibrous glass insulation boards.*

**Uses:**

Fibrous glass insulation boards may be applied to the exterior of sheet metal ducts, housings, and plenums. These semi-rigid to rigid boards are also suitable for insulating chillers and other cold or hot equipment, and can be used in applications operating within the temperature range of 0°F (-18°C) to 450°F (232°C). They are available in thicknesses from 1 in. (25 mm) to 4 in. (102 mm) in 1/2 in. (13 mm) increments.

**Description:**

These products are composed of glass fibers bonded together with a thermosetting resin. They are manufactured in various types. Fibrous glass insulation boards are available unfaced, or faced with FSK (foil/scrim/kraft) or ASJ (all-service jacket) facings. Both are excellent vapor retarders; FSK provides a metallic finish, while ASJ presents a white finish.

**Features and benefits:**

**Versatility**

Fibrous glass insulation boards are available in a range of stiffnesses, faced or unfaced, and in a range of thicknesses. They may be applied to round, rectangular, oval, or irregularly shaped ducts, plenums, and equipment.

**Thermally efficient**

These insulations reduce heat loss or gain through duct, plenum, and equipment walls, saving energy and helping to reduce equipment operating costs.

**Mechanical strength**

Higher density insulations resist compression. They are especially suited for use in mechanical rooms, where traffic is frequent and a neat finished appearance is desired.

**Easy to install**

Fibrous glass insulation boards can be installed simply by impaling on weld pins and securing with speed clips or washers, or using special weld pins with integral cupped head washers. Panels are easy to handle, cut, and install. They are frequently used as insulations in systems exposed to the weather.

**Acoustical performance**

These fibrous glass insulations provide excellent sound absorption properties for vibration damping but do not control airborne noise. Consult manufacturers' literature for specific sound absorption data.

**Code compliance**

Fibrous glass insulation boards meet the physical property requirements of ASTM C 612 as well as meeting fire safety requirements of NFPA 90A and 90B including limited combustibility. They also comply with all widely used model codes including ICC, BOCA, CABO, ICBO, and

**C. International Energy Conservation Code (IECC), 2003 Edition**

Promulgated by the International Code Council (ICC), this national code establishes minimum regulations for the energy efficient design and construction of both residential and commercial buildings using prescriptive and performance-related provisions. Chapters 4, 5, and 6 contain various compliance paths for residential buildings; Chapters 7 and 8 contain the same for commercial buildings.

Table 503.3.3.3 of the IECC 2003 edition contains minimum HVAC duct insulation requirements for residential buildings.

Duct insulation requirements for commercial buildings are established in Chapter 7 by reference to ANSI/ASHRAE/IESNA 90.1-2001, tables 6.2.4.2a and 6.2.4.2b (see pages 13 and 14 of this publication). The IECC 2000 Edition references ASHRAE/IESNA 90.1-1989, table 9.2 (see page 12). Finally, Section 803.2.8 contains the following alternate commercial duct insulation requirements:

- "All supply and return air ducts and plenum shall be insulated with a minimum of R-5 insulation when located in conditioned spaces and with a minimum of R-8 insulation when located outside the building. When located within a building envelope assembly, the duct or plenum shall be separated from the building exterior or unconditioned or exempt space by a minimum of R-8 insulation. Exceptions: 1. When located within equipment.
- 2. When design temperature differential between the interior and exterior of the duct or plenum does not exceed 15°F (8°C)".

**Table 503.3.3.3 – Minimum Duct Insulation Insulation R-Value (hr·ft<sup>2</sup>·°F/Btu)**

Annual Heating Degree Days	Ducts in unconditioned attics or outside building		Ducts in unconditioned basements, crawl spaces, and other unconditioned spaces	
	Supply	Return	Supply	Return
Below 1,500	8	4	4	0
1,500 to 2,500	8	4	6	2
2,501 to 7,500	8	4	8	2
Above 7,500	11	6	11	2

**D. International Residential Code (IRC), 2002 and 2003 Edition**

Promulgated by the International Code Council (ICC), this national code applies to one and two family dwellings and townhouses up to three stories and is limited by glazing area. It consists of a comprehensive collection of basic minimum construction regulations, containing prescriptive provisions ranging from structural and fire safety to electrical, plumbing, mechanical, and energy conservation. Chapter 16, *Duct Systems*, covers HVAC duct construction and acceptable duct materials, including fibrous glass insulation as covered in this guide.

Section N1 103.3 of this code contains the following duct insulation requirements: "All portions of the air distribution system ... shall be insulated to an installed R-5 when system components are located within the building but outside of conditioned space, and R-8 when located outside of the building. When located within a building envelope assembly, at least R-8 shall be applied between the duct and that portion of the assembly furthest from conditioned space. Exceptions: Exhaust air ducts and portions of the air distribution system within appliances or equipment."

**4. SUMMARY**

Consult the table below to determine applicability of the codes, standards, and specifications listed herein with respect to each of the fibrous glass HVAC duct insulation products described in this Guide.

	Fibrous Glass Duct Board	Fibrous Glass Duct Liner	Fibrous Glass Duct Wrap	Insulation Boards	Insulated Flexible Duct
<b>NATIONAL FIRE PROTECTION ASSOCIATION</b>					
NFPA 90A	•	•	•	•	•
NFPA 90B	•	•	•	•	•
NFPA 255	•	•	•	•	•
NFPA 259	•	•	•	•	•
<b>UNDERWRITERS LABORATORIES INC.</b>					
UL 181	•				•
UL 181 A	•				•
UL 181 B	•				•
UL 723	•	•	•	•	•

**ASTM International**

ASTM E 84	•	•	•	•	•
ASTM C 411	•	•	•	•	•
ASTM C 423	•	•	•		
ASTM C 518	•	•	•	•	•
ASTM C 612				•	
ASTM C 1071	•	•			
ASTM G 21	•	•			
ASTM G 22	•	•			
ASTM C 916 (adhesive)					
ASTM C 1290			•		

**MANUFACTURING, FABRICATION, AND INSTALLATION STANDARDS**

NAIMA Fibrous Glass Duct Construction Standard	•				
NAIMA Fibrous Glass Residential Duct Const. Std.	•				
NAIMA Fibrous Glass Duct Liner Standard			•		
SMACNA Fibrous Glass Duct Construction Standards	•				•
SMACNA HVAC Duct Construction Standards			•		•
ADC Flexible Duct Performance & Installation Stds.					
MICA Commercial and Industrial Insulation Standards				•	

**ENERGY CONSERVATION STANDARDS AND CODES:**

ASHRAE/IESNA 90.1-1989	•	•	•	•	•
ANSI/ASHRAE/IESNA 90.1-2001	•	•	•	•	•
IECC - INTL. ENERGY CONSERVATION CODE	•	•	•	•	•
IRC - INTL. RESIDENTIAL CODE	•	•	•	•	•

Dimensions in Table 7 are established by ASTM C 1290 and should be used when cutting duct wrap insulation so that, once installed, it is not compressed to less than 75% of nominal (out-of-package) thickness.

