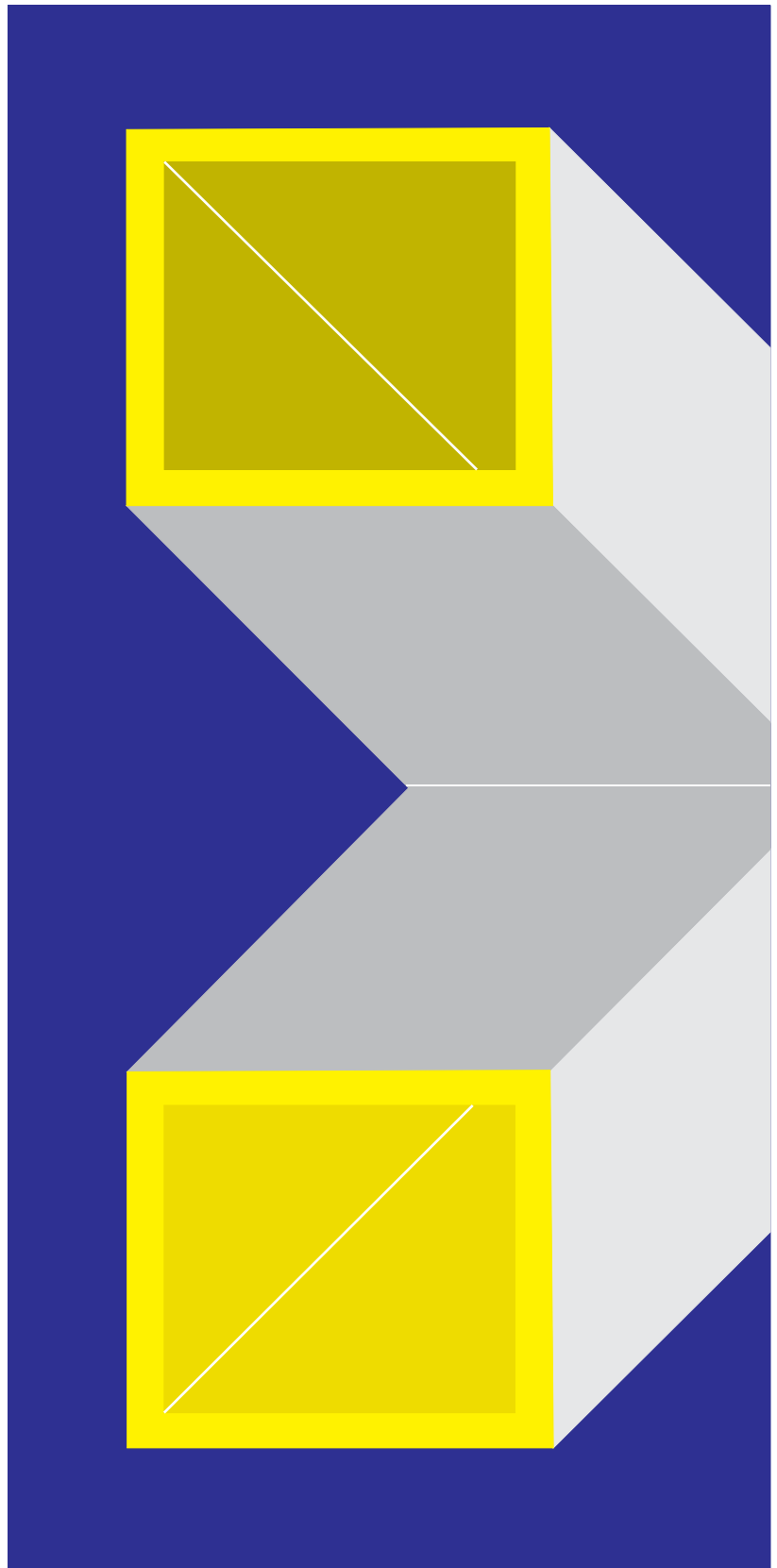


***CLEANING
FIBROUS GLASS
INSULATED
AIR DUCT
SYSTEMS
RECOMMENDED PRACTICE***



***RECOMMENDATIONS
FOR OPENING AND
CLOSING INSULATED
DUCTS BEFORE AND
AFTER CLEANING***



CONTENTS

SECTION I INTRODUCTION

Scope of this manual 1

References 2

Duct cleaning and air quality 3

Deciding if and when insulated ducts need to be cleaned 4

Three duct cleaning methods 5

SECTION II PRE-CLEANING PROCEDURES

Preparation for cleaning 6

Personnel protection 6

Protecting the indoor environment 6

Opening ducts for inspection 6

Detailed inspection procedures 7

SECTION III OPENING DUCTWORK

Access through existing openings 8

Opening fibrous glass ducts 9

Opening lined sheet metal ducts 10

Opening wrapped sheet metal ducts 11

Opening metal ducts insulated with rigid fibrous glass board 12

Opening insulated flexible ducts 13

SECTION IV DUCT CLEANING

Duct cleaning techniques 14

Contact vacuum method 15

Air washing method 16

Power brushing method 17

Cleaning HVAC equipment 18

Sanitizing 18

Sealing 18

SECTION V CLOSING DUCTS

General closing requirements 19

Closing fibrous glass ducts 20

Closing lined sheet metal ducts 21

Closing wrapped sheet metal ducts 22

Closing metal ducts insulated with rigid fibrous glass board 23

Replacing insulated flexible ducts 24

Final inspection 25

SECTION VI APPENDIX

How HVAC systems work 26

Why insulate duct systems? 26

Insulated duct system types 27, 28, 29

Properties of insulated duct systems 30 - 34

Pre-cleaning system inspection checklist 35

Duct cleaning inspection checklist 37

The facts on fiber glass 39, 40

Summary Inside back cover

SECTION I - INTRODUCTION

SCOPE OF THIS MANUAL

The North American Insulation Manufacturers Association (NAIMA) presents this manual of recommended practices for the inspection, opening, closing, and return to service after cleaning of air ducts incorporating internal or external fibrous glass thermal and acoustical insulation.

A primary objective of these recommended practices is to ensure that the structural and functional integrity of the duct system is maintained after it has been opened, cleaned, closed, and returned to service. Chief considerations are focused on returning the cleaned system to service with its thermal, acoustical, and airtightness properties unimpaired.

Generally covered by these procedures are heating, ventilating, and air-conditioning (HVAC) duct systems made of the following materials:

- Fibrous glass duct board.
- Sheet metal lined with fibrous glass insulation.
- Sheet metal wrapped with fibrous glass insulation.
- Sheet metal with exterior or interior rigid fibrous glass insulation.
- Insulated flexible ducts.

The following steps in the duct cleaning process are covered:

- How to evaluate the scope of the problem, and to determine when and if ducts require cleaning.
- Pre-cleaning inspection; protection of the indoor environment.
- Opening of ducts for cleaning.
- Cleaning methods; sequence of work; sanitizing and sealing.
- Closing of duct systems after cleaning.
- Final inspection procedures.

Users of this manual should consider:

Three commonly used methods of duct cleaning are described in general terms in this manual. No attempt is made to define specific cleaning techniques and equipment, since these may vary among duct cleaning contractors in different parts of the country, confronting different types of duct contamination, and using different cleaning methods and equipment. If further, more detailed

information on the subject of HVAC duct cleaning is required, it is suggested that trade associations such as the National Air Duct Cleaners Association (NADCA) be consulted.

On the other hand, the duct cleaning contractor needs to take into consideration some of the problems unique to the opening, cleaning, and closing of duct systems insulated with fibrous glass materials. This is important regardless of whether the fibrous glass insulation is applied to the air duct exterior or interior.

Furthermore, unless also licensed as an HVAC systems contractor, consultation with someone experienced in fibrous glass insulated duct systems and HVAC system design and operation is strongly advised. This manual is not a substitute for that expertise. It is designed to provide general guidance only, and should be viewed only as a source of general information on matters within its scope.

The information provided herein is based upon current scientific and technical understanding of the matters discussed, and is subject to revision in light of new information about the handling of specific situations.

The North American Insulation Manufacturers Association assumes no responsibility and accepts no liability for the application of the principles or techniques contained in this Standard. In particular, NAIMA makes no warranty of any kind, express or implied or regarding merchantability or fitness for any particular purpose, in connection with the information supplied herein.

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

REFERENCES

The following may be used as references when working with information in this publication.

NOTE: Current editions of some references may differ from editions of listed date.

ADC

Air Diffusion Council

11 S. LaSalle, Suite 1400
Chicago, IL 60601

- Flexible Duct Performance & Installation Standards, Third Edition, 1996

ASHRAE

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

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

- 1997 ASHRAE Handbook - Fundamentals
- ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality
- ASHRAE Standard 90.1-1989, Energy Efficient Design of New Buildings Except Low Rise Residential Buildings

ASTM

American Society for Testing and Materials

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

- Source for copies of ASTM test methods referenced throughout this manual

EPA

Environmental Protection Agency Washington, DC

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

NADCA

National Air Duct Cleaners Association

1518 K St., NW, Suite 503, Washington, DC 20005

- Standard 01-1992, Mechanical Cleaning of Non-Porous Air Conveyance System Components, 1992
- Introduction to HVAC System Cleaning Services, 1994
- Understanding Microbial Contamination in HVAC Systems, 1996

NADCA is currently (8/97) developing standards and guidance documents regarding the cleaning of porous HVAC system components including fibrous glass insulation. Contact NADCA for more information.

NAIMA

North American Insulation Manufacturers Association

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

- Pub. # AH 105, Requirements for Listing UL 181A Closure Systems
- Pub. # AH 107, Preventing Moisture Accumulation in Ducts
- Pub. # AH 113, The Facts About Mold Growth
- Pub. # AH 116, Fibrous Glass Duct Construction Standard
- Pub. # AH 124, Fibrous Glass Duct Liner Standard
- 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, PO Box 9101, Quincy, MA 02269

- NFPA 90A - Standard for the Installation of Air Conditioning & Ventilating Systems, 1996 Edition
- NFPA 90B - Standard for the Installation of Warm Air Heating & Air Conditioning Systems, 1996 Edition

SMACNA

Sheet Metal and Air Conditioning Contractors National Association

P.O. Box 221230, Chantilly, VA 22022

- HVAC Duct Construction Standards - Metal and Flexible, Second Edition, 1995
- Indoor Air Quality Manual, Second Edition, 1993

UL

Underwriters Laboratories, Inc.

333 Pfingsten Road, Northbrook, IL 60062

- Standard for Factory-Made Air Ducts and Air Connectors, UL 181
- Standard for Closure Systems for Use with Rigid Air Ducts, UL 181A
- Standard for Closure Systems for Use with Flexible Air Ducts and Air Connectors, UL 181B

DUCT CLEANING AND AIR QUALITY

With growing awareness of the importance of indoor environmental quality, the cleaning of HVAC ductwork is being given increased attention. Many factors need to be investigated and evaluated as possible contributors to any indoor environmental quality problem, before it can be conclusively determined that the system needs to be cleaned. Among factors to be considered are:

- How widespread, or how localized, is the problem?
- How good, or how poor, is the overall house keeping?
- Is adequate ventilation being supplied to occupied spaces?
- Is the HVAC system being properly operated and maintained?
- What is the quality of air entering the duct system?
- What is the condition and efficiency of air filtration equipment?
- What is the condition of central air equipment, coils, etc.?
- What contaminants may be present in the indoor air?
- Might these contaminants be originating from the duct airstream surface?
- Will duct cleaning help?

How can ducts get contaminated?

HVAC ducts fabricated from all types of materials will become contaminated as dirt and dust accumulate, which will inevitably occur. Air entering the system usually carries dust and dirt which will not be completely prevented from entering the system, especially when filtration is inefficient or poorly maintained. When dirt and dust are combined with liquid water, conditions exist for microbial amplification within the duct system.

These conditions do not normally occur in duct systems that were properly designed and installed and are being properly operated and maintained.

Fibrous glass duct materials have been incorrectly blamed for causing or sustaining microbial growth. Tests show that fibrous glass duct insulation materials do not provide sustenance for mold and

fungus to amplify, either within the fibers or on the airstream surface. Fibrous glass duct insulation products tested following standard ASTM and UL test methods showed no sign of microbial growth. In many instances where microbial amplification was suspected, none was detected — even in high humidity. In other instances, where microbial amplification was found, the cause was determined to be accumulated dust and dirt due to inadequate filtration plus the presence of liquid water. For more information, refer to NAIMA Publications AH 113, *The Facts About Mold Growth* and AH 107, *Preventing Moisture Accumulation in Ducts*.

For these reasons, the following three factors should be thoroughly investigated before a decision is made to have the ducts cleaned:

- The quality of air entering the system;
- The condition and efficiency of filtration;
- The presence of liquid water in the system — the ultimate culprit when microbial amplification occurs in the ducts.

An ounce of prevention ...

To reduce the probability of microbial amplification in duct systems, the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) recommends the following system design and maintenance procedures in its publication, *Indoor Air Quality*:

1. Promptly detect and permanently repair all areas where water collection or leakage has occurred.
2. Maintain relative humidity at less than 60 percent in all occupied spaces. During the summer, cooling coils should be run at a low enough temperature to properly dehumidify conditioned air.
3. Check for, correct, and prevent further accumulation of stagnant water under cooling deck coils of air handling units, through proper inclination and continuous drainage of drain pans.
4. Use only steam as the moisture source for humidifiers in the ventilation systems. Steam should not be contaminated with volatile amines (sometimes used as rust inhibitors).

5. Once contamination has occurred (through dust or dirt accumulation or moisture-related problems) downstream of heat exchange components (as in ductwork or plenums), additional filtration may be necessary before air is introduced into occupied areas

6. Water-damaged porous furnishings, including carpets, upholstery and ceiling tiles, should be discarded rather than disinfected, to effectively eliminate microbial contamination.

7. Air handling units should be constructed so that equipment maintenance personnel have easy and direct access to both heat exchange components and drain pans for checking drainage and cleaning. Access panels or doors should be installed where needed.

8. Non-porous surfaces where moisture collection has promoted microbial growth (e.g. drain pans, cooling coils) should be cleaned and disinfected with detergents, chlorine-generating slimicides (bleach), and/or proprietary biocides. Care should be taken to ensure that these cleaners are removed before air handling units are reactivated.

NAIMA recommends that fibrous glass insulations that have become wet in service should be removed and replaced to reduce the risk of mold growth and to restore design thermal and acoustical performance levels. These insulations may be very difficult to dry under normal operating conditions.

The most effective way to keep ductwork clean and maintain indoor air quality standards is to have, and maintain, a high efficiency filtration system. This provides protection of the air handling system and building occupants by reducing airborne contaminants. These are therefore less likely to accumulate in the equipment or ductwork and become distributed throughout the occupied space.

DECIDING IF AND WHEN INSULATED DUCTS NEED TO BE CLEANED

Cleaning of an HVAC duct system can be difficult and costly. It may also be ineffective in solving the indoor air quality problem if the source of that problem lies elsewhere.

Before the decision is reach to clean the ducts, all potential causes of the air quality problem should

be thoroughly investigated in a total indoor environmental “check-up.” The check list that follows may serve as a guide.

- **What are the symptoms?** The very first signs that an indoor air quality problem is present are usually the human responses to it. Occupants may complain that the air in the building is too warm, too cool, or stuffy. They may remark about unpleasant smells, dust, or dirt. Or they may actually be suffering physical discomfort — coughing, sneezing, headaches, nausea, or worse — in which case the services of a physician or an industrial hygienist should be sought.
- **Where’s the problem?** Is it general (throughout the building), or localized to a single floor or to one office area? Does it happen to be near a kitchen, a laboratory, or some other potential source of local airborne contamination?
- **How’s the housekeeping?** Is the space well maintained and cleaned on a regular basis? Are storage areas clean and tidy? Are cleaning materials and chemicals safe for interior use and properly stored so fumes can’t leak into occupied spaces of the building?
- **How’s the air distribution?** Is adequate ventilation air being efficiently distributed to all parts of the occupied space? Is the return duct system adequate and effective in exhausting or recirculating acceptable indoor air?
- **Is the HVAC system being maintained and operated properly?** Is central air equipment in good condition, and controls set and operating correctly? Are air filters and cleaners in good condition, well maintained, and adequate for the job? Are cooling coils clean? Are drain pans free of standing water? Is water in the system properly managed?
- **What’s in the incoming air?** One of the first potential causes of an indoor air quality problem may be outdoors. Is the air entering the system acceptable for ventilation? Are air intakes entraining exhaust air from other sources such as nearby buildings, a busy street, or a parking lot? Is filtration of incoming air inadequate, inefficient, or in need of maintenance?
- **What’s in the inside air?** Sampling and laboratory analysis of indoor air can reveal the presence of unacceptable levels of particulate matter, odors, fumes, aerosols, volatile organic compounds (VOCs), and other potential indoor air

contaminants. This may in turn lead to the source of the problem.

