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WASHINGTON, D.C.

FIBROUS GLASS DUCT CONSTRUCTION STANDARDS

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC.

FIBROUS GLASS DUCT CONSTRUCTION STANDARDS

Sixth Edition-1992

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FIBROUS GLASS DUCT CONSTRUCTION STANDARDS

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SPECIAL NOTICES:

1. *Although this 1992 Sixth Edition contains references to and excerpts from the 1985 First Edition of the HVAC Duct Construction Standards, its contents may be coordinated with the 1995 Second Edition of the HVAC DCS.*

2. *The appendix of this reprint contains the 1997 SMACNA contractors' guide to Current Safety and Health Issues in Fiberglass.*

FOREWORD

The sixth edition of this standard reflects significant changes from former editions. SMACNA has discontinued the pressure sensitive tape standards AFTS 100 and 101. Underwriters Laboratories Standard 181A supersedes them. The omission of rigid round duct and ten-sided duct and 1400 EI board construction details is solely due to infrequent use and is not intended to discourage their use.

Many new provisions for fitting reinforcement are included. They, along with other details and the inspection list, are adapted from research and documentation made available from the Thermal Insulation Manufacturers Association (TIMA). After a merger the North American Insulation Manufacturers Association (NAIMA) replaced TIMA. All references to TIMA in this publication shall mean NAIMA. NAIMA currently maintains an office in Alexandria, Virginia. The acronym TIMA is used only because it is more familiar. Differences in this standard and the 1989 TIMA Fibrous Glass Duct Construction Standards are mainly distinguished by TIMA's inclusion of detailed fabrication instructions. Some technical content differences occur out of preference. They should not be construed as disapproval of methodology.

SMACNA gratefully acknowledges the contributions of its own committees, of TIMA, and of those who reviewed drafts of the sixth edition. Former contributors are acknowledged in the appendix.

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REFERENCES

The following should be used as reference material when working with the information contained in this Standard.

ASHRAE Handbook and Product Directory—Fundamentals, Systems and Equipment Volumes
American Society of Heating, Refrigerating and Air-Conditioning Engineers

NFPA Standard 90A—Installation of Air Conditioning and Ventilating Systems

NFPA Standard 90B—Installation of Residence Type Warm Air Heating and Air Conditioning Systems
National Fire Protection Association

Standard for Safety—Factory-Made Air Duct Materials and Air Duct Connectors UL 181
Underwriters' Laboratories, Inc.

Test Methods for Pressure Sensitive Tapes
Pressure Sensitive Tape Council.

HVAC Duct Construction Standards, Metal and Flexible, 1st Edition, 1985—SMACNA

HVAC Air Duct Leakage Test Manual, 1st Edition, 1985—SMACNA

Health and Safety Aspects of Fiber Glass—
Thermal Insulation Manufacturers Association

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MODEL PROJECT SPECIFICATION

Fibrous glass duct shall be of type (475) (800) and shall be of (1″ (25.4 mm)) (1½″ (38.1mm)) thickness conform to the SMACNA Fibrous Glass Duct Construction Standards, 6th Edition, 1992 (FGDS-9) or the TIMA Fibrous Glass Duct Construction Standards, 1st Edition, 1989 (TFGDS-89). The fabricator shall submit for the approval of owner's representative or the approval of local mechanical code official the following:

1. The title of the standard the fabricator chooses to comply with;
2. A list of any deviations from the selected standard and the reason(s) therefor;
3. The name and product rating of manufacturer of the duct board;
4. The type of closures systems selected, along with confirmation that they are acceptable to the board manufacturer and are listed by U.L.
5. A schedule of duct pressure classifications and the air handling systems for which they are selected.
6. The type and spacing interval of supports selected;

Zinc coating weight for all galvanized steel sheet shall be (G 60) (G 90).

Notice to Specifiers: The separate SMACNA and TIMA standards were produced with different objectives. Although much of the construction detail is similar in the two manuals, there are significant differences. In some instances SMACNA has featured only methods that contractors would consider to be the most economical. In others a conservative approach was taken to limit the number of alternatives in order to have fewer nuances to be concerned with. Otherwise, having other qualified training resources precludes the need for comprehensive fabrication instructions. Discrediting the TIMA approach to the scope of standards was not an objective. For fabrication with type 1400 board, see TIMA standards noted above.

CHAPTER 1

PERFORMANCE CRITERIA

FIBROUS GLASS DUCT CHARACTERISTICS AND LIMITATIONS

1. Flexural Rigidity (EI)

Average in the board, not less than rating of 475,800 or 1400 lb./sq. in. per inch of width when tested in accordance with TIMA Test Method HS-100-74. Consult TIMA or board manufacturers for 1400 EI board construction schedules; they are not in this edition due to infreqent use.

2. Maximum static pressure in duct

2″ W. G. (498 Pa), positive or negative

3. Maximum air velocity in duct

2,400 feet per minute (13.92 m/s)

4. Maximum allowable deflection

Duct width/100 (for rectangular duct wall).

5. Maximum allowable stress in steel members used for reinforcement or support

22,000 pounds per square inch (152 MPa) with 30,000 psi (207 MPa) yield strength minimum.

6. Board fatigue

No significant deformation or deficiency of duct sections after 50,000 cycles at 3 to 4 cycles per minute from natural sag to 1½ times operating pressure.

7. Moisture adsorption

Moisture adsorption of the board will not exceed 5% by weight under conditions of 120 deg. F. (49 deg. C) dry bulb at 95% R.H. for 96 hours duration, when tested in accordance with ASTM C 553.

8. Temperature

250 deg. F (121 deg. C.) maximum inside the duct, continuous operation. 150 deg. F. (66 deg. C.) maximum duct surface temperature.

9. Corrosiveness

Non-corrosiveness on 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.

10. Closure

Closure conforms to: Underwriters' Standard UL 181, (or UL 181A) installed in accordance with the manufacturer's Class 1 Air Duct listing.

11. Safety Standards

NFPA Standard 90A, 90B

12. Reinforcement testing

Test programs have demonstrated that fibrous glass duct systems, including fittings such as offsets, tees, elbows, branches, transitions, and accessory items are capable of maintaining their structural integrity through 50,000 cycles at one and one half times system design pressurization. While this testing demonstrates the reliability of properly constructed systems, it does not imply that systems should be operated at pressures above their reinforcement rating.

13. Restrictions

Fibrous glass duct systems should not be used in the following applications:

- **a.** Kitchen exhaust or fume exhaust ducts, or to convey solids or corrosive gases.
- **b.** Installation in concrete or buried below grade.
- **c.** Outdoors
- **d.** As casings and/or housings of built-up equipment.
- **e.** Immediately adjacent to high temperature electric heating coils without radiation protection. Refer to NFPA Standard 90A.
- **f.** In more than two stories of riser.
- **g.** With equipment of any type which does not include automatic maximum temperature controls.
- **h.** With coal or wood fueled equipment.
- **i.** Where normal operating pressure or occasional over pressure would exceed product rating.

j. As penetrations in construction where fire dampers are required.

k. Where moisture would collect in the duct.

l. Where clean room condition is needed in the duct.

m. Where condensation would occur on the duct exterior, unless the duct exterior was a vapor barrier (impermeable).

14. Mounting of accessories

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

15. Class 1 Air Duct Rating

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

a. They shall be constructed of Class 1 duct materials as tested in accordance with Underwriters' Laboratories Standard for Factory-Made Duct Materials and Air Duct Connectors, UL 181.

b. Such ducts shall be installed in accordance with conditions of their listing.

c. They may not be used in air duct systems which operate continuously with an air temperature higher than 250 deg. F. (121 deg. C.) entering the ducts. (Test data on Class 1 rigid ducts exposed to 350 deg. F. (177 deg. C.) for 24 hours show no visible deterioration).

d. They shall not be used as vertical risers of more than two stories.

e. They may be directly attached to listed heating and cooling equipment designed to operate at temperatures not exceeding 250 deg. F. (121 deg. C.).

f. Under UL Standard 181 Class 1 air duct materials have Flame Spread rating not exceeding 25 without evidence of continued progressive combustion and a Smoke Developed rating not exceeding 50. Furthermore, the following portions of UL 181 are applicable to rigid fibrous glass ducts in new material condition:

(1) Fire hazard classification
(2) Flame penetration
(3) Burning
(4) Temperature
(5) Puncture
(6) Static load
(7) Impact
(8) Erosion
(9) Pressure and collapse
(10) Leakage
(11) Corrosion, mold growth and humidity.

Pressure sensitive tapes that pass UL Standard 181A tests are imprinted with the producers name (or symbol), date of manufacture, product code and the wording "UL Listed 181A-P". Heat activated tapes, coded 181A-H, have similar imprinting.

16. Use in Medical Facilities

The United States Department of Health, Education and Welfare requirements for construction of hospitals and medical facilities (including outpatient surgical facilities) prohibit use of duct linings in systems supplying operating rooms, nurseries, isolation rooms and intensive care units unless terminal filters of at least 90% efficiency are installed downstream of linings.

17. Other Performance Characteristics

Consult design handbooks and board manufacturers for friction loss coefficients and thermal and acoustical performance. Duct leakage is not expected to exceed SMACNA Class 6. The applicable rates in CFM per 100 S.F. of duct surface area at various inches water gage static pressure levels are: 2.4 @ 0.25″; 3.8 @ 0.5″; 5.0 @ 0.75″; 6.0 @ 1.0″; 7.8 @ 1.5″ and 9.4 @ 2.0″.

CFM per 100 S.F.	2.4	3.8	5.0	6.0	7.8	9.4
l/s per 10 S.M.	1.2	1.9	2.5	3.0	3.9	4.7

IN. W.G.	0.25	0.5	0.75	1.0	1.5	2.0
Pa	62	125	187	249	374	498

CHAPTER 2

SPECIFICATIONS AND CLOSURE

GENERAL SPECIFICATION REQUIREMENTS

2.0 All ducts required to meet Class 1 Air Duct rating shall comply with Underwriters Laboratories (U.L.) Standard 181. All closure systems shall meet U.L. 181 or U.L. 181A. Pressure sensitive tapes shall be, imprinted with the coding 181 A-P, the manufacturers name and a date code. Heat-sealable tape shall have similar imprinting but carry the coding 181A-H.

2.1 All fibrous glass duct shall be of (475) (800) E I flexural rigidity rating as determined by TIMA Test Number AHS-100 and shall be constructed so that the duct wall deflection does not exceed one one-hundredth of the span when pressurized at or below the rated pressure classification. The EI rating shall be imprinted on the facing.

2.2 Construction detail not otherwise required to conform to a condition of listing or a superimposed requirement in these standards shall conform to the recommendations of the board manufacturer.

2.3 Sheet metal items shall be fabricated as specified in the HVAC Duct Construction Standards, Metal and Flexible 1985 Edition, (hereinafter referred to as the HVAC-DCS) except as necessarily altered for incorporation in fibrous glass duct. Metal items shall be installed in a manner that does not cut or damage the duct surface. Metal sleeves and collars of undesignated thickness shall be of duct wall gauge prescribed in the HVAC-DCS.

2.4 All fastenings not otherwise identified shall be #10 sheet metal screws with 2½″ (63.5 mm) square washers 0.020″ (0.51 mm) minimum thickness. All screws penetrating duct board shall be ½″ (12.7 mm) longer than board thickness. Washers shall be used under screw heads wherever the head does not rest on channel, sleeve or other metal bearings and shall be used as retainers on duct interiors wherever metal sleeves, equipment flanges, vane rails or other suitable retainers are not present.

2.5 All horizontal branches and runouts to air terminals shall be supported independent of the main duct.

2.6 Extractor installations, if required by the designer's contract drawings, shall not be installed without metal sleeves on the duct interior.

2.7 Metal dovetail tabs that have less than ¾″ (19.1 mm) length on duct interiors shall have 22 gauge (0.8534 mm) 3″ (76.2 mm) wide bearing plates between the tabs and the duct wall.

2.8 Provision shall be made for locking dampers in position after flow adjustment. Quadrant damper operators shall not be used for controls without metal mounting plates to prevent damage or erosion.

2.9 All 90 degree square throat, square heel elbows other than those in transfer air ducts shall be vaned. Elbows with molded fibrous glass vanes must have tie rod or channel reinforcement on cheeks to prevent wall deflection.

2.10 Grille clips shall not be used for attachment or support of air terminals.

2.12 Metal turning vane and runner assemblies shall be fabricated in accordance with the 1985 HVAC-DCS requirements. Runners shall be fastened, two minimum, to the duct wall at 12″ (305 mm) maximum intervals.

2.13 Metal access doors shall conform to the construction detail in the 1985 HVAC-DCS. Frames to receive the doors shall conform to these standards.

2.14 Access doors shall be located at least 4″ (102 mm) from the end of duct joints and connections.

2.15 Ducts shall be made as indicated in these standards. They shall be secured and reinforced as specified.

2.16 All heat seal tape shall be 3″ (76.2 mm) wide minimum. All pressure sensitive tape shall be 2½″ (63.5 mm) minimum width.

2.17 Tapes shall be adhered to at least a 1″ (25.4 mm) wide strip of each contact surface being closed. The application of tape over staples shall not result in staples puncturing the tape. Crumpled staples should be recovered and replaced with good staples prior to application of closure tape.

2.18 Staple spacing is indicated to be 2″ (50.8 mm); a tolerance of plus 2″ is permitted provided that the maximum distance across any 3 staples in series is 6″ (152 mm).

2.19 The depth and thickness of shiplaps and all other grooving shall be that appropriate for the specific board thickness of 1″ (25.4 mm) or 1½″ (38.1 mm).

2.20 Shiplaps may be premolded by the duct board manufacturer or be shop made. Damaged shiplaps shall be removed properly relaced prior to assembly of joints or seams.

2.21 Shiplap joints, except at tee or branch connections, shall be oriented so that air flow direction is from the male end to the female end.

2.22 All fibrous glass duct branches that connect to mains shall use male shiplap ends on the branch at the connection or they shall have 3″ (76.2 mm) × 3″ (76.2 mm) × 22 gauge (0.8534 mm) metal angle brackets on the duct interior held in place with screws and washers, angles or channels on the exterior. Openings in mains and submains that do not have internal metal brackets shall have female shiplap forming to receive male ship. Exception: a 45 degree sloped entry should be straight cut beveled at 45 degrees.

2.23 On horizontal duct walls of less than 48″ (1.22 m) width channel reinforcement extending completely around and contacting all the duct perimeter does not require attachment to the duct on positive pressure application. For 48″ (1.22 m) or more width in top horizontal position the channel must be fastened to the duct with a screw and washer to control sag.

2.24 All straight duct sections and all direction change and size change fittings in positive pressure systems shall be reinforced as required herein by channel or tie rod method. Only channel reinforcement for negative pressure straight duct sections is provided in this standard.

2.25 Illustrations of tie rod end fastenings on isometric drawings are not intended to restrict alternatives to the style shown unless the associated text limits the style.

2.26 Channel reinforcements may run in either direction across end caps as is necessary to comply with the reinforcement interval and to limit end panel deflection to 1/100 of the greater span.

2.27 Tie rod reinforcements shall not be used where they will be subject to fan vibration.

2.28 The 16″ (0.41 m) nominal spacing of tie rods is subject to a 2″ (50.8 mm) tolerance on occasional rod location deviation. No row of tie rods is allowed on 18″ (0.46 m) spacing.

2.29 Only volcano hole washers are permitted with loop terminated tie rods. Flat types may be used under the heads of metal screws and cap or rivet termination techniques.

2.30 Riser length shall not be more than two story heights.

2.31 Flexible ducts and flexible connectors shall be of the type and ratings set forth by the designer. Where the manufacturer or a testing and listing authority does not prescribe otherwise they shall be connected and supported as required by the HVAC-DCS.

2.32 Installed ducts must be free of visible damage, debris, moisture, sag and significant misalignment.

2.33 Joints without staple flaps are permitted only on gored elbows and offsets.

2.34 The omission of reinforcements and complete closure details in drawings herein that are illustrating particular features shall not be used as grounds for omitting requirements that are elsewhere and otherwise specified. Some fittings may require reinforcement even though schedules for straight ducts of the same span may show reinforcement is not required.

NOTICE Although molded round fibrous glass ducts and ten-sided ducts are not covered in this set of standards, such exclusion is not intended to discourage consideration of their use based on TIMA recommendations and conditions of listing or classifying by a testing authority.

CLOSURES

GENERAL

Closures 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 181 or UL 181A are suitable for use with rigid fibrous glass duct systems. Listed closures include:

1. Pressure-sensitive aluminum foil tapes.
2. Heat activated aluminum foil/scrim tapes.
3. Mastic and glass fabric tape system (GFM).

Model codes and project specifications require that nonmetallic duct construction, which includes fibrous glass ducts, conform to UL 81, Class 1 requirements. Under UL 181A listing procedures, an individual closure system may be qualified for use on all manufacturers' boards which meet the UL 181 requirement. UL 181A tapes are imprinted for identification.

JOINT AND SEAM PREPARATION

Longitudinal seams are prepared as described in Figure 2-3. Transverse joints between two duct sections are prepared by joining two duct sections, pulling the staple flap over the adjoining section and stapling as shown in the illustrations.

SEAMS AND JOINTS WITHOUT STAPLE FLAPS

When staple flaps are not present, cross tabs are used to hold seams and joints in position prior to application of the closure system. Cross tabs, made from 8″ minimum lengths of closure tape, are to be equally spaced on each side of the joint and on 12″ (maximum) centers with at least one cross tab per duct side (Fig. 2-2). Cross tabs may be placed either under or over the closure tape.

SURFACE PREPARATION

In order to obtain satisfactory adhesion and bonding, the 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 would be sufficient. However, for the 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.

NOTES

1. Manufacturers closure application instructions must be followed.
2. Heat activated tapes have color change dots to indicate satisfactory bond.
3. Glass fabric closure requires mastic application before and after fabric placement and has a prescribed set up time.
4. See mechanical reinforcement requirements at seams and joints in the reinforcement provisions.