**Table 7. Installation stretch-out dimensions, in. (mm) (ASTM C 1290)**

Nominal thickness (as manufactured), in.	Nominal thickness (mm)	Average installed thickness, (mm)		INSULATION STRETCH-OUT DIMENSIONS, P* + in. (mm)					
		in.	(mm)	Round duct, in.	Square duct, (mm)	Rectangular duct, in.	(mm)		
1	(25)	3/4	(19)	P + 7	(178)	P + 6	(152)	P + 5	(127)
1 1/2	(38)	1 1/8	(29)	P + 9 1/2	(241)	P + 8	(203)	P + 7	(178)
2	(51)	1 1/2	(38)	P + 12	(305)	P + 10	(254)	P + 8	(203)
2 1/2	(64)	1 7/8	(48)	P + 14 1/2	(368)	P + 12 1/2	(318)	P + 9 1/2	(241)
3	(76)	2 1/4	(57)	P + 17	(432)	P + 14 1/2	(368)	P + 11 1/2	(292)
3 1/2	(89)	2 5/8	(67)	P + 19 1/2	(495)	P + 16 1/2	(419)	P + 13	(330)
4	(102)	3	(76)	P + 22	(559)	P + 19	(483)	P + 16	(406)

Stretch-out dimension must be followed to achieve labeled installed R-values. \*P = perimeter of sheet metal duct

**Short Form Field Inspection Check List (Refer to MICA National Commercial & Industrial Insulation Standards for details)**

	YES	NO
• Is duct system operating within humidity and temperature range for which duct wrap insulation is rated (40°F – 250°F, or 4°C – 121°C)?	<input type="checkbox"/>	<input type="checkbox"/>
• Were all joints in ductwork tightly sealed before applying duct wrap insulation?	<input type="checkbox"/>	<input type="checkbox"/>
• Is duct wrap certified to comply with ASTM C 1290?	<input type="checkbox"/>	<input type="checkbox"/>
• Is the duct wrap insulation's installed R-value clearly printed on the facing?	<input type="checkbox"/>	<input type="checkbox"/>
• Are all seams and joints properly stapled with outward clinching staples every 6 in. (150mm) or tacked using tape across seam?	<input type="checkbox"/>	<input type="checkbox"/>
• When a vapor retarder is required, are seams tightly taped with pressure-sensitive tape or sealed with glass fabric and mastic?	<input type="checkbox"/>	<input type="checkbox"/>
• Was correct stretch-out dimension used so wrap is not excessively compressed?	<input type="checkbox"/>	<input type="checkbox"/>
• If rectangular ducts are 24 in. (600 mm) wide or greater, is duct wrap secured to bottom of duct with mechanical fasteners to prevent sagging of insulation?	<input type="checkbox"/>	<input type="checkbox"/>

**SHEET METAL DUCTS WITH FIBROUS GLASS INSULATION WRAP**

**Installation:**

Fibrous glass duct wrap insulations are installed with facings away from the duct surface. See Figure 22. A stapling flap, prepared at the time of installation, overlapping the insulation and facing at the other end of the piece of duct wrap, is stapled to form a longitudinal seam. Where a vapor retarder is required, the seam is sealed with pressure-sensitive tape. Adjoining duct wrap sections are similarly stapled and sealed using the facing flap on one edge of the duct wrap as produced at the factory. Seams and joints may also be sealed with mastic and glass fiber fabric. For complete installation details, consult manufacturers or *National Commercial and Industrial Insulation Standards*, 1999, 5<sup>th</sup> Edition, Midwest Insulation Contractors Association (MICA).



Fig. 22. Fibrous glass duct wrap may be installed on round, oval, or rectangular ducts after joints have been tightly sealed

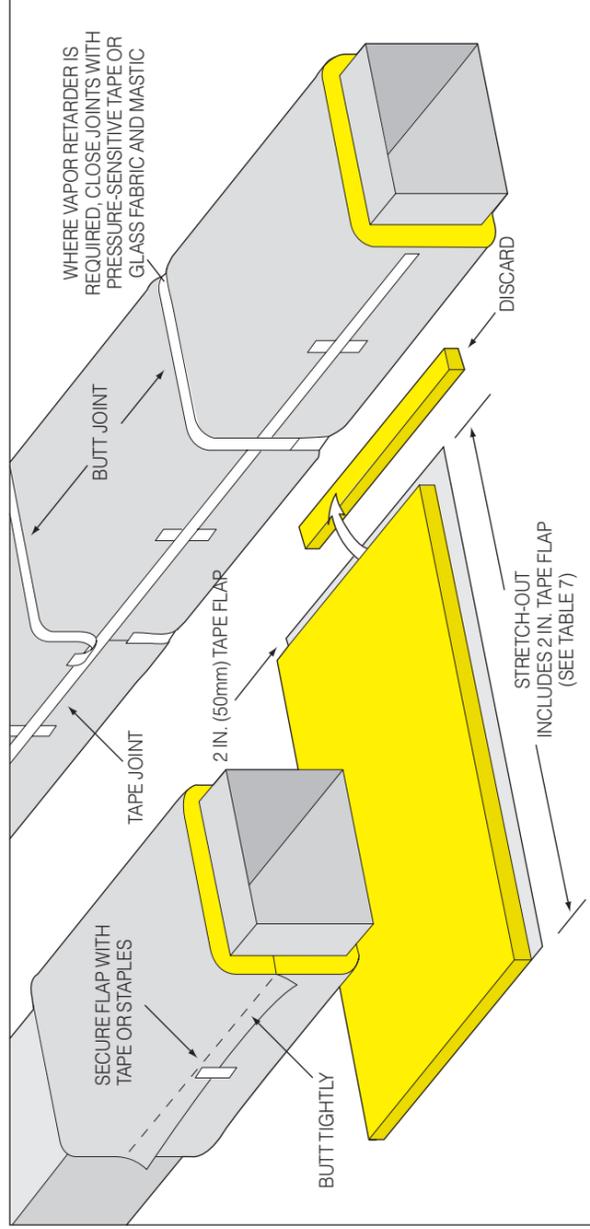


Fig. 23. Installing fibrous glass duct wrap insulation to assure full installed R-value