- **What's going on in the space?** Is current space use compatible with building design? Are there more occupants working or living in the space than the building was intended to accommodate and the HVAC system designed to serve?
- **What kind of equipment is in use?** Copiers, computer printers, and many other kinds of office machines involve processes and chemicals which introduce VOCs and other contaminants into occupied space. Air sampling tests can reveal their presence and lead to the source of the problem.
- **How about furniture and fixtures?** Many kinds of materials found in building interiors — paint, adhesives, plastic furnishings, carpeting, wall treatments, upholstery — are potential sources of volatile organic compounds released into the air. VOC “outgassing” often continues for some time after their sources are newly installed.

Now, how about the ducts?

Although indoor air quality problems are often attributable to some of the causes suggested above, contaminated ductwork can also be the source of the problem and careful inspection of duct interiors should be made. However, two points should be kept in mind:

- Microbial amplification does not occur in ducts unless dirt and water are both present. While it may be necessary to clean or replace the ducts to remove contamination, the microbial problem will not be corrected until all existing or potential sources of water have been located and remedied.
- If upon inspection the duct insulation appears to have been wet or is presently wet or moldy, or if an unacceptable odor is present, the affected area should be replaced.

A light film of dirt or dust is generally present (and to be expected) on the inside surfaces of the HVAC system. This does not necessarily indicate the existence of a problem. However, if inspection reveals the presence of debris or particulate matter other than a light film of dust or dirt, HVAC system cleaning may be appropriate. The services of a qualified IAQ professional should then be engaged to:

- Determine whether either duct cleaning or

replacement is necessary;

- Determine external sources of contamination and remediation needed prior to duct cleaning in order to prevent a recurrence;
- Oversee selection of a duct cleaning contractor and direction of the duct cleaning work;
- Evaluate the effectiveness of the work.

THREE DUCT CLEANING METHODS

The following methods are more fully discussed in Section IV of this manual. In some cases, combining methods may be required.

- **Contact vacuuming:**

A portable vacuum cleaner with a high efficiency particle arrestor (HEPA) filter is operated with its brush in contact with interior duct surfaces to dislodge and remove contaminants. This method requires more and larger openings into the duct than other methods since cleaning action is limited to the operator's reach. This method may allow escape of contaminants from the duct during the cleaning process because the duct section is not being subjected to negative pressure.

- **Air washing:**

Compressed air introduced into the duct loosens accumulated contaminants; these are drawn into a vacuum collector machine which generates a negative pressure in the duct section being cleaned.

- **Power brushing:**

Pneumatically or electrically powered rotating brushes loosen contaminants so these may be drawn downstream and into the vacuum device as in the air washing method. Use of this method requires care so as not to damage the insulation surfaces.

Important: Steam cleaning and other systems involving water should not be used on any kind of insulated ductwork, as it is impossible to avoid getting the insulation wet.

SECTION II - PRE-CLEANING PROCEDURES

PREPARATION FOR CLEANING

Before opening the duct system for a pre-cleaning inspection, it is advisable to obtain the services of a qualified HVAC contractor or consultant capable of inspecting the entire system and determining the scope of work.

An inspection should include all of the ductwork as well as central air handling units, variable air volume units, in-line electric heaters, coils, filters, humidifiers, and drain systems. This individual should also be able to document interior surface conditions in a detailed inspection report that indicates areas of the duct system or HVAC equipment that need to be cleaned or replaced.

The contractor should also be able to perform proper duct opening and closing as described in Sections III and V of this manual.

After the inspection is completed, the inspector's report should be carefully reviewed and checked against building or HVAC system drawings or blueprints (if available) to determine where and how much ductwork is to be cleaned.

PERSONNEL PROTECTION

- **System shut-down:**

The HVAC system must be shut down for inspection and applicable federal and state worker safety requirements must be followed.

- **Protection of building occupants:**

Precautions should be taken to prevent exposure of occupants to contamination deposited in the duct system which might be dislodged during inspection activity and blown into occupied spaces before duct cleaning takes place. Building occupants should be conducted at times when the building is unoccupied.

- **Protection of inspection crew:**

Workers must be protected from exposure to contaminants in the duct system. Inspection crews should wear gloves, eye protection, long sleeved shirts, and hard hats where federal, state or local requirements dictate. Workers should also wear ap-

propriate respirators NIOSH-approved for use in areas where microbiological, particulate, and organic vapor contaminants may be present.

If work is to be conducted in areas where electrical equipment is present, power must be disconnected and kept disconnected until all inspection work is complete.

PROTECTING THE INDOOR ENVIRONMENT

It is also important to protect the indoor environment during pre-cleaning inspection activity, as well as for the duration of the actual cleaning process once it starts. Drop cloths are recommended for use below any areas where inspection procedures take place, as well as below areas of cleaning work when it begins. Additional protection should be provided for all office equipment, furniture, fixtures, carpeting, acoustical space dividers, plants, and other building contents that could be damaged or contaminated as a result of inspection or cleaning activity. This protection can be achieved either by covering with drop cloths or by removal from the area. Computers and office equipment with cooling fans should not be completely covered while running, to lessen the chance that they may become overheated.

OPENING DUCTS FOR INSPECTION

Wherever possible, access to duct interiors for inspection purposes should be through existing openings such as access doors and grille or register openings. When this is not practical, small inspection holes may be cut in duct walls through the fibrous glass insulation to permit visual inspection of duct interiors with a borescope or similar instrument. If larger inspection holes are required, follow procedures in Section III of this manual.

When cutting inspection holes in ducts, avoid areas where there is visual evidence of locations of fasteners, reinforcements, or attachment points for equipment and accessories. Visually inspect interior surfaces of all supply and return ductwork in the system to determine the extent of contamination (i.e. whether localized in one area

of the system, or occurring throughout), through inspection holes cut at suitable intervals along the length of the duct.

Wherever mold growth or other foreign matter is observed in the ducts (except for dirt accumulation no greater than a light film), collect samples for analysis before selecting a cleaning strategy.

DETAILED INSPECTION PROCEDURES

- Check to see that all air dampers, whether manual or motorized, are operable as designed and in their recommended position. NOTE: Mark positions of all dampers so they may be restored to those positions after completion of inspection and cleaning work.
- Inspect air filtration equipment throughout the system, checking the condition of all filter media to ensure proper fit, cleanliness, absence of moisture, and possible contaminants.
- Inspect coils for cleanliness, clear air flow, and absence of leaks. There should be no visible evidence of microbial amplification or standing water in drain pans.
- Inspect central heating and cooling units, including humidifiers, variable air volume units, re-heat coils, and other equipment to ensure that they are operating properly. If there are fibrous glass thermal or acoustical insulation components in any equipment, make sure these components are clean and dry, showing no evidence of microbial amplification and no signs of physical damage or deterioration. Otherwise, remove and replace with new material.

• Check for the presence of internal reinforcement in fibrous glass ducts, installed to limit duct board deflection in some large span duct systems. Two types of reinforcement are used: exterior sheet metal channels (Fig. 1) and internal tie rods (Fig. 2). External channel reinforcement will not generally create a problem for the duct cleaning contractor.

However, internal tie rod reinforcement members

may interfere with duct cleaning equipment, may preclude the use of power brushing as a cleaning method, and will require care in the use of cleaning equipment to avoid damage.

• After the inspection is complete and the inspector’s report carefully reviewed, the scope of work should be determined. Duct cleaning specifications should be drafted by a qualified indoor air quality consultant or mechanical engineer.

• Inspection holes should be closed before duct cleaning begins. Refer to Section V of this manual for closure procedures.

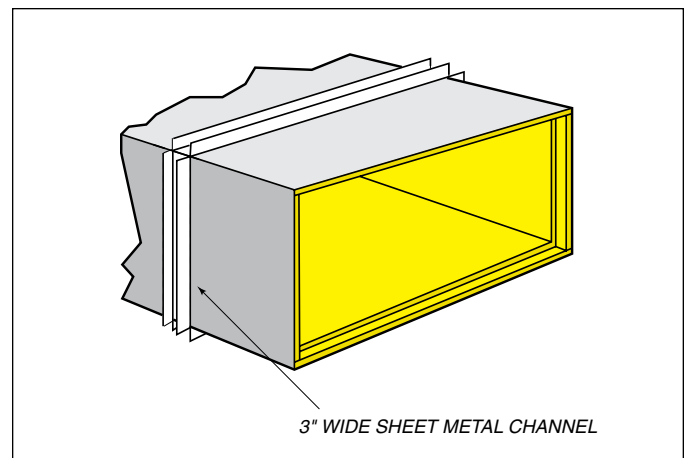


Fig. 1. Fibrous glass duct with channel reinforcement.

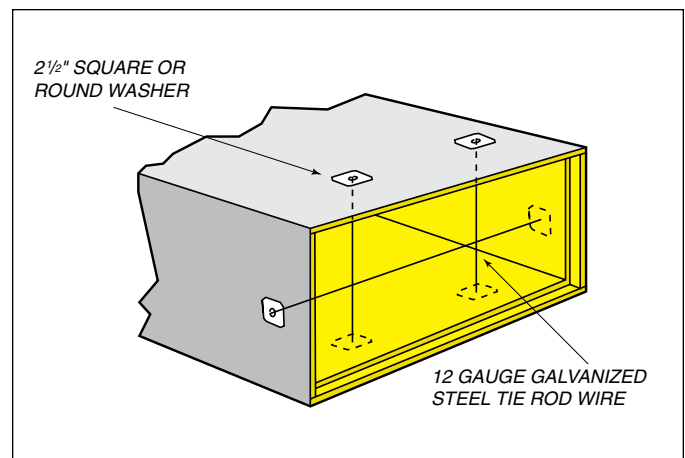


Fig. 2. Fibrous glass duct with tie rod reinforcement.

SECTION III - OPENING DUCTWORK

ACCESS THROUGH EXISTING OPENINGS

Access to duct interiors to permit entry of cleaning equipment should, wherever possible, be through existing openings such as access doors and openings for grilles, registers and diffusers. However, it will almost always be necessary to cut through duct walls to insert cleaning equipment where locations at a distance from existing openings must be treated.

Regardless of the type of duct construction and insulation, it is important that openings for cleaning access be made so that when cleaning is completed and the openings are closed they will be airtight. The insulation must be replaced or repaired so that there are no gaps or openings that would form paths for heat loss or gain through duct walls, or for water vapor condensation to occur.

It should rarely be necessary for workers to enter the duct system themselves, either for inspection purposes or to perform cleaning work. If this should be required, workers should first assure themselves that the duct system is strong enough, and sufficiently well supported, to sustain the added weight load. Internal thermal or acoustical insulation must be protected to prevent damage by workers moving within ducts. (Fibrous glass duct systems are not designed to support the added weight of human traffic.)

The following pages cover detailed procedures to be followed when cutting openings in each of the five basic types of insulated duct systems:

- Fibrous glass duct board;
- Lined sheet metal ducts;
- Wrapped sheet metal ducts;
- Metal ducts insulated with rigid fibrous glass board;
- Flexible ducts.

Included are guidelines on how to visually identify the particular type of duct system.

Opening other types of ducts:

Several types of specialty insulated sheet metal duct systems are in use. For instructions on how to open, inspect, clean, and close these specialty systems, their manufacturers should be consulted.

OPENING FIBROUS GLASS DUCTS

How to identify fibrous glass ducts:

See Fig. 3. Look for:

- Scrim-reinforced aluminum foil (FRK) facing. (Some older fibrous glass duct systems may have smooth aluminum foil (FR) facings showing no scrim pattern.)
- The duct board manufacturer's name and product identification printed on the facing. The board should be marked 475, 800 or 1400. These numbers indicate duct board stiffness. Type 1400 is the stiffest.
- Duct board will be either 1" (25mm), 1½" (38mm), or 2" (51mm) thick. Thickness should be printed on the facing.
- Duct sections will usually be taped together with aluminum foil tape bearing the manufacturer's name; recently built systems will have tape marked "UL 181A/P" or "UL 181A/H." Occasionally, fiber glass fabric and mastic connections will be found.

Tools required:

- Special duct board shiplap cutting tool.
- Sharp insulation knife.
- Protective equipment.

Opening the duct:

See Fig. 4.

- Determine location and width of opening. Height should be full panel dimension.
- Draw straight lines representing opening.
- Cut along lines A - B and A' - B' with shiplap tool in position shown. Pull firmly to cut through facing and insulation.
- Cut through facing only along either line A - A' or line B - B' — whichever one does not lie along the longitudinal taped corner of the duct. The fourth line (the one not cut) will form a hinge for a "door" to the opening. This door can be lifted up or dropped down out of the way, depending on where the taped corner is.
- If the opening doesn't have to be more than 3" (75mm) in either dimension, use the shiplap tool to cut all around the opening lines. Save the removed piece of duct board to plug the opening after cleaning is complete. See Fig. 5. A line drawn across the opening area before cutting will help to position the plug for closing.
- Small holes can also be cut with a straight knife held at a 45° angle to make a "pumpkin" cut. See Fig. 6.



Fig. 3. Fibrous glass duct (rectangular).

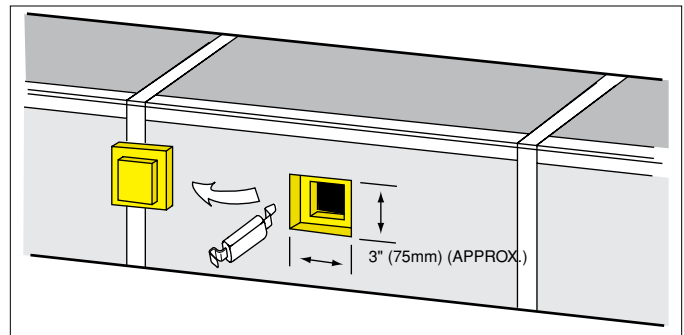


Fig. 5. Cutting small opening in fibrous glass duct.

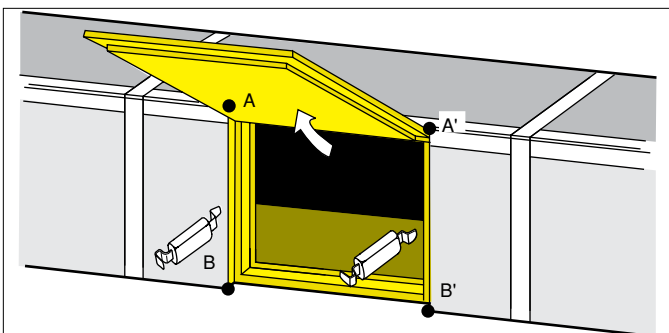


Fig. 4. Cutting large opening in fibrous glass duct.

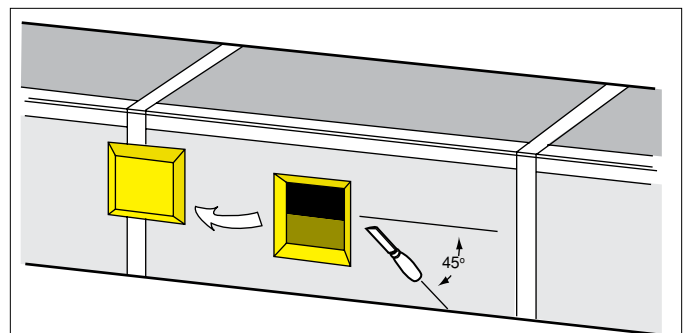


Fig. 6. Making "pumpkin" cut in fibrous glass duct.

OPENING LINED SHEET METAL DUCTS

How to identify lined sheet metal ducts:

See Fig. 7. Look for:

- Smooth sheet metal exterior.
- Rectangular shape.
- Visible evidence of locations of fasteners used to secure fibrous glass duct liner to the inside of the duct. These are usually 12" (300mm) to 18" (450mm) apart.

