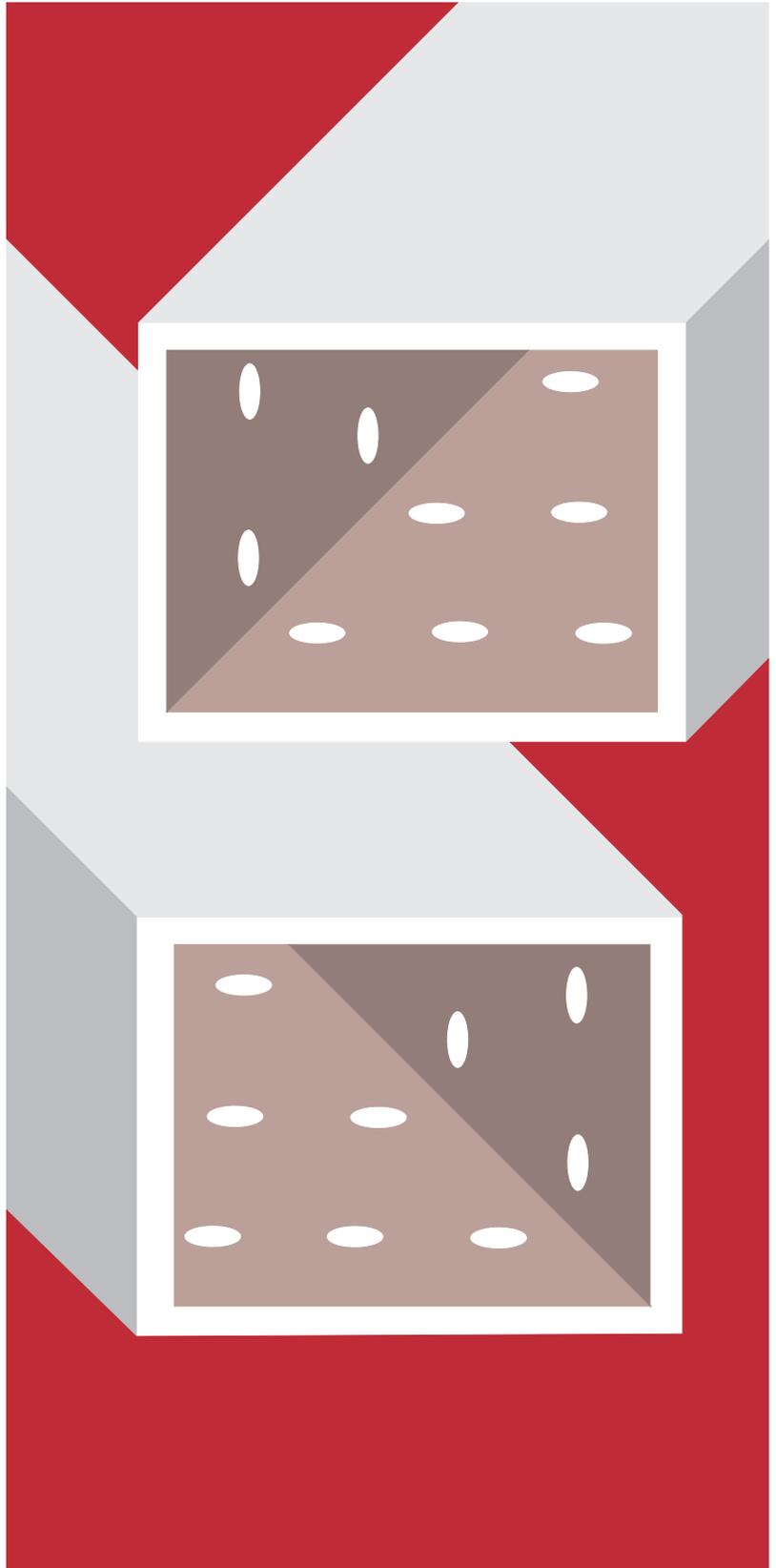


FIBROUS GLASS DUCT LINER STANDARD

***DESIGN,
FABRICATION AND
INSTALLATION
GUIDELINES***

THIRD EDITION, 2002



PREFACE

The North American Insulation Manufacturers Association (NAIMA) presents this Standard as a recommended guideline for the selection, fabrication and installation of fibrous glass duct liner insulations in sheet metal air handling ducts as defined herein. Fibrous glass duct liner insulations are designed for use in air duct systems operating at air velocities not exceeding 6,000 feet per minute (30.5 m/s), or not to exceed rated air velocities for product types as listed by their manufacturers.

This voluntary standard has been prepared to meet the need for detailed information regarding materials, specification, fabrication, and installation of fibrous glass liners. Additionally, brief recommendations are offered regarding the commissioning, operation, and maintenance of fibrous glass lined duct systems so that they may more dependably provide desired acoustical, thermal, and indoor air comfort performance for the system's design service life.

This Standard is intended to expand references to fibrous glass materials and installation methods in *HVAC Duct Construction Standards - Metal and Flexible*, first edition, 1985, seventh printing (1989), published by the Sheet Metal and Air Conditioning Contractors National Association (SMACNA), in particular, pages 2-25 through 2-31.

This Standard was developed using reliable engineering principles and research, plus consultation with and information obtained from manufacturers, contractors, testing laboratories, and others having specialized experience. It is subject to revision as further experience and investigation may show is necessary or desirable. Constructions and products which comply with this Standard will not necessarily be considered acceptable if, when examined and tested, they are found to have other features which impair the result contemplated by this Standard.

The North American Insulation Manufacturers Association assumes no responsibility and accepts no liability for the application of the principles or techniques contained in this manual. **In particular, NAIMA makes no warranty of any kind, express or implied, regarding merchantability or fitness for any particular purpose, in connection with the information supplied herein.** Authorities considering adoption of this Standard should review all Federal, State, local, and contractual regulations applicable to specific installations.

This Standard is not intended to preclude alternate methods and materials of fabrication when such methods and materials can be documented as providing equivalent performance.

This Standard is not intended to address issues relating to thermal or acoustical insulation within and furnished as integral parts of HVAC equipment such as air handling units, coils, air cleaners, silencers, humidifiers, and terminal devices. Manufacturers of such equipment are responsible for design, specification, and installation of appropriate insulation components in their products so that thermal, acoustical, and indoor air quality requirements are met.

The North American Insulation Manufacturers Association extends its thanks to the member companies of its Air Handling Technical Subcommittee who contributed their time and talents in the development of this Standard.

NAIMA Air Handling Member Companies:

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
 1 Knauf Drive, Shelbyville, IN 46176
 800-825-4434

Owens Corning
 One Owens Corning Parkway,
 Toledo, OH 43659
 800-GET-PINK

CONTENTS

Preface 1
 Contents 2
 References 3, 4

SECTION I. DESIGN CRITERIA

Background, Benefits 5
 Properties of Materials per ASTM C 1071 5
 Properties of Duct Liner Adhesives and Fasteners 6
 System Acoustical Performance 7
 Definitions 7
 System Thermal Performance, ASHRAE/IES 90.1-1989 8
 System Thermal Performance, ANSI/ASHRAE/IESNA 90.1-2001 9, 10
 System Thermal Performance, ASHRAE 90.2-2001 11
 Indoor Environmental Quality and Duct Insulation 12
 Fire Safety Considerations 12
 Condensation Control Performance 13
 Design Considerations 14
 Short Form Specification 15
 CSI 3-Part Specification 16, 17

SECTION II. FABRICATION STANDARDS

Application Considerations 18
 Cutting Fibrous Glass Duct Liner 18
 Duct Liner Adhesives 18
 Mechanical Fastening 19
 General Fabrication and Installation Principles 20
 Duct Liner Corner Treatments 21
 Duct Liner Nosing Treatments 21
 Build-out for Installing Turning Vanes and Accessories 22
 Interruption of Duct Liner at Fire Dampers 23

SECTION III. SYSTEM OPERATION

Installing and commissioning lined duct systems 24
 Operation and preventive maintenance of ducts 24
 Cleaning of lined duct systems 25, 26

INSPECTION CHECK LIST FOR FIBROUS GLASS DUCT LINER INSTALLATION 27
FACTS ON FIBROUS GLASS DUCT INSULATION 28, 29

REFERENCES

The following may be used as references when working with information in this Standard. NOTE: Current editions of some references may differ from editions of listed date.

ASHRAE - American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

1791 Tullie Circle, N.E., Atlanta, GA 30329-2305

- 1999 ASHRAE Handbook - Heating, Ventilating, and Air-Conditioning Applications
- 2000 ASHRAE Handbook - Heating, Ventilating, and Air-Conditioning Systems and Equipment
- 2001 ASHRAE Handbook - Fundamentals
- ANSI/ASHRAE Standard 52.2-1999, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
- ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality
- ASHRAE/IES 90.1-1989, Energy Efficient Design of New Buildings Except Low Rise Residential Buildings
- ANSI/ASHRAE/IESNA Standard 90.1-2001, Energy Standard for Buildings Except Low Rise Residential Buildings
- ASHRAE 90.2-2001, Energy Efficient Design of New Low Rise Residential Buildings
- A Practical Guide to Noise and Vibration Control for HVAC Systems: Mark E. Schaffer
- ASHRAE Humidity Control Design Guide For Commercial and Institutional Buildings, ISBN 1-B83413-98-2

ASTM - American Society for Testing and Materials

100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

- ASTM C 167 - Test Methods for Thickness and Density of Blanket or Batt Thermal Insulation
- ASTM C 177 - Test Method for Steady-State Heat Flux Measurement and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
- ASTM C 390 - Criteria for Sampling and Acceptance of Preformed Thermal Lots
- ASTM C 411 - Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation
- ASTM C 423 - Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
- ASTM C 518 - Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

- ASTM C 665 - Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
- ASTM C 916 - Standard Specification for Adhesives for Duct Liner Insulation
- ASTM C 1104/C - 1104M Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation
- ASTM C 1071 - Standard Specification for Duct Lining Insulation (Thermal and Sound Absorbing Material)
- ASTM C 1338 - Test Method for Determining Fungi Resistance of Insulation Materials and Facings
- ASTM E 84 - Test Method for Surface Burning Characteristics of Building Materials
- ASTM E 795 - Practices for Mounting Test Specimens During Sound Absorption Tests
- 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

EPA - Environmental Protection Agency

1200 Pennsylvania Ave., Washington, DC 20460

- Building Air Quality: A Guide for Facility Owners and Building Managers

NAIMA - North American Insulation Manufacturers Association

44 Canal Center Plaza, Suite 310, Alexandria, VA 22314

- Pub. # AH-106, Benefits and Recommended Use of Fibrous Glass Duct Liners
- Pub. # AH-110, Fiber Glass HVAC Insulations: An Essential Component of Indoor IEQ
- Pub. # AH-113, The Facts About Mold Growth
- Pub. # AH-114, The Facts About Airborne Fibers
- Pub. # AH-122, Cleaning Fibrous Glass Insulated Air Duct Systems, Recommended Practice
- Pub. # AH-125, Facts About the Use of Biocides and Encapsulants with Fiber Glass Air Duct Insulations

NFPA - National Fire Protection Association

1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269

- NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems, 1999 Edition
- NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems, 1999 Edition

- NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials
- NFPA 259 – Standard Test Method for Potential Heat of Building Materials, 1993 Edition

SMACNA - Sheet Metal and Air Conditioning Contractors National Association

P.O. Box 221230, Chantilly, VA 22022-1230

- HVAC Duct Construction Standards - Metal and Flexible, Second Edition, 1995
- HVAC Systems Duct Design, Third Edition, 1990
- Ducted Electric Heater Guide for Air Handling Systems, Second Edition, 1994
- Fire, Smoke & Radiation Damper Guide for HVAC Systems, Fourth Edition, 1992
- HVAC Systems Applications, First Edition, 1987
- Indoor Air Quality Manual, Second Edition, 1993

ICC - International Code Council, Inc.