**National Fire Protection Association Building and Energy Codes**

This organization has published a building code, NFPA 5000™, *Building Construction and Safety Code*. Comparable in scope to the ICC code set, it was developed in partnership with the International Association of Plumbing and Mechanical Officials (IAPMO), Western Fire Chiefs Association (WFCA), and ASHRAE.

NFPA has also issued Proposed Standard 900, *Building Energy Code*, which establishes minimum energy-efficient requirements for new and existing buildings.

Further information concerning codes and standards may be obtained by visiting the following websites:

- National Fire Protection Association ..... [www.nfpa.org](http://www.nfpa.org)
- Underwriters Laboratories Inc. .... [www.ul.com](http://www.ul.com)
- ASTM International ..... [www.astm.org](http://www.astm.org)
- North American Insulation Manufacturers Association ..... [www.naima.org](http://www.naima.org)
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers ..... [www.ashrae.org](http://www.ashrae.org)
- International Code Council ..... [www.iccsafe.org](http://www.iccsafe.org)
- Sheet Metal & Air Conditioning Contractors National Association ..... [www.smacna.org](http://www.smacna.org)
- Air Diffusion Council ..... [www.flexibleduct.org](http://www.flexibleduct.org)
- Midwest Insulation Contractors Association ..... [www.micainsulation.org](http://www.micainsulation.org)

FIBROUS GLASS DUCT SYSTEMS

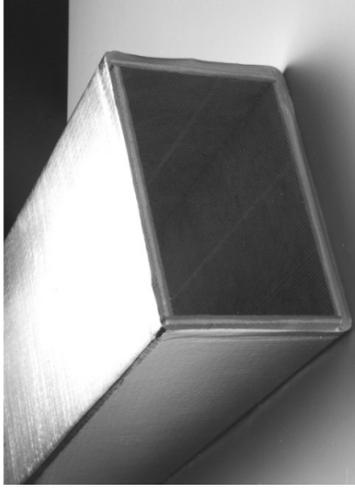


Figure 5. Fibrous glass duct module

**Uses:**

The fibrous glass duct system is used to conserve heating and cooling energy and to control duct-borne noise in commercial, institutional, or residential heating, ventilating, and air-conditioning ductwork operating in the range of ±2 in. w.g. (± 500 Pa) static pressure, up to at least 5,000 fpm (25.4 m/sec) internal air velocity, and internal air temperature between 40°F (4°C) and 250°F (121°C). Ducts are only for indoor use and should be located in areas where ambient temperature does not exceed 150°F (66°C).

**Description:**

The fibrous glass duct system is normally made up of nominal four foot (1.2m) modules which are fabricated from 1, 1 1/2, or 2 in. (25, 38, or 51mm) thick, flat fibrous glass duct board stock having a factory-applied reinforced aluminum exterior air barrier finish. Duct system modules are fabricated using either specially designed hand tools or grooving and closure machines. These modules may have factory shiplapped male and female ends which assure close-fitting, smooth joints when duct sections are joined. Ducts with spans up to 96 in. (2.4m) may be constructed when proper reinforcement is used. Duct fittings such as tees, offsets, elbows, and transitions are also fabricated from these modules or from flat duct board. Equipment such as electric or hot water in-line heaters, manual or powered volume dampers, registers and grilles, diffuser drops, and access doors may be incorporated into a fibrous glass duct system. Fibrous glass duct boards are available with a durable interior surface treatment to enhance cleanliness when NAIMA guidelines are followed.

Fabrication tools are available to produce ten-sided (essentially round) fibrous glass duct modules. Performed round fibrous glass duct is also available in a range of diameters and wall thicknesses up to 2 in. (51mm).

**Features and benefits:**

**Single-component system**

Thermal and acoustical insulation plus essentially air-tight performance are provided with one product installed by a single contractor.

**Factory-controlled insulation thickness**

Factory-controlled insulation thickness assures that specified R-values are met.

**Acoustically efficient**

Fibrous glass insulation absorbs fan and air turbulence noise, reduces popping noises caused by expansion, contraction, and vibration.

**Light weight**

Fibrous glass duct components are easy to fabricate, transport, and install. Compared with metal ductwork, they impose less load on the building structure.

**Essentially air-tight**

Closures made with UL 181A listed pressure-sensitive tape, heat-activated tape, or glass fabric and mastic, save energy by virtually eliminating air leakage.

**Code compliance**

Fibrous glass duct systems qualify under UL 181 as Class 1 Air Ducts, meeting the fire safety requirements of NFPA 90A and 90B including limited combustibility. They also comply with all widely used model codes including ICC, BOCA, CABO, ICBO, and SBCCI.

**Backed by industry standards**

Fabrication and installation standards published by NAIMA and SMACNA help the contractor to provide reliable, long-term system performance.

**Condensation control:**

Figures 20 and 21 show the installed R-values of fibrous glass duct wrap required to prevent moisture condensation on the vapor retarder surface under varying conditions of ambient temperature and relative humidity. Curves are based on cold duct internal temperatures of 55°F (13°C) and no air movement on the external surface.

NOTE: R-values as required by ASHRAE 90.1-1989 may not be sufficient for condensation control, as may be seen in the figures below.

