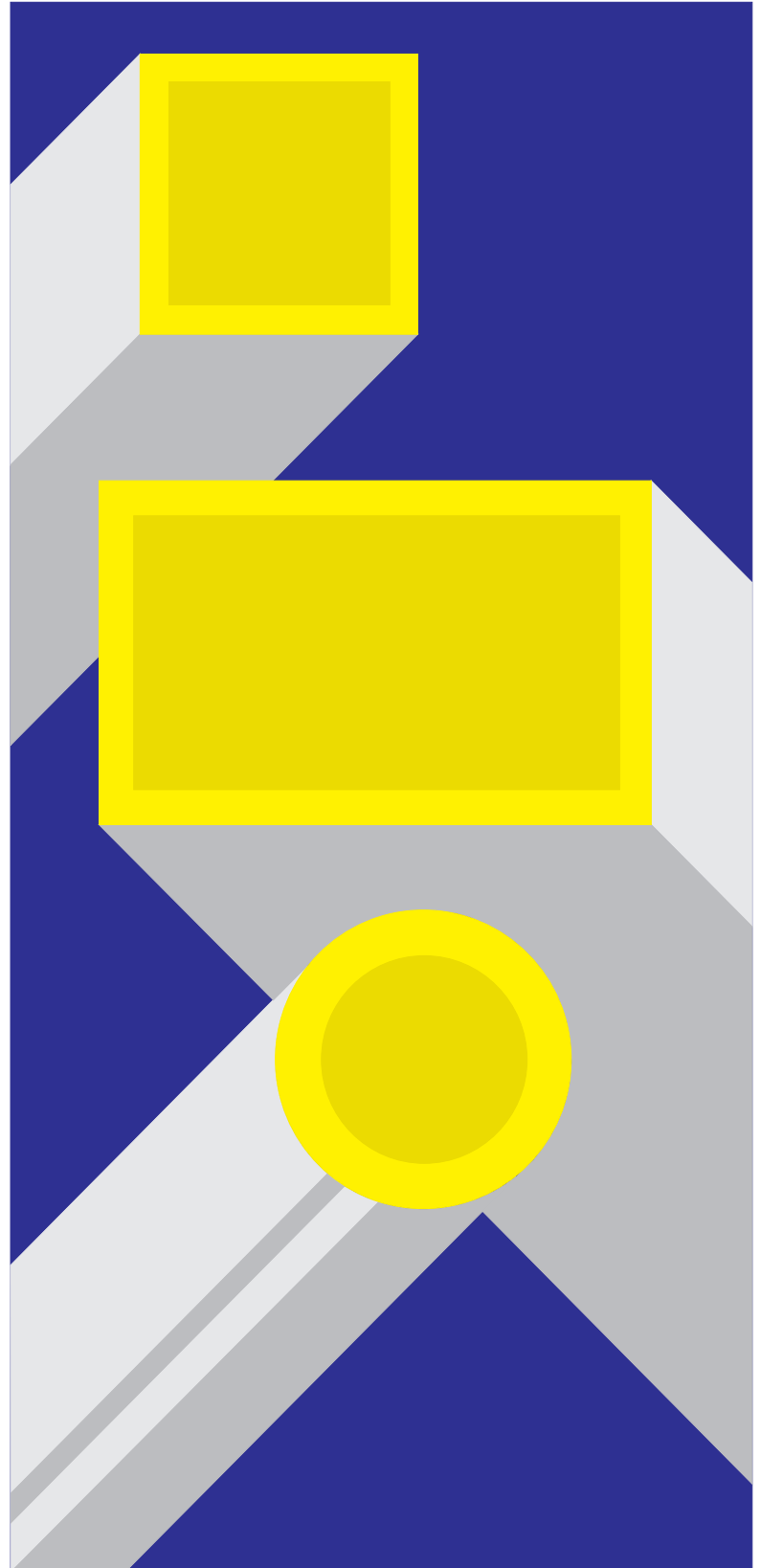


**FIBROUS GLASS
RESIDENTIAL DUCT
CONSTRUCTION
STANDARD**
THIRD EDITION, 2002



**FABRICATION
AND INSTALLATION
TECHNIQUES FOR THE
RESIDENTIAL HVAC
DUCT CONTRACTOR**



***FIBROUS GLASS
RESIDENTIAL DUCT
CONSTRUCTION
STANDARD***

*LOW VELOCITY SYSTEMS
1/2" w.g. (125 Pa) Maximum Static Pressure*

THIRD EDITION, 2002

PREFACE

The North American Insulation Manufacturers Association (NAIMA) presents this Standard as a recommended method of fabricating and installing air transmission ducts in residential buildings using fibrous glass material as specified herein.

Rectangular residential ducts covered by this Standard are designed to operate at 1/2" w.g. (125 Pa) static pressure or less. Maximum unreinforced duct size covered by this Standard is 36" (900mm) for 475 and 800 EI board and 42" (1050mm) for 1400 EI board. For fabrication of rectangular ducts of larger sizes or for operation at greater static pressures, refer to NAIMA Publication AH116, *Fibrous Glass Duct Construction Standard*. Applicable portions of that Standard have been adapted for use by the residential fibrous glass duct contractor.

Fibrous glass duct products are designed for use in comfort heating and cooling systems operating at internal air temperatures not less than 40°F (4°C) and not greater than 250°F (121°C).

While fibrous glass duct board is rated at 2,400 feet per minute (12 m/sec) air velocity or greater, residential duct systems typically operate at velocities of 1,200 feet per minute (6 m/sec) or less.

Flexible duct installation techniques covered by this Standard are designed to complement rectangular, ten-sided, or round fibrous glass duct systems. More comprehensive information on the subject of flexible ducts may be found in the current edition of the Air Diffusion Council (ADC) publication, *Flexible Duct Performance and Installation Standards*.

Overall HVAC duct system design issues are beyond the scope of this Standard. However, if satisfactory duct system performance is to be achieved, it is important for the system designer to calculate HVAC loads on a room-by-room basis and to size ducts accordingly. It is recommended that industry information, such as Air Conditioning Contractors Association (ACCA) Manuals D (duct sizing) and J (load calculation), be consulted for guidance in these critical areas.

Underwriters Laboratories Inc. Standard for Closure Systems for Use With Rigid Air Ducts and Air Connectors, UL 181A, incorporates key provisions of the UL 181 Standard, as well as additional provisions developed by NAIMA and various closure material manufacturers. The resultant standard provides the means for assuring the contractor and building owner that the selected closure system will, when properly applied, perform within varied environmental conditions.

This Standard was developed using reliable engineering principles and research, plus consultation with and information obtained from manufacturers, contractors, testing laboratories, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable. Construction and products which comply with this Standard will not necessarily be acceptable if, when examined and tested, they are found to have other features which impair the result contemplated by these requirements. 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, regarding merchantability or fitness for any particular purpose, in connection with the information supplied herein.

Authorities considering adoption of this Standard should review all Federal, state, local and contractual regulations applicable to specific installations.

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

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 in the development of this Standard.

NAIMA Air Handling Member Companies:

- | | |
|--|--------------|
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| Johns Manville Corp.
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| Knauf Fiber Glass
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One Owens Corning Parkway
Toledo, OH 43659 | 800-GET-PINK |

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A NOTE ABOUT THE USE OF METRIC (SI) UNITS IN THIS STANDARD

Two forms of conversion are used in this document:

1. Critical fabrication dimensions, where accuracy is essential for correct fabrication, are converted from U.S. (IP) units (inches) to the nearest whole millimeter. **Example: 2" = 102mm.**
2. Where accuracy is not critical, or where dimensions are given as approximate, nominal, or minimum/maximum, inches are rounded to the nearest convenient SI value. **Example: 2" = 100mm.**

SECTION I

**PERFORMANCE
CRITERIA**

SECTION I - PERFORMANCE CRITERIA

General requirements of air ducts

A duct system is a structural assembly whose primary function is to convey air between specific points. In fulfilling this function, the duct assembly must perform satisfactorily with respect to certain fundamental performance characteristics. Elements of the assembly are duct material, seams and joint treatments. With regard to the duct assembly and its elements, theoretical and/or practical limits must be established for:

1. Dimensional stability, deformation and deflection.
2. Containment of the air being conveyed.
3. Exposure to damage, weather, temperature extremes, flexure cycles or other in-service conditions.
4. Support.

Analysis and determination of requirements for fibrous glass ducts

Fibrous glass duct systems designed for use in residential situations are fabricated from three types of product:

1. Boards of resin bonded inorganic glass fibers 1", 1¹/₂", or 2" (25mm, 38mm, or 51mm) thick, having a factory-applied reinforced aluminum foil/kraft laminate exterior air barrier finish, for fabricating rectangular and ten-sided ducts, plenums and distribution boxes.
2. Lengths of preformed rigid tubular fibrous glass duct of various diameters, with a reinforced aluminum exterior finish.
3. Lengths of round flexible duct, having a reinforced inner air barrier core, resilient fibrous glass insulation, and an outer vapor retarder jacket, cut to required lengths for ducts or run-outs from fibrous glass trunk ducts or plenums to grilles and diffusers.

General requirements for air ducts are as follows, except where differing procedures are part of a manufacturer's UL 181 listing and must be used in lieu of the procedures shown in this manual.

1. DUCT BOARD

1.1. Strength and Deflection

Board stiffness is defined by flexural rigidity, which is the product of Young's Modulus of Elasticity (E) and the moment of inertia (I) per unit width. Boards are identified by ratings of 475-EI, 800-EI, and 1400-EI, respectively.

Flexural rigidity rating is determined in accordance with NAIMA Test Number AHS-100-74 and is an average of specimens taken from a sheet of the duct board.

Duct board deflection relative to a flat position of the board is limited to one one-hundredth (1/100) of the span. This criterion is based on stress in the material not exceeding the proportional elastic limit of the material with suitable safety margins built in.

1.2. Fatigue Tests

In normal service conditions, ducts incur pressure cycles. In investigating the potential effects of fatigue occurring in a duct system, sections of each duct board type (475-EI and 800-EI) were cycled from atmospheric pressure to 150% of design pressure. Each test assembly consisted of not less than three 48" (1200mm) (nominal) long sections of fibrous glass duct. The tests were conducted at 3 to 4 cycles per minute for 50,000 cycles, after which samples were removed from the center of the duct and the board's flexural rigidity (EI) determined in accordance with NAIMA AHS-100-74. For comparison of board strengths and deterioration, comparable samples of new duct board of each class were tested in accordance with the same NAIMA test method. In each case there was no significant reduction in the flexural rigidity of the cycled boards.

1.3. UL 181 Class 1 Air Duct Rating

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

1. They shall be constructed of Class 1 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 which operate 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.

Under UL Standard 181 Class I air duct materials have a flame spread rating of 25 and a smoke developed rating

of 50. The following portions of UL 181 are applicable to rigid fibrous glass ducts:

- Surface burning characteristics
- Flame penetration
- Burning
- Corrosion (metal parts not inherently corrosion resistant)
- Mold growth and humidity
- Temperature
- Puncture
- Static load
- Impact
- Erosion*
- Pressure*
- Collapse*
- Leakage

*Erosion, pressure, and collapse tests are run at 2^{1/2} 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.

1.4. Longitudinal Seams, Transverse Joints

Recommended methods of forming and aligning duct sides are given in detail in this manual. In order to maintain alignment of the duct assembly, both longitudinal seams and transverse joints are sealed with a continuous closure system. Field observations and laboratory testing have indicated very low leakage rates.

Closures are an integral part of fibrous glass duct construction. Only those closures complying with UL 181A, Part I (P) for pressure sensitive aluminum foil tape, Part II (H) for heat activated aluminum foil tape, or Part III (M) for glass fabric and mastic, have been tested for compliance with all structural and safety requirements. See Section V of this Standard for detailed closure application information.

1.5. Duct Support

Hanger sizing and spacing for fibrous glass duct board systems are coordinated with other performance requirements of duct components. Hangers and supports must be placed for proper support of all duct board fittings and accessories so that taped joints are not placed under additional unanticipated stress. See Section VI of this Standard. For further information, Section VI, *NAIMA Fibrous Glass Duct Construction Standard*, should be consulted.

1.6. Thermal Performance

At 75°F (24°C) mean temperature, fibrous glass duct board provides the following thermal performance values:

	1" (25mm)	1 1/2" (38mm)	2" (51mm)
R value, hr•ft ² •°F/Btu (RSI, m ² •°C/W)	4.3 (0.76)	6.5 (1.14)	8.7 (1.53)
k value, Btu•in/hr•ft ² •°F (W/m•°C)	0.23 (0.033)	0.23 (0.033)	0.23 (0.033)
C value, Btu/hr•ft ² •°F (W/m ² •°C)	0.23 (1.32)	0.16 (0.88)	0.12 (0.65)

Consult local codes for specific thermal requirements. Where codes do not address thermal value, NAIMA recommends using current ASHRAE minimum duct insulation requirements. See Appendix, Pages A-6, A-7.

1.7. Acoustical Performance

Fibrous glass duct board absorbs fan and air turbulence noise and reduces the popping noises caused by expansion and contraction. Typical acoustical performance of fibrous glass duct board, measured in accordance with ASTM C 423 (mounting A), is as follows:

	SOUND ABSORPTION COEFFICIENTS AT OCTAVE BAND CENTER FREQUENCIES, Hz						
	125	250	500	1000	2000	4000	NRC
1.0" (25mm)	.03	.18	.61	.83	.89	.93	.65
1.5" (38mm)	.09	.33	.89	.96	.95	.94	.80
2.0" (51mm)	.17	.68	1.08	1.05	1.04	1.06	.95

A major benefit of the fibrous glass duct system is its contribution to a quiet indoor environment. However, acoustical performance is an extremely complex subject; manufacturers of the products involved should be consulted for further information.

1.8. Leakage

Ducts should be sufficiently airtight to ensure quiet, economical performance. Supply duct leakage reduces the delivered volumes of air at diffusers and registers, which must be compensated for by increasing the total quantity of supply air. Return duct leakage reduces system thermal efficiency and may draw unwanted air and contaminants into the system.

Duct systems covered in this Standard have inherently low leakage. For details on tests which have been conducted, refer to *NAIMA Fibrous Glass Duct Construction Standard*, current edition.

2. RIGID FIBROUS GLASS DUCT CHARACTERISTICS AND LIMITATIONS FOR RESIDENTIAL SYSTEMS

2.1. Flexural Rigidity (EI)

Average in the board, not less than rating of 475, 800 or 1400 pounds-inches² per inch of width when tested in accordance with NAIMA Test Method AHS-100-74.

2.2. Maximum Static Pressure in Duct

1/2" w.g. (125 Pa), positive or negative, maximum duct span 36" (900mm) for 475 and 800 EI board and 42" (1050mm) for 1400 EI board. For ducts of greater span, or for duct systems operating at higher pressures, see NAIMA *Fibrous Glass Duct Construction Standard*.

2.3. Maximum Air Velocity in Duct

Rated at 2,400 feet per minute (12 m/sec) or greater. Refer to manufacturers' published data.

2.4. Maximum Allowable Deflection

One one-hundredth of duct span.

2.5. Board Fatigue

No significant deformation or deficiency of duct sections after 50,000 cycles at 3 to 4 cycles per minute from zero to 1 1/2 times operating pressure.

2.6. 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.

2.7. Temperature

40°F (4°C) minimum inside duct.
250°F (121°C) maximum inside duct.
150°F (66°C) maximum duct surface temperature

2.8. Corrosiveness

Non-corrosive in contact with galvanized steel, copper, or aluminum when compared to control specimen in contact with

clean sterile cotton when tested in accordance with ASTM C 665.

2.9. Closure

Closure materials (pressure sensitive tapes, heat activated tapes, glass fabric and mastic) shall conform to Underwriters Laboratories Standard UL 181A. When installed in accordance with manufacturers' instructions, closure systems will conform to UL 181 Class 1 Air Duct requirements.

2.10. Safety standards

National Fire Protection Association Standards 90A/90B.

2.11. Bacteria and fungi resistance

Fibrous glass duct products meet fungal and bacterial growth requirements when subjected to microbial attack as described in ASTM C 1338 and standard practices ASTM G 21-96 (fungus test) and ASTM G 22-95 (bacteria test). UL 181 also includes a mold growth test.

2.12. 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 or buried below grade.
- Outdoors.
- As casings and/or housings of built-up equipment.
- Immediately adjacent to high temperature electric heating coils without radiation protection. Refer 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.

2.13. 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.

2.14. Moisture control

The following precautions should be taken to avoid exposure of duct board to 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 during the heating season to prevent accumulation of water vapor in the duct system.
- 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.

3. FLEXIBLE DUCT

3.1. UL 181 Testing Program

Flexible duct referred to in this Standard is tested in accordance with Underwriters Laboratories Standard for Factory-Made Air Ducts and Air Connectors, UL 181.

The test program for flexible duct includes the following:

- 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*
- Tension
- Torsion
- Bending

*Erosion, pressure, and collapse tests are run at 2 1/2 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.

3.2. ADC Testing Program

Other properties of flexible air duct are tested in accordance

with test standards set by the Air Diffusion Council. These include thermal performance, friction loss, acoustical performance, static pressure / temperature performance, and leakage.

3.3. Connections with Flexible Duct

Recommended methods of connecting flexible duct to fibrous glass duct board are shown in Section IV of this Standard. If other methods are used, proponents of such methods are responsible for demonstrating equivalency.

Recommended methods of connecting flexible duct to diffusers, registers and grilles are available from the Air Diffusion Council.

For further information or for detailed design data, refer to the current edition of Air Diffusion Council's *Flexible Air Duct Performance & Installation Standards*.

4. Compliance with Building Codes

Fibrous glass insulated duct systems meet the following model codes and most other applicable codes:

- ICC - International Code Council, Inc.
 - International Mechanical Code
 - International Building Code
 - International Residential Code
 - International Energy Conservation Code
 Note: This code is replacing BOCA, CABO, ICBO, and SBCCI codes, although some jurisdictions may continue to reference some of them.
- BOCA - Building Officials and Code Administrators International
 - National Building Code
 - National Mechanical Code: (see ICC above)
- CABO - Council of American Building Officials
 - One and Two Family Dwelling Code
 - CABO Model Energy Code
- ICBO - International Conference of Building Officials
 - Uniform Building Code
 - Uniform Mechanical Code
- SBCCI - Southern Building Code Congress International
 - Standard Building Code
 - Standard Mechanical Code

See Appendix for current code edition and how to contact code organizations.

FIBROUS GLASS RESIDENTIAL DUCT SYSTEM INSTALLATION CHECK LIST

All answers should be in the "YES OR NOT APPLICABLE" column. If a check mark appears in the "NO" column, bring it to the attention of the HVAC Contractor.

Project name and number _____

HVAC contractor _____ Builder _____

Checklist compiled by _____ Date _____

A. Product	YES/NA	NO
(Refer to manufacturer's literature and current UL Instruction Sheet)		
1. Is product used identified as duct board by facing imprint?	()	()
2. Is UL label present? (While each board has one UL label, not every duct section will be labeled.)	()	()
3. Are there NO visual signs of facing delamination (ballooning, condensation if system operating)?	()	()
B. Fabrication and installation (See Sections II, III, IV)		
4. Are connections to unit or sheet metal ducts in accordance with NAIMA manual standards?	()	()
5. Are turning vanes, where required, installed in accordance with NAIMA manual standards?	()	()
6. Is correct hardware attaching metal parts to duct per NAIMA manual or submittal drawings?	()	()
7. Are round duct take-offs of a type designed for use with fibrous glass duct board?	()	()
8. If spin-in fittings are used, are both inner and outer rings secure against the duct board?	()	()
9. If dove-tail fittings are used, are all tabs bent outward 90° to secure the fitting to the duct board?	()	()
10. Are round duct take-off holes properly sized to fittings?	()	()
11. Are fibrous glass duct board distribution boxes fabricated per manufacturer's instructions?	()	()
12. Are staples galvanized steel, and of the outward clinching type?	()	()
13. If staples are not used, are tape tabs, min. 1 per side and 12" (300mm) on centers, used instead?	()	()
14. Are NO panels in any fitting shorter than 6" (150mm), including male and female shiplap joints?	()	()
15. Do the joints and seams on distribution boxes have stapling flaps or tape tabs?	()	()
C. Closure (See Section V)		
16. Are all joints and seams properly taped or closed with glass fabric and mastic?	()	()
17. Is the closure system listed under UL 181A, Parts I (P), II (H), or III (M)?	()	()
18. Are all pressure sensitive tape closures the proper width and rubbed down adequately, with staples or scrim in facing clearly visible?	()	()
19. Are heat activated closures applied correctly, as shown by changing dot color?	()	()
20. Does tape show manufacturer name, UL 181A nomenclature, and date code?	()	()
D. Hanging and Support (See Section VI)		
21. Are hangers installed in accordance with the hanger schedule published in the NAIMA manual?	()	()
22. Are hanger designs in accordance with those shown in the NAIMA manual?	()	()
23. Are accessories that add weight to the system separately supported so as not to stress the system?	()	()
24. If codes allow ducts to rest on ceiling joists, are they secured to prevent accidental movement?	()	()
25. In humid climates, is system suspended or elevated at least 1" (25mm) above ceiling insulation?	()	()
26. Are ducts in crawl spaces at least 1" (25mm) from floor insulation with at least 4" (100mm) ground clearance?	()	()
E. General		
27. Is system operating within the design limitations for which it was built?	()	()
28. Have all tears or punctures of facing material been repaired per methods shown in the NAIMA manual?	()	()
29. Are all metal accessory items galvanized?	()	()
30. Are all runs of flexible duct installed in accordance with Air Diffusion Council Standards manual?	()	()
31. Are all flexible duct connections to fibrous glass duct board made as shown in ADC Standards Manual?	()	()
32. Are all runs of flexible duct as straight as possible and free from unnecessary loops or bends?	()	()

NOTE: For fabrication, installation, hanging, and other details, refer to NAIMA *Fibrous Glass Residential Duct Construction Standard* and/or *Air Diffusion Council Flexible Air Duct Performance & Installation Standards*, current editions.

SECTION II

GENERAL SYSTEM FABRICATION

INTRODUCTION TO BASIC SYSTEM TYPES

Features and Benefits

Heating, ventilating and air conditioning duct systems incorporating fibrous glass duct board provide levels of thermal and acoustical efficiency and occupant comfort that uninsulated, unsealed sheet metal systems may not deliver. Fibrous glass duct board eliminates the need to wrap or line sheet metal with insulation to achieve acceptable thermal and acoustical performance.

Fibrous glass duct board and insulated flexible duct systems provide assured thermal performance through controlled insulation thickness. They absorb central equipment and air turbulence noise, and reduce noise caused by expansion, contraction and vibration.

These systems are UL181 listed and labeled. With the use of UL181A or UL181B listed closure systems, they meet model codes and are fully supported by both manufacturing and contracting industry standards. Light in weight, easy to transport and handle, fibrous glass air duct systems can be quickly and easily installed with assurance of substantially airtight performance.

This Standard describes HVAC duct systems designed for use in residential situations including but not limited to

- Single family residences of one or more stories;
- Two, three, and four family apartment buildings of one to three stories;
- Condominium and cluster housing projects of one to three stories.

Types of Systems

Air duct systems for residential installation generally fall into either of two basic types, more fully described on the following two pages:

1. Extended Plenum Supply Systems

A plenum is installed on the central fan unit. Single fibrous glass ducts extend from this plenum toward perimeter walls, supplying run-outs to individual room registers or diffusers. Run-outs may be fabricated from fibrous glass duct board, pre-formed round duct, ten-sided fibrous glass duct, insulated flexible duct, or insulated metal duct. See page 2-3. Depending on the building layout, number of rooms, location of central equipment, local climatic conditions, and other factors, a fibrous glass duct system of this type may be as simple or as complex as the situation requires.

The extended plenum system is preferred for large residential situations and is the ideal system for basement installation. It combines sturdiness with highly efficient acoustical and thermal performance.

2. Radial Supply Systems

A plenum is installed on the central fan unit. Single trunks of flexible duct extend from this plenum to rectangular or triangular distribution boxes fabricated from fibrous glass duct board. From each distribution box, two or more flexible ducts run out to individual room registers or diffusers. See page 2-4. A simpler type of radial system incorporates lengths of flexible duct, each of which runs from the plenum directly to an individual room register or diffuser.

These systems are typically used in unfinished attics. The system is less suited for basement locations. The radial system is harder to balance than the extended plenum system, and thermal and acoustical performance are not as efficient. However, a carefully designed radial duct system with distribution boxes can be a good compromise between the extended plenum system and a simple radial duct system.

EXTENDED PLENUM SYSTEM
(See Section III for fabrication details)

Fibrous glass ducts extend from central equipment supplying run-outs to individual room registers. Run-outs may be fibrous glass duct, rigid round duct, ten-sided duct, insulated flexible duct, or insulated metal duct. Systems may either be simple (i.e., a straight run of duct of one size) or complex (including reducers, branches, offsets and other fittings), depending on structural and room layout.

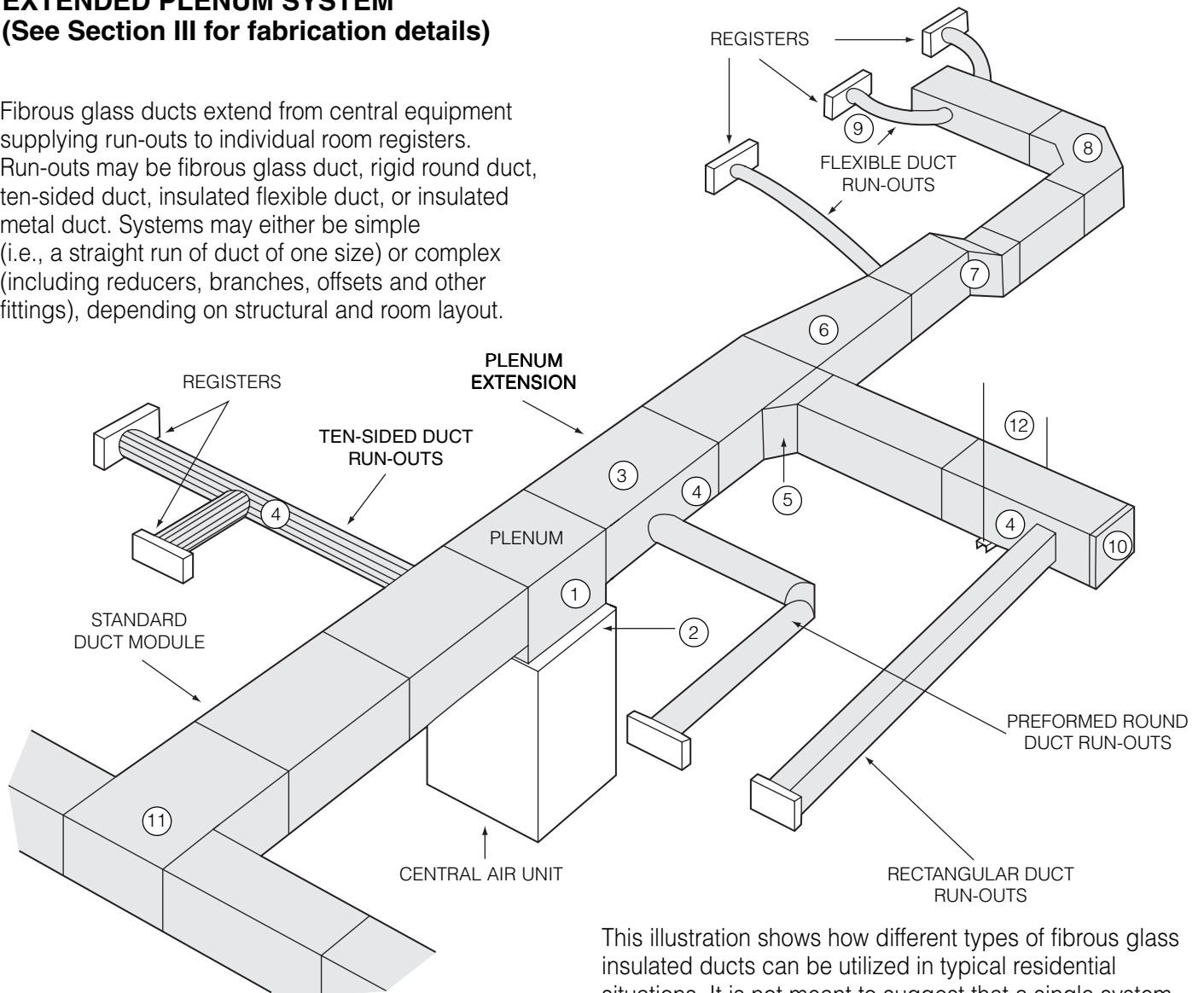


Fig. 2-1. Extended plenum system

This illustration shows how different types of fibrous glass insulated ducts can be utilized in typical residential situations. It is not meant to suggest that a single system would combine all of these types in the manner shown.

Extended plenum system components

A typical extended plenum system may be made up of a variety of duct components. Typical ones are shown in Fig. 2-1. Many others are detailed in Section III of this Standard.

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Plenum 2. Connection of plenum to central air equipment 3. Standard fibrous glass duct module, used in straight duct runs of one size to extend plenum, or as a basis for fabricating fittings 4. Taps for square and round duct run-outs | <ol style="list-style-type: none"> 5. Wide mouth tap 6. Transition (reducer) - Several types are described in Section III 7. One-way offset (other configurations are described in Section III) 8. Three piece 90° elbow (other configurations are described in Section III) 9. Connections to registers 10. End cap (three types are described in Section III) 11. Tee with equal legs 12. Hangers and supports |
|---|--|

RADIAL SYSTEM

(See Section IV for Fabrication Details)

In place of an extended plenum fabricated from fibrous glass duct board, flexible duct is used to supply air from plenum to room registers. Flexible duct trunks extend from the plenum to triangular or rectangular distribution boxes fabricated from fibrous glass duct board. Individual room registers and diffusers are supplied by flexible duct run-outs from these distribution boxes.

Load calculation and duct sizing are especially important in the design of a radial system. In nearly all cases, various sizes of flexible duct will be needed to supply adequate conditioned air to each room. Consult sources such as ACCA Manual J (for guidance on room load calculation) and ACCA Manual D (duct sizing). (See references, Appendix, Page A-1.)

In the simplest version of the radial system, fibrous glass duct board distribution boxes are eliminated and each room register or diffuser is supplied by a single flexible duct running directly from the plenum.

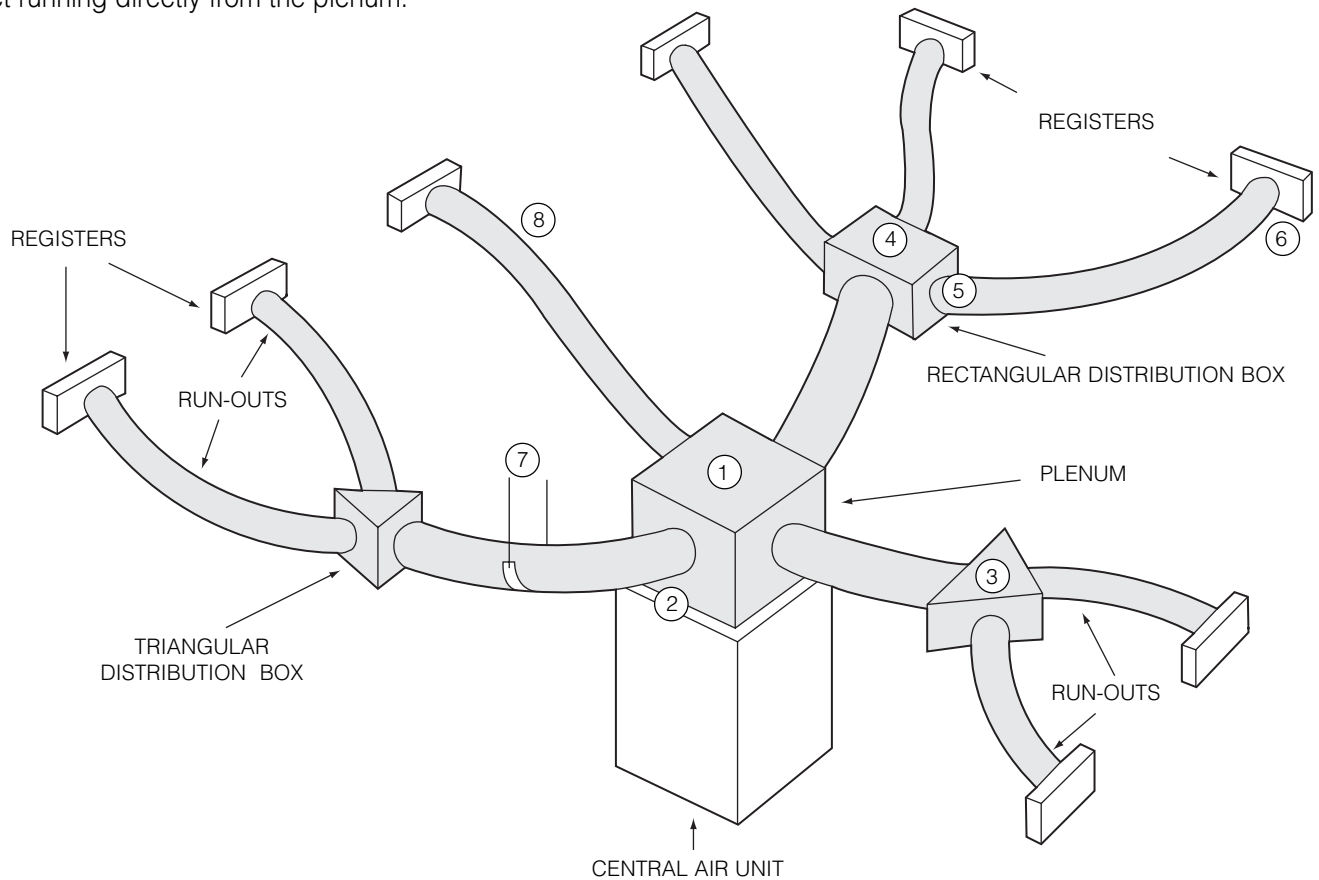


Fig. 2-2. Radial system with distribution boxes

Radial Duct System Components

Fig. 2-2 shows a radial system with fibrous glass duct board distribution boxes supplied by three flexible duct trunks coming from the plenum. The fourth flexible duct from the plenum supplies a single register, as would be the case for all registers in the simplest version of the radial system.

1. Plenum
2. Connection of plenum to central air equipment
3. Triangular distribution box
4. Rectangular distribution box
5. Flexible duct connections to fibrous glass units
6. Flexible duct connections to registers
7. Hangers and supports
8. Flexible duct run-out to a single register

RETURN SYSTEMS

General

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

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

Ducted return systems

Ducted return systems are preferable because ducts provide the most thermally and acoustically efficient path for air to return to central units.

Ideally, every room or space should have a return air register ducted into the return system. This makes it unnecessary to resort to such expedients as placing grilles in doors, under-cutting doors so return air can flow under them, or (in worst cases) simply leaving doors open and suffering the resulting lack of privacy.

Return ducts must be tightly sealed. If return air ducts leak, air and contaminants may be drawn into the system from undesirable sources such as hot or cold attics, crawl spaces, or garages.

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

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

Non-Ducted Return Systems

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

The figures below suggest two ways in which leakage can be minimized when stud and joist cavities are used as return ducts.

The Importance of Planning Ahead

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

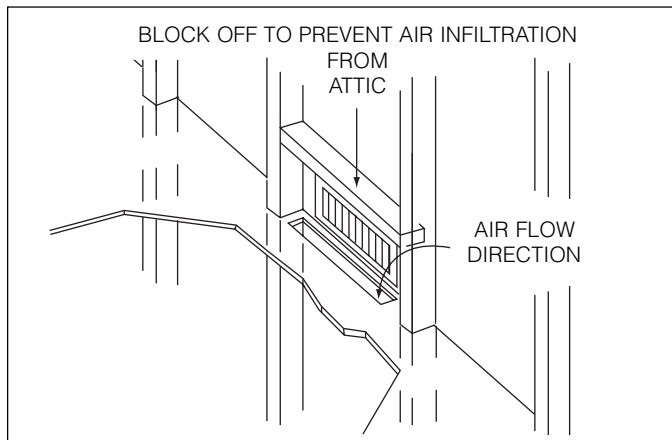


Fig. 2-3. Stud cavity used as path for return air.

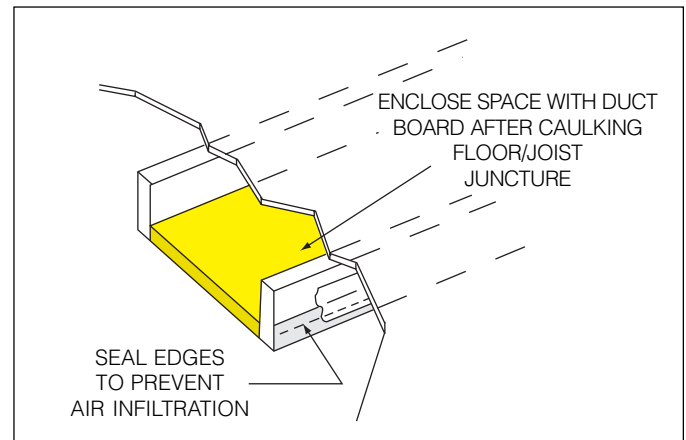


Fig. 2-4. Space between joists used as path for return air.

FABRICATION LOGISTICS

When planning fibrous glass duct system fabrication logistics, the contractor has several choices concerning tools and workplace. Selection of the most suitable fabrication tools, and the best place to do the work, will depend on such considerations as:

- Type of system being installed: extended plenum, radial system with duct board distribution boxes, or simple flexible duct radial system.
- Type of project: whether large or small single family residence, a number of similar tract houses, a multi-family or condominium project.
- Availability of suitable clean, dry work space either at the duct fabricator's shop or on the job-site.
- Availability of trained, experienced workers.

Fabrication Tools

This Standard identifies and describes the use of both hand tools and machines designed for fabrication of fibrous glass duct board. (Fabrication of flexible duct is all done with hand tools.)

- Hand tool fabrication of fibrous glass duct board: Specially designed tools are used to cut grooves and stapling flaps in fibrous glass duct board. See pages 2-9 through 2-13. Straight duct modules are then fabricated by folding, stapling, and sealing grooved boards as described on page 2-26.
- Machine fabrication of fibrous glass duct board: The same grooves and stapling flaps are cut in fibrous glass duct board by powered groove-cutting machines. See pages 2-14 and 2-15. Straight duct modules are then fabricated as described on page 2-26.
- Duct board fitting fabrication: Fittings such as elbows, tees, offsets and transitions are made using hand grooving tools either from straight duct modules or flat duct board. See Section III of this Standard.
- System assembly: Straight duct modules, fittings and rectangular run-outs of fibrous glass duct board are connected by stapling and sealing as shown on page 2-27. Joints and seams are sealed with pressure sensitive or heat activated aluminum foil tape or with glass fabric and mastic as shown in Section V of this Standard.
- Flexible duct fabrication: Run-outs from trunk ducts of plenum extensions to individual room registers and diffusers may be made using insulated flexible duct cut to required lengths using a knife and a wire cutter. Connections of flexible duct to trunk ducts, plenum extensions, and register boots are made in accordance with ADC Standard (See References, page A-1) and/or manufacturers' instructions.

How and Where to Fabricate

Depending on the nature of the job, the contractor has several options as to how and where to fabricate the fibrous glass duct system. Some of these are:

- To fabricate all the straight duct modules and fittings in the shop, using powered grooving and closure machines. This would be a good option if the project requires many duct modules of the same size and/or many fittings of the same design. Since fibrous glass duct elements are light in weight and easy to handle, it may be practical to pre-assemble lengths of duct and truck these to the job-site.
- To do all fabrication work at the job-site, including machine grooving. This might be the best option if the job is a very large one and there is space to set up a job-site shop with room for the machine plus storage space that is clean, warm, and protected from the elements.
- To do all fabrication at the job-site using hand grooving tools.
- To groove the duct board on machines in the shop, shipping the flat grooved board to the job-site where workers can assemble straight modules, fabricate fittings, connect elements, and install the system. A truck can haul much more of a fibrous glass duct system in one load when it's in flat board form than when it consists of fabricated modules and fittings.
- If the system is of the radial type with fibrous glass duct board distribution boxes, the contractor can perform nearly all of the fabrication work in the shop. Job-site work will be limited to making connections between the plenum and the distribution boxes with the flexible duct, and connecting the flexible duct to registers and diffusers.
- If the system is of the simple radial type that does not include distribution boxes, essentially all of the fabrication work will be done at the job-site since the work consists mainly of connecting the flexible duct to the central unit plenum and to room registers and diffusers.

In any of the above cases, all duct system materials must be transported and stored so they are protected from exposure to water, dirt, and physical damage. Job-site work areas must be clean, dry, and protected from the weather.

Pressure sensitive tape closures should not be attempted at ambient temperatures below 50°F (10°C) unless heat is provided as defined in Section V, CLOSURE. Consult mastic manufacturers regarding protection of material during storage, transportation and installation. Also read and follow instructions on product labels. For complete closure details, refer to Section V of this Standard.

PRINCIPLES OF MODULAR DUCT CONSTRUCTION

In designing, fabricating and installing fibrous glass duct systems, the principle of Modular Duct Construction (MDC) is used. This is based on use of the 48" (1220mm) (nominal)* duct module for both straight duct runs and fittings of most types.

The remaining pages of this section show how these objectives are met using the MDC principle.

Use of the MDC principle enhances productivity, minimizes the number of circumferential joints, simplifies fabrication of fittings both in the shop and on the job, and improves the quality of workmanship.

*For actual installed length, subtract shiplap length from nominal:

DUCT BOARD THICKNESS	SHIPLAP LENGTH	INSTALLED DUCT LENGTH
1" (25mm)	7/8" (22mm)	47 1/8" (1200mm)
1 1/2" (38mm)	1 3/8" (35mm)	46 5/8" (1185mm)
2" (51mm)	1 7/8" (48mm)	46 1/8" (1170mm)

Application of the MDC principle involves the following design considerations:

- The modified shiplap groove is used in preference to the V-groove method (see page 2-8).
- Elbows and tees are designed to be throatless.
- Transitions are extended to maintain the module dimension.
- Sweep and radius fittings are not used.
- The male shiplap end of the duct section is always installed facing the fan or equipment.
- Branch taps should be made from shiplap panels wherever possible.
- The integrity of the module should be maintained as consistently as possible throughout the system during design, fabrication and installation. Shop drawings and blueprints should reflect this.