900 Montclair Road, Birmingham, AL 35213-1206

The following International codes replace BOCA and CABO codes as noted:

- International Mechanical Code, 2000
- International Building Code, 2000
- International Residential Code, 2000
- International Energy Conservation Code, 2000

- **BOCA** - Building Officials and Code Administrators International, Inc.

4051 North Flossmoor Road, Country Club Hills, IL 60478-5795

- BOCA National Building Code, 1996 Edition
- BOCA National Mechanical Code, 1996 Edition (Replaced by ICC; see above)

- **CABO** - Council of American Building Officials

5203 Leesburg Pike, Suite 708, Falls Church, VA 22041

- CABO One and Two Family Dwelling Code, 1995 Edition (Replaced by ICC; see above)
- CABO Model Energy Code, 1995 Edition. 1997 Amendments (Replaced by ICC; see above), 1995 Edition (Replaced by ICC; see above)

- **ICBO** - International Conference of Building Officials

5360 Workman Mill Road, Whittier, CA 90601

- Uniform Building Code, 1997 Edition

- Uniform Mechanical Code, 1997 Edition

- **SBCCI** - Southern Building Code Congress International

900 Montclair Road, Birmingham, AL 35213-1206

- Standard Building Code, 1997 Edition

- Standard Mechanical Code, 1997 Edition

Refer to area codes and municipal ordinances for additional specific local requirements for ducted heating and air conditioning systems.

ADDITIONAL REFERENCES

AIA - American Institute of Architects

- Guidelines for Design and Construction of Hospital and Health Care Facilities (ISBN I-57165-002-4), 2001.

AMA - American Medical Association

- Archives of Environmental Health, February 1971, Volume 22: Erosion of Fibers From Installed Fibrous-Glass Ducts: Jacob Cholak, ChE, and Lawrence J. Schafer, BSE(ChE), Cincinnati

AIHA - American Industrial Hygiene Association

- American Industrial Hygiene Association Journal, August 1971, Volume 32, Number 8: Fibrous Glass-Lined Air Transmission Systems: An Assessment of Their Environmental Effects. J. LeRoy Balzer, W. Clark Cooper, M.D., and Douglas P. Fowler, Environmental Health Sciences, School of Public Health, University of California, Berkeley, California 94720

For product design and performance reference data, refer to manufacturers' catalogs and/or data sheets.

SECTION I. DESIGN CRITERIA

A. BACKGROUND

Introduction of forced air heating, ventilating, and air conditioning systems established the need for duct insulation. A forced air duct system is designed to be a conduit for supply and return of conditioned air to and from occupied spaces of a building. It is insulated to control duct-borne noise, to reduce heat loss or gain through metal duct walls, and to minimize water vapor condensation. An internally lined duct system conveys conditioned air quietly to occupied spaces at design temperature and humidity.

B. BENEFITS

A sealed sheet metal duct system with fibrous glass duct liner provides outstanding performance in these ways:

- Fibrous glass duct liners attenuate the noises generated by HVAC equipment, air velocity, and occupant cross-talk.
- Fibrous glass duct liners reduce heat loss or gain through sheet metal duct surfaces.
- Fibrous glass duct liner thermal performance, in combination with sealed sheet metal duct surfaces acting as an air and vapor retarder, helps to prevent the formation of water vapor condensation inside the duct as well as on its outside surface.
- Exterior surfaces of metal duct systems with fibrous glass liners protect the insulation from abuse.
- Fibrous glass duct liners may be fabricated along with the sheet metal ductwork in the shop, allowing for quality workmanship under controlled conditions.

C. PROPERTIES OF MATERIALS

1. FIBROUS GLASS DUCT LINERS

TYPES: Fibrous glass duct liners are manufactured of 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: (1) flexible blankets supplied in rolls; (2) rigid boards supplied in sheet form.

PROPERTIES: Fibrous glass duct liners are designed to meet physical property requirements of ASTM C 1071, *Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)*. This specification defines the two types of duct liner described above: Type I - Flat, in roll form; Type II - Flat, in sheet form.

Acoustical performance: When tested in accordance with ASTM C 423 (Mounting A), duct liner insulation shall have sound absorption coefficients not less than those in the table below:

| Thickness inches (mm) | Sound absorption coefficients at octave band center frequencies, Hz | | | | | | |
|--------------------------|--|-----|-----|------|------|------|-----|
| | 125 | 250 | 500 | 1000 | 2000 | 4000 | NRC |
| TYPE I | | | | | | | |
| 1/2 (13) | .02 | .07 | .18 | .37 | .52 | .67 | .30 |
| 1 (25) | .04 | .19 | .35 | .55 | .69 | .72 | .45 |
| 1 1/2 (38) | .08 | .31 | .58 | .75 | .82 | .81 | .60 |
| 2 (51) | .16 | .42 | .76 | .85 | .85 | .83 | .70 |
| TYPE II | | | | | | | |
| 1 (25) | .02 | .20 | .52 | .72 | .82 | .84 | .55 |
| 1 1/2 (38) | .05 | .40 | .77 | .88 | .88 | .86 | .75 |
| 2 (51) | .12 | .57 | .90 | .95 | .95 | .92 | .85 |

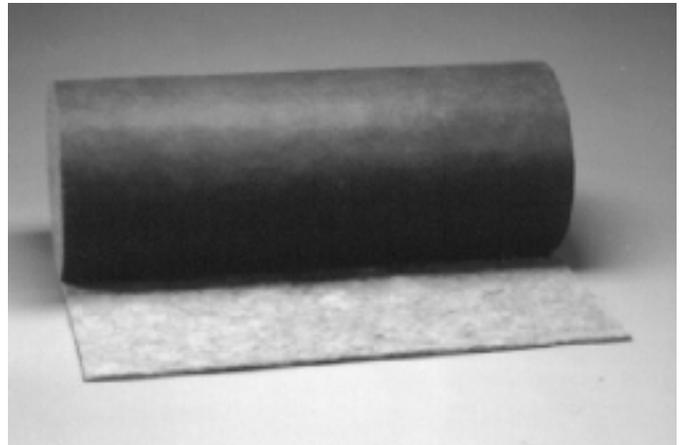


Fig. I-1. Flexible fibrous glass duct liner, Type I

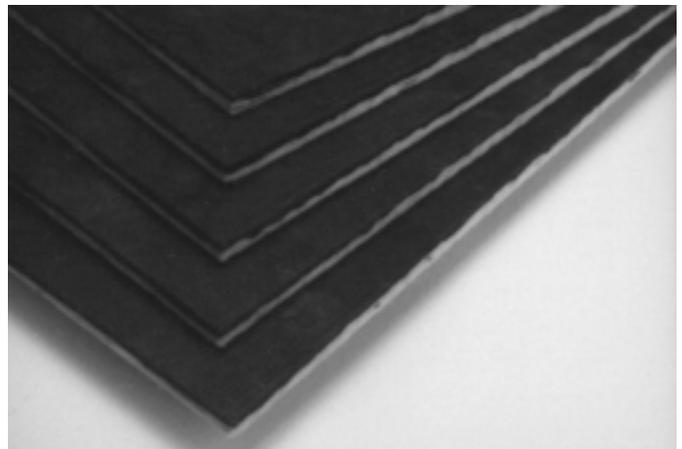


Fig. I-2. Rigid fibrous glass duct liner - Type II

Other properties defined by ASTM C 1071:

ASTM C 1071 also establishes the following property requirements and methods of testing for fibrous glass duct liner:

- Corrosiveness - When tested in accordance with ASTM C 665, the metal plate in contact with the back side (non-air surface side) of the insulation shall show no corrosion greater than the comparative plates in contact with sterile cotton which has been tested in the same manner.
- Water vapor sorption - When tested in accordance with ASTM C 1104, the water vapor sorption of the insulation shall not be more than 3% by weight.
- Fungi resistance - When tested in accordance with ASTM C 1338, the insulation shall be observed as having no fungal growth.
- Temperature resistance - When tested in accordance with ASTM C 411, the air stream surface shall have no evidence of flaming, glowing, smoldering, visible smoke, or delamination, cracking, deformation or reduction of thickness.
- Erosion resistance - When tested in accordance with ASTM C 1071, the insulation shall not break away, crack, peel, flake off, or show evidence of delamination or continued erosion when air is passed through typical duct sections at test air velocity of 2.5 (+ 5%) times the product's rated maximum use velocity.
- Odor emission - When tested in accordance with ASTM C 1304, a detectable odor of objectionable nature recorded by more than two of the five panel members shall constitute failure of the material.
- Surface burning characteristics - When tested in accordance with ASTM E 84,* the air stream surface of the insulation shall have a maximum flame spread index of 25* and a maximum smoke developed index of 50. (NOTE: Adhesive used to adhere the insulation to the interior of the sheet metal duct shall have flame spread and smoke developed ratings no greater than 25 / 50.)
- Combustion characteristics – When tested in accordance with NFPA Standard 259, the material shall have a potential heat value not exceeding 3500 Btu/lb (8141 kJ/kg).

- Apparent thermal conductivity - When tested in accordance ASTM C 177 or ASTM C 518, the apparent thermal conductivity of the insulation at the specified thickness shall not exceed the following values:

Type I - 0.31 Btu·in/hr·ft²·°F ($\lambda = 0.045 \text{ W/m}\cdot\text{°C}$)
Type II - 0.27 Btu·in/hr·ft²·°F ($\lambda = 0.039 \text{ W/m}\cdot\text{°C}$)

*This standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire-hazard or fire-risk assessment of the materials, products, or assemblies under actual fire conditions. Values are reported to the nearest 5 rating.