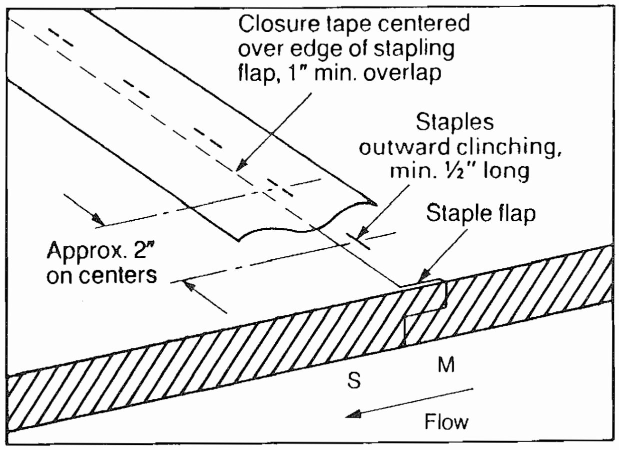


Figure 2-1 TAPE CLOSURE JOINT, WITH STAPLE FLAP

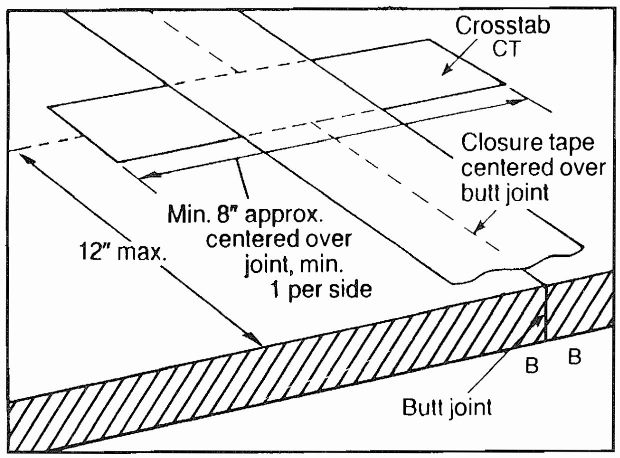


Figure 2-2 TAPE CLOSURE JOINT, WITHOUT STAPLE FLAP

IN	½	1	2	8	12
MM	12.7	25.4	51	203	305

CLOSURES *(Continued)*

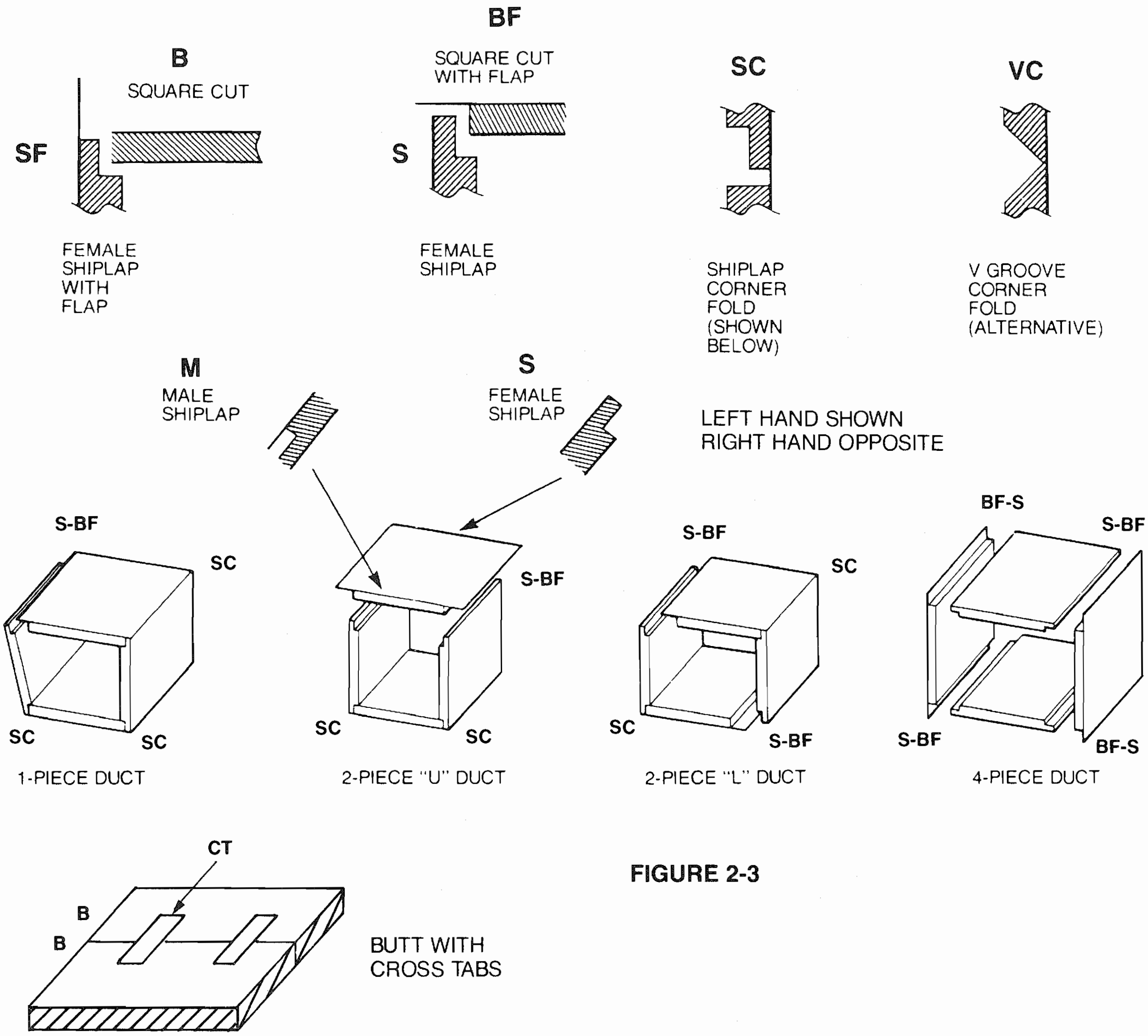


FIGURE 2-3

NOTES

1. Corner seams are closed with ½″ (12.7 mm) minimum outward clinching staples approximately 2″ (50.8 mm) o.c.
2. With machine applied heat-sealable tape staples may be omitted.
3. Tape is centered over the edge of the flap so that a minimum of 1″ (25.4 mm) overlap occurs on adjacent surfaces.
4. Tape must be essentially free of wrinkles, uniformly adhered, free of staple punctures and pressed sufficiently to show duct facing reinforcement impressions in the tape.
5. Assembly of corners with two square cut butt edges is not permitted.
6. Cross tabs are 8″ (203 mm) long tape strips 12″ (305 mm) o.c. maximum: not fewer than one shall be used. They may go on before or after the closure tape.

ONE WAY TRANSITION, CHANGING HEIGHT

$Y = H_1 - H_2$

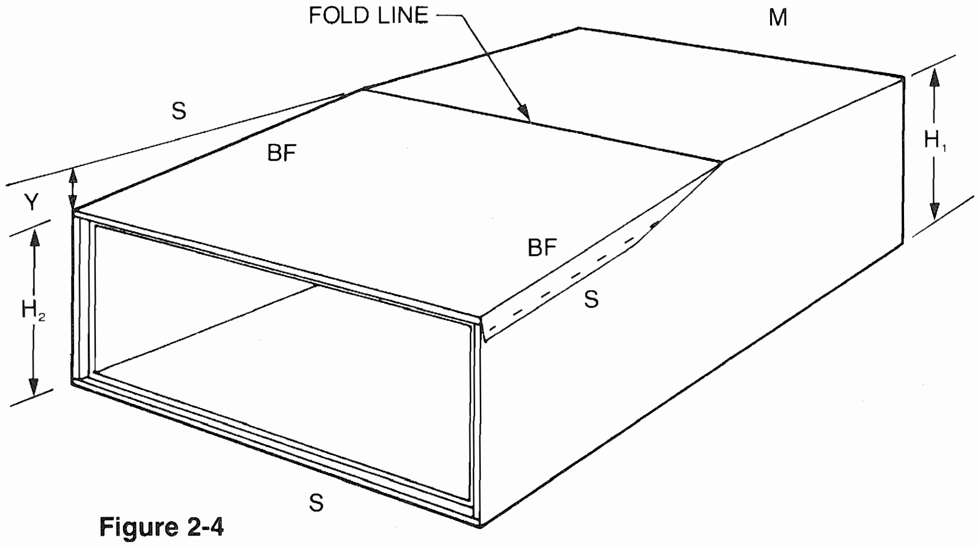


Figure 2-4

NOTE
Maximum Slope: for expanding flow 22½ degrees; for contracting flow 30 degrees.

ONE-WAY TRANSITION, CHANGING WIDTH

X = Dimension change

$W_2 = W_1 - X$

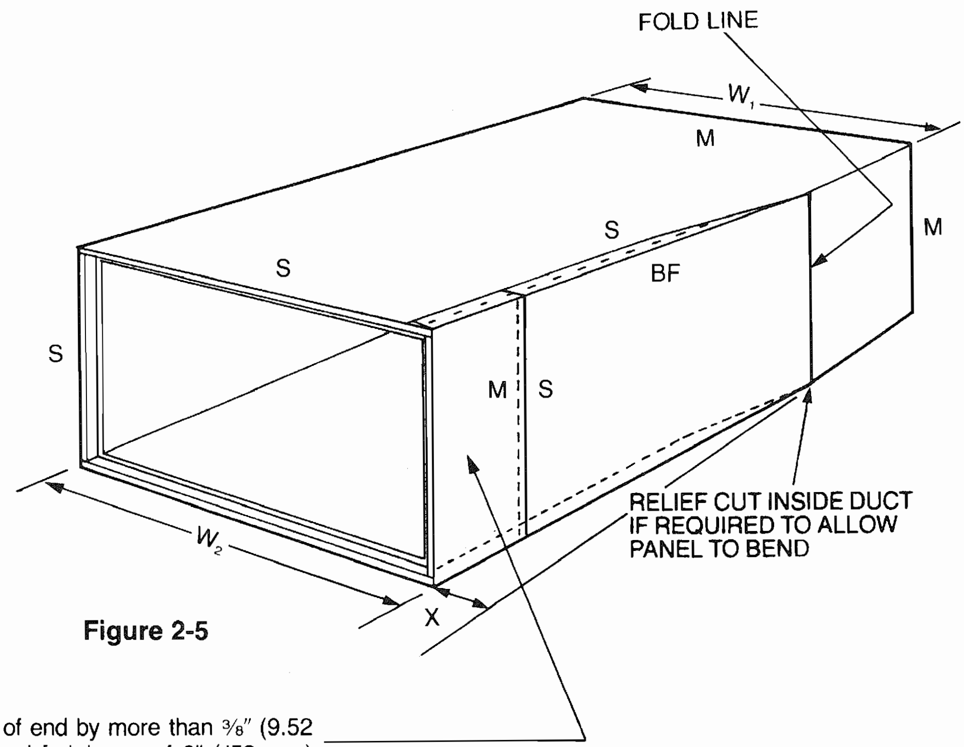


Figure 2-5

NOTE
If the sloping panel is short of end by more than ⅜″ (9.52 mm), a shiplapped filler panel [minimum of 6″ (152 mm) long] is used at either end of sloped panel or the slope is equally divided on two opposite sides to meet the ⅜″ (9.52 mm) limit.

NOTE: SEE COMPLETE CLOSURE SPECIFICATIONS

TWO WAY TRANSITION, CHANGING WIDTH AND DEPTH

$W_2 = W_1 - 2X$

$H_2 = H_1 - Y$

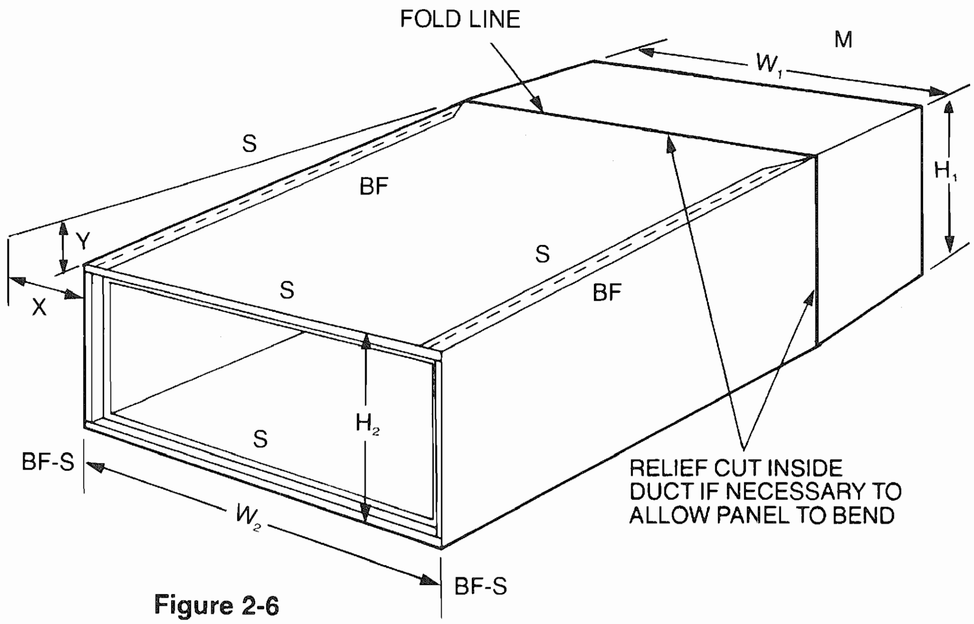


Figure 2-6

NOTES

1. Maximum Slope: for expanding flow 22½ degrees; for contracting flow 30 degrees.
2. If sloping panel is short of end by more than ⅜″ (9.52 mm) a shiplapped filler panel [minimum 6″ (152 mm) long] is used at either end of sloping panel, or the slope is equally divided on two opposite sides to meet a ⅜″ (9.52 mm) limit.

TWO WAY TRANSITION, ALTERNATE

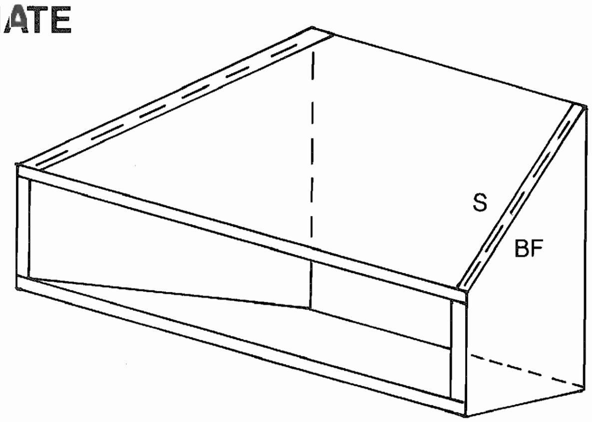


Figure 2-6A

NOTE: SEE COMPLETE CLOSURE SPECIFICATIONS

MULTIGORE ELBOW

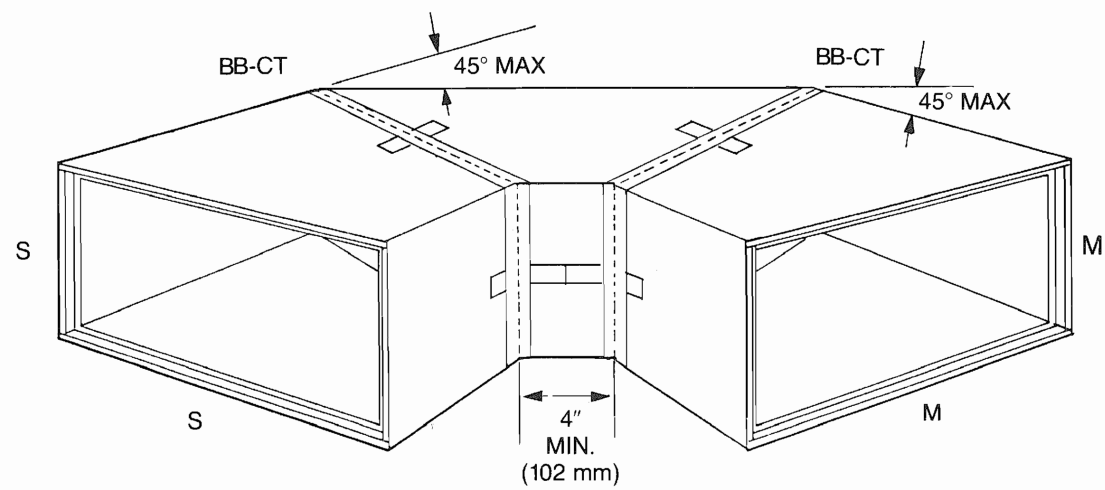


Figure 2-7

ELBOWS OF LESS THAN 45 DEGREES

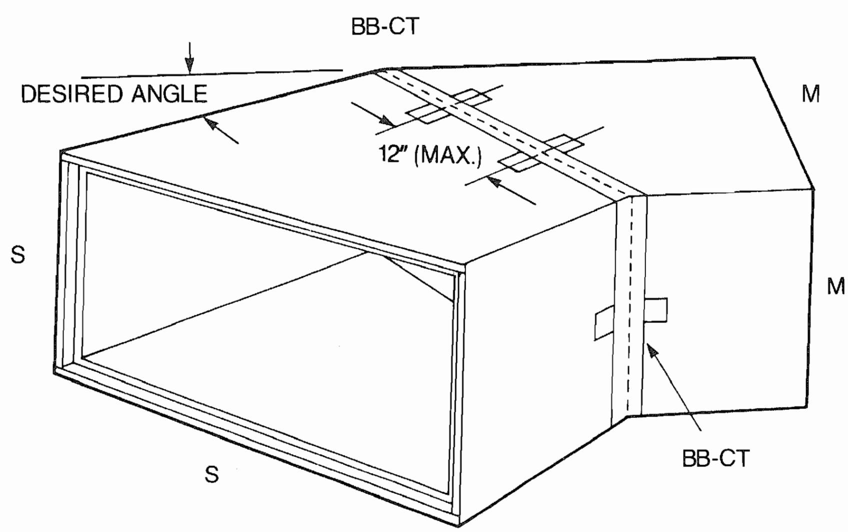
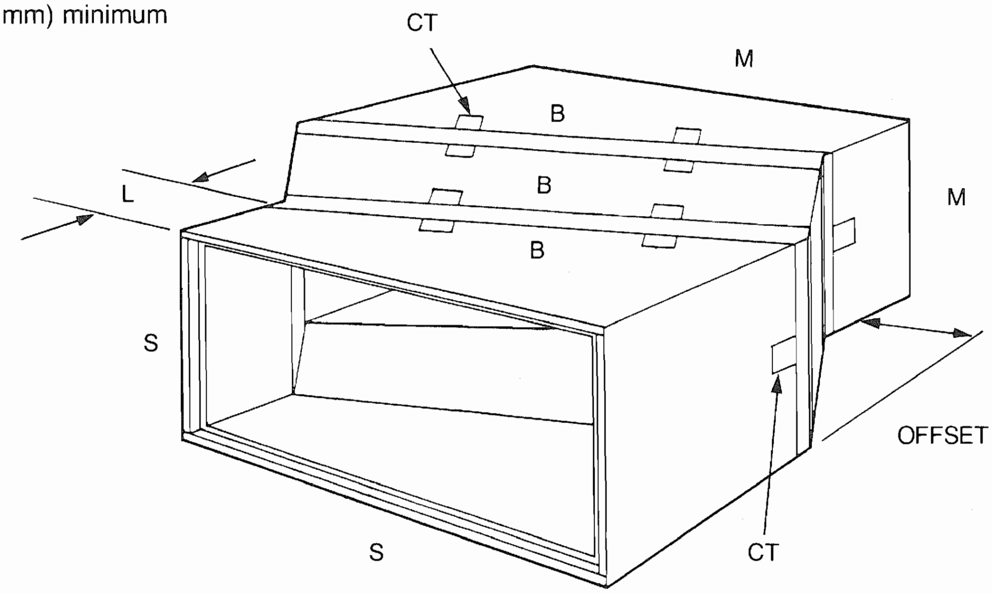