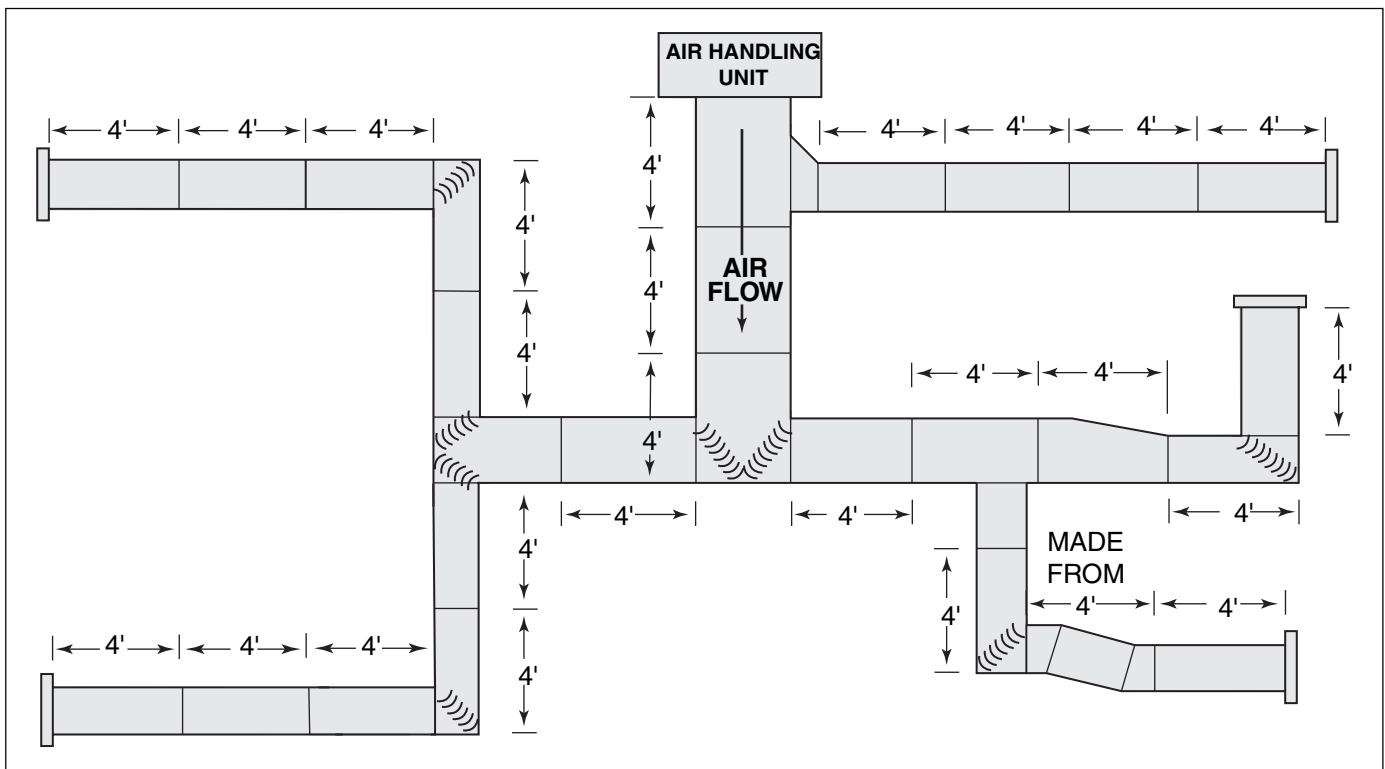


Fig. 2-1. Modular Duct Construction (MDC) Layout.

LAYOUT METHODS

Fibrous glass ducts may be laid out using either of two layout methods.

Centerline Method

Lines are drawn on the duct board (Fig. 2-5) to locate centerlines of grooves which form the corner breaks and closure flap. Inside dimensions of the duct, plus add-ons (see “Stretch-out” below), determine the location of each centerline.



Fig. 2-5. Centerline layout.

Guide Edge Method

Grooves are cut using a special squaring tool (Fig. 2-6) as a guide edge. Inside dimensions of the duct determine how far the tool is moved after each cut. Various hand tool and squaring tool combinations are available; consult tool manufacturers’ literature for instructions.



Fig. 2-6. Guide edge layout.

Stretch-out

When laying out a straight duct module, an allowance is added to each inside duct dimension to compensate for the widths of corner breaks and closure flaps. The sum of these allowances is added to the inside duct dimensions (twice the height plus twice the width) to determine “stretch-out,” which is the total board length necessary to fabricate a straight duct module with the desired inside dimensions.

Four basic ways to make a duct module

There are four basic ways to fabricate straight duct modules (Fig. 2-8 at right). Stretch-out calculations for each way are shown on pages 2-16 through 2-19. Selection of the best way depends on the duct size, total stretch-out, labor and material optimization, and availability of left-over duct board after large one-piece or two-piece duct modules have been fabricated.

FABRICATION METHODS

Fibrous glass duct board may be fabricated using either of two types of corner joints.

Modified Shiplap

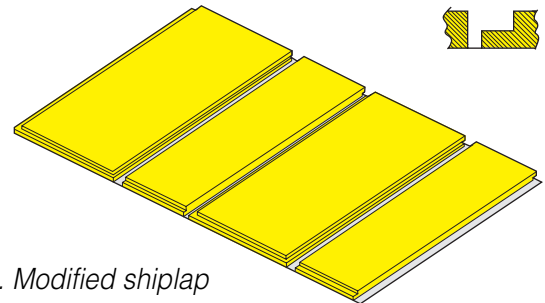


Fig. 2-7A. Modified shiplap

The modified shiplap is considered the industry standard for machine grooving. Hand and machine tools are available for all three duct board thicknesses.

V-Groove

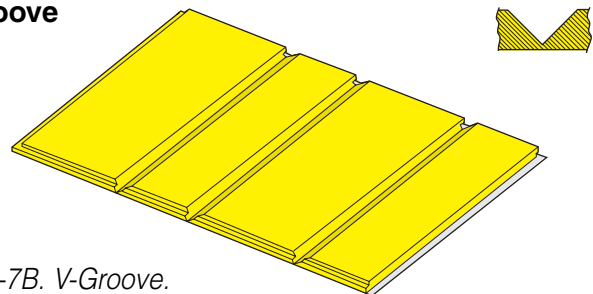


Fig. 2-7B. V-Groove.

This is an alternative method used for grooving duct board. Hand and machine tools are available for all three duct board thicknesses. Fabrication of many of the fittings shown in this manual is not possible using V-Grooved duct modules.

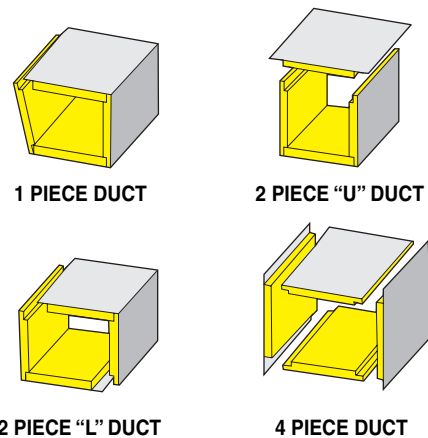


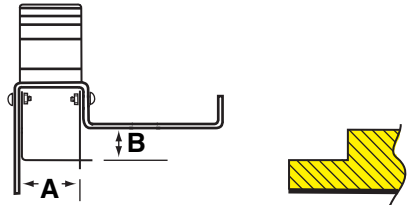
Fig. 2-8. Four ways to make a duct section.

HAND GROOVING TOOLS

Hand grooving tools normally required in fabricating straight sections of fibrous glass duct board are shown below. Correct hand tool blade settings are very important in assuring accurate fabrication, tight joints and connections, and an air-tight duct system that performs to specifications. Be sure

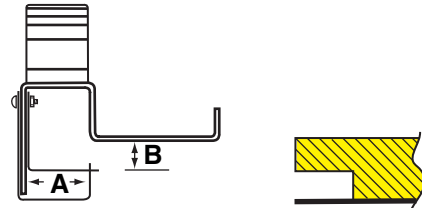
to check blade settings before work is started because blades may not be in proper position when the tools arrive from the factory. This will cause inaccurate cuts to be made.

Dimensions shown below are nominal and may vary among different tool manufacturers.



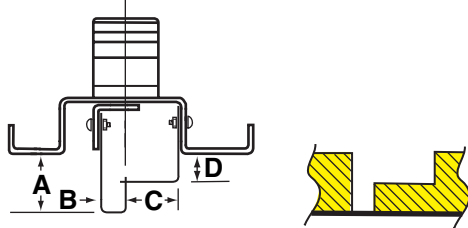
BOARD THICKNESS	A	B
1" (25mm)	7/8" (22mm)	1/2" (13mm)
1 1/2" (38mm)	1 3/8" (35mm)	3/4" (19mm)
2" (51mm)	1 7/8" (48mm)	1" (25mm)

Fig. 2-9A. Female Shiplap Tool - Cuts female slip joint. Also cuts seating edge of duct board at longitudinal closure corner.



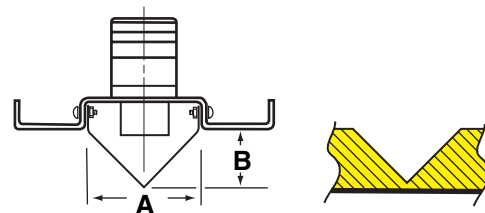
BOARD THICKNESS	A	B
1" (25mm)	7/8" (22mm)	1/2" (13mm)
1 1/2" (38mm)	1 3/8" (35mm)	3/4" (19mm)
2" (51mm)	1 7/8" (48mm)	1" (25mm)

Fig. 2-9D. Male Shiplap Tool - Cuts male slip joint which mates with female slip joint to connect two duct sections.



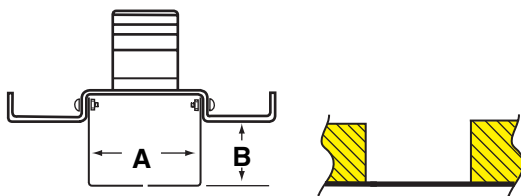
BOARD THICKNESS	A	B	C	D
1" (25mm)	15/16" (24mm)	3/8" (24mm)	7/8" (22mm)	1/2" (13mm)
1 1/2" (38mm)	1 3/8" (35mm)	9/16" (14mm)	1 1/8" (35mm)	11/16" (17mm)
2" (51mm)	1 7/8" (48mm)	7/8" (22mm)	1 7/8" (48mm)	15/16" (24mm)

Fig. 2-9B. Modified Shiplap Tool - Removes insulation for shiplap corner folds. Reversing the tool allows both left hand and right hand shiplaps to be cut.



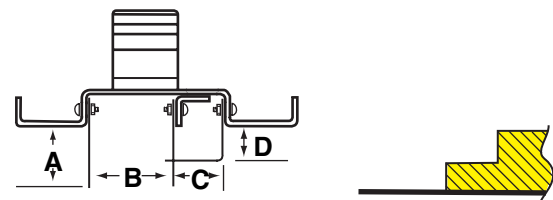
BOARD THICKNESS	A	B
1" (25mm)	1 3/4" (44mm)	7/8" (22mm)
1 1/2" (38mm)	2 3/4" (67mm)	1 3/8" (35mm)
2" (51mm)	3 3/4" (95mm)	1 7/8" (48mm)

Fig. 2-9E. V-Groove Tool - Cuts 90° V-grooves for corner folds when modified shiplap grooving method is not used.



BOARD THICKNESS	A	B
1" (25mm)	1 3/4" (44mm)	1" (25mm)
1 1/2" (38mm)	2 5/8" (67mm)	1 1/2" (38mm)

Fig. 2-9C. Staple Flap Tool - Used with straight knife to make staple flap and end cut



BOARD THICKNESS	A	B	C	D
1" (25mm)	7/8" (22mm)	1 3/8" (35mm)	7/8" (22mm)	1/2" (13mm)
1 1/2" (38mm)	1 3/8" (35mm)	1 11/16" (43mm)	1 3/8" (35mm)	3/4" (19mm)
2" (51mm)	1 3/4" (48mm)	2 1/8" (54mm)	1 3/4" (44mm)	1" (25mm)

Fig. 2-9F. Shiplap and End Cut-Off Tool - Cuts shiplap on end of board for longitudinal corner closure, plus staple flap. May also be used in some fitting fabrication techniques.

HAND FABRICATION, CENTERLINE METHOD

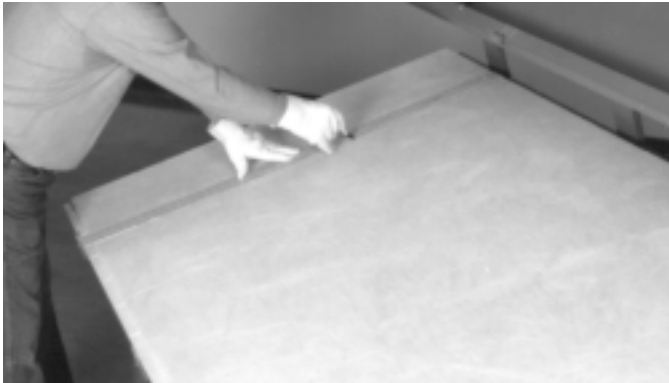
First, determine board length required for straight duct module of specified size. This “stretch-out” is the sum of inside duct dimensions (2x height + 2x width) plus add-on allowance for one-piece duct. (Procedure shown based on use of Amcraft tools.)

EXAMPLE: 12" x 10" (305mm x 254mm) duct, 1" (25mm) board thickness, shiplap method:
 (12" X 2) + (10" X 2) = total inside dimension 44"
 1 3/4" + 1 3/4" + 1 3/4" + 1 3/8" + 1 3/8" = add-on allowance 8"
 Total stretch-out, 12" X 10" duct, 1" duct board 52"
 ([305mm x 2] + [254mm + 2]) = total inside dimension 1118mm
 (44mm + 44mm + 44mm + 35mm + 35mm = add-on allowance ... 202mm)
 (Total stretch-out, 305mm X 254mm duct, 25mm duct board .. 1320mm)

LAYOUT: One-piece fabrication method is shown. Two-piece “L”, two-piece “U”, and four-piece fabrication methods are also possible. See pages 2-16 through 2-19 for add-on dimensions.



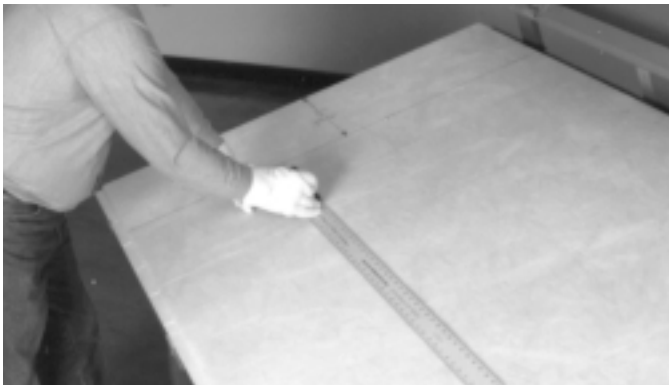
3. From there, measure 12" (305mm), same as first inside duct dimension, + add-on allowance of 1 3/4" (44mm), total 13 3/4" (349mm). Draw third corner groove centerline.



1. With factory female shiplap toward you, from left edge of board measure 12" (305mm) (first inside duct dimension) + add-on allowance of 1 3/4" (44mm), total 13 3/4" (349mm). Draw first corner groove centerline.



4. From there, measure 10" (254mm), same as second inside duct dimension, + add-on allowance of 1 3/8" (35mm), total 11 3/8" (289mm). Draw fourth corner groove centerline.



2. From there, measure 10" (254mm) (second inside duct dimension) + add-on allowance of 1 3/4" (44mm), total 11 3/4" (298mm). Draw second corner groove centerline.



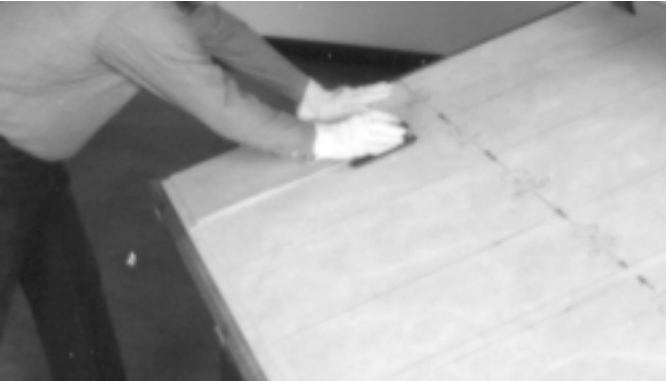
5. From there, measure 1 3/8" (35mm) and draw line locating edge of closure flap. The board is now ready to be grooved. See next page.



6. GROOVING: Cut along left edge of first panel using female shiplap tool to form the shiplap edge without closure flap. Remove scrap.



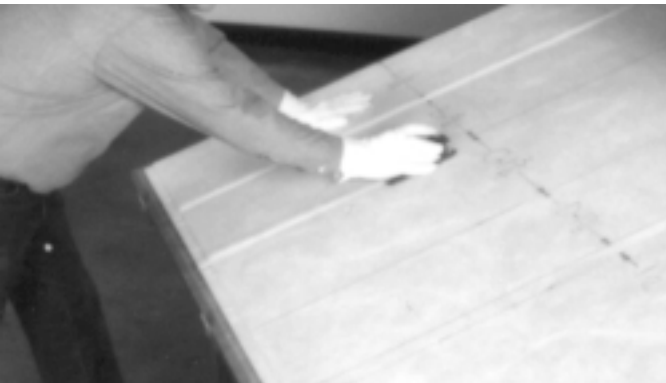
9. Rotate modified shiplap tool back to position in step 7. Cut along third corner break centerline so right hand side of panel #3 is shiplapped and left hand side of panel #4 is cut straight. Remove scrap.



7. Cut along first corner centerline with modified shiplap tool so shiplap is on right side of panel #1 and left side of panel #2 is cut straight. Remove groove scrap; this is easily done if board is lifted slightly.



10. Using straight knife, cut along fourth corner break line through insulation only. Do not cut through or score the facing.



8. Rotate modified shiplap tool end for end (or use next sequentially numbered tool) and cut along second corner break centerline so right side of panel #2 is cut straight and shiplap is on left side of panel #3. Lift board slightly and remove groove scrap.



11. Using straight knife, cut through insulation and facing along last line - the line representing outer edge of closure flap. Peel insulation from flap. The board is now ready for assembly and closure to form a straight duct module or fitting.

HAND FABRICATION, GUIDE EDGE METHOD

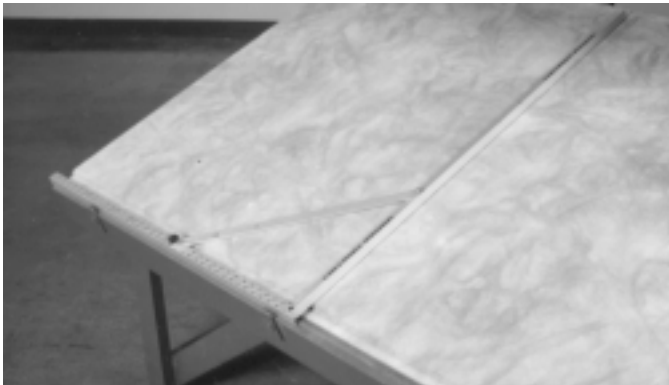
Shown on pages 2-12 and 2-13 is the typical method where grooving tools are used working from the right hand side of the guide edge. Some tool manufacturers also provide for using tools by working from the left hand side of the guide edge. Both the squaring tool and hand grooving tools must be changed to accomplish this. Consult tool manufacturers' detailed instructions on using their products.

LAYOUT AND GROOVING

Unlike the centerline method (pages 2-10 and 2-11), it is not necessary to draw layout lines and calculate stretch-out before cutting grooves. One-piece duct fabrication method is shown. Two-piece "L", two-piece "U", and four-piece fabrication methods are also possible. See pages 2-16 through 2-19 for add-on dimensions.



3. Place squaring tool on duct board so rule edge is parallel with factory female shiplap. Line up inside duct width dimension on rule with right hand edge of cut made in Step 2.



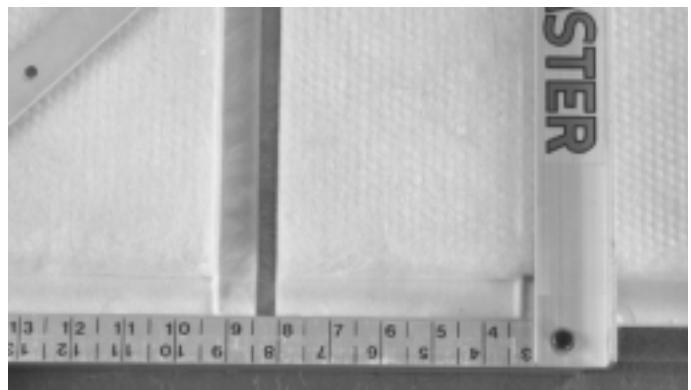
1. For right hand shiplap and staple flap, set up squaring tool as shown above. Guide edge will be at right. Factory female shiplap will be toward you.



4. Place corner grooving tool (modified shiplap or V-groove) along guide edge of squaring tool and cut first corner groove. Remove groove scrap.



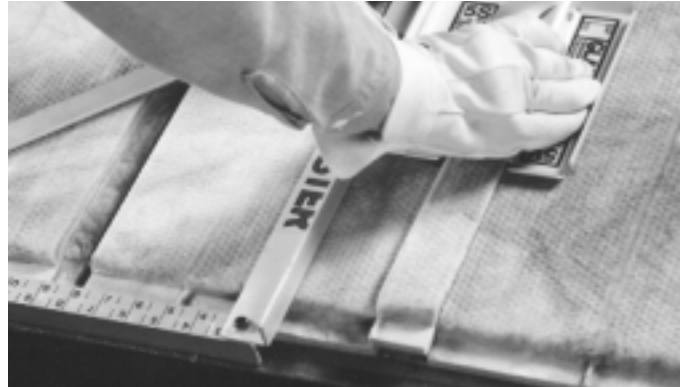
2. Cut along left edge of duct board using female shiplap tool to form shiplap edge without closure flap. Remove scrap from groove.



5. Re-position squaring tool to right, lining up desired inside duct height dimension on rule with right hand edge of first corner cut.



6. Rotate corner grooving tool end-for-end (or use next sequentially numbered tool) and place along guide edge of squaring tool to cut second corner groove. Remove groove scrap.



8. Re-position squaring tool to right to make stapling flap cut.



7. Re-position squaring tool to the right, to line up desired inside duct width dimension as in Step 3. Cut third corner groove using tool as in Step 4.



9. Using a straight knife, cut through insulation and facing along right hand cut. Peel insulation from closure flap. Board is now ready for assembly and closure to form a straight duct module.

IMPORTANT NOTE:

These instructions are general in nature. Since several manufacturers produce tools and guide edge squares, the tool manufacturer's instructions should be followed. Also, total stretch-out dimensions may vary. Therefore, the user must determine the actual total stretch-out applying to the tools being used.

MACHINE FABRICATION OF STRAIGHT DUCT MODULES - SHIPLAP MODULES

Machine fabrication is fast, accurate, repeatable, and usually more productive than hand fabrication.

Grooving machines can cut all of the corner fold cuts for a one-piece straight module of fibrous glass duct board, plus cutting to correct stretch-out dimensions and finishing the longitudinal seam edges with staple flap, all in one pass. Two-piece “L”, two-piece “U”, and four-piece duct components can also be cut on grooving machines.

The modified shiplap method is recommended for machine fabrication of straight modules of fibrous glass duct board, although V-groove tools for all three thicknesses of duct board are available for most grooving machines.

Machine grooving tools have numbered or lettered tabs corresponding to the location and width of the cutting portion. To set up the machine, the interior dimensions of the duct are measured between the tabs on the tools; the tabs represent the necessary add-on allowances.

There are three methods for setting up the cutting tools in the grooving machine: Preferred, Reverse, and Standard. See Figs. 2-10A, 2-10B, and 2-10C below.

Closure machines:

These provide tightly sealed longitudinal seams at high production rates. When using approved heat activated tape on closure machines, it is not necessary to staple the longitudinal flap.

PREFERRED TOOLING SET-UP

The Preferred tooling set-up for one-piece straight duct produces the closure flap at the left hand side of the duct board as it passes through the grooving machine. Tools are identified by letters. See Fig. 2-10A.

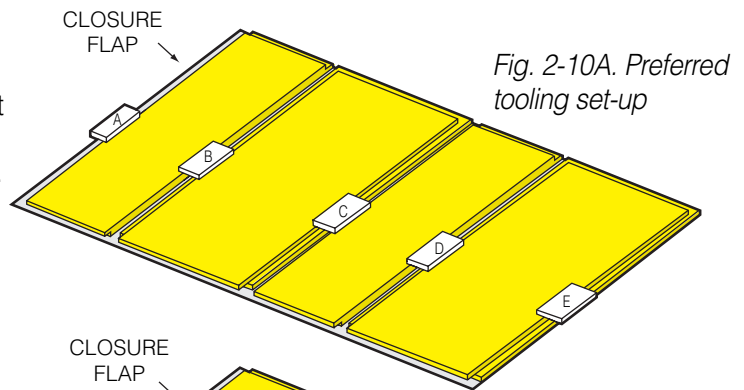


Fig. 2-10A. Preferred tooling set-up

REVERSE TOOLING SET-UP

The Reverse tooling set-up produces results which are identical to those of the Preferred set-up. The only difference is that the tools are identified by numbers. See Fig. 2-10B.

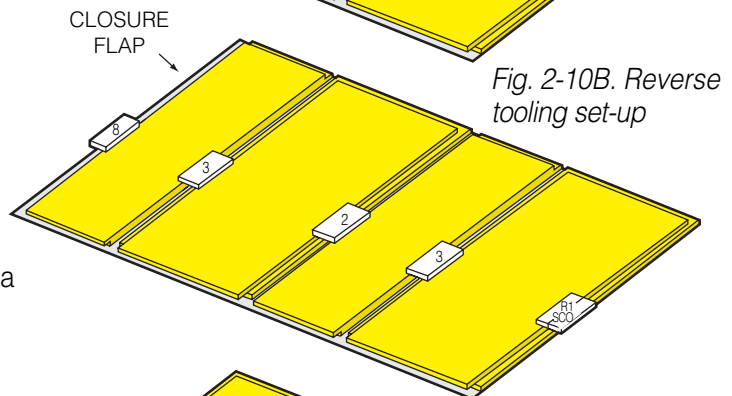


Fig. 2-10B. Reverse tooling set-up

Preferred and Reverse tooling set-ups both offer the advantage of cutting the closure flap by the blade nearest the side frame of the machine where the tool roller is supported. This contributes to the formation of a cleaner staple flap requiring less hand labor to remove the remaining insulation.

When longitudinal closures are produced by machine, the Preferred or Reverse tooling set-up must be used.

STANDARD TOOLING SET-UP

The Standard tooling set-up for one-piece straight duct produces the closure flap at the right hand side of the duct board as it passes through the grooving machine. Tools are identified by numbers. See Fig. 2-10C.

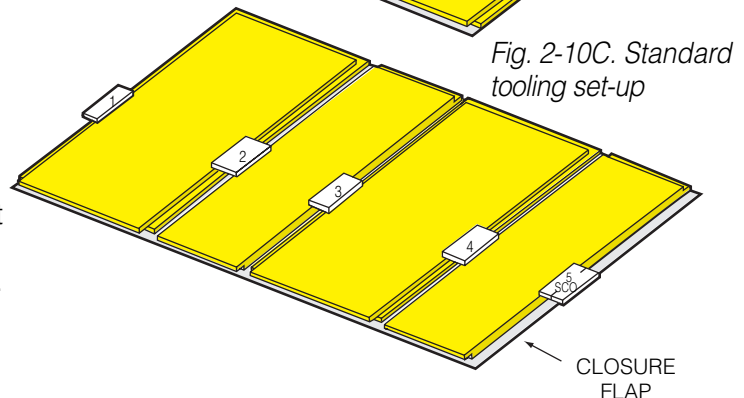


Fig. 2-10C. Standard tooling set-up

TYPICAL GROOVING MACHINE TOOLS



#1 (or F). Left hand female shiplap tool.



#R1 (or E + SCO). Right hand female shiplap tool.



#2 & #4 (or C). Right hand modified shiplap tool.



#3 (or B). Left hand modified shiplap tool.



#5 (or G). Right hand square cut tool with closure flap.



#6. Left hand female shiplap tool with cutoff.



#7. Right hand female shiplap tool with cutoff.



#8 (or A). Left hand square cut tool with closure flap.



#9. Left hand male shiplap tool.



#0. Right hand male shiplap tool.



#SCO. Straight cutoff tool. May be used with #R1 to make the same cut as #7 tool.

Fig. 2-11. Grooving machine tools.

MACHINE FABRICATION



1. Install tools in grooving machine according to machine manufacturer's instructions, board layout, and cutting plan (see pages 2-16 - 2-19), using either Standard or Reverse tooling set-up (see page 2-10).



2. Feed duct board into machine, female shiplap edge first, left hand edge firmly against guide, parallel to rollers. Turn on machine and guide board as friction rollers pick it up and pull it through the cutting tools.



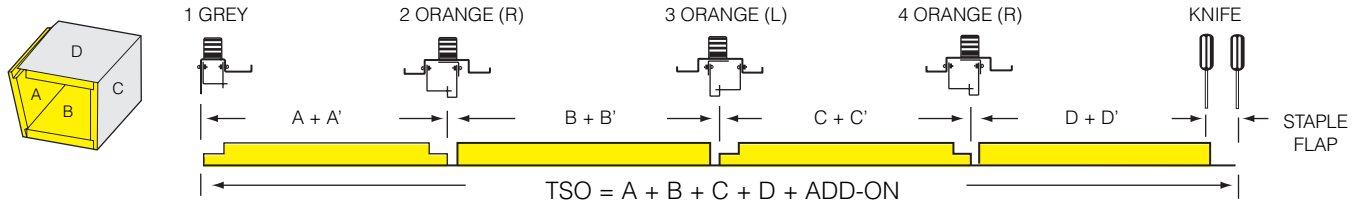
3. Remove groove scrap. Confirm dimensions. The board is now ready for assembly and closure of a straight duct module, or for fabrication of a fitting.

Fig. 2-16. FABRICATION, ONE-PIECE DUCT

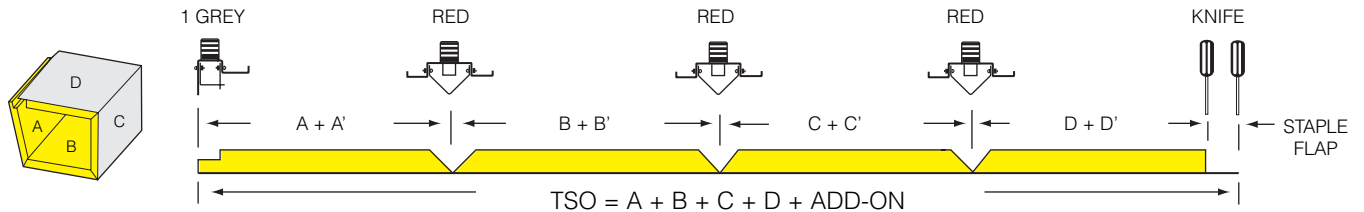
Layout and fabrication methods below are typical. Others are possible. When fabricating by machine, check set-up dimensions carefully. Dimensions may vary from machine to machine.

HAND FABRICATION - SHIPLAP METHOD

TSO = total stretch-out

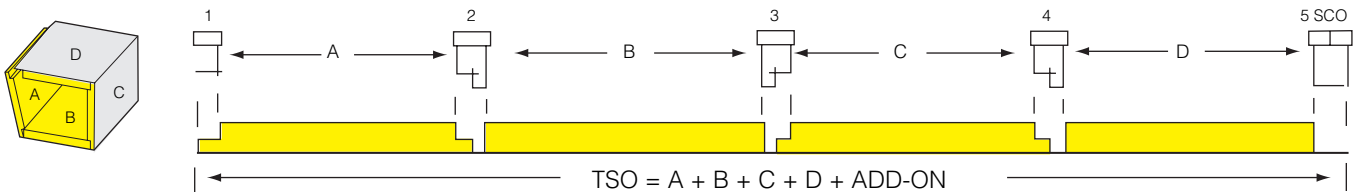


HAND FABRICATION - V-GROOVE METHOD

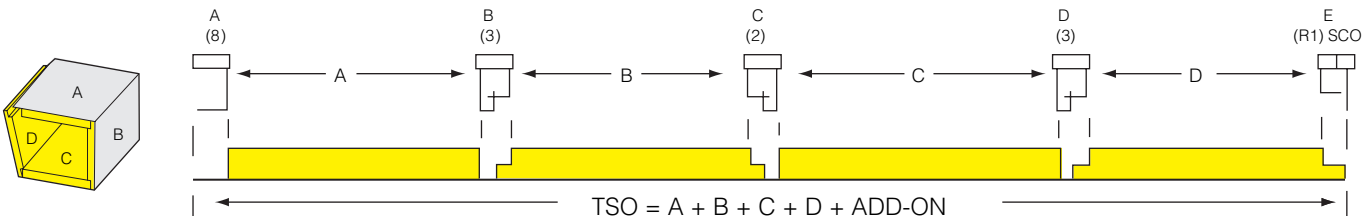


	DUCT BOARD THICKNESS	PANEL ADD-ON DIMENSIONS				STAPLING FLAP	STRETCH-OUT ADD-ON
		A'	B'	C'	D'		
A, B, C, D ARE	1" (25mm)	1 3/4" (44mm)	1 3/4" (44mm)	1 3/4" (44mm)	1 3/8" (35mm)	1 3/8" (35mm)	8" (203mm)
INSIDE	1 1/2" (38mm)	2 3/4" (70mm)	2 3/4" (70mm)	2 3/4" (70mm)	2 1/8" (54mm)	2 1/8" (54mm)	12 1/2" (318mm)
DIMENSIONS	2" (51mm)	3 3/4" (95mm)	3 3/4" (95mm)	3 3/4" (95mm)	2 7/8" (73mm)	2 1/2" (64mm)	16 5/8" (422mm)

MACHINE FABRICATION - STANDARD



MACHINE FABRICATION - PREFERRED



Inside duct dimensions A, B, C, D are measured between tool tabs.

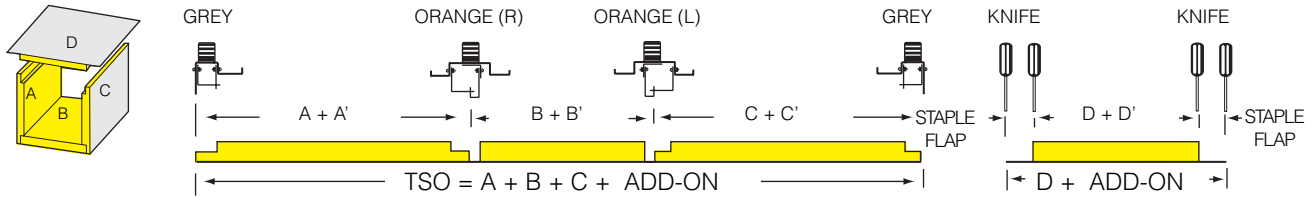
DUCT BOARD THICKNESS	STRETCH-OUT ADD-ON
1" (25mm)	8" (203mm)
1 1/2" (38mm)	12" (305mm)
2" (51mm)	16" (406mm)

Fig. 2-17. FABRICATION, TWO-PIECE U-STYLE DUCT

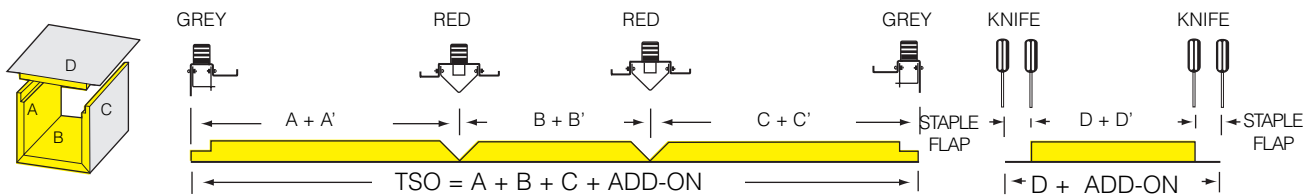
Layout and fabrication methods below are typical. Others are possible. When fabricating by machine, check set-up dimensions carefully. Dimensions may vary from machine to machine.

HAND FABRICATION - SHIPLAP METHOD

TSO = total stretch-out

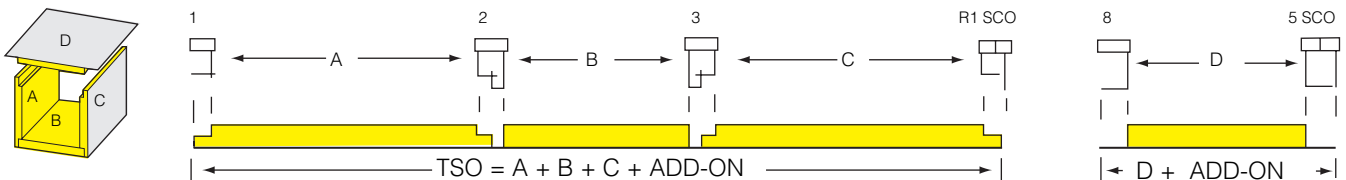


HAND FABRICATION - V-GROOVE METHOD

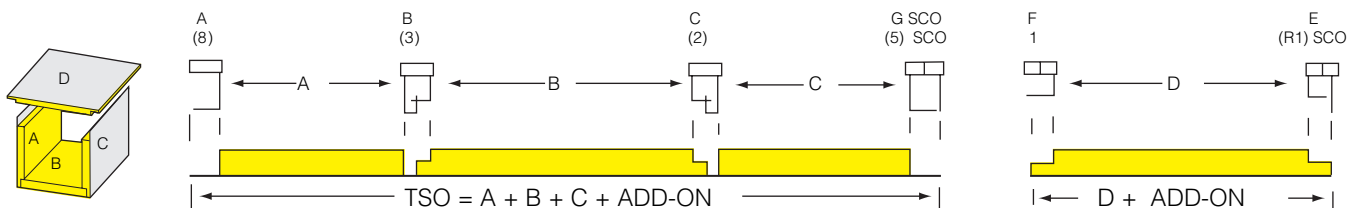


	DUCT BOARD THICKNESS	PANEL ADD-ON A', B', C'	U SECTION TSO ADD-ON	D'	STAPLING FLAP	PANEL D TSO ADD-ON
A, B, C, D ARE	1" (25mm)	1 3/4" (44mm)	5 1/4" (133mm)	1" (25mm)	1 1/2" (38mm)	4" (102mm)
INSIDE	1 1/2" (38mm)	2 3/4" (70mm)	8 1/4" (210mm)	1 1/2" (38mm)	2 1/8" (54mm)	5 3/4" (146mm)
DIMENSIONS	2" (51mm)	3 3/4" (95mm)	11 1/4" (286mm)	2" (51mm)	2 1/2" (64mm)	7" (178mm)

MACHINE FABRICATION - STANDARD



MACHINE FABRICATION - PREFERRED



Inside duct dimensions A, B, C, D are measured between tool tabs.

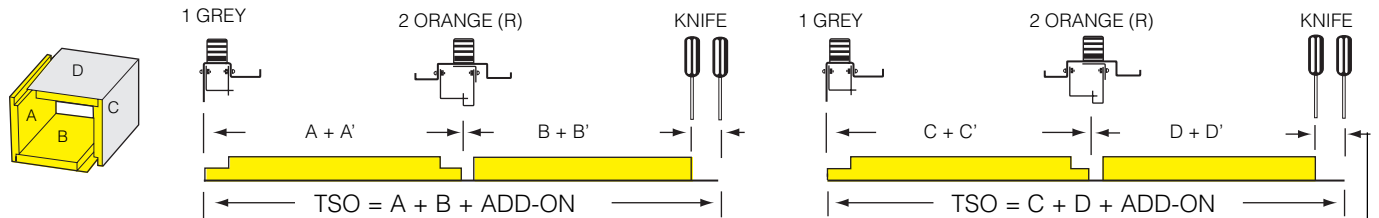
DUCT BOARD THICKNESS	STANDARD		PREFERRED	
	U-SECTION ADD-ON	FILLER PANEL ADD-ON	U-SECTION ADD-ON	FILLER PANEL ADD-ON
1" (25mm)	4 3/4" (121mm)	4 1/4" (108mm)	7 3/4" (197mm)	1 1/2" (38mm)
1 1/2" (38mm)	7 5/8" (194mm)	5 3/4" (146mm)	11" (279mm)	2 1/2" (64mm)
2" (51mm)	10 1/2" (267mm)	7 1/4" (184mm)	14 1/4" (362mm)	3 1/2" (89mm)

Fig. 2-18. FABRICATION, TWO-PIECE L-STYLE DUCT

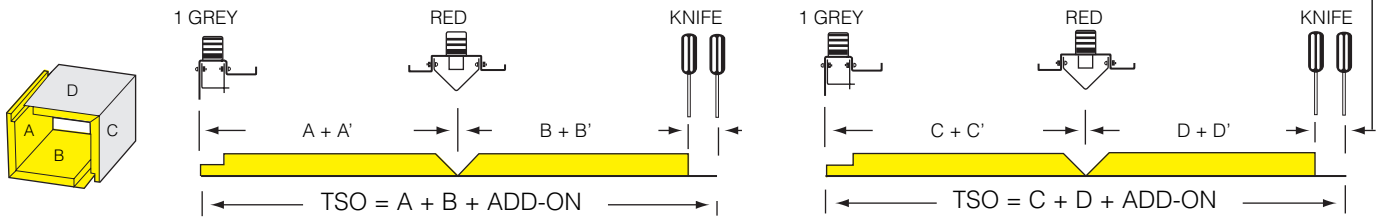
Layout and fabrication methods below are typical. Others are possible. When fabricating by machine, check set-up dimensions carefully. Dimensions may vary from machine to machine.

HAND FABRICATION - SHIPLAP METHOD

TSO = total stretch-out

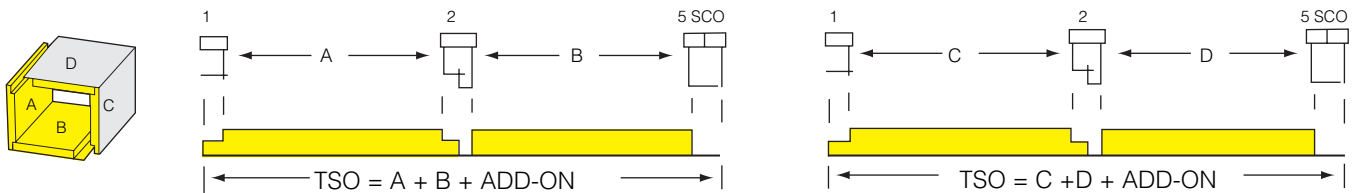


HAND FABRICATION - V-GROOVE METHOD

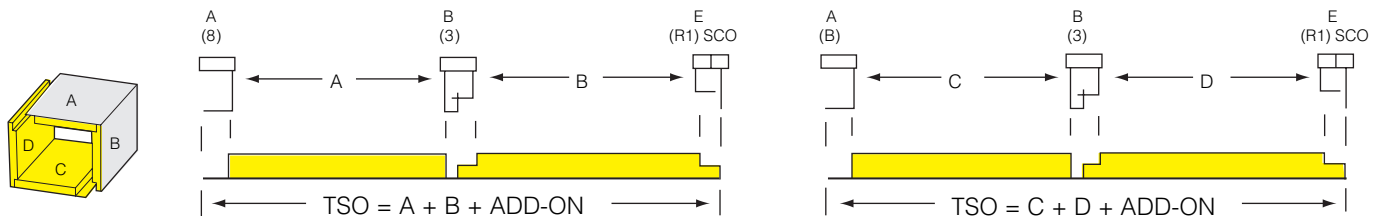


	DUCT BOARD THICKNESS	PANEL ADD-ON DIMENSIONS				STAPLE FLAP	TSO ADD-ON
		A'	B'	C'	D'		
A, B, C, D ARE	1" (25mm)	1 ³ / ₄ " (44mm)	1 ³ / ₈ " (44mm)	1 ³ / ₄ " (44mm)	1 ³ / ₈ " (44mm)	1 ¹ / ₂ " (38mm)	4 ⁵ / ₈ " (117mm)
INSIDE	1 ¹ / ₂ " (38mm)	2 ³ / ₄ " (70mm)	2 ¹ / ₈ " (54mm)	2 ³ / ₄ " (70mm)	2 ¹ / ₈ " (54mm)	2 ¹ / ₈ " (54mm)	7" (178mm)
DIMENSIONS	2" (51mm)	3 ³ / ₄ " (95mm)	2 ⁷ / ₈ " (73mm)	3 ³ / ₄ " (95mm)	2 ⁷ / ₈ " (73mm)	2 ¹ / ₂ " (64mm)	9 ¹ / ₈ " (232mm)

MACHINE FABRICATION - STANDARD



MACHINE FABRICATION - PREFERRED



Inside duct dimensions A, B, C, D are measured between tool tabs.