Tools required:

- Sheet metal shears.
- Sharp insulation knife.
- Drill.
- Protective equipment.

Opening the duct:

See Fig. 8.

- Determine location and dimensions of opening.
- Draw straight lines on the duct that establish the height and width of the opening.
- Drill two overlapping holes through sheet metal only at one corner of these lines. The overlapping holes should be just large enough to serve as a starting point for cutting the opening with shears. Do not drill through insulation.

- Cut along drawn lines with shears. Carefully loosen the sheet metal piece from the insulation inside the duct, and discard it.
- Draw straight lines approximately 1/2" (15mm) outside all four sides of the opening. These establish the size of a sheet metal patch approximately 1" (25mm) larger in both dimensions than the opening. This patch will be used to close the duct.
- Cut through the insulation with the knife around three sides of the opening at a 45° angle. Leave the upstream side uncut. See Fig. 9.
- Carefully pull the insulation out through the opening, bending at the upstream side so that the surface opposite the airstream surface is the most tightly folded. Tape it out of the way.

NOTE: If the duct is lined with rigid liner board insulation rather than flexible duct liner, the insulation must be cut away on all four sides and removed. See Fig. 10. Duct liner board can be distinguished from flexible duct liner by its board-like rigidity and yellow base color. It also has a black airstream coating. Most duct liners have dark-colored base material; airstream surfaces are either smooth black coatings or dark-colored mats.



Fig. 7. Sheet metal duct with fibrous glass duct liner.

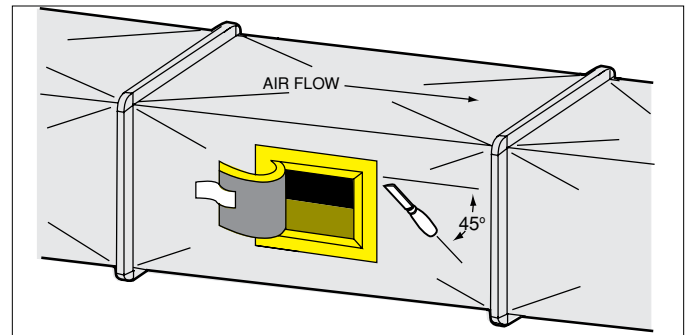


Fig. 9. Cutting into duct liner at 45° angle.

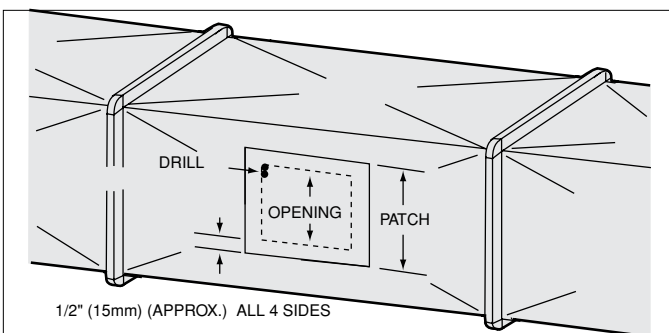


Fig. 8. Laying out location for opening in sheet metal.

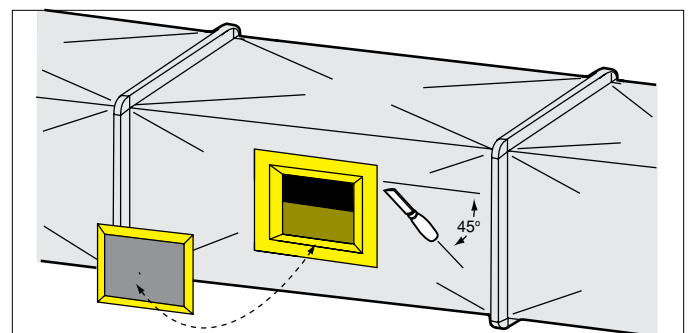


Fig. 10. Cutting hole in duct liner board.

OPENING WRAPPED SHEET METAL DUCTS

How to identify wrapped sheet metal ducts:

See Fig. 11. Look for:

- Flexible, faced insulation wrapped around the duct exterior.
- Facing - either scrim reinforced aluminum foil or plastic film.
- Manufacturer's name and insulation type printed on the facing.
- R-value of insulation printed on the facing.
- Wrapped ducts may be rectangular, round, or oval.

Tools required:

- Sheet metal shears.
- Sharp insulation knife.
- Drill.
- Protective equipment.

Opening the duct: See Fig. 12.

- Determine location and dimensions of opening. Avoid locations where mechanical fasteners may have been installed to prevent insulation from sagging.
- Using a sharp knife, carefully cut through the duct wrap around three sides of the area where the opening will be made, staying about 4" (100mm) to 6" (150mm) outside the opening location.
- Tuck the flap of insulation up and out of the way under the uncut duct wrap above the opening. See Fig. 12.
- Draw straight lines on the duct that establish the height and width of the opening.
- Drill two overlapping holes through sheet metal only at one corner of these lines. The overlapping holes should be just large enough to serve as a starting point for cutting the opening with shears. See Fig. 13.
- Cut the opening along drawn lines with shears.
- Discard the piece of sheet metal.
- Draw straight lines approximately 1/2" (15mm) outside all four sides of the opening. See Fig. 14. These establish the size of a sheet metal patch approximately 1" (25mm) larger in both dimensions than the opening. This patch will be used to close the duct.



Fig. 11. Sheet metal duct with fibrous glass wrap.

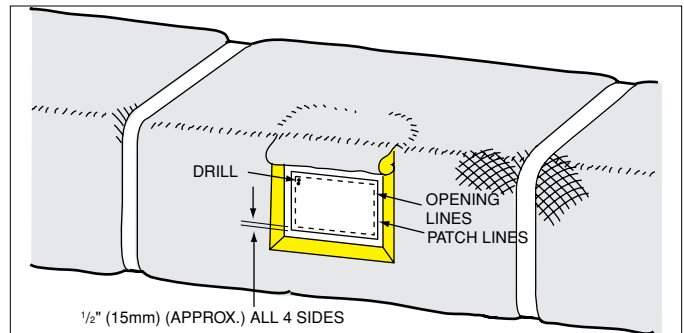


Fig. 13. Laying out opening in sheet metal.

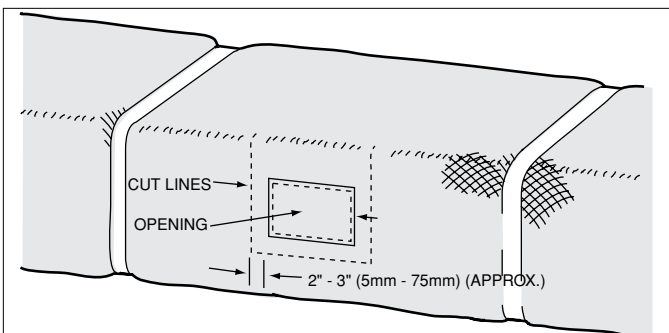


Fig. 12. Cutting duct wrap away from opening area.

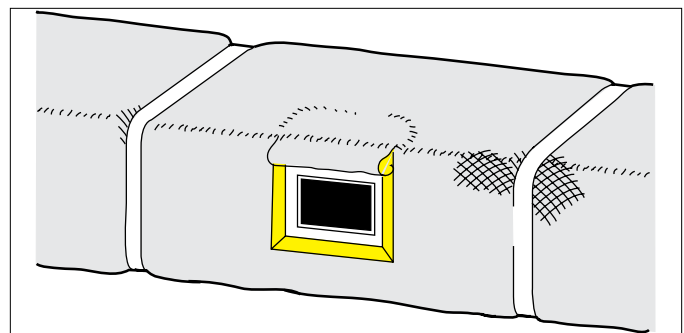


Fig. 14. Cutting opening in duct, wrap out of the way.

OPENING METAL DUCTS INSULATED WITH RIGID FIBROUS GLASS BOARD

Insulation on outside of sheet metal duct:
See Fig. 15.

Tools required:

- Sharp insulation knife.
- Sheet metal shears.
- Drill.
- Protective equipment.

Opening the duct:

- Draw cutting lines about 2" (50mm) to 3" (75mm) larger in both dimensions than the desired access opening. Stay at least 3" (75mm) from duct corner.
- Cut through insulation (and facing, if present) with sharp knife along these lines. Remove piece of insulation, saving it for use as a closure plug.
- Draw straight lines that establish the height and width of the desired opening.
- Drill two overlapping holes through the duct at one corner of these lines. The overlapping holes should be just large enough to serve as a starting point for cutting the opening with shears. See Fig. 15.
- Cut along drawn lines with shears. Remove and discard piece of sheet metal.
- Draw straight lines approximately 1/2" (15mm) outside all four sides of the opening. See Fig. 16. These establish the size of a patch approximately 1" (25mm) larger in both dimensions than the open-

ing. This patch will be used to close the duct.

Insulation inside sheet metal duct: See Fig. 16.

Tools required:

- Sharp insulation knife.
- Sheet metal shears.
- Drill.
- Protective equipment.

Opening the duct:

- Determine location and dimensions of opening.
- Draw straight lines on the duct the size of the opening plus 1/2" (15mm) on all four sides. These lines establish the size of the sheet metal patch required when closing.
- Drill two overlapping holes through sheet metal only at one corner, staying 1/2" (15mm) inside drawn lines. Do not drill into insulation.
- Cut along opening lines with shears, staying 1/2" (15mm) inside drawn lines. Carefully loosen the sheet metal piece from the insulation inside, and discard it.
- Cut the insulation on all four sides, holding knife at a 45° angle to make a "pumpkin" cut, and remove it. Save it for use as a plug when closing the duct.

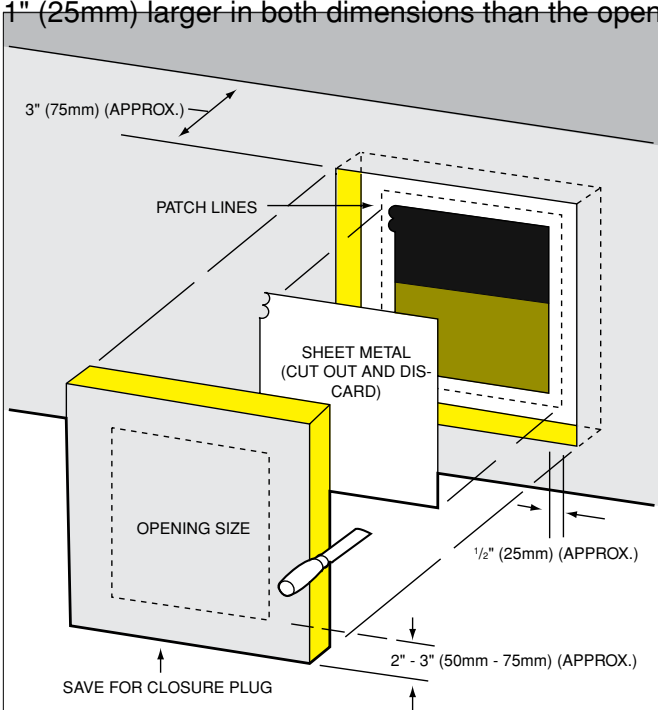


Fig. 15. Opening when insulation is outside duct.

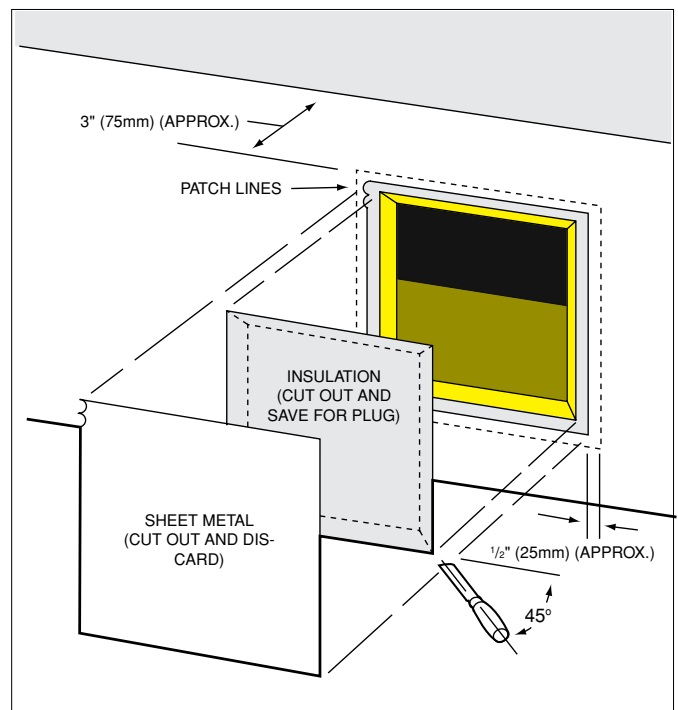


Fig. 16. Opening when insulation is inside duct.

OPENING INSULATED FLEXIBLE DUCTS

How to identify insulated flexible ducts:

See Fig. 17. Look for:

- A resilient, round inner air tube wrapped with fibrous glass insulation and sheathed with an outer jacket. This jacket may be an aluminum foil/polymeric film reinforced with scrim or strands, or an unreinforced polymeric film.
- Outside diameter generally between 6" (150mm) and 24" (600mm).
- The manufacturer name, product type, listing mark, R-value, and other information are generally printed on the facing.

Tools required:

- Shears or wire cutters.
- Screwdriver.
- Sharp insulation knife.
- Protective equipment.

Opening the duct:

See Figs. 18, 19, 20.

- Openings cannot be cut into insulated flexible ducts and later repaired, as with other types. They must be opened for inspection by disconnecting them from trunk ducts, plenums, equipment grilles, or registers at either or both ends.
- If the flexible duct is attached to a sheet metal collar with plastic closure straps, cut through the strap with wire cutters. See Fig. 18. If the flexible duct is attached to a sheet metal collar with a metal hose clamp, remove clamp using a screwdriver. See Fig. 19.
- If the flexible duct connection is taped to a sheet metal collar, loosen end of tape with knife and remove it. See Fig. 20.
- If the flexible duct insulation has been installed in such a way that the sheet metal collar must be removed from the trunk duct to disconnect the flexible duct, remove the collar. Slip the flexible duct off the sheet metal collar, or off the equipment flange or register boot.



Fig. 17. Insulated flexible duct.

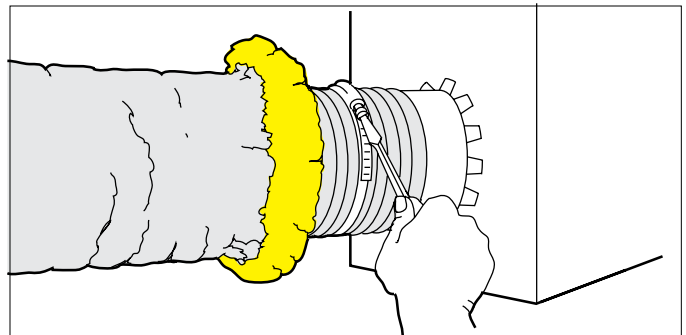


Fig. 19. Removing flexible duct by loosening hose clamp.

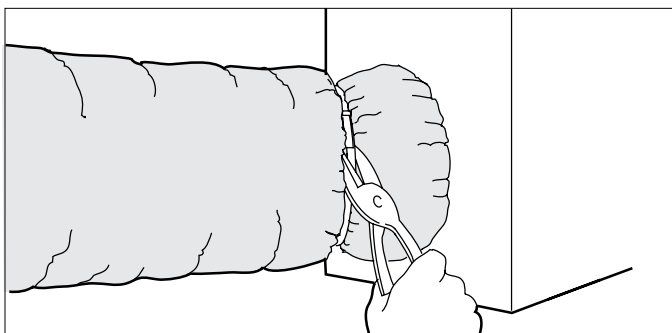


Fig. 18. Removing flexible duct by cutting closure strap.

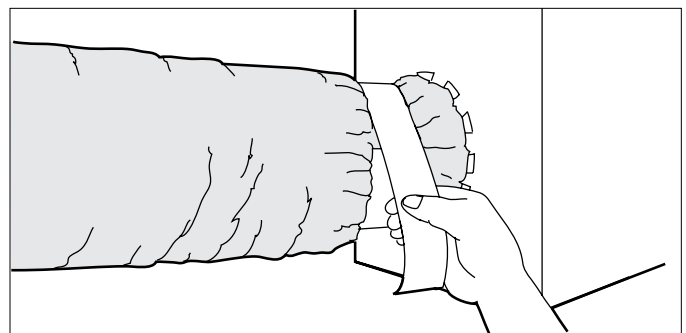


Fig. 20. Removing flexible duct by undoing tape.