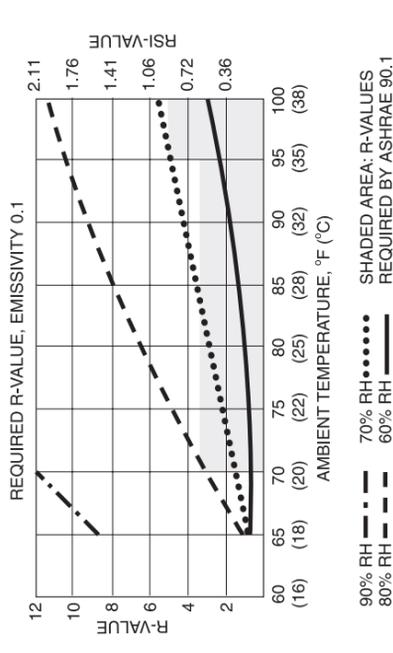


Fig. 20. Required R-value, emissivity 0.1 (FSK)

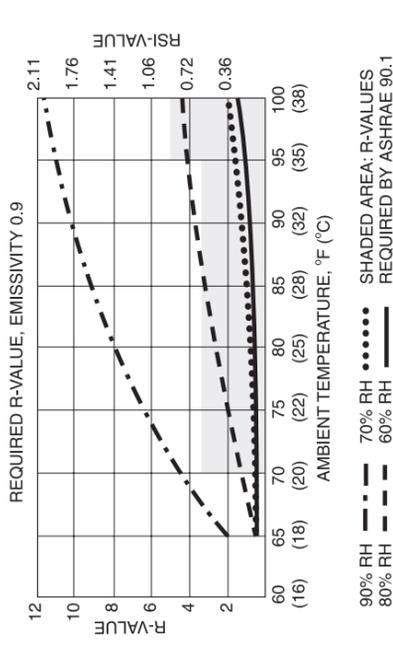


Fig. 21. Required R-value, emissivity 0.9 (vinyl, PSK)

Commonly available R-values as published by manufacturers show fibrous glass duct wrap insulations to perform in the R-value ranges shown in Table 6.

Table 6. Commonly available installed R-values

Thickness in. (mm)	R-value*, hr·ft²·°F/Btu	(RSI, m²·°C/W)
1 (25)	3.1 – 3.6	(0.54 – 0.68)
1 1/2 (38)	4.2 – 6.2	(0.74 – 1.09)
2 (51)	5.6 – 8.3	(0.99 – 1.46)
2 1/2 (64)	6.0 – 7.0	(1.06 – 1.28)
3 (76)	8.3 – 10.3	(1.46 – 1.81)
3 1/2 (89)	10.0 – 12.0	(1.76 – 2.11)
4 (102)	11.2 – 16.6	(2.00 – 3.00)

Thermal values are for insulation only as determined by ASTM C 518 at 75°F (24°C) mean temperature and do not include air films or reflective surfaces. Values are subject to normal manufacturing and testing tolerances.

Note (Figs. 20, 21) that condensation will occur at higher relative humidity. Condensation on the sheet metal duct surface is controlled by using a sealed vapor retarder of sufficient perm rating.

**SHEET METAL DUCTS WITH FIBROUS GLASS INSULATION WRAP**



Fig. 19. Fibrous glass duct wrap with FSK facing

**Uses:**

Fibrous glass duct wrap insulation is designed for application to the exteriors of commercial and residential sheet metal heating, ventilating, and air-conditioning ducts and plenums operating at temperatures between 40°F (4°C) and 250°F (121°C). Duct wrap insulation reduces heat loss or gain through duct walls, conserving energy and controlling moisture condensation. Fibrous glass duct wrap insulations are useful in situations where acoustical performance is not an issue.

**Description:**

Fibrous glass duct wrap insulations are flexible, resilient, light-density blankets of glass fibers factory-laminated to vapor retarder facings. These products are easily cut and fitted to achieve a neat, thermally effective insulation blanket over the exteriors of rectangular, round, oval, or irregularly shaped duct surfaces. They are available in a range of R-values depending on product type, thickness and density.

**Features and benefits:**

**Condensation control**

When installed thickness recommendations are followed, fibrous glass duct wrap insulation installed over sealed sheet metal ducts reduces the likelihood of condensation occurring on the vapor retarder facing, and of moisture damage to ceilings and other interior finishes.

**Enhanced comfort control**

By reducing heat loss or gain through duct walls, conditioned air reaches occupied spaces at temperatures close to design conditions. Central air equipment may therefore be operated at reduced levels, saving energy.

**Flexible, easily installed**

Fibrous glass duct wrap insulation is easily cut to proper fit. For ease of application, a staple flap is provided by the manufacturers.

**Code compliance**

Fibrous glass duct wraps meet the physical property requirements of ASTM C 1290 as well as meeting the fire safety requirements of NFPA 90A and 90B including limited combustibility. They also comply with all widely used model codes including ICC, BOCA, CABO, ICBO, and SBCCI.

**Assured thermal performance:**

When installed in accordance with manufacturers' instructions, fibrous glass duct wraps will provide specified thermal performance as printed on the vapor retarder facing. This is achieved by determining the "stretch-out" cutting dimension required so that, once installed, the duct wrap is not compressed to less than 75% of nominal (out-of-package) thickness.

**Microbial growth resistance:**

Fibrous glass duct systems resist fungal and bacterial growth when tested in accordance with UL 181 and standard practices ASTM G 21-96 (fungus test) and G 22-96 (bacteria test).

**Thermal performance:**

Fibrous glass duct board minimizes heat loss or gain through duct walls, efficiently delivering conditioned air to occupied spaces at or near design temperatures. Values, measured in accordance with ASTM C 518, are shown in Table 1.

**Table 1. Thermal performance**

Thermal values	Thicknesses, in. (mm)	
	1 (25)	1½ (38) 2 (51)
R-value*, hr•ft²•°F/Btu (RSI, m²•°C/W)	4.3 (0.76)	6.5 (1.14) 8.7 (1.53)
k value, Btu•in/hr•ft²•°F (λ, W/m•°C)	0.23 (0.033)	0.23 (0.033) 0.23 (0.033)
C value, Btu/hr•ft²•°F (C, W/m²•°C)	0.23 (1.32)	0.16 (0.88) 0.12 (0.65)

\*Thermal values are for insulation only as determined by ASTM C 518 at 75°F (24°C) mean temperature and do not include air films or reflective surfaces. Values are subject to normal testing and manufacturing tolerances.