2. DUCT LINER ADHESIVES

Adhesives complying with ASTM C 916 for use with fibrous glass duct liners are either solvent or water based. Adhesives are classified according to their flammability in both wet and dry states. Designers shall specify only those adhesives that meet construction and code requirements and shall assure themselves that adhesives specified possess acceptable fire hazard classification values under installed conditions. Installers should carefully follow ventilation, storage and other precautions published by manufacturers of these adhesives.

3. DUCT LINER FASTENERS

In addition to adhesives, mechanical fasteners are required when installing fibrous glass duct liners. Two types of fasteners are in general use:

- Mechanically secured (see Fig. I-3). These hardened steel fasteners form positive mechanical attachments to the sheet metal; they are impact-driven into the duct.
- Weld-secured (see Figs. I-4 and I-5). These are attached to the duct by resistance or capacitance discharge welding processes. Correct adjustment of welding equipment, especially timing devices, is necessary to obtain a solid weld without burn-through.

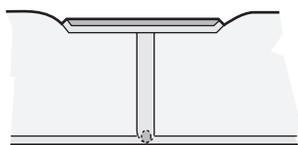


Fig. I-3. Clinched pin, impact applied, integral head

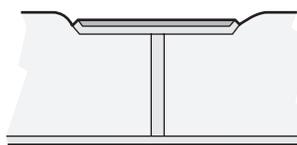


Fig. I-4. Welded pin, integral head

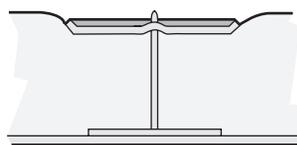


Fig. I-5. Welded pin, press-on head

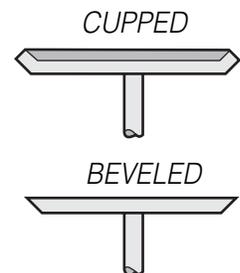


Fig. I-6. Head types

Fastener heads or washers shall have a minimum area of 0.75 in.² (480mm²) and a minimum thickness of 0.010" (0.25 mm), and shall have either cupped or beveled heads as shown in Figure I-6. When installed, they shall not compress the insulation more than 1/8" (3mm) based on the nominal insulation thickness.

Adhesive fasteners are also available. These have a large base for use with an adhesive. Due to uncertain long term adhesive aging characteristics, before being specified for use with fibrous glass duct liners, adhesive fasteners should be carefully evaluated for long term performance in the intended application.

D. SYSTEM ACOUSTICAL PERFORMANCE

Fibrous glass duct liners have been proven to be among the most efficient and cost-effective ways to reduce duct-borne noise. The sound absorbing property of fibrous glass duct liners provides attenuation of noise from HVAC equipment, air flow, and cross-talk.

Sheet metal ductwork can act as speaker tubes transmitting noise throughout the duct system and into the occupied spaces. The direction of air flow has little to do with the direction of noise transmitted. Sound can be transmitted both upstream and downstream from the source.

HVAC equipment is a major source of unwanted noise in a building. Noise generated by mechanical equipment, as well as by other sources, must be considered in relation to the overall indoor environmental quality of a building. A proper acoustical environment is as important for occupant comfort as are other environmental factors controlled by air-conditioning systems.

Selection of duct liner thickness depends on the duct dimensions, predominant frequencies, and the amount of sound attenuation required. Providing basic noise control principles are understood, adequate noise control in a duct system with fibrous glass duct lining materials is not difficult to achieve during the design of the system.

Detailed information can be found in ASHRAE's 2000 *Handbook of Fundamentals* and 2000 *HVAC Applications Handbook*, and in SMACNA's *HVAC Systems Duct Design Manual*.

DEFINITIONS

The following definitions are related to the determination of acoustical performance of fibrous glass duct liners.

Frequency - the number of cycles per second measured in units of Hertz (Hz). A frequency of 1,000 Hz means 1,000 cycles per second.

Insertion loss - of a silencer or other sound-reducing element, in a specified frequency band, the decrease in sound power level, measured at the location of the receiver, when a sound insulator or a sound attenuator is inserted in the transmission path between the source and the receiver.

Noise reduction coefficient - a single number rating derived from measured values of sound absorption coefficients in accordance with 11.7 of Test Method ASTM C 423. It provides an estimate of the sound absorptive property of an acoustical material.

Octave band - A frequency band with an upper frequency limit equal to twice the lower limit.

Sound absorption - (1) the process of dissipating sound energy, (2) the property possessed by materials, objects and structures such as rooms of absorbing sound energy.

Sound absorption coefficient (dimensionless) - of a surface in a specified frequency band, the measure of the absorptive property of a material as approximated by Test Method ASTM C 423. Ideally, it is the fraction of the randomly incident sound power absorbed or otherwise not reflected.

Sound attenuation - the reduction of the intensity of sound as it travels from the source to a receiving location. Sound absorption is often involved as, for instance, in a lined duct.

ASTM C 423 Type A mounting - Test specimen laid directly against the test surface.

E. SYSTEM THERMAL PERFORMANCE

Fibrous glass duct liners applied to sheet metal ducts contribute to energy efficiency by controlling heat loss or gain through duct walls, as well as helping to control moisture condensation.

1. Energy Conservation Standards

a. ASHRAE/IES 90.1-1989, Energy Efficient Design of New Buildings Except Low Rise Residential Buildings

A widely accepted energy standard is ASHRAE/IES Standard 90.1-1989, Energy Efficient Design of New Buildings Except Low Rise Residential Buildings. This 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 recommended thermal resistance (R) values for air ducts, plenums, and enclosures based on the design temperature differential (TD) between the air in the duct and the duct surface in degrees F. Table 1 shows these recommended 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.

TABLE 1. MINIMUM DUCT INSULATION (a)

| Duct Location | Cooling (b) | | Heating (c) | | |
|--|--|-----------------------------------|--|-----------------------------------|-----------|
| | Annual cooling degree days, base 65°F (18°C) | Insulation R-value (d) IP (SI) | Annual heating degree days, base 65°F (18°C) | Insulation R-value (d) IP (SI) | |
| Exterior of building | | | | | |
| | Below 500 (below 276) | 3.3 (0.6) | Below 1,500 (below 833) | 3.3 | (0.6) |
| | 500-1,150 (278-639) | 5.0 (0.9) | 1,500-4,500 (833-2,500) | 5.0 | (0.9) |
| | 1,151-2,000 (639-1,111) | 6.5 (1.1) | 4,501-7,500 (2,500-4,167) | 6.5 | (1.1) |
| | Above 2,000 (1,111) | 8.0 (1.4) | Above 7,500 (4,167) | 8.0 | (1.4) |
| Inside of building envelope or in unconditioned space (g) | | | | | |
| TD (e) ≤ 15°F | (TD = ≤ 8.3°C) | None required | | None required | |
| 40°F ≥ TD > 15°F | (22°C ≥ TD > 8.3°C) | 3.3 | (0.6) | 3.3 | (0.6) |
| TD > 40°F | (TD > 22°C) | 5.0 | (0.9) | 5.0 | (0.9) (f) |

- (a) Insulation 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.
- (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 9.4.1) between the space within which the duct is located and the design air temperature in the duct.
- (f) Insulation resistance for runouts to terminal devices less than 10 ft (3.05 m) in length need not exceed R-value of 3.3 (0.6).
- (g) Unconditioned spaces include crawl spaces and attics.

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, the American Society of Heating, Refrigerating, and Air Conditioning Engineers; it was co-sponsored by both the American National Standards Institute (ANSI) and the Illuminating Engineering Society of North America. It supersedes

ASHRAE/IES 90.1-1989. 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 below and 6.2.4.2B on page 10.

TABLE 6.2.4.2A. MINIMUM DUCT INSULATION R-VALUE,^(a) COOLING AND HEATING ONLY SUPPLY DUCTS AND RETURN DUCTS

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

(a) Insulation R-values, measured in (hr•ft²•°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. 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, COMBINED HEATING AND COOLING DUCTS

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

- (a) Insulation R-values, measured in (hr•ft²•°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. 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.

b. ANSI/ASHRAE 90.2-1993, Energy Efficient Design of New Low Rise Residential Buildings

This National Voluntary Consensus Standard was developed by ASHRAE for residential construction. It includes energy-efficient design requirements for HVAC systems and equipment intended to improve utilization of energy in low-rise residential construction.

Its recommended R-values, based on climatic zones, generally call for greater duct insulation thicknesses than those recommended by ASHRAE/IES 90.1-1999. Some code jurisdictions in the United States have already adopted its R-value recommendations. Some have extended its applicability to commercial HVAC construction; others have adopted even more stringent energy conservation standards.

TABLE 1. MINIMUM DUCT INSULATION – RESIDENTIAL CONSTRUCTION

| Duct Location | Climatic Zone ⁽¹⁾ | Insulation levels, * hr•ft ² •°F/Btu (m ² •°C/W) | |
|---|---|--|------------|
| | | Heating | Cooling |
| On roof or building exterior | I, II, III | R-6 (1.06) | R-6 (1.06) |
| Attic or garage | I | R-4 (0.70) | R-4 (0.70) |
| | II | R-6 (1.06) | R-6 (1.06) |
| Basement under insulated floor or crawl space | II | R-6 (1.06) | R-6 (1.06) |
| | I | R-4 (0.70) | R-4 (0.70) |
| | II | R-4 (0.70) | R-4 (0.70) |
| | III | R-6 (1.06) | R-6 (1.06) |
| Concrete slab or within ground:** | See Installation Techniques for Perimeter Heating and Cooling Systems, Manual 4, Air Conditioning Contractors of America (ACCA) | | |
| ⁽¹⁾ Climatic zone values: | Heating (Degree Days) | Cooling (Cooling Hours) | |
| Zone I | Below 3,000 (Below 1,667) | Below 15,000 (Below 8,333) | |
| Zone II | 3,001-6,000 (1,667-3,333) | 15,001-30,000 (8,333-16,667) | |
| Zone III | Over 6,000 (Over 3,333) | Over 30,000 (Over 16,667) | |

* Values are for insulation only and do not include air films. Except when required for condensation, duct insulation is not required when ductwork is within the conditioned space, where supply or return ducts are used for heating only and are installed in basements or unvented crawl spaces having insulated walls, or on exhaust air ducts.