SECTION IV – DUCT CLEANING

DUCT CLEANING TECHNIQUES

This section of the manual describes in general the three methods commonly used in cleaning ducts with fibrous glass insulation: contact vacuuming, air washing, and power brushing. In all cases, the sequence of work should follow the same principle.

Sequence of work:

Cleaning of ducts should be done at times when the building is unoccupied. The following sequence is recommended.

- Start at the fresh air and return intakes and proceed toward the central air handling equipment.
- Once the fresh air intake and return systems are completed, the central air handling equipment is cleaned.
- Proceed downstream from the central HVAC equipment via supply side trunk ducts and run-outs to registers and grilles. Work in the same direction as system air flow, to avoid re-contaminating any portion of the system previously cleaned.
- Sections of duct being cleaned should be sealed off from adjacent sections by closing dampers, or by plastic film barriers taped tightly in place. Before closing or moving dampers, mark their normal positions so they may be reset correctly after cleaning is completed.
- In branches or zones of supply duct systems, start work with the duct or branch farthest upstream.
- Work upstream in the branch toward the trunk duct connection. Proceed down the trunk to the next branch connection, clean that branch, then continue working downstream, until the entire zone has been cleaned.

CONTACT VACUUM METHOD

Principle of operation:

Of the three commonly employed cleaning methods described in this manual, contact vacuum cleaning of interior duct surfaces through openings cut into the ducts is least likely to damage fibrous glass insulation. Only HEPA (high efficiency particle arrester) vacuuming equipment should be used if discharge will be into occupied space.

Cleaning procedure: See Fig. 21.

- Direct (contact) vacuuming may require larger access openings in the ducts in order for cleaning crews to reach into all parts of the duct. Spacing between openings will depend on the type of vacuum equipment used and the distance from each opening it is able to reach.
- The vacuum cleaner head is introduced into the duct at the opening farthest upstream. Vacuuming proceeds downstream slowly enough to allow the vacuum to pick up all contaminants. The larger the duct, the longer this will take. Close observation of the process is the best way to determine how long it takes before duct interior surfaces are considered to be sufficiently clean.
- When observation indicates the section of duct has been cleaned sufficiently, the vacuum device is withdrawn from the duct and inserted through the next opening downstream, where the process is repeated.

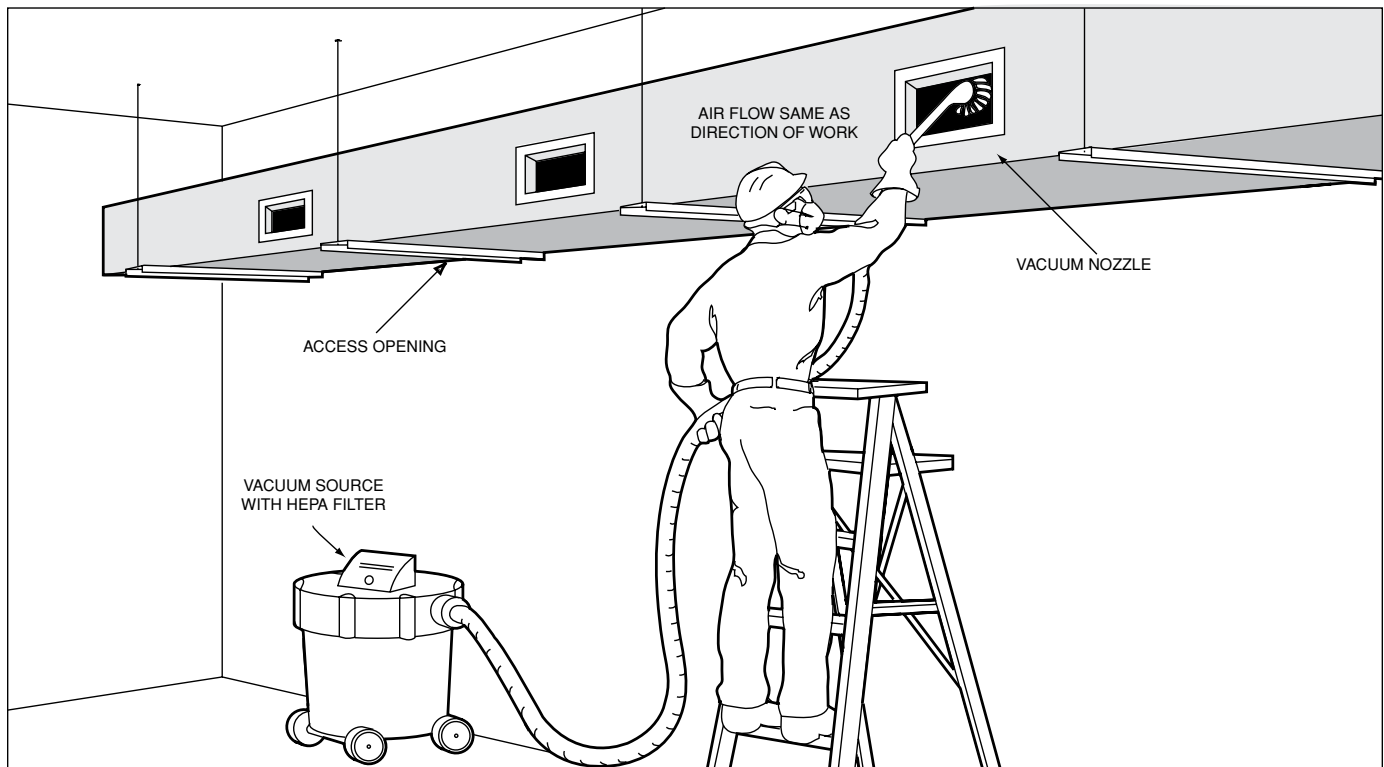


Fig. 21. Contact vacuum cleaning with HEPA filter vacuum source.

AIR WASHING METHOD

Principle of operation:

A vacuum collection device is connected to the downstream end of the section being cleaned through a predetermined opening. It is recommended that the isolated area of the duct system being cleaned be subjected to approximately 1" (250 Pa) static pressure to ensure proper transport of loosened material (taking care not to collapse the duct). Compressed air is introduced into the duct through a hose terminating in a "skipper" nozzle. This nozzle is designed so that the compressed air propels it along inside the duct. This dislodges contaminants which, becoming airborne, are drawn downstream through the duct and out of the system by the vacuum collection equipment. (Dirt and dust particles must be dislodged from duct surfaces and become airborne before they can be removed from the duct system.) If the vacuum collector will be discharging to occupied space, HEPA filtration should be used.

This method is most effective in cleaning ductwork no larger than 24" x 24" (600mm x 600mm) inside dimensions.

Cleaning procedure: See Fig. 22.

- Openings for cleaning purposes may need to be no larger than those cut for borescope inspection purposes. These should be drilled through the duct wall and the insulation (if present) at intervals which depend on type of equipment and duct size.
- The vacuum collection equipment is turned on and the proper negative pressure established. The compressed air hose with the skipper nozzle is inserted in the hole farthest upstream.
- The skipper nozzle is allowed to travel downstream slowly enough to allow the skipping motion to dislodge contaminants. The larger the duct, the more time cleaning will take; observation of the process in each case is the best way to determine how long. When observation indicates that the section of duct has been cleaned sufficiently, the compressed air hose is withdrawn from the duct and inserted in the next downstream hole, where the process is repeated. The condition of the cleaned section may be inspected with a borescope inserted in the hole.

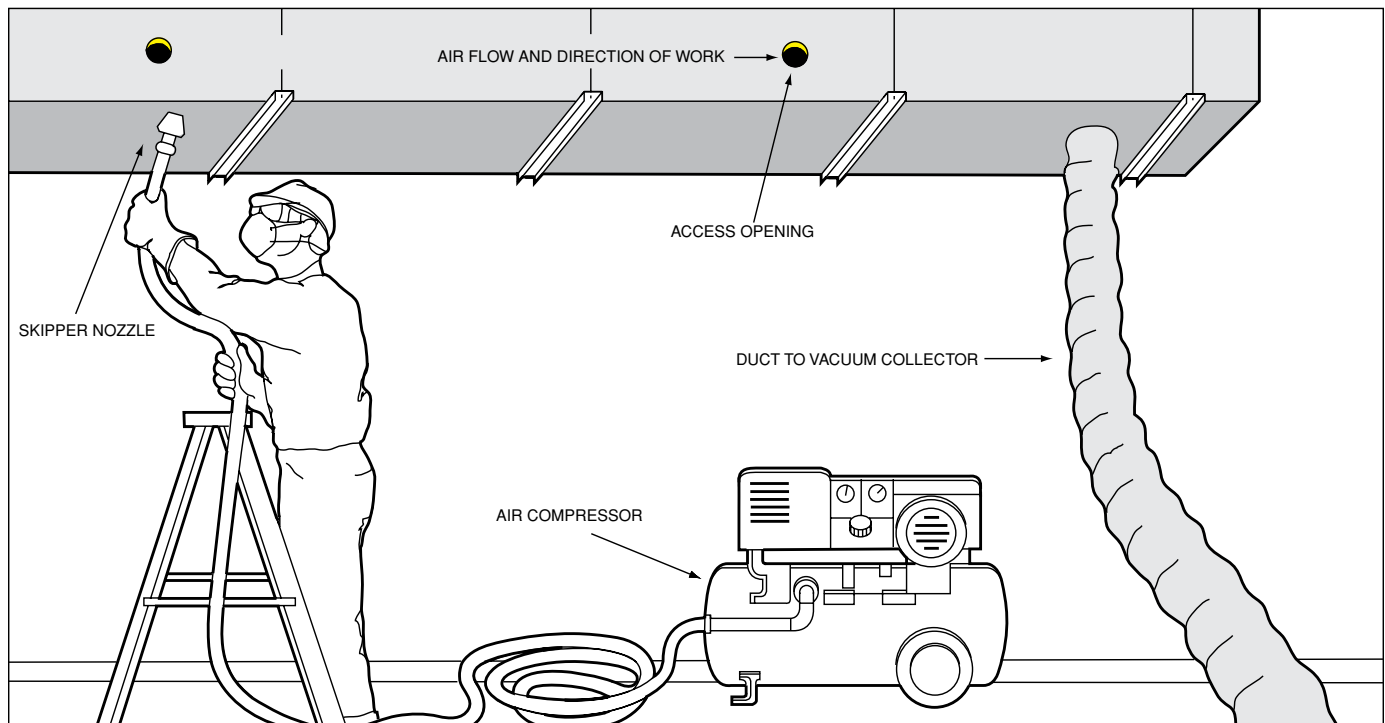


Fig. 22. Air washing. Skipper nozzle dislodges contaminants.

POWER BRUSHING METHOD

Principle of operation:

As with the air washing system, a vacuum collection device is connected to the downstream end of the section being cleaned through a predetermined opening. Pneumatically or electrically powered rotary brushes are used to dislodge contaminants which become airborne, are drawn downstream through the duct system, and are evacuated by the vacuum collector. Power brushing works satisfactorily with all types of ducts and all types of fibrous glass surfaces, provided the bristles are not too stiff nor the brush permitted to remain in one place for such a long time that it may damage the surfaces. If the vacuum collector discharges to occupied space, HEPA filtration should be used.

Bristle lengths should be carefully selected with respect to duct inside dimensions to avoid damaging the fibrous glass interior insulation surfaces.

NOTE: It may prove impossible to use the power brushing method to clean fibrous glass ducts with tie rod reinforcement (see page 7).

Cleaning procedure: See Fig.23.

- Power brushing will usually require larger access openings in the ducts in order for cleaning crews to reach inside and manipulate the equipment. However, fewer openings may be required; some power brushing devices are able to reach up to 20 feet (6 m) in either direction from an opening.
- Once the isolated section of the duct to be cleaned is under negative pressure as described in the air washing method, the rotary power brushing device is introduced into the duct at the opening farthest upstream. The brushes are worked downstream slowly to allow them to dislodge contaminants.
- Visual observation may help to determine how long it will take to clean the duct section sufficiently; the larger the duct, the more time this will take.
- When working in ducts with internal insulation, keep brushes in motion to avoid gouging or digging into the surfaces. When observation suggests the section of duct is sufficiently clean, the power brush is withdrawn from the duct and inserted in the next downstream opening, where the process is repeated.

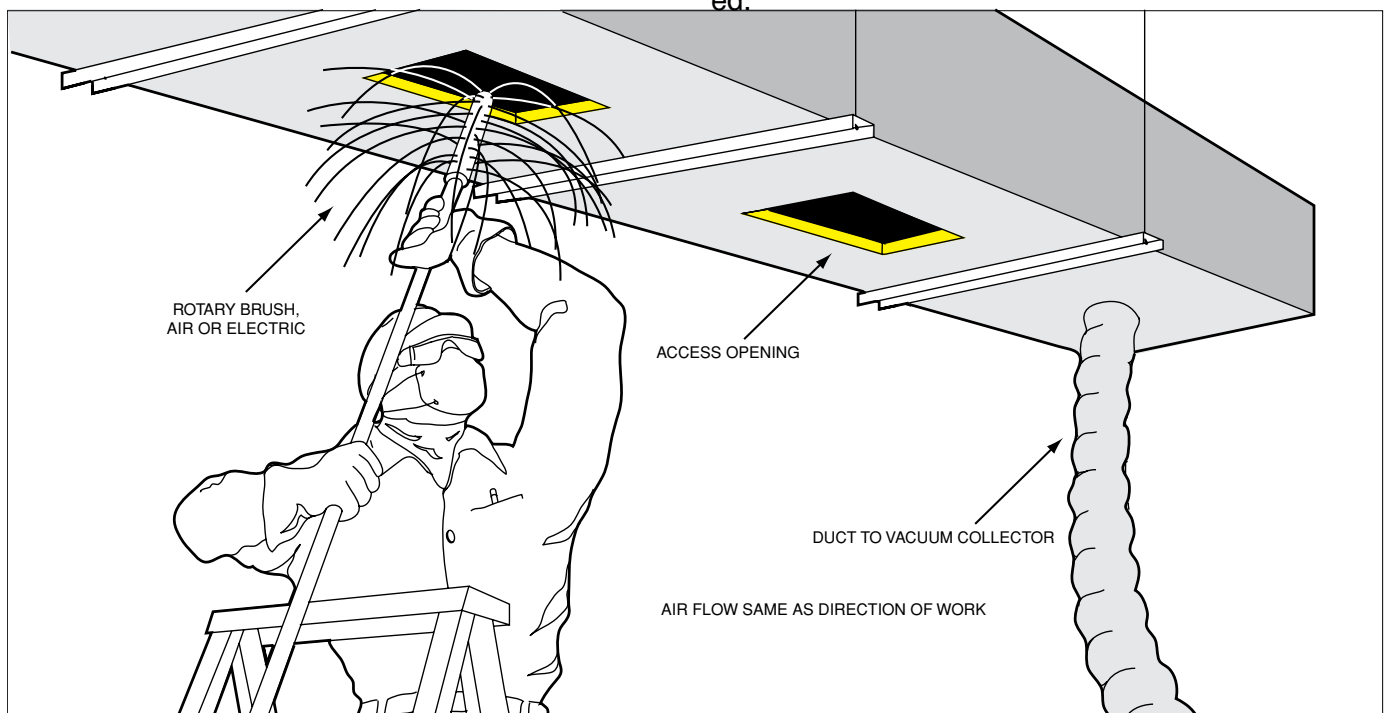


Fig. 23. Power brushing using pneumatic or electric equipment.

CLEANING HVAC EQUIPMENT

Whether or not any fibrous glass thermal or acoustical insulation elements are installed within equipment in the duct system, it is necessary to clean all components thoroughly and carefully. This will prevent any contamination that may be present in equipment from being blown into newly cleaned ducts when the HVAC system is turned back on. Cleaning of equipment should be done in accordance with manufacturers' instructions.

If there are fibrous glass thermal or acoustical elements present in any equipment, these should be thoroughly vacuumed with HEPA filtered vacuuming equipment and not permitted to get wet. If there is any evidence of damage, moisture, or microbial amplification, these elements should be removed and replaced with new fibrous glass duct liner material.