Figure 2-8

NOTE: SEE COMPLETE CLOSURE SPECIFICATIONS

OFFSET

L = 4″ (102 mm) minimum

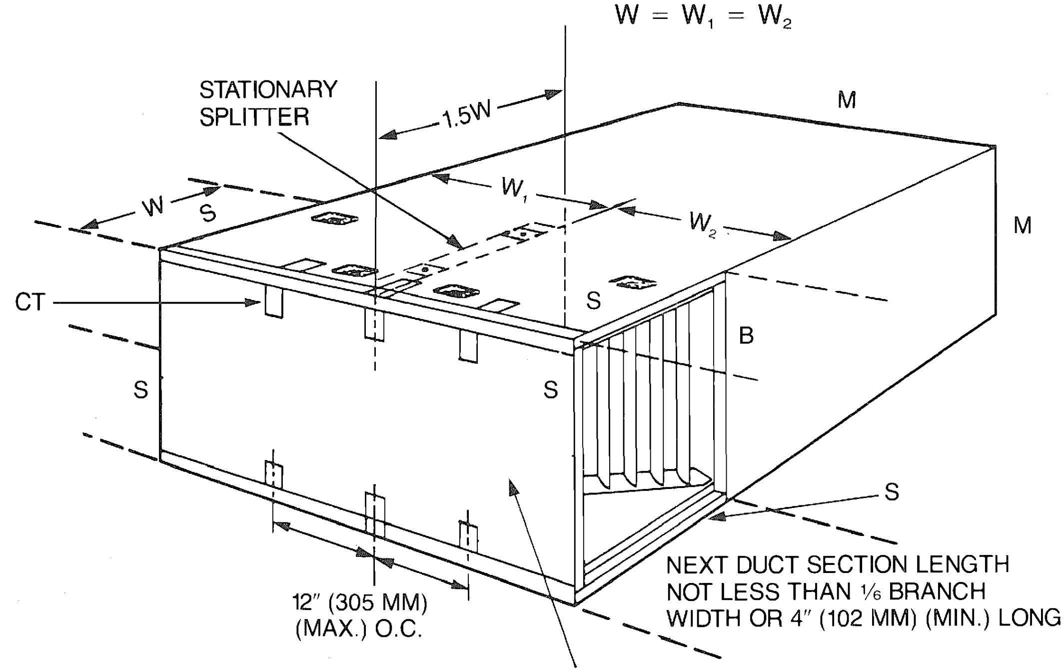


NOTE
Slope of offset is 30 degrees maximum.

Figure 2-9

NOTE: SEE COMPLETE CLOSURE SPECIFICATIONS

TEE WITH EQUAL LEGS AND SPLITTER



NOTE

Reinforcement, two sets of vanes are used in this type of tee.

Figure 2-10

NOTE

Stationary metal splitters for both figures have hemmed leading edges and 1½″ (38 mm) min. Flanges fastened with two screws and washers each side, minimum.

BRANCH TAKE-OFF WITH SPLITTER

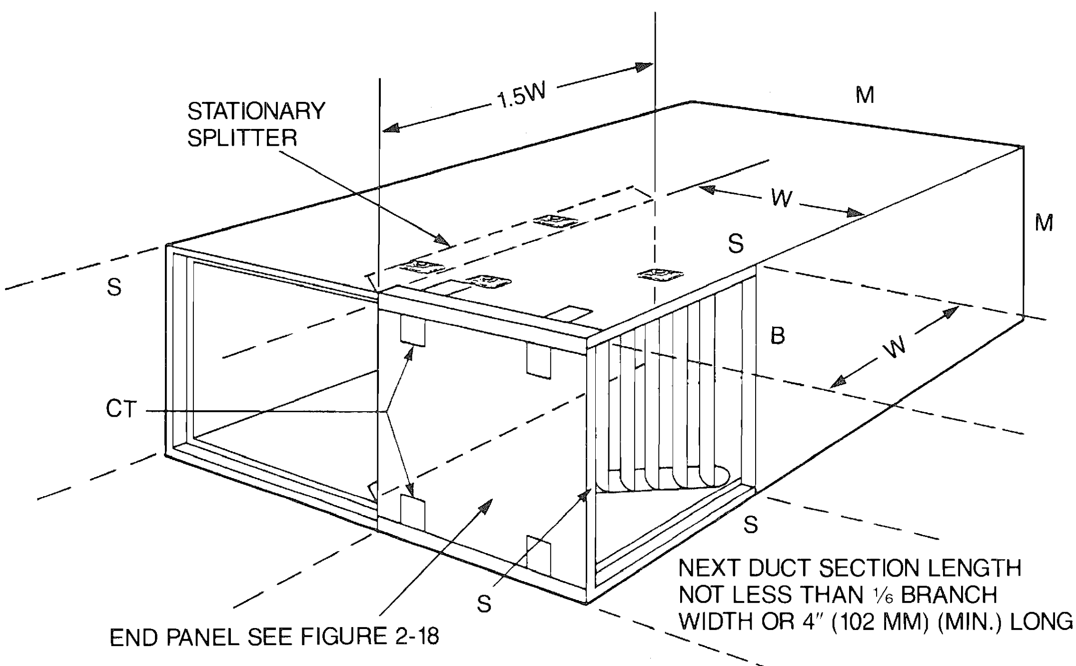


Figure 2-11

NOTE: SEE COMPLETE CLOSURE SPECIFICATIONS

90 DEGREE ELBOW WITH SHEET METAL TURNING VANES

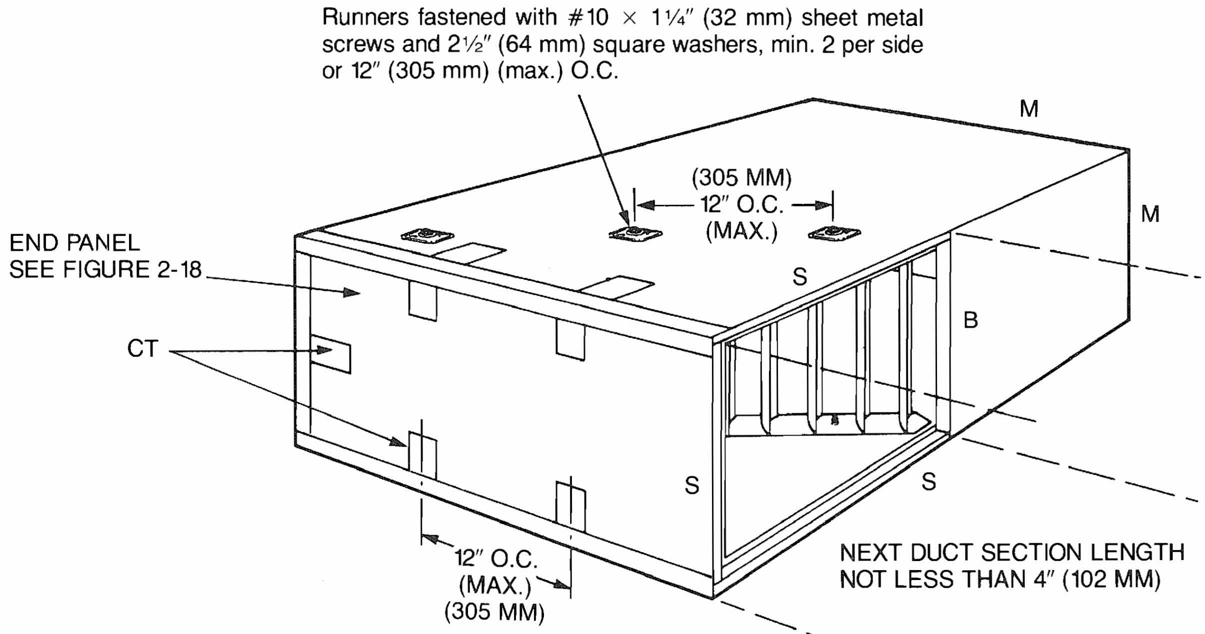


Figure 2-12

90 DEGREE ELBOW WITH FIBROUS GLASS TURNING VANES

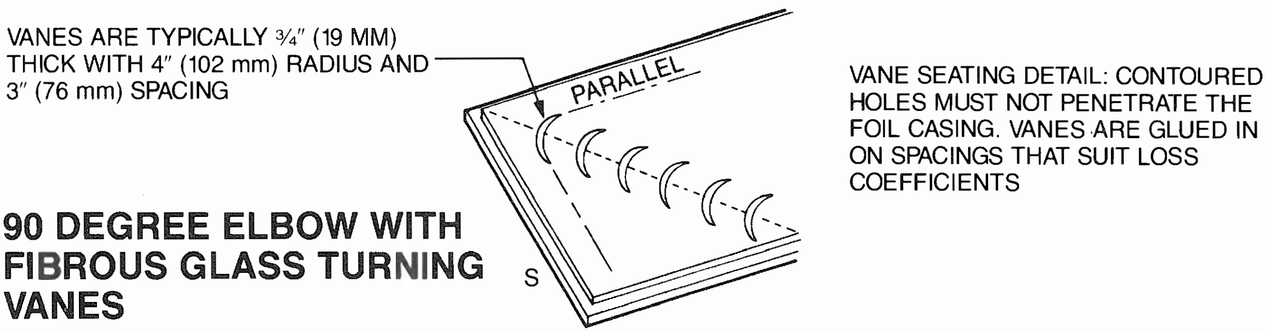


Figure 2-13

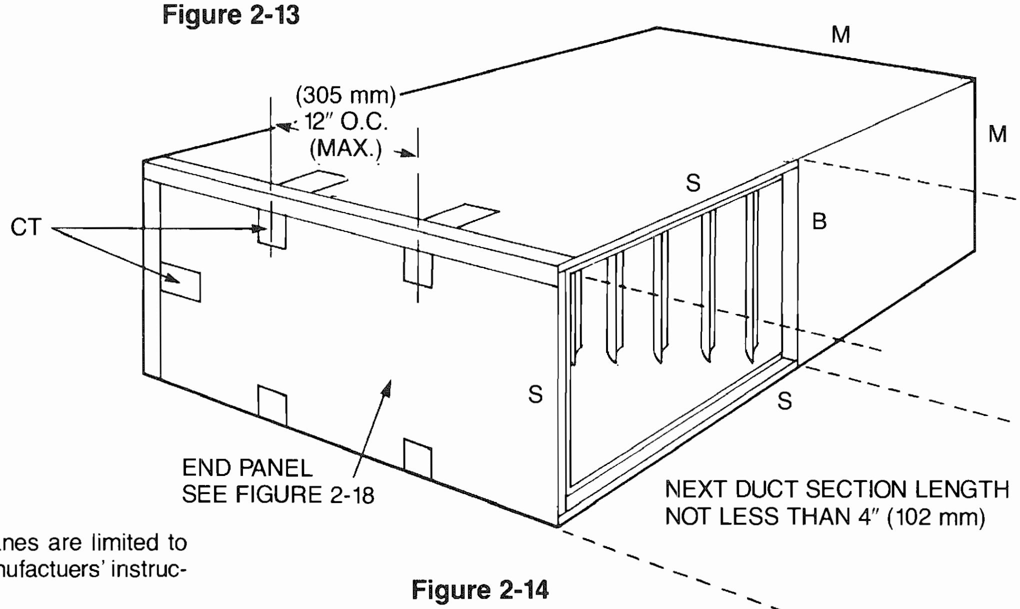


Figure 2-14

NOTE

Fibrous glass turning vanes are limited to specific lengths. See manufactuers' instructions.

NOTE: SEE COMPLETE CLOSURE SPECIFICATIONS

45 DEGREE ENTRY BRANCH

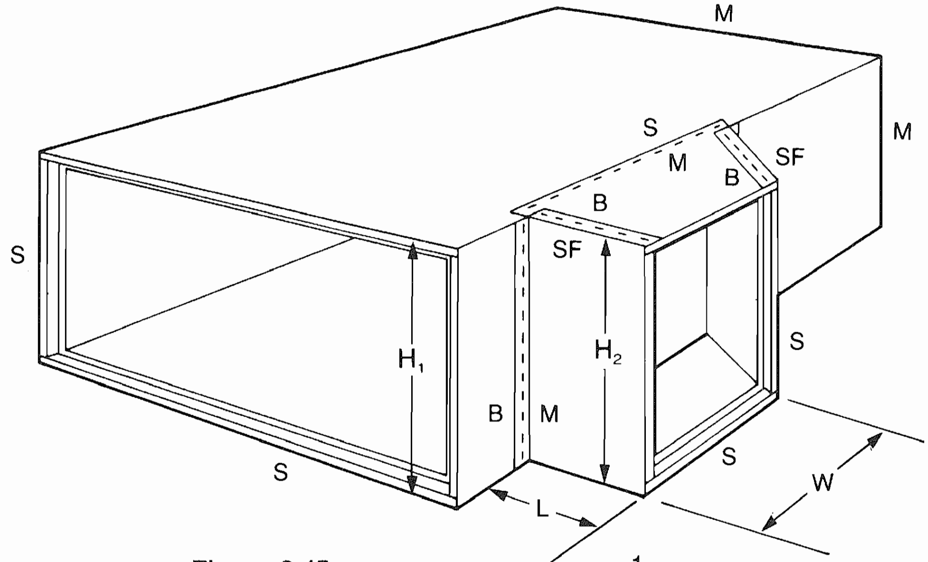


Figure 2-15

$L = \frac{1}{4}W$, 6″ MIN. (152 mm)

$H_2 = H_1$

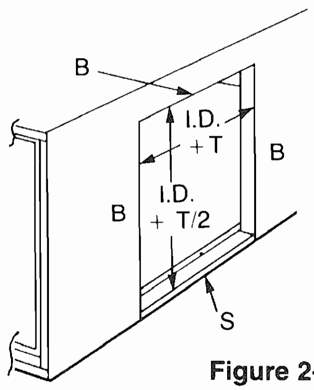
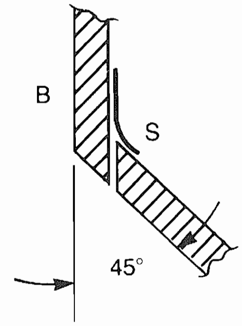


Figure 2-16

T = Broad thickness
Branch depth is less than main depth



ANGLED ENTRY DETAIL

ADJUSTABLE SPLITTER DAMPER (Used on supply duct only)

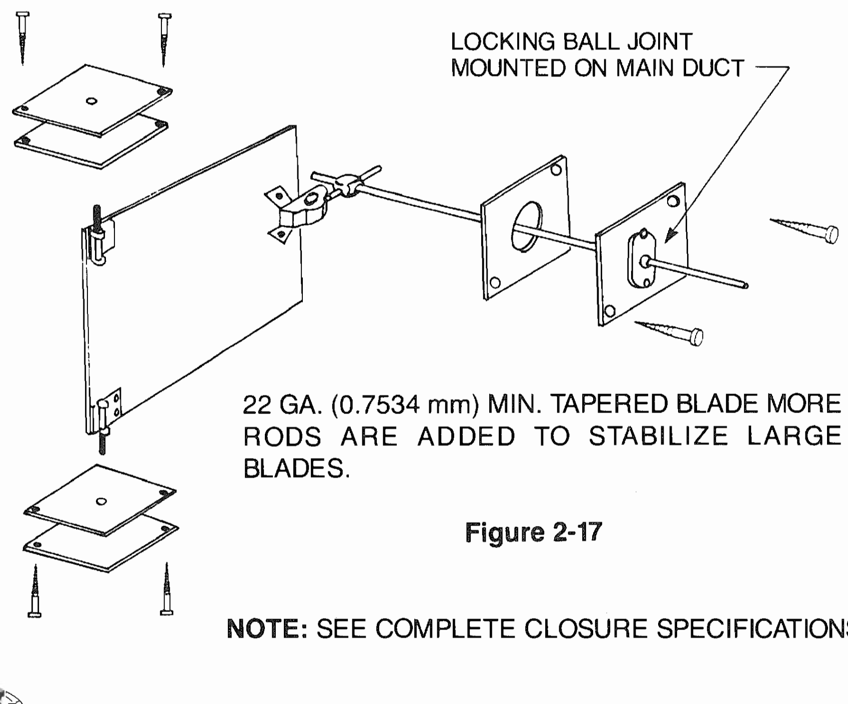


Figure 2-17

NOTE: SEE COMPLETE CLOSURE SPECIFICATIONS

END CAPS

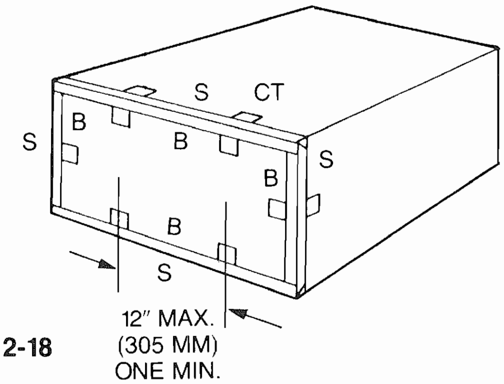


Figure 2-18

NOTE
See figure 3-31

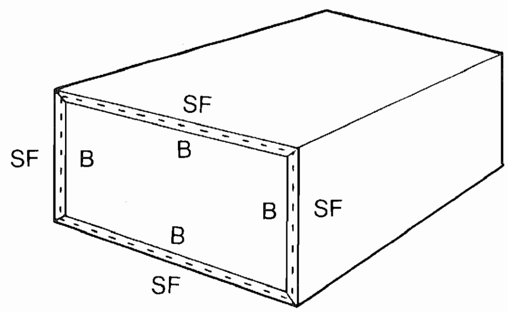


Figure 2-19

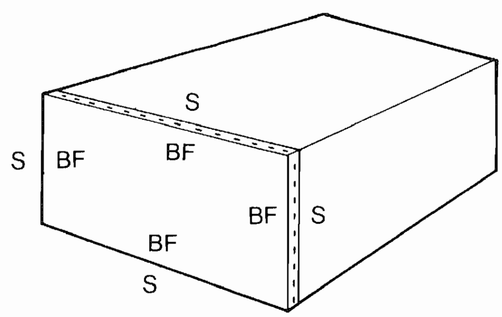


Figure 2-20

NOTE: SEE COMPLETE CLOSURE SPECIFICATIONS

ACCESS DOORS

ACCESS DOOR, FLANGE ON OPENING

NOTE
See Figure 3-29

PRESSURE RANGE, INCHES W.G.	ACCESS DOOR SIZE
0″ to 1″	24″ × 24″ MAX.
1″ to 2″	16″ × 16″ MAX.