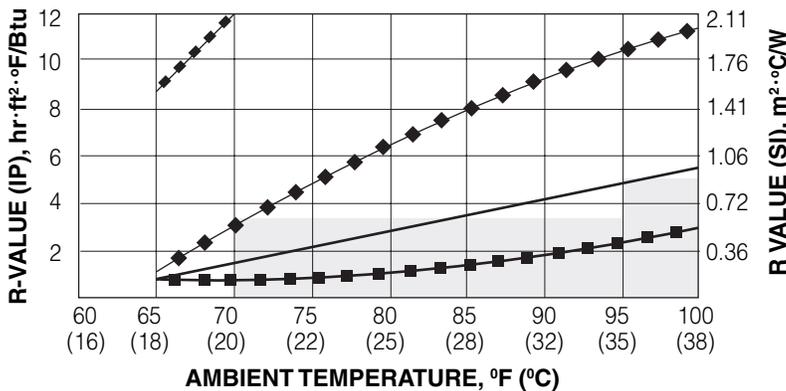
** Neither rigid fibrous glass duct systems nor most types of flexible duct are suitable for this application.

F. CONDENSATION CONTROL PERFORMANCE

Fibrous glass duct liners are effective in helping to control moisture condensation on both interior and exterior surfaces of sheet metal ductwork. This helps the insulation to stay dry, maintaining its full thermal efficiency. It also helps to prevent damage to ceilings and other building components caused by condensation dripping from ductwork.

The charts below show installed R-values of fibrous glass duct liner required to prevent moisture condensation on the outside surface of the duct under varying conditions of ambient temperature and relative humidity. Curves are based on cold duct internal temperature of 55°F (13°C), no wind.

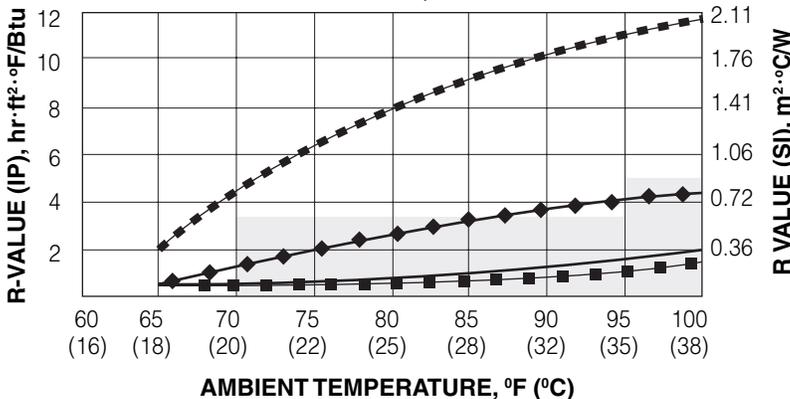
REQUIRED R-VALUE, EMISSIVITY 0.1



90% RH ———
80% RH —◆—
70% RH ———
60% RH —■—

SHADED AREA: R-VALUES REQUIRED BY ASHRAE 90.1 - 1989

REQUIRED R-VALUE, EMISSIVITY 0.9



90% RH ———
80% RH —◆—
70% RH ———
60% RH —■—

SHADED AREA: R-VALUES REQUIRED BY ASHRAE 90.1 - 1989

G. INDOOR ENVIRONMENTAL QUALITY AND DUCT INSULATION

When properly designed, installed, operated and maintained, air transmission systems with fibrous glass duct liners can enhance indoor environmental quality by controlling heat loss or gain while reducing condensation and providing control of duct-borne noise.

Tests on fibrous glass duct liners have not indicated significant fiber contribution to the occupied space. In fact, test samples contained fewer fibers than values reported for outdoor ambient air. Reviewing a number of major studies, the World Health Organization's International Programme on Chemical Safety (1988) concluded: "The contribution of fibrous-glass-lined air transmission systems to the fibre content of indoor air is insignificant."

It is vital that HVAC systems be properly designed, installed, operated and maintained, to minimize moisture carry-over from humidifiers and/or cooling coils by the air stream into the duct system. High efficiency filtration should be selected and regularly maintained to reduce dirt accumulation in the duct system and the possibility of microbial contamination. Condensate drains must also be inspected to assure that they are operating properly.

H. FIRE SAFETY CONSIDERATIONS

Excerpts from NFPA Standard 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*, 1999 Edition

DEFINITIONS:

Air Duct Lining. Air duct lining includes materials such as adhesive, insulation, coating, and film used to line the inside surface of an air duct, fan casing, or duct plenum. Air ducts shall be constructed of materials, reinforced and sealed to satisfy the requirements of use of the air duct system such as supply air systems, return or exhaust air systems, and variable volume/pressure air systems.

Limited Combustible Material. A building construction material not complying with the definition of noncombustible material, which, in the form in which it is used, has a potential heat value not exceeding 3,500 Btu/lb (8141 kJ/kg) where tested in accordance with NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, and complies with (a) or (b):

(a) Materials having a structural base of noncombustible material, with a surfacing not exceeding a thickness of $\frac{1}{8}$ " (3.2 mm), that has a flame spread index not greater than 50.

(b) Materials, in the form and thickness used, other than as described in (a), having neither a flame spread index greater than 25 nor evidence of continued progressive 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 index greater than 25 nor evidence of continued progressive combustion.

Materials subject to increase in combustibility or flame spread index beyond the limits herein established through the effects of age, moisture, or other atmospheric condition shall be considered combustible.

When supplementary materials such as duct coverings, duct linings, vapor barrier facings, fasteners, tapes, and core materials added to air ducts, plenums, panels, and duct silencers are to be applied with adhesives, they shall be tested with such adhesives applied, or the adhesives used shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when in the final dry state.

Air duct, panel and plenum linings shall not flame, glow, smolder or smoke when tested in accordance with similar test for pipe covering, 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 250°F (121°C).

Air duct linings shall be interrupted at fire dampers so as not to interfere with the operation of these devices. (See page 23 for installation details.)

I. DESIGN CONSIDERATIONS

When determining the application of fibrous glass duct liner in an air duct system, the designer should consider:

1. USES SUBJECT TO INDICATED PRECAUTIONS

- Duct liner should only be used in systems where operating temperatures will not exceed 250°F (121°C).
- To avoid contact with liquid water, duct liner shall be protected by use of a sheet metal sleeve and drip pan adjacent to such equipment as evaporative coolers, humidifiers, cooling coils, and outside air intakes.
- When duct systems run through unconditioned space and are used for cooling only, register openings must be tightly sealed during the heating season to prevent accumulation of water vapor in the duct system.
- To avoid damage to the duct liner due to the physical abuse caused by maintenance personnel working in accessible plenums, some means of duct liner protection must be considered.
- Lined ductwork supplying clean rooms should have terminal filtration of the efficiency required for the particular class of clean rooms.

2. APPLICATION LIMITATIONS

The use of fibrous glass duct liner is not recommended for the following applications:

- With equipment of any type which does not include automatic maximum temperature controls and where an operating temperature of 250°F (121°C) may be exceeded.
- In kitchen or fume exhaust ducts, or ducts conveying solids or corrosive gases.
- With coal or wood fueled equipment.
- In any application where the duct liner may come in direct contact with liquid water (such as cooling coils, humidifiers, evaporative coolers) unless protected from the water source.
- Inside fire damper sleeves. (See page 23 for details of duct liner interruption at fire dampers.)
- Immediately adjacent to high temperature heating coils without radiation protection.
- In systems supplying operating rooms, delivery rooms, recovery rooms, nurseries, isolation rooms, and intensive care.

DUCT LINER SPECIFICATIONS

Short Form Specification

All heating, cooling, and ventilation supply and return ducts operating at a maximum air velocity of 6,000 FPM (30.5 m/sec) and service temperature not exceeding 250°F (121°C) or lower than 40°F (4°C) shall be lined with duct liner having an airstream surface treatment. The duct liner shall meet the requirements for life safety as set forth in NFPA 90A and 90B, and shall conform to the requirements of ASTM Specification C 1071.

Duct liner shall be installed in accordance with the latest edition of North American Insulation Manufacturers Association *Fibrous Glass Duct Liner Standard* (NAIMA FGDLS) or Sheet Metal and Air Conditioning Contractors National Association *HVAC Duct Construction Standard, Metal & Flexible* (SMACNA HVAC DCS). Liner shall be installed with the labeled or printed surface exposed to the air stream. Subject to the specified application limitations, all interior surfaces of all ductwork and fittings shall be completely covered with duct liner, except where required by codes (as in areas of fire dampers or electric heaters).

Adhesive shall be applied to the sheet metal with a minimum coverage of 90%. All transverse edges not receiving sheet metal nosing shall be coated. Longitudinal joints in duct liner should occur at the corners of ducts. However, duct size and standard duct liner product dimensions may make exposed longitudinal joints necessary. In such cases, the exposed joints shall be coated with an adhesive or coating designed for duct liner application, and additionally secured with mechanical fasteners in accordance with NAIMA FGDLS as if it were a transverse joint. Adhesive shall meet the requirements of ASTM C 916.

All joints shall be neatly butted. All rips and tears on the air stream surface shall be repaired by coating damaged areas with approved adhesive or coating, or damaged duct liner shall be replaced. Longitudinal corner joints may be folded and/or overlapped and compressed.

Mechanical fasteners shall be used to secure the duct liner to the sheet metal, and shall be spaced in accordance with NAIMA FGDLS or SMACNA HVAC DCS. These may be either impact-driven or weld-secured.

Mechanical fasteners shall be installed perpendicular to the duct surface and shall not compress the insulation more than $\frac{1}{8}$ " (3mm) based on the nominal insulation thickness.

Metal nosings (either channel or zee profile) shall be securely installed over transverse liner edges facing the air stream at fan discharge and any interval of lined duct preceded by unlined duct. In addition, where velocities exceed 4,000 FPM (20.3 m/sec), metal nosing shall be installed on upstream edges of lined duct sections.

CSI 3-Part MASTERFORMAT® Specification
SECTION 15812
**Sheet Metal Ducts - Acoustical Lining Insulation
Commercial/Residential Duct Systems**
PART 1.00 - GENERAL
1.01 Scope

A. The 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 commercial or residential air duct systems of sheet metal lined with fibrous glass duct liner, 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 velocities not exceeding rated duct liner limitations and internal air temperature not exceeding 250°F (121°C) nor below 40°F (4°C).

2. Duct liner products shall conform to the requirements of ASTM C 1071.

3. The manufacturer's product identification shall appear on the air stream surface.

4. Duct liner adhesive shall conform to the requirements of ASTM C 916.

5. The finished duct system shall meet the requirements of NFPA 90A and 90B including:

- It shall be rated for maximum operating temperature of 250°F (121°C) per ASTM C 411.
- It shall have a flame spread index not greater than 25 and a smoke developed index not greater than 50 per NFPA 255 (ASTM E 84).
- It shall have a potential heat value not greater than 3500 Btu/lb (8141 kJ/kg) per NFPA 259.
- It shall have no microbial growth when tested per ASTM C 1338, ASTM G 21-96 (fungus test) and ASTM G 22-96 (bacteria test).