CAUTION: Before cleaning any powered equipment, make certain that power has been disconnected. Follow federal, state, or OSHA lock-out/tag-out regulations.

A secondary aspect of the duct cleaning process often involves the introduction of chemical "sanitizing" agents into the duct system in an attempt to kill all bacteria, germs, and fungi. Expert assistance should be sought to determine if this process is necessary, and what (if any) sanitizing agents should be used. NAIMA does not endorse or recommend any specific sanitizing agent.

Air purifier type chemicals sprayed into duct systems may have a "fresh" smell, but they provide no real lasting effects and in worst cases may further degrade indoor environmental quality.

Finally, few of these materials may have any significant positive effect. By simply atomizing them into the operating duct system, the majority of the material will be transported through the system and out into occupied spaces.

To be effective against microorganisms, a substantial portion of the contaminated surface would have to be treated, and there is little evidence that a sufficient amount of material can be deposited through long duct runs by the atomization process to provide any real benefit.

SEALING DUCT SYSTEMS

Manufacturers of sealants marketed to coat and seal duct surfaces assert that these sealants prevent the release of dust and dirt particles into the air stream. As with sanitizers, these materials are often applied by atomizing the sealant into the operating duct system. Tests evaluating the effectiveness of this process tend to indicate that materials introduced in this manner do not provide a complete coating of the duct interior surface, and thus may be of little benefit if total coating of the surface is the desired result.

The acoustical performance of fibrous glass duct interior surfaces may also be altered by applying sealants; this may adversely affect the ability of the insulation to control noise and cross-talk.

Application of these sealants may also alter the surface burning characteristics of fibrous glass duct materials. Underwriters Laboratories Inc. considers the listed surface burning characteristics of fibrous glass duct insulation materials to be voided by field application of a coating material to the inside of the ducts. Additionally, sealants must be examined for resistance to deterioration which could cause them to become contributors to airborne material. Other questions concerning the combustion toxicity of such products have not been fully answered.

Further, these materials must be thoroughly evaluated with regard to the outgassing of volatile organic compounds which could have negative health effects.

If sealants are to be used, it is essential that all interior duct surfaces be properly cleaned before their application.

Fibrous glass duct products are available with interior mat or coated surfaces which may provide additional isolation of the glass fibers from the air stream and further inhibit penetration of the insulation by contaminants. As with standard products, these products are also treated to resist microbial growth when tested in accordance with ASTM standard practices. NAIMA does not recommend the use of additional sanitizing and sealing agents on fibrous glass air stream surfaces. For further information, refer to NAIMA Publication AH125, *Facts About the Use of Biocides and Encapsulants with Fiber Glass Air Duct Insulations*.

SECTION V – CLOSING DUCTS

GENERAL CLOSING REQUIREMENTS

Two considerations are critical when closing openings in duct systems after cleaning is complete:

- The insulation must be replaced so there are no openings or gaps between replaced portions and the clean, undisturbed fibrous glass insulation. Openings and gaps are potential paths for heat gain or loss through the duct wall which degrade the thermal efficiency of the system, also compromising acoustical effectiveness.
- Patches over vapor barriers, whether aluminum foil (as with duct board or duct wrap) or sheet metal (as with lined or wrapped metal ducts), must be carefully sealed so that the system remains airtight and water vapor is retarded from entering the system and the insulation.

CLOSING FIBROUS GLASS DUCTS

Regardless of the method used in opening a fibrous glass duct, it is important that the opening be re-sealed using approved closure methods and materials.

Model codes and project specifications require that non-metallic duct construction, which includes fibrous glass ducts, shall conform to UL 181, Class 1 requirements. Only those closure systems that comply with UL 181A are suitable for use with fibrous glass duct systems. These closures include:

- Pressure sensitive aluminum foil tapes listed and labeled under UL 181A, Part I (P). Such tapes must be marked UL 181A/P.
- Heat activated aluminum foil/scrim tapes listed and labeled under UL 181A, Part II (H). Such tapes must be marked UL 181A/H.
- Mastic and glass fabric tape systems listed and labeled under UL 181A, Part III (M).

For specific closure instructions, refer to manufacturers' instruction sheets or to current edition of Fibrous Glass Duct Construction Standard, North American Insulation Manufacturers Association (NAIMA) Publication AH116, Section III.

Closure: See Fig. 26.

- If the opening was made by cutting on three sides and lifting up or dropping down the cut-away piece of duct board, this piece may be hinged back into place and tightly sealed on the three open sides with one of the above approved closure systems. Duct board surfaces to which tape will be applied must be clean and dry. Dust, dirt, oil, grease and moisture may result in bonding failure. Follow tape manufacturer's cleaning recommendations. Pressure sensitive tape should be rubbed down firmly until the scrim pattern of the fibrous glass duct board facing shows through.

- If the opening is small, and made with either the shiplap duct board tool or an insulation knife held at a 45° angle ("pumpkin" cut), push the duct board plug back into the opening, using the mark made to aid replacement in proper position. Seal all four sides with one of the approved closure materials. If using pressure sensitive tape, clean following tape manufacturer's recommendations and rub down firmly. See Fig. 25.

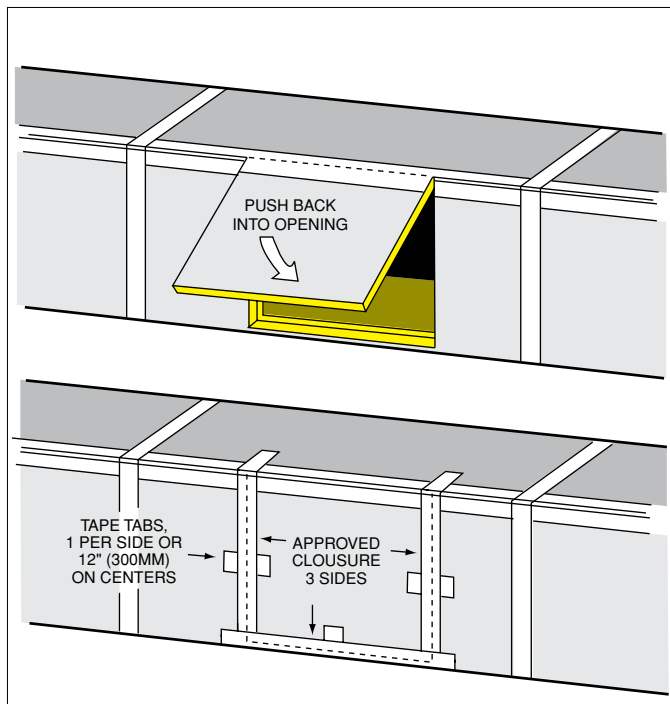


Fig. 24. Closing opening in fibrous glass duct

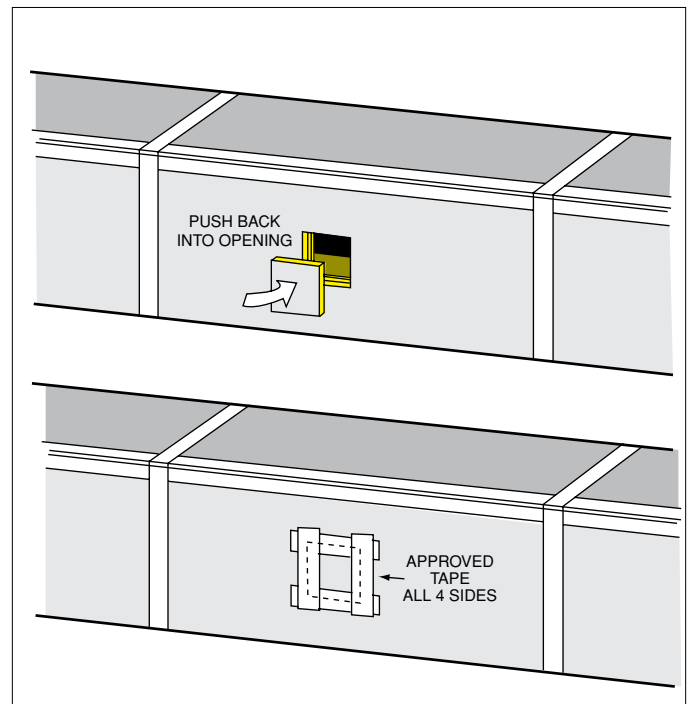


Fig. 25. Sealing closure with pressure sensitive tape.

CLOSING LINED SHEET METAL DUCTS

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

Closure: See Fig. 26.

- Coat edges of duct liner flap or cut-out piece with adhesive meeting requirements of ASTM C 916.
- Replace the flap or cut-out piece of duct liner in its original position, plugging the hole in the duct lining.
- Cut a sheet metal patch to dimensions drawn on duct after cutting the opening (see P. 10).
- Apply a bead of sealant around the opening (See Fig. 26). Sealant must be rated for system operating pressure and temperature.
- Apply adhesive to the duct liner and press the sheet metal patch in place over the flap or cut-out area.
- Screw the patch to the duct wall with sheet metal screws on 8" (200mm) (approx.) centers so that the patch will overlap the opening by about $\frac{1}{2}$ " (15mm) on all four sides. See Fig. 27.

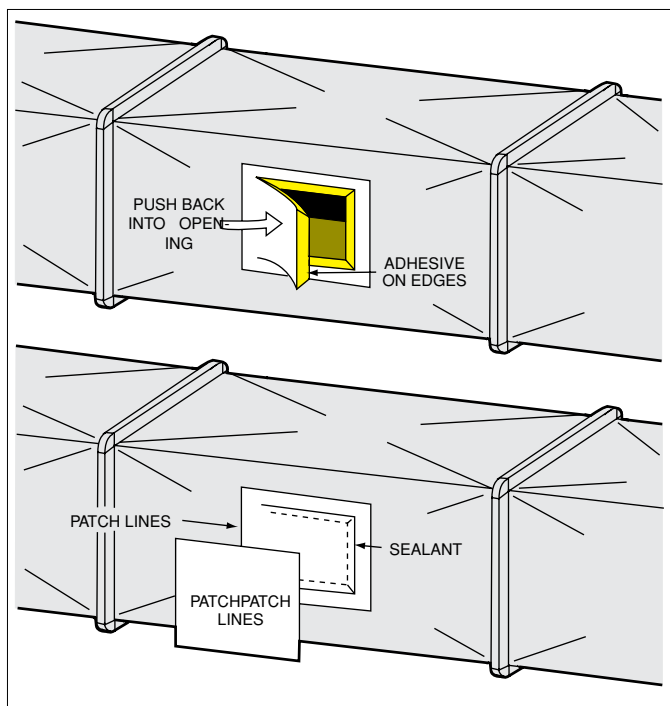


Fig. 26. Replacing duct liner insulation.

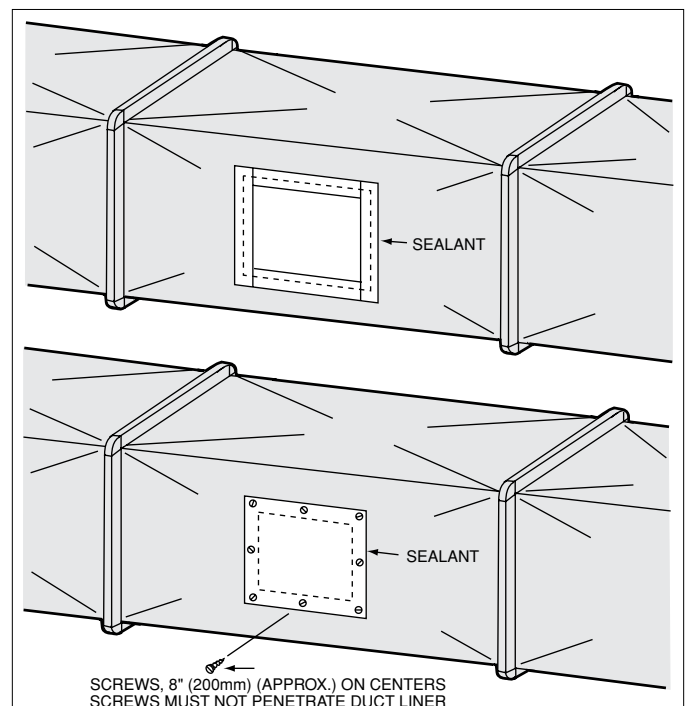


Fig. 27. Patching and sealing sheet metal.

CLOSING WRAPPED SHEET METAL DUCTS

It is important, when closing openings made in wrapped sheet metal ducts, to patch and seal the hole in the sheet metal duct as well as to patch and tape the foil facing of the duct wrap insulation.

Closure: See Fig. 28.

- Cut a sheet metal patch to dimensions drawn on duct after cutting the opening (see P. 11). Position the patch over the opening in the duct so that it overlaps about 1/2" (15mm) on all four sides.
- Apply a bead of sealant around the opening (Fig. 28). Sealant must be rated for system operating pressure and temperature.
- Screw the patch to the duct wall with sheet metal screws on 8" (200mm) (approx.) centers on all four sides.
- Re-position the cut-out flap of duct wrap so that it covers the patched sheet metal duct and so there are no gaps in the insulation. See Fig. 29. Seal the foil edges of the flap with approved tape matching the facing, pressing firmly to get a tight seal.

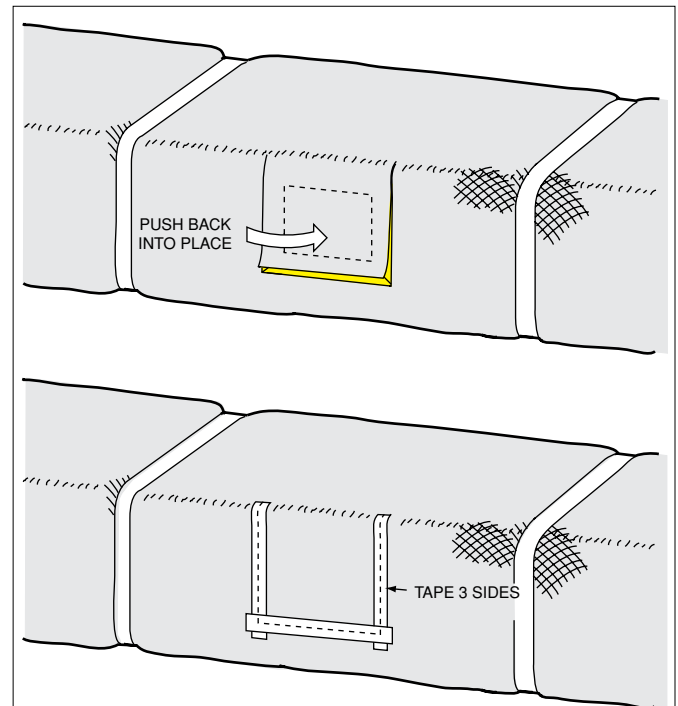
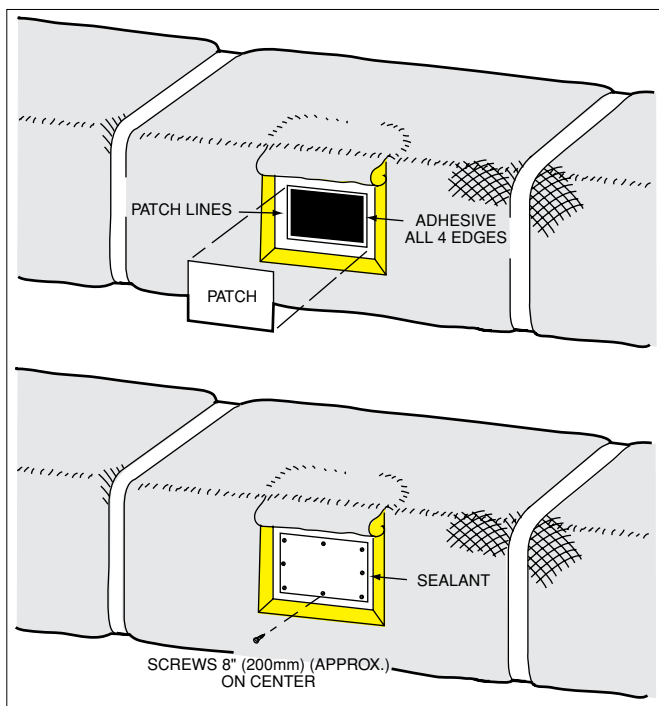


Fig. 28. Patching sheet metal duct with insulation wrap. Fig. 29. Patching and sealing duct wrap insulation.