Reinforcement is provided as necessary to maintain duct pressure classification

CONVERSIONS	
1″ WG	249 Pa
2″ WG	498 Pa
1″	25.4 mm
1¼″	32 mm
3″	76 mm
6″	154 mm
16″	0.41 m
24″	0.61 m
22 GA.	0.7534 mm

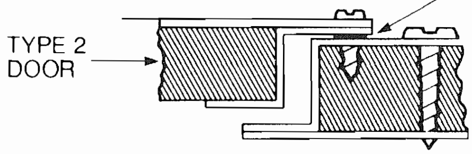


Figure 2-21

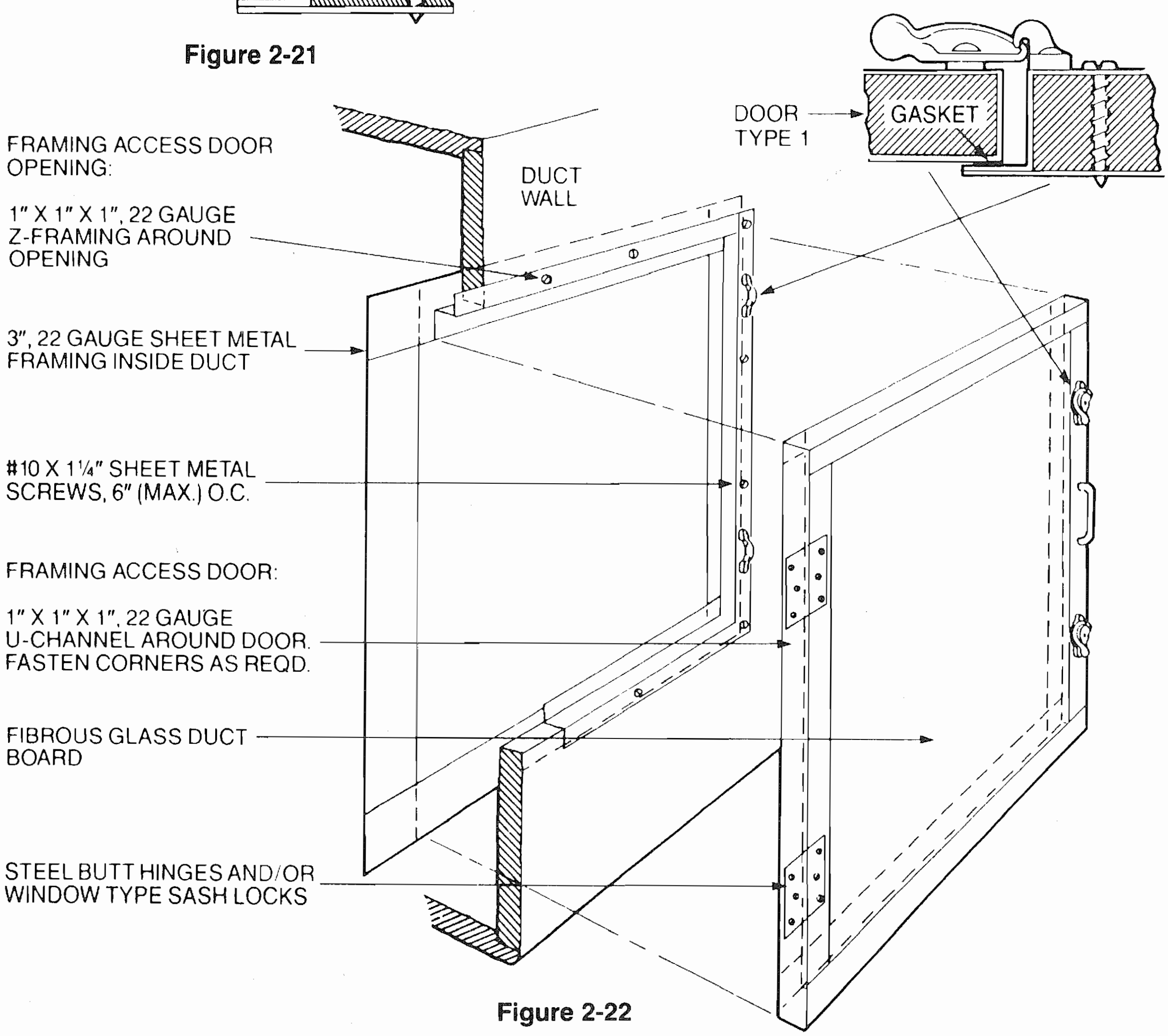


Figure 2-22

NOTE: SEE COMPLETE CLOSURE SPECIFICATIONS

SHEET METAL AND EQUIPMENT CONNECTION DETAILS

NOTE

Sheet metal connections must be made using glass fabric and mastic (GFM).

EXCEPTION:

When construction pressure class is 1" W.G. or less and sheet metal surfaces are cleaned carefully UL listed pressure-sensitive aluminum tape may be used.

All connections of fibrous glass duct to equipment and metal duct must be mechanically attached 12" (max.) on centers.

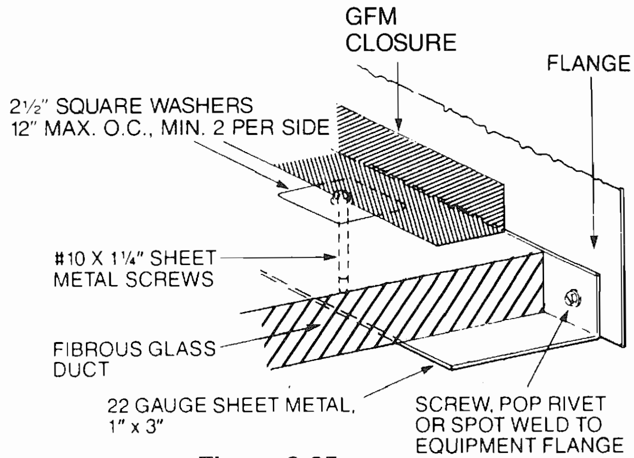


Figure 2-25

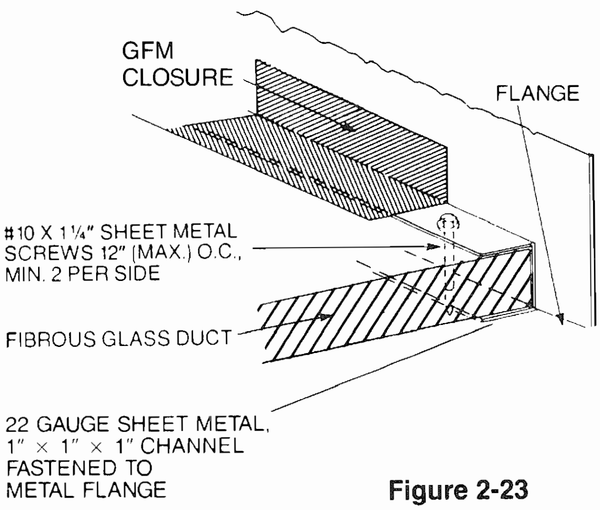


Figure 2-23

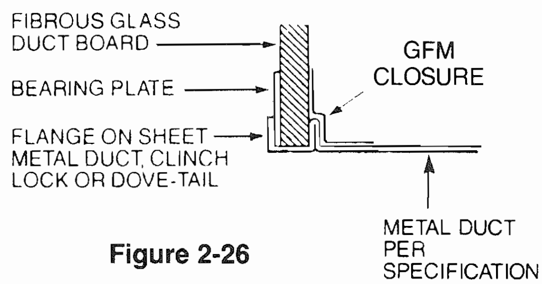


Figure 2-26

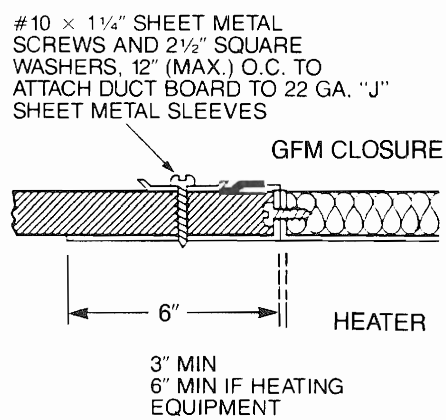


Figure 2-27

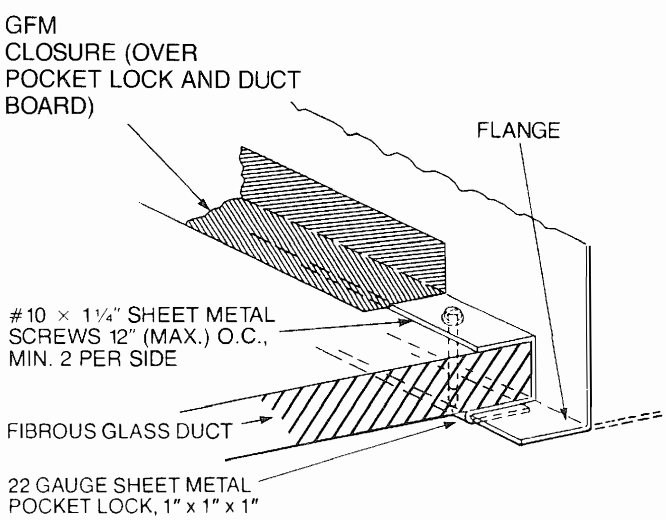


Figure 2-24

CONVERSIONS	
1" WG	249 Pa
1"	25.4 mm
1¼"	32 mm
2½"	64 mm
3"	76 mm
6"	152 mm
12"	305 mm
22 GA.	0.7534 mm

NOTE: SEE COMPLETE CLOSURE SPECIFICATIONS

SHEET METAL AND EQUIPMENT CONNECTION DETAILS *(Continued)*

NOTE

Sheet metal connections must be made using glass fabric and mastic (GFM).

EXCEPTION:

When construction pressure class is 1" W.G. or less and sheet metal surfaces are cleaned carefully UL listed pressure-sensitive aluminum tape may be used.

All connections of fibrous glass duct to equipment and metal duct must be mechanically attached 12" (max.) on centers.

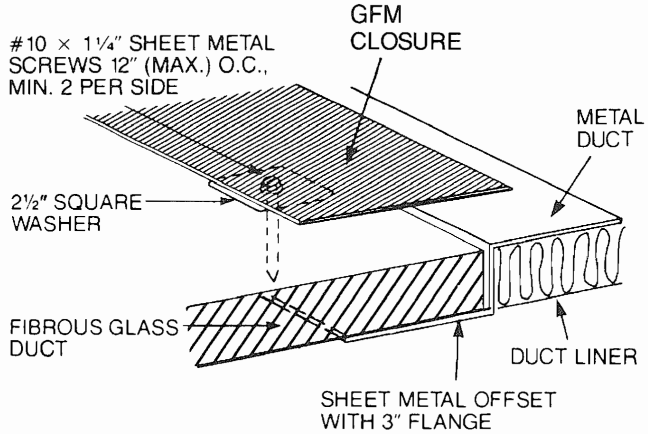
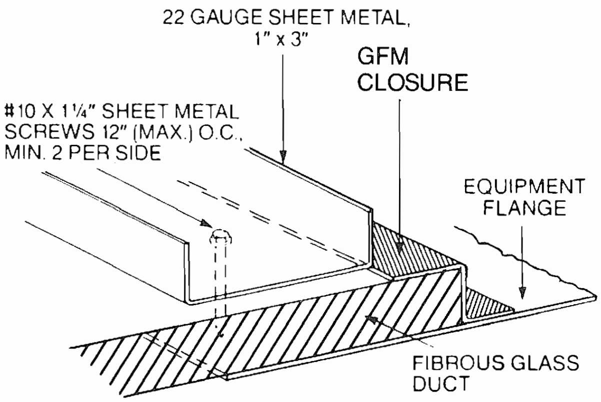


Figure 2-29



USE THIS CONNECTION WHEN:
Duct span is greater than 60", OR
Static pressure is greater than 1" W.G.

Figure 2-28

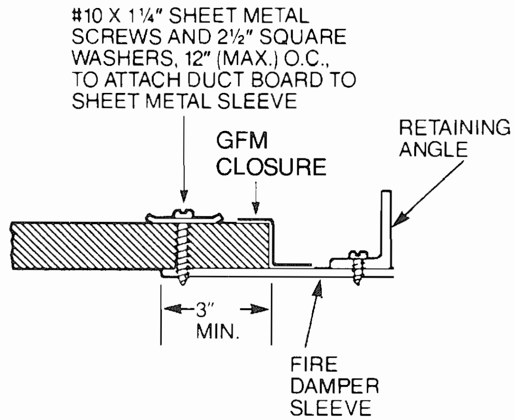


Figure 2-30

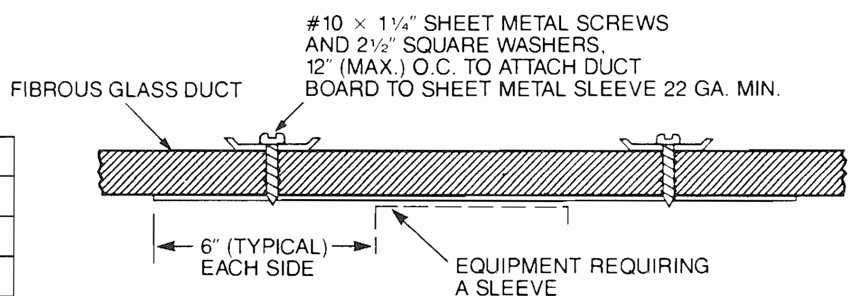


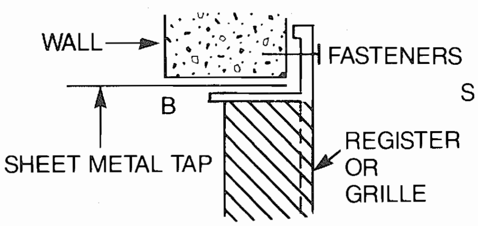
Figure 2-31

CONVERSIONS	
1" WG	249 Pa
1"	25.4 mm
1¼"	32 mm
2½"	64 mm
3"	76 mm
6"	152 mm
12"	305 mm
60"	1.52 m
22 GA.	0.7534 mm

NOTE: SEE COMPLETE CLOSURE SPECIFICATIONS

ACCESSORY INSTALLATION (REGISTER AND GRILLE)

NOTE: Some ducts containing registers and grilles may require reinforcement even though schedules for straight ducts of the same size may show reinforcement is not required.

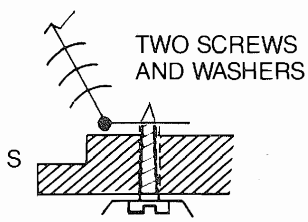


ALTERNATE DETAIL

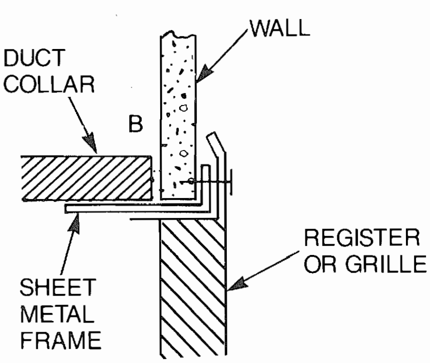
Sheet metal tap connection requires use of bearing plate inside duct. Sleeve and bearing plate sheet metal gauge are shown in table below.

DUCT SPAN, INCHES	SHEET METAL GAUGE (MM)
12″ or less (305 m)	26 (.012)
13″ to 30″ (.33–.76 m)	24 (.010)
31″ to 54″ (.79–1.4m)	22 (.534)

Connection may be made with glass fabric and mastic or with pressure-sensitive aluminum foil tape. See CLOSURES.