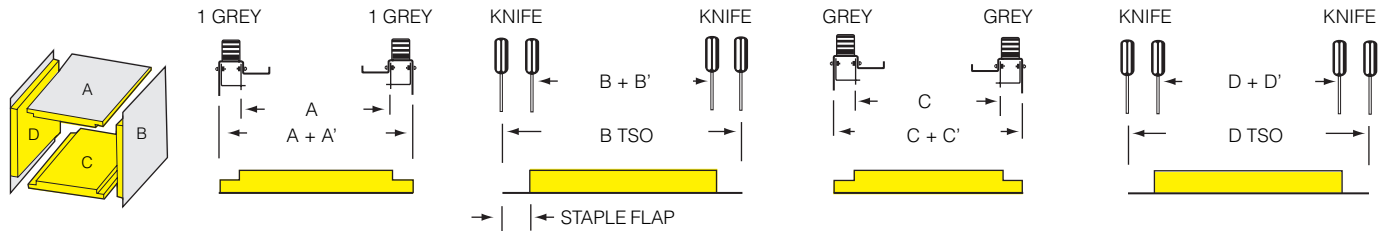
DUCT BOARD THICKNESS	L-SECTION TSO ADD-ON
1" (25mm)	4 ¹ / ₂ " (114mm)
1 ¹ / ₂ " (38mm)	6 ³ / ₄ " (171mm)
2" (51mm)	8 ⁷ / ₈ " (225mm)

Fig. 2-19. FABRICATION, FOUR-PIECE DUCT

Layout and fabrication methods below are typical. Others are possible. When fabricating by machine, check set-up dimensions carefully. Dimensions may vary from machine to machine.

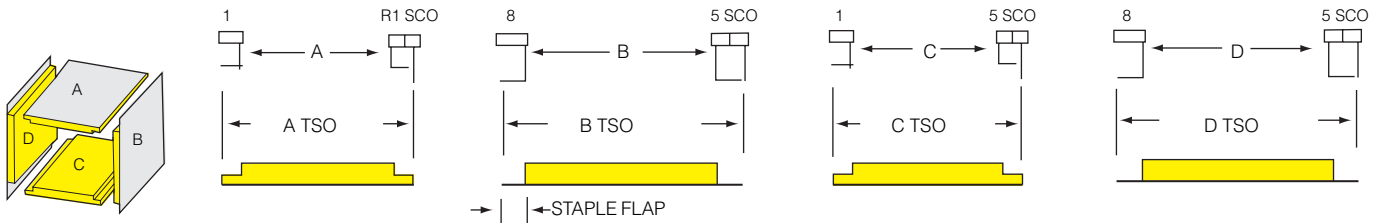
HAND FABRICATION - HAND TOOL METHOD

TSO = total stretch-out

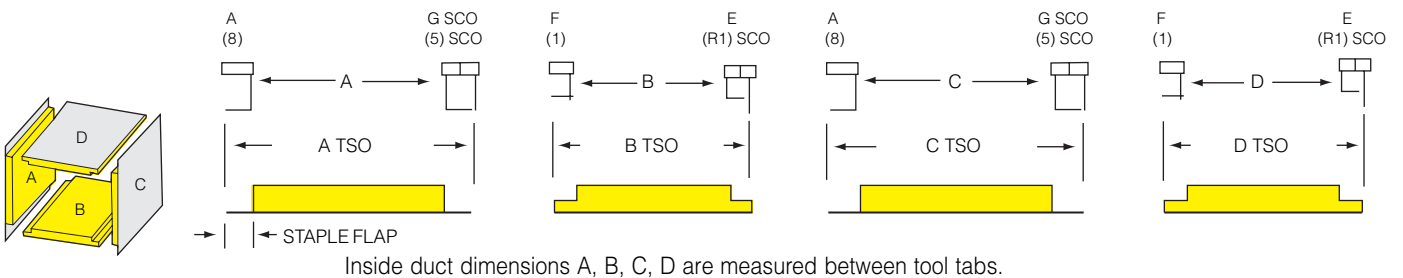


	DUCT BOARD THICKNESS	PANEL ADD-ON DIMENSIONS A' & C'	B' & D'	STAPLE FLAP	B & D TSO ADD-ON
A, B, C, D ARE	1" (25mm)	1 3/4" (44mm)	1" (25mm)	1 1/2" (38mm)	4" (102mm)
INSIDE	1 1/2" (38mm)	2 3/4" (70mm)	1 1/2" (38mm)	2 1/8" (54mm)	5 3/4" (146mm)
DIMENSIONS	2" (51mm)	3 3/4" (95mm)	2" (51mm)	2 1/2" (64mm)	7" (178mm)

MACHINE FABRICATION - STANDARD



MACHINE FABRICATION - PREFERRED



	DUCT BOARD THICKNESS	STANDARD TSO ADD-ON		PREFERRED TSO ADD-ON		STAPLE FLAP (REFERENCE)
		PANELS A & C	PANELS B & D	PANELS A & C	PANELS B & D	
A, B, C, D ARE	1" (25mm)	1 1/2" (38mm)	4 1/4" (108mm)	4 1/4" (108mm)	1 1/2" (38mm)	1 5/8" (41mm)
INSIDE	1 1/2" (38mm)	2 1/2" (64mm)	5 3/4" (146mm)	5 3/4" (146mm)	2 1/2" (64mm)	2 1/8" (54mm)
DIMENSIONS	2" (51mm)	3 1/2" (89mm)	7 1/4" (184mm)	7 1/4" (184mm)	3 1/2" (89mm)	2 5/8" (67mm)

ONE PIECE STRETCH-OUT DIMENSIONS IN INCHES, 1" DUCT BOARD

DUCT WIDTH in.	DUCT HEIGHT, in.															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
6	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92
8	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	
10	40	44	48	52	56	60	64	68	72	76	80	84	88	92		
12	44	48	52	56	60	64	68	72	76	80	84	88	92			
14	48	52	56	60	64	68	72	76	80	84	88	92				
16	52	56	60	64	68	72	76	80	84	88	92					
18	56	60	64	68	72	76	80	84	88	92						
20	60	64	68	72	76	80	84	88	92							
22	64	68	72	76	80	84	88	92								
24	68	72	76	80	84	88	92									
26	72	76	80	84	88	92										
28	76	80	84	88	92											
30	80	84	88	92												
32	84	88	92													
34	88	92														
36	92															

NOTE: These tables assume the total stretch-out (add-on) dimension is 8". If the process used results in a different stretch-out dimension, these tables must be modified accordingly.

ONE PIECE STRETCH-OUT DIMENSIONS IN MILLIMETERS, 25mm DUCT BOARD

DUCT WIDTH mm.	DUCT HEIGHT, mm.															
	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900
150	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
200	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	
250	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300		
300	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300			
350	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300				
400	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300					
450	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300						
500	1500	1600	1700	1800	1900	2000	2100	2200	2300							
550	1600	1700	1800	1900	2000	2100	2200	2300								
600	1700	1800	1900	2000	2100	2200	2300									
650	1800	1900	2000	2100	2200	2300										
700	1900	2000	2100	2200	2300											
750	2000	2100	2200	2300												
800	2100	2200	2300													
850	2200	2300														
900	2300															

NOTE: These tables assume the total stretch-out (add-on) dimension is 200mm. If the process used results in a different stretch-out dimension, these tables must be modified accordingly.

BOARD UTILIZATION, ONE PIECE DUCT, 1" DUCT BOARD, FT² PER LINEAL FOOT OF DUCT

DUCT WIDTH in.	DUCT HEIGHT, in.															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
6	2.67	3.00	3.33	3.67	4.00	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67
8	3.00	3.33	3.67	4.00	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	
10	3.33	3.67	4.00	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67		
12	3.67	4.00	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67			
14	4.00	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67				
16	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67					
18	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67						
20	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67							
22	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67								
24	5.67	6.00	6.33	6.67	7.00	7.33	7.67									
26	6.00	6.33	6.67	7.00	7.33	7.67										
28	6.33	6.67	7.00	7.33	7.67											
30	6.67	7.00	7.33	7.67												
32	7.00	7.33	7.67													
34	7.33	7.67														
36	7.67															

NOTE: This table is based on a total add-on allowance of 8". If the process and tools used result in a different add-on allowance, these tables must be modified accordingly.

BOARD UTILIZATION, ONE PIECE DUCT, 25mm DUCT BOARD, m² PER LINEAL METER OF DUCT

DUCT WIDTH mm.	DUCT HEIGHT, mm.															
	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900
150	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3
200	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	
250	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3		
300	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3			
350	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3				
400	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3					
450	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3						
500	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3							
550	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3								
600	1.7	1.8	1.9	2.0	2.1	2.2	2.3									
650	1.8	1.9	2.0	2.1	2.2	2.3										
700	1.9	2.0	2.1	2.2	2.3											
750	2.0	2.1	2.2	2.3												
800	2.1	2.2	2.3													
850	2.2	2.3														
900	2.3															

NOTE: This table is based on a total add-on allowance of 200mm. If the process and tools used result in a different add-on allowance, these tables must be modified accordingly.

ONE PIECE STRETCH-OUT DIMENSIONS IN INCHES, 1½” DUCT BOARD

DUCT WIDTH in.	DUCT HEIGHT, in.															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
6	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96
8	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	
10	44	48	52	56	60	64	68	72	76	80	84	88	92	96		
12	48	52	56	60	64	68	72	76	80	84	88	92	96			
14	52	56	60	64	68	72	76	80	84	88	92	96				
16	56	60	64	68	72	76	80	84	88	92	96					
18	60	64	68	72	76	80	84	88	92	96						
20	64	68	72	76	80	84	88	92	96							
22	68	72	76	80	84	88	92	96								
24	72	76	80	84	88	92	96									
26	76	80	84	88	92	96										
28	80	84	88	92	96											
30	84	88	92	96												
32	88	92	96													
34	92	96														
36	96															

NOTE: These tables assume the total stretch-out (add-on) dimension is 12". If the process used results in a different stretch-out dimension, these tables must be modified accordingly.

ONE PIECE STRETCH-OUT DIMENSIONS IN MILLIMETERS, 38mm DUCT BOARD

DUCT WIDTH mm.	DUCT HEIGHT, mm.															
	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900
150	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
200	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	
250	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400		
300	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400			
350	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400				
400	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400					
450	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400						
500	1600	1700	1800	1900	2000	2100	2200	2300	2400							
550	1700	1800	1900	2000	2100	2200	2300	2400								
600	1800	1900	2000	2100	2200	2300	2400									
650	1900	2000	2100	2200	2300	2400										
700	2000	2100	2200	2300	2400											
750	2100	2200	2300	2400												
800	2200	2300	2400													
850	2300	2400														
900	2400															

NOTE: These tables assume the total stretch-out (add-on) dimension is 300mm. If the process used results in a different stretch-out dimension, these tables must be modified accordingly.

BOARD UTILIZATION, ONE PIECE DUCT, 1½" DUCT BOARD, FT² PER LINEAL FOOT OF DUCT

DUCT WIDTH in.	DUCT HEIGHT, in.															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
6	3.00	3.33	3.67	4.00	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00
8	3.33	3.67	4.00	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00	
10	3.67	4.00	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00		
12	4.00	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00			
14	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00				
16	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00					
18	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00						
20	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00							
22	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00								
24	6.00	6.33	6.67	7.00	7.33	7.67	8.00									
26	6.33	6.67	7.00	7.33	7.67	8.00										
28	6.67	7.00	7.33	7.67	8.00											
30	7.00	7.33	7.67	8.00												
32	7.33	7.67	8.00													
34	7.67	8.00														
36	8.00															

NOTE: This table is based on a total add-on allowance of 12". If the process and tools used result in a different add-on allowance, these tables must be modified accordingly.

BOARD UTILIZATION, ONE PIECE DUCT, 38mm DUCT BOARD, m² PER LINEAL METER OF DUCT

DUCT WIDTH mm.	DUCT HEIGHT, mm.															
	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900
150	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4
200	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	
250	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4		
300	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4			
350	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4				
400	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4					
450	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4						
500	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4							
550	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4								
600	1.8	1.9	2.0	2.1	2.2	2.3	2.4									
650	1.9	2.0	2.1	2.2	2.3	2.4										
700	2.0	2.1	2.2	2.3	2.4											
750	2.1	2.2	2.3	2.4												
800	2.2	2.3	2.4													
850	2.3	2.4														
900	2.4															

NOTE: This table is based on a total add-on allowance of 300mm. If the process and tools used result in a different add-on allowance, these tables must be modified accordingly.

ONE PIECE STRETCH-OUT DIMENSIONS IN INCHES, 2" DUCT BOARD

DUCT WIDTH in.	DUCT HEIGHT, in.																		
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
6	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112
8	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	
10	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112		
12	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112			
14	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112				
16	60	64	68	72	76	80	84	88	92	96	100	104	108	112					
18	64	68	72	76	80	84	88	92	96	100	104	108	112						
20	68	72	76	80	84	88	92	96	100	104	108	112							
22	72	76	80	84	88	92	96	100	104	108	112								
24	76	80	84	88	92	96	100	104	108	112									
26	80	84	88	92	96	100	104	108	112										
28	84	88	92	96	100	104	108	112											
30	88	92	96	100	104	108	112												
32	92	96	100	104	108	112													
34	96	100	104	108	112														
36	100	104	108	112															
38	104	108	112																
40	108	112																	
42	112																		

NOTE: This table assumes the total stretch-out (add-on) dimension is 16". If the process used results in a different stretch-out (add-on) dimension, this table must be modified accordingly.

NOTE: Maximum unreinforced size at 1/2" w.g. is 36" for 800EI board and 42" for 1400EI board.

ONE PIECE STRETCH-OUT DIMENSIONS IN MILLIMETERS, 51mm DUCT BOARD

DUCT WIDTH mm	DUCT HEIGHT, mm																		
	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050
150	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800
200	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	
250	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800		
300	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800			
350	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800				
400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800					
450	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800						
500	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800							
550	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800								
600	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800									
650	2000	2100	2200	2300	2400	2500	2600	2700	2800										
700	2100	2200	2300	2400	2500	2600	2700	2800											
750	2200	2300	2400	2500	2600	2700	2800												
800	2300	2400	2500	2600	2700	2800													
850	2400	2500	2600	2700	2800														
900	2500	2600	2700	2800															
950	2600	2700	2800																
1000	2700	2800																	
1050	2800																		

NOTE: This table assumes the total stretch-out (add-on) dimension is 400mm. If the process used results in a different stretch-out (add-on) dimension, this table must be modified accordingly.

NOTE: Maximum unreinforced size at 1/2" w.g. is 900mm for 800EI board and 1050mm for 1400EI board.

BOARD UTILIZATION, ONE PIECE DUCT, 2" DUCT BOARD, FT² PER LINEAL FOOT OF DUCT

DUCT WIDTH in.	DUCT HEIGHT, in.																		
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
6	3.33	3.67	4.00	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00	8.33	8.67	9.00	9.33
8	3.67	4.00	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00	8.33	8.67	9.00	9.33	
10	4.00	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00	8.33	8.67	9.00	9.33		
12	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00	8.33	8.67	9.00	9.33			
14	4.67	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00	8.33	8.67	9.00	9.33				
16	5.00	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00	8.33	8.67	9.00	9.33					
18	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00	8.33	8.67	9.00	9.33						
20	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00	8.33	8.67	9.00	9.33							
22	6.00	6.33	6.67	7.00	7.33	7.67	8.00	8.33	8.67	9.00	9.33								
24	6.33	6.67	7.00	7.33	7.67	8.00	8.33	8.67	9.00	9.33									
26	6.67	7.00	7.33	7.67	8.00	8.33	8.67	9.00	9.33										
28	7.00	7.33	7.67	8.00	8.33	8.67	9.00	9.33											
30	7.33	7.67	8.00	8.33	8.67	9.00	9.33												
32	7.67	8.00	8.33	8.67	9.00	9.33													
34	8.00	8.33	8.67	9.00	9.33														
36	8.33	8.67	9.00	9.33															
38	8.67	9.00	9.33																
40	9.00	9.33																	
42	9.33																		

NOTE: This table assumes the total stretch-out (add-on) dimension is 16". If the process used results in a different stretch-out (add-on) dimension, this table must be modified accordingly.

NOTE: Maximum unreinforced size at 1/2" w.g. is 36" for 800EI board and 42" for 1400EI board.

BOARD UTILIZATION, ONE PIECE DUCT, 51mm DUCT BOARD, m² PER LINEAL METER OF DUCT

DUCT WIDTH mm	DUCT HEIGHT, mm																		
	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050
150	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8
200	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	
250	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8		
300	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8			
350	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8				
400	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8					
450	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8						
500	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8							
550	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8								
600	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8									
650	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8										
700	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8											
750	2.2	2.3	2.4	2.5	2.6	2.7	2.8												
800	2.3	2.4	2.5	2.6	2.7	2.8													
850	2.4	2.5	2.6	2.7	2.8														
900	2.5	2.6	2.7	2.8															
950	2.6	2.7	2.8																
1000	2.7	2.8																	
1050	2.8																		

NOTE: This table assumes the total stretch-out (add-on) dimension is 400mm. If the process used results in a different stretch-out (add-on) dimension, this table must be modified accordingly.

NOTE: Maximum unreinforced size at 1/2" w.g. is 900mm for 800EI board and 1050mm for 1400EI board.

FABRICATION OF DUCT MODULE



1. Cut shiplates and corner grooves with hand tools or by machine as shown on pages 2-16 through 2-19. Remove groove scrap. Lifting board as shown will make it easier to remove shiplate groove scrap.



3. While holding the duct canted over at about 30° beyond square, staple the longitudinal flap approximately 2" (50mm) on centers. Staples shall be outward clinching, galvanized steel, 1/2" (13mm) long, crown width 0.400" (10mm) (min.), flat wire, 0.040" x 0.020" (1.2 x 0.5mm) (min.).



2. Fold to form the duct section, making sure ends are flush and seated properly in the shoulder of the shiplate edge.



4. Complete the longitudinal seam according to procedures shown in Section V, CLOSURE, page depending on the approved closure method chosen. (Pressure sensitive tape shown above.)

JOINING TWO DUCT MODULES



1. Slit facing flaps back at corners, making sure you do not cut below the male shiplap shoulder or into inside duct surfaces.



3. Staple flaps on all four sides with 1/2" (13mm) (minimum) outward clinching staples approximately 2" (50mm) on centers.



2. Push the two modules together. Make sure male and female shiplaps are tightly fitted together.



4. Complete closure of circumferential joint with UL 181A listed closure. The minimum width pressure sensitive tape for 1" board is 2 1/2". Three inch tape is recommended for 1 1/2" and required for 2" board. Duct board surface must be clean and dry. (Pressure sensitive tape shown above.)

PERFORMED ROUND FIBROUS GLASS DUCT

Performed round fibrous glass duct meets requirements of NFPA 90A and 90B, and is UL 181 listed as a Class 1 Air Duct.

A male-female shiplap joint system, similar to that of flat fibrous glass duct board, is used to make connections between duct sections.

Closure is accomplished using materials and methods described in Section V of this Standard, except that staples are not required.

FABRICATION OF PERFORMED ROUND STRAIGHT SECTIONS

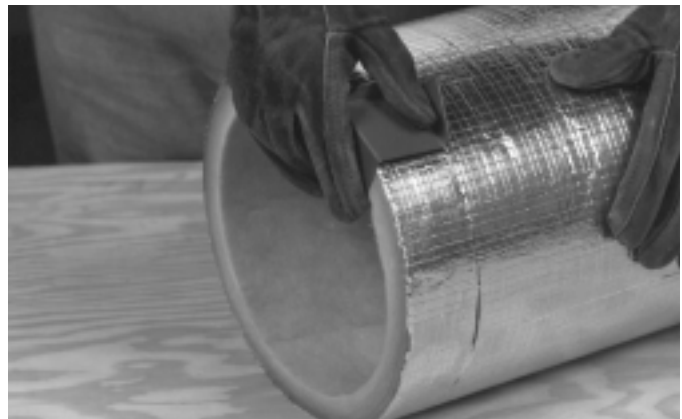
Straight sections of performed round fibrous glass duct have factory-formed male and female shiplap ends. When cutting to length with a straight knife cut, these shiplaps must be replaced using the red slip joint cutter.

For male shiplap: Place cutter over end of duct with blade positioned to cut into exterior of duct wall. Draw cutter completely around duct, then diagonally across the outer edge to permit removal of excess strip of fibrous glass.

For female shiplap: Reverse position of cutter so it cuts into inner surface of duct. Follow same procedure as for male shiplap. Remove excess strip of fibrous glass.



1. Performed round duct sections are joined with male and female shiplaps. Joints are taped; staples are not required.



2. Using shiplap cutter to make male shiplap. Cutter is positioned to cut into exterior of duct wall.



3. Using shiplap cutter to make female shiplap. Cutter is positioned to cut into inside of duct wall.

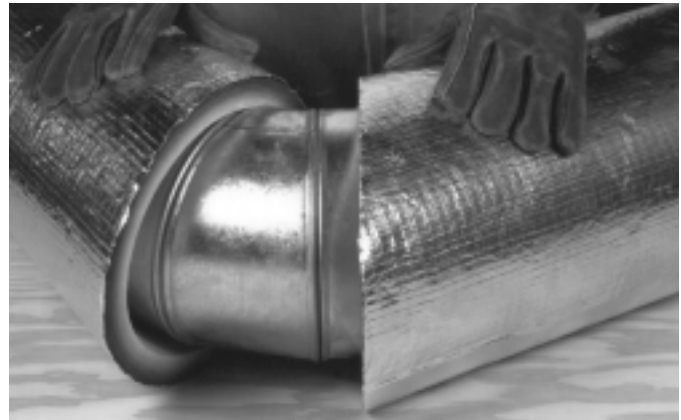
FABRICATING FITTINGS WITH PREFORMED ROUND FIBROUS GLASS DUCT

ELBOWS:

Use standard sheet metal practice to determine throat dimensions. Mark all cuts for mitering. A fine-tooth saw and miter box are recommended to ensure straight, accurate cuts.

90° 2-Piece Elbow:

Make one 45° angle cut. Insert metal elbow in one opening and align other piece of duct to fit tightly. Seal with tape.



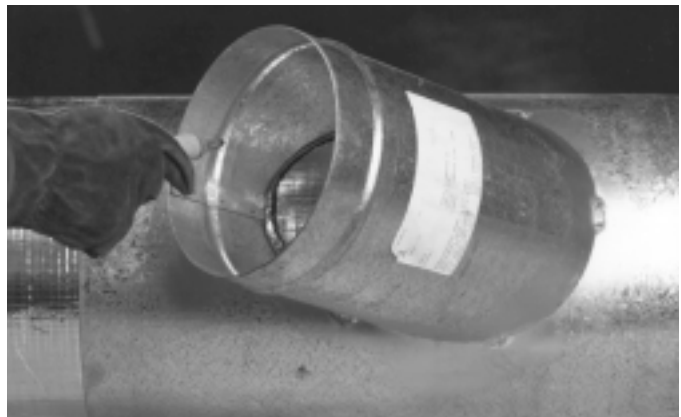
4. Assembling 90° 2-piece elbow with sheet metal sleeve.

Branch Connection:

Fabricate sheet metal saddle and branch collar to conform to outside diameter of main duct, and insert a sheet metal collar to support branch connection properly.

Using the saddle as a template, mark opening in main duct to conform to inside diameter of branch duct. Take care to maintain branch angle with knife.

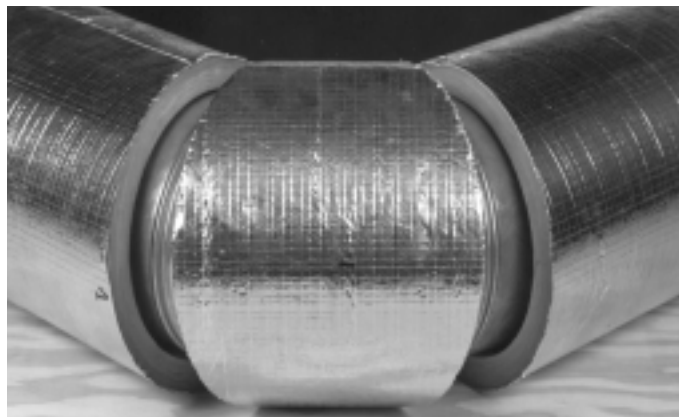
Fasten sheet metal saddle in place. Secure branch duct in place and seal with tape as recommended by round duct manufacturer. NOTE: Staples are not required.



5. Using saddle as a template to mark hole in main duct for branch connection.

90° 3-Piece Elbow:

Make two 22½° angle cuts. Make 180° cut inside back of mitered section tapering from zero thickness on either side to about half the wall thickness at back. Remove material to provide clearance over metal elbow. Assemble mitered section, align, and seal with tape.



6. Assembling 90° 3-piece elbow. Duct material must be removed for clearance over sheet metal elbow.

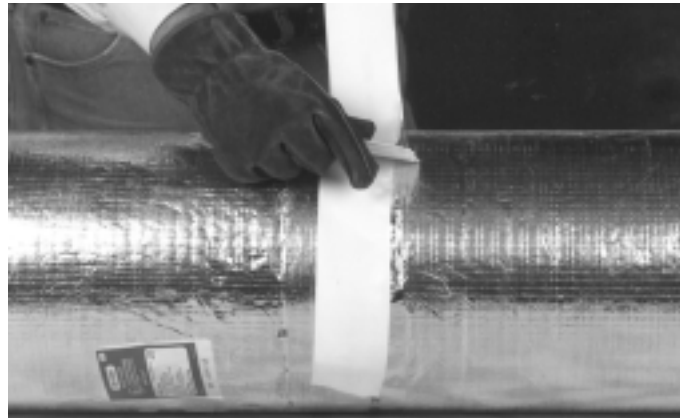
CLOSURE OF PREFORMED ROUND DUCT JOINTS

Closure of circumferential joints in preformed round duct is accomplished using materials and procedures in compliance with the manufacturer's UL 181 listing. NOTE: Staples are not used in making closures with rigid round fibrous glass duct.

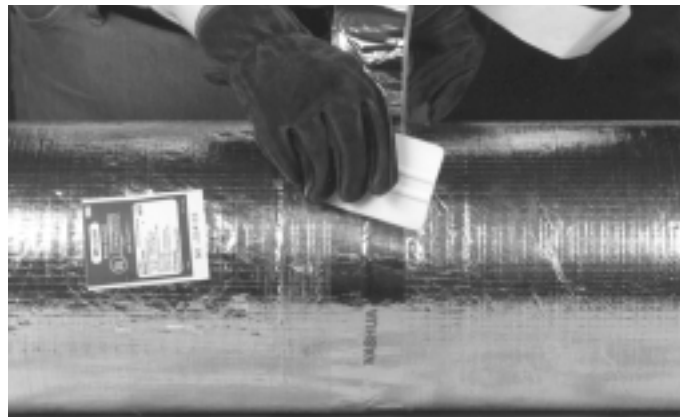
If using pressure sensitive tape, center tape over joint and overlap ends 3" (75mm) (minimum).

Rub tape firmly with sealing tool until scrim pattern of duct facing shows through tape to assure an air-tight seal.

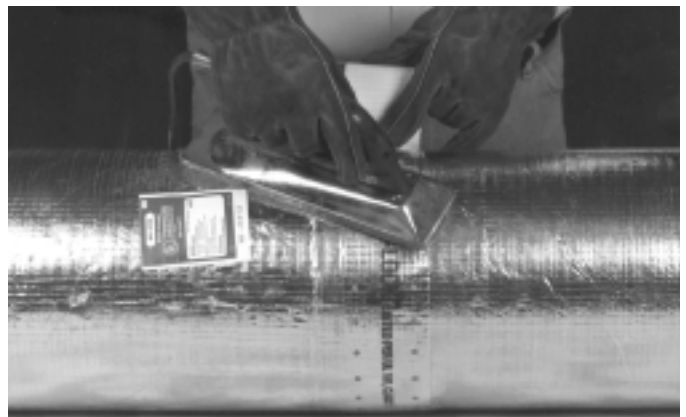
If using heat activated tape, take care to apply heat uniformly around entire circumference of duct. Check to make sure all temperature indicator dots change color.



7. Applying pressure sensitive tape to joint of preformed round duct. Tape is centered over joint.



8. Closure with pressure sensitive tape. Rub tape firmly with sealing tool until scrim pattern of duct facing shows through tape.



9. Closure with heat activated tape. Apply heat uniformly all around duct. Make sure all temperature indicator dots change color.

FABRICATION WITH TEN-SIDED FIBROUS GLASS DUCT

Ten-sided fibrous glass duct is approximately round in cross-section, and is an acceptable substitute for rigid round duct.

Sections of ten-sided duct up to 10 ft (3.05m) may be fabricated from standard fibrous glass duct board with a grooving machine equipped with the required tooling. A gauge is used to set the spacing between groove cutting tools.

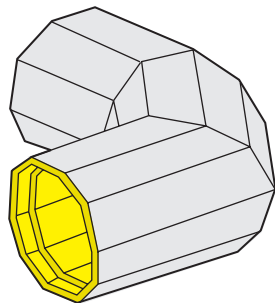
Circumferential joints may be shiplapped or butt-edged. Male and female ends should be fabricated while the material is in flat board form.

Internal metal sleeves must be used on all return air ducts, and on supply ducts without shiplap joints.

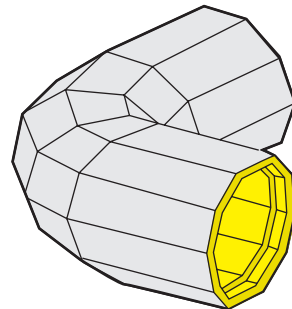
Typical fittings, such as elbows, branch connections, tees, and offsets can be fabricated with ten-sided fibrous glass duct. Examples are shown below.



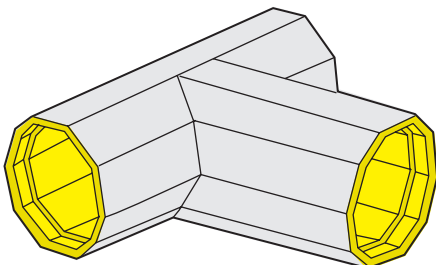
10. Duct board grooving machine set up for cutting ten-sided fibrous glass duct.



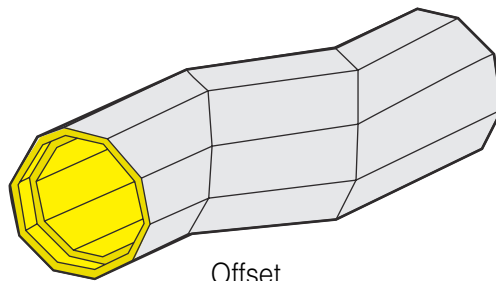
90 degree elbow, 3 gore



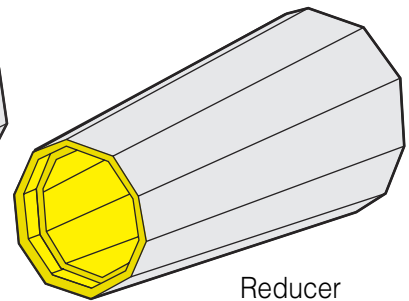
90 degree elbow, 5 gore



90 degree tee



Offset



Reducer

Fig. 2-17. Typical ten-sided fibrous glass duct fittings.

TEN-SIDED DUCT BOARD UTILIZATION

The table below shows options available in converting standard duct board sizes into ten-sided duct. The table is based on ideal tool settings. Because of variation in blade settings, tool bar height, and size of sheet metal fittings which might be used with ten-sided duct, the fabricator should always check material made on his specific machine for dimensional accuracy before producing large quantities of duct. He should also select the best combination of duct board length versus drop-off which fits the specific ten-sided duct application.

Be certain to check your specific tool arrangement to verify these values.

Example:

20 ft. (6m) lengths of 5" (150mm) nominal inside diameter ten-sided duct can be made in two ways:

- (1) With two sections 10 ft. (3.0 m) long;
- (2) With five sections 4 ft. (1.2 m) long.

Both involve minimum drop-off. Use of 20 ft. (6m) of ten-sided duct in 10 ft. (3.0 m) lengths has the advantage of requiring only one circumferential joint, compared to four required for 4-section construction. In making 4 ft. (1.2 m) long, 7" (178mm) nominal inside diameter ten-sided duct, 10 ft. (3.0 m) duct board will yield four sections with essentially no drop-off.

8 ft. (2.4 m) duct board yields 3 sections with 2.3 sq.ft. (.22 m²) of scrap.

STRETCH-OUT TEN-SIDED DUCT

Nominal Inside Diameter		1"(25mm) duct board				1 1/2"(38mm) duct board			
		Full Section 10 sides		Half Section 5 sides		Full Section 10 sides		Half Section 5 sides	
in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
5	(127)	23 ³ / ₄	(603)	12 ³ / ₈	(314)	27 ³ / ₄	(705)	14 ³ / ₈	(365)
6	(152)	26 ⁷ / ₈	(683)	13 ¹⁵ / ₁₆	(354)	30 ⁷ / ₈	(784)	15 ¹⁵ / ₁₆	(405)
7	(178)	30	(762)	15 ¹ / ₂	(394)	34	(864)	17 ¹ / ₂	(445)
8	(203)	33 ¹ / ₈	(841)	17 ¹ / ₁₆	(433)	37 ¹ / ₈	(943)	19	(483)
9	(229)	36 ¹ / ₄	(921)	18 ⁵ / ₈	(473)	40 ¹ / ₄	(1022)	20 ⁵ / ₈	(524)
10	(254)	39 ⁷ / ₁₆	(1002)	20 ¹ / ₄	(514)	43 ⁷ / ₁₆	(1103)	22 ¹ / ₄	(565)
12	(305)	45 ³ / ₄	(1162)	23 ³ / ₈	(594)	46 ¹¹ / ₁₆	(1186)	25 ³ / ₈	(645)
14	(356)	52	(1321)	26 ¹ / ₂	(673)	56	(1422)	28 ¹ / ₂	(724)
16	(406)	58 ¹ / ₄	(1480)	29 ⁵ / ₈	(752)	62 ¹ / ₄	(1581)	31 ⁵ / ₈	(803)
18	(457)	64 ⁹ / ₁₆	(1640)	32 ³ / ₄	(832)	68 ⁹ / ₁₆	(1745)	34 ³ / ₄	(883)
20	(508)	70 ¹³ / ₁₆	(1799)	35 ¹⁵ / ₁₆	(913)	74 ¹³ / ₁₆	(1900)	37 ¹⁵ / ₁₆	(964)
22	(559)	77 ¹ / ₈	(1959)	39 ¹ / ₁₆	(992)	81 ¹ / ₈	(2061)	41 ¹ / ₁₆	(1043)
24	(610)	83 ³ / ₈	(2118)	42 ¹ / ₄	(1073)	87 ³ / ₈	(2219)	44 ¹ / ₄	(1124)
26	(660)	89 ¹¹ / ₁₆	(2278)	45 ³ / ₈	(1153)	93 ¹¹ / ₁₆	(2380)	47 ³ / ₈	(1203)
28	(711)	96	(2438)	48 ¹ / ₂	(1226)	100	(2540)	50 ¹ / ₂	(1283)
30	(762)	102 ¹ / ₄	(2597)	51 ⁵ / ₈	(1311)	106 ¹ / ₄	(2699)	53 ⁵ / ₈	(1362)

NOTE:

Full section denotes 10 sides plus stapling flap.
 Half section denotes 5 sides plus stapling flap.
 Joining two half sections requires two longitudinal joints.

BOARD UTILIZATION, TEN-SIDED DUCT

The table below shows options available in converting standard duct board sizes into ten-sided duct. The table is based on ideal tool settings. Because of variation in blade settings, tool bar height, and size of sheet metal fittings which might be used with ten-sided duct, the fabricator should always check material made on his specific machine for dimensional accuracy before producing large quantities of duct. He should also select the best combination of duct board length versus drop-off which fits the specific ten-sided duct application.

Example:

20 ft. (6m) lengths of 5" (150mm) nominal inside diameter ten-sided duct can be made in two ways:

- (1) With two sections 10 ft. (3.05 m) long;
- (2) With five sections 4 ft. (1.22m) long.

Both involve minimum drop-off. Use of 20 ft. (6m) of ten-sided duct in 10 ft. (3.05 m) lengths has the advantage of requiring only one circumferential joint, compared to four required for 4-section construction. In making 4 ft. (1.2 m) long, 7" (178mm) nominal inside diameter ten-sided duct, 10 ft. (3.05 m) duct board will yield four sections with essentially no drop-off. 8 ft. (2.44m) duct board yields 3 sections with 2.3 sq.ft. (.22 m²) of scrap. Be certain to check your specific tool arrangement to verify these values.

TEN-SIDED DUCT BOARD UTILIZATION, 1" (25mm) DUCT BOARD

10 ft. (3.05m) ducts from 4 ft. (1.2m) duct board

Nominal inside diam., in	(mm)	No. of sections	Material left, in. (mm)	Drop-off, ft ² (m ²)
5	(127)	2	1 (25)	0.8 (0.24)
6	(152)	1 1/2	7 1/2 (191)	6.3 (1.92)
7	(178)	1 1/2	2 7/8 (73)	2.4 (0.73)
8	(204)	1	15 1/8* (384)	12.6 (3.84)
9	(229)	1	12 (305)	10.0 (3.05)
10	(254)	1	8 7/8 (225)	7.4 (2.25)
11	(279)	1	5 3/4 (146)	4.8 (1.46)
12	(305)	1	2 5/8 (67)	2.2 (0.67)
13	(330)	1/2	23 1/4* (591)	19.4 (5.91)
14	(356)	1/2	21 5/8* (549)	18.0 (5.48)
15	(381)	1/2	20 1/8* (511)	16.8 (5.12)
16	(406)	1/2	18 1/2* (470)	15.4 (4.69)
17	(432)	1/2	17* (432)	14.2 (4.33)
18	(457)	1/2	15 3/8* (390)	12.8 (3.90)
19	(483)	1/2	13 7/8* (352)	11.6 (3.53)
20	(508)	1/2	12 1/4* (311)	10.2 (3.11)

4 ft. (1.2m) ducts from 10 ft. (3.05m) duct board

Nominal inside diam., in	(mm)	No. of sections	Material left, in. (mm)	Drop-off, ft ² (m ²)
5	(127)	5	2 1/2 (25)	0.8 (0.24)
6	(152)	4	13 1/2* (191)	4.5 (1.37)
7	(178)	4	1 (73)	0.3 (0.09)
8	(204)	3 1/2	4 3/8 (384)	1.5 (0.45)
9	(229)	3	12 (305)	4.0 (1.22)
10	(254)	3	2 5/8 (225)	0.9 (2.25)
11	(279)	2 1/2	13 7/8 (146)	4.6 (0.49)
12	(305)	2 1/2	6 (152)	2.0 (0.61)
13	(330)	2	23* (701)	7.7 (2.34)
14	(356)	2	16 3/4* (425)	5.6 (1.71)
15	(381)	2	10 1/2 (267)	3.5 (1.07)
16	(406)	2	4 1/4 (108)	1.4 (0.43)
17	(432)	1 1/2	28* (711)	23.3 (7.10)
18	(457)	1 1/2	23 1/4* (591)	19.4 (5.91)
19	(483)	1 1/2	18 5/8* (473)	15.5 (4.72)
20	(508)	1 1/2	13 7/8* (352)	11.6 (3.53)

4 ft. (1.2m) ducts from 8 ft. (2.44m) duct board

Nominal inside diam., in	(mm)	No. of sections	Material left, in. (mm)	Drop-off, ft ² (m ²)
5	(127)	4	2 (51)	0.7 (0.24)
6	(152)	3 1/2	2 1/4 (57)	0.8 (1.37)
7	(178)	3	6 3/4 (171)	2.3 (0.70)
8	(204)	2 1/2	13 1/4* (337)	4.4 (1.34)
9	(229)	2 1/2	5 1/2 (140)	1.8 (0.55)
10	(254)	2	17 3/4* (451)	5.9 (1.80)
11	(279)	2	11 1/2 (292)	3.8 (1.16)
12	(305)	2	5 1/4 (133)	1.8 (0.55)
13	(330)	1 1/2	22 3/4* (578)	7.6 (2.32)
14	(356)	1 1/2	18* (457)	6.0 (1.83)
15	(381)	1 1/2	13 3/8* (340)	4.5 (1.37)
16	(406)	1 1/2	8 5/8 (219)	2.9 (0.88)
17	(432)	1 1/2	4 (102)	2.7 (0.82)
18	(457)	1	31 7/8* (810)	21.3 (6.49)
19	(483)	1	28 3/4* (730)	19.2 (5.85)
20	(508)	1	25 5/8* (651)	17.1 (5.18)

*Denotes usable material.

**Half sections are five-sided with stapling flap. Joining two half sections requires two longitudinal joints.

CLOSURE OF TEN SIDED FIBROUS GLASS DUCT

Longitudinal joints are formed in the same manner as in rectangular ducts.

After stapling, use closure materials listed in Section V, CLOSURE.

When two half sections are to be joined, it is easiest to make the first joint while the duct board is in flat form. Sections must be tightly butted together before stapling.

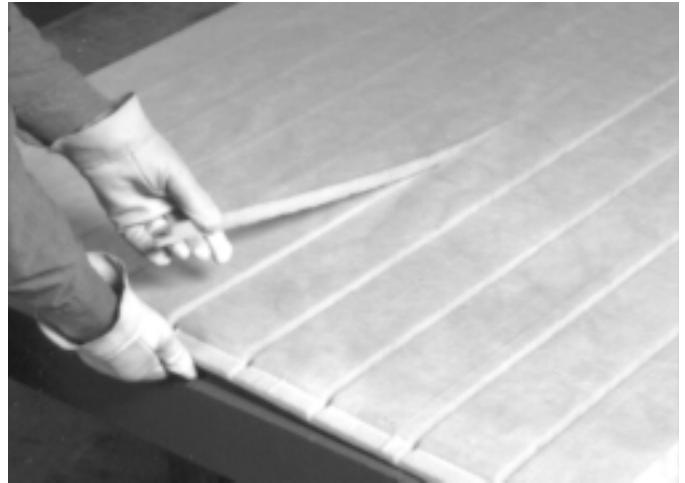


Fig.2-32A. Removing scrap from grooved duct board.



Fig. 2-32B. Stapling longitudinal joint of ten sided duct.

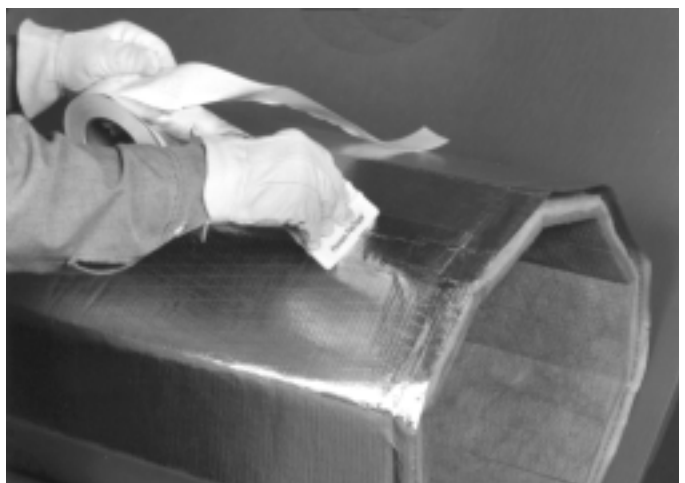


Fig. 2-32C. Taping longitudinal joint of ten sided duct.