CLOSING DUCTS INSULATED WITH RIGID FIBROUS GLASS BOARD

If the duct has exterior insulation:

- Cut a sheet metal patch to dimensions drawn on duct after cutting the opening (see P. 12).
- Apply a bead of sealant around the opening (Fig. 30). Sealant must be rated for system operating pressure and temperature.
- Position the patch over the opening in the duct so that it overlaps about 1/2" (15mm) on all four sides.
- Screw the patch to the duct wall with sheet metal screws on 8" (200mm) (approx.) centers on all four sides.
- Replace the insulation with the piece saved for this purpose when opening the duct, applying adhesive to edges. Replace and seal facing with appropriate tape or mastic. See Fig. 30.

If the duct has interior insulation:

- Replace the "pumpkin-cut" piece in the hole after applying adhesive to edges and to the outer surface. See Fig. 31.
- Cut a sheet metal patch to dimensions drawn on duct after cutting the opening (see P. 12).
- Apply a bead of sealant around the opening. Sealant must be rated for system operating pressure and temperature.
- Position the patch over the opening in the duct so it overlaps about 1/2" (15mm) on all four sides.
- Screw the patch to the duct with sheet metal screws on 8" (200mm) (approx.) centers on all four sides.

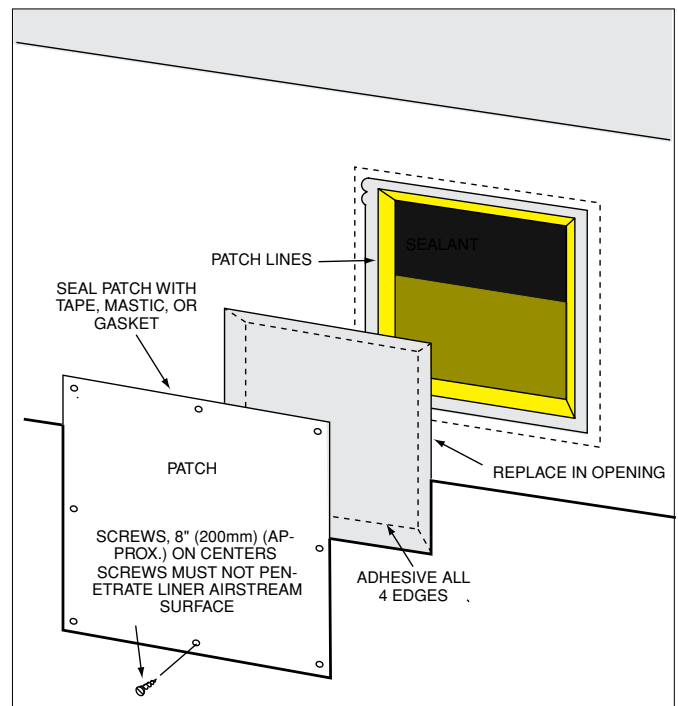
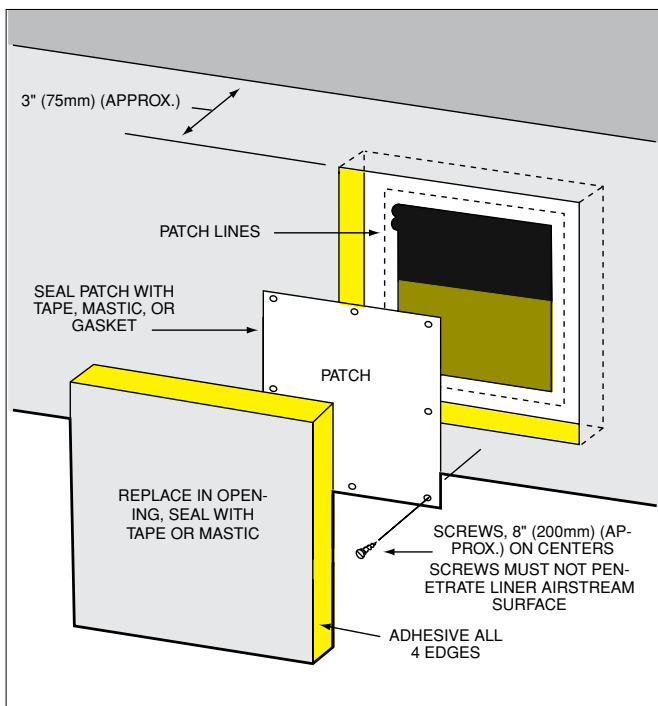


Fig. 30. Closing ducts with exterior fibrous glass board. Fig. 31. Closing ducts with interior fibrous glass board.

REPLACING FLEXIBLE DUCTS

Flexible ducts should be re-connected or spliced in accordance with their manufacturers' instructions, or guidelines given in *Flexible Duct Performance & Installation Standards*, Air Diffusion Council.

Connections

- Determine required length of duct. Cut all around and through duct with knife and scissors. Cut wire with snips or shears.
- Pull back jacket and insulation from core. Slide 1" (25mm) (min.) of core over collar or fitting. Tape with at least two full wraps of tape listed under UL 181B. Secure with approved clamp.

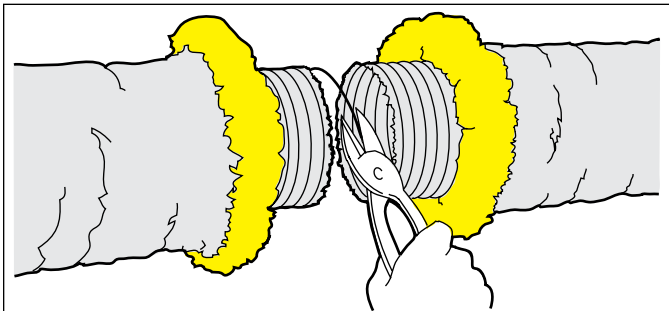


Fig. 32. Cutting flexible duct to required length.

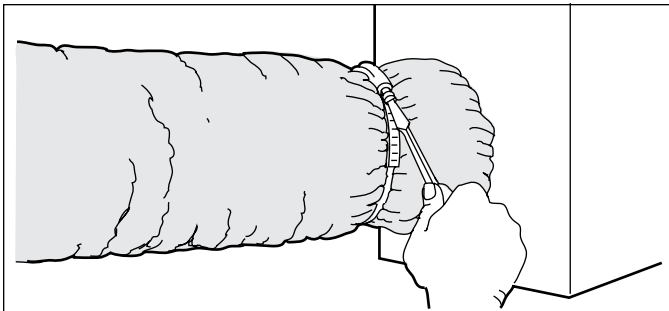


Fig. 33. Connecting flexible duct to collar or fitting.

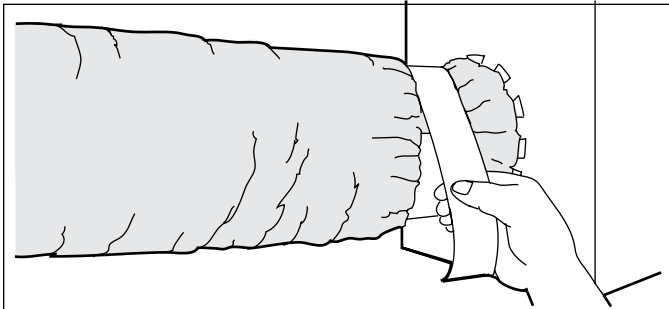


Fig. 34. Taping connection to collar or fitting.

- Pull jacket and insulation back over core. Tape jacket with two full wraps of tape listed under UL 181B. Approved clamp may be used in place of, or in addition to, UL 181B listed tape.

Splices

- Peel back jacket and insulation from core. Butt the two cores together over a standard 4" (100mm) metal sleeve.
- Tape core together with at least two full wraps of tape listed under UL 181B and secure with two approved clamps.
- Pull jacket and insulation back over cores. Tape jackets together with two full wraps of duct tape.

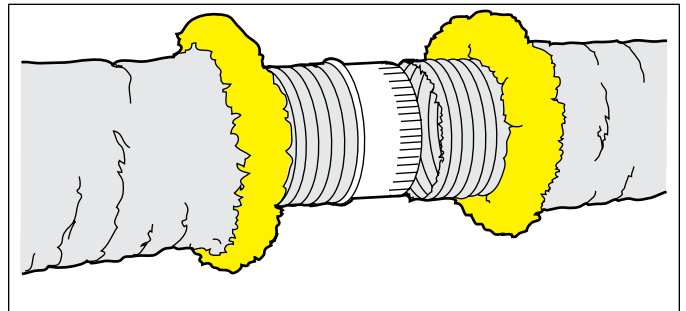


Fig. 35. Connecting ducts with metal sleeve.

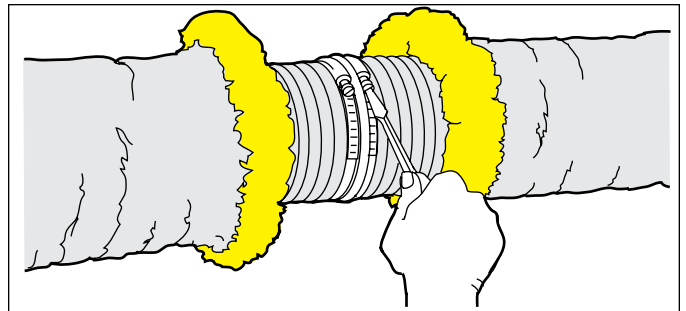


Fig. 36. Taping and clamping the splice

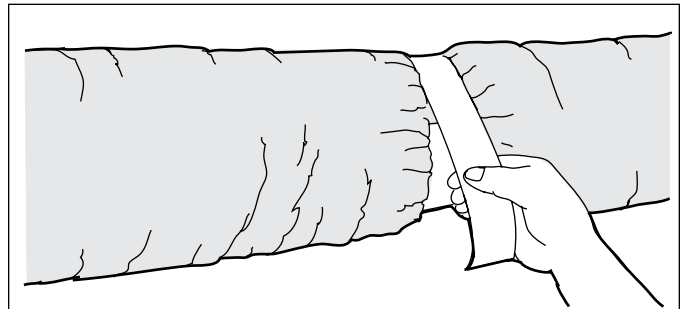


Fig. 37. Taping flexible duct jackets at splice.

FINAL INSPECTION

After all cleaning work is complete and all inspection and cleaning holes have been properly closed and sealed, a final inspection of the entire HVAC system should be conducted. This inspection should include, at minimum, the following steps:

- Thoroughly clean and replace all grilles, registers, and diffusers.
- Thoroughly clean and replace all filters (if removed from equipment) in accordance with manufacturers' instructions.
- Restore all dampers to their original positions.
- Cover supply openings with a filter medium such as cheesecloth prior to system start-up to catch any loose material not removed during the cleaning process.
- Turn the HVAC system on and allow it to run until steady state operation is reached. NOTE: After cleaning, duct system air flow properties may have changed making it necessary to adjust dampers to restore desired air delivery. This should be performed by an individual or contractor qualified to perform air balancing.
- Remove the temporary filter medium from supply openings and, along with it, any loose material blown downstream and caught by the filter medium.

SECTION VI – APPENDIX

HOW HVAC SYSTEMS WORK

To communicate understanding of the role of ductwork in an HVAC system, as well as comprehension of the many other factors that may be involved in a potential duct cleaning situation, it may be helpful to consider how a typical system works.

There are many different types of heating, ventilating and air conditioning systems, but all of them generally consist of the same basic components and all do basically the same thing. See Fig. 38. the central equipment (B) draws air into the system from outside the building via a fresh air intake (A) or from occupied spaces within, filters it, heats or cools it, and distributes it through supply ducts (C) to occupied spaces within the building. Return ductwork (D), if present, provides a path for air to be drawn back into central equipment, where it may be recirculated into the supply system after again being filtered, heated or cooled, or from where it may be exhausted outside the building.

WHY INSULATE DUCT SYSTEMS?

HVAC duct systems may be insulated for three reasons:

- To control heat loss or gain through duct walls as conditioned air moves from heating and/or cooling equipment to occupied spaces. This contributes to energy efficiency as well as occupant comfort.
- To control noise emanating from heating and cooling equipment, generated by air movement through the ducts, or caused by “cross-talk” between rooms. This helps to create a quieter, more pleasant working or living environment.
- To control moisture condensation on the outside of the duct (a frequent problem in warm, high-humidity climates). This helps prevent damage to the insulation, or to building components such as ceiling panels caused by water dripping from ductwork.

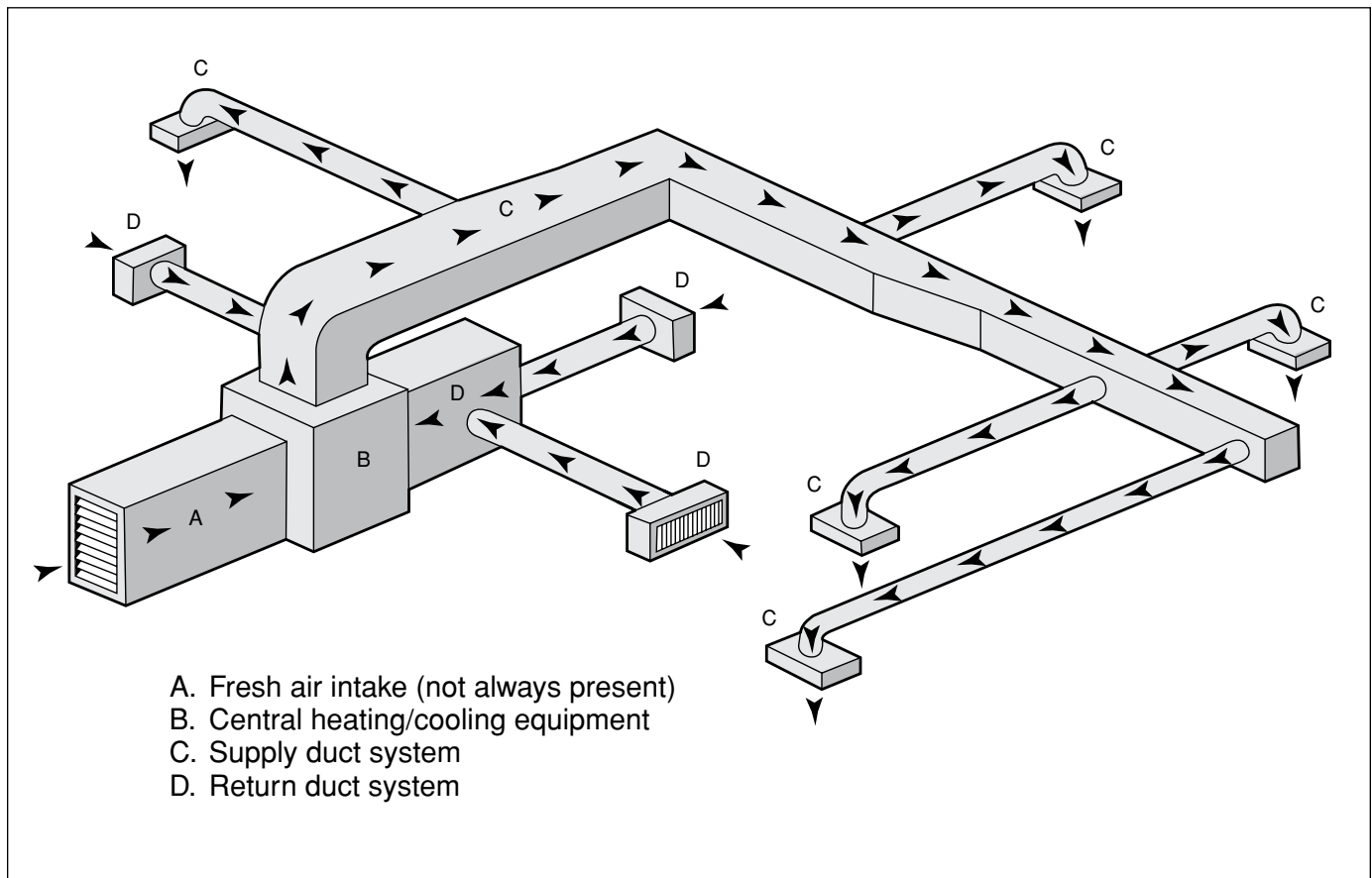


Fig. 38. Typical HVAC system schematic.