EXTRACTOR SUPPORT



ALTERNATE DETAIL

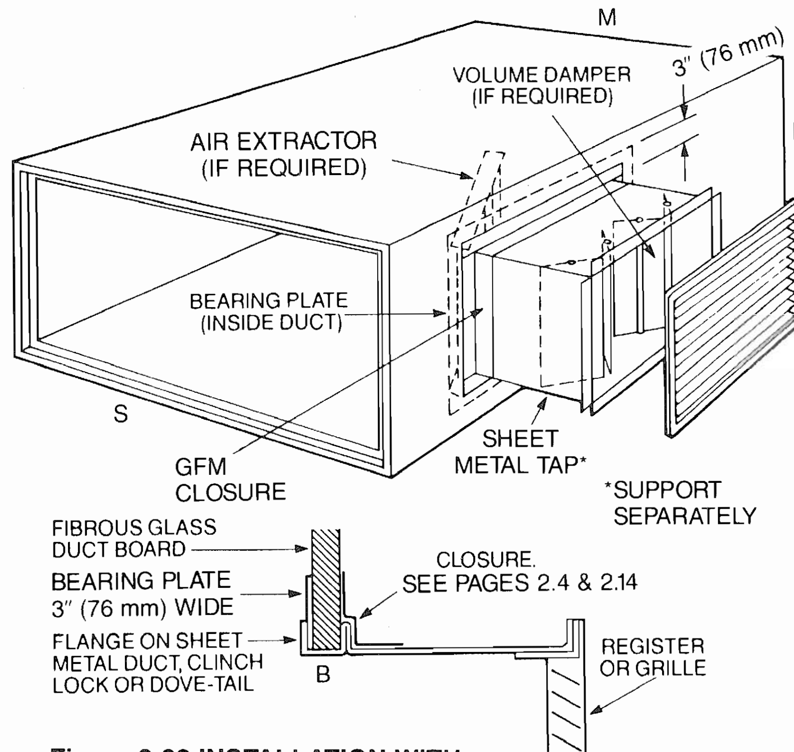


Figure 2-32 INSTALLATION WITH SHEET METAL TAP

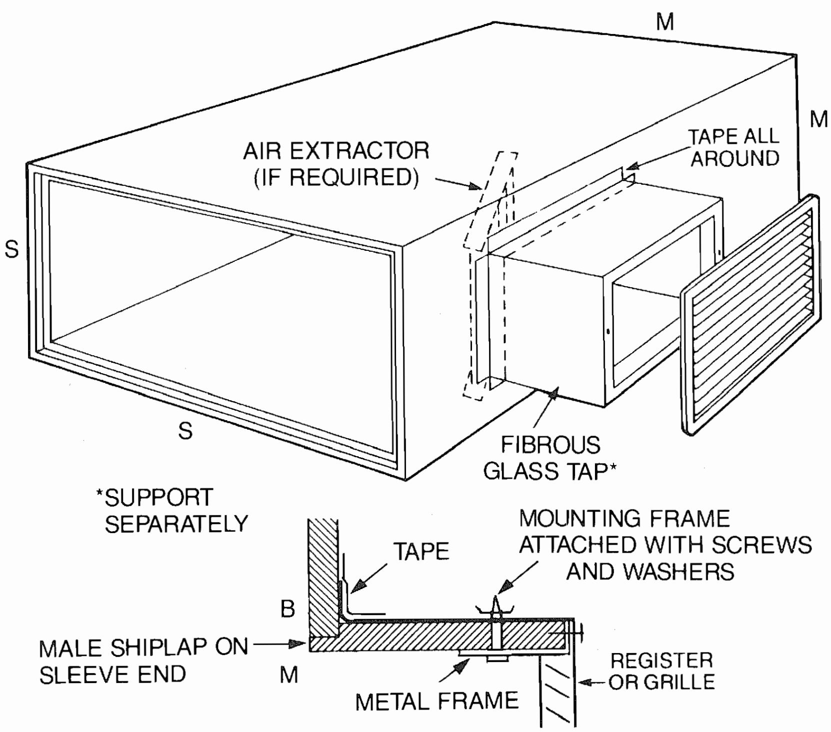


Figure 2-33 INSTALLATION WITH FIBROUS GLASS TAP

NOTE: SEE COMPLETE CLOSURE SPECIFICATIONS

ACCESSORY INSTALLATION *(Continued)*

DIFFUSER CONNECTIONS

NOTE: Some ducts containing diffuser drops may require reinforcement even though schedules for straight ducts of the same span may show reinforcement is not required.

Construction as shown in Figure 2-34 is for use when the entire drop assembly weighs less than 15 pounds. When weight exceeds 15 pounds,* diffuser must be separately supported.

*Confirm local code allowance; if any.

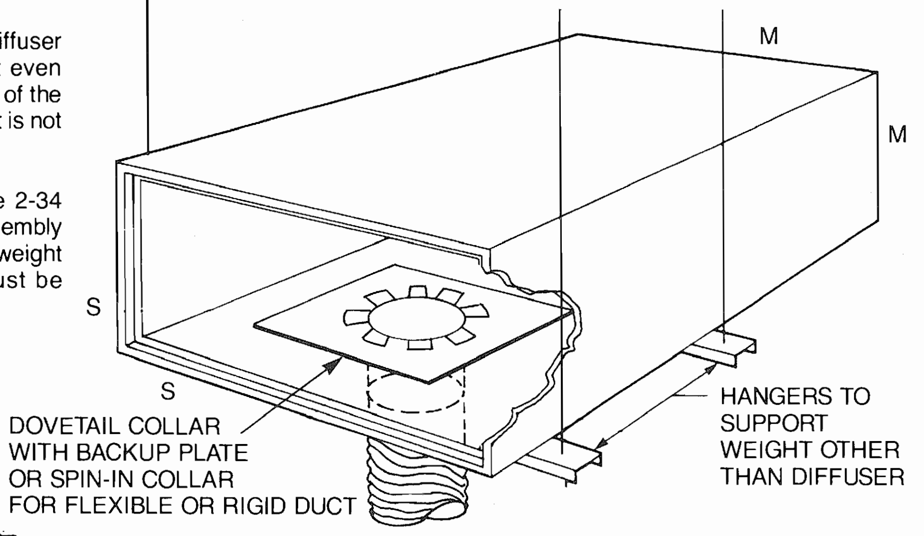


Figure 2-34

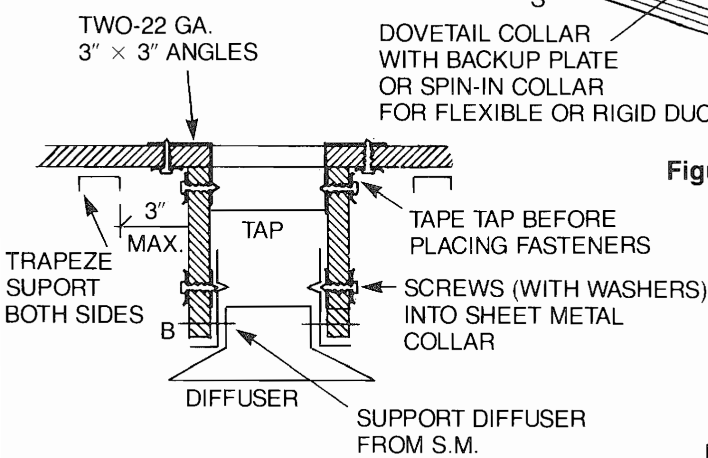
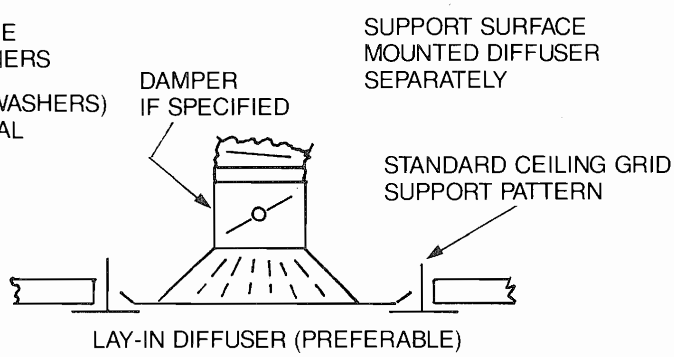
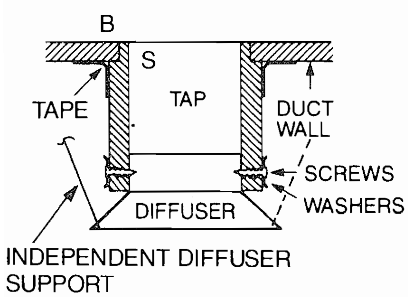


Figure 2-35



CONVERSIONS	
1¼″	32 mm
2½″	64 mm
3″	76 mm
12″	305 mm
22 GA.	0.7534 mm
15 lbs	6.8 Kgm.



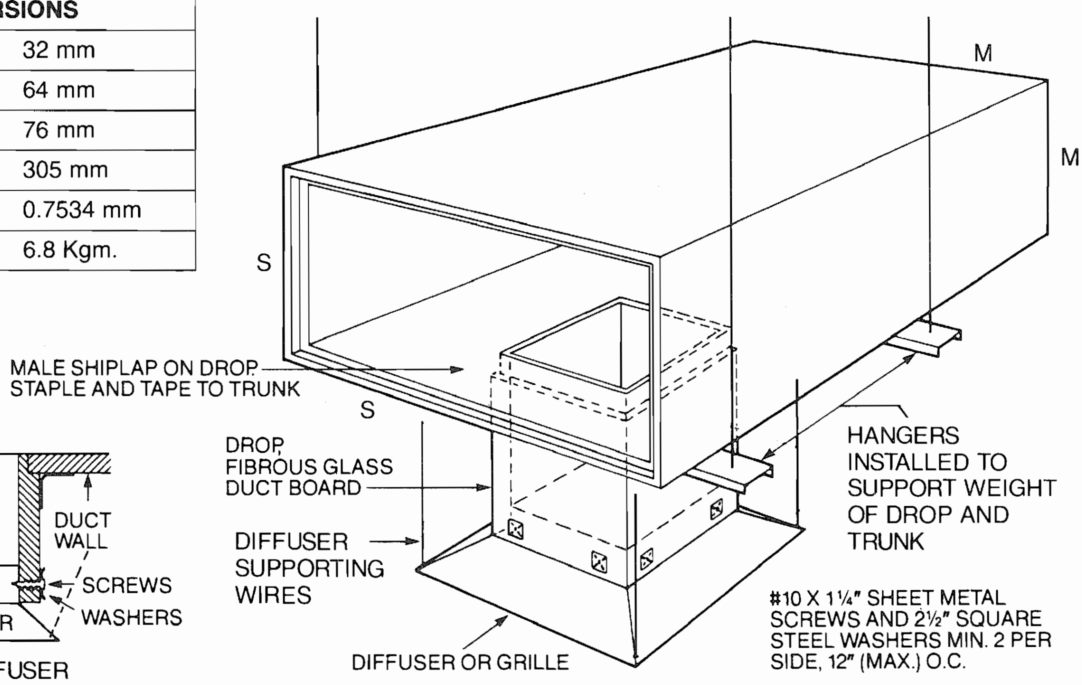


Figure 2-36 INSTALLATION WITH STAPLING FLAP

NOTE: SEE COMPLETE CLOSURE SPECIFICATIONS

CHAPTER 3
REINFORCEMENT

TIE ROD REINFORCEMENT

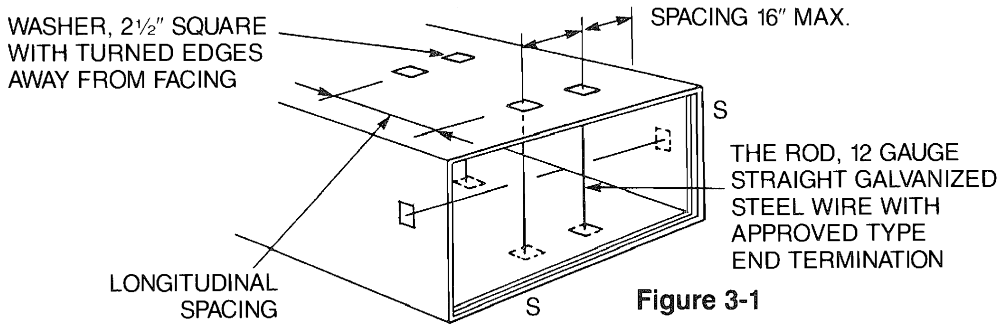


Figure 3-1

TABLE 3-1. TIE ROD SYSTEM REINFORCEMENT SCHEDULE

W.G. Positive Static Pressure	Maximum Inside Duct Dimension, Inches	TYPE 475 BOARD			TYPE 800 BOARD		
		No. Rods Across Dimension	Maximum Longitudinal Spacing	No. Rods Per 4 Ft. Section	No. Rods Across Dimension	Maximum Longitudinal Spacing	No. Rods Per 4 Ft. Section
0 thru ½″ W.G.	0-36	NOT REQUIRED			NOT REQUIRED		
	37-42	2	24″	4	2	48″	2
	43-48	↓		↓	↓		↓
	49-60	3		6	3	↓	3
	61-64	↓		↓	↓	24″	6
	65-80	4		8	4		8
	81-96	5	↓	10	5	↓	10
Over ½″ thru 1″ W.G.	0-24	NOT REQUIRED			NOT REQUIRED		
	25-30	1	24″	2	1	48″	1
	31, 32	↓		↓	↓	24″	2
	33-36	2		4	2		4
	37-48	↓		↓	↓		↓
	49-64	3		6	3		6
	65-80	4		8	4		8
	81-96	5	↓	10	5	↓	10
Over 1″ thru 2″ W.G.	0-15	NOT REQUIRED			NOT REQUIRED		
	16-18	1	24″	2			
	19-24		↓	↓	1	48″	1
	25-32	↓	16″	3	↓	24″	2
	33-48	2		6	2		4
	49-60	3		9	3	↓	6
	61-64	↓		↓	↓	16″	9
	65-80	4		12	4		12
	81-96	5	↓	15	5	↓	15

NOTES

1. Tie rods and washers must be no more than 16″ on centers across duct dimension.
2. Ducts of 48″ width and over require use of anti-sag devices.
3. If dimensions require, tie rods run in both horizontal and vertical directions.
4. Some fittings may require reinforcement even though the schedule for straight duct does not require it.

TIE ROD REINFORCEMENT (METRIC)

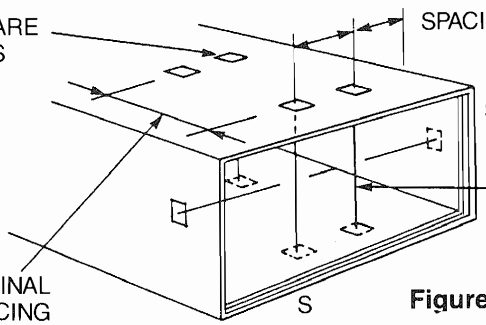


Figure 3-1M

TABLE 3-1M. TIE ROD SYSTEM REINFORCEMENT SCHEDULE

W.G. Positive Static Pressure	Maximum Inside Duct Dimension, (m)	TYPE 475 BOARD			TYPE 800 BOARD		
		No. Rods Across Dimension	Maximum Longitudinal Spacing	No. Rods Per 1.2 m Section	No. Rods Across Dimension	Maximum Longitudinal Spacing	No. Rods Per 1.2 m Section
0 thru 12.7 mm	0–.91	NOT REQUIRED			NOT REQUIRED		
	0.94–1.06	2	.600 m	4	2	1.200 m	2
	1.09–1.22	↓		↓	↓		↓
	1.24–1.52	3		6	3	↓	3
	1.55–1.63	↓		↓	↓	.600 m	6
	1.65–2.03	4		8	4		8
	2.06–2.44	5	↓	10	5	↓	10
Over 12.7 thru 25 mm	0–.61	NOT REQUIRED			NOT REQUIRED		
	0.64–.76	1	.600 m	2	1	1.200 m	1
	0.79–.81	↓		↓	↓	.600 m	2
	0.84–.91	2		4	2		4
	0.94–1.22	↓		↓	↓		↓
	1.24–1.63	3		6	3		6
	1.65–2.03	4		8	4		8
	2.06–2.44	5	↓	10	5	↓	10
Over 25 thru 50 mm	0–.38	NOT REQUIRED			NOT REQUIRED		
	0.41–.46	1	.600 m	2			
	0.48–.61		↓	↓	1	1.2 m	1
	0.64–.81	↓	.400 m	3	↓	.600 m	2
	0.84–1.22	2		6	2		4
	1.24–1.52	3		9	3	↓	6
	1.55–1.62	↓		↓	↓	.410 m	9
	1.65–2.03	4		12	4		12
	2.06–2.44	5	↓	15	5	↓	15

NOTES

1. Tie rods and washers must be no more than .410 m on centers across duct dimension.
2. Ducts of 1.200 m width and over require use of anti-sag devices.
3. If dimensions require, tie rods run in both horizontal and vertical directions.
4. Some fittings may require reinforcement even though the schedule for straight duct does not require it.

TIE ROD TERMINATION METHODS

FASLOOP METHOD* (PROPRIETARY)

Materials required per the road assembly:

- 12 gauge galvanized steel wire 1¾″ longer than outside duct dimension.
- Two washers, 2½″ square × 0.028″ thick galvanized steel, volcano type with beveled edges and 0.150″ hole in center. NOTE: Other types of manufactured flat washers are not suitable for this application.

*A TIMA report states that no other size or shape of loop has been tested to determine compliance with the 50,000 cycle test.

IN	.020	.028	0.05	0.15	3⁄16	7⁄32	3⁄8
MM	.51	.71	1.3	3.7	4.8	5.6	9.5

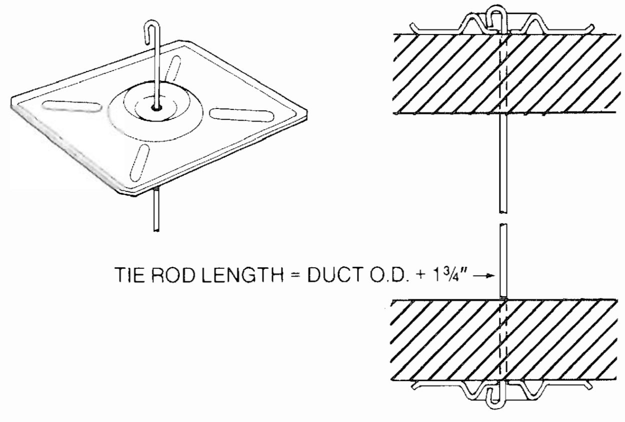


Figure 3-2 FASLOOP TERMINATION

POP RIVET SLEEVE METHOD

Materials required per tie rod assembly:

- 12 gauge galvanized steel wire, cut exactly to outside duct dimension.
- Two washers, 2½″ square × 0.020″ (min.) thick galvanized steel with beveled edges and 7⁄32″ diameter center hole.
- Two 3⁄16″ steel pop rivet sleeves, 3⁄8″ long.