SECTION III

EXTENDED PLENUM SYSTEM FABRICATION

NOTES TO SECTION III

1. FASTENER SCHEDULE

#10 plated sheet metal screws, board thickness + $\frac{1}{4}$ " (6mm), with $2\frac{1}{2}$ " (64mm) square or 3" (76mm) round galvanized steel washers, 0.028" (0.7mm) thick, volcano type, with turned edges facing away from duct board, 12" (300mm) (nominal) centers.

2. TAPE TAB SCHEDULE

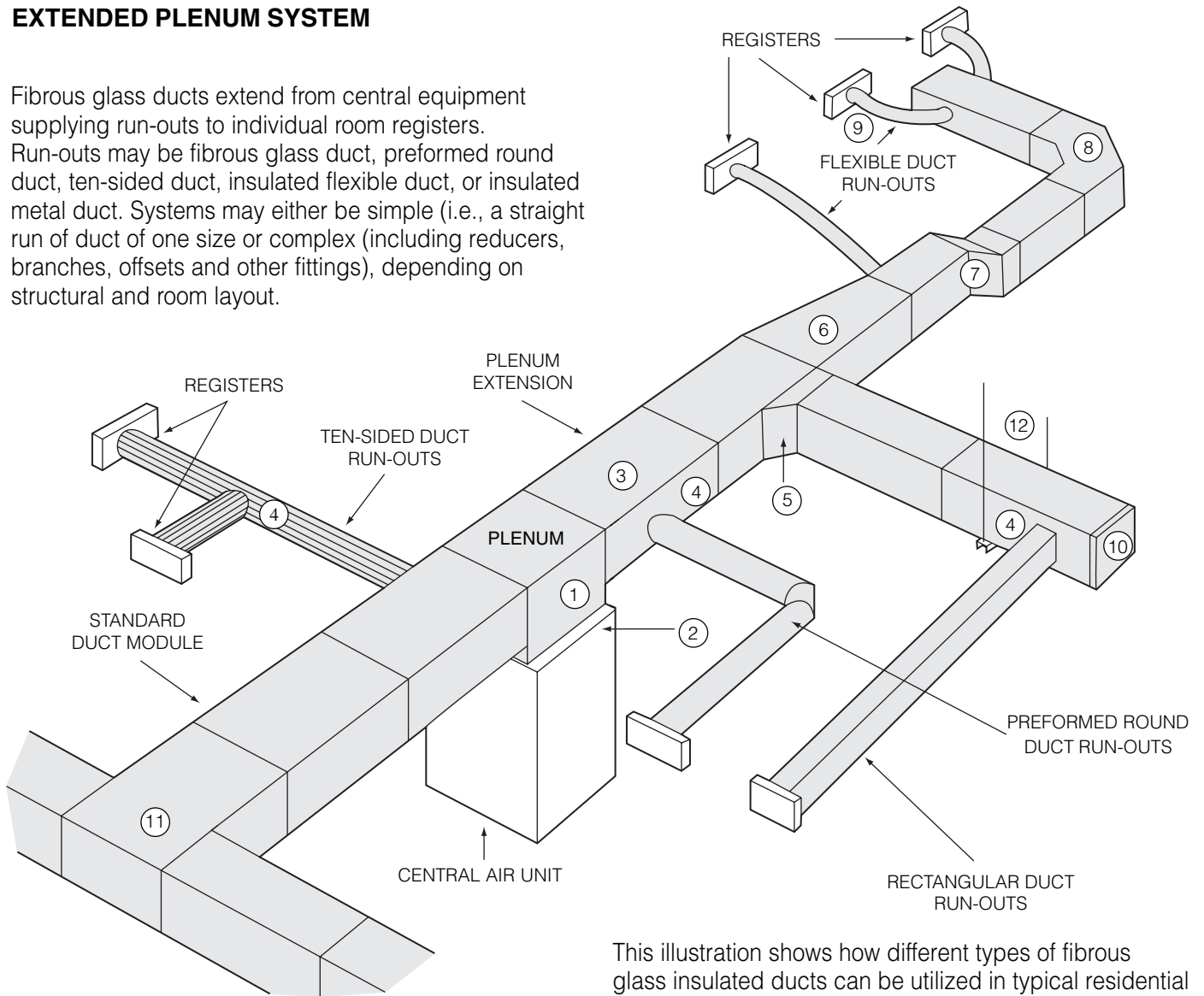
UL 181A pressure sensitive or heat activated tape, 8" (200mm) nominal length, on 12" (300mm) nominal centers, at least one per side. Refer to Section V, CLOSURE.

3. SHIPLAP ORIENTATION

Male shiplap ends of duct modules and fittings always face TOWARD the equipment. Female shiplap ends always face AWAY from the equipment.

EXTENDED PLENUM SYSTEM

Fibrous glass ducts extend from central equipment supplying run-outs to individual room registers. Run-outs may be fibrous glass duct, preformed round duct, ten-sided duct, insulated flexible duct, or insulated metal duct. Systems may either be simple (i.e., a straight run of duct of one size or complex (including reducers, branches, offsets and other fittings), depending on structural and room layout.



This illustration shows how different types of fibrous glass insulated ducts can be utilized in typical residential situations. It is not meant to suggest that a single system would combine all of these types in the manner shown.

Fig. 3-2. Extended plenum system

FOR FABRICATION DETAILS, SEE:

	Page
1. Fibrous glass duct board plenum	4-3
2. Connection of fibrous glass duct board plenum to equipment	3-3
3. Standard fibrous glass duct module	2-26
4. Square and round taps	3-19
5. Wide mouth tap	3-20
6. Transitions (reducers), transformers	3-12 -3-18
7. One-way offsets	3-10, 3-11
8. Elbows from fibrous glass duct module	3-4 -3-7
9. Connections to diffusers and registers	3-23
10. End caps	3-21
11. Tee from fibrous glass duct module and flat duct board	3-8, 3-9
12. Hangers and supports	6-2, 6-3

SHEET METAL AND EQUIPMENT CONNECTIONS

Mechanical connections of fibrous glass duct board to carefully cleaned sheet metal equipment flanges may be sealed with UL 181A/P listed pressure-sensitive aluminum foil tape. (For systems operating at 1/2" w.g. (125 Pa) static pressure).

See Section V, CLOSURES. Follow instructions exactly.

All mechanical connections (screws or screws and washers) of fibrous glass duct to equipment must be 12" (300mm) (max.) on centers.

Washers shall be 0.028" (0.7mm) thick (min.), with turned edges to prevent their cutting into the duct board or the facing.

NOTE: For other connections of fibrous glass duct to equipment or sheet metal ducts, refer to NAIMA Fibrous Glass Duct Construction Standard (FGDCS), Page 3-30.

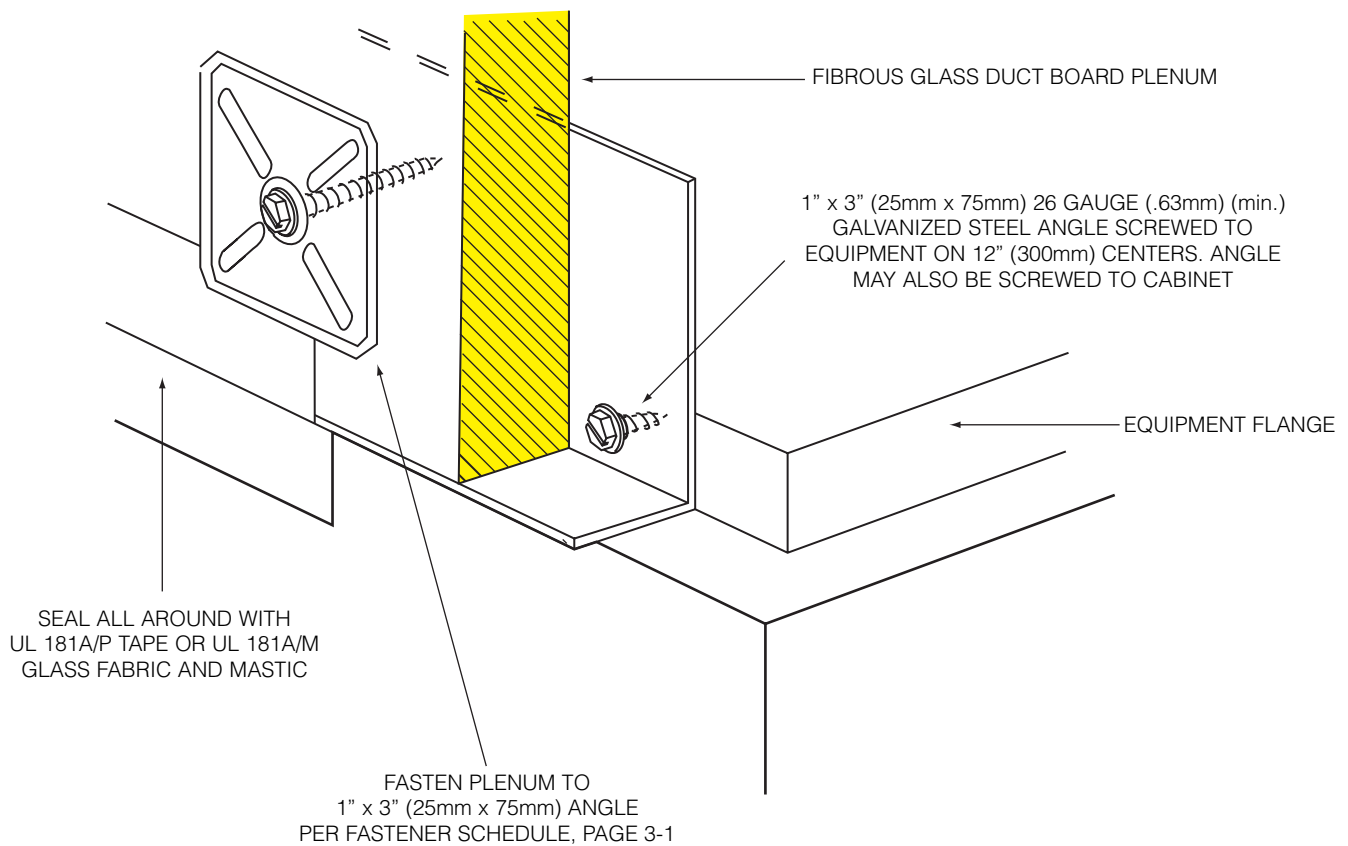


Fig. 3-3 Connecting fibrous glass duct board plenum to equipment flange

**90° ELBOW WITH RAIL MOUNTED
METAL TURNING VANES FROM MODULE**

BRANCH WIDTH = I.D. + 1 1/2 x BOARD THICKNESS

1. Cut on dashed lines A - B and A' - B' with straight knife: through facing only along duct corners. Cut on dashed line A - A' through board and facing across square edge tap-out panel. See Fig. 3-4A and 3-4B.

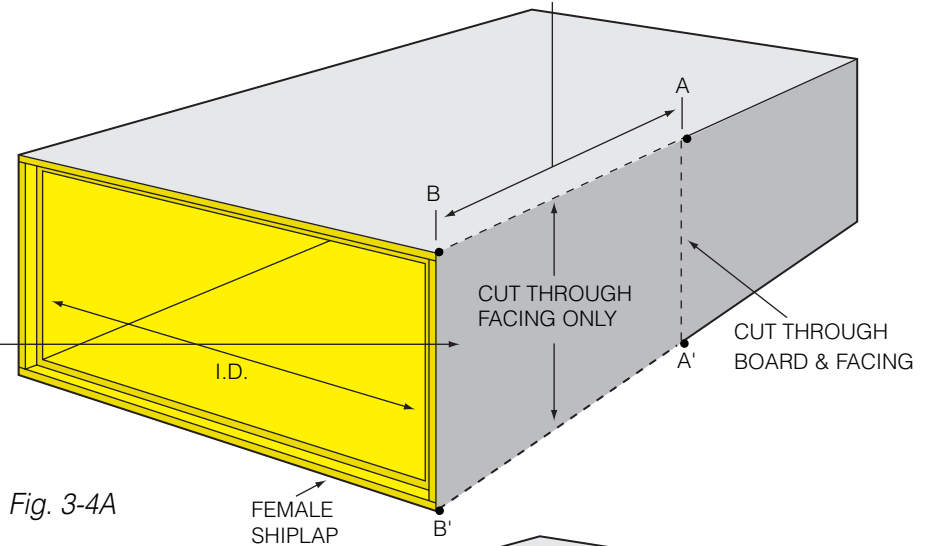
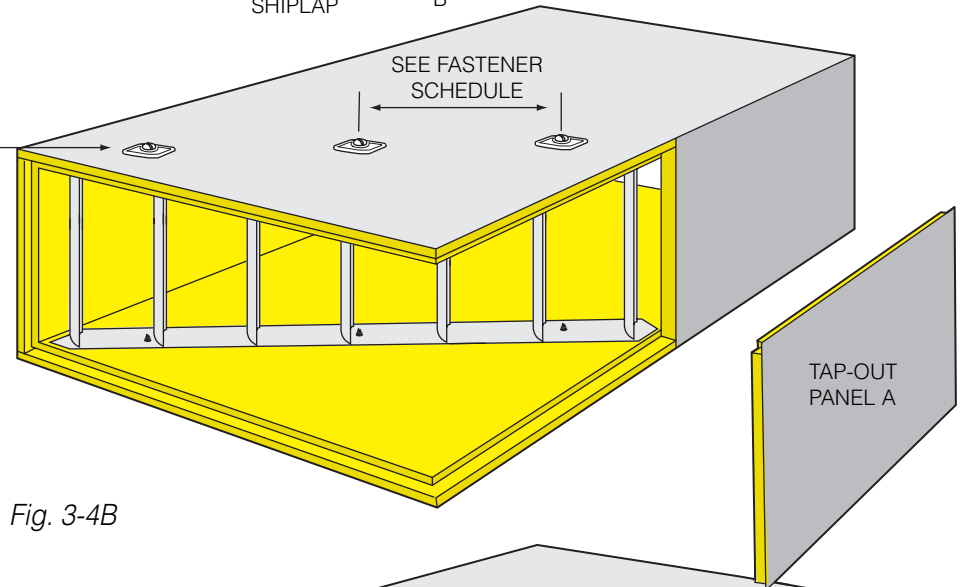


Fig. 3-4A

2. Install turning vanes per Fastener Schedule, Page 3-1, minimum 2 per rail.



3. Rotate tap-out panel A and place in end of elbow so female shiplap faces away from equipment. See Fig. 3-4C.

4. Apply tape tabs per Tape Tab Schedule, Page 3-1

5. Apply closure to all circumferential joints. See Section V, CLOSURE.

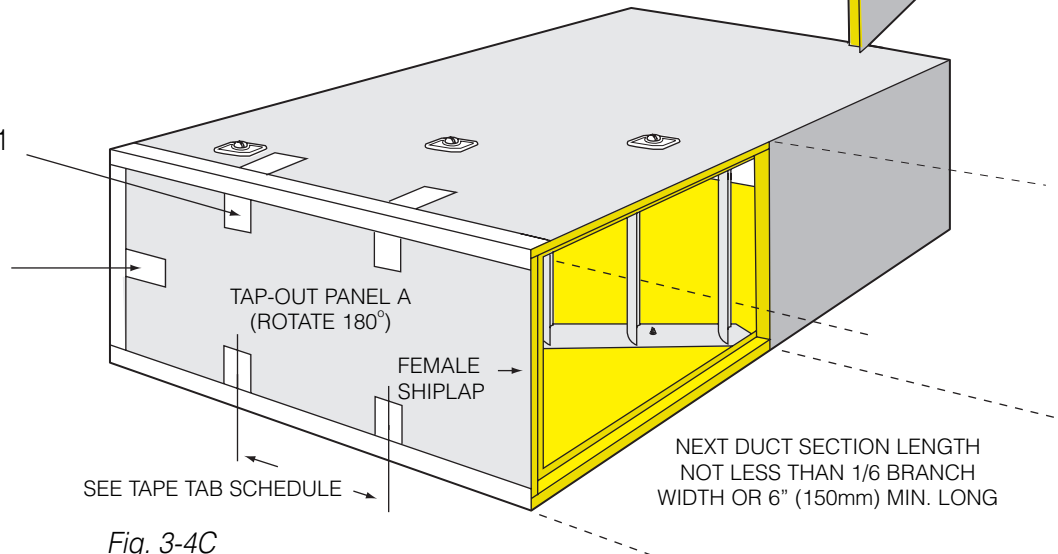


Fig. 3-4C

**90° ELBOW WITH TURNING VANES
FROM FLAT GROOVED DUCT BOARD**

Turning vanes may be fibrous glass or metal. Metal vanes must be rail mounted. Fibrous glass vanes may be installed as shown in Figs. 3-5B and 3-5C.

1. Draw diagonal lines A - B and A' - B' for turning vane placement (Fig. 3-5A).

2. Cut vane sockets, approx. 3" (75mm) spacing along diagonal lines, first vane at edge of panel, using vane socket cutter. Remove loose insulation.

3. Cut turning vane stock to inside duct height plus 1 1/2" to 1 3/4" (38mm to 44mm) and insert in sockets in bottom of panel (Fig.3-5C). Orient vanes to direct air parallel to axis of next duct section.

4. Cut tap-out panel A from board with straight knife (Fig. 3-5B).

5. Close fitting and staple longitudinal seam (Fig. 3-5C).

6. Rotate tap-out panel A and place in end of duct section so female shiplap faces away from equipment (Fig. 3-5D).

7. Apply tape tabs per Tape Tab Schedule, Page 3-1.

8. Apply closure to longitudinal seam and circumferential joints. See Section V, CLOSURE.

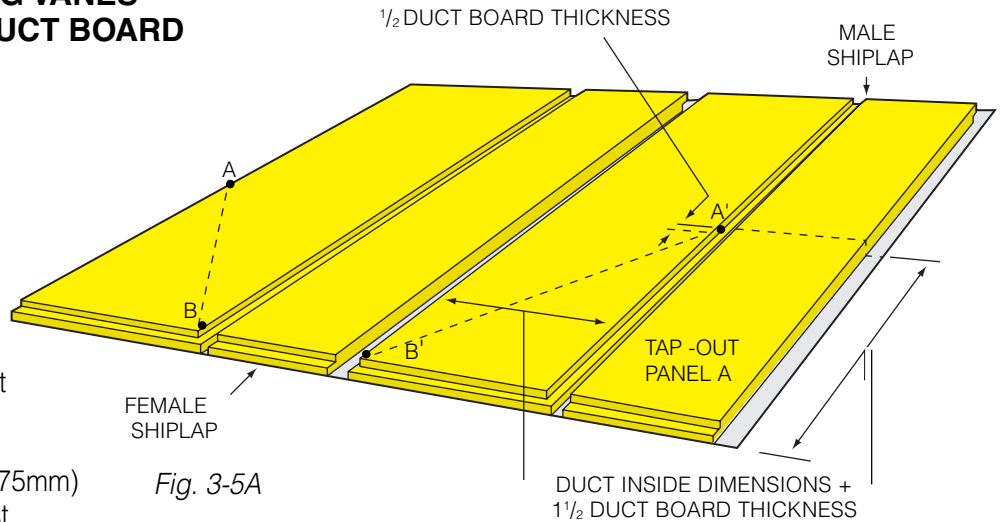


Fig. 3-5A

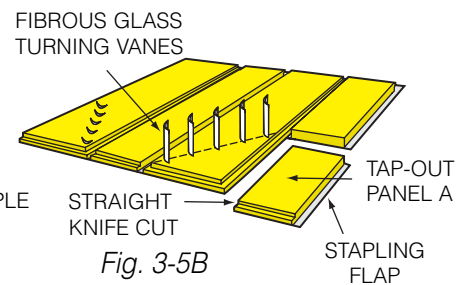
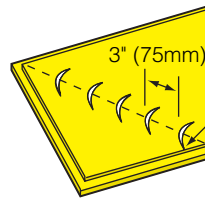


Fig. 3-5B

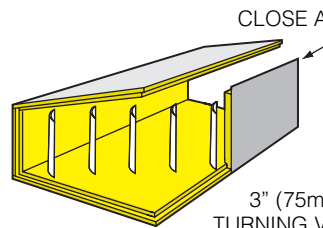


Fig. 3-5C

VANE SPACING:
3" (75mm) OR 3 1/4" (81mm), ACCORDING TO
TURNING VANE MANUFACTURERS' INSTRUCTIONS

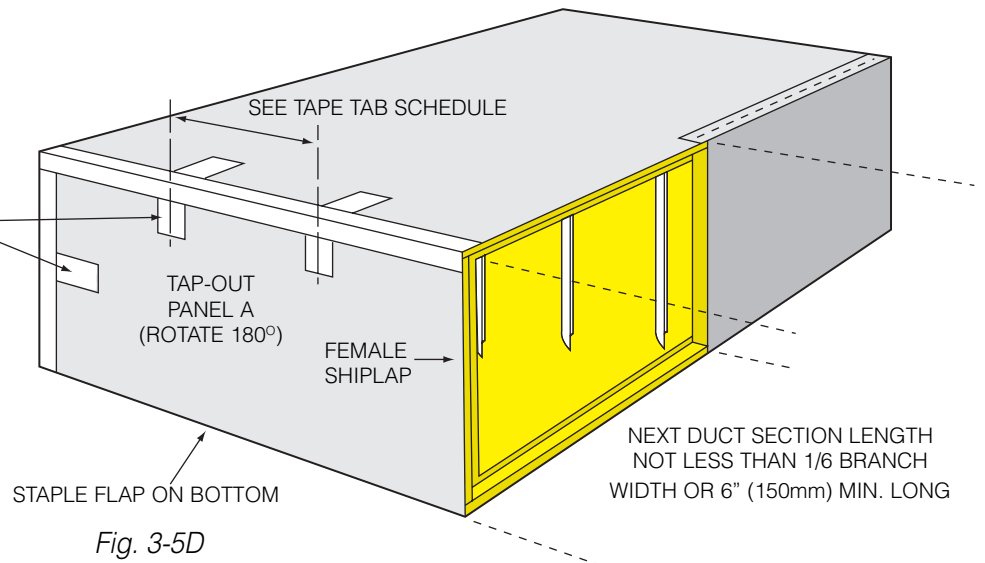


Fig. 3-5D

**THREE PIECE 90° ELBOW
FROM DUCT BOARD MODULE**

1. Make straight knife cuts along dashed lines A - B - C - D - A and A' - B' - C' - D' - A' (Fig. 3-6A). Maintain cheek panel angle when making side panel cuts.

OPTIONAL: CHEEK PANELS ONLY:
Make cuts with shiplap tool, lines A-B- and A'-B', C-D and C'-D'. Maintain shiplap orientation of original duct section. See Fig. 3-6C.

2. Separate three pieces (Fig. 3-6C). Rotate center piece 180° (Fig. 3-6D). Push three pieces together (Fig. 3-6E).

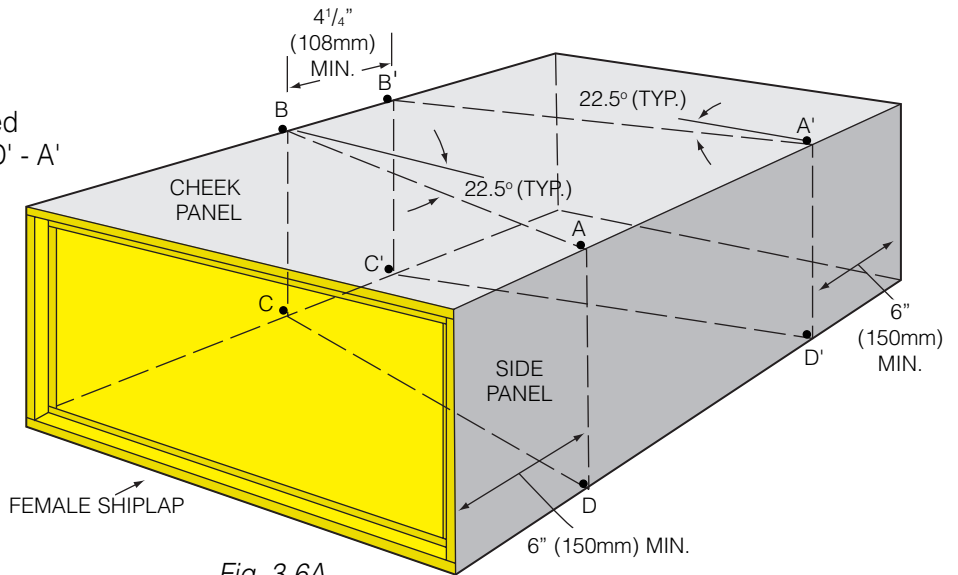


Fig. 3-6A

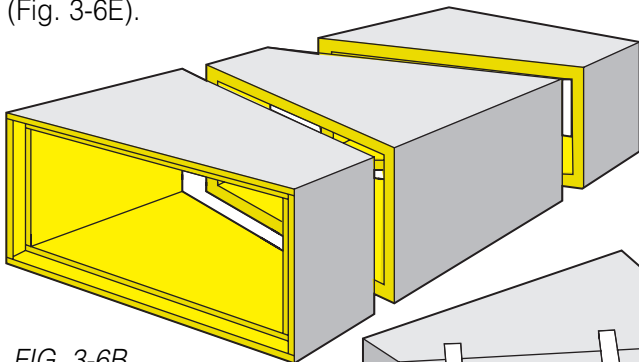


FIG. 3-6B

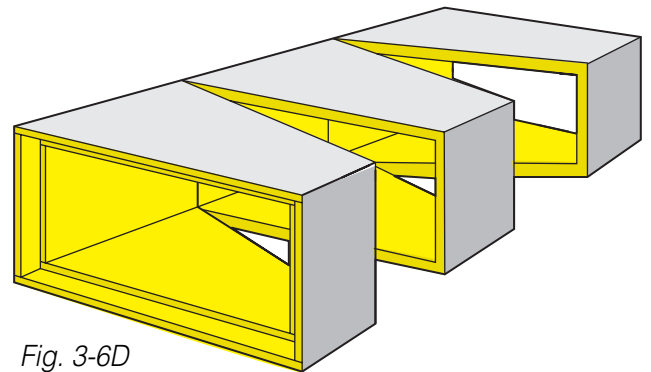


Fig. 3-6D

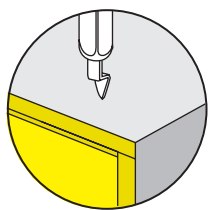


FIG. 3-6C

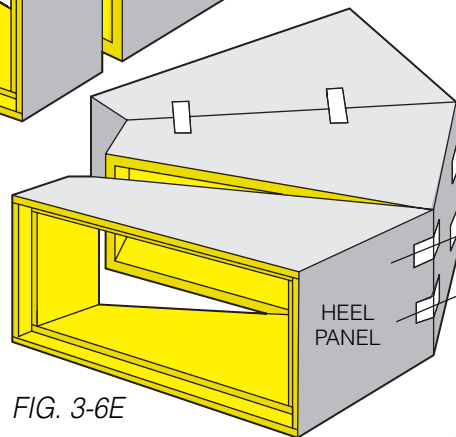


FIG. 3-6E

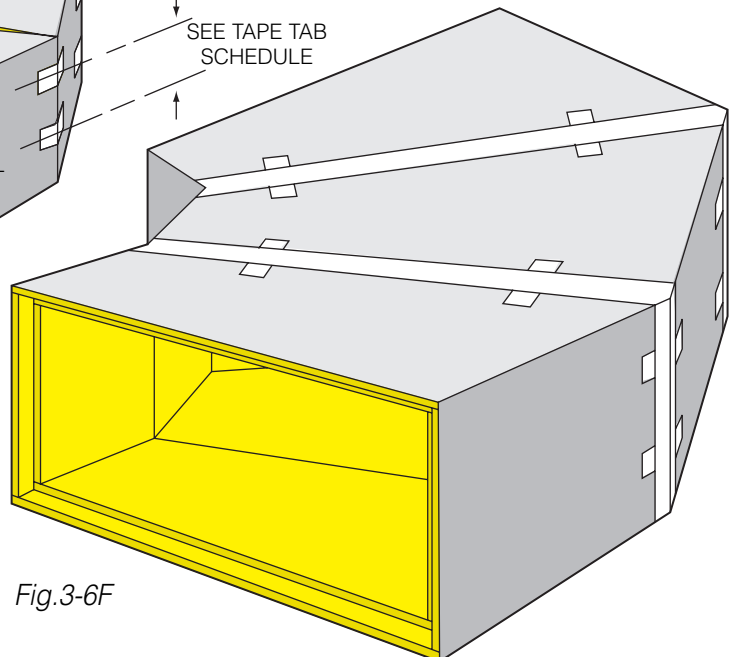


Fig. 3-6F

3. Apply tape tabs per Tape Tab Schedule, Page 3-1, starting with heel panels (Fig. 3-6E).

3. Apply closure to all circumferential joints (Fig. 3-6F). See Section V, CLOSURE.

Note: Turning vanes are not required.

**ELBOWS OF LESS THAN 90°
FROM DUCT BOARD MODULE**

1. Make straight knife cut around duct section, dashed line A - B - C - D - A, maintaining cheek panel angle when making side panel cuts. See Fig. 3-7B.

OPTIONAL, CHEEK PANELS ONLY:
Score facing with knife and cut along lines A - B and C - D with shiplap tool. Maintain shiplap orientation. See Fig. 3-7C.

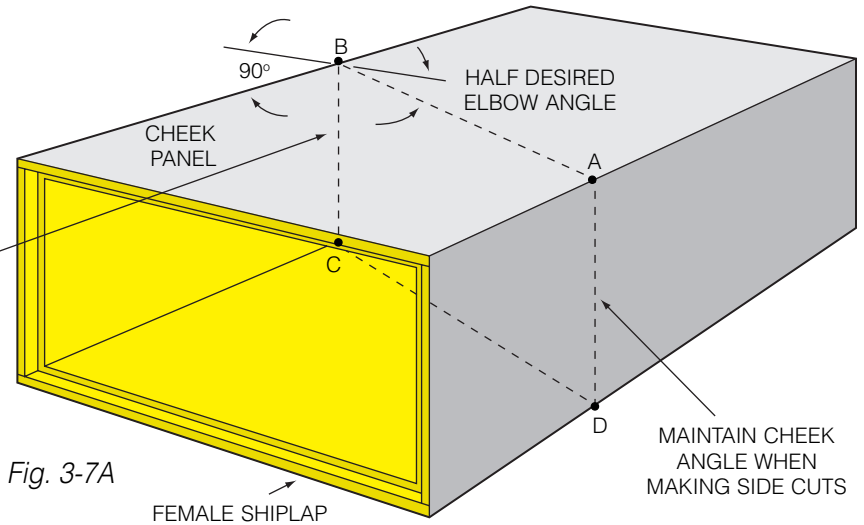


Fig. 3-7A

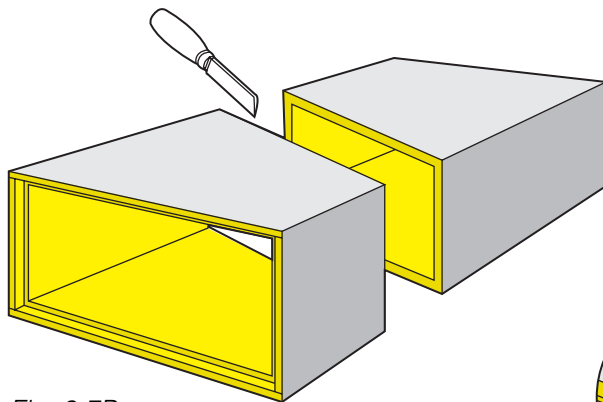


Fig. 3-7B

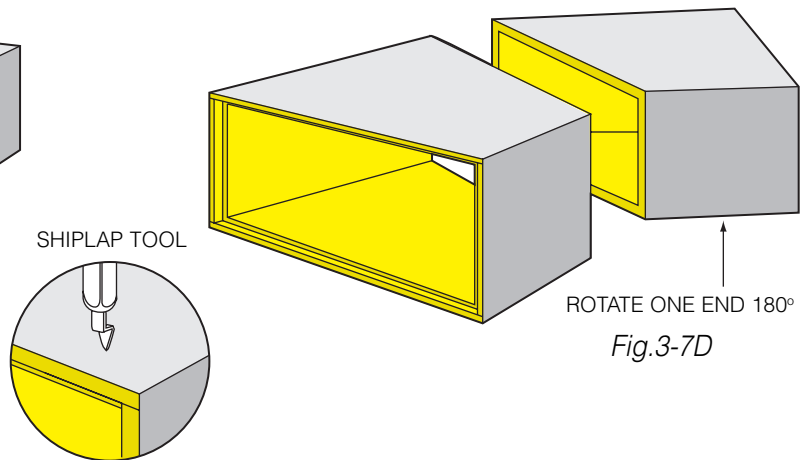


Fig. 3-7C

Fig. 3-7D

2. Separate two pieces (Fig. 3-7B). Rotate one piece 180° (Fig. 3-7D). Push pieces together (Fig. 3-7E).

3. Apply tape tabs per Tape Tab Schedule, Page 3-1, starting with cheek panels.

4. Apply closure to circumferential joint (Fig. 3-7E). See Section V, CLOSURE.

Note: Turning vanes are not required.

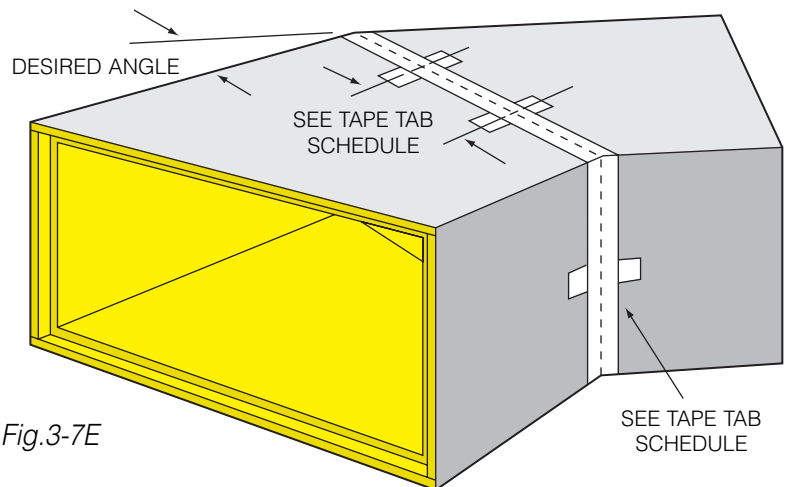


Fig. 3-7E

**TEE FROM DUCT BOARD MODULE
WITH RAIL MOUNTED METAL
TURNING VANES**

1. Cut with straight knife on dashed lines A - B and A' - B', all four corners, through facing only (See Fig. 3-8A).

2. Cut on dotted lines A - A', both square edge tap-out panels, with straight knife, through board and facing (see Fig. 3-8A). Discard tap-out panels (Fig. 3-8B).

3. Install turning vanes. See Fig. 3-8B and Fastener Schedule, Page 3-1, minimum 2 per rail.

4. Fabricate end cap with two female shiplaps to close fitting (Fig. 3-8C). Apply tape tabs per Tape Tab Schedule, Page 3-1.

5. Apply closure to circumferential joints (Fig. 3-8C). See Section V, CLOSURE.

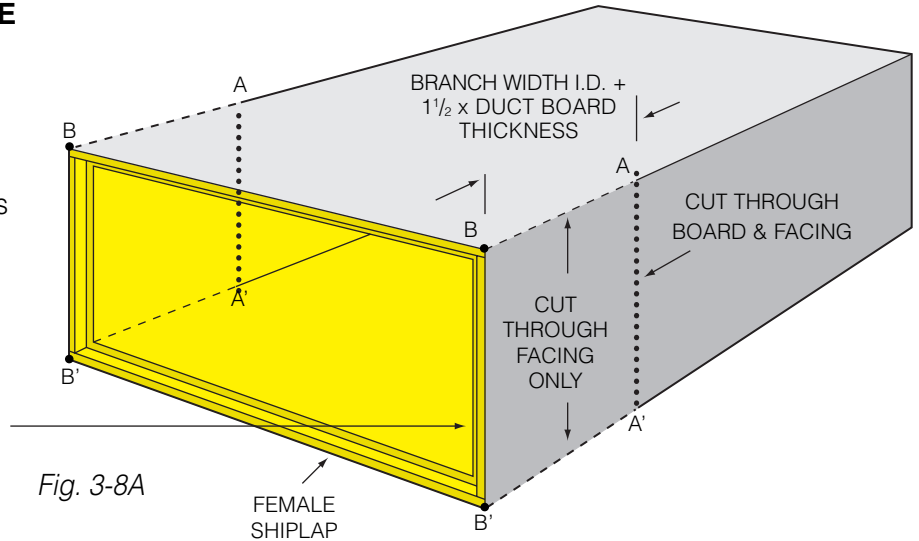


Fig. 3-8A

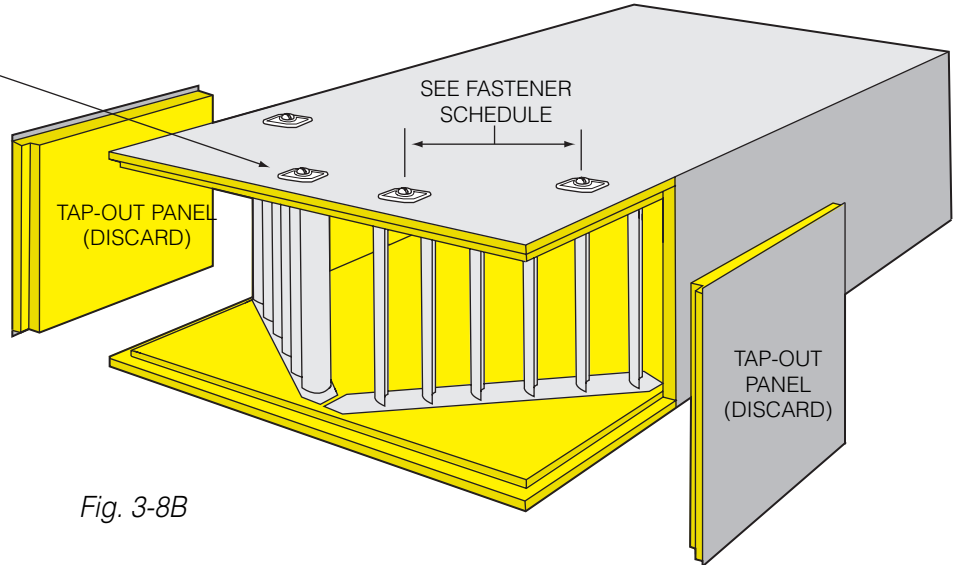


Fig. 3-8B

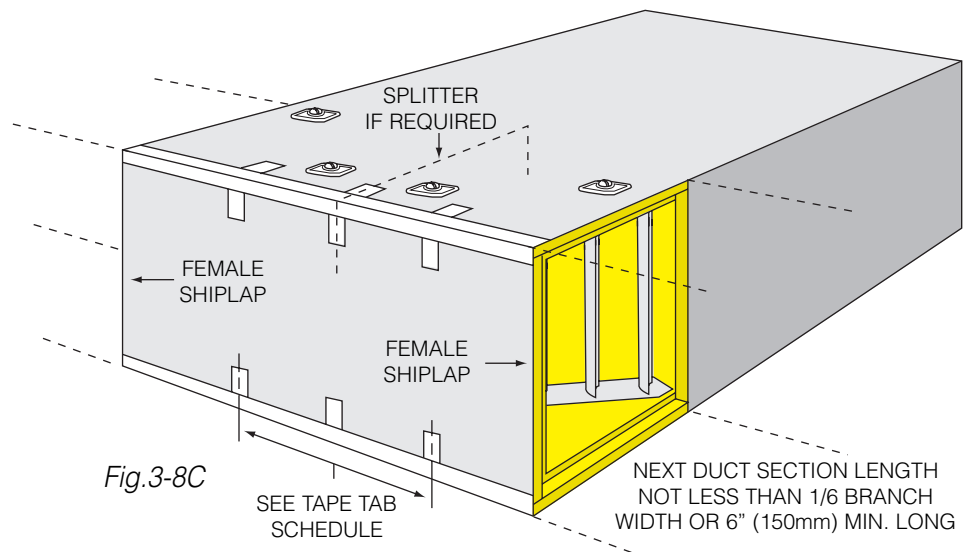


Fig. 3-8C

TEE FROM FLAT DUCT BOARD WITH FIBROUS GLASS TURNING VANES

1. Draw turning vane center lines A - B for one branch, A' - B' for other. Draw lines C - D and C' - D' for tee openings (see Fig. 3-9A).

2. Cut with straight knife along tee opening lines C - D and C' - D'. Cut with straight knife along shiplap panel edges so tee opening panels

3. Cut vane sockets on 3" (75mm) spacing (approx.) along lines A - B and A' - B', first vane at edge of panel, using vane socket cutter (Fig. 3-9C). Orient vanes to direct air parallel to axis of each branch. Remove loose insulation from sockets.

4. Cut turning vane stock to inside duct height plus 1 1/2" to 1 3/4" (38mm to 44mm). Insert in sockets in bottom of panel.

5. Close fitting and staple longitudinal seam (Fig. 3-9D).

6. Fabricate end cap with two female shiplaps. Install in end of fitting and apply tape tabs per Tape Tab Schedule, Page 3-1. Close fitting and staple longitudinal seam (Fig. 3-9D).