INSULATED DUCT SYSTEM TYPES

HVAC duct systems with fibrous glass insulation generally fall into one of the following categories:

Fibrous glass duct system:

Fibrous glass ducts are fabricated from 1" (25mm), 1½" (38mm), or 2" (51mm) thick boards of insulation material manufactured from resin bonded inorganic glass fibers. The outside surface of the board is a factory-applied reinforced aluminum/kraft laminate which serves as the air barrier and water vapor retarder. Products having mat-faced or coated airstream surfaces are available. The system controls heat loss or gain through duct walls, distributes air quietly, helps to control moisture condensation, and is substantially airtight when properly assembled and sealed. For more than forty years, fibrous glass duct systems have been widely used in both residential and commercial HVAC systems. See Fig. 39.

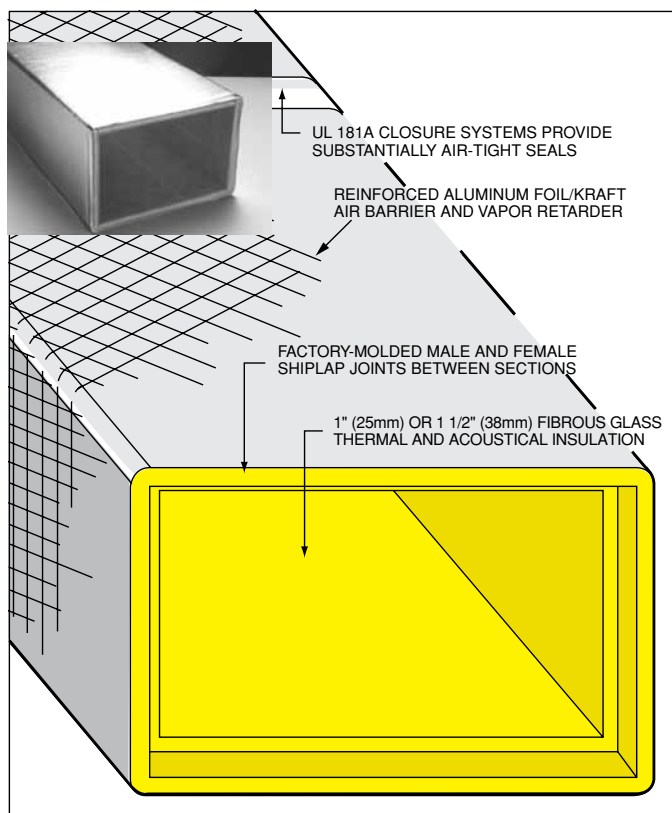


Fig. 39. Fibrous glass duct board system.

Sheet metal ducts lined with fibrous glass insulation:

Thermal and acoustical insulation may be applied to the inside of sheet metal ductwork in the form of fibrous glass duct liners to control heat loss or gain through duct walls, distribute air quietly, and control moisture condensation on the outside of the duct. These have coated or mat-faced airstream surfaces which resist damage during installation and in service.

Fibrous glass duct liner insulations are applied to the interiors of rectangular sheet metal ductwork with metal fasteners and adhesives. Both roll and board products are offered in a selection of several densities and thicknesses. See Fig. 40.

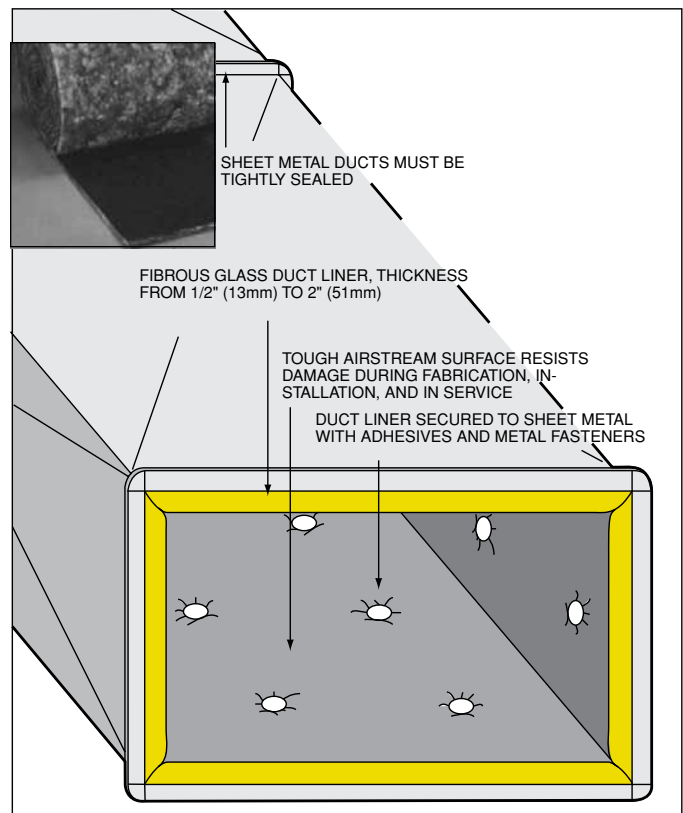


Fig. 40. Sheet metal duct lined with fibrous glass.

SECTION VI – APPENDIX

INSULATED DUCT SYSTEM TYPES

Sheet metal ducts with exterior fibrous glass insulation:

Flexible fibrous glass duct wraps are applied to the outside of the metal duct. Fibrous glass exterior duct insulation is useful in applications where noise control is not a problem but where heat flow through duct walls must be retarded and/or moisture condensation controlled. See Fig. 41.

Fibrous glass insulated flexible ducts:

Flexible ducts insulated with fibrous glass are an efficient and economical way to connect trunk ducts with room diffusers or registers. A spiral wire-reinforced inner air core is wrapped with light density fibrous glass insulation and jacketed with a flexible vapor retarder or reinforced foil or plastic film. This flexible product conforms to bends when connecting trunk ducts to diffusers, or when routing through obstructed areas. See Fig. 42.

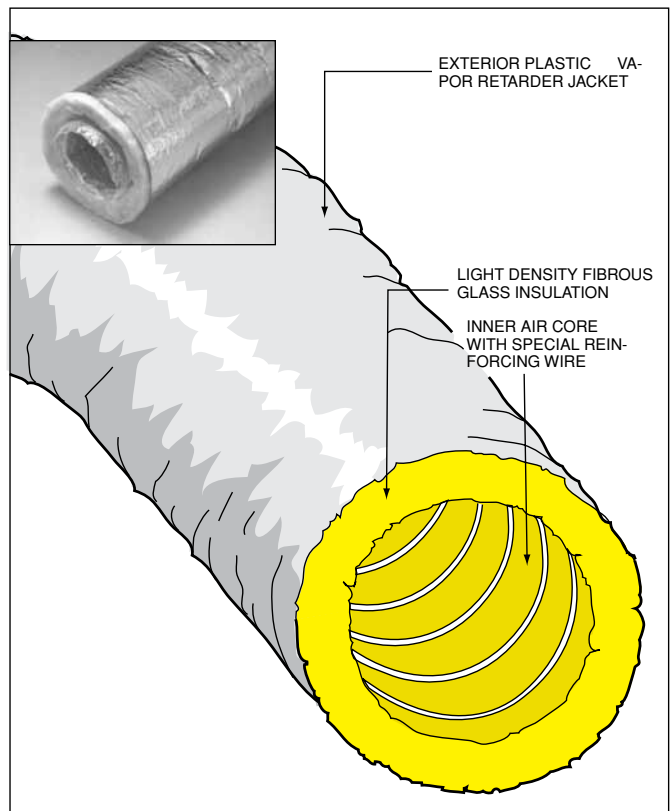
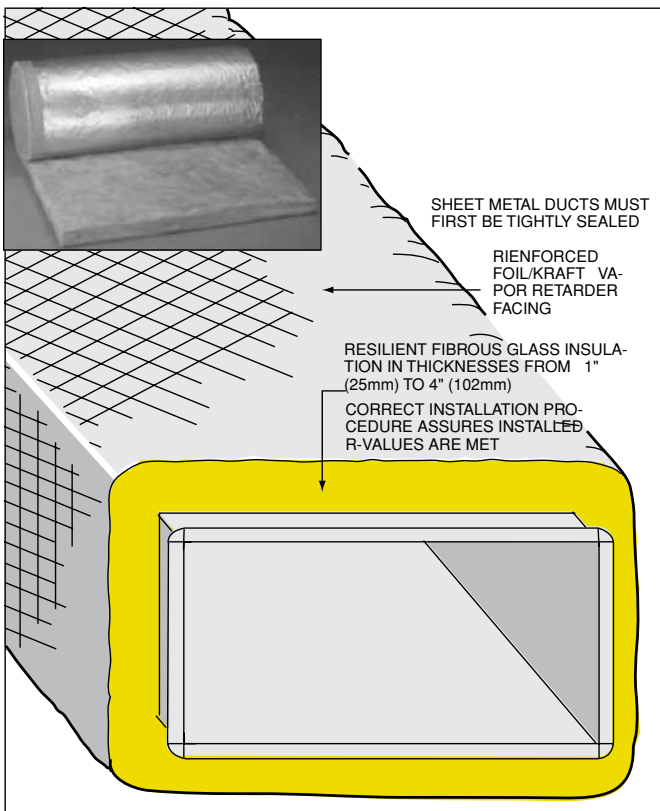


Fig. 41. Sheet metal duct with exterior wrap insulation. Fig. 42. Flexible duct

INSULATED DUCT SYSTEM TYPES

Rigid boards of fibrous glass insulation:

Rigid boards of fibrous glass insulation are available with reinforced foil or all-service jacket facings for use as exterior insulation on large metal ductwork (unfaced insulation boards are also available for field-jacketing applications). These boards are available in various densities and thicknesses. Some are flexible enough to conform to curved surfaces such as large diameter round or oval sheet metal ducts. See Figs. 43 and 44.

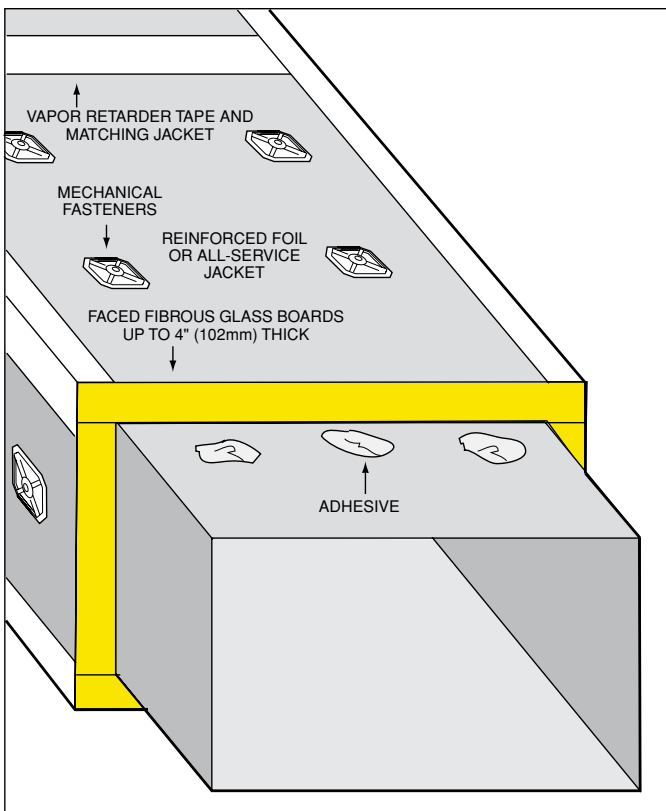
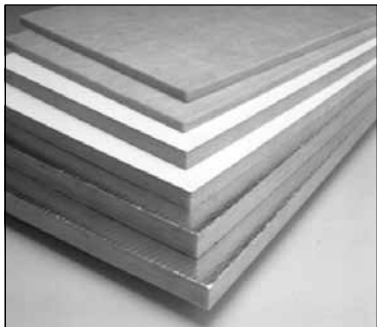


Fig. 43. Rigid fibrous glass board insulation.

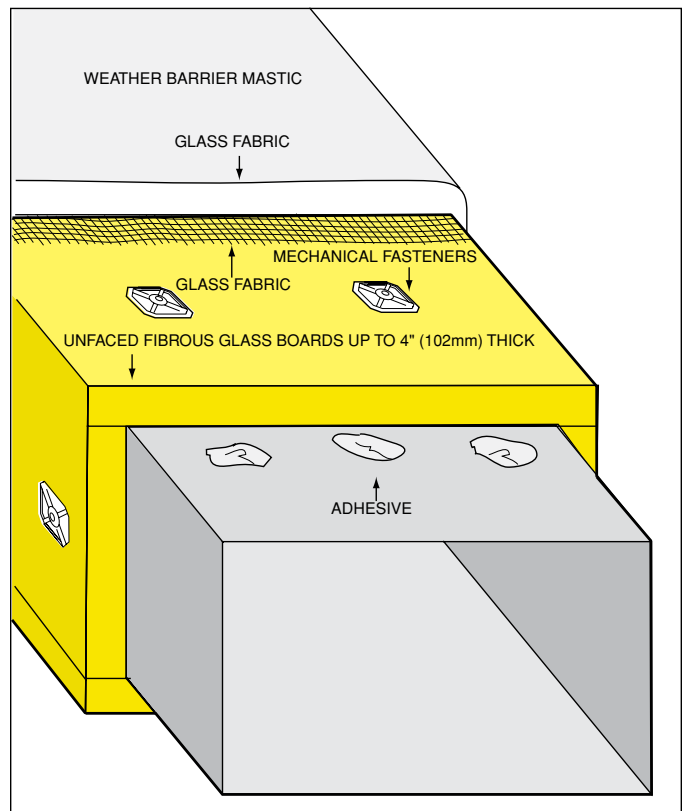


Fig. 44. Unfaced rigid fibrous glass board insula-

PROPERTIES OF INSULATED DUCT SYSTEMS

Fibrous Glass Duct Board Systems

Duct Board – UL Class 1 Air Duct Rating:

When ducts must conform to NFPA Standard 0A/90B and/or model codes, fibrous glass ducts are required to conform to the following requirements.

1. They shall be constructed of Class I duct materials as tested in accordance with Underwriters Laboratories Standard for Factory-Made Air Ducts and Air Connectors, UL 181.
2. Such ducts shall be installed in accordance with the conditions of their listing.
3. They may not be used in air duct systems operating continuously with an air temperature higher than 250°F (121°C) entering the ducts.
4. They shall not be used as vertical risers in air duct systems serving more than two stories.

The following portions of UL 181 are applicable to rigid fibrous glass ducts:

- Surface burning characteristics (UL 723) - Class 1 Material:
- Flame spread 25 or less
- Smoke developed 50 or less
- Flame penetration
- Burning
- Corrosion (metal parts not inherently corrosion resistant)
- Mold growth and humidity
- Temperature
- Puncture
- Static load
- Impact
- Leakage
- Erosion*
- Pressure*
- Collapse*

*Erosion, pressure, and collapse tests are run at 2½ times manufacturers' stated ratings. For the erosion test, the variable is velocity. For the pressure test, the variable is positive pressure. For the collapse test, the variable is negative pressure.

Short Form Specification – Fibrous Glass Duct Board

All supply and return ductwork operating within the range of positive or negative 2" w.g. (500 Pa) static pressure, 2,400 fpm (12 m/sec) internal air velocity, and 250°F (121°C) internal air temperature shall be constructed of fibrous glass duct board with a Class 1 UL 181 rating of one of the following types:

1. 1" (25mm) thick
R value at 75°F mean, hr·ft²·°F/Btu, 4.3
(RSI value at 24°C mean, m²·°C/W, 0.76)
2. 1½" (38mm) thick
R value at 75°F mean, hr·ft²·°F/Btu, 6.5
(RSI value at 24°C mean, m²·°C/W, 1.14)
3. 2" (51mm) thick
R value at 75°F mean, hr·ft²·°F/Btu, 8.7
(RSI value at 24°C mean, m²·°C/W, 1.53)

Fabrication and installation of fibrous glass duct shall conform to the requirements of the North American Insulation Manufacturers Association's Fibrous Glass Duct Construction Standard, current edition, and/or to the duct board manufacturer's recommendations.

Fabrication and installation of flexible duct components shall conform to the requirements of the above plus those published in the current edition of the Air Diffusion Council's *Flexible Air Duct Performance & Installation Standards*. Flexible duct shall have a Class 1 UL 181 listing.