**Acoustical performance:**

The fibrous glass insulation absorbs fan and air turbulence noise and reduces the popping noises caused by expansion and contraction. Typical acoustical performance values are shown in Table 2.

**Table 2. Acoustical performance (ASTM C 423)**

Thickness in. (mm)	125	250	500	1000	2000	4000	NRC
1 (25)	.03	.18	.61	.83	.89	.93	.65
1½ (38)	.09	.33	.89	.96	.95	.94	.80
2 (51)	.17	.63	1.08	1.05	1.04	1.06	.95

Type A mounting per ASTM E 795. Consult individual manufacturers for specific acoustical performance data.

**Condensation control:**

Figure 6 shows the R-values of fibrous glass duct board required to prevent moisture condensation on the outer duct surface under varying conditions of ambient temperature and relative humidity. Curves are based on cold duct internal temperatures of 55°F (13°C) and no air movement on the exterior surface.

NOTE: R-values as required by ASHRAE 90.1-1989 may not be sufficient for condensation control, as may be seen in the figure below.

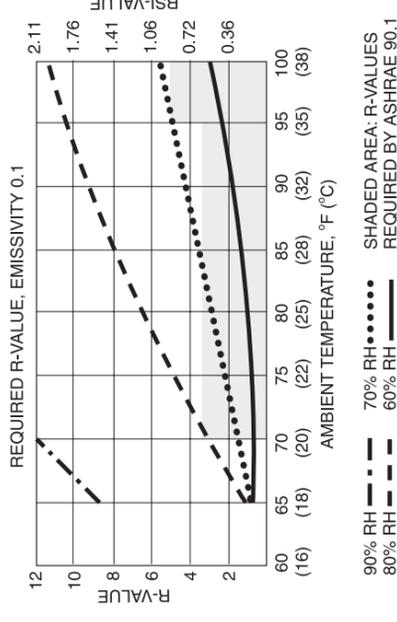


Figure 6. Required R-values to prevent moisture condensation

**Leakage control:**

Fibrous glass duct systems have inherently low leakage. While air duct leakage is a relative concept and air-tightness not an absolute requirement, ducts should be sufficiently air-tight to ensure quiet, economical performance. Duct leakage also reduces the delivered volumes of air at diffusers and grilles; this must be compensated for by increasing the total quantity of supply air. For details on test results, refer to NAIMA Fibrous Glass Duct Construction Standard, current edition.

**Reinforcement:**

Tie rods or sheet metal channels may be used when reinforcement is required to restrain duct wall deflection due to duct span and/or operating pressure. Reinforcement details are found in Section V of the NAIMA Fibrous Glass Duct Construction Standard previously referenced.

**FIBROUS GLASS DUCT SYSTEMS**

**Closure:**

Longitudinal and transverse joints of fibrous glass duct modules are sealed using one of three UL 181A listed closures:

- UL 181A, Part I (P) — Staples and pressure-sensitive aluminum foil tape. 2 1/2 in. (64mm) wide tape may be used in making closures with 1 in. (25mm) duct board. 3 in. (76mm) wide tape is recommended for 1 1/2 in. (38mm) duct board, and is mandatory with 2 in. (51mm) duct board.
- UL 181A, Part II (H) — Heat-activated aluminum foil/scrims tapes, 3 in. (76mm) wide.
- UL 181A, Part III (M) — Mastic reinforced with 3 in. (76mm) wide glass fiber fabric (scrim). This closure system may be required when the system is part of a fire-rated assembly.

**Equipment connections:**

When connecting fibrous glass duct systems to sheet metal components such as equipment flanges, fasteners such as sheet metal screws and washers are used to carry the mechanical load. Mastic and glass fiber fabric are used to seal the connections at these points. However, approved pressure-sensitive aluminum foil tape may be used to seal fibrous glass ducts to sheet metal when operating pressure is less than 1 in. w.g. (250 Pa) and when sheet metal surfaces are cleaned in accordance with tape manufacturers' instructions. Closure details may be found in Section IV of the NAIMA Fibrous Glass Duct Construction Standard.

**The use of non-listed closure materials or techniques voids the UL 181 Class 1 Air Duct rating.**

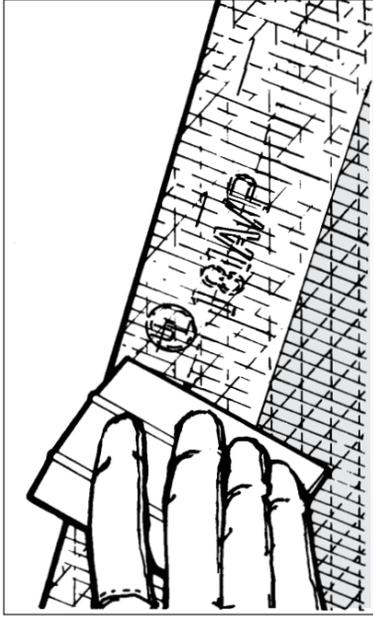


Fig. 7. Closure with pressure-sensitive foil tape

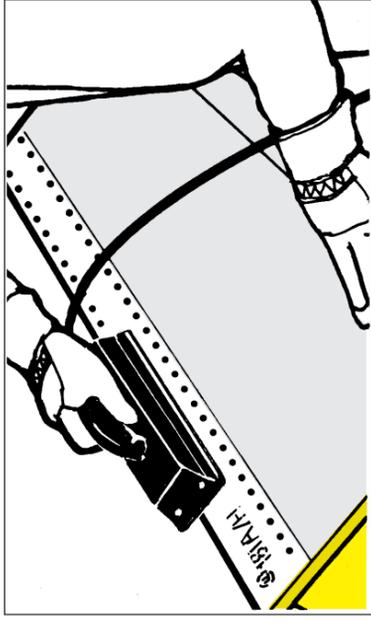


Fig. 8. Closure with heat-activated foil tape

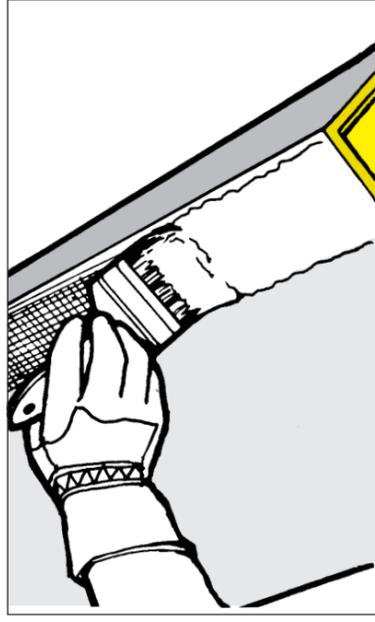


Fig. 9. Closure with glass fiber fabric and mastic

**Condensation control:**

Figure 18 shows the installed R-values of fibrous glass duct liner required to prevent moisture condensation on the outer duct surface under varying conditions of ambient temperature and relative humidity. Curves are based on internal air temperature of 55°F (13°C) and no air movement on the external surface.