7. Apply closure to longitudinal seam and circumferential joints. See Section V, CLOSURE.

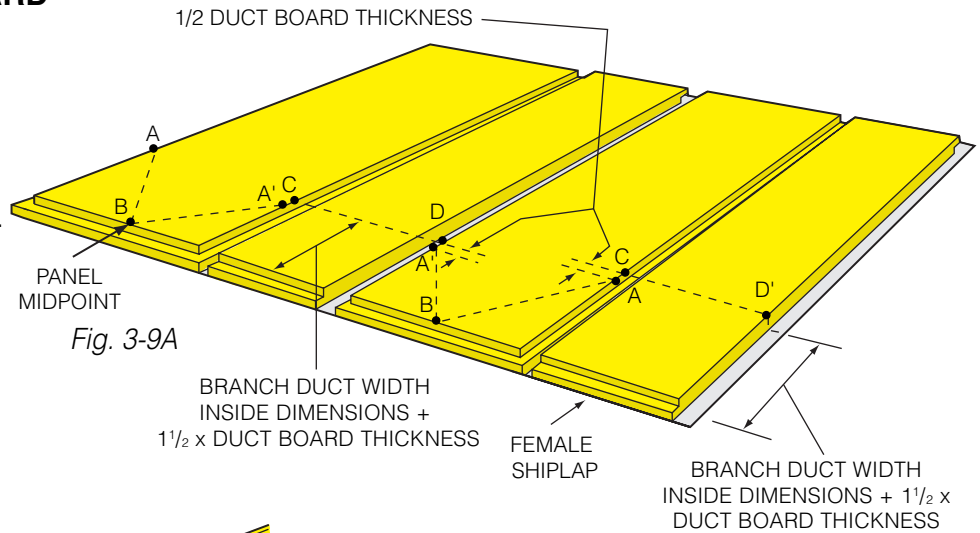


Fig. 3-9A

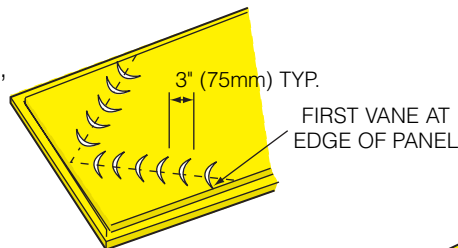


Fig. 3-9B

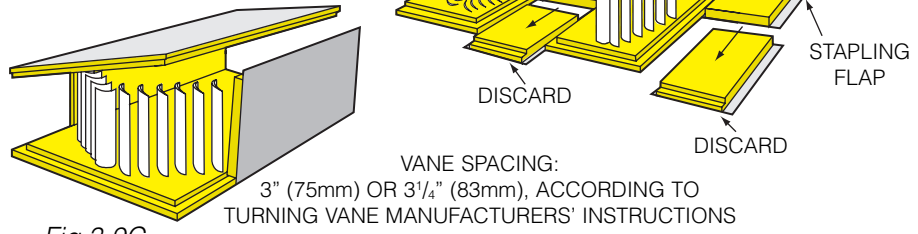


Fig. 3-9C

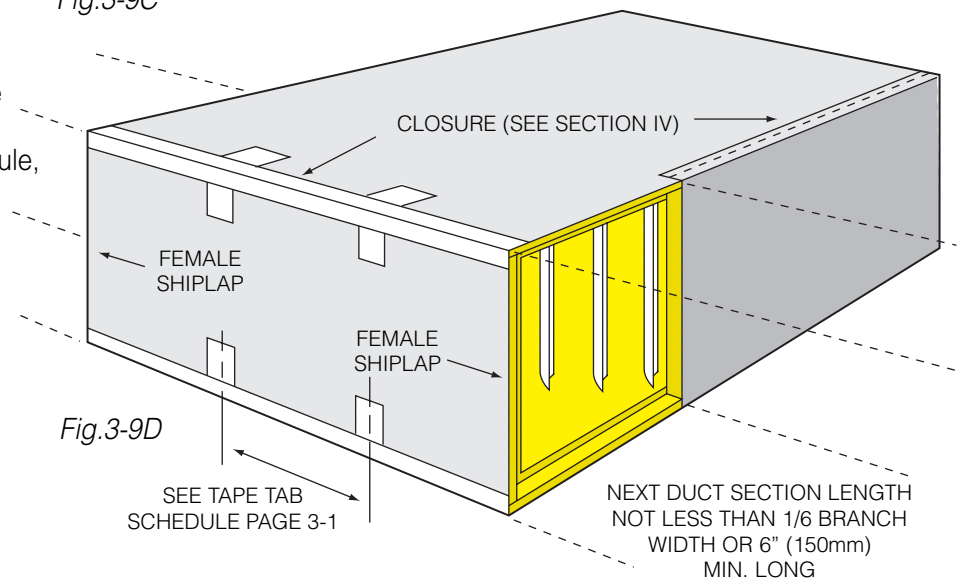


Fig. 3-9D

**ONE WAY 30° OFFSET
FROM DUCT BOARD MODULE**

1. Make straight knife cuts along dashed lines A - B - C - D - A and A' - B' - C' - D' - A'. Maintain 15° cheek panel angle when making side panel cuts. See Fig. 3-10B.

OPTIONAL, CHEEK PANELS ONLY:
Score facing with knife and cut along lines A - B, A' - B', C - D, and C' - D' with shiplap tool. Maintain the shiplap orientation. See Fig. 3-10C.

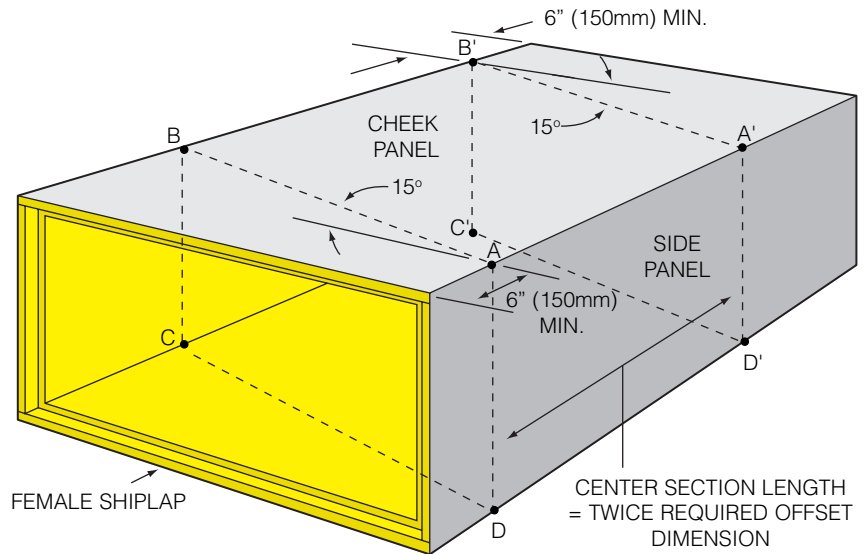


Fig. 3-10A

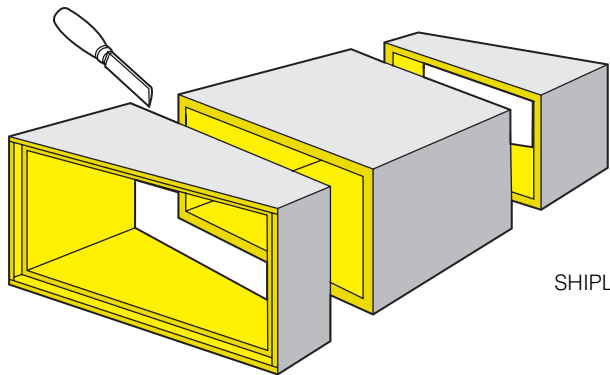


Fig. 3-10B

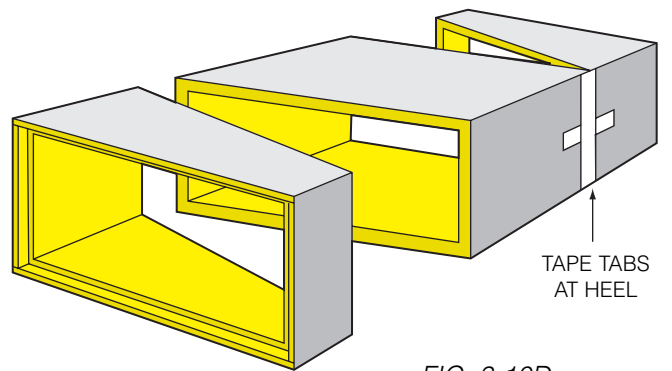


FIG. 3-10D

2. Separate three pieces (Fig. 3-10B). Rotate center piece 180° (Fig. 3-10D). Push three pieces together.

Fig. 3-10C

3. Apply tape tabs per Tape Tab Schedule, Page 3-1, starting with cheek panels (Fig. 3-10E).

4. Apply closure to circumferential joints (Fig. 3-10E). See Section V, CLOSURE.

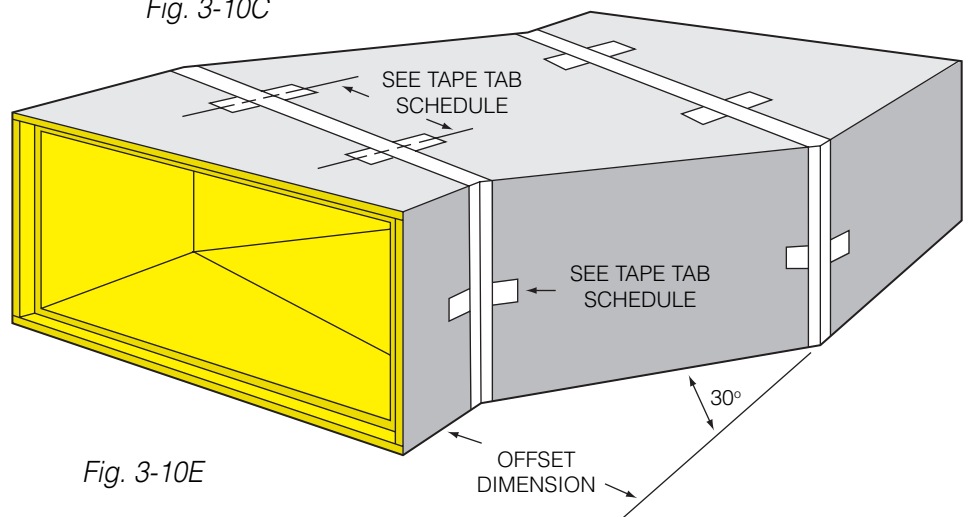


Fig. 3-10E

**ONE WAY OFFSET OF ANY
ANGLE FROM DUCT BOARD MODULE**

Assume field conditions determine starting point A, offset length L, and offset dimension. See Fig. 3-11A.

1. Draw line O - O' parallel to duct edge, offset dimension from edge.

2. Locate point B by measuring distance L (offset length) from point A. Then strike arc using B as center and L as radius. Intersection of arc with line O - O' establishes point A'.

3. Draw line A - A', extending it across cheek panel to point C. Mark point C. Line A - C establishes offset angle.

4. Measure L distance from point C to locate and mark point D. Draw line B - D, extending layout lines around duct section.

5. Make two straight knife cuts around duct section on dashed lines. Extend layout lines square with corner. Maintain cheek panel angle when making side panel cuts. See Figure 3-11B.

OPTIONAL, CHEEK PANELS ONLY:
Score facing with knife and cut along lines A - C and B - D, E - F and G - H with shiplap tool (Fig. 3-11D). Maintain the shiplap orientation.

6. Separate three pieces (Fig. 3-11B). Rotate center section 180° (Fig. 3-11C). Push three pieces together.

7. Apply tape tabs per Tape Tab Schedule, Page 3-1, starting with heel panels (Fig. 3-11C).

8. Apply closure to circumferential joints (Fig. 3-11E). See Section V, CLOSURE.

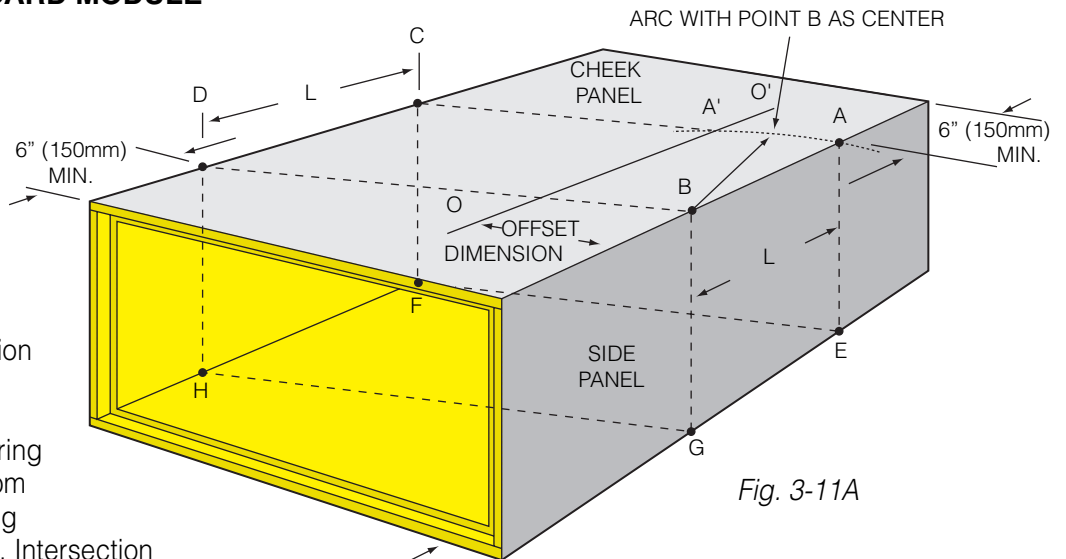


Fig. 3-11A

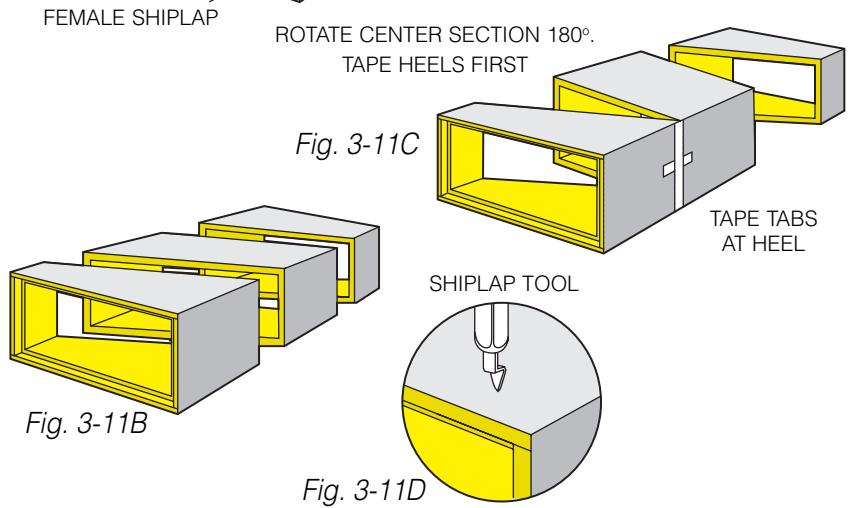


Fig. 3-11B

Fig. 3-11C

Fig. 3-11D

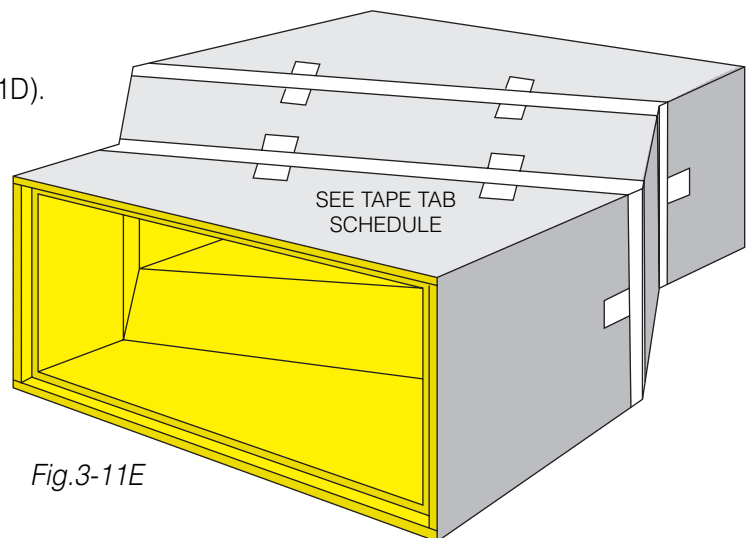


Fig. 3-11E

**ONE WAY TRANSITION
FROM DUCT BOARD MODULE,
REDUCING SQUARE EDGE PANEL**

Change dimension = difference between height of male and female shiplap ends. If shiplap and square edge panels are reversed, follow instructions on page 3-13.

1. Make straight knife cut through insulation and facing along dashed lines A - B and A' - B' (Fig. 3-12A).

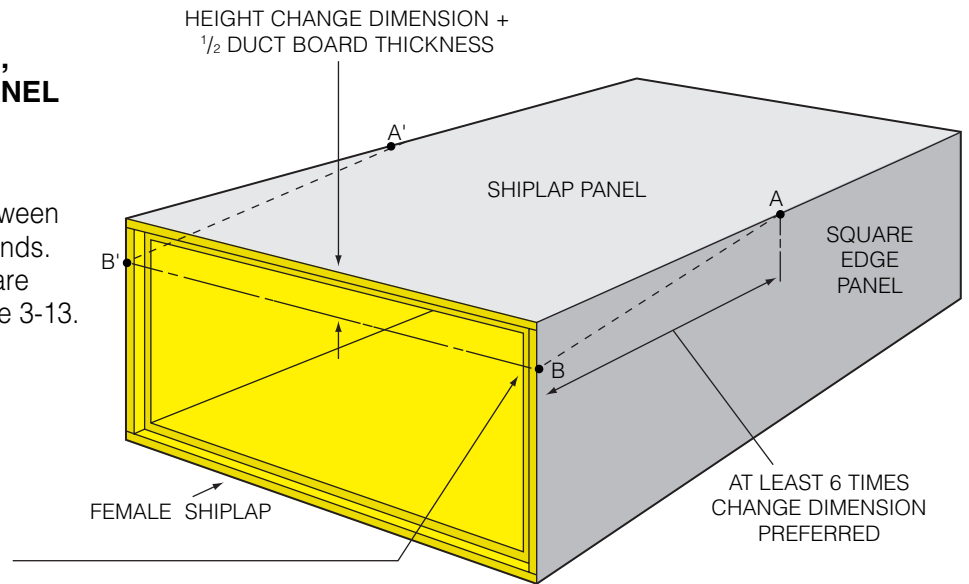


Fig. 3-12A

2. Remove and discard triangular scrap. Trim facing on both sides leaving 2" (50mm) (approx.) staple flaps (Fig. 3-12B).

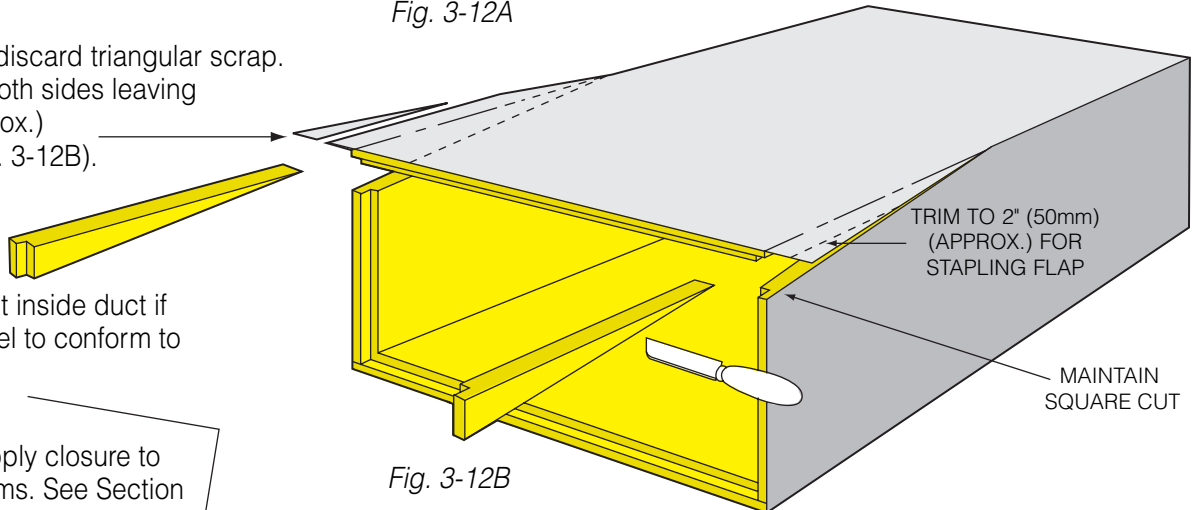


Fig. 3-12B

3. Make relief cut inside duct if required for panel to conform to transition angle.

4. Staple and apply closure to longitudinal seams. See Section V, CLOSURE.

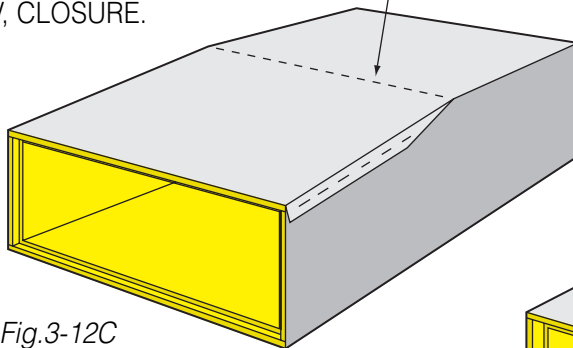


Fig. 3-12C

NOTE: If sloping panel is short of end by more than 3/8" (10mm), insert shiplapped filler panel 6" (150mm) (min.) long at end of sloping panel, OR halve slope angle by using focal transition (see page 3-16).

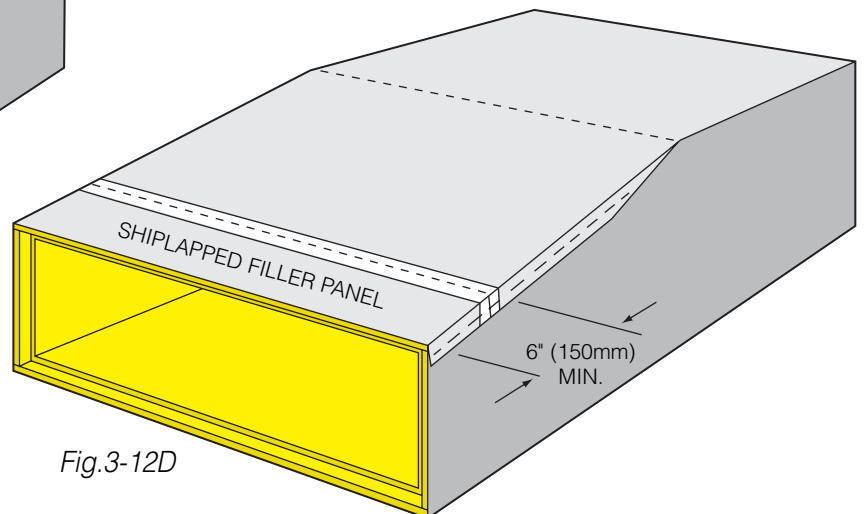


Fig. 3-12D

**ONE WAY TRANSITION
FROM DUCT BOARD MODULE
REDUCING SHIPLAP PANEL**

Change dimension = difference between width of male and female shiplap ends. If shiplap and square edge panels are reversed, follow instructions on page 3-12.

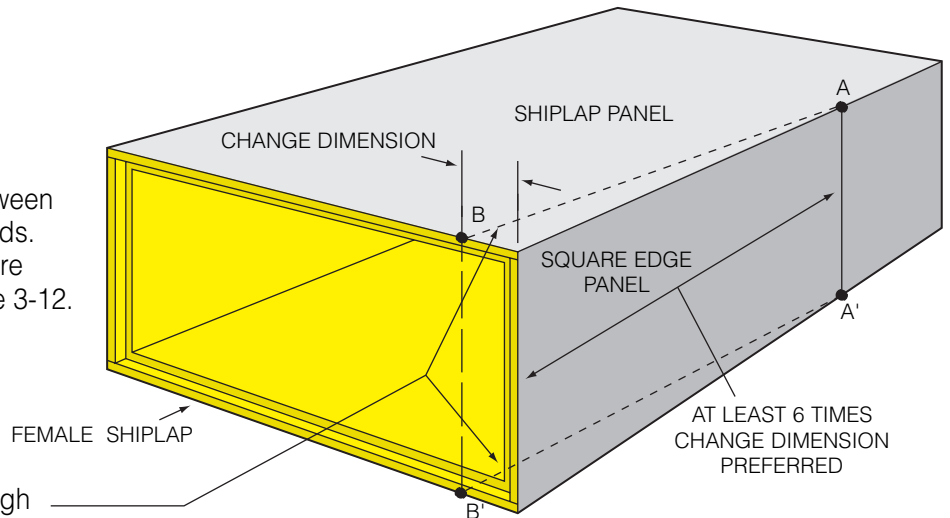


Fig. 3-13A

1. Use hand shiplap tool to cut through insulation and facing along dashed lines A - B and A' - B' (Fig. 3-14A). Maintain shiplap orientation of original module (Fig. 3-13B).

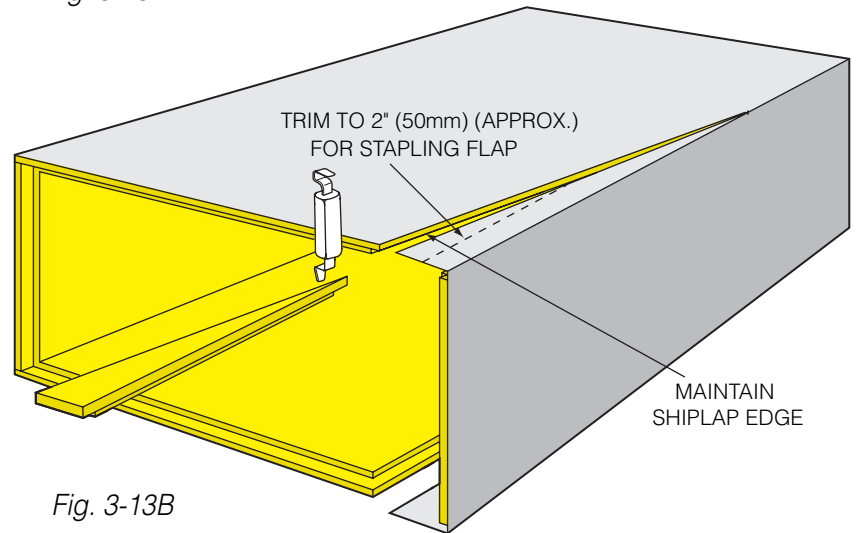


Fig. 3-13B

2. Remove and discard triangular scrap. Trim facing both sides leaving 2" (50mm) (approx.) staple flaps (Fig. 3-13B).

3. Make relief cut inside duct if required for panel to conform to transition angle.

4. Staple and apply closure to longitudinal seams. See Section V, CLOSURE.

NOTE: If sloping panel is short of end by more than $\frac{3}{8}$ " (10mm), insert shiplapped panel 6" (150mm) (min.) long at end of sloping panel, OR halve slope angle by using focal transition (see page 3-16).

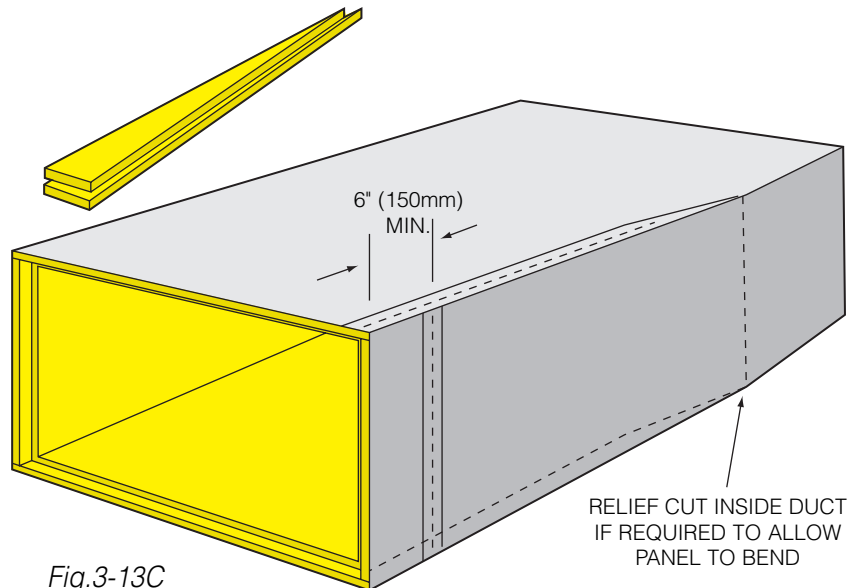


Fig. 3-13C

**TWO WAY TRANSITION
FROM DUCT BOARD MODULE
REDUCING SHIPLAP AND
SQUARE EDGE PANELS**

Width change dimension = difference between width of male and female shiplap ends.

Height change dimension = difference between height of male and female ends.

1. Use hand shiplap tool to cut through insulation and facing along dashed lines A - B and A' - B' on shiplapped panels (Fig. 3-14A). Maintain shiplap orientation of original module (Fig. 3-14B).

2. Fold back facing and make straight knife cuts through insulation along dotted lines A - C and D - C' on square edge panels (Fig. 3-14B).

3. Remove and discard triangular scrap. Trim facing both sides leaving 2" (50mm) (approx.) staple flaps.

4. Make relief cut inside duct if required for panels to conform to transition angles.

5. Staple and apply closure to longitudinal seams. See Section V, CLOSURE.

NOTE: If sloping panels are short of end by more than $\frac{3}{8}$ " (10mm), insert shiplapped panels 6" (150mm) (min.) long at ends of sloping panels (see Fig. 3-15D), trim two long panels back to align with foreshortened panel ends*, OR halve slope angle by using focal transition (see page 3-16).

*This must be done correctly so module length will not be shortened.

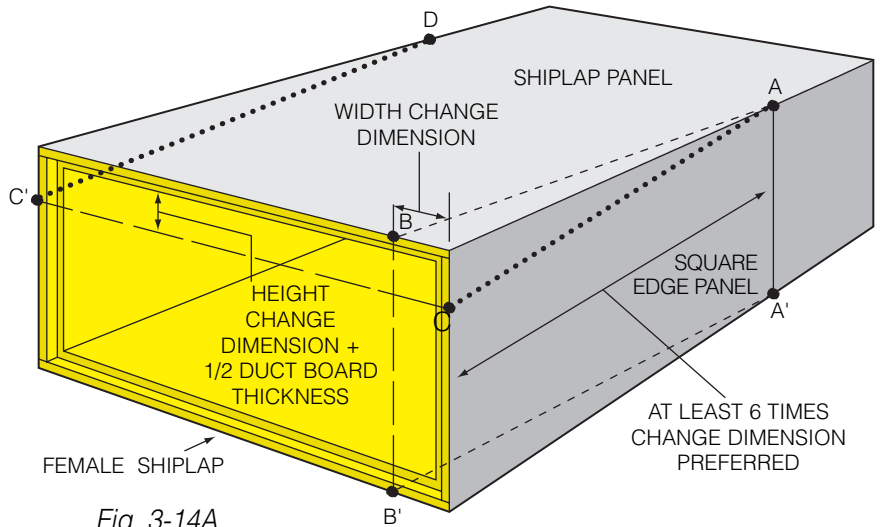


Fig. 3-14A

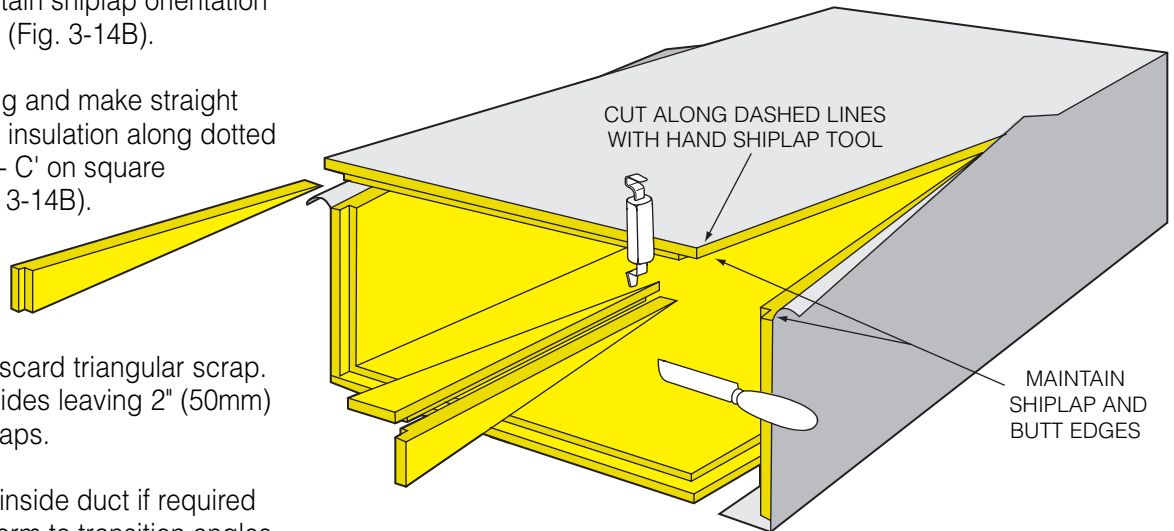


Fig. 3-14B

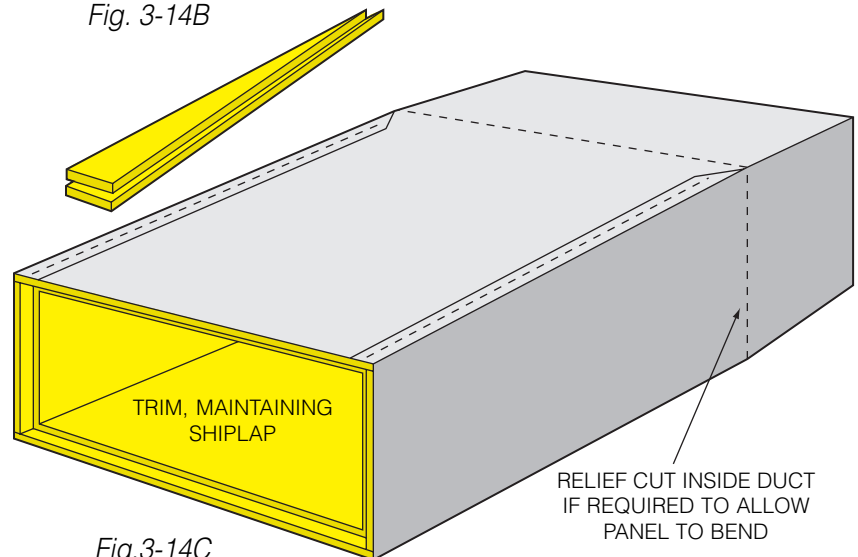
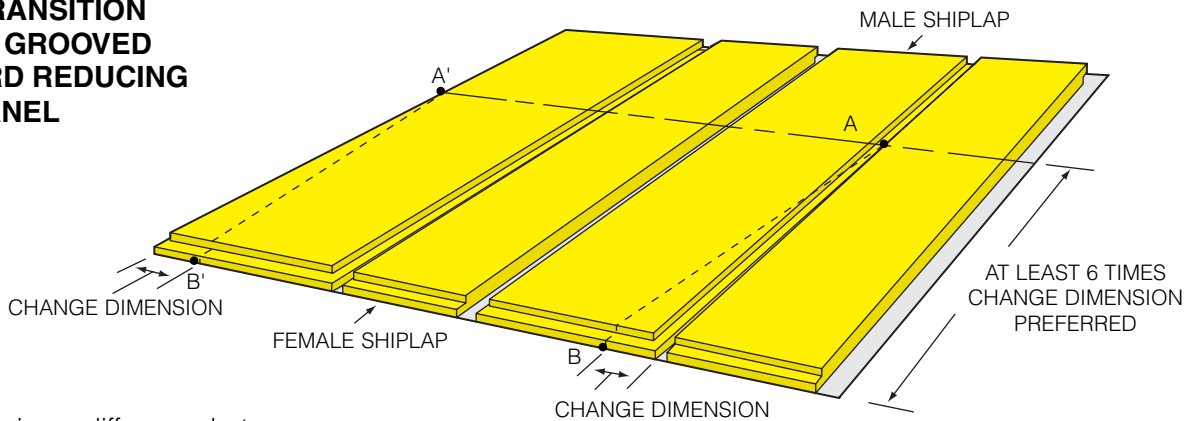


Fig.3-14C

**ONE WAY TRANSITION
FROM FLAT GROOVED
DUCT BOARD REDUCING
SHIPLAP PANEL**



Change dimension = difference between width of male and female shiplap ends.

Fig. 3-15A

1. Draw diagonal lines A - B and A' - B' establishing transition angle (Fig. 3-15A).

2. Make straight knife cut through insulation and facing along diagonal lines A - B and A' - B' (Fig. 3-15B). Remove and discard triangular scrap. Trim facing to 2" (50mm) (approx.) for staple flaps.

Fig. 3-15B

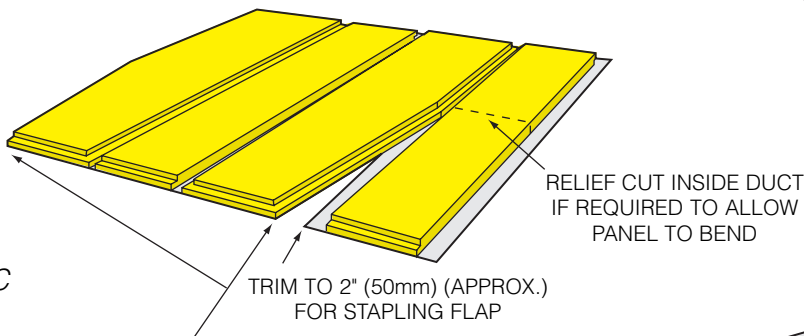
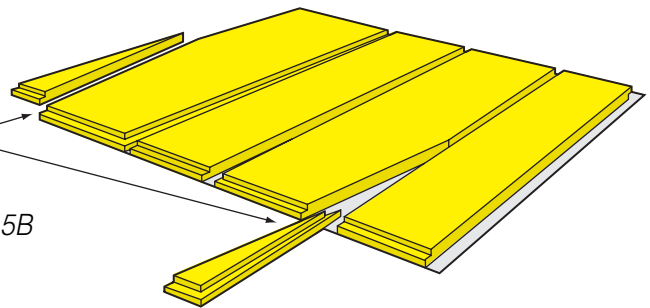


Fig. 3-15C

3. Shiplap diagonal cuts with gray (female) shiplap tool along diagonals (Fig. 3-15C).

4. Make relief cut (Fig. 3-15C) inside duct if required for panel to conform to transition angle.

5. Staple and apply closure to longitudinal seams. See Section V, CLOSURE.

NOTE: If sloping panel is short of end by more than 3/8" (10mm), insert shiplapped panel 6" (150mm) (min.) long at end of sloping panel (see Fig. 3-15D), OR halve slope angle by using focal transition (see page 3-16).

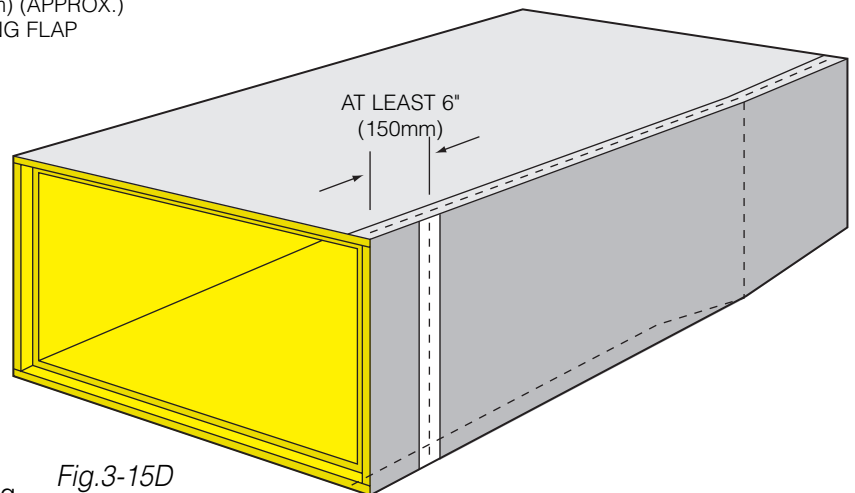


Fig. 3-15D

**FOCAL (CENTERLINE)
TRANSITIONS**

Change dimension = difference between width of male and female ends.

1. Divide change dimension by 2. Draw diagonal lines A - B, A' - B', C - D, and C' - D' to take half the change dimension from each side of module (Fig. 3-16A).
2. Use hand shiplap tool to cut through insulation and facing along dashed lines (Fig 3-16B). Maintain shiplap orientation of original module.
3. Discard triangular scrap. Trim facing both sides leaving 2" (50mm) (approx.) staple flaps.
4. Make relief cut (Fig.3-16B) inside duct if required for panels to conform to transition angles.
5. Staple and apply closure to longitudinal seams. See Section V, CLOSURE.

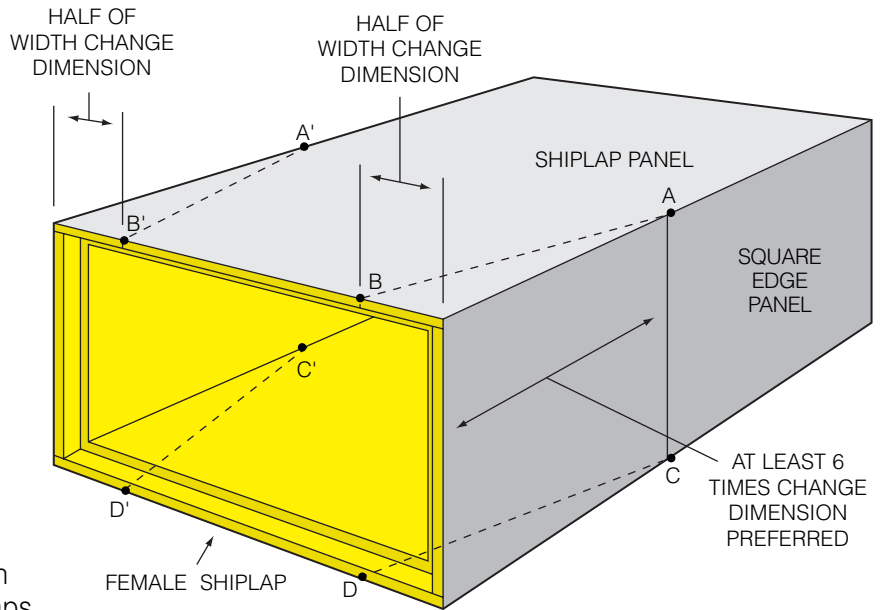


Fig. 3-16A

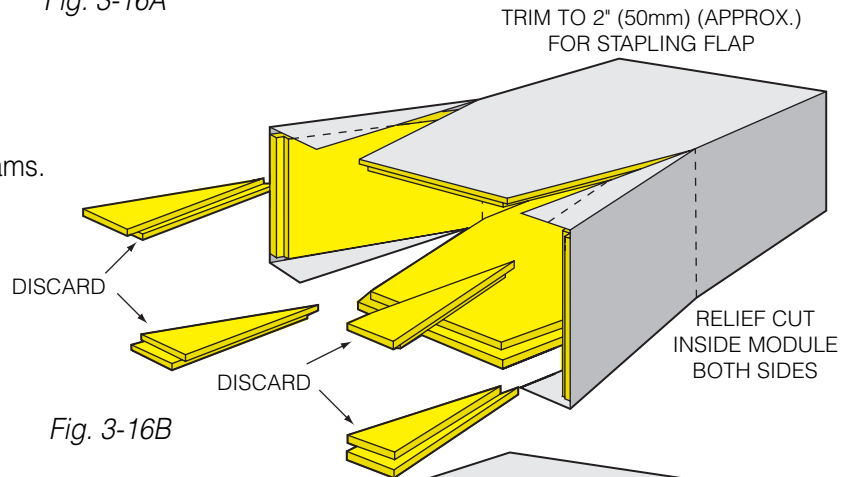


Fig. 3-16B

NOTE:
If both height and width must be changed at each corner, refer to Page 3-12 and take half the height change from both top and bottom of both square edge panels.

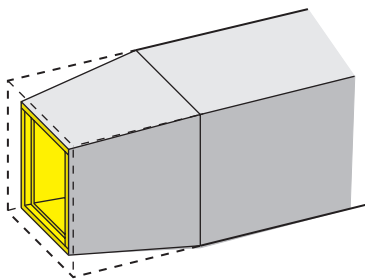


Fig.3-16C

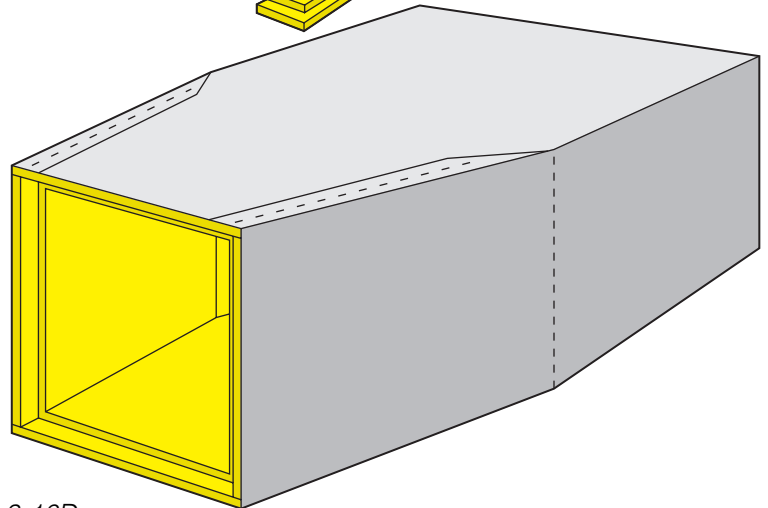


Fig.3-16D

**TRANSITION CHANGING HEIGHT AND WIDTH
FROM ONE PIECE OF FLAT DUCT BOARD**

Size is determined by taking the larger of both height and width dimensions.