IN	7⁄16	7⁄8	1¾	2½	12 GA
MM	11	22.2	44	63	2.7

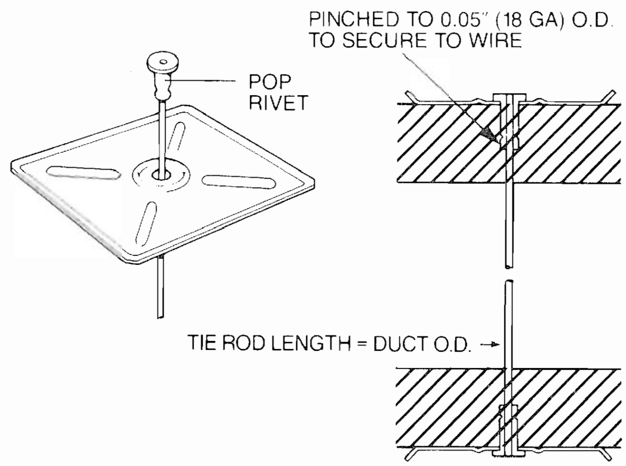


Figure 3-3 POP RIVET SLEEVE TERMINATION

LOCKING CAP METHOD

(Not to be used on sloped panels of fittings)

Materials required per tie rod assembly:

- 12 gauge galvanized steel wire, cut 7⁄16″ longer than outside duct dimension.
- Two washers, 2½″ square × 0.020″ (min.) thick galvanized steel with beveled edges and 0.150″ dia. hole in center
- Two locking caps, 7⁄8″ diameter, having spring steel or stainless steel locking inserts.

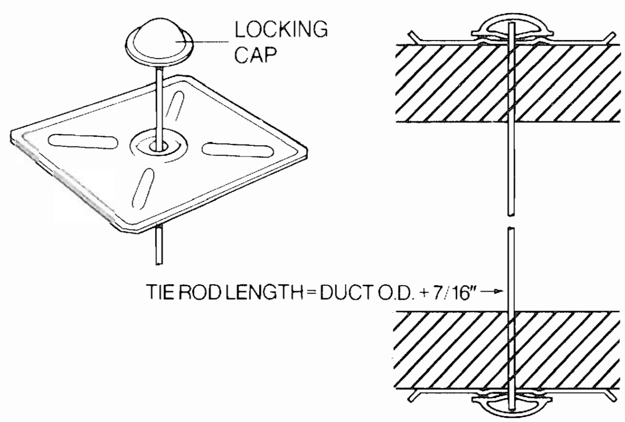


Figure 3-4 LOCKING CAP TERMINATION

NOTES

1. An ordinary insulation locking washer does not have sufficient holder power.
2. Wire must be free to move within the 2½″ square washer.
3. Do **not** re-use locking caps.

Reuse of cap is prohibited.

TIE ROD REINFORCEMENT AT JOINT

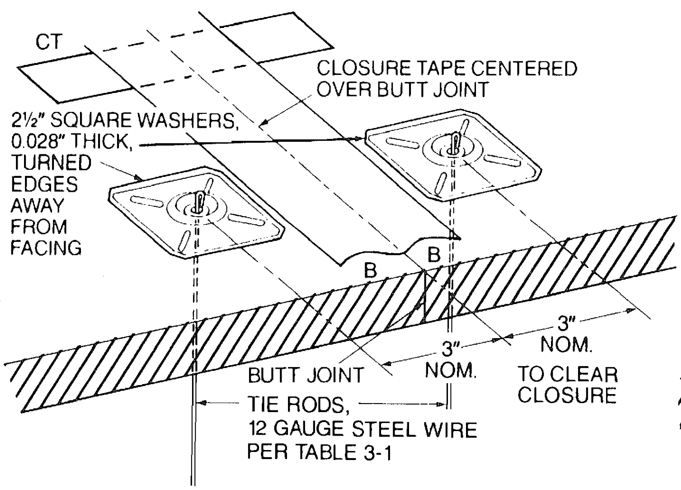


Figure 3-5 BUTT JOINT REINFORCEMENT

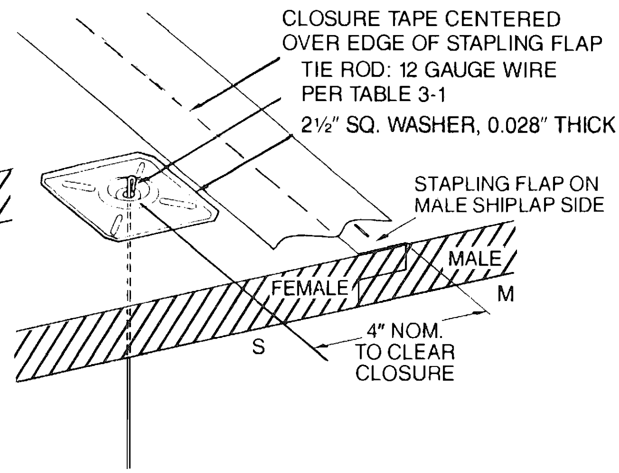


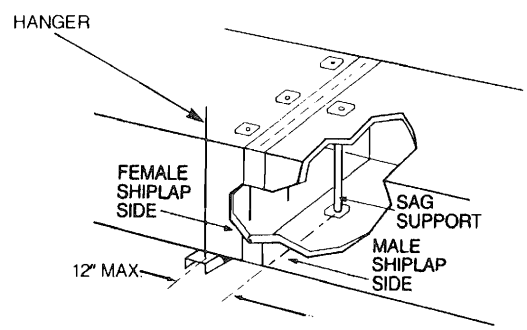
Figure 3-6 SHIPLAP JOINT REINFORCEMENT

SAG CONTROL—TIE ROD REINFORCEMENT

Top panels of fibrous glass duct sections or fittings 48" wide or greater must have sag supports per Figure 3-7 or 3-8.

Sag supports do not replace tie rod assemblies as called for in the reinforcement schedule, but must be installed in addition to them. Sag supports must be located within 12" of hangers.

IN	12 GA	.028	½	2½	3	4	12	48
MM	2.7	.71	12.7	63	76	101	305	1.22 m



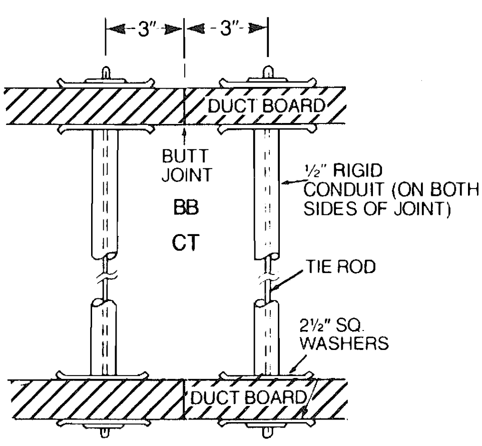


Figure 3-7 SAG CONTROL

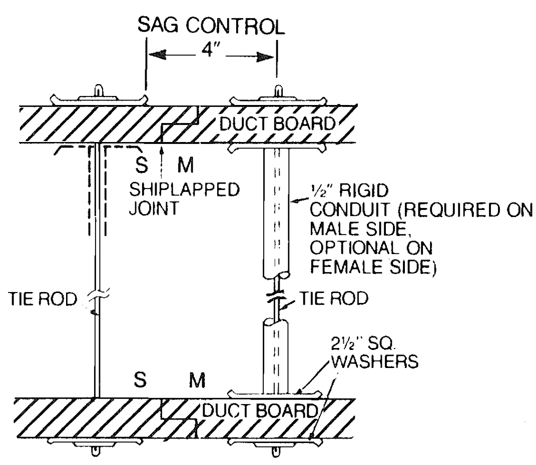


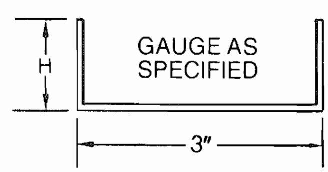
Figure 3-8 SAG CONTROL

CHANNEL REINFORCEMENT

Table 3-2 gives perimeter wrap reinforcement schedules for galvanized steel channels having G 60 or G 90 zinc coating weight. The application is for straight duct sections. Supplemental requirement for fittings are given in Table 3-3 and details related thereto.

TABLE 3-2. CHANNEL SYSTEM REINFORCEMENT SCHEDULE

Static Pressure,		Maximum Inside Duct Dimension (I.D.), in.	TYPE 475 BOARD Maximum longitudinal spacing	TYPE 475 BOARD Channel gauge	TYPE 475 BOARD H dimension (see below)	TYPE 800 BOARD Maximum longitudinal spacing	TYPE 800 BOARD Channel gauge	TYPE 800 BOARD H dimension (see below)
0 thru ½" W.G.	negative	0-30	NOT REQUIRED			NOT REQUIRED		
		31-36	24"	22	1"	48"	22	1"
	positive	0-36	NOT REQUIRED			NOT REQUIRED		
0 thru ½" W.G. positive or negative		37-42	24"	22	1"	48"	22	1"
		43-48						
		49-60						1½"
		61-72				24"		1"
		73-84						
		85-96			1¼"			
Over ½" thru 1" W.G. positive or negative		0-24	NOT REQUIRED			NOT REQUIRED		
		25-30	24"	22	1"	48"	22	1"
		31-36				24"		
		37-42						
		43-48						
		49-60						
		61-72		18			18	
		73-84			1¼"			1¼"
		85-96						
Over 1" thru 2" W.G. positive or negative		0-15	NOT REQUIRED			NOT REQUIRED		
		16-18	24"	22	1"			
		19-24				24"	22	1"
		25-36	16"					
		37-48						1¼"
		49-60						
		61-72		18		16"	18	1"
		73-84			1¼"			1¼"
		85-96			1½"			1½"



NOTES

1. Ducts of 48" maximum width and over require use of anti-sag devices. See Figure 3-11 and 3-12.
2. Some fittings may require reinforcement even though the schedule for straight duct does not require it.
3. Reinforcement for positive pressure need not be attached to the duct board except when required for sag control. See attachment details for both positive and negative pressure application.
4. On negative pressur ducts, attach channels to each duct side on 16" centers one fastener minimum (see Figure 3-15).

CHANNEL REINFORCEMENT (METRIC)

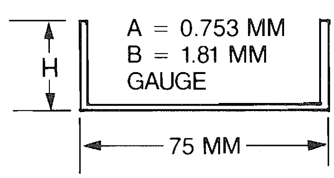
Table 3-2M gives perimeter wrap reinforcement schedules for galvanized steel channels having G 60 or G 90 zinc coating weight. The application is for straight duct sections. Supplemental requirements for fittings are given in Table 3-3 and details related thereto.

TABLE 3-2M. CHANNEL SYSTEM REINFORCEMENT SCHEDULE

W.G. Static Pressure		Maximum Inside Duct Dimension (I.D.) Meters	TYPE 475 BOARD			TYPE 800 BOARD		
			Maximum longitudinal spacing	Channel gauge	H dimension (see below)	Maximum longitudinal spacing	Channel gauge	H dimension (see below)
0 thru 12.7 mm	negative	0–.76	NOT REQUIRED			NOT REQUIRED		
		.79–.91	.600 m	A	25 mm	1.200 m	A	25 mm
	positive	0–.91	NOT REQUIRED			NOT REQUIRED		
0 thru 12.7 mm positive or negative		.94–1.07	.600 m	A	25 mm	1.200 m	A	25 mm
		1.09–1.22						↓
		1.24–1.52				↓		38 mm
		1.55–1.83				.600 m		25 mm
		1.85–2.13			↓			
		2.16–2.44	↓	↓	32 mm	↓	↓	↓
Over 12.7 mm thru 25.4 mm positive or negative		0–.61	NOT REQUIRED			NOT REQUIRED		
		.64–.76	.600 m	A	25 mm	1.200 m	A	25 mm
		.79–.91				.600 m		
		.94–1.07						
		1.09–1.22						
		1.24–1.52		↓			↓	
		1.55–1.83		B	↓		B	↓
		1.85–2.13			32 mm			32 mm
		2.16–2.44	↓	↓	↓	↓	↓	↓
Over 25.4 mm thru 50.8 mm positive or negative		0–.38	NOT REQUIRED			NOT REQUIRED		
		.41–.46	.600 m	A	25 mm			
		.48–.61	↓			.600 m	A	25 mm
		.64–.91	.400 m					↓
		.94–1.2						A
		1.24–1.52		↓		↓	↓	↓
		1.55–1.83		B	↓	.400 m	B	25 mm
		1.85–2.13			32 mm			32 mm
		2.16–2.44	↓	↓	38 mm	↓	↓	38 mm

NOTES

1. Ducts of 1.20 m maximum width and over require use of anti-sag devices.
2. Some fittings may require reinforcement even though the schedule for straight duct does not require it.
3. Reinforcement for positive pressure need not be attached to the duct board except when required for sag control. See attachment details for both positive and negative pressure application.
4. On negative pressure ducts, attach channels to each duct side on .41 m centers, one side.

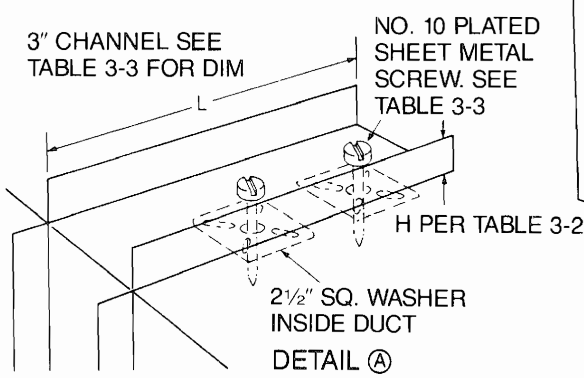


FITTING REINFORCEMENT POSITIVE PRESSURE SYSTEMS

PARTIAL WRAP-AROUND REINFORCEMENT

Where reinforcement is required but cannot be fastened to opposite sides of a duct section or fitting, it is necessary to install formed sheet metal channels that partially wrap around a fibrous glass duct system fitting at the reqiured location. In such cases, #10 × 1¼″ plated sheet metal screws and 2½″ square washers are used to attach the ends of the channels to the duct board.

LS is the longitudinal spacing.



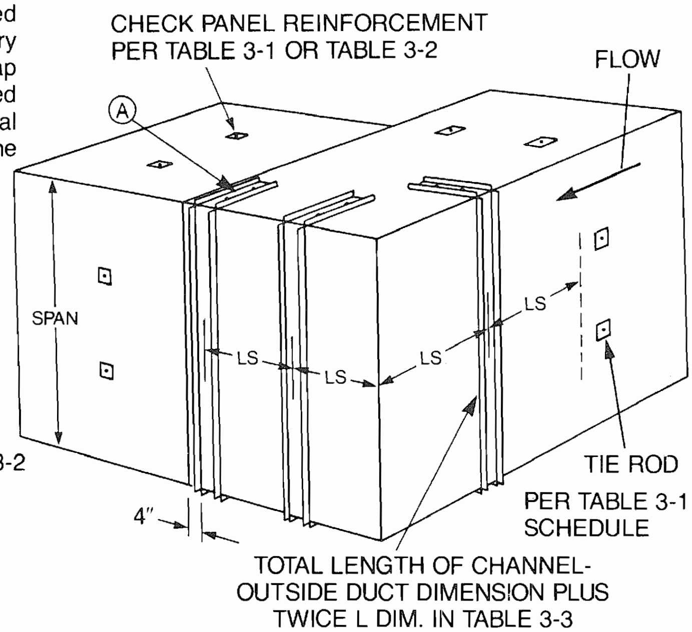


Figure 3-9 PARTIAL WRAP-AROUND REINFORCEMENT

TABLE 3-3. PARTIAL WRAP-AROUND REINFORCEMENT SCHEDULE

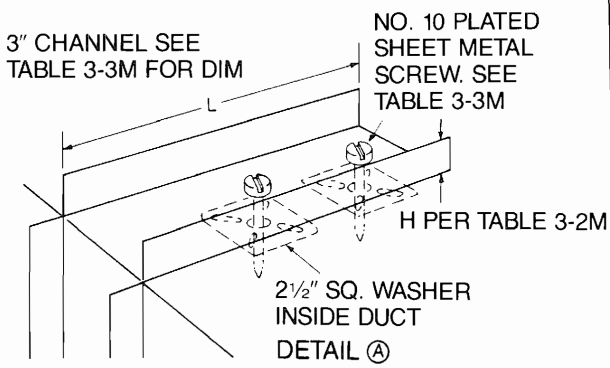
	TYPE 475 BOARD				TYPE 800 BOARD			
Positive static Pressure	Maximum Inside Duct Dimension, Inches	LS Longi-tudinal spacing	Dimen-sion L	No. of screws, each end	Maximum Inside Duct Dimension, Inches	LS Longi-tudinal spacing	Dimen-sion L	No. of screws, each end
0″ thru ½″ W.G.	0-36	NOT REQUIRED			0-36	NOT REQUIRED		
	37-96	24″	4″	1	37-60	48″	4″	1
					61-96	24″	↓	↓
Over ½″ thru 1″ W.G.	0-24	NOT REQUIRED			0-24	NOT REQUIRED		
	25-48	24″	4″	1	25-30	48″	4″	1
	49-64	↓	7″	2	31-48	24″	↓	↓
	65-80		10″	3	49-64	↓	7″	2
	81-96		13″	4	65-80		10″	3
					81-96		13″	4
Over 1″ thru 2″ W.G.	0-15	NOT REQUIRED			0-18	NOT REQUIRED		
	16-24	24″	4″	1	19-24	24″	4″	1
	25-32	16″	↓	↓	25-32	↓	7″	2
	33-48	↓	7″	2	33-48		10″	3
	49-64		10″	3	49-60		13″	4
	65-80		13″	4	61-64	16″	10″	3
	81-96		16″	5	65-80	↓	14″	↓
					81-96		16″	5

FITTING REINFORCEMENT POSITIVE PRESSURE SYSTEMS (METRIC)

PARTIAL WRAP-AROUND REINFORCEMENT

Where reinforcement is required but cannot be fastened to opposite sides of a duct section or fitting, it is necessary to install formed sheet metal channels that partially wrap around a fibrous glass duct system fitting at the required location. In such cases, #10 × 1¼″ plated sheet metal screws and 2½″ square washers are used to attach the ends of the channels to the duct board.