NOTE: R-values as required by ASHRAE 90.1-1989 may not be sufficient for condensation control, as may be seen in the figure below.

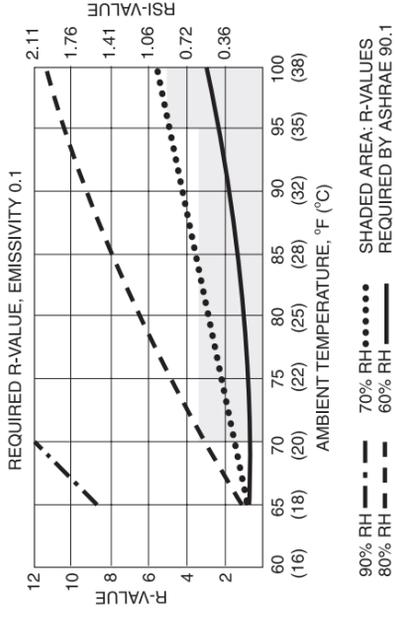


Figure 18. Required R-values to prevent moisture condensation

**Table 5. Commonly available fibrous glass duct liner R-values**

Thickness, in. (mm)	R-value, hr•ft <sup>2</sup> •°F/Btu (RSI, m <sup>2</sup> •°C/W)
<b>Type I</b>	
1/2 (13)	1.9 – 2.2 (0.34 – 0.38)
1 (25)	3.6 – 4.3 (0.63 – 0.77)
1 1/2 (38)	5.4 – 6.3 (0.94 – 1.11)
2 (51)	7.1 – 8.3 (1.26 – 1.47)
<b>Type II</b>	
1 (25)	4.3 (0.76)
1 1/2 (38)	6.2-6.5 (1.10-1.15)
2 (51)	8.3-8.7 (1.47-1.53)

Thermal values are for insulation only as determined by ASTM C 518 at 75°F (24°C) mean temperature and do not include air films or reflective surfaces. Values are subject to normal manufacturing and testing tolerances.

**Short Form Field Inspection Check List**

	YES	NO
• Has duct liner been installed with airstream surface printing visible?	<input type="checkbox"/>	<input type="checkbox"/>
• Does duct liner completely cover all inside surfaces of the system, including fittings?	<input type="checkbox"/>	<input type="checkbox"/>
• Is the duct liner free of visible damage (tears, punctures, abrasions?)	<input type="checkbox"/>	<input type="checkbox"/>
• Is duct certified to comply with ASTM C 1071?	<input type="checkbox"/>	<input type="checkbox"/>
• Has duct liner been adhered to sheet metal with adhesive meeting ASTM C 916?	<input type="checkbox"/>	<input type="checkbox"/>
• Are fasteners of the proper type and properly installed perpendicular to sheet metal?	<input type="checkbox"/>	<input type="checkbox"/>
• Are fastener washers cupped or beveled, installed so as not to cut into duct liner?	<input type="checkbox"/>	<input type="checkbox"/>
• Are fasteners spaced correctly for system air velocity? no more than 1/8 in. (3mm)?	<input type="checkbox"/>	<input type="checkbox"/>
• Do fastener heads or washers compress duct liner no more than 1/8 in. (3mm)?	<input type="checkbox"/>	<input type="checkbox"/>
• Are leading edges and transverse joints factory-coated or are they field-coated with adhesive meeting requirements of ASTM C 916?	<input type="checkbox"/>	<input type="checkbox"/>
• Are transverse joints firmly butted, with no gaps or open seams?	<input type="checkbox"/>	<input type="checkbox"/>
• Are all corner joints compressed and overlapped or folded?	<input type="checkbox"/>	<input type="checkbox"/>
• Are longitudinal joints at corners unless duct size or product dimensions prohibit?	<input type="checkbox"/>	<input type="checkbox"/>
• Are top panels of duct liner board supported by side panels?	<input type="checkbox"/>	<input type="checkbox"/>
• Are all leading edges finished with sheet metal nosing if air velocity requires it?	<input type="checkbox"/>	<input type="checkbox"/>
• If installation is two layer, is second layer securely bonded to first layer?	<input type="checkbox"/>	<input type="checkbox"/>
• Are all sheet metal joints sealed to prevent air leakage?	<input type="checkbox"/>	<input type="checkbox"/>
• Has construction debris been blown or removed from ducts?	<input type="checkbox"/>	<input type="checkbox"/>
• Are sources of potential moisture controlled in order to keep duct liner dry?	<input type="checkbox"/>	<input type="checkbox"/>