EXAMPLE:

For transition from 24" x 12" (approx. 600mm x 300mm) to 18" x 18" (approx. 450mm x 450mm), groove duct board for 24" x 18" (approx. 600mm x 450mm).

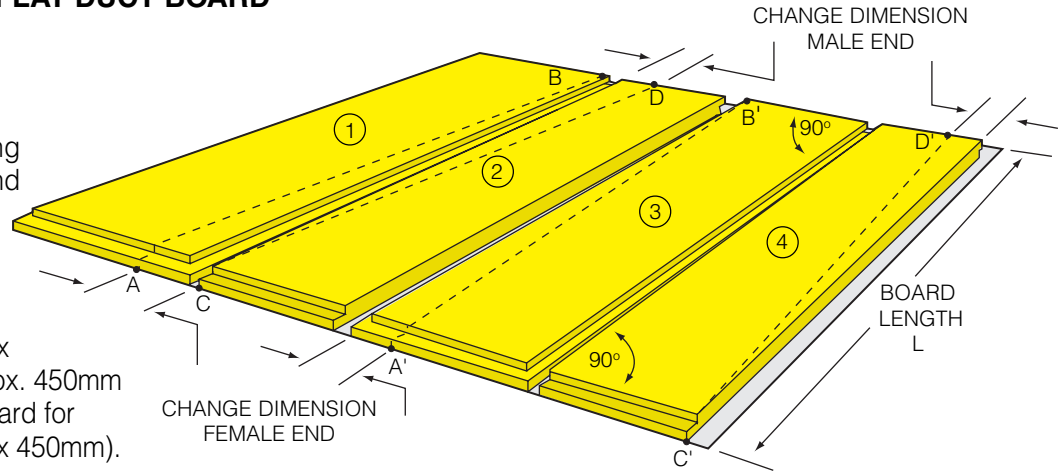


Fig. 3-17A.

1. Layout: Draw lines A-B and A'-B' on shiplap panels ① and ③. Draw lines C-D and C'-D' on square edge panels ② and ④. See Fig. 3-17A.

2. Make straight knife cuts along lines A - B and A' - B' through board and facing on panels ① and ③. Replace female shiplaps. Discard triangular scrap. See Fig. 3-17B.

3. Straight knife cut through insulation only along lines C-D and C'-D'. Remove and discard triangular scrap. Trim facing to provide 2" (50mm) staple flaps. See Fig. 3-17B.

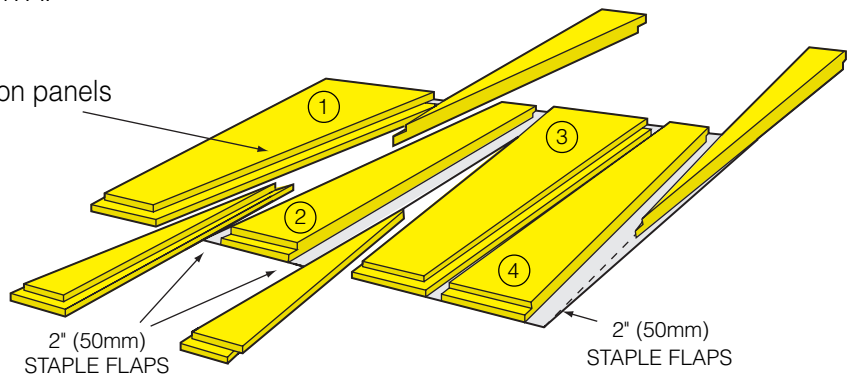


Fig. 3-17B.

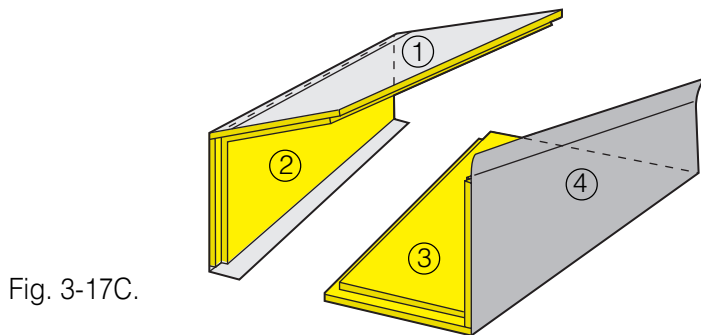


Fig. 3-17C.

4. Staple and tape panel ① to panel ②. Staple and tape panel ② to panel ③. See Fig. 3-18C. Fold into finished shape and staple panel ④ to panel ①. Apply closure to all staple flaps. See Section V, CLOSURE.

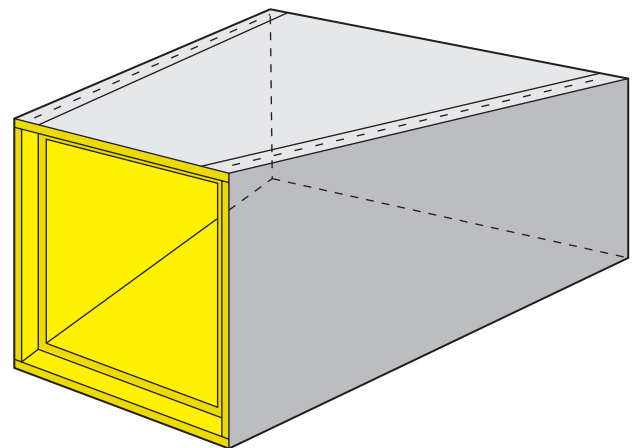


Fig. 3-17D.

**TRANSITION CHANGING HEIGHT AND WIDTH
FROM FOUR PIECES OF DUCT BOARD**

1. Lay out four pieces of duct board as shown in Fig. 3-19A.
Panels ① and ③ have square-cut edges with staple flaps on both sides.
Panels ② and ④ have shiplapped edges on both sides, and no staple flaps.

EXAMPLE:
Inside measurements for a transition from 24" x 12" (approx. 600mm x 300mm) to 18" x 18" (approx. 450mm x 450mm) are shown in Fig. 3-18A. (Dimensions for 1" (25mm) fibrous glass duct board.)

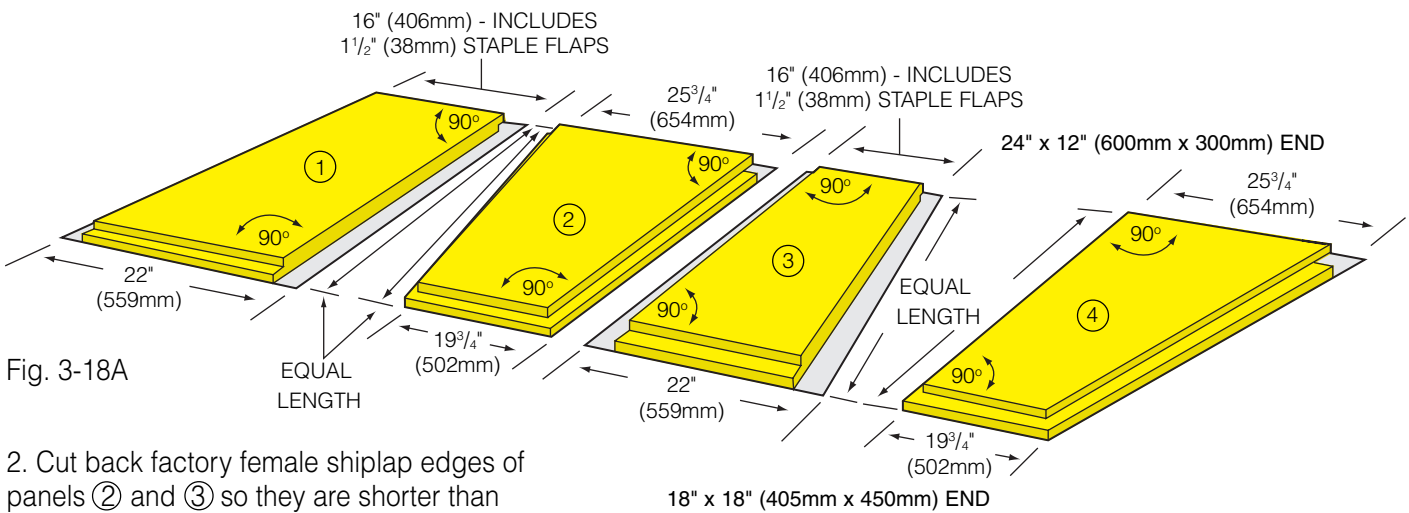


Fig. 3-18A

2. Cut back factory female shiplap edges of panels ② and ③ so they are shorter than panels ① and ④ as shown and so diagonal cuts are same length as 90° cuts, to allow for foreshortening when assembled. See Fig. 3-18A.

3. Staple panel ① to panel ②.
Staple panel ③ to panel ④. See Fig. 3-18B.
Staple assembled panels ① - ② to assembled panels ③ - ④.

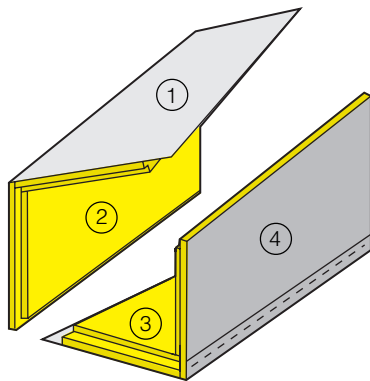


Fig. 3-18B

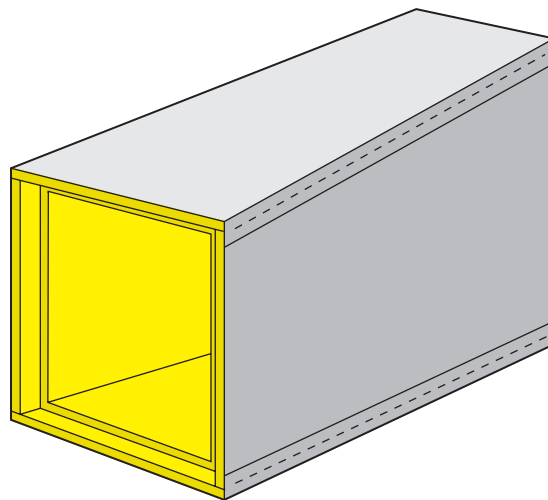


Fig. 3-18C

4. Tape all staple flaps.
See Section V, CLOSURE.

SQUARE AND ROUND TAP-OUTS

1. **PREFERRED METHOD:** Full height tap. This provides greatest strength. Tap panel must be square-edged.

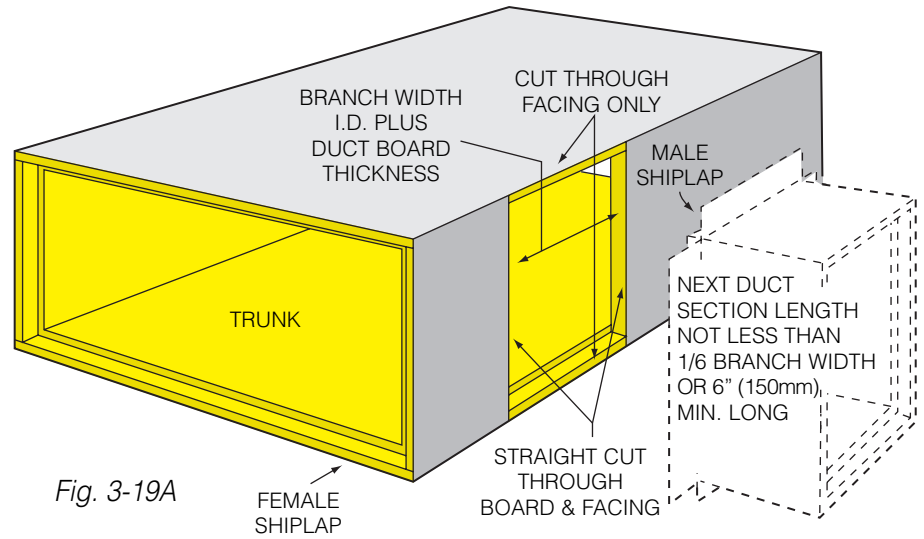


Fig. 3-19A

2. **ALTERNATIVE METHOD:** Tap of less than full trunk height often requires trunk duct be reinforced. It is preferable to use a full trunk height tap and make the transition in the branch.

Assemble, staple and apply closure. See Section V, CLOSURE.

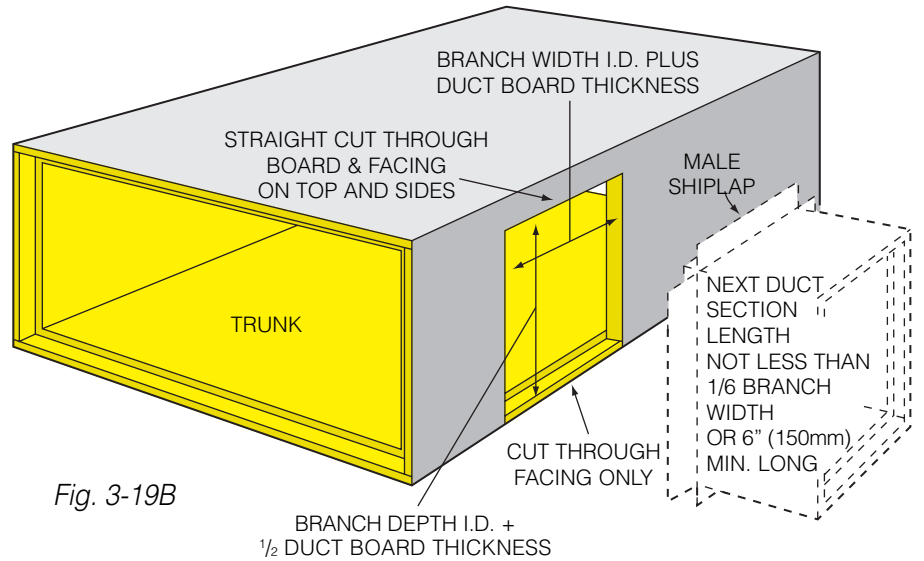


Fig. 3-19B

3. **ROUND TAPS:** Cut hole in trunk with round hole cutter, not with knife. Tap may be made in any panel.

NOTE: Either dove-tail or spin-in collars may be used to make round duct connections to trunk duct. See pages 4-6 and 4-7, or follow installation instructions provided by fitting and/or round duct manufacturers.

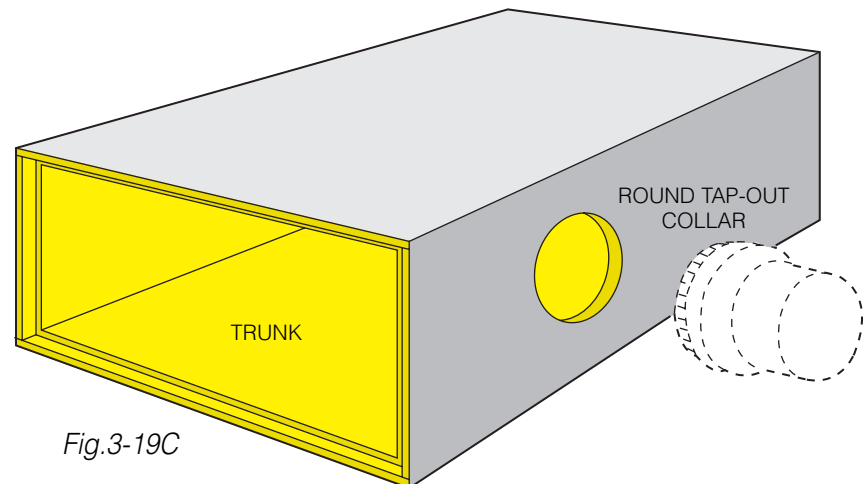


Fig. 3-19C

WIDE MOUTH TAP

Dim. A = 6" (150mm) (min.) or, for taps over 30" (750mm) wide, 1/4 branch width.

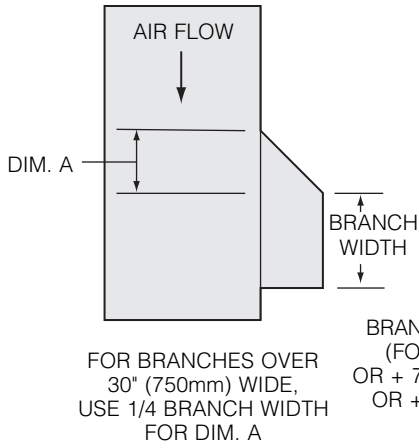


Fig. 3-20B

1. Groove downstream ends of all four pieces with female shiplap tool. Groove upstream ends of all four pieces with male shiplap tool.

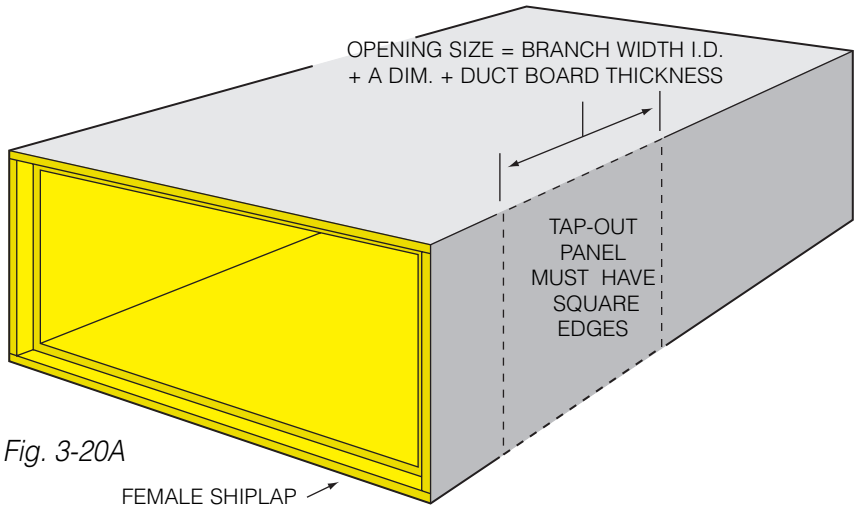


Fig. 3-20A

BRANCH WIDTH I.D. + 7" (175mm) (FOR 1" (25mm) DUCT BOARD)
OR + 7 1/2" (188mm) (FOR 1 1/2" (38mm) DUCT BOARD)
OR + 8" (204mm) (FOR 2" (51mm) DUCT BOARD)

1 3/8" (35mm) FOR 1" (25mm) DUCT BOARD
1 11/16" (43mm) FOR 1 1/2" (38mm) DUCT BOARD
2 1/8" (54mm) FOR 2" (51mm) DUCT BOARD

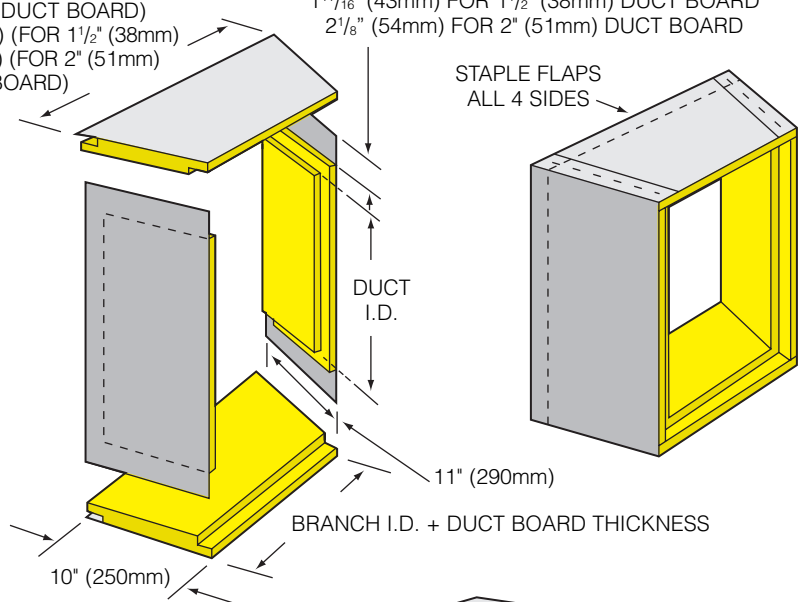
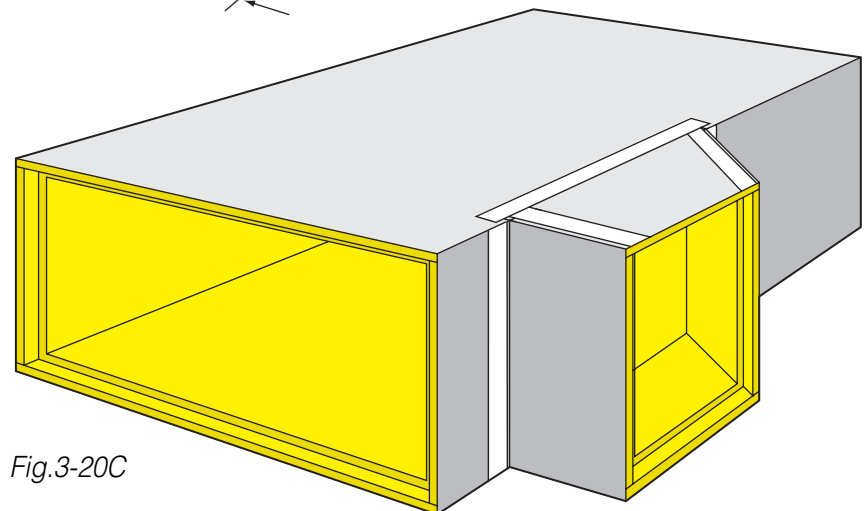


Fig. 3-20C

2. Assemble, staple, and apply closure. See Section V, CLOSURE.



END CAPS

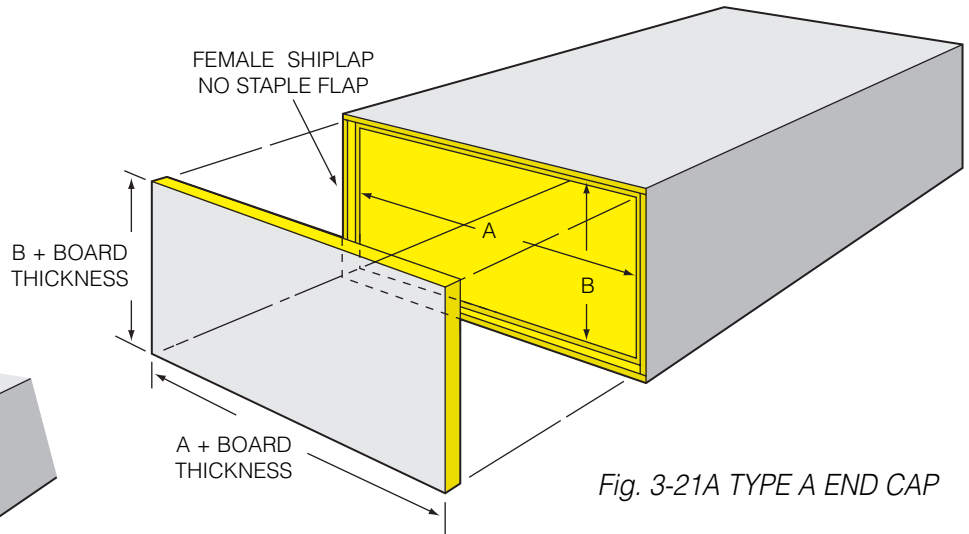
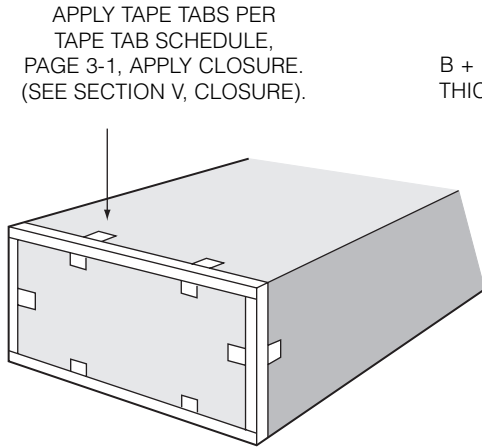


Fig. 3-21A TYPE A END CAP

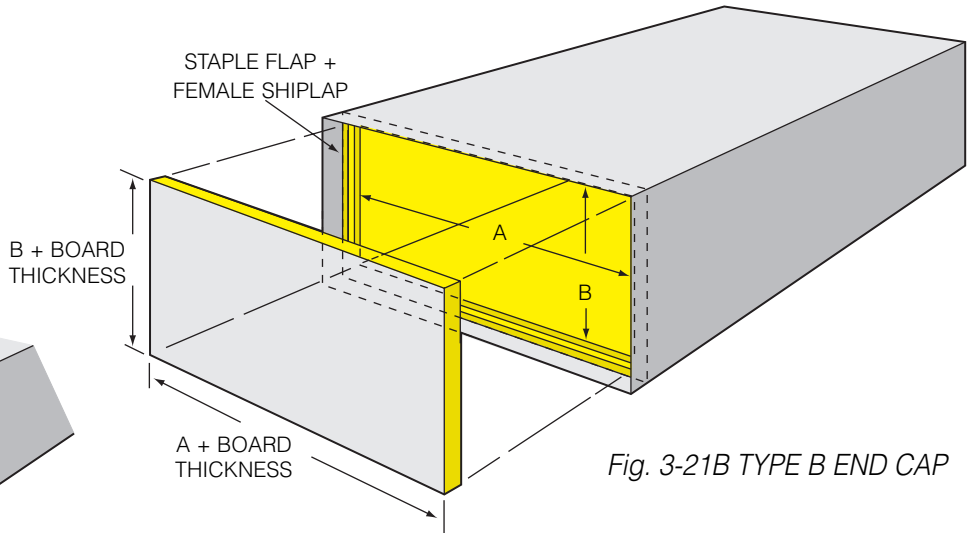
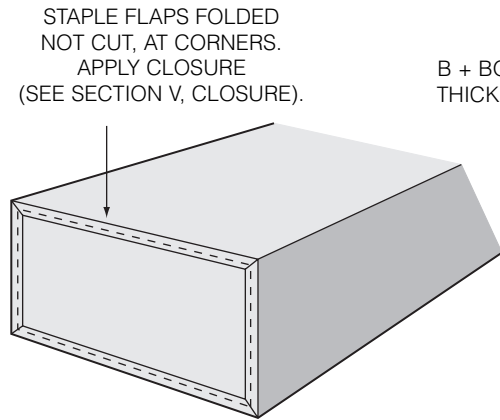


Fig. 3-21B TYPE B END CAP

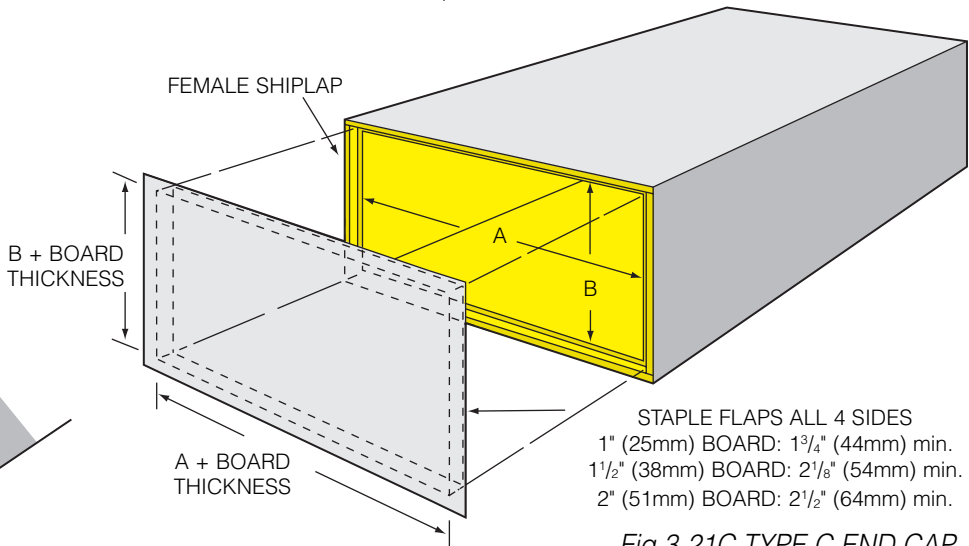
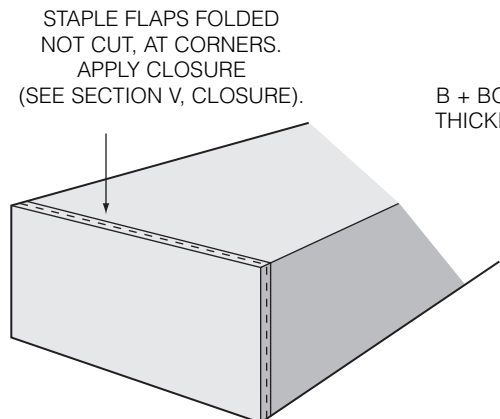


Fig. 3-21C TYPE C END CAP

SINGLE BLADE VOLUME DAMPER

When single blade manual dampers are installed with suitable mounting hardware in ducts of less than two square feet (0.2m²) inside cross section area, sheet metal sleeves and extra hangers are not required. Hem damper blade as needed for stiffness.

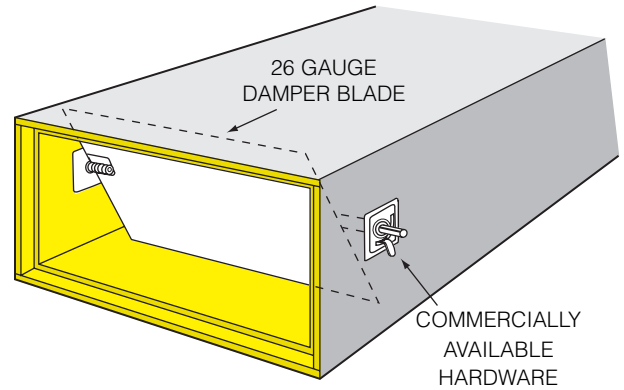


Fig. 3-22A

FIRE DAMPER INSTALLATION

Sheet metal sleeve must be installed through rated fire wall. Check local codes and damper manufacturer's installation instructions for proper sheet metal gauge and attachment angle.

NOTE: Sealing of fibrous glass duct board to sheet metal sleeve must be made with UL 181A/P pressure-sensitive aluminum foil tape after sheet metal surfaces are first carefully cleaned.

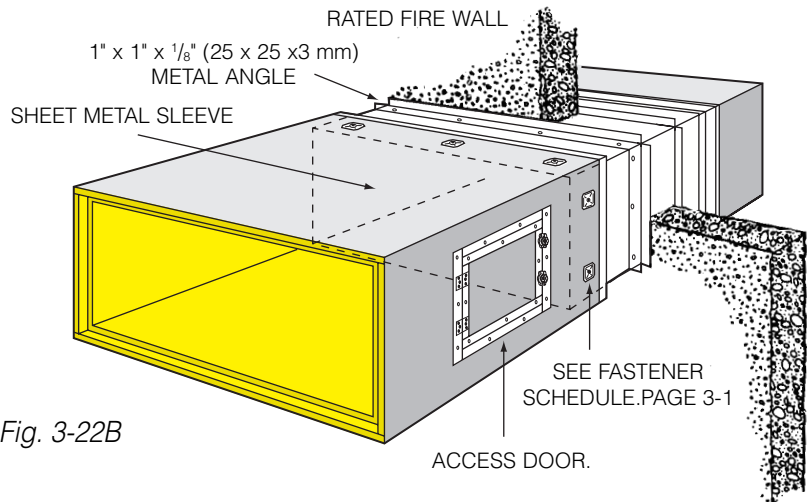


Fig. 3-22B

SLEEVED ACCESSORY MOUNTING
(electrostatic air cleaners, humidifiers, heaters, etc.)

Hangers must be installed at sleeves to support accessory separately if weight exceeds 50 pounds (75Kg). See Section VI, HANGERS AND SUPPORTS

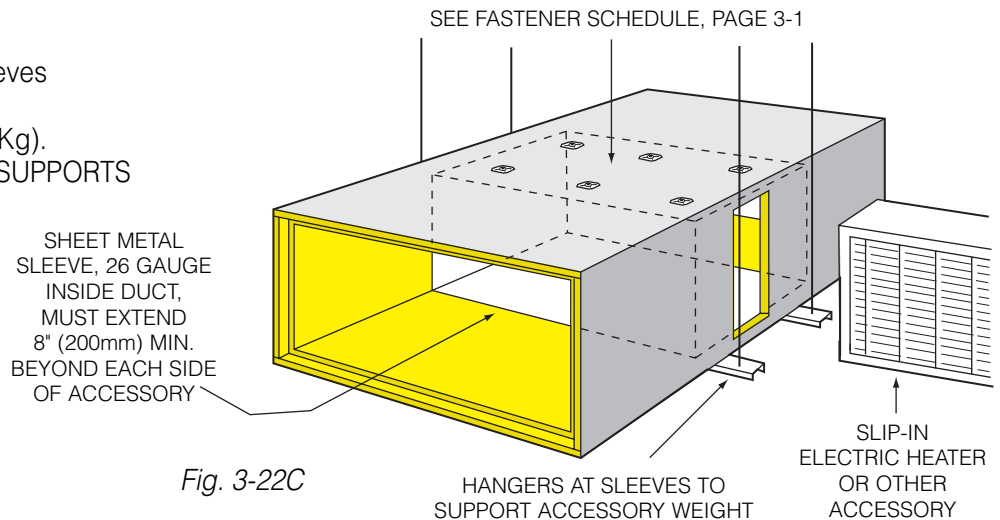


Fig. 3-22C

INSTALLATION OF TAPS TO REGISTERS

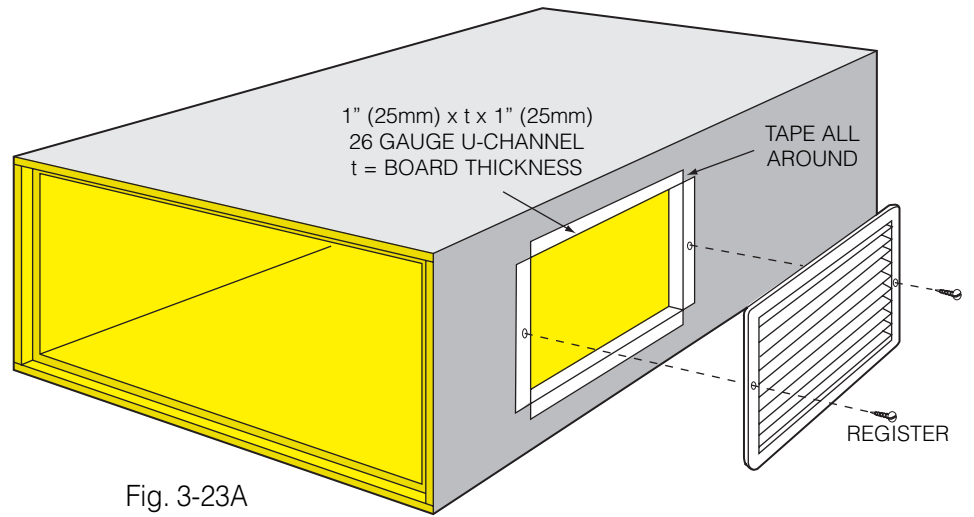


Fig. 3-23A

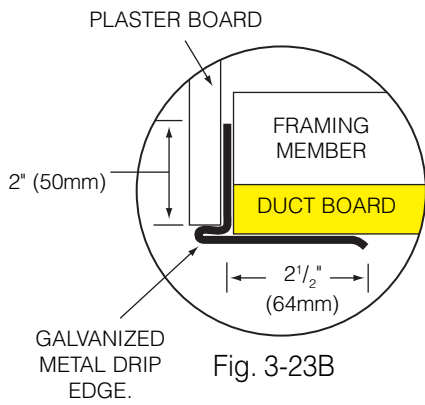


Fig. 3-23B

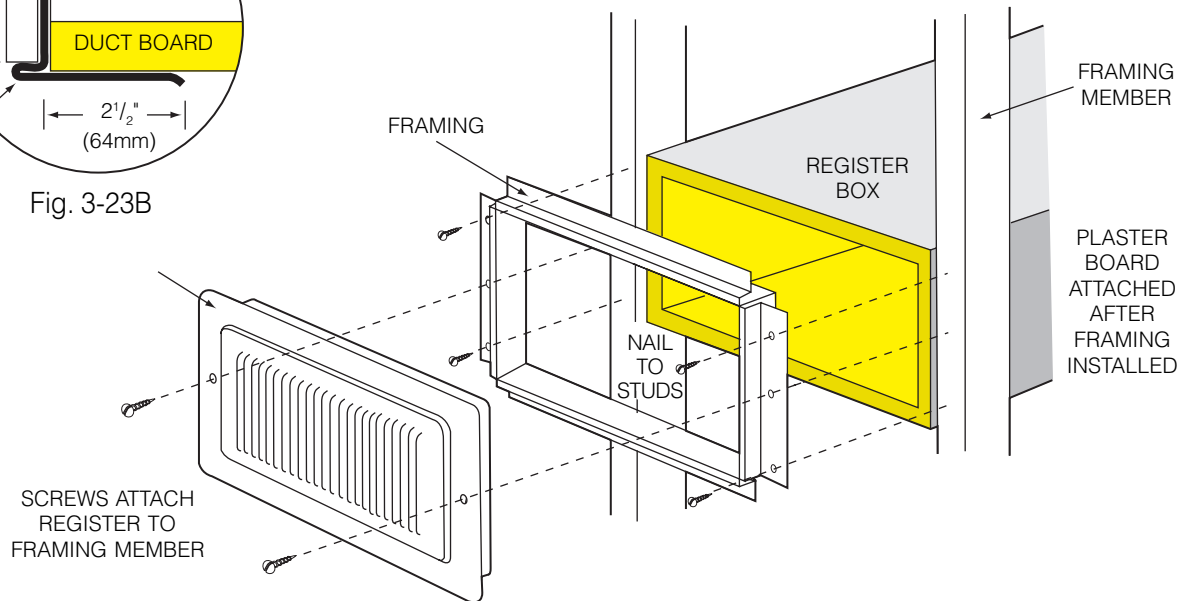


Fig. 3-23C

SECTION IV

RADIAL FLEXIBLE DUCT SYSTEM FABRICATION

RADIAL SYSTEM

(See Section IV for Fabrication Details)

In place of an extended plenum fabricated from fibrous glass duct board, flexible duct is used to supply air from plenum to room registers. Flexible duct trunks extend from the plenum to triangular or rectangular distribution boxes fabricated from fibrous glass duct board. Individual room registers are supplied by flexible duct run-outs from these distribution boxes.

Load calculation and duct sizing are especially important in the design of a radial system. In nearly all cases, various sizes of flexible duct will be needed to supply adequate conditioned air to each room. Consult sources such as ACCA Manual J (for guidance on room load calculation) and ACCA Manual D (duct sizing). (See references, Appendix, Page A-1.)

In the simplest version of the radial system, fibrous glass duct board distribution boxes are eliminated and each room register or diffuser is supplied by a single flexible duct running directly from the plenum.

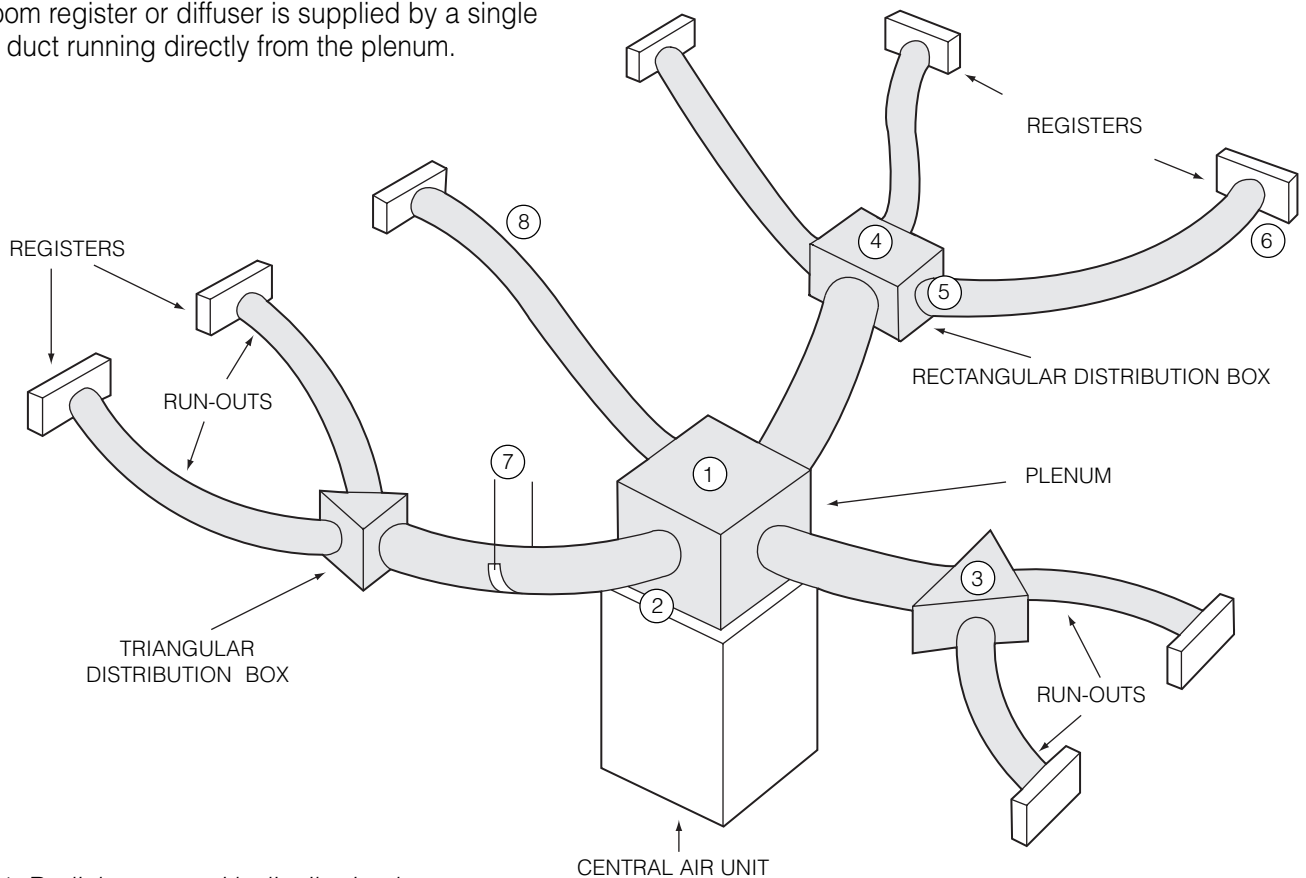


Fig. 4-1. Radial system with distribution boxes

Radial Duct System Components	Page
1. Plenum	4-3
2. Connection of plenum to central air equipment	3-3
3. Triangular distribution boxes	4-4
4. Rectangular distribution box	4-5
5. Flexible duct connections to fibrous glass units	4-6
6. Flexible duct connections to registers	4-7
7. Hangers and supports	6-2
8. Flexible duct run-out to a single register	4-6 or 4-7

FIBROUS GLASS DUCT BOARD PLENUM

Inside dimensions A and B are to fit snugly over the flange or opening on the central air unit.