The closure system shall meet the requirements of UL 181A (for fibrous glass duct board) or UL 181B (for flexible duct). Application shall comply with pro-

Characteristics and limitations - fibrous glass duct board

Flexural Rigidity: Average in the board, not less than rating of 475, 800 or 1400 pounds-inches² (1310 kPa, 2207 kPa, or 3863 kPa) per inch of width when tested in accordance with NAIMA Test Method AHS-100-74.

Maximum Static Pressure in Duct: 2" w.g. (500 Pa), positive or negative. For ducts operating at higher pressures, see manufacturers' literature.

Maximum Air Velocity in Duct: Rated at 2,400 feet per minute (12 m/sec) or greater. For higher air velocities, see manufacturers' literature.

Maximum Allowable Deflection: One one-hundredth of duct span.

Board Fatigue: No significant deformation or deficiency of duct sections after 50,000 cycles at 3 to 4 cycles per minute from zero to 1½" times operating pressure.

Water Vapor Sorption: Water vapor sorption of the duct board shall not exceed 5% by weight under conditions of 120°F (49°C) dry bulb at 95% relative humidity for 96 hours' duration when tested in accordance with ASTM C 1104.

Temperature: 250°F (121°C) maximum inside duct. 150°F (66°C) maximum duct surface temperature.

Corrosiveness: Non-corrosive in contact with galvanized steel, copper, or aluminum compared to control specimen in contact with clean sterile cotton when tested in accordance with ASTM C 665.

Safety Standards: National Fire Protection Association Standards 90A/90B.

Bacteria and Fungal Growth Resistance: Resists fungal and bacterial growth per UL 181, as well as when subjected to microbial attack as described in ASTM C 1338 and standard practices ASTM G 21 (fungus test) and ASTM G 22 (bacteria test).

Restrictions: Fibrous glass duct systems should not be used in the following applications:
 Kitchen or fume exhaust ducts, or to convey solids or corrosive gases.

Installation in concrete, buried below grade, or outdoors.

Immediately adjacent to high temperature electric heating coils without radiation protection. Refer to NFPA Standard 90A, and also to NAIMA *Fibrous Glass Duct Construction Standard* for proper design.

For vertical risers in air duct systems serving more than two stories.

With equipment of any type which does not include automatic maximum temperature controls.

With coal or wood fueled equipment.

As penetrations in construction where fire dampers are required, except as shown in NAIMA *Fibrous Glass Duct Construction Standard* with the fire damper installed in a sheet metal sleeve extending through the wall.

Mounting of accessories: When mounting equipment, dampers, damper operators, control motors, etc., the duct system shall be adequately reinforced and supported to accommodate the additional weight of the equipment without damage to the duct material. Particularly important is mounting both dampers and operators on the same sleeve or mounting plate.

Moisture control: The following precautions should be taken to avoid soaking of duct board with liquid water:

When using either evaporative coolers or humidifiers, the immediate area around the device introducing water into the system should be protected by using a drip pan and protective sheet metal sleeve.

Duct systems running through non-conditioned space and used for cooling only must be tightly closed to prevent accumulation of water vapor in the duct system during the heating season. (For further information, refer to NAIMA Publication AH107, *Preventing Moisture Accumulation in Ducts*.)

Fibrous glass duct materials that have become wet at the job-site before or during installation should not be installed. Duct systems which, in service, are found to be wet should be replaced. Consult the product manufacturer for further information.

Properties of Fibrous Glass Duct Liner Materials

Excerpts from NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems, 1989 Edition

Definition:

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 may be rigid or flexible, and 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.

Supplementary materials such as duct covering, duct linings, vapor barrier facings, adhesives, fasteners, tapes, and core materials added to air ducts, plenums, panels, and duct silencers used in duct system shall have a flame spread rating not over 25 without evidence of continued progressive combustion and a smoke developed rating no higher than 50. If air duct coverings and linings are to be applied with adhesives, they shall be tested as applied with such adhesives, or the adhesives used shall have a flame spread rating not over 25 and a smoke developed rating no higher than 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 devices.

Short Form Specification - Fibrous Glass Duct Liner:

All heating, cooling, and ventilation supply and return ducts operating at a maximum air velocity of up to 6,000 fpm (30.5 m/sec) and service temperature not exceeding 250°F (121°C) shall be lined with duct liner with a fire-and damage-resistant air 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, Type I (Flexible) or Type II (Rigid).

Duct liner shall be installed in accordance with the latest edition of North American Insulation Manufacturers Association's *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 surface treatment exposed to the air stream.

All interior surfaces of all ductwork and fittings shall be completely covered with duct liner without interruptions or gaps, except where required by code (as in areas of fire dampers or electric heaters.)

Adhesive designed for duct liner application, meeting requirements of ASTM C 916, shall be applied to the sheet metal with a minimum coverage of 90%. Unless factory-coated, all transverse edges and exposed longitudinal joints of the duct liner shall also be coated.

All joints shall be firmly butted without gaps. All rips and tears on the air stream surface shall be repaired by coating damaged areas with approved adhesive or coating, or the duct liner shall be replaced. Longitudinal corner joints may be folded and/or 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. Due to concerns with long term aging characteristics of adhesives, fasteners which rely on adhesive application are not recommended. Mechanical fasteners shall be installed perpendicular to the duct surface and shall not compress the insulation more than 1/8" (3mm). Longitudinal corner joints shall be overlapped and compressed.

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

Properties of Fibrous Glass Duct Wraps

Excerpts from NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems, 1989 Edition

Definition:

Air Duct Covering. Air duct covering includes materials such as adhesive, insulation, banding, coating(s), film, and jacket used to cover the outside surface of an air duct, fan casing, or duct plenum. Air Ducts may be rigid or flexible, and 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.

Supplementary materials such as duct covering, duct linings, vapor barrier facings, adhesives, fasteners, tapes, and core materials added to air ducts, plenums, panels, and duct silencers used in duct system shall have a flame spread rating not over 25 without evidence of continued progressive combustion and a smoke developed rating no higher than 50. If air duct coverings and linings are to be applied with adhesives, they shall be tested as applied with such adhesives, or the adhesives used shall have a flame spread rating not over 25 and a smoke developed rating no higher than 50 when in the final dry state.

Exception: Air duct weatherproof coverings shall not be required to meet these requirements when they are located entirely outside of a building, do not penetrate a wall or roof, and do not create an exposure hazard.

Air duct, panel and plenum coverings 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 coverings shall not be installed so as to conceal or prevent use of any service opening.

Short Form Specification – Fibrous Glass Duct Wrap

Before applying duct wrap, sheet metal ducts shall be clean, dry, and tightly sealed at all joints and seams.

All heating, cooling, and ventilation supply ducts having a service temperature not exceeding 250°F (121°C) shall be wrapped with flexible fibrous glass duct wrap having a reinforced foil/kraft laminate facing with a maximum water vapor transmission rate of 0.02 perm (0.35) complying with requirements of ASTM C 1290. Insulation thickness shall be as recommended by ASHRAE 90.1 and/or as noted on drawings.

Install duct wrap with facing outside so that the tape flap overlaps the insulation and facing at the other end of the piece of duct wrap. Insulation shall be firmly butted at all joints with a maximum allowable compression of 25% to assure that its installed R-value will be as printed on the facing of the duct wrap. All seams shall overlap a minimum of 2" (50mm) and be stapled with 1/2" (25mm) (min.) outward clinching staples 6" (300mm) (approx.) on centers.

For rectangular ducts over 24" (600mm) in width, duct wrap shall be additionally secured to the bottom of the duct with mechanical fasteners on 18" (450mm) (approx.) centers to reduce sagging. Washers shall be applied without compressing the insulation. On ducts conveying cool air all seams, joints, penetrations, and damage to the facing shall be sealed with vapor retardant mastic or with pressure sensitive aluminum foil tape.

Properties of Flexible Insulated Ducts

From current edition of Air Diffusion Council's *Flexible Air Duct Performance & Installation Standards*.

Flexible Duct – UL Class 1 Air Duct Listing

General Requirements:

Flexible duct conforming to this Standard shall be tested, listed, reported and certified as applicable, in accordance with Underwriters Laboratories *Standard for Factory-Made Air Ducts and Air Connectors*, UL 181. Testing requirements by category are shown below.

- Surface burning characteristics*
 - Flame penetration
 - Burning
 - Corrosion (metal parts not inherently corrosion resistant)
 - Mold growth and humidity
 - Temperature
 - Puncture
 - Static load (only when jacket has integral field support devices such as grommets)
 - Impact
 - Erosion**
 - Pressure**
 - Collapse**
 - Tension
 - Torsion
 - Bending
 - Leakage

*Tests for surface burning characteristics are to be conducted as specified in tests for Surface Burning Characteristics of Building Materials, UL 723. Class 1 material shall have flame spread rating of not over 25 without evidence of continued progressive combustion and a smoke developed rating of not over 50.

**Erosion, pressure and collapse tests are run at 2½ times manufacturer's stated ratings for that property. For the erosion test, the variable is velocity. For the pressure test, the variable is positive pressure. For the collapse test, the variable is negative pressure.

Performance Values

Below are required tests and units of measurement of standard and recommended values of minimum performance where applicable.

Property	Recommended Value
Thermal loss, all diameters	R, hr•ft ² •°F/Btu: 4.2 min. @ 75°F mean (RSI, m ² •°C/W: (0.74 min. @ 24°C mean)
Friction loss, straight	in. w.g. per 100 ft.: 0.3 max. @ 1,000 fpm (Pa/m: 2.5 max. @ 5.1 m/sec) (5 m/sec): 12" dia., in.
Friction loss, 90° bend	loss coefficient @ R/D = 2 1.0 max.
Acoustical, dB sound attenuation	Due to complexity of data, no recommended value of performance is stated.
Radiated noise	Refer to manufacturer's data.
Static pressure vs temperature at operating positive pressure, in. w.g. (Pa), 12" (300mm) dia.	140°F (60°C) continuous 180°F (83°C) intermittent
Leakage, all diameters, duct only	0.03 cfm/in. (dia.)•ft. 1.7 x 10 L/s/mm (dia.)•ft.
Leakage, including connections	0.87 cu.ft./hr D ² (1.1 x 10 ⁵) D ² where D = duct internal diameter, inches (mm)
Permeance, all diameters	1.0 perm (max.) (57.5 ng/(s•m ² •Pa max.)

PRE-CLEANING SYSTEM INSPECTION CHECKLIST

Project Name _____ Date _____

Sheet Metal Contractor _____

Mechanical Contractor _____

General Contractor _____

Engineer _____

System: Fibrous glass duct board Sheet Metal, lined Metal ducts, rigid fibrous glass covering
 Sheet metal, wrapped Flexible duct Metal ducts, rigid fibrous glass lining

Level of contamination: 1 = very clean 2 = light film of dust 3 = heavy build-up 4 = air flow reduction

SYSTEM COMPONENT	CONDITION 1 TO 4	NOT ACCESSIBLE	REMARKS
Fresh Air Intake			
Supply Fan			
Return Fan			
Heating Coils			
Cooling Coils			
Condensate Pan & Drain			
Internal Duct			
Air Filters			
Supply Air Ducts			
Return Air Ducts			
Supply Diffusers			
Return Grilles			
Local Toilet Exhaust Fans			
Screens or Louvers			
Turning Vanes			
Grilles			
Reclaim Coils			
Other (1)			
Other (2)			

DUCT CLEANING INSPECTION CHECKLIST

Project Name _____ Date _____

Sheet Metal Contractor _____

Mechanical Contractor _____

General Contractor _____

Engineer _____

System: Fibrous glass duct board Sheet Metal, lined Metal ducts, rigid fibrous glass covering
 Sheet metal, wrapped Flexible duct Metal ducts, rigid fibrous glass lining

ONLY "YES" BOXES SHOULD BE CHECKED. IF A "NO" BOX IS CHECKED BRING IT TO CONTRACTOR'S ATTENTION

	YES	NO
PRE-CLEANING INSPECTION		
Are all dampers operable and in recommended position? (Mark positions before proceeding)	<input type="checkbox"/>	<input type="checkbox"/>
Is adequate incoming air being delivered to all occupied areas of the building?	<input type="checkbox"/>	<input type="checkbox"/>
Is air filtration equipment clean, free from moisture and contaminants?	<input type="checkbox"/>	<input type="checkbox"/>
Are refrigeration coils clean, free of leaks, and permitting clear air flow?	<input type="checkbox"/>	<input type="checkbox"/>
Are central heating and cooling units, including humidifiers, operating properly?	<input type="checkbox"/>	<input type="checkbox"/>
Are variable volume units, re-heat coils, and other equipment free from mold, dirt and moisture?	<input type="checkbox"/>	<input type="checkbox"/>
OPENING THE DUCTWORK		
Have existing openings been considered wherever possible, rather than cutting openings in duct?	<input type="checkbox"/>	<input type="checkbox"/>
(Fibrous glass duct board) Are openings in duct board shiplapped or pumpkin-cut, all four sides?	<input type="checkbox"/>	<input type="checkbox"/>
(Lined sheet metal ducts) Is duct liner material cut at a 45 degree angle?	<input type="checkbox"/>	<input type="checkbox"/>
(Wrapped sheet metal ducts) Is opening cut in duct wrap large enough for sheet metal patch?	<input type="checkbox"/>	<input type="checkbox"/>
(Flexible ducts) Are flexible ducts disconnected from trunks or grilles for inspection purposes?	<input type="checkbox"/>	<input type="checkbox"/>
(Metal ducts, rigid exterior insulation) Is opening in insulation large enough for sheet metal patch?	<input type="checkbox"/>	<input type="checkbox"/>
(Metal ducts, rigid interior insulation) Is opening in insulation beveled (pumpkin-cut)?	<input type="checkbox"/>	<input type="checkbox"/>
CLEANING		
(Contact Vacuum Method) Is HEPA vacuum equipment used if discharge is into occupied space?	<input type="checkbox"/>	<input type="checkbox"/>
(Air Washing Method) Is vacuum source properly connected and operating downstream?	<input type="checkbox"/>	<input type="checkbox"/>
(Power Brushing Method) Is vacuum source properly connected and operating downstream?	<input type="checkbox"/>	<input type="checkbox"/>
Has HVAC equipment been properly cleaned with HEPA vacuum equipment?	<input type="checkbox"/>	<input type="checkbox"/>
CLOSING OF DUCTWORK		
Are all holes in insulation replaced so there are no openings or gaps?	<input type="checkbox"/>	<input type="checkbox"/>
Are all slits or holes in vapor retarders sealed to maintain vapor retarder performance?	<input type="checkbox"/>	<input type="checkbox"/>
Are all patches in sheet metal ductwork attached with sheet metal screws on 8" (200mm) (approx.) centers?	<input type="checkbox"/>	<input type="checkbox"/>
Are all patches in sheet metal ductwork sealed with aluminum foil tape or duct sealant?	<input type="checkbox"/>	<input type="checkbox"/>
Are all flexible duct connections in accordance with Air Diffusion Council standards?	<input type="checkbox"/>	<input type="checkbox"/>
FINAL INSPECTION		
Were all grilles, registers and diffusers thoroughly cleaned before being replaced?	<input type="checkbox"/>	<input type="checkbox"/>
Were all filters cleaned and replaced in accordance with manufacturers' instructions?	<input type="checkbox"/>	<input type="checkbox"/>
Are all dampers restored to their original positions as marked before work began?	<input type="checkbox"/>	<input type="checkbox"/>
Has the system been turned on and allowed to run until steady state operation is reached?	<input type="checkbox"/>	<input type="checkbox"/>
Is the system completely free of debris and ready to return to normal operation?	<input type="checkbox"/>	<input type="checkbox"/>

FACTS ON FIBROUS GLASS 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 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 22-95 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.

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 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

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 by contacting NAIMA at the following address:

NAIMA

NORTH AMERICAN INSULATION
MANUFACTURERS ASSOCIATION

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 wood insulation products.

For more information, contact:

The North American Insulation Manufacturers Association includes the following companies involved in the development, manufacture and marketing of fibrous glass duct board and insulations for air duct systems:

- CertainTeed Corporation, Valley Forge, PA
- Johns Manville Corporation, Denver, CO
- Knauf Fiber Glass, GmbH, Shelbyville, IN
- Owens Corning, Toledo, OH

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>