Marking on the airstream surface of the duct liner shall provide evidence of compliance.

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 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. Deliver all materials and/or fabricated, insulated duct sections and fittings to the job site and store in a safe, dry place.

B. Protect materials from dust, dirt, moisture, and physical abuse before and during installation. Replace wet, contaminated duct liner.

PART 2.00 - PRODUCTS
2.01 Insulated Duct System

A. Insulate all supply ducts, return ducts, and related fittings 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" (13mm to 51mm) in 1/2" (13mm) increments. Maximum thermal conductivity at 75°F (24°C) mean temperature: 0.31 Btu·in/hr·ft²·°F ($\lambda = 0.045$ W/m·°C).

2. Type II - Flat, in sheet form, in thicknesses of 1", 1 1/2", and 2" (25mm, 38mm, and 51mm).

Maximum thermal conductivity at 75°F (24°C) mean temperature: 0.27 Btu·in/hr·ft²·°F ($\lambda = 0.039$ W/m·°C).

The duct liner shall have an airstream surface treatment.

PART 3.00 - EXECUTION
3.01 Inspection

A. 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. Cover completely with duct liner all portions of duct designated to receive duct liner. Neatly butt all joints. Install duct liner with the labeled or printed surface exposed to the air stream.

B. Adhere duct liner to sheet metal with 90% (min.) coverage of adhesive complying with requirements of ASTM C 916.

C. Coat all transverse edges not receiving sheet metal nosing. Longitudinal joints in duct liner should occur at the corners of ducts. However, duct size and standard duct liner product dimensions may make exposed

longitudinal joints necessary. In such cases, coat exposed joints with adhesive designed for duct liner application. Adhesive shall meet requirements of ASTM C 916. Additionally secure such joints with mechanical fasteners in accordance with NAIMA FGDLs as if they were transverse joints.

D. Additionally secure duct liner with mechanical fasteners, either weld-secured or impact-driven. Mechanical fasteners shall not compress the insulation more than $\frac{1}{8}$ " (3 mm) based on nominal insulation thickness, and shall be 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.² (480mm²) with beveled or cupped edges.

E. Securely install metal nosings (either channel or zee profile) over transverse liner edges facing the airstream at fan discharge and at any point where lined duct is preceded by unlined duct. In addition, where air velocities exceed 4,000 FPM (20.3 m/sec), install metal nosing on upstream edges of lined duct sections.

F. Fold duct liner in roll form and compress in the corners of rectangular duct sections, or cut and fit to assure a lapped, compressed corner joint.

G. Cut and fit duct liner in sheet form to assure tight, overlapped corner joints. Install so top pieces of rigid duct liner are supported at the edges by the 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. Adhere first layer of duct liner to the sheet metal in the usual manner.
2. Adhere top layer of duct liner to bottom layer using a minimum of 90% adhesive coverage.
3. Use mechanical fasteners of the proper length for the double layer of duct liner.
4. Treat the leading edges of double layer duct linings to prevent separation of the two layers in accordance with requirements for single layer applications (determined by service air velocity).

3.03 Inspection

A. Upon completion of installation of lined duct and before HVAC system start-up, visually inspect the ductwork and verify that duct liner has been correctly installed. Confirm that the duct system is free from construction debris.

3.04 Commissioning

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

1. Check all registers, grilles, and diffusers to ensure that they are clean and free from construction debris.
2. Check all filters in accordance with their manufacturers' instructions. Use specified grade of filters at all times system is operating.
3. Cover supply openings with filter media prior to system start-up to catch any loose material that may remain inside the ductwork.
4. Turn the HVAC system on and allow it to run until steady state operation is reached.
5. Remove the temporary filter media from supply openings and, along with it, any loose material blown downstream and caught by the filter media.
6. Check to ensure that air delivery performance meets all requirements and complies with SMACNA leakage specifications.

3.05 Safety Precautions

A. Conduct all job site operations 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.

SECTION II. FABRICATION STANDARDS

A. Application considerations

This Standard is based on the presumption that the duct system designer has:

1. Clearly designated on contract drawings the sections of ductwork to be lined;
2. Specified the type and thickness of duct liner to be installed, and adhesive to be used;
3. Determined that the specified duct liner has the thermal, acoustical, friction loss, and other performance characteristics required for the application;
4. Provided for condensation control where interruptions of lined ductwork might cause a problem.

B. Cutting fibrous glass duct liner

Fibrous glass duct liner may be cut:

1. By hand, with a utility knife or other suitable sharp knife (see Fig. II-1). Knives specifically designed for cutting duct liner are available from several manufacturers.
2. By machines, such as automated coil line equipment (see Fig. II-2). Many different types of coil line equipment exist; follow cutting recommendations of the equipment manufacturers.
3. By computerized equipment which can be programmed to cut rectangular shapes for straight duct sections or special shapes for fittings such as ells, tees, offsets and transitions.

For appropriate work practices when cutting fibrous glass duct liner, refer to manufacturer’s Material Safety Data Sheet (MSDS).



Fig. II-1. Cutting fibrous glass duct liner by hand.

C. Duct liner adhesives

Adhesives shall comply with the property requirements of ASTM C 916. These may be either water-based or solvent-based. Water-based duct liner adhesives may not develop fast tack and early bond strength as quickly as solvent-based adhesives. In situations where fittings have tight radii and the duct liner shows a tendency to separate from the sheet metal before the adhesive has had time to set, additional mechanical fasteners should be applied to ensure that the duct liner will remain in contact with the sheet metal while the adhesive dries.

Vapor emanating from some solvent-based adhesives may be explosive. Adhesives should not be applied near open flames, welding operations, or other potential ignition sources. Follow adhesive label instructions.

Adhesives may be applied by roller coating, spraying, or brushing. Application instructions and precautions provided by adhesive manufacturers should be carefully followed.



Fig. II-2. Cutting and processing fibrous glass duct liner on an automatic coil line.



Fig. III-3. Applying duct liner adhesive with spray equipment. Adhesive may also be applied with brush or roller.

D. Mechanical fastening

Mechanical fasteners shall be located with respect to interior duct dimensions, regardless of air flow direction. See Fig. II-4.

See page 5 for types of mechanical fasteners.

Mechanical fasteners also must:

1. Be as corrosion-resistant as G60 galvanized steel when installed.
2. Indefinitely sustain a 50 pound (22.7 Kg) tensile dead load test perpendicular to the duct wall.
3. Not adversely affect the fire hazard classification of the duct liner and adhesive.
4. Not damage the duct liner when applied as recommended.
5. Not cause leakage in the duct.
6. Be installed perpendicular to the duct surface.
7. Be the correct length for the specified duct liner thickness.
8. Not compress the duct liner insulation more than 1/8" (3mm).
9. Not project more than nominally into the air stream.

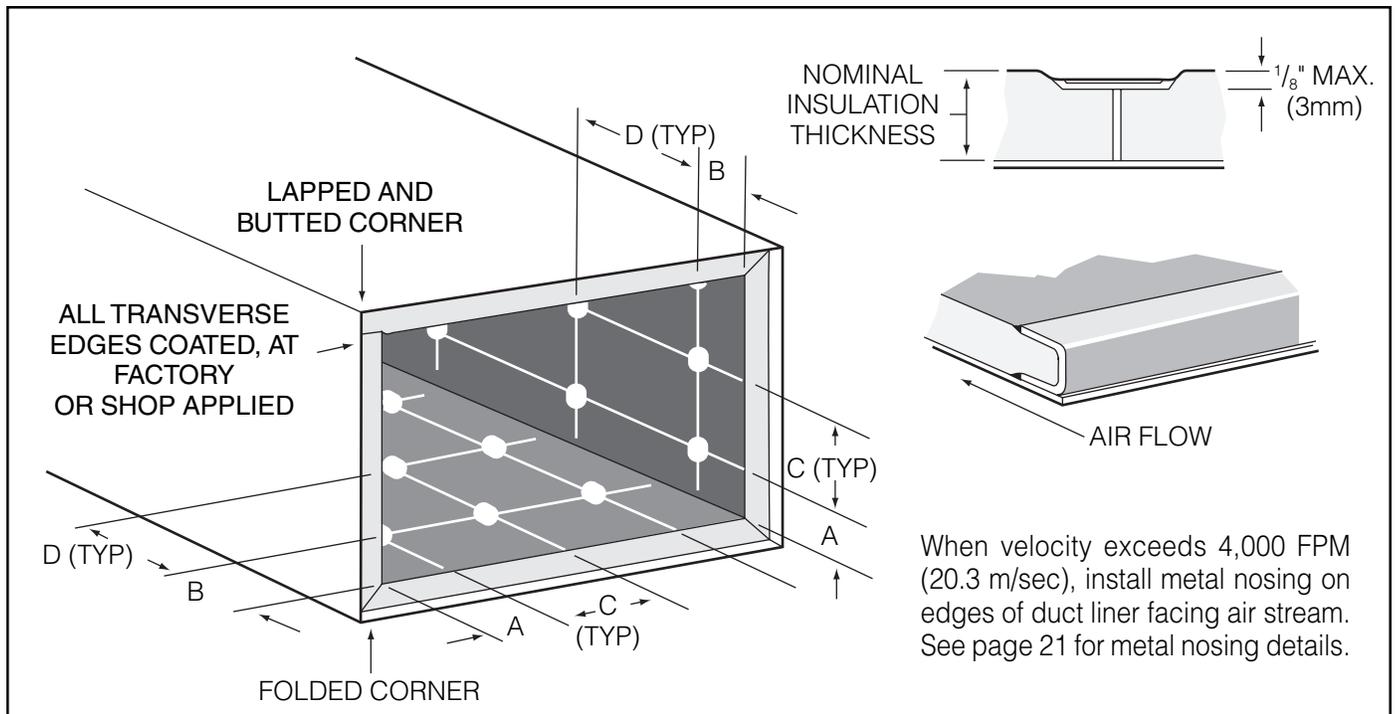


Fig. II-4. Mechanical fastener spacing

| Dimension | | Velocity, feet per minute (meters per second) | |
|-----------|--|---|--------------------------|
| | | 0-2,500 (0 - 12.7) | 2,501-6000 (12.7 - 30.5) |
| A | From corners of duct | 4" (100mm) | 4" (100mm) |
| B | From transverse end of duct liner | 3" (75mm) | 3" (75mm) |
| C | Across width of duct, on centers (min. 1 per side) | 12" (300mm) | 6" (150mm) |
| D | Along length of duct, on centers (min. 1 per side) | 18" (450mm) | 16" (400mm) |

E. General fabrication and installation principles

1. Unless otherwise indicated, the inside dimensions of the duct shown on contract drawings shall be maintained (see Fig. II-5). Duct dimensions shall be increased as necessary to compensate for liner thickness.