**SHEET METAL DUCTS WITH FIBROUS GLASS INSULATION LINER**

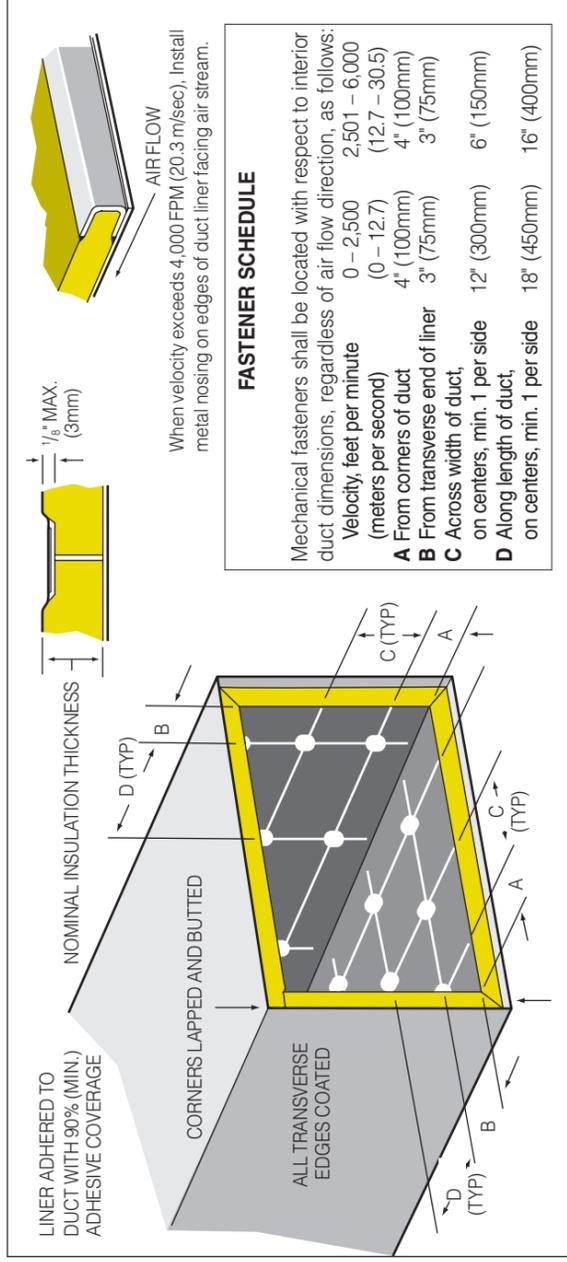


Figure 16. Mechanical fastener spacing for fibrous glass duct liner

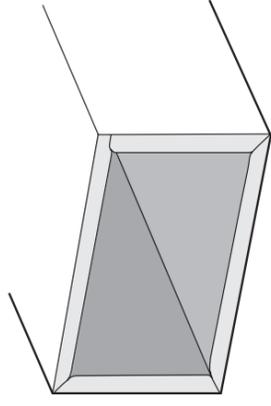


Fig. 17a. Type I duct liner: three corners folded, one corner lapped

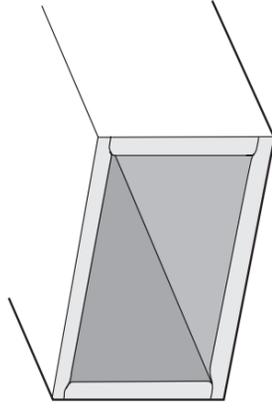


Fig. 17b. Type I duct liner: corners lapped and slightly compressed

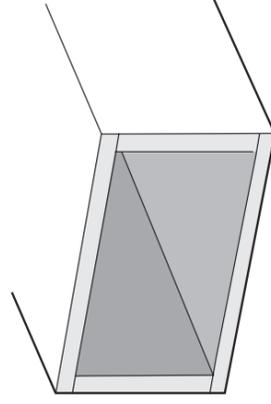


Fig. 17c. Type II duct liner: corners lapped, side pieces supporting top piece

**Hanging and support:**

Fibrous glass ducts are light in weight and can be supported with a minimum of hangers. Care must be taken as to placement of hangers and support. Details may be found in Section VI of the NAIMA Fibrous Glass Duct Construction Standard.

**Note:** NAIMA Fibrous Glass Duct Construction Standard (AH116) is applicable to all types of duct construction. For residential construction, NAIMA Fibrous Glass Residential Duct Construction Standard (AH119) may be used.



Fig. 10. Hand grooving fibrous glass duct board



Fig. 11. Machine grooving fibrous glass duct board

**Short Form Field Inspection Check List (Refer to NAIMA Fibrous Glass Duct Construction Standard for details)**

	YES	NO
• Is duct system static pressure within specified limits?	<input type="checkbox"/>	<input type="checkbox"/>
• Is the EI rating (475, 800, or 1400) printed on the board?	<input type="checkbox"/>	<input type="checkbox"/>
• Are all sheet metal accessories of galvanized steel?	<input type="checkbox"/>	<input type="checkbox"/>
• Is foil closure tape marked UL 181 A-P or UL 181 A-H?	<input type="checkbox"/>	<input type="checkbox"/>
• Is all duct stock labeled UL 181?	<input type="checkbox"/>	<input type="checkbox"/>
• Do glass fabric and mastic closures meet UL 181 A-M requirements?	<input type="checkbox"/>	<input type="checkbox"/>
• Are all seams and joints properly stapled or, where stapling flaps are not available, are tape tabs used, minimum of one per side, 12 in. (300mm) on center?	<input type="checkbox"/>	<input type="checkbox"/>
• Does fitting fabrication meet NAIMA standard requirements?	<input type="checkbox"/>	<input type="checkbox"/>
• Does equipment installation meet NAIMA standard requirements?	<input type="checkbox"/>	<input type="checkbox"/>
• Do reinforcement elements meet NAIMA standard requirements?	<input type="checkbox"/>	<input type="checkbox"/>
• Do hangers and supports meet NAIMA standard requirements?	<input type="checkbox"/>	<input type="checkbox"/>
• Are ducts free from unrepaired tears or punctures?	<input type="checkbox"/>	<input type="checkbox"/>



Fig. 12. Fibrous glass duct closure machine

**SHEET METAL DUCTS WITH FIBROUS GLASS INSULATION LINER**

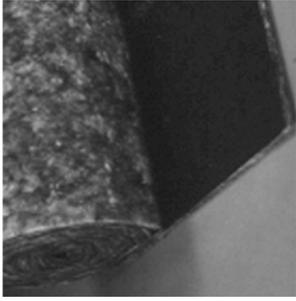


Fig. 13. Fibrous glass duct liner, Type I (flexible)

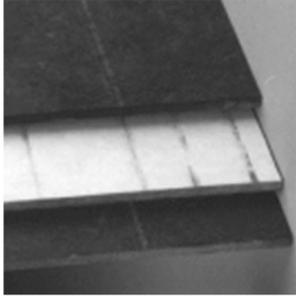


Fig. 14. Fibrous glass duct liner, Type II (rigid)

**Uses:**

Fibrous glass duct liner insulation is designed for application to the interiors of commercial and residential sheet metal heating, ventilating, and air-conditioning ducts operating at internal air temperatures not exceeding 250°F (121°C). Duct liner helps to attenuate noise generated by central air handling equipment, air movement within the ducts, and occupant cross-talk. It also serves to reduce heat loss or gain through sheet metal duct surfaces, and helps to prevent the formation of water vapor condensation both inside the duct and on its exterior surface. Fibrous glass duct liner insulation is fabricated along with the sheet metal ductwork in the shop, providing quality workmanship under controlled conditions.