Outside dimension C is to be as required to accommodate sheet metal fittings, overhead clearance, ceiling joist location, insulation, and/or other factors.

1. Cut off male shiplap at required dimension (Fig.4-3A) so this end is straight (butt) cut.
2. Install plenum on central air equipment flange (Fig. 4-3B). See page 3-3.
3. Make all flexible duct connections as shown on page 4-6 or 4-7, depending on method used, before installing end cap.
5. Apply end cap to top of plenum (female shiplap end) after all flexible duct connections have been completed

For Type C (preferred), See Fig. 4-3C.
For Type A end cap, See Fig. 4-3D and tape tab schedule, Page 3-1.

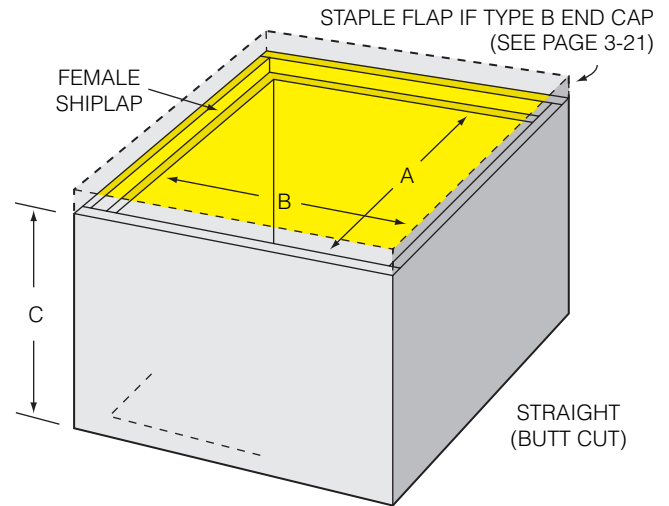


Fig. 4-3A. Fibrous glass duct board plenum.

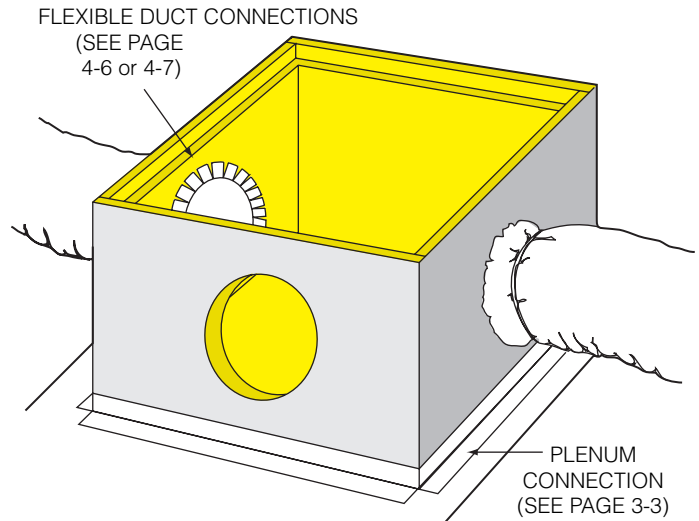


Fig. 4-3B. Connecting flexible duct to plenum.

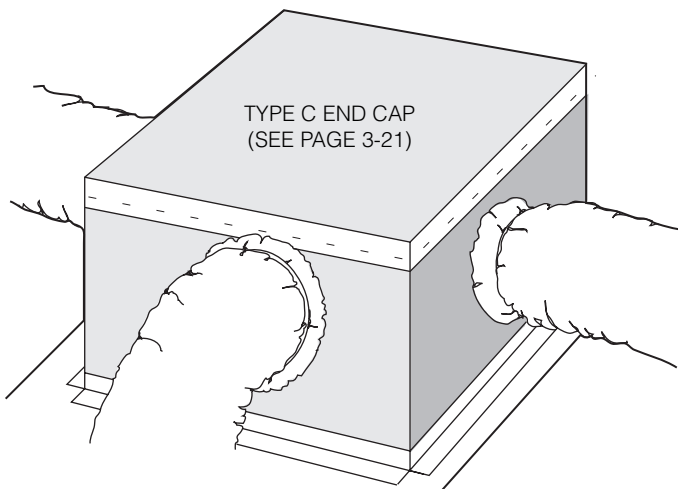


Fig. 4-3C. Installing Type C end cap on top of plenum.

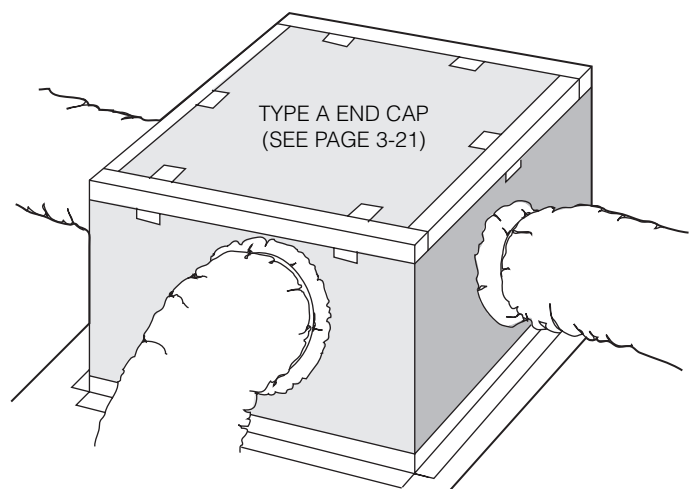
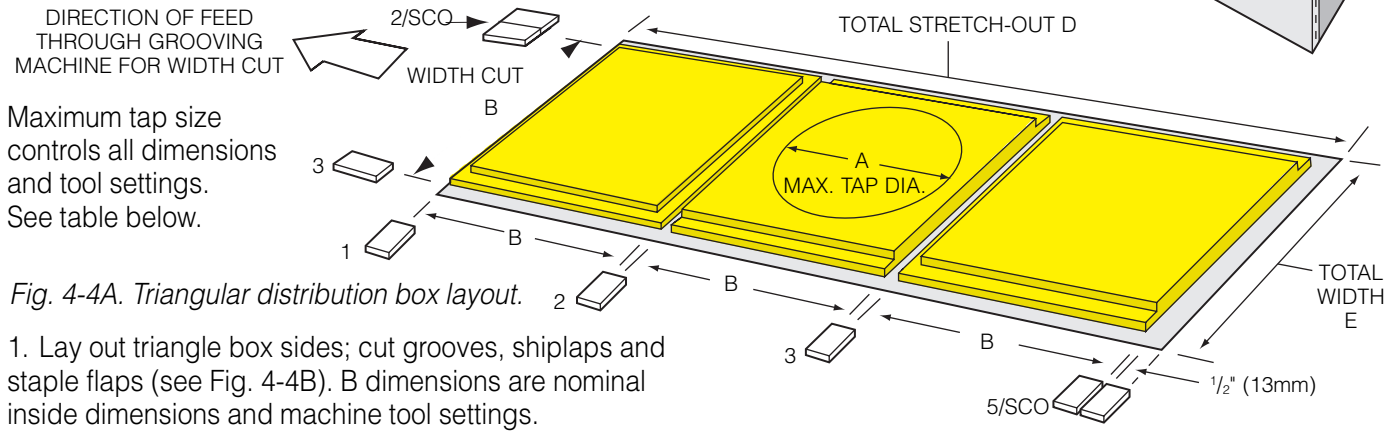


Fig. 4-3D. Installing Type A end cap on top of plenum.

TRIANGULAR DISTRIBUTION BOX - 1" (25mm) DUCT BOARD

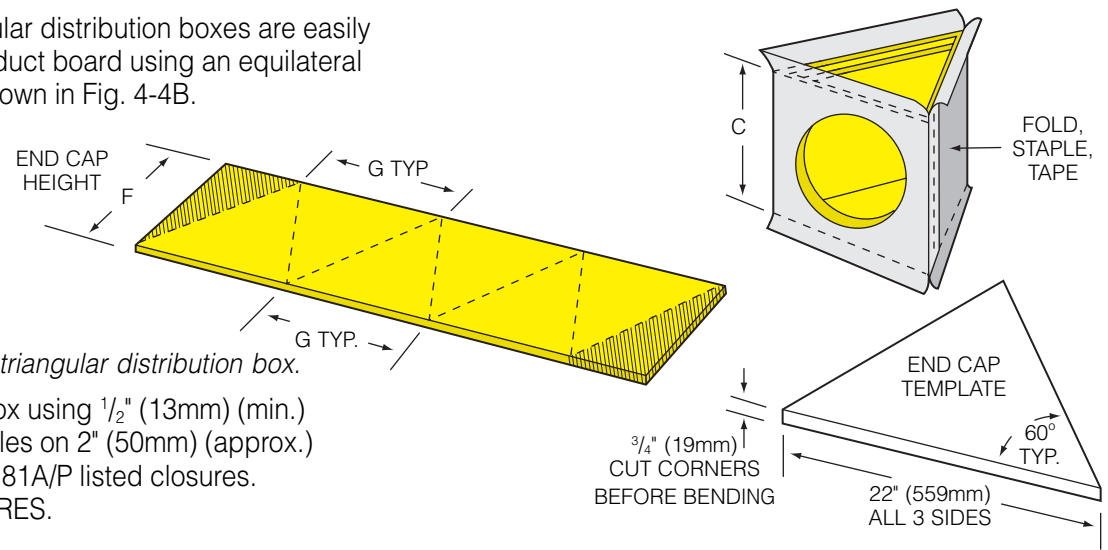
Triangular distribution boxes are square-sided equilateral triangles fabricated from fibrous glass duct board. See Fig. 4-4A.



Maximum tap size controls all dimensions and tool settings. See table below.

1. Lay out triangle box sides; cut grooves, shiplaps and staple flaps (see Fig. 4-4B). B dimensions are nominal inside dimensions and machine tool settings.

2. End caps for triangular distribution boxes are easily cut from fibrous glass duct board using an equilateral triangle template as shown in Fig. 4-4B.



3. Close distribution box using 1/2" (13mm) (min.) outward clinching staples on 2" (50mm) (approx.) centers. Seal with UL 181A/P listed closures. See Section V, CLOSURES.

MAXIMUM TAP SIZE	(A)	8 (203mm)	10 (254mm)	12 (305mm)	14 (356mm)	16 (406mm)	18 (457mm)
		in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)	in. (mm)
Nom. I.D. and tool setting ⁽¹⁾	(B)	9 ³ / ₄ (248)	11 ³ / ₄ (298)	13 ³ / ₄ (349)	15 ³ / ₄ (400)	17 ³ / ₄ (451)	19 ³ / ₄ (502)
Nom. outside face, square	(C)	11 ¹ / ₂ (292)	13 ¹ / ₂ (343)	15 ¹ / ₂ (394)	17 ¹ / ₂ (445)	19 ¹ / ₂ (495)	21 ¹ / ₂ (546)
Total stretch-out	(D)	36 (914)	42 (1067)	48 (1219)	54 (1372)	60 (1524)	66 (1676)
Total width	(E)	14 ¹ / ₂ (368)	16 ¹ / ₂ ⁽³⁾ (419)	18 ¹ / ₂ (470)	20 ¹ / ₂ (521)	22 ¹ / ₂ (572)	24 ¹ / ₂ ⁽³⁾ (622)
End cap height	(F)	9 ¹ / ₄ (235)	11 (279)	12 ³ / ₄ (324)	14 ¹ / ₂ (368)	16 ¹ / ₄ (413)	18 (457)
End cap base	(G)	10 ³ / ₄ (273)	12 ³ / ₄ (324)	14 ³ / ₄ (375)	16 ³ / ₄ (425)	18 ³ / ₄ (476)	20 ³ / ₄ (520)
No. end caps per 4-ft (1219mm) length		7	6	5	4	4	3
Total material required, ft ² (m ²) ⁽²⁾		4.4 (0.46)	5.9 (0.61)	7.9 (0.82)	11.4 (1.15)	112.7 (1.28)	15.0 (1.56)
Approx. total lin. ft. (mm) tape		6.7 (2042)	7.9 (2408)	9.0 (2743)	10.2 (3109)	11.4 (3365)	12.5 (3810)

NOTES:
 (1) Dimensions based on GlassMaster tooling.
 (2) Includes scrap allowance.
 (3) Reduce to even dimension to obtain an even number of pieces across duct board width.
 (4) Consult product manufacturers for dimensions if using 1 1/2" (38mm) or 2" (51mm) duct board.

RECTANGULAR DISTRIBUTION BOX - 1" (25mm) DUCT BOARD

Rectangular distribution boxes are fabricated like regular straight fibrous glass duct modules (see Fig. 4-5A), with end caps on both ends. Maximum tap size controls all dimensions and tool settings. See table below. End caps for rectangular distribution boxes are fabricated from fibrous glass duct board as shown in Fig. 4-5B below.

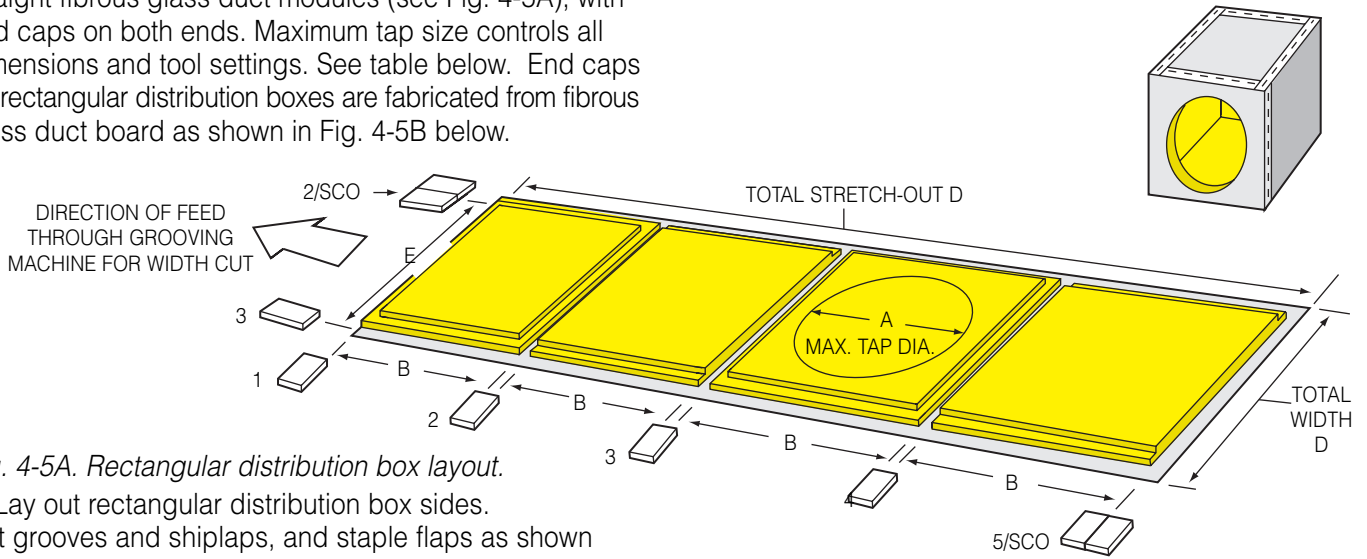


Fig. 4-5A. Rectangular distribution box layout.

1. Lay out rectangular distribution box sides. Cut grooves and shiplaps, and staple flaps as shown above. B dimensions are nominal inside dimensions and machine tool settings.

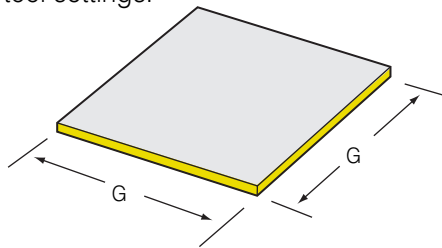
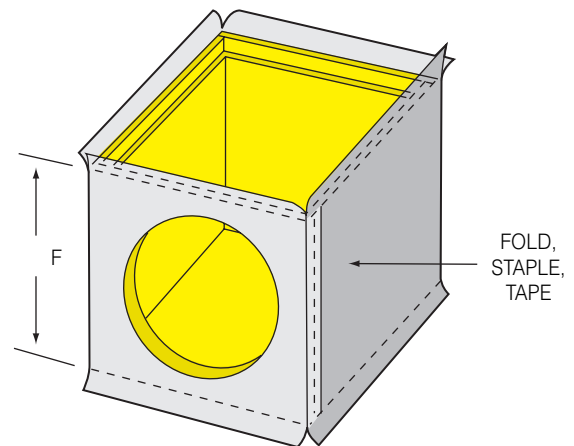


Fig. 4-5B. End cap for rectangular distribution box.

2. Close distribution box using 1/2" (13mm) (min.) outward clinching staples on 2" (50mm) (approx.) centers. Seal with UL 181A/P listed closures. See Section V, CLOSURE.



MAXIMUM TAP SIZE	(A)	8 (203mm)		10 (254mm)		12 (305mm)		14 (356mm)		16 (406mm)		18 (457mm)	
		in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
Nom. I.D. and tool setting ⁽¹⁾	(B)	10	(254)	12	(305)	14	(356)	16	(406)	18	(457)	20	(508)
Total stretch-out	(C)	48	(1219)	56	(1422)	64	(1626)	72	(1829)	88	(2235)	96	(2438)
Total width	(D)	24	(610)	24	(610)	24	(610)	24	(610)	24	(610)	24	(610)
Width tool setting	(E)	19 1/4	(489)	19 1/4	(489)	19 1/4	(489)	19 1/4	(489)	19 1/4	(489)	19 1/4	(489)
Total height	(F)	21	(533)	21	(533)	21	(533)	21	(533)	21	(533)	21	(533)
End cap dimension (square)	(G)	11	(279)	13	(330)	15	(381)	17	(432)	19	(483)	21	(533)
No. end caps per 4-ft (1219mm) length		4		3		3		2		2		2	
Total material required, ft ² (m ²) ⁽²⁾		9.8	(1.02)	12.2	(1.29)	14.0	(1.46)	17.7	(1.84)	21.0	(2.19)	23.0	(2.40)
Approx. total lin. ft. (mm) tape		9.6	(2926)	10.9	(3322)	12.3	(3749)	13.6	(4145)	14.9	(4541)	16.3	(4554)

NOTES:

(1) Dimensions based on GlassMaster tooling.

(2) Includes scrap allowance.

(3) Consult product manufacturers for dimensions if using 1 1/2" (38mm) or 2" (51mm) duct board.

FLEXIBLE DUCT CONNECTIONS TO DUCT BOARD - CLOSURE STRAP METHOD

1. Cut hole in plenum, duct section, or distribution box with hole cutter sized to accept a sheet metal collar. If using spin-in collar, also cut a 1" (25mm) slit radial to the hole (Fig. 4-6A).

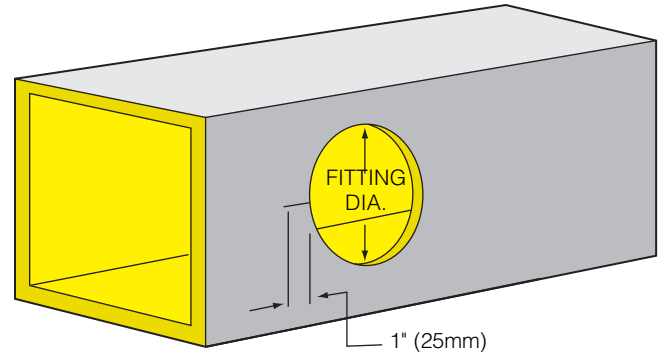


Fig. 4-6A. Cutting hole in duct board for flexible duct connection.

2. To reduce leakage, coat the collar flange with mastic listed under UL 181A, Part III, to seal the collar to the duct board.

3(a). If using spin-in collar, be sure lead edge of inner flange is bent down at an angle. Install by screwing into duct board until flange is snugly sealed against duct board facing and entire inner ring is visible inside duct. See Fig. 4-6B.

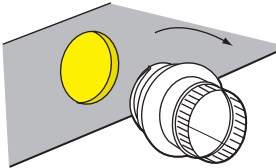
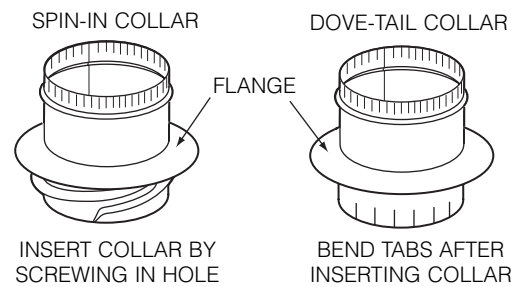


Fig. 4-6B. Installing spin-in collar.

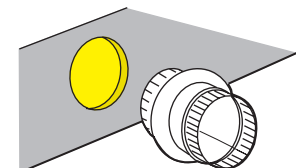


Fig. 4-6C. Installing dove-tail collar.

3(b). If using dove-tail collar, install by pushing into duct board until flange is snugly sealed against duct board facing. Bend all tabs 90° to lock the collar in place. See Fig. 4-6C.

4. Pull inner air core of flexible duct over collar. Seal with UL181B tape and clamp per flexible duct manufacturers' recommendations. See Fig. 4-6D.

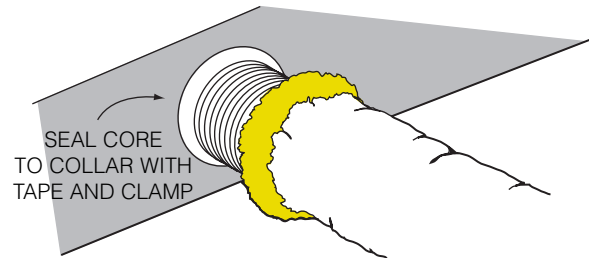


Fig. 4-6D. Installing flexible duct over collar.

5. Pull flexible duct insulation over inner air core so it is butted firmly against duct wall (Fig. 4-6E). Complete installation of flexible duct to collar in accordance with manufacturer's instructions.

For additional information on connecting flexible duct to fibrous glass duct board, refer to Air Diffusion Council *Flexible Duct Performance & Installation Standards* and manufacturers' instructions.

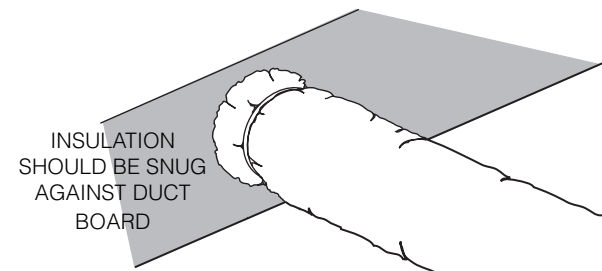


Fig. 4-6E. Install flexible duct to collar according to manufacturer's instructions.

FLEXIBLE DUCT CONNECTIONS TO DUCT BOARD - INSULATED COLLAR METHOD

1. From a 1" (25mm) piece of duct board, cut a ring whose inside diameter is the same as that of the sheet metal collar and whose outside diameter gives a thickness that corresponds to the R-value of the flexible duct insulation as follows:

INSIDE DIAMETER PLUS:	FLEXIBLE DUCT R-VALUE
2" (51mm)	4.2 (0.74 RSI)
3" (76mm)	6.0 (1.06 RSI)
4" (102mm)	8.0 (1.41 RSI)

2. Slide ring onto sheet metal collar with foil facing of duct board away from flange. Tape to back of flange with UL181A listed pressure sensitive tape (see Fig. 4-7A).

3. Cut hole in duct board to accommodate sheet metal collar. If using spin-in collar (see page 4-6), cut 1" (25mm) slit radial to hole (see Fig. 4-6A). To reduce leakage, coat the collar flange with mastic listed under UL 181A, Part III to seal the collar to the duct board facing.

4. If installing dove-tail collar, push into hole in duct board until outer flange is snug against facing. Bend dove-tails 90° outward to lock in place (see Fig. 4-7B).

5. If installing spin-in collar, bend leading edge of inner flange down at an angle and slip through slit in duct board. Screw collar into place with outer flange snug against foil facing and inner ring fully visible inside duct.

6. Pull inner air core of flexible duct over collar. Seal with UL181B tape and secure with closure strap between bead on collar and duct board (see Fig. 4-7B).

7. Butt flexible duct insulation firmly against duct board ring (Fig. 4-7C). Pull flexible duct vapor retarder jacket over ring so it covers about one half the width of ring.

8. Tape jacket to ring using UL181B tape (Fig. 4-7D).

This procedure maintains full thickness of insulation across the flexible duct connection, minimizes through-metal conductance of the sheet metal fitting, and completes the vapor retarder across the connection to prevent moisture condensation.

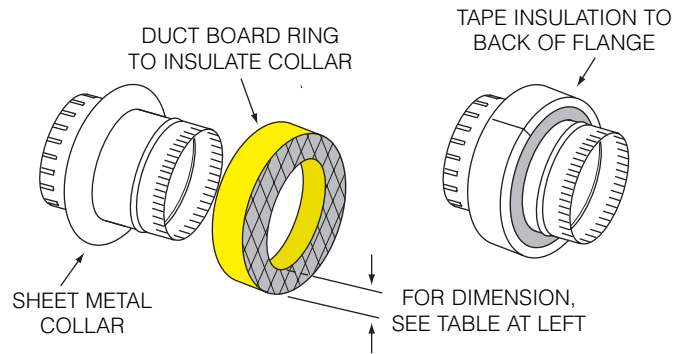


Fig. 4-7A. Insulating collar of sheet metal fitting.

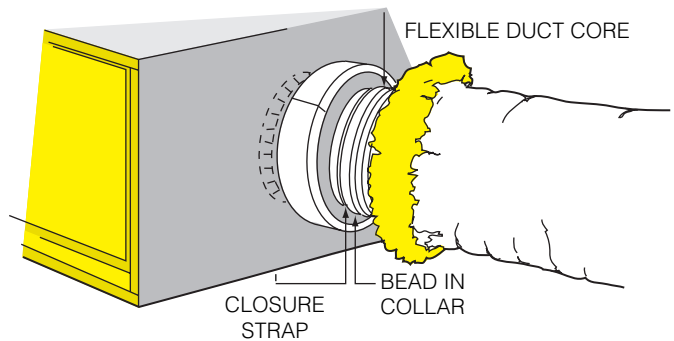


Fig. 4-7B. Securing flexible duct with plastic strap.

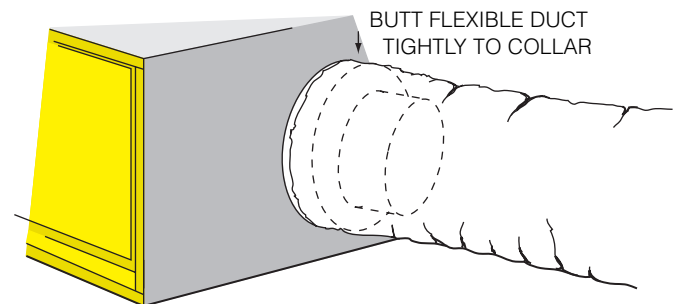


Fig. 4-7C. Positioning flexible duct insulation and vapor retarder jacket against insulated collar.

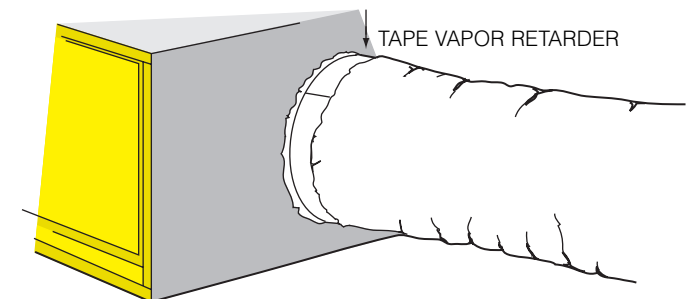


Fig. 4-7D. Taping flexible duct jacket to collar.

SECTION V

CLOSURE

CLOSURE

Closure systems are a vital element in the proper assembly of fibrous glass duct systems, providing both the structural connection and sealing of seams and joints. Only those closure systems that comply with UL 181A are suitable for use with rigid fibrous glass duct systems. Listed closures include:

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

Model codes and project specifications require that non-metallic duct construction, which includes fibrous glass ducts, conform to UL 181, Class 1 requirements. Under UL 181A listing procedures, an individual closure system may be qualified for use on all manufacturers' duct boards which meet the UL 181 requirement.

Joint and Seam Preparation

Longitudinal seams are prepared as described on page 2-21. Transverse joints between two duct sections are prepared as described on page 2-22 and as shown in Fig. 5-2A at right.

Staples

Staples shall be galvanized steel, outward clinching, 1/2" (13mm) (min. long, crown width 0.400" (12mm) (min.), flat wire, 0.040" x 0.020" (1.2mm x 0.51mm) (min.).

Tape Tabs

When staple flaps are not present, tape tabs of either pressure sensitive or heat activated tapes are used at seams and joints. Tape tabs, made from 8" (200mm) (minimum) lengths of closure tape, are equally spaced on either side of the joint on 12" (300mm) (maximum) centers, with at least one tape tab per side (see Fig. 5-2B). Tape tabs may be placed either over or under the tape closure, or under mastic and glass fabric closures.

Surface Preparation

In order to obtain satisfactory adhesion and bonding, the

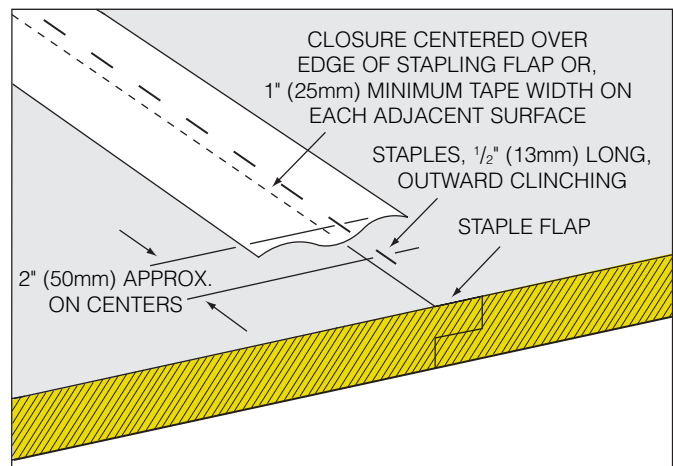


Fig. 5-2A. Joint closure with shiplap and staple flap.

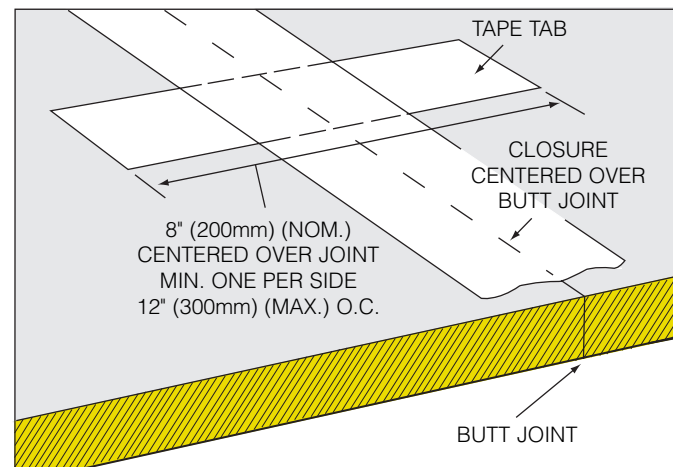


Fig. 5-2B. Joint closure with tape tabs and no staple flap.

surface on which closures will be applied must be clean and dry. Dust, dirt, oil, grease, moisture and similar substances may result in adhesion and bonding failure when present. In many cases, wiping the application surface with an oil-free, lint-free rag or paper towel is sufficient. However, for best results on contaminated surfaces, the cleaning recommendations of the tape manufacturer should be consulted.

Shelf Life

Tapes and mastics often have storage requirements and shelf life limitations. The installer should verify that these conditions have not been exceeded prior to use.

Closure systems may also be qualified under UL 181 by individual duct board manufacturers.

APPLICATION OF PRESSURE SENSITIVE ALUMINUM FOIL TAPE CLOSURES

Application above 50°F (10°C):

Use 2½" (64mm) (minimum) wide tape for 1" (25mm) duct board. For 1½" (38mm) duct board, 3" (76mm) wide tape is recommended. For 2" (51mm) duct board, 3" (76mm) wide tape is required. Position the tape along the edge of the flap in a manner that will allow 1" (25mm) (minimum) overlap on adjacent surfaces. While holding the tape taut, press in place taking care to avoid wrinkles and folds. See Fig. 5-3A.

Rub tape firmly with a plastic sealing tool until the facing reinforcement shows through the tape. Avoid excessive pressure on the sealing tool that could cause the tape to be punctured at staple locations. See Fig. 5-3B.

Connections to sheet metal:

Pressure sensitive tape may be used to seal fibrous glass ducts to sheet metal in systems operating at less than 1" w.g. (250 Pa) static pressure when the sheet metal surfaces are first carefully cleaned in accordance with tape manufacturer's instructions.

Application below 50°F (10°C):

If the temperature of either the duct board surface or the tape is less than 50°F (10°C) at time of application, heat must be applied.

Using any suitable heating iron with the plate temperature set at approximately 400°F (200°C), pre-heat the area to be taped. Quickly position the tape on the pre-heated area and press in place. Pass the iron two or three times over the taped area using a rapid ironing motion (see Fig. 5-3C).

Complete the bond by rubbing the tape firmly with the plastic sealing tool until the facing reinforcement shows through the tape clearly.

If tape has been stored at temperatures below 50°F (10°C), it may be conditioned prior to use by placing it in a warm environment to improve the initial tack.

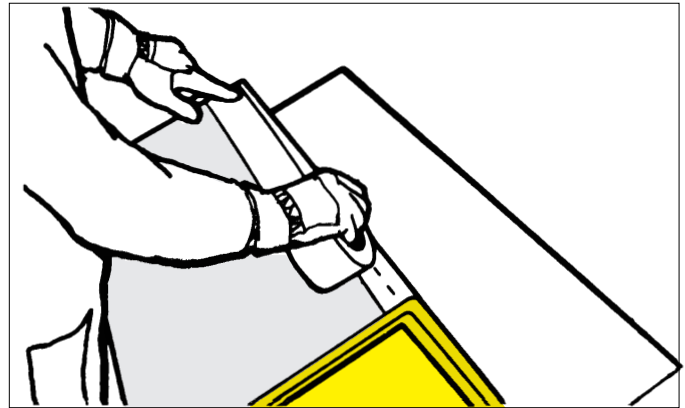


Fig. 5-3A. Applying pressure sensitive aluminum foil tape to longitudinal seam. Hold one end in place firmly and press tape in place, taking care to avoid wrinkles and folds.

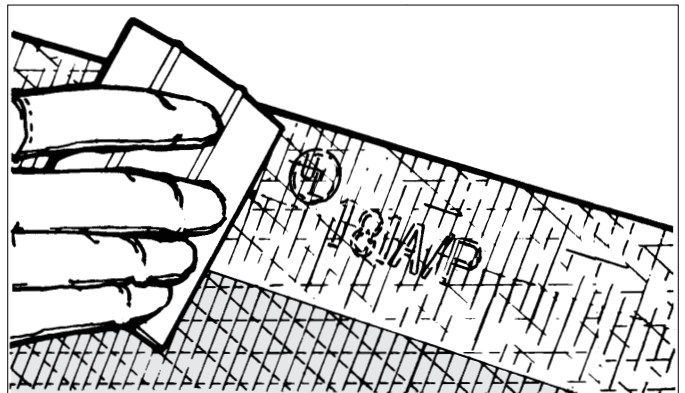


Fig. 5-3B. Rub tape firmly with plastic sealing tool until the facing reinforcement shows clearly through the tape. Avoid tearing or puncturing tape at staples.

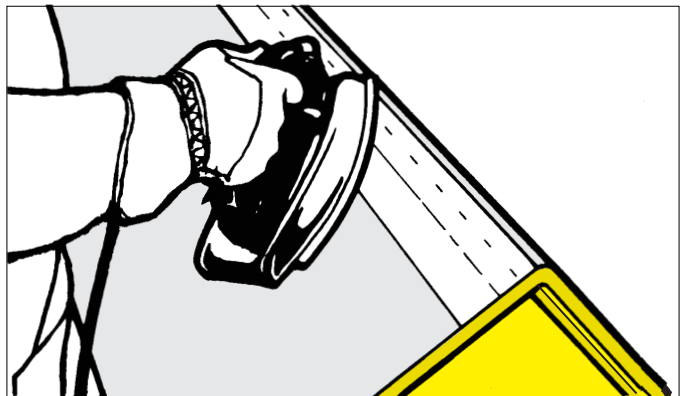


Fig. 5-3C. When applying pressure sensitive tape at temperatures below 50°F (10°C), use iron set at 400°F (200°C) to pre-heat area to be taped, then press tape in place.

APPLICATION OF HEAT ACTIVATED ALUMINUM FOIL TAPE CLOSURES

Position the 3" (76mm) wide tape along the edge of the flap in a manner that will allow a minimum overlap of 1" (25mm) on adjacent surfaces. Using a suitable heating iron with a plate temperature of between 550°F (288°C) and 600°F (316°C), pass the iron along the tape seam with sufficient pressure and dwell time to activate the adhesive (see Fig. 5-4A). A satisfactory bond has been achieved when the heat indicator dots on the tape have darkened (see Fig. 5-4B).

Use a second pass of the iron to complete the bond by applying pressure to the front edge of the iron in a smearing action. Exercise caution to prevent burn injuries from contact with the iron or with heated surfaces.

Allow all joints and seams to cool below 150°F (66°C) surface temperature before any stress is applied. Avoid puncturing the tape at staple locations with excessive pressure from the iron.



Fig. 5-4A. Apply heat with iron. Do not use a blowtorch; both heat and pressure are required for an effective bond. Complete the bond with a second pass of the iron.

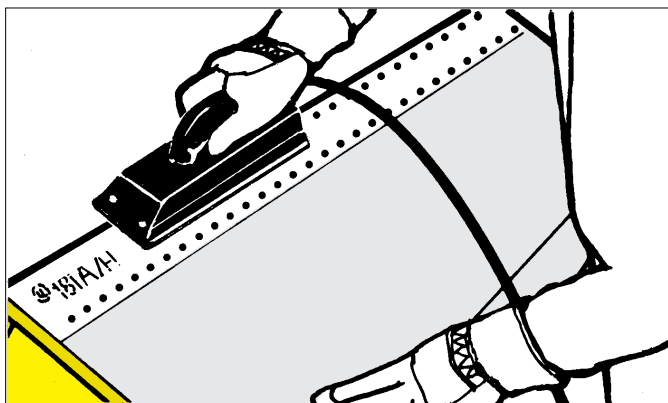


Fig. 5-4B. A satisfactory bond has been achieved when the heat indicator dots on the tape become darkened.

Closure machines:

Automatic closure machines using approved heat activated tape provide tightly sealed longitudinal seam closures at high production rates. Stapling of the longitudinal flap may be omitted.

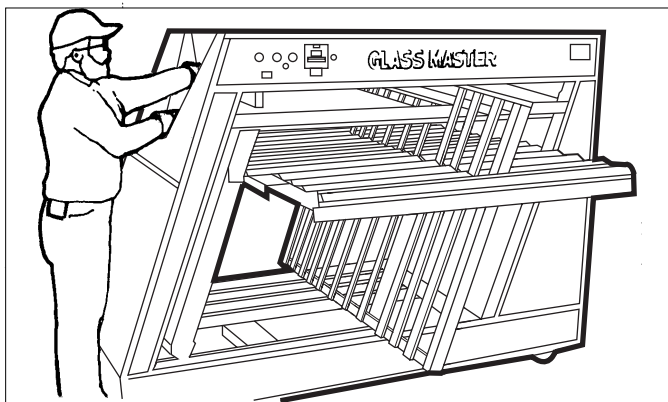


Fig. 5-4C. Closure machines automatically close and seal the longitudinal seam. They can be particularly useful in high volume production.

APPLICATION OF MASTIC AND GLASS FABRIC CLOSURE SYSTEMS

Apply a thin coat of mastic approximately 3 1/2" (90mm) wide over the center of the seam or 1" (25mm) minimum width on each adjacent surface. Embed the 3" (76mm) wide glass fabric in the mastic (see Fig. 5-5A).

Apply a second coat of mastic over the glass fabric, filling the scrim pattern (see Fig. 5-5B).

Follow the mastic manufacturer's label instructions on application rate, safety precautions, shelf life limitations, and minimum set-up time required before stress can be applied to the joint or seam.

Contact mastic manufacturers regarding protection of material during storage, transportation, and installation. Also read and follow instructions on product label.

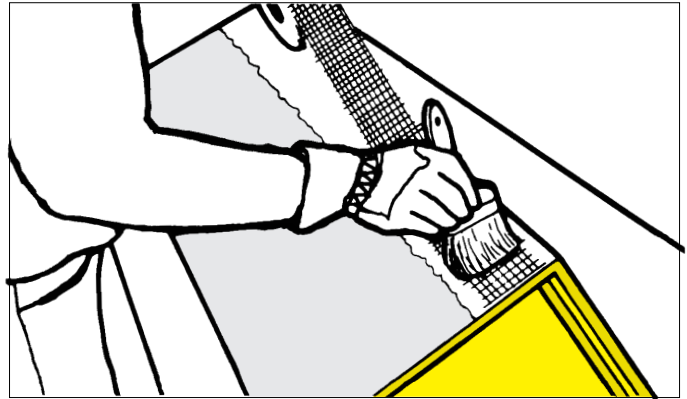


Fig. 5-5A. Apply a thin coat of mastic over the center of the joint seam. Embed glass fabric in mastic.

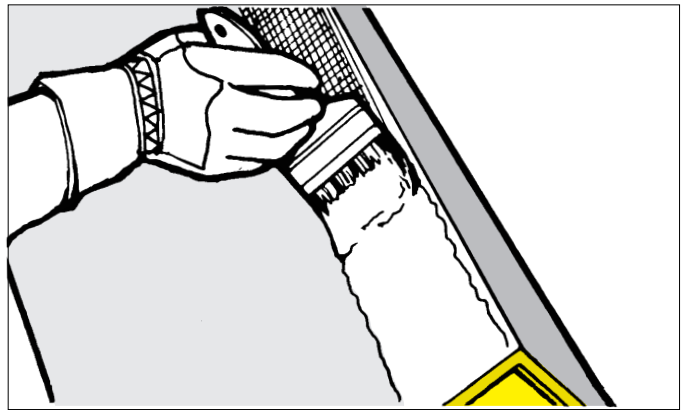


Fig. 5-5B. Apply a second coat of mastic over the glass fabric, filling the scrim pattern.

Glass Fabric and Mastic Over Sheet Metal:

When connecting fibrous glass duct systems to sheet metal, as in connections to flanges of central air equipment, fasteners such as sheet metal screws and washers must be used to carry the mechanical load. Glass fabric and mastic can then be applied to seal the connections at these points. See Fig. 5-5C. Usually, two widths of glass fabric will be required.

See page 3-3 for recommended fibrous glass-to-sheet metal connection details.

NOTE: Either pressure sensitive or heat activated tape tabs may be used in conjunction with glass fabric and mastic closure systems.