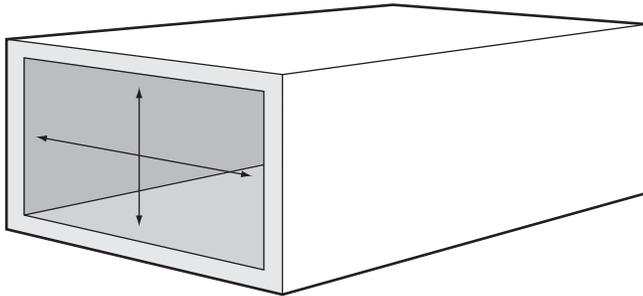


Fig. II-5. Net free area

2. The duct liner shall cover 100% of the interior metal surfaces of duct sections and fittings in finished form. Liner should not be patched in fittings, except that seams may be allowed at break points. Allowance for sheet metal add-on dimensions must be made when cutting duct liner.

3. The duct liner shall be installed with the labeled or printed surface exposed to the air stream.

4. The duct liner shall be adhered with a minimum of 90% coverage of adhesive of the liner contact surface area. Adhesive shall conform to ASTM C 916.

5. All transverse edges not receiving metal nosing shall be fully coated with adhesive conforming to ASTM C 916 or coating approved (or applied) by the duct liner manufacturer. Liner shall be neatly butted at all joints.

6. Liner shall be folded and compressed at corners of rectangular duct sections, or cut and fit to assure lapped, compressed joints (see Figs. II-6a, b, c, page 21). Longitudinal joints in duct liner should occur at the corners of ducts. However, duct size and standard duct liner product dimensions may make exposed longitudinal joints necessary. In such cases, the exposed joints shall be coated with adhesive and additionally secured with mechanical fasteners in accordance with NAIMA Fibrous Glass Duct Liner Standard as if it were a transverse joint.

7. Metal nosings (either channel or zee profile) shall be securely installed over transversely oriented liner edges facing the air stream at fan discharge and at any point where lined duct is preceded by unlined duct (see Figs. II-7a, b, c, page 21). In addition, where air velocities exceed 4,000 fpm (20.3 m/sec), metal nosing shall be applied to upstream edges of lined duct sections. When installing duct system components with nosings, make sure they are properly oriented with respect to the direction of air flow.

8. Where dampers, turning vanes, or other devices are placed inside of lined duct or fittings, the installation must not damage the airstream surface. The use of metal hat sections or other "build-out" means is optional; when used, "build-outs" shall be mechanically secured to the duct wall. (See Fig. II-8, page 22.)

9. Duct liners shall be interrupted at fire dampers to avoid interference with damper operation, and at heat sources to meet minimum clearance specified as a condition of equipment listing. (See Fig. II-9, page 23.)

10. Installation of two layers of duct liner to meet a minimum specified thickness is not recommended. When specifications require two layers, minimum adhesive coverage of 90% for each layer shall be applied. Fasteners of sufficient length for both layers must be used. In addition, special attention to leading edge nosings is required (See Fig. II-7c, page 21).

Fabrication Standard - Duct Liner Corner Treatments

Nosing Treatments

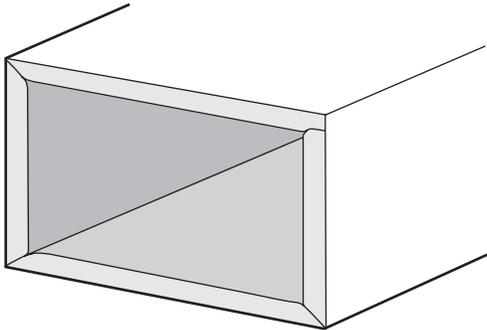


Fig. II-6a. Type I duct liner, corners folded.

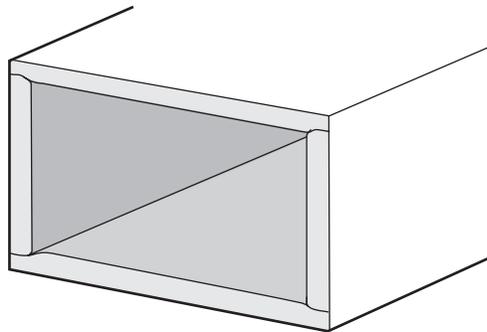


Fig. II-6b. Type I duct liner, corners lapped and compressed.

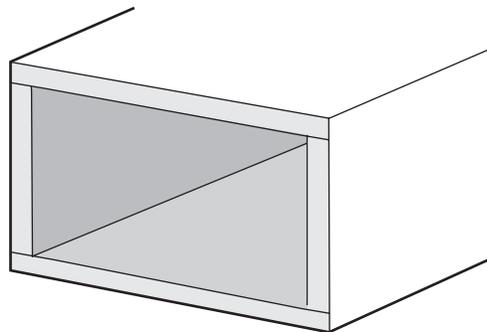


Fig. II-6c. Type II duct liner, corners lapped, side pieces supporting top piece.

Longitudinal seams shall occur only at the corners of the duct unless duct size and standard duct liner product dimensions make it impossible to do so.

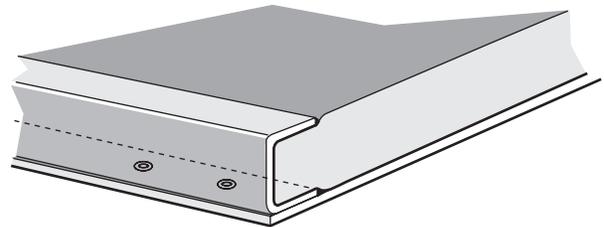


Fig. II-7a. Channel nosing, 1" (25mm) x liner thickness x 1" (25mm), mechanically secured to sheet metal duct.

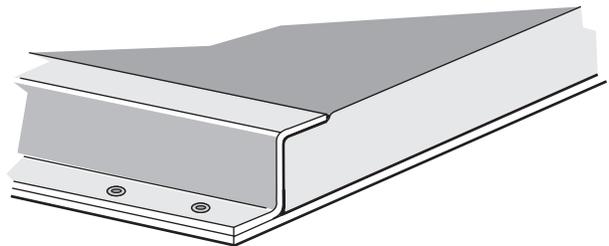


Fig. II-7b. Zee nosing, 1" (25mm) x liner thickness x 1" (25mm), mechanically secured to sheet metal duct.

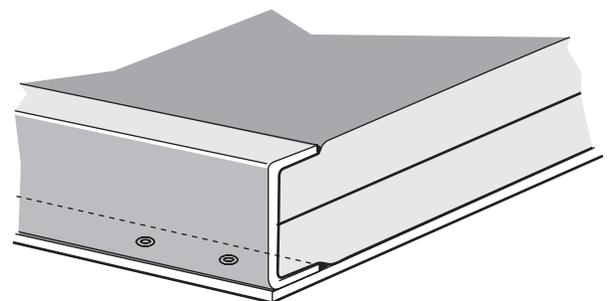


Fig. II-7c. Nosing in two-layer duct liner installations, 1" (25mm) x thickness of both layers x 1" (25mm). Second layer of duct liner shall also be adhered to first layer with 90% (minimum) coverage of adhesive complying with ASTM C 916. Duct liner fasteners must be of sufficient length for both layers of duct liner.

Build-out for Installing Turning Vanes and Accessories

Hat section, 3" (75mm) (min.) wide x duct liner thickness, with 1" (25mm) flanges mechanically secured to duct. Inside of hat section shall also be insulated. Wider hat sections shall be used if required for adequate support of accessories installed within duct.

If air velocity range is between 4,001 and 6,000 fpm (20.3 to 30.5 m/sec), nosing must be applied to upstream exposed edges of duct liner. See page 21 for nosing details.

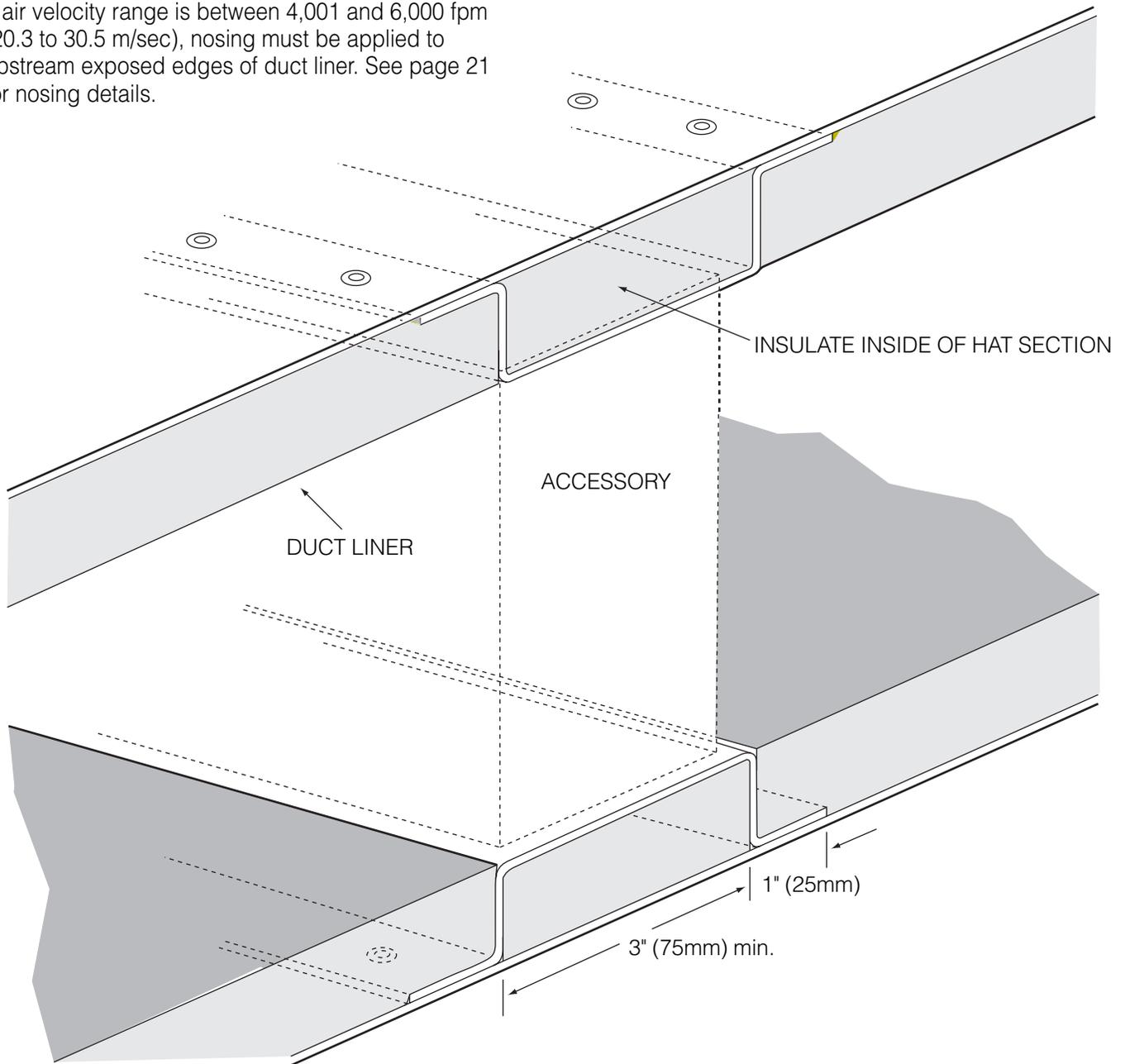


Fig. II-8. Build-out for installation of turning vanes or other equipment.