**Description:**

Fibrous glass duct liner insulations are manufactured from glass fibers bonded with thermosetting resin. They are dimensionally stable, withstand abuse, and provide a cleanable, fire-resistant interior surface designed to minimize friction loss. This interior treatment may be in the form of a coating and/or a mat facing. Two forms are available. Both are designed to meet physical property requirements of ASTM C 1071, *Standard Specification for Duct Lining Insulation (Thermal and Sound Absorbing Material)*:

- **Type I** – Flexible blankets, supplied in roll form; thicknesses of 1/2 to 2 in. (13 to 51 mm) in 1/2 in. (13 mm) increments.
- **Type II** – Rigid boards, supplied in sheet form; thicknesses of 1 to 2 in. (25 to 51mm) in 1/2 in. (13mm) increments.

**Features and benefits:**

**Acoustically effective**

Fibrous glass duct liner absorbs fan and air turbulence noise, reduces noises caused by expansion, contraction and vibration typical of sheet metal ducts.

**Thermally efficient**

Factory controlled insulation thickness assures that specified R-values will be met when installed in accordance with manufacturers' instructions.

**Mat-faced or coated air stream surface**

Fibrous glass duct liner minimizes air friction loss while enabling the insulation to withstand easily the duct cleaning process when NAIMA recommendations are followed.

**Factory-applied edge coating**

This coating saves fabricators the time and cost involved in coating transverse joints to meet industry requirements.

**Bacteria and fungus resistant**

Fibrous glass duct liners resist fungal and bacterial growth when subjected to microbial attack as described in ASTM C 1338, required for airstream surfaces per ASHRAE 62.1-2001; and, additionally, ASTM G 21-96 (fungus test) and G 22-96 (bacteria test), required by ASTM C 1071.

**Code Compliance**

Fibrous glass duct liners meet the physical property requirements of ASTM C 1071 as well as meeting the fire safety requirements of NFPA 90A and 90B including limited combustibility. They also comply with all widely used model codes including ICC, BOCA, CABO, ICBO, and SBCCI.

**Thermal performance:**

ASTM C 1071 establishes the following maximum thermal conductivity values for fibrous glass duct liners at 75°F (24°C). (See Table 3, page 23.)

Table 3. Maximum thermal conductivity values (ASTM C 518)

Fibrous glass duct liner	Apparent thermal conductivity	
	k, Btu•in/hr•ft <sup>2</sup> •°F	(λ, W/m <sup>2</sup> •°C)
Type I, flexible:	0.31	(0.045)
Type II, rigid:	0.27	(0.039)

Thermal values are for insulation only as determined by ASTM C 518 at 75°F (24°C) mean temperature and do not include air films or reflective surfaces. Values are subject to normal manufacturing and testing tolerances.

**Acoustical performance:**

When tested in accordance with ASTM C 423, Mounting A, fibrous glass duct liner insulation shall have sound absorption coefficients not less than those in Table 4.

Table 4. Maximum sound coefficients (ASTM C 423)

Thickness in. (mm)	Sound absorption coefficients, Hz			
	125	250	500	1000 2000 4000 NRC
<b>Type I (Flexible)</b>				
1/2 (13)	.02	.07	.18	.37 .52 .67 .30
1 (25)	.04	.19	.35	.55 .69 .72 .45
1 1/2 (38)	.03	.31	.58	.75 .82 .81 .60
2 (51)	.16	.42	.76	.85 .85 .83 .70

<b>Type II (Rigid)</b>				
1 (25)	.02	.20	.52	.73 .82 .84 .55
1 1/2 (38)	.05	.40	.77	.88 .88 .86 .75
2 (51)	.12	.67	.99	.97 .91 .87 .90

Consult individual manufacturers for specific acoustical performance and/or data on thickness not listed.

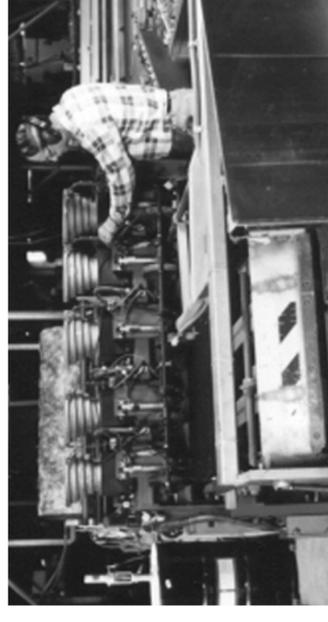


Fig. 15. Shop fabricating with fibrous glass duct liner

**Other properties established by Specification ASTM C 1071:**

**Corrosiveness**

Fibrous glass duct liner shall not corrode stainless steel, copper, or aluminum in contact with duct liner to an extent greater than sterile cotton.

**Temperature resistance**

The air stream surface shall have no evidence of flaming, glowing, smoldering, visible smoke, or delamination, cracking, deformation or reduction in thickness at minimum service temperature of 250°F (121°C).

**Erosion resistance**

The insulation shall not break away, flake off, or show evidence of delamination or continued erosion when air is passed through sections at 2 1/2 times rated air velocity.

**Odor emission**

The insulation shall have no detectable odor of objectionable nature as determined by an odor panel.

**Moisture vapor sorption**

Moisture vapor sorption shall not exceed 3% by weight.

**Installation**

Fibrous glass duct liner insulations are applied to interior surfaces using adhesives complying with the property requirements of ASTM C 916, *Standard Specification for Adhesives for Duct Thermal Insulation*, plus mechanical fasteners designed specifically for this purpose, spaced as shown in Figure 16. All joints and seams in the sheet metal ductwork should be tightly sealed. Corner joints are made as shown in Figures 17a, 17b, 17c.