LS is the longitudinal spacing.



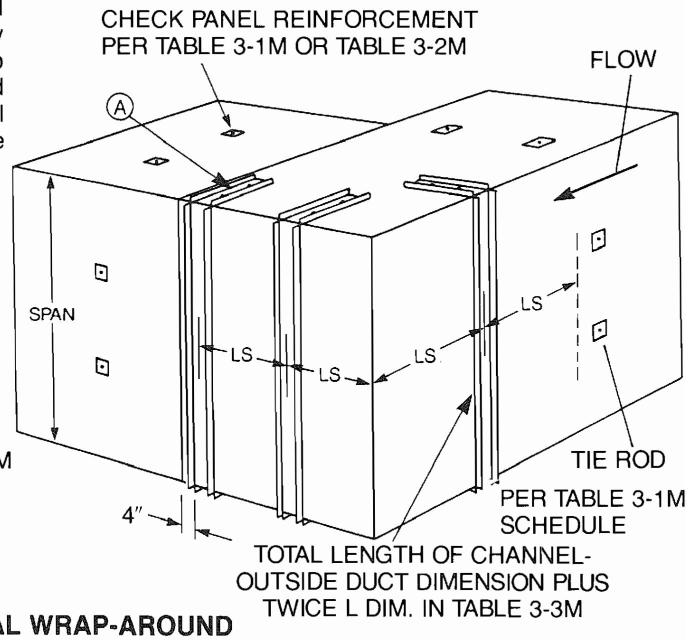


Figure 3-9M PARTIAL WRAP-AROUND REINFORCEMENT

TABLE 3-3M. PARTIAL WRAP-AROUND REINFORCEMENT SCHEDULE

W.G. Positive static Pressure	TYPE 475 BOARD Maximum Inside Duct Dimension, Meters	LS Longitudinal spacing	Dimension L	No. of screws, each end	TYPE 800 BOARD Maximum Inside Duct Dimension, Meters	LS Longitudinal spacing	Dimension L	No. of screws, each end
0″ thru 12.7 mm	0–.91	NOT REQUIRED			0–.91	NOT REQUIRED		
	.94–2.44	.61 m	102 mm	1	.94–1.52	1.22 m	102 mm	1
					1.55–2.44	.61 m	↓	↓
Over 12.7 mm thru 25.4 mm	0–.61	NOT REQUIRED			0–.61	NOT REQUIRED		
	.64–1.22	.61 m	102 mm	1	.64–.76	1.22 m	102 mm	1
	1.24–1.63		178 mm	2	.79–1.22	.61 m	↓	↓
	1.65–2.03		250 mm	3	1.24–1.63		178 mm	2
	2.06–2.44	↓	.33 m	4	1.65–2.03		250 mm	3
					2.06–2.44	↓	.33 m	4
Over 25.4 mm thru 50.8 mm	0–.38	NOT REQUIRED			0–.46	NOT REQUIRED		
	.41–.61	.61 m	102 mm	1	.48–.61	.61 m	102 mm	1
	.64–.81	.41 m	↓	↓	.64–.81		178 mm	2
	.84–1.22		178 mm	2	.84–1.22		250 mm	3
	1.24–1.63		250 mm	3	1.24–1.52	↓	.33 m	4
	1.65–2.03		.33 m	4	1.55–1.63	.41 m	250 mm	3
	2.06–2.44	↓	.41 m	5	1.65–2.03		.36 m	↓
					2.06–2.44	↓	.41 m	5

IN	MM
1¼	32
2½	64
3	76
4	102

CHANNEL REINFORCEMENT EXAMPLES, POSITIVE PRESSURE

The number of channels along the duct shall be as shown in Table 3-2 or 3-2M.

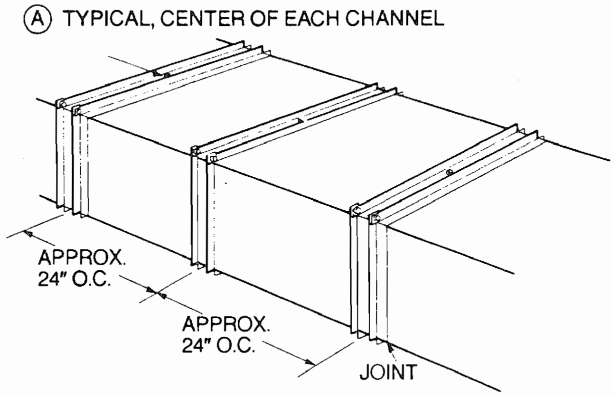


Figure 3-12 TYPICAL CHANNEL REINFORCEMENT ON 24″ CENTERS, 48″ DUCT SECTIONS AND 48″ OR MORE WIDTH

See Table 3-2.

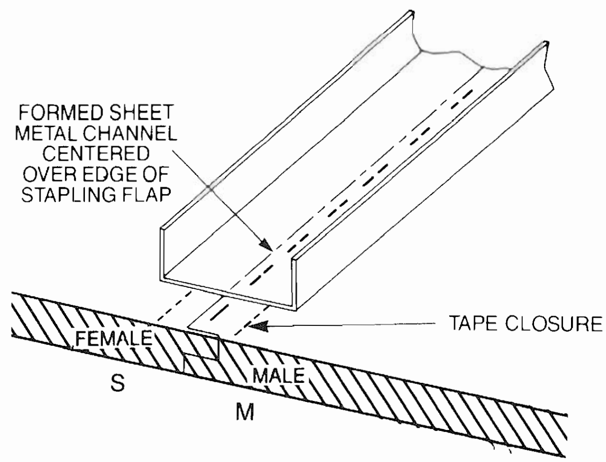
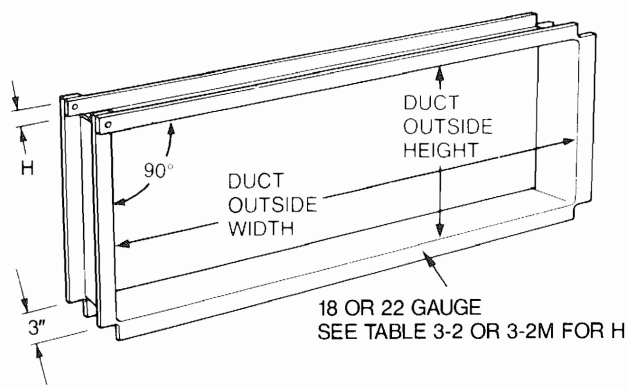


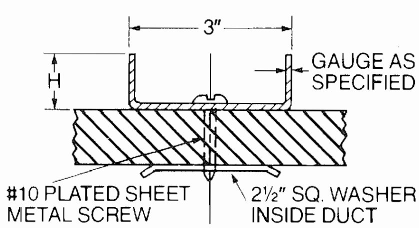
Figure 3-10 CHANNEL REINFORCEMENT, AT JOINTS ON DUCTS WITH WIDTH LESS THAN 48″

IN	2½	3	4	24	48	18 GA	22 GA
MM	63	76	101	.61 M	1.22 M	1.181	.7534



DETAIL A. CHANNEL REINFORCEMENT DETAIL

For sag support in ducts 48″ or greater in maximum dimension, each reinforcement must be fastened to top of duct in midspan. Detail Ⓐ.



DETAIL Ⓐ

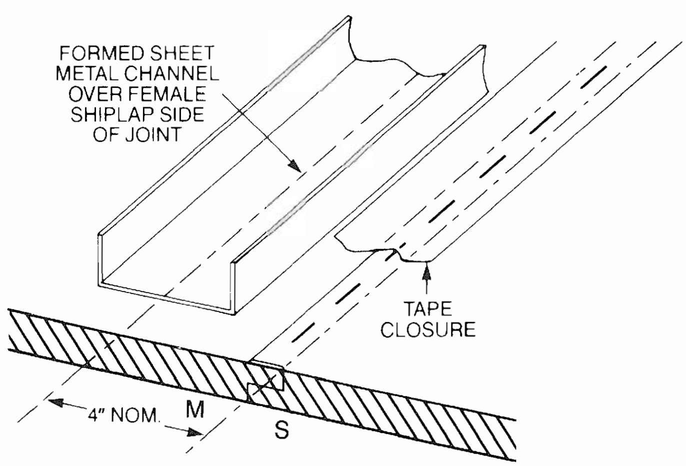


Figure 3-11 CHANNEL REINFORCEMENT OFFSET TO CLEAR CLOSURE ON DUCTS 48″ AND OVER

CHANNEL REINFORCEMENT NEGATIVE PRESSURE SYSTEMS

CONSTRUCTION DETAILS

Each reinforcement may be fabricated from a continuous length of channel having three 90 degree bends and a fourth 90 degree corner which is securely fastened with bolts, screws, rivets, spotwelds or staples. Reinforcements may also be fabricated with two, three, or four securely fastened corners.

LOCATING REINFORCING CHANNELS

In negative pressure applications, reinforcement is applied over male shiplap and is attached with screws and clips at intervals not exceeding 16″. When additional channels are required (between joints), they are attached to the duct with #10 plated sheet metal screws and 2½″ square washers as in Figure 3-15A, for positive pressure applications.

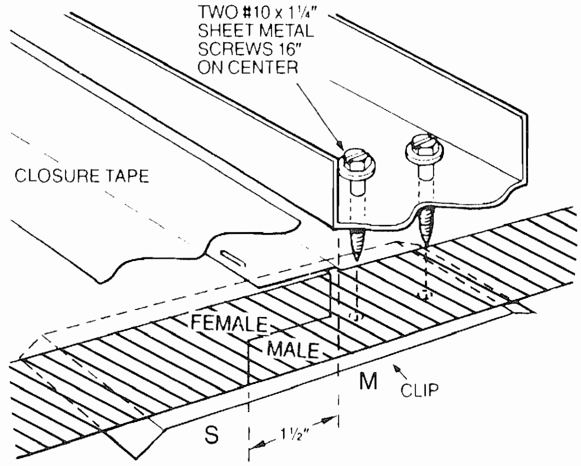


Figure 3-13 CHANNEL REINFORCEMENT AT JOINTS FOR NEGATIVE PRESSURE SYSTEMS

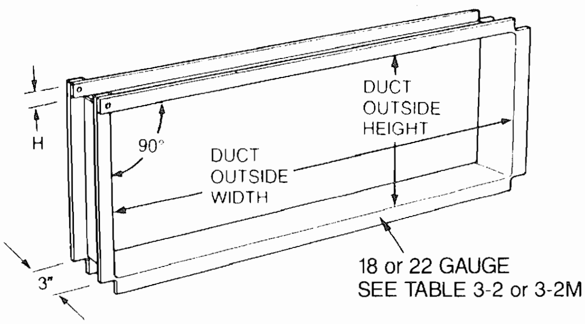
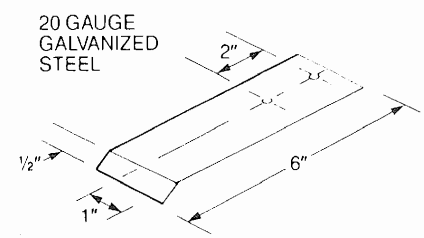


Figure 3-14 CHANNEL REINFORCEMENT



CLIP FOR NEGATIVE PRESSURE REINFORCEMENT SYSTEMS

IN	½	1	1½	2	2½	3	6	16	48	18GA	20GA	22GA
MM	13	25	38	50	64	76	152	.41 M	1.22 M	1.181	.906	.7534

FASTENER REQUIREMENTS, NEGATIVE PRESSURE		
Transverse Dimension		Minimum number of clips or washers per reinforcing member
INCHES	METERS	
16″–32″	.41–.81	1
33″–48″	.84–1.22	2
49″–64″	1.24–1.63	3
65″–80″	1.65–2.03	4
81″–96″	2.06–2.44	5

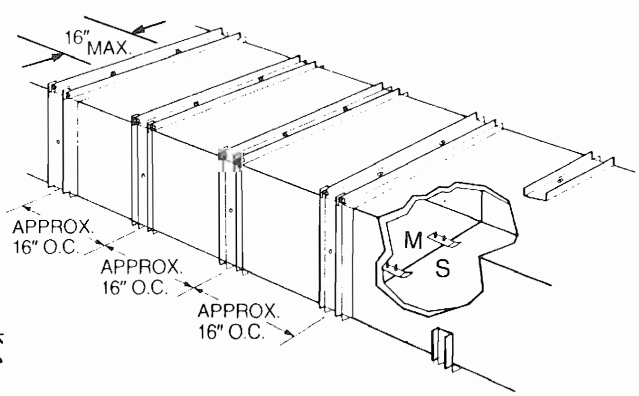


Figure 3-15 TYPICAL CHANNEL REINFORCEMENT ON 16″ CENTERS, 48″ DUCT SECTIONS

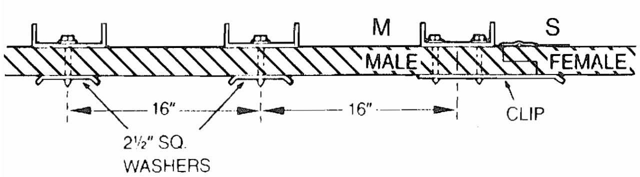
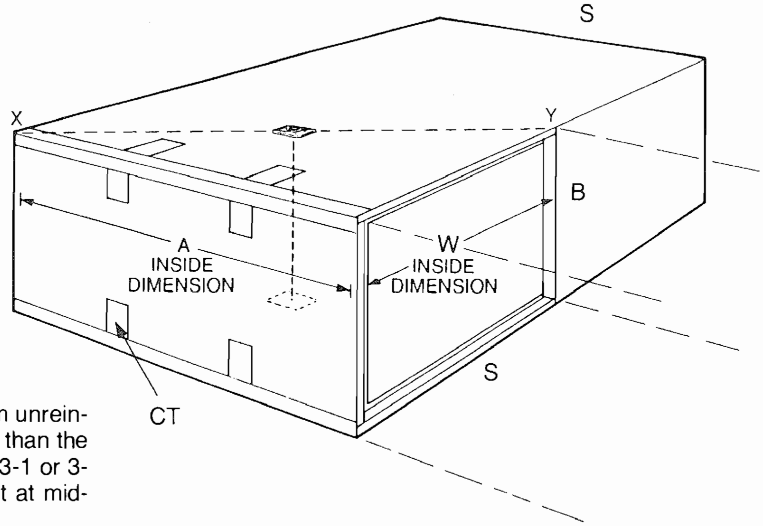


Figure 3-15A

FITTING REINFORCEMENT 90 DEGREE ELBOWS

SHIPLAP CONSTRUCTION
Cheek Panels—Positive Pressure

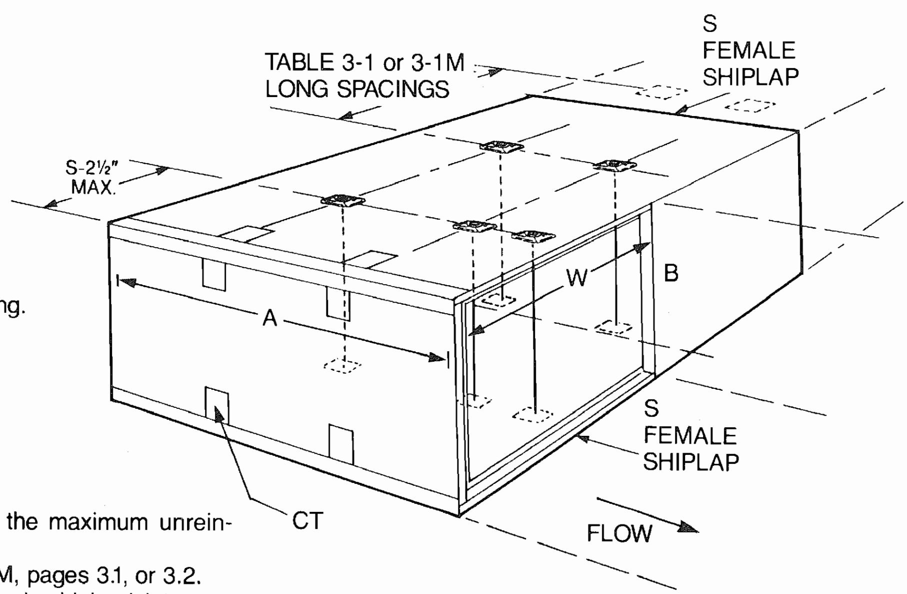


If neither A nor W are greater than the maximum unreinforced duct dimension *but* diagonal X-Y *is* greater than the maximum unreinforced duct dimension per Table 3-1 or 3-1M, pages 3.1 or 3.2; install tie rod reinforcement at mid-span of diagonal.

Figure 3-16 TIE ROD REINFORCEMENT AT DIAGONAL X-Y MID-SPAN, 90° ELBOWS

NOTE
Turning vanes omitted for clarity.

IN	2½	4
MM	64	101



S = Max. longitudinal spacing.

If either A or W is greater than the maximum unreinforced duct dimension:
- Reinforce per Table 3-1, or 3-1M, pages 3.1, or 3.2.
- Reinforce 4″ upstream from female shiplap joints.
- Reinforce where centerlines intersect.

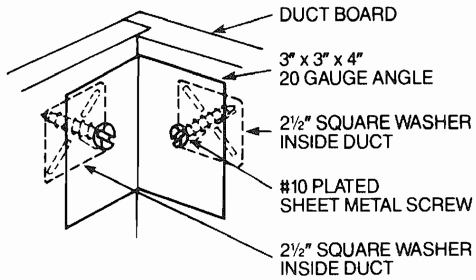
Figure 3-17 TIE ROD REINFORCEMENT, CHEEK PANELS, LARGE 90° ELBOWS

NOTE
Turning vanes do *not* replace reinforcement. For reinforcement of mitered elbows use reinforcement standards for offsets.