Fabrication Standard - Interruptions of Duct Liner (as at Fire Dampers)

Sleeve assembly installed through fire wall, secured to wall with retaining angle, per damper manufacturer's listing. Duct shall be attached to sleeve assembly with "S" connectors. Exposed sleeve surfaces shall be insulated with duct wrap. Nosing is required on upstream exposed edges of duct liner.

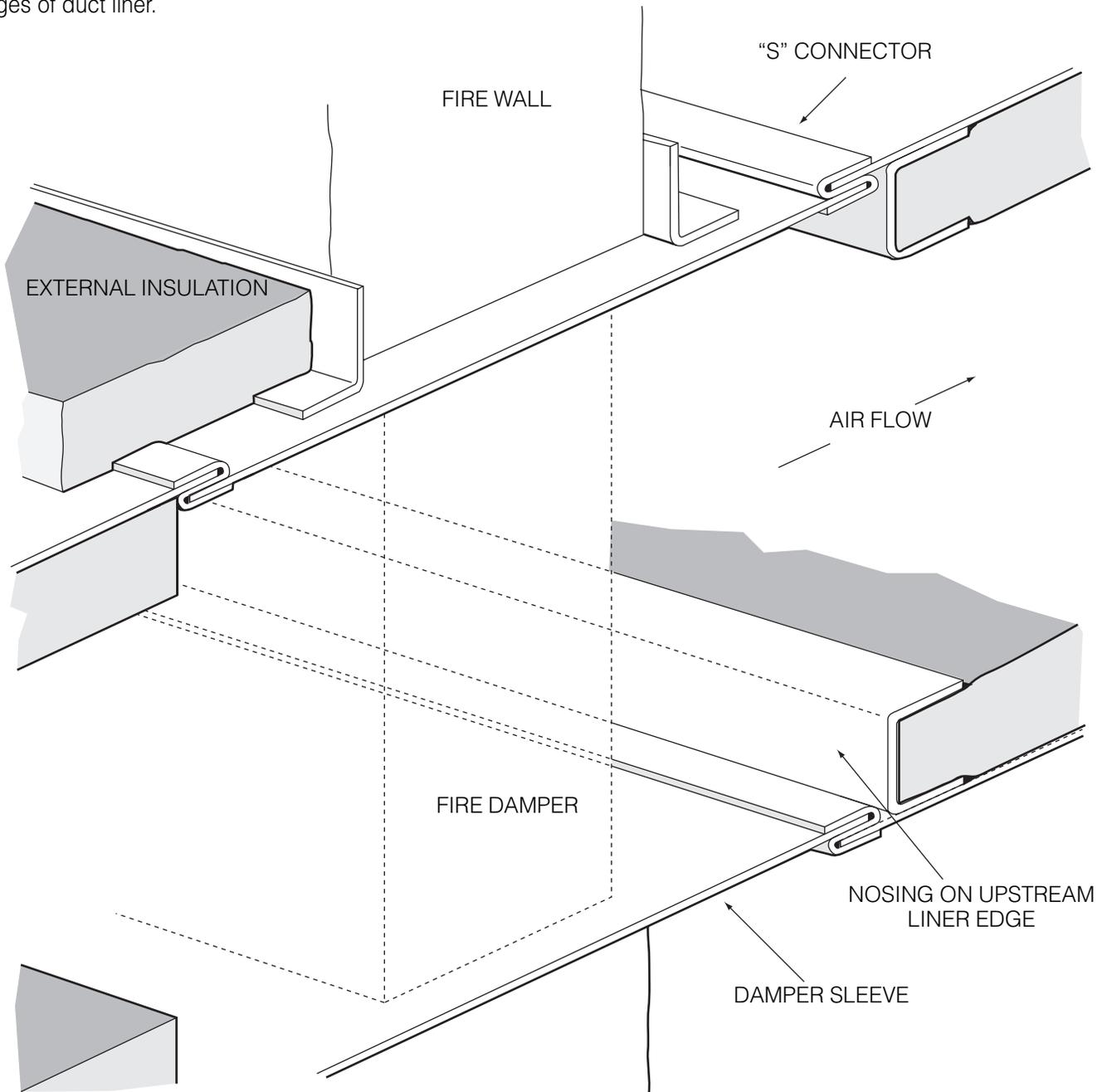


Fig. II-9. Interruption of duct liner, as at fire dampers.

SECTION III. SYSTEM OPERATION

A. Installation

Application of fibrous glass duct liner insulation is normally a shop-fabrication process. After each duct system component has been completed and duct liner installed with adhesives, fasteners, and (where required) nosings applied in accordance with this Standard, all components should be carefully cleaned and inspected to make sure all seams and joints are neatly butted, all fasteners secure, and all interior surfaces completely covered with liner.

Care should be taken at the jobsite to ensure that fibrous glass duct linings are not damaged during jobsite storage, handling and installation. If damage occurs, apply adhesive conforming to ASTM C 916 (or coating approved by the duct liner manufacturer) to repair as required. If damage is sufficiently severe, carefully replace the damaged area with a patch, coating edges with adhesive. In extreme cases, remove and replace liner.

Lined duct components should be kept clean and dry at all times. Discard any material which has become contaminated during storage.

B. Commissioning

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

1. Check all registers, grilles, and diffusers to ensure that they are clean and free from construction debris.
2. Check all filters in accordance with their manufacturers' instructions. Use the specified grade of filters at all times the system is operating.
3. Cover supply openings with filter media prior to system start-up to catch any loose material that may remain inside the ductwork.
4. Turn the HVAC system on and allow it to run until steady state operation is reached.
5. Remove the temporary filter media from supply openings and, along with it, any loose material blown downstream and caught by the filter media.
6. Check to ensure that air delivery performance of the duct system meets all requirements and complies with SMACNA leakage specifications.

C. Operation and Maintenance

Operation of any duct system includes preventive maintenance which should follow certain basic principles whether or not the system is lined with fibrous glass insulation materials. These include:

1. Operating within system design operating temperatures and air velocities.
2. Maintaining filtration equipment in good, clean condition throughout the system, and following manufacturers' recommendations for maintenance, cleaning, and replacement.
3. Controlling condensation and other sources of moisture to prevent the duct liner from becoming wet. The system should be operated and maintained so as to avoid moisture carry-over from humidifiers and/or coils by the air stream into the duct system. Condensate drains must be inspected to assure proper operation. When duct systems run through unconditioned space and are used for cooling only, register openings must be tightly sealed during the heating season to prevent accumulation of water vapor in the duct system.
4. Fibrous glass duct liner that has become wet in service should be removed and replaced to reduce the risk of mold growth, and to restore thermal and acoustical performance levels. The source of the water must be identified and eliminated prior to replacement of the liner.

D. Preventive maintenance

Careful maintenance of the HVAC system, including the ductwork, is important in preventing accumulation of dirt, dust and moisture which can restrict air flow, impair the ability of fibrous glass duct linings to perform satisfactorily, and jeopardize the quality of the indoor air.

The Sheet Metal and Air Conditioning Contractors National Association (SMACNA) recommends system design and maintenance procedures in its publication *Indoor Air Quality*. These procedures include inspection, detection, and repair of probable sources of moisture and are consistent with those recommended in ASHRAE Standard 62-2001, *Ventilation for Acceptable Indoor Air Quality*, and the Environmental Protection Agency (EPA) publication *Building Air Quality: A Guide for Facility Owners and Building Managers*.

E. Accessing fibrous glass lined ducts for cleaning

In some cases, when preventive maintenance has been inconsistent, system cleaning may become necessary. Fibrous glass duct liners can be cleaned successfully. Proper cleaning practices will ensure that the insulated duct system’s structural and functional integrity is maintained. The entire air distribution system needs to be opened, cleaned, closed, and returned to service with all its thermal, acoustical, and air-tightness properties intact.

Care must be taken in the selection and application of the cleaning process. Several viable methods are available which have proven effective in cleaning insulated duct systems, and professional duct cleaning services are widely available.

Refer to the NAIMA handbook, *Cleaning Fibrous Glass Insulated Air Duct Systems*, Pub. No. AH-122, for details. It is recommended that an independent expert be consulted before committing to proceed with duct cleaning, especially if introduction of “sanitizing” anti-microbial agents into the system is under consideration.

Opening ductwork

1. Determine location and dimensions of openings.
2. Draw straight lines the size of the opening plus 1/2” (15mm) on all four sides. These lines will establish the size of a sheet metal patch that will be required when closing the duct.
3. Drill two overlapping holes through the duct only at one corner, staying 1/2” (15mm) inside drawn lines. Do not drill into duct liner. See Fig. III-1.
4. Cut along opening lines with shears, staying 1/2” (15 mm) inside drawn lines.
5. Carefully loosen the sheet metal piece from the duct liner inside, and discard it.
6. Cut through the insulation with a knife around three sides of the opening at a 45° angle, leaving the upstream end uncut. See Fig. III-2.
7. Carefully pull the insulation out through the opening, bending it at the upstream side so that the surface opposite the airstream surface is the most tightly folded. Tape it out of the way.

Opening ducts lined with rigid duct liner board

If the duct is lined with Type II rigid duct liner board rather than Type I flexible duct liner, the insulation must be cut away on all four sides and removed (see Fig. III-3). Rigid duct liner board can be distinguished from flexible duct liner by its uniform thickness, rigidity, and yellow base color. It also has a black airstream surface. Most duct liners have dark-colored base material; airstream surfaces are either smooth black coatings or dark-colored mats.