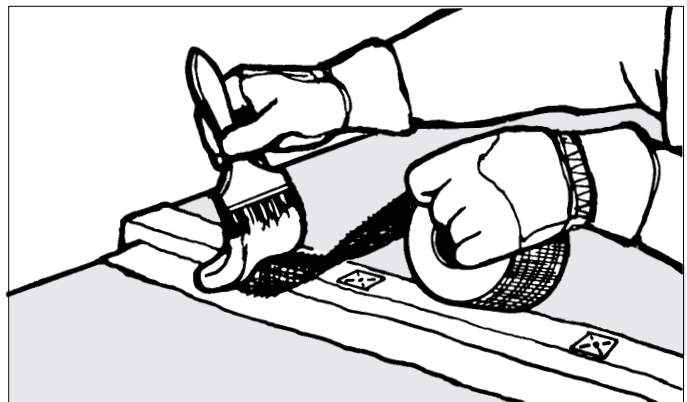


Fig. 5-5C. Glass fabric and mastic are used to seal equipment connections over mechanical fasteners applied to carry the mechanical load.

SECTION VI

HANGERS AND SUPPORTS

SUSPENDING FIBROUS GLASS DUCTWORK

Fibrous glass ducts are light in weight and, to a large degree, self-supporting. They can be supported with a minimum of hangers if care is taken as to placement of hangers and support.

Fibrous glass ductwork up to 42" (1050mm) in width should be suspended by means of one of the two methods shown in Figs. 6-2A and 6-2B. Check local codes to determine whether both straps and wires are acceptable. Hanger spacing should not exceed 6 feet (1.8m) on centers, when duct depth is less than 12" (300mm). Ducts 12" (300mm) and over in depth may be supported with hangers not exceeding 8 feet (2.4m) on centers. For fibrous glass ductwork of larger sizes, refer to NAIMA *Fibrous Glass Duct Construction Standard*.

Additional support must be provided at turns or changes in direction to avoid placing excessive stress on joints.

Restraint of Ductwork in Attics or Unfinished Space:

If fibrous glass ductwork (including distribution boxes in radial systems) will simply rest on joists or rafters in attics or other unfinished spaces, restraints should be provided to prevent the ductwork from being pushed out of place, either during construction or after completion and occupancy.

Hanging and Supporting Fibrous Glass Duct Fittings:

Additional support must be provided for fittings such as tees, elbows, offsets, and transitions to avoid undue stress on taped joints. Additional hangers may also be required to support the weight of equipment such as humidifiers. For further details, refer to NAIMA *Fibrous Glass Duct Construction Standard*.

Hanging Fibrous Glass Duct Systems in Humid Climates:

In high humidity areas, duct systems must be suspended or elevated at least 1" (25mm) above ceiling insulation.

Hanging fibrous glass ducts in crawl spaces:

Spacing at least 1" (25mm) from floor insulation, at least 4" (100mm) ground clearance. Do not install where system may be exposed to flooding.

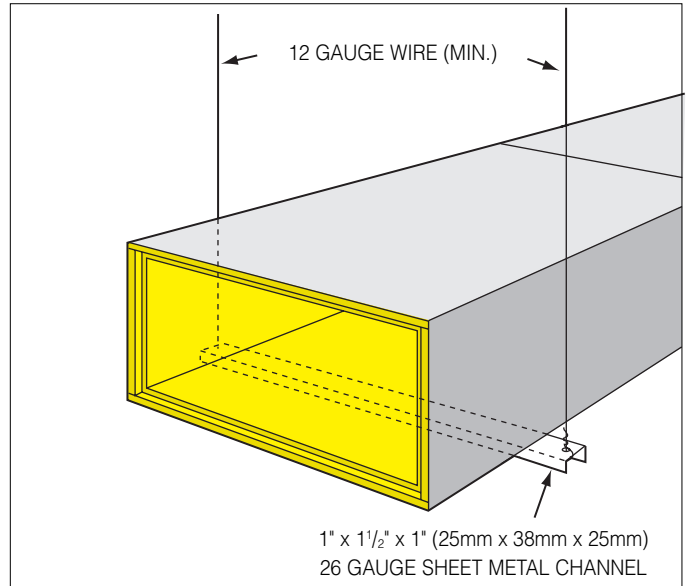


Fig. 6-2A. Suspending fibrous glass ductwork with wires

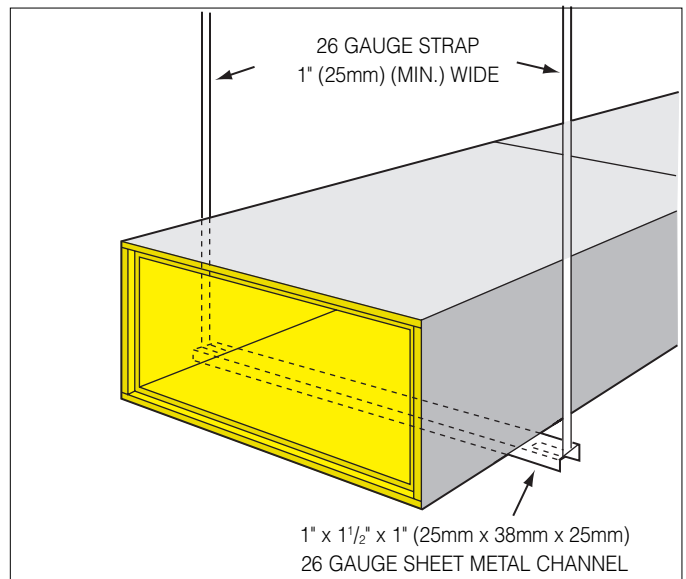


Fig. 6-2B. Suspending fibrous glass ductwork with 1" (25mm) wide strap

Other duct hanging and support systems may work equally well. However, it must be demonstrated that alternate methods can provide the same load-bearing capabilities without undue stress to either the hanger or the fibrous glass ductwork and must meet local codes. Use of alternate methods without careful consideration of the long term stability of the technique is discouraged.

HANGING AND SUPPORTING FLEXIBLE DUCT

Flexible duct shall be supported at manufacturers' recommended intervals but at no greater distance than 5 feet (1.52m) on centers. Maximum permissible sag is 1/2" per foot (42mm per meter) of spacing between supports. See Fig. 6-3A.

Connections to rectangular fibrous glass duct shall be considered a support point. Long horizontal duct runs with sharp bends shall have additional supports before and after the bend approximately one duct diameter from the centerline of the bend.

Hanger or saddle material in contact with the flexible duct shall be of sufficient width to prevent any restriction of the internal diameter of the duct when the weight of the supported section rests on the hanger or saddle material. In no case will the material contacting the flexible duct be less than 1 1/2" (38mm) wide. See Fig. 6-3B.

Support flexible duct between a connection to rectangular ductwork and a bend by allowing the flexible duct to extend straight for a short distance before making the bend. This will avoid possible damage to the flexible duct by the edge of the sheet metal collar. See Fig. 6-3C.

Vertically installed flexible duct shall be stabilized by support straps located 6 feet (1.83m) on centers. See Fig. 6-3D.

NOTE: Fibrous glass ducts, including flexible duct, may not be used for vertical risers in air duct systems serving more than two stories.

NOTE: Information on this page is from *Flexible Duct Performance & Installation Standards*, Air Diffusion Council.

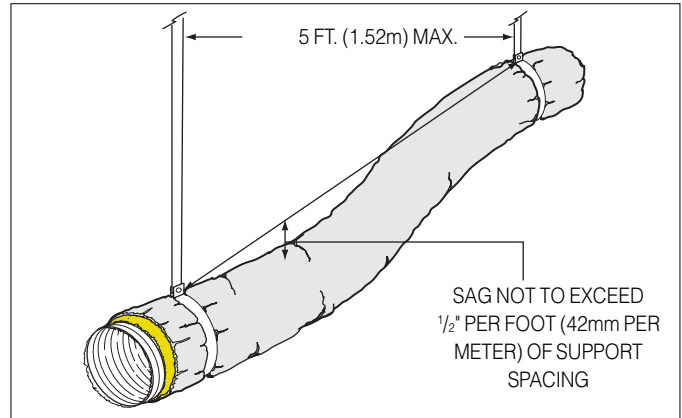


Fig. 6-3A. Support flexible duct every 5 ft (1.52m) (max.). Maximum allowable sag: 1/2" per foot (42mm per meter) of support spacing.

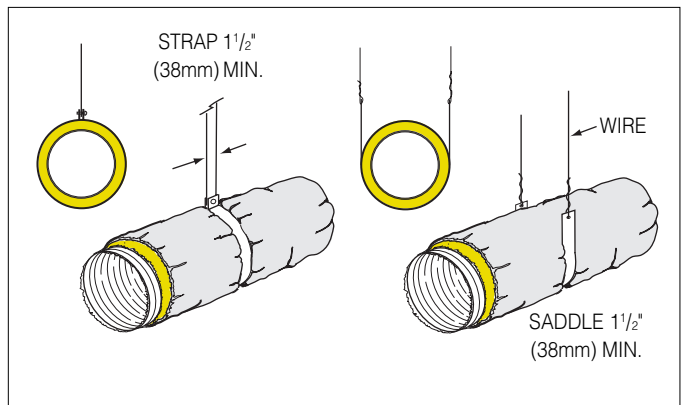


Fig. 6-3B. Hangers or saddle material must be at least 1 1/2" (38mm) wide to prevent restriction of the internal diameter of the flexible duct.

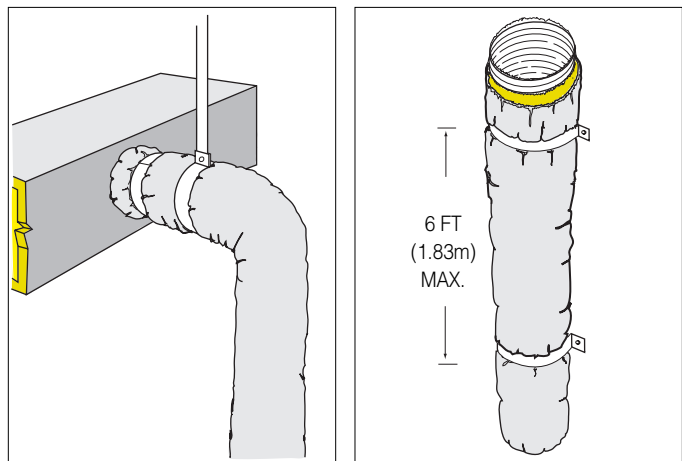


Fig. 6-3C. Support flexible duct between connection to rectangular duct and bend.

Fig. 6-3D. Vertical ducts shall be supported at 6 ft. (1.83m) (max.) intervals.

HANGING TEN SIDED AND ROUND DUCT

Ten sided and preformed round fibrous glass duct should be hung so that the hanger will not damage the duct facing. Straps or saddles in contact with the duct shall be $1\frac{1}{2}$ " (38mm) (minimum) wide. Avoid sharp edges and burrs. Hangers should be spaced on 8 ft. (2.44m) centers (maximum). Where practical, hangers should be located at circumferential joints. Provide hanger support at all fittings.

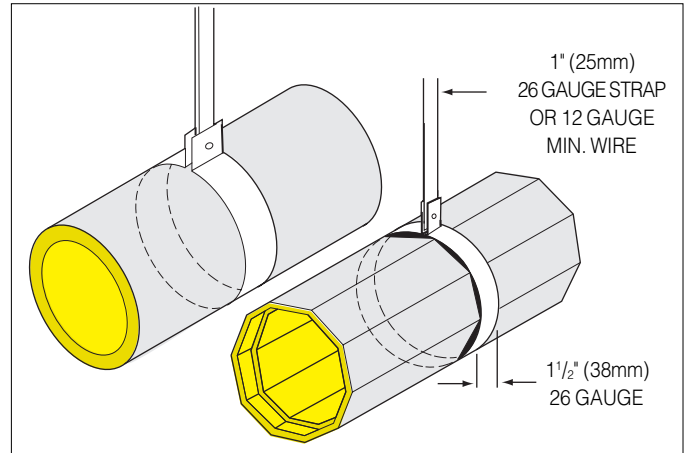


Fig. 6-4A. Single point hanging of ten sided and preformed round fibrous glass duct.

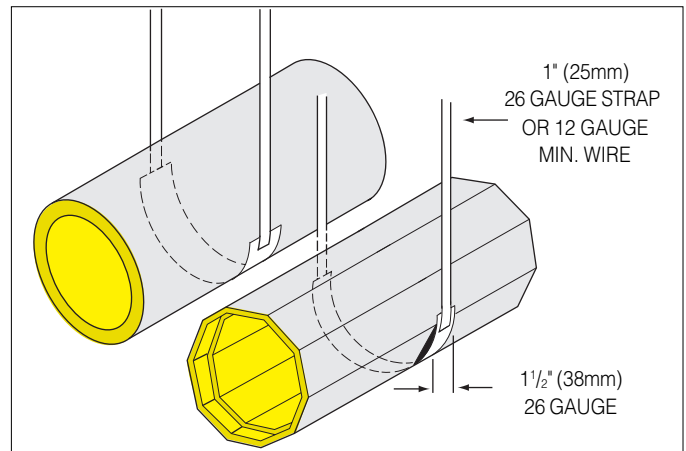


Fig. 6-4B. Hanging ten sided and preformed round fibrous glass duct with saddles and sheet metal straps.

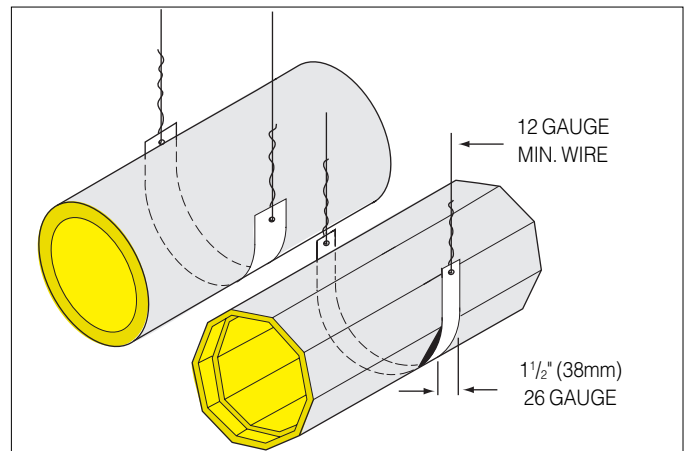


Fig. 6-4C. Hanging ten-sided and preformed round fibrous glass duct with saddles and wire.

SECTION VII

DAMAGE REPAIR

**REPAIR OF SMALL FACING OR CLOSURE TEARS
without loss or damage to insulation**

If facing tear is limited to just a straight slit, apply closure material in accordance with Section V, CLOSURE.

When facing damage is more than just a straight slit but is not greater than 1/2" (15mm) wide, repair as shown in Fig. 7-2A. Closure must extend beyond tear at least 1" (25mm) on all sides of tear.

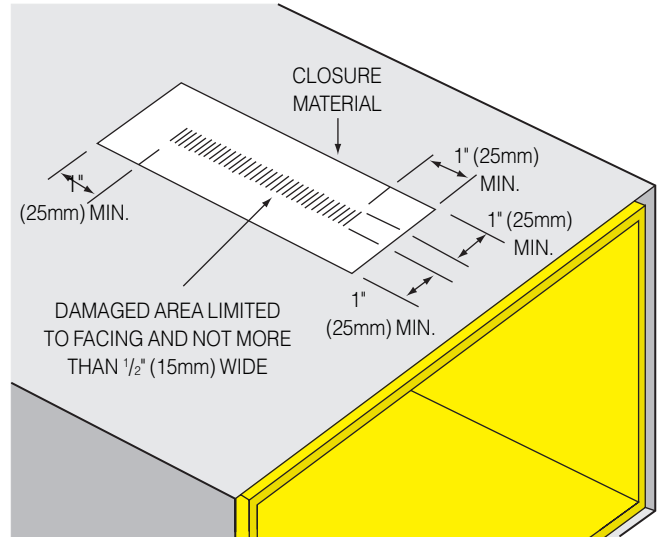


Fig. 7-2A. Repair of minor facing damage - less than 1/2" (15mm) wide.

When facing damage is wider than 1/2" (15mm) wide but less than width of closure material, smooth facing and repair as shown in Fig. 7-2B with double layer of material.

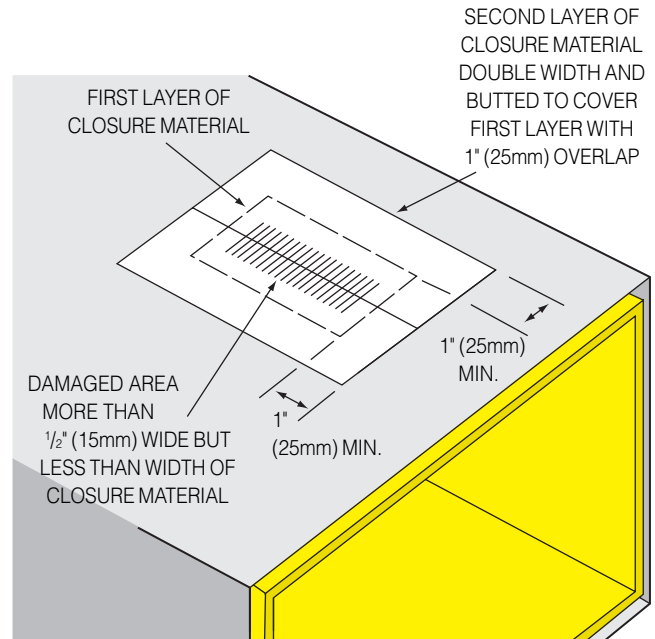


Fig. 7-2B. Repair of minor facing damage - 1/2" (15mm) wide or greater.

NOTES:

1. Use approved closure materials and methods only. Do not use heat activated tape over either pressure sensitive tape or glass fabric and mastic closure systems. See Section V, CLOSURE.

REPAIR OF MAJOR DAMAGE TO ONE PANEL

When damage extends into the insulation and involves loss or severe displacement of material, repair per Fig. 7-3A. Staple and tape plug on all four sides. See Section V, CLOSURE.

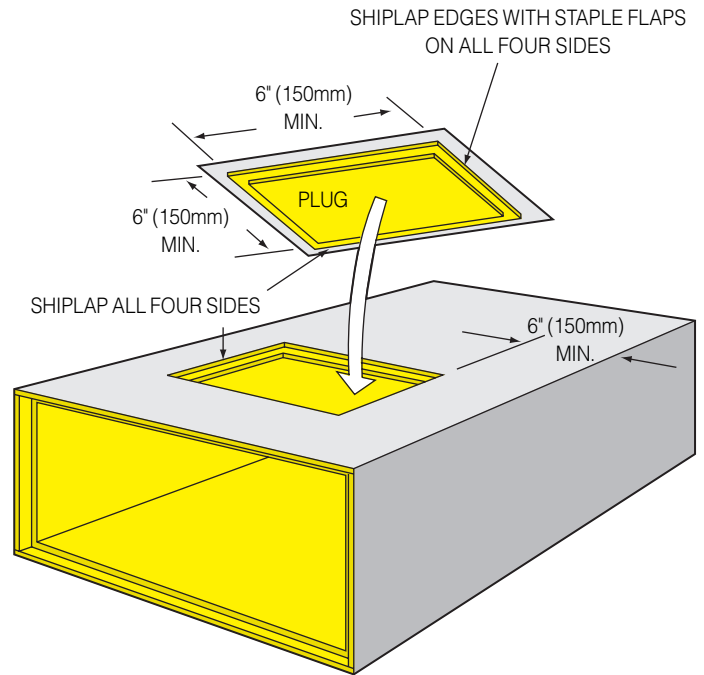


Fig. 7-3A. Repairing major damage to one panel.

If damaged area extends to within 6" (150mm) of edge, cut out and repair entire width of damaged panel per Fig. 7-3B. Staple and tape plug on all four sides. See Section V, CLOSURE.

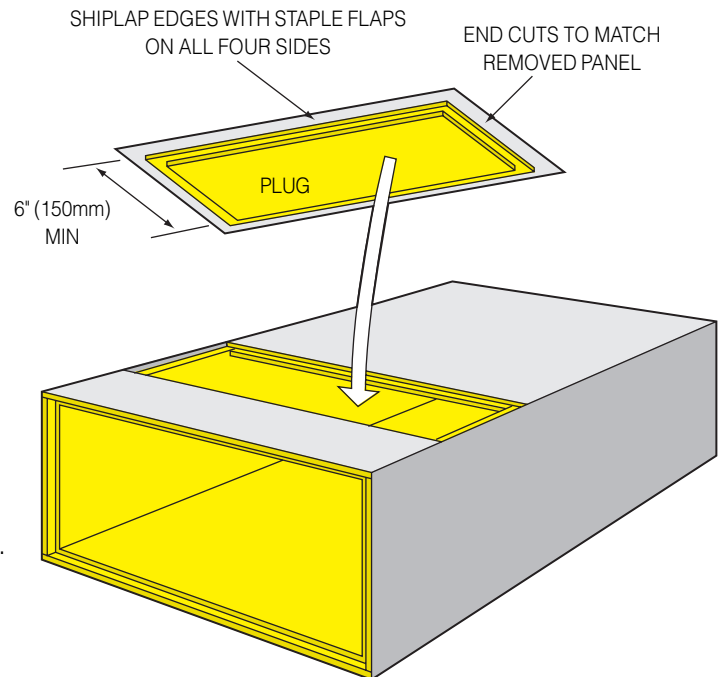


Fig. 7-3B. Repairing major damage involving entire width of panel.

NOTES:

1. Use approved closure materials and methods only. Do not use heat activated tape over either pressure sensitive tape or glass fabric and mastic closure systems. See Section V, CLOSURE.

REPLACING ENTIRE SHIPLAPPED PANEL

When damage to a shiplapped panel is so extensive that the entire panel must be removed, such as impact damage that has cracked or creased the entire panel, repair per Fig. 7-4A.

Fabricate a new panel per U-style method (see Section II) and attach to undamaged sides of duct section using approved closure materials and methods. See Section V, CLOSURE.

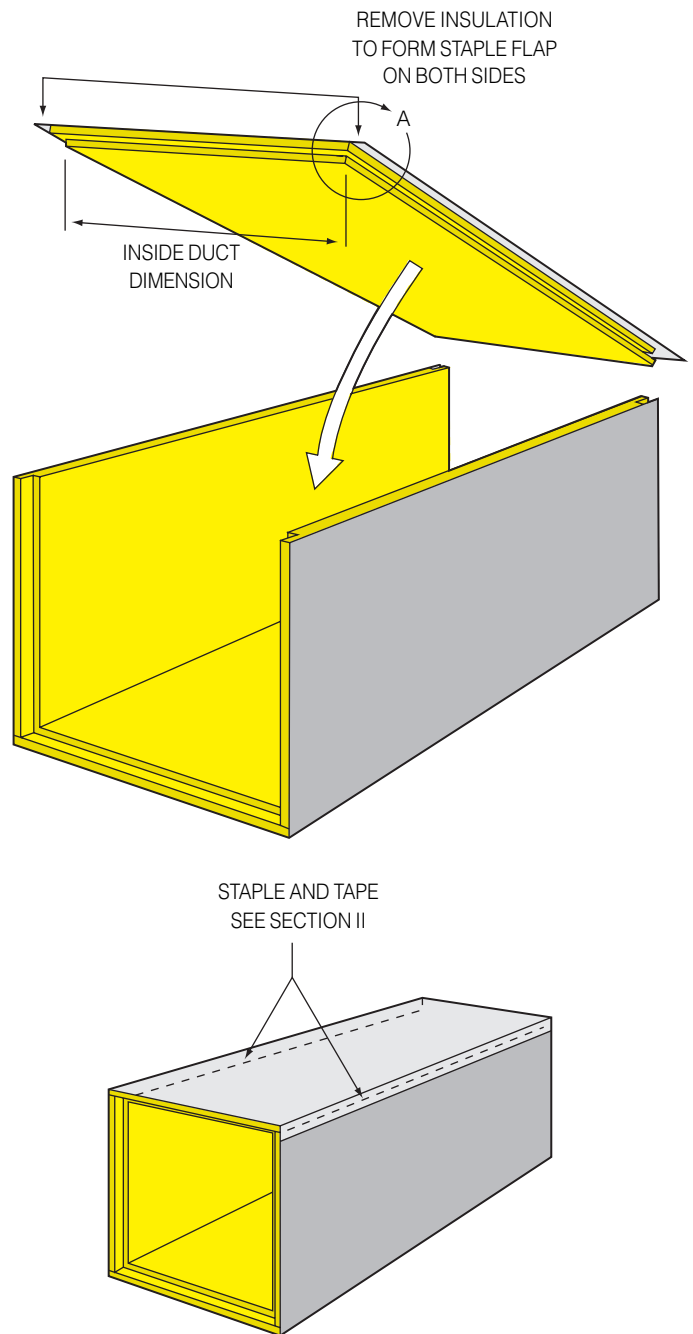
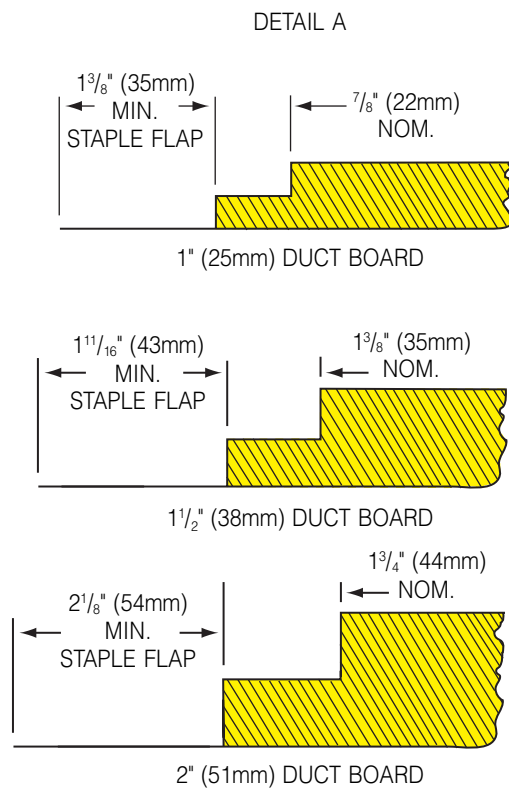


Fig. 7-4A. Replacing shiplapped panel.

NOTES:

1. Use approved closure materials and methods only. Do not use heat activated tape over either pressure sensitive tape or glass fabric and mastic closure systems. See Section V, CLOSURE.

REPLACING ENTIRE SQUARE EDGE PANEL

When damage to a square edge panel is so extensive that the entire panel must be removed, such as impact damage that has cracked or creased the entire panel, repair per Fig. 7-5A.

Fabricate a new panel per U-style method (see Section II) and attach to undamaged sides of duct section using approved closure materials and methods. See Section V, CLOSURE.

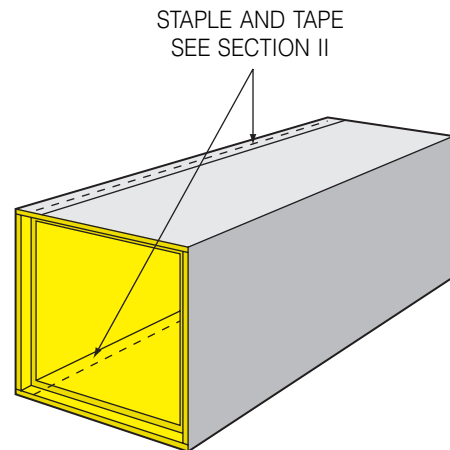
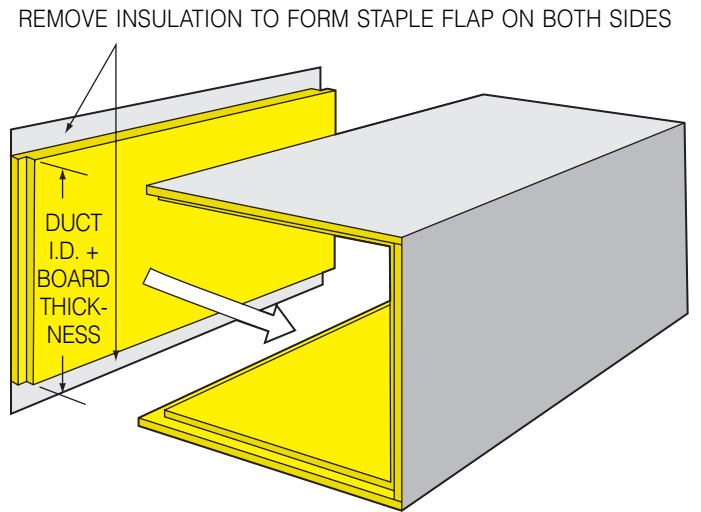


Fig. 7-5A. Replacing square edge panel.

NOTES:

1. Use approved closure materials and methods only. Do not use heat activated tape over either pressure sensitive tape or glass fabric and mastic closure systems. See Section V, CLOSURE.

REFERENCES

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

ACCA - Air Conditioning Contractors of America

1712 New Hampshire Ave. N.W., Washington, DC 20009

- Manual D, Residential Duct System Design
- Manual J, Load Calculation for Residential Winter and Summer Air Conditioning

ADC - Air Diffusion Council

100 E Woodfield Rd., Suite 102, Schaumburg, IL 60173-5921

- 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

- 1999 ASHRAE Handbook - Heating, Ventilating, and Air-Conditioning Applications
- 2000 ASHRAE Handbook - Heating, Ventilating, and Air-Conditioning Systems and Equipment
- 2001 ASHRAE Handbook - Fundamentals
- ASHRAE Standard 62.1-1999, Ventilation for Acceptable Indoor Air Quality
- ASHRAE/IES 90.1-1989, Energy Efficient Design of New Buildings (Except Low Rise Residential Buildings)
- ASHRAE Standard 90.2-2001, Energy Efficient Design of New Low Rise Residential Buildings
- A Practical Guide to Noise and Vibration Control for HVAC Systems: Mark E. Schaffer

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 duct construction standards manual

EPA - Environmental Protection Agency

1200 Pennsylvania Ave., NW., Washington, DC 20460

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

NAIMA - North American Insulation Manufacturers Association

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

- Pub. # AH100, Fibrous Glass HVAC Duct Systems: Proven Performance

- Pub. # AH105, Requirements for listing UL181A Closure Systems
- Pub. # AH109, A comparison of Duct Systems Energy Savings and Acoustical Performance
- Pub. # AH110, An Essential Component of Indoor Environmental Quality ... Fiber Glass HVAC Insulations
- Pub. # AH113, The Facts About Mold Growth
- Pub. # AH114, The Facts About Airborne Fibers
- Pub. # AH116, Fibrous Glass Duct Construction Standard
- Pub. # AH120, Fibrous Glass Duct Construction With 1 1/2" Duct Board
- Pub. # AH121, A Guide to Insulated Air Duct Systems
- Pub. # AH122, Cleaning Fibrous Glass Insulated Duct Systems
- Pub. # AH125, Facts About the Use of Biocides and Encapsulants with Fiber Glass Air Duct Insulations

NFPA - National Fire Protection Association

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

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

SMACNA - Sheet Metal and Air Conditioning Contractors National Association

P.O. Box 221230, Chantilly, VA 22022

- Fibrous Glass Duct Construction Standards, Sixth Edition, 1992
- HVAC Duct Construction Standards - Metal and Flexible, Second Edition, 1995
- HVAC Systems Duct Design, Third Edition, 1990
- Ducted Electric Heater Guide for Air Handling Systems, Second Edition, 1994
- Fire, Smoke & Radiation Damper Guide for HVAC Systems, Fourth Edition, 1992
- Indoor Air Quality Manual, Third Edition, 1998

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

REFERENCES (CONTINUED)**ICC - International Code Council, Inc.**

900 Montclair Rd., Birmingham, AL 35213-1206

- International Mechanical Code, 1998 Edition

NOTE: This code is replacing BOCA, CABO, ICBO, and SBCCI codes, although some jurisdictions may continue to reference some of them.

BOCA - Building Officials and Code Administrators International, Inc.

4051 N. Flossmoor Rd., Country Club Hills, IL 60487-5795

- BOCA National Building Code, 1996 Edition
- For mechanical code, refer to ICC International Mechanical Code

CABO - Council of American Building Officials

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

- CABO One and Two Family Dwelling Code, 1985 Edition, 1997 Amendments
- CABO Model Energy Code, 1995 Edition, 1997 Amendments

ICBO - International Conference of Building Officials

5360 Workman Mill Road, Whittier, CA 90601

- Uniform Building Code, 1997 Edition
- Uniform Mechanical Code, 1997 Edition

SBCCI - Southern Building Code Congress International, Inc.

900 Montclair Rd., Birmingham, AL 35213-1206

- Standard Building Code, 1997 Edition
- Standard Mechanical Code, 1997 Edition

GUIDE SPECIFICATION - THREE PART FORMAT
SECTION 15082
**Fiber Glass Duct Work - Thermal/Acoustical Insulation
 Light Commercial and Residential Building Systems**
PART 1.00 - GENERAL
1.01 Scope

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

1. All air duct systems operating at internal static pressures not exceeding $\pm 1/2$ " w.g. (125 Pa), internal air velocities not exceeding 2,400 fpm (12 m/sec), and internal air temperatures not less than 40°F (4°C) or exceeding 250°F (121°C).

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

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

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

E. When flexible ducts are used as part of the system, installation shall be in accordance with the manufacturer's recommendations and to the requirements of the current edition of the Air Diffusion Council's *Flexible Duct Performance and Installation Standards*.

1.02 Delivery and Storage of Materials

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

B. Use all means necessary at the job site to protect materials from dust, dirt, moisture, and physical abuse before and during installation.

PART 2.00 - PRODUCTS
2.01 Insulated Duct System

A. All rectangular supply ducts, return ducts, and related fittings of 36" (900mm) span or less for 475-EI or 800-EI duct board, or of 42" (1050mm) span or less for 1400-EI duct board, operating at plus or minus $1/2$ " w.g. (125 Pa) shall be fabricated from one of the following:

1. Type 475-EI or Type 800-EI fibrous glass duct board 1" (25mm) thick having an R-value of 4.3 (RSI, 0.76).
2. Type 800-EI fibrous glass duct board $1\frac{1}{2}$ " (38mm) thick having an R-value of 6.5 (RSI, 1.14).
3. Type 800-EI or 1400-EI fibrous glass duct board 2" (51mm) thick having an R-value of 8.7 (RSI, 1.53).
4. Insulated flexible duct of like R-value may be used for run-outs to registers and grilles.

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

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

2.02 Closure Materials
Closure materials shall be one of the following:

A. Pressure sensitive aluminum foil tapes listed under UL 181A, Part I (P) identified by name, date of manufacture, product name/number, and UL 181A/P. The minimum width of pressure sensitive tape for 1" (25mm) duct board is $2\frac{1}{2}$ " (64mm). Three inch (76mm) pressure sensitive tape is recommended for $1\frac{1}{2}$ " (38mm) duct board and required for 2" (51mm) duct board.

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

C. Mastic as listed under UL 181A, Part III (M) and applied in conjunction with 3" (76mm) wide glass fabric tape. This closure system may be used as an alternative to either pressure sensitive or heat activated tapes for all closure applications.

PART 3.00 - EXECUTION

3.01 Inspection

A. Verify that the duct system may be installed in accordance with project drawings, operating performance parameters, limitations, and standards published in NAIMA FGRDCS.

3.02 Fabrication, Straight Duct and Fittings

A. All straight duct sections shall be fabricated in accordance with NAIMA FGRDCS, Section II, using proper machinery and tools.

B. All fittings shall be fabricated in accordance with NAIMA FGRDCS, Section III, using proper machinery, tools and techniques.

C. All fibrous glass duct board distribution boxes shall be fabricated in accordance with NAIMA FGRDCS, Section IV, using proper machinery, tools, and templates.

3.03 Closure

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

B. Flaps on all field joints shall be stapled approximately 2" (50mm) on centers with 1/2" (13mm) (min.) outward clinching galvanized steel staples near the edge of the flap. Staples shall be formed of 0.040" x 0.020" (1.2 x 0.51mm) flat wire and shall have a crown width of 0.400" (10mm) (min.). On fitting joints where stapling flaps cannot be included as part of the construction, tape tabs 8" (200mm) (nom.) in length shall be used. Tabs shall be centered over the joint, a minimum of one tab per duct side and/or 12" (300mm) (nom.) on centers.

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

D. Pressure sensitive tape shall be firmly rubbed in place immediately after application using a squeegee type tool. When the duct surface temperature is below 50°F (10°C), a heat sealing tool shall be used on pressure sensitive tapes to assure bonding. Pressure sensitive tapes may be used to seal to properly cleaned sheet metal.

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

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

3.04 Hanging and Support

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

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

3.05 Accessories

A. Accessory items shall be installed as detailed in NAIMA FGRDCS with adequate support to accommodate additional weight without damage to the duct board.

B. Dampers over 2 sq. ft. (0.2m²) shall be supported by sheet metal sleeves with all moving parts shielded with galvanized sheet metal at abrasion points.

3.06 Inspection

A. Upon completion of installation of the duct system and before operation is to commence, visually inspect the system and verify that it has been correctly installed using the Inspection Check List in NAIMA FGRDCS. Remove any scraps and loose pieces of material from inside the duct system.

B. Open all system dampers and turn on fans to blow all remaining loose material out of the duct system.

C. Check the duct system to ensure that there are no air leaks through joints, or through tears or punctures of the air barrier facing. If tears or punctures are found, repair these using procedures detailed in Section VII, NAIMA FGRDCS.

3.07 Safety Precautions

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

SHORT FORM SPECIFICATION

All supply and return ductwork operating within the range of positive or negative $1/2$ " w.g. (125 Pa) static pressure, 2,400 fpm (12 m/sec) internal air velocity, and 40°F (4°C) to 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, $\text{hr}\cdot\text{ft}^2\cdot\text{°F}/\text{Btu}$, 4.3
(RSI-value at 24°C mean, $\text{m}^2\cdot\text{°C}/\text{W}$, 0.76)
2. $1\frac{1}{2}$ " (38mm) thick
R-value at 75°F mean, $\text{hr}\cdot\text{ft}^2\cdot\text{°F}/\text{Btu}$, 6.5
(RSI-value at 24°C mean, $\text{m}^2\cdot\text{°C}/\text{W}$, 1.14)
3. 2" (51mm) thick
R-value at 75°F mean, $\text{hr}\cdot\text{ft}^2\cdot\text{°F}/\text{Btu}$, 8.7
(RSI value at 24°C mean, $\text{m}^2\cdot\text{°C}/\text{W}$, 1.53)

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

The closure system shall be one of those listed by the duct board manufacturer or meeting the requirements of UL 181A. Application shall comply with procedures specified in the manufacturer's instruction sheets. The minimum width pressure sensitive tape for 1" (25mm) duct board is $2\frac{1}{2}$ " (64mm). Three inch (76mm) tape is recommended for $1\frac{1}{2}$ " (38mm) duct board and required for 2" (51mm) duct board.

Details governing hanging of ducts and the installation of other accessory items shall be in compliance with the latest edition of NAIMA FGRDCS or as specified by the duct board manufacturer.

Thermal performance standards as recommended in National Voluntary Consensus Standard ASHRAE/IES 90.1-2001, *Energy Efficient Design of New Buildings Except Low Rise Residential Buildings* (American Society of Heating, Refrigerating and Air-Conditioning Engineers), are widely accepted by code jurisdictions across the country. For new commercial construction, ASHRAE/IES 90.1 provides minimum thermal resistance (R) standards for ducts, plenums and enclosures. These standards are based on the design temperature differential (TD) between the air in the duct and the duct surfaces in degrees F (C).

ASHRAE/IES 90.1-2001 MINIMUM DUCT INSULATION ^(a)

Duct location	Cooling ^(b)		Heating ^(c)		Insulation R-value ^(d) (RSI-value)
	Annual Cooling Degree Days Base 65°F (18°C)	Insulation R-value ^(d) (RSI-value)	Annual Heating Degree Days Base 65°F (18°C)	Insulation R-value ^(d) (RSI-value)	
BUILDING EXTERIOR					
	Below 500	(Below 278)	3.3 (0.58)	Below 1,500	(Below 833) 3.3 (0.58)
	500 to 1,150	(278 to 638)	5.0 (0.88)	1,500 to 4,500	(833 to 2,500) 5.0 (0.88)
	1,151 to 2,000	(639 to 1,111)	6.5 (1.15)	4,501 to 7,500	(2,501 to 4,167) 6.5 (1.15)
	Above 2,000	(Above 1,111)	8.0 (1.41)	Above 7,500	(Above 4,167) 8.0 (1.41)
INSIDE OF BUILDING ENVELOPE OR IN UNCONDITIONED SPACES ^(g)					
	TD ^(e) < 15°F (TD ^(e) < 8.3°C)		N/R		N/R
	40°F ≥ TD > 15°F (22°C ≥ TD > 8.3°C)		3.3 (0.58)		3.3 (0.58)
	TD > 40°F (TD > 22°C)		5.0 (0.88) ^(f)		5.0 (0.88) ^(f)

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

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

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

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

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

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

(g) Unconditioned spaces include crawl spaces and attics.

ASHRAE Standard 90.2-2001, *Energy Efficient Design of New Low-Rise Residential Buildings*, was developed for residential construction. Its recommended R-values, based on climatic zones, generally call for greater duct insulation thicknesses than those recommended by ASHRAE/IES.

ASHRAE 90.2-2001 MINIMUM DUCT INSULATION

Duct location	Climatic Zone ⁽¹⁾	Insulation levels*, hr•ft ² •°F/Btu (m ² •°C/W)	
		Heating	Mech.Cooling
On roof or building exterior Attic or garage	I, II, III	R-6 (1.06)	R-6 (1.06)
	I	R-4 (0.70)	R-4 (0.70)
	II	R-6 (1.06)	R-6 (1.06)
	III	R-6 (1.06)	R-6 (1.06)
Basement under insulated floor or crawl space	I	R-4 (0.70)	R-2 (0.35)
	II	R-4 (0.70)	R-2 (0.35)
	III	R-6 (1.06)	R-4 (0.70)
Concrete slab or within ground**	See Installation Techniques for Perimeter Heating and Cooling Systems, Manual 4, Air Conditioning Contractors of America (ACCA)		

⁽¹⁾ Climatic zone values:	Heating (Degree Days)	Cooling (Cooling Hours)
Zone I	Below 3,000 (Below 1,667)	Below 15,000 (Below 8,333)
Zone II	3,001-6,000 (1,667-3,333)	15,001-30,000 (8,333-16,667)
Zone III	Over 6,000 (Over 3,333)	Over 30,000 (Over 16,667)

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

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

FACTS ON FIBROUS GLASS DUCT INSULATION

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

One of the world's most useful materials, fiber glass can absorb sound, help control heat flow, diminish impurities from liquids and gases, reinforce other materials and, with a vapor retarder, help control condensation. Fiber glass duct insulation will not support the growth of mold 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 they become available.

Safety of In-Place Duct Products

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

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

- The IPCS Environmental Health Criteria 77 on man-made mineral fibers has concluded: “... it has generally been concluded that the contribution of fibrous glass lined air transmission systems to the fibre content of indoor air is insignificant.”
- Duke University – A 1997 study showed that mold is no more likely to grow on fiber glass than on any other surface in the duct system. Mold grows in the presence of water. By helping to reduce condensation, fiber glass insulated ducts actually help minimize microbial growth.
- University of Nevada Las Vegas – A 1996 study confirmed the results of numerous earlier studies showing that fiber content in the indoor air from fiber glass lined systems is insignificant and does not adversely affect the health of building occupants.

Conclusion

NAIMA members believe fiber glass is safe to manufacture, install and use when recommended work practices are followed. Complete details on work practices and exposure guidelines are contained in NAIMA's Health and Safety Partnership Program and can be obtained in written or video form by contacting NAIMA at the following address:



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Or visit us on the Internet at www.naima.org.

About NAIMA

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

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

For more information, contact:



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