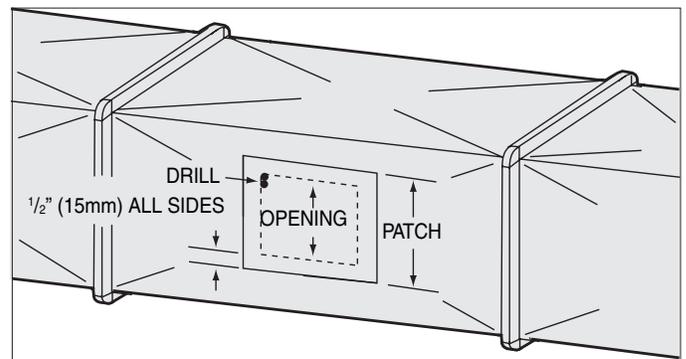


Fig. III-1. Laying out location for opening in duct.

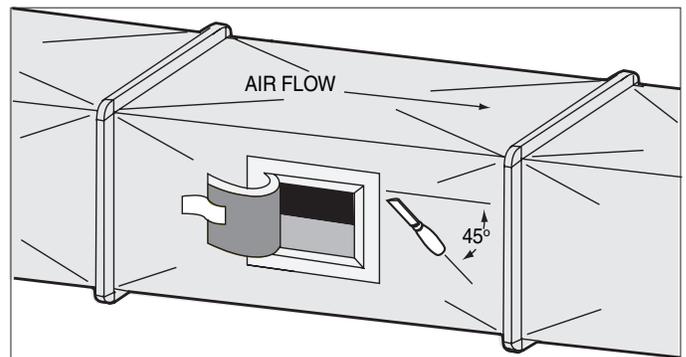


Fig. III-2. Cutting into flexible duct liner at 45° angle.

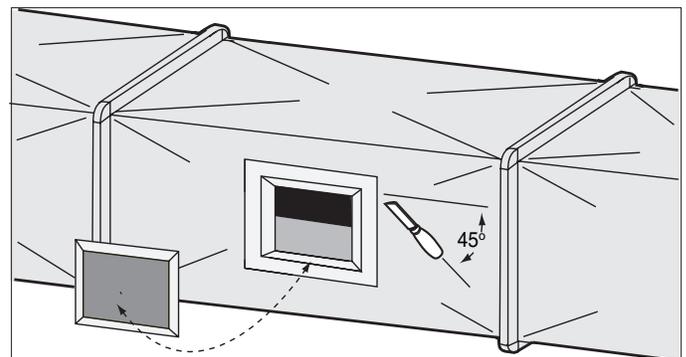


Fig. III-3. Opening duct lined with rigid duct liner board

Closing cleaned ductwork

When closing openings made for cleaning sheet metal ducts lined with fibrous glass duct liners, the insulation must be secured in its original position before the sheet metal is patched.

1. Coat edges of flexible duct liner flap (or cut-out piece of rigid duct liner board) with adhesive complying with ASTM C 916.
2. Replace the flap or cut-out piece in its original position so the hole in the duct liner is tightly plugged (See Fig. III-4).
3. Cut a sheet metal patch to dimensions drawn on duct when opening (see page 25). The patch should be about 1" (25mm) larger in both dimensions than the hole in the sheet metal which it must cover.
4. Apply a bead of sealant around the opening (see Fig. III-5). Sealant must be suitable for use on sheet metal ducts.
5. Apply adhesive to the duct liner flap or cut-out piece of duct liner board, and press the sheet metal patch in place over it.
6. Screw the sheet metal patch to the duct with sheet metal screws on 8" (200mm) centers (approx.) so the patch will overlap the opening by 1/2" (15mm), all four sides (see Fig. III-6).

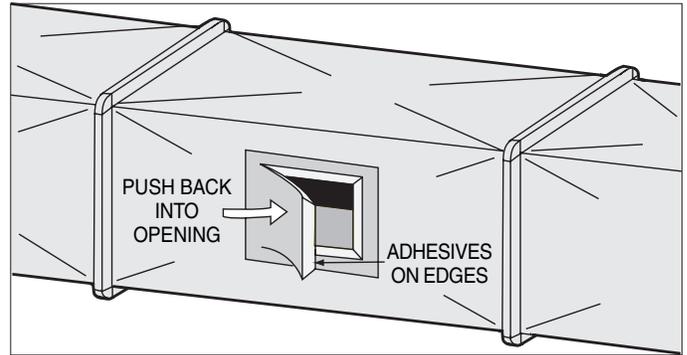


Fig. III-4. Replacing duct liner insulation after cleaning.

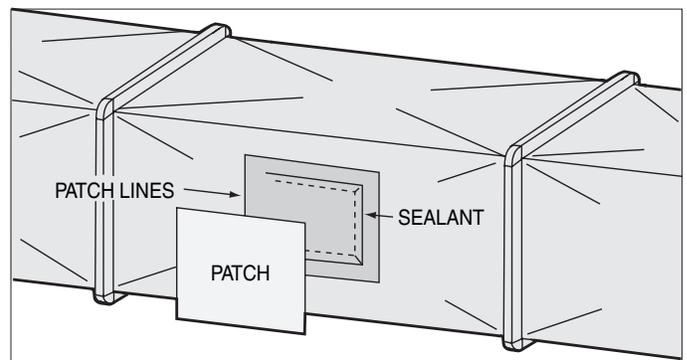


Fig. III-5. Sealing around opening and placing patch.

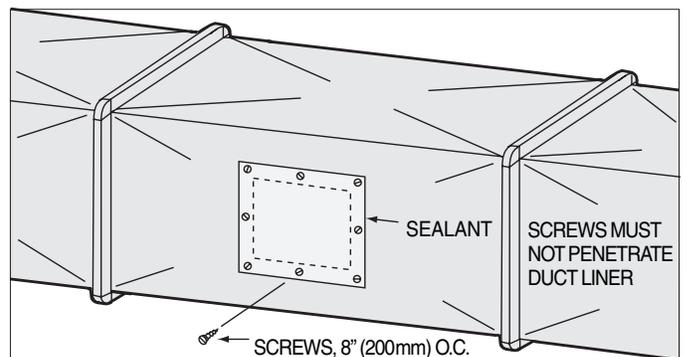


Fig. III-6. Fastening metal patch in place over opening.

Inspection Check List for Fibrous Glass Duct Liner Installation

All check-marks should be in the **YES** column. If a check-mark appears in the **NO** column, it should be brought to the duct system contractor's attention.

Project Name and Number _____
 Duct System Contractor _____
 Mechanical Contractor _____
 General Contractor _____
 Engineer _____
 Inspected by _____ Date _____

DOCUMENTATION

- _____ Current edition, NAIMA Fibrous Glass Duct Liner Standard
- _____ SMACNA Duct Construction Standards - Metal and Flexible
- _____ Duct Liner Manufacturer's Installation Recommendations
- _____ Submittal Drawings
- _____ Plans and Job Specifications
- _____ Applicable Building / Energy Codes

PRODUCT

- | | YES | NO |
|--|-----|-----|
| _____ Does duct liner comply with NFPA 90A as stated on product data sheet? | () | () |
| _____ Does duct liner R-value conform to code requirements? | () | () |
| _____ Is duct liner thickness in accordance with job plans and specifications? | () | () |

INSTALLATION

- | | | |
|---|-----|-----|
| _____ Has duct liner been correctly installed with labeled or printed surface visible? | () | () |
| _____ Has duct liner been adhered to sheet metal with at least 90% coverage of adhesive? | () | () |
| _____ Does duct liner completely cover all inside surfaces of system, including fittings? | () | () |
| _____ Is the duct liner free of visible damage (tears, punctures, abrasions)? | () | () |
| _____ Are fasteners of the proper type and properly installed? | () | () |
| _____ Are fastener washers cupped or beveled, installed so they will not cut into duct liner? | () | () |
| _____ Are fasteners spaced at the correct intervals for system air velocity? | () | () |
| _____ Are fasteners correctly installed so they are perpendicular to the sheet metal? | () | () |
| _____ Do fastener heads or washers compress duct liner no more than 1/8" (3mm)? | () | () |
| _____ Are transverse joints factory coated, or field coated with adhesive meeting ASTM C 916? | () | () |
| _____ Are all leading edges finished with sheet metal nosing if air velocity requires it? | () | () |
| _____ Are transverse joints neatly butted? | () | () |
| _____ Are all corner joints compressed and either overlapped or folded? | () | () |
| _____ Are longitudinal joints at corners unless duct size or product dimensions prohibit? | () | () |
| _____ Are top panels of duct liner board supported by side panels? | () | () |
| _____ If installation is 2-layer, are layers bonded together with adhesive? | () | () |

COMMISSIONING

- | | | |
|--|-----|-----|
| _____ Are all sheet metal joints sealed per project specifications to prevent air leakage? | () | () |
| _____ Has all construction debris been blown or physically removed from the duct system? | () | () |
| _____ Are all registers, grilles and diffusers free from construction debris? | () | () |
| _____ Have all filters been installed in accordance with manufacturers' instructions? | () | () |
| _____ Are all sources of potential moisture installed or treated so duct liner won't become wet? | () | () |
| _____ Is the system operating within design temperatures, air velocities and static pressures? | () | () |

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 will not support the growth of mold or bacteria 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 and G 22 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) will train workers to keep airborne exposures below 1 fiber-per-cubic-centimeter (1 f/cc). The HSPP is also supported by the Insulation Contractors Association of America (ICAA) and the National Insulation Association (NIA).

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.

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 downgrading the classification of these fibers from Group 2B (possible carcinogen) to Group 3 (not classifiable as to carcinogenicity in humans). All 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 downgrade 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 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 stated: “ 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 by contacting 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.

About NAIMA

NAIMA is the association for North American manufacturers of fiber glass, rock wool, and slag wool insulation products. Its role is to promote energy efficiency and environmental preservation through the use of fiber glass, rock wool, and slag wool insulation, and to encourage the safe production and use of these materials.

In May 1999, NAIMA began implementing a comprehensive voluntary work practice partnership with the U.S. Occupational Safety and Health Administration (OSHA). The program, known as the Health and Safety Partnership Program, or HSPP, promotes the safe handling and use of insulation materials and incorporates education and training for the manufacture, fabrication, installation and removal of fiber glass, rock wool and slag wool insulation products.

For more information, contact:

NAIMA

**NORTH AMERICAN INSULATION
MANUFACTURERS ASSOCIATION**

44 Canal Center Plaza, Suite 310
Alexandria, VA 22314

Tel: 703-684-0084

Fax: 703-684-0427

E-mail: insulation@naima.org

Website: <http://www.naima.org>

For additional information on fibrous glass duct systems, contact one of the manufacturers listed below.

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

1 Knauf Drive
Shelbyville, IN 46176
800-825-4434

Owens Corning

One Owens Corning Parkway
Toledo, OH 43659
800-GET-PINK