FITTING REINFORCEMENT 90 DEGREE ELBOWS *(Continued)*

SHIPLAP CONSTRUCTION—HEAD AND THROAT PANELS—POSITIVE PRESSURE

If duct dimension H is less than the maximum unreinforced duct dimension from Table 3-1 or 3-1m, page 3.1 or 3.2, but more than 24″, install sheet metal angle per Detail Ⓐ below. (Angle may also be installed on inside of throat.)



DETAIL Ⓐ. THROAT REINFORCEMENT

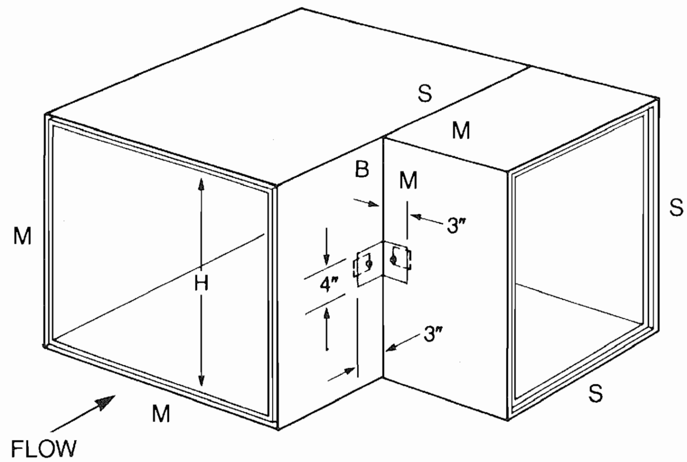
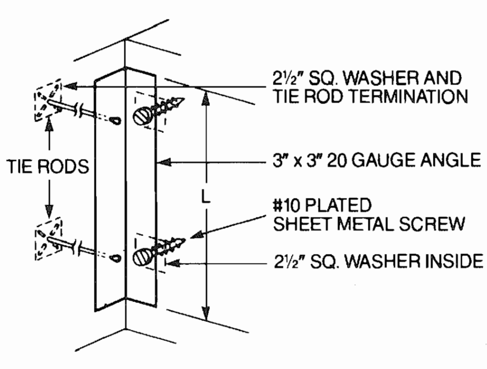


Figure 3-18 SHEET METAL ANGLE REINFORCEMENT AT THROAT, 90 DEGREE ELBOWS

IN	2½	3	4	16	20	24	36	52	68	20 GA
MM	64	76	101	.41 M	.51 M	.61 M	.91 M	1.32 M	1.73 M	.906

When duct dimension H normally requires reinforcing, install sheet metal angle per Detail Ⓑ below. Install tie rods through angle on upstream side, 16″ on centers, in accordance with Table 3-1 or 3-1M, page 3.1 or 3.2 with angle length L from table below.

No. Tie Rods	1	2	3	4	5
Angle Length L, in.	4	20	36	52	68



DETAIL Ⓑ. THROAT REINFORCEMENT

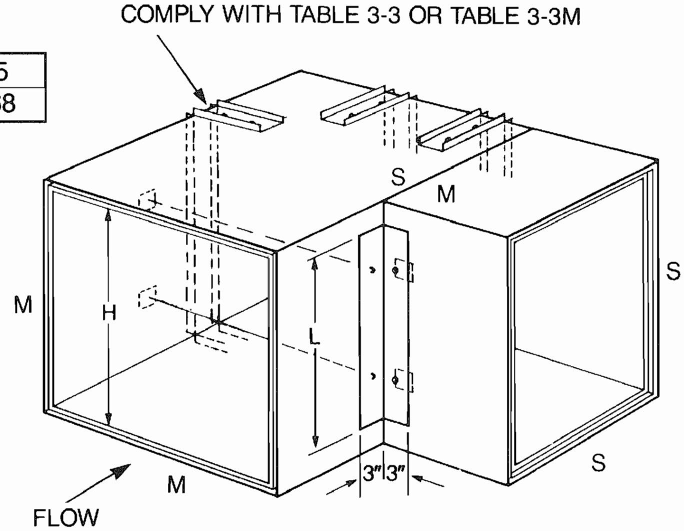


Figure 3-19 SHEET METAL ANGLE REINFORCEMENT AT THROAT, LARGE 90 DEGREE ELBOWS

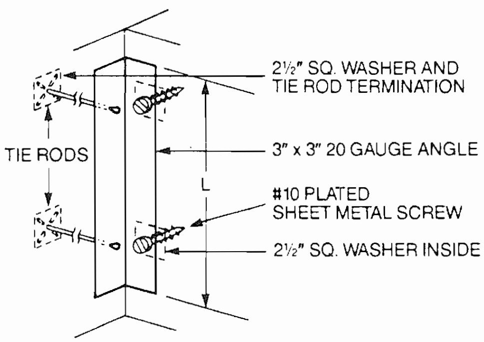
For reinforcement of mitered elbows use reinforcement standards for offsets

FITTING REINFORCEMENT BRANCH CONNECTIONS

BRANCH CONNECTIONS

Reinforcement–Positive Pressure

If W is greater than one half the Table 3-1, or 3-1M maximum unreinforced duct dimension, but not greater than the maximum unreinforced duct dimension, reinforce per Fig. 3-20, 4″ off female shiplap.



DETAIL Ⓐ THROAT REINFORCEMENT

If H is greater than 16″ and W is greater than the Table 3-1, or 3-1 maximum unreinforced duct dimension, reinforce per Fig. 3-21, Detail Ⓐ and Table 3-1, or 3-1M, page 3.1, or 3.2. For angle length L, see table below.

No. Tie Rods	1	2	3	4	5
Angle Length L, in.	4	20	36	52	68

3″ × 3″ × 20 GAUGE ANGLE

IN	2½	3	4	16	20	24	36	52	68	20 GA
MM	64	76	101	.41 M	.51 M	.61 M	.91 M	1.32 M	1.73 M	.906

If W is greater than the maximum longitudinal reinforcement spacing of the trunk duct, and/or H is greater than 16″, reinforce per Fig. 3-22 and Table 3-3 or 3-3M, page 3.7 or 3.8.

NOTE

When a tie rod location per Table 3-1 or 3-1M falls in the branch opening it is omitted and a tie rod is placed on each side of the branch.

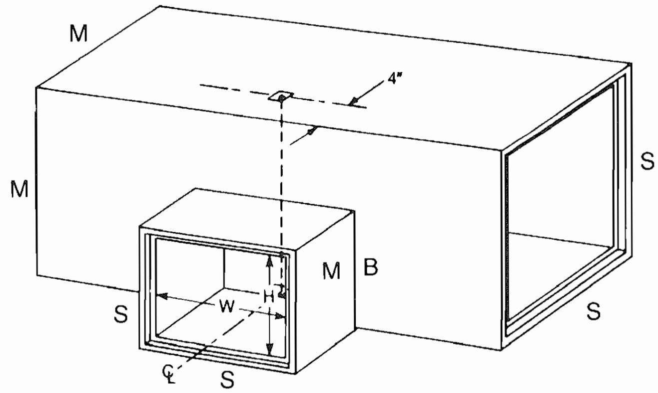


Figure 3-20 TRUNK DUCT REINFORCEMENT 4″ OFF FEMALE SHIPLAP

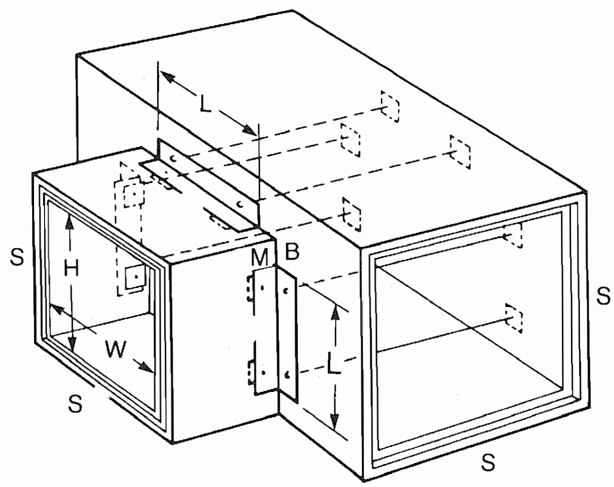
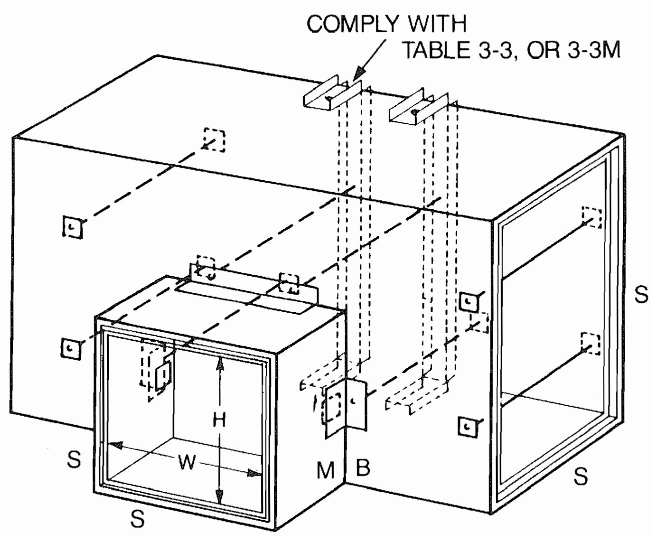


Figure 3-21 SHEET METAL ANGLE REINFORCEMENT, TOP AND SIDES OF BRANCH



Figue 3-22 TRUNK DUCT REINFORCEMENT WITH 3″ CHANNELS

FITTING REINFORCEMENT TEES

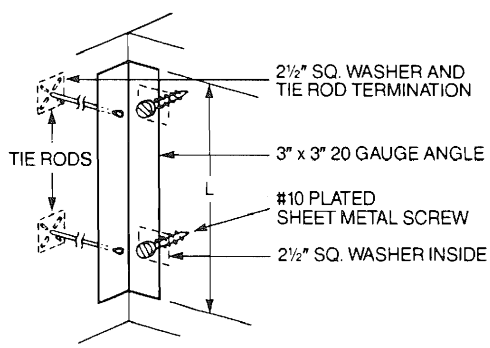
TEES—CHEEK PANELS—POSITIVE PRESSURE

If W1 is less than the maximum unreinforced duct dimension but diagonals X-Y or Y-Z exceed the maximum allowable unreinforced duct dimensions, install tie rods per Fig. 3-23, 4″ from female shiplaps.

NOTE

Turning vanes omitted for clarity.

No. Tie Rods	1	2	3	4	5
Angle Length L, in.	4	20	36	52	68



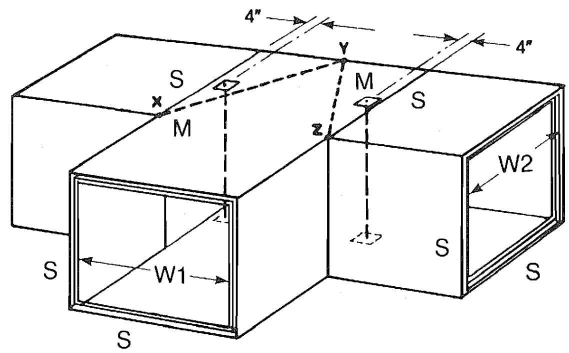


Figure 3-23 TEE REINFORCEMENT AT FEMALE SHIPLAP JOINTS

DETAIL Ⓐ THROAT REINFORCEMENT

If W1 is greater than the maximum unreinforced duct dimension and W2 is greater than half the maximum unreinforced duct dimension, install tie rods 4″ from female shiplap joints, per Figure 3-24 along W2 width center lines spaced per Table 3-1, or 3-1M and across W1 width per Table 3-1, or 3-1M.

Where a splitter damper interferes with rod reinforcement, wraparound channels must be used in their place.

NOTE

Throat reinforcement is the same as for Figures 3-18, 3-19 and 3-21.

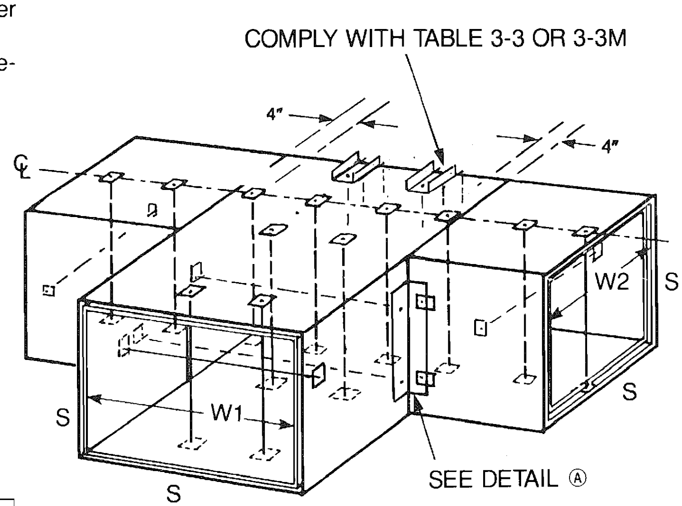


Figure 3-24 TEE REINFORCEMENT NORMAL TIE ROD LOCATIONS

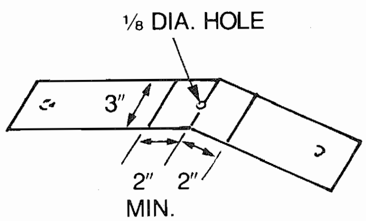
NOTE

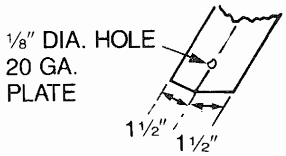
Turning vanes do not replace reinforcement.

IN	2½	3	4	20	24	36	52	58	20 GA
MM	64	76	101	.51 M	.61 M	.91 M	1.32 M	1.47 M	.906

FITTING REINFORCEMENT OFFSETS AND MITERED ELBOWS

OFFSETS AND MITERED ELBOWS—POSITIVE PRESSURE





REINFORCEMENT PLATE DETAILS

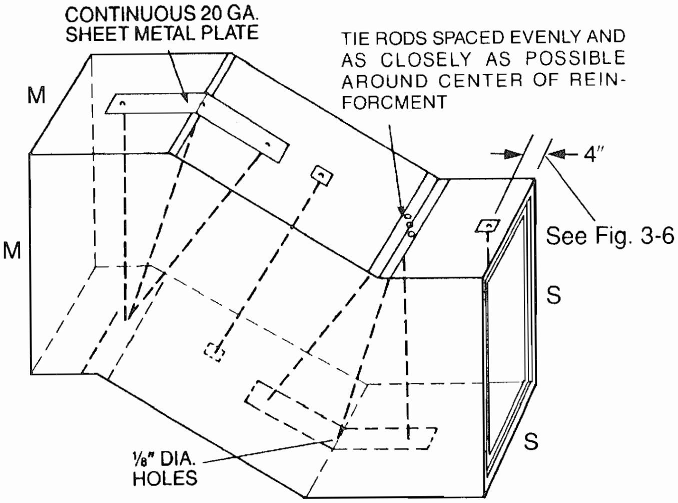


Figure 3-25 MITER REINFORCEMENT WITH INTERMEDIATE TIE RODS AND EXTENDED SHEET METAL PLATES

If H is greater than the maximum unreinforced duct dimensional and cheek panels have butt joints, install reinforcement at butt joints.

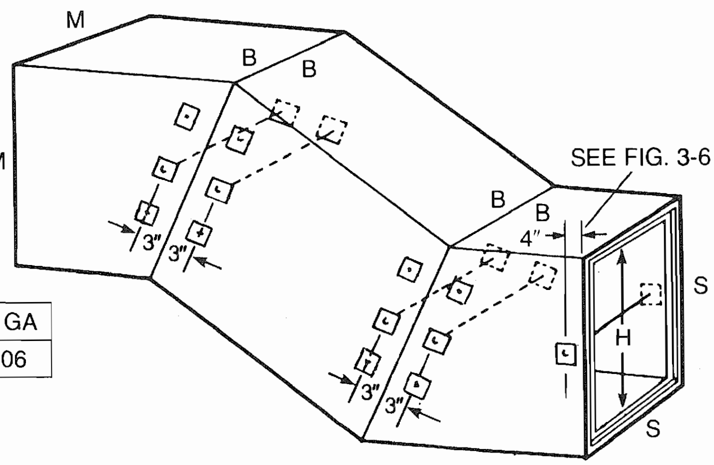


Figure 3-26 REINFORCEMENT CHEEK PANELS WITH BUTT JOINTS

IN	1/8	1 1/2	2	3	4	20 GA
MM	3.18	38	51	76	102	.906

NOTES

1. Tie rod spacing must not exceed Table 3-1, or 3-1M in either direction.
2. Reinforcement of mitered connections shall otherwise conform to Figure 3-5 through 3-8 and Table 3-1, or 3-1M.

FITTING REINFORCEMENT TRANSITIONS

TRANSITIONS—CHEEK PANELS—POSITIVE PRESSURE

If H is greater than the maximum unreinforced duct dimension, reinforce per Table 3-1, or 3-1M, page 3.1 or 3.2. Determine tie rod spacing from larger duct dimension per Table 3-1, or 3-1M. Maintain spacing and number of tie rods throughout length of transition.

IN	2½	3	4	20 GA
MM	64	76	102	.906

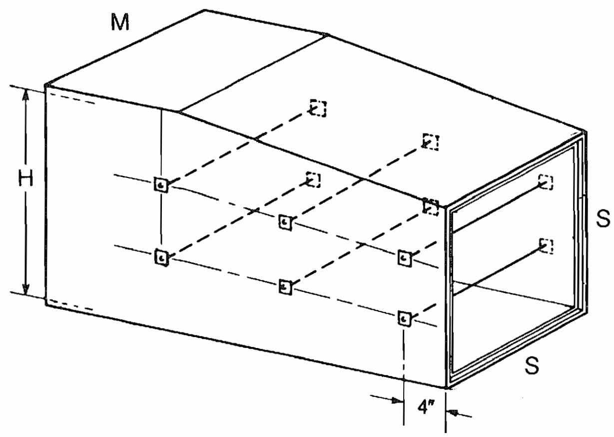


Figure 3-27 TRANSITION REINFORCEMENT CHEEK PANELS

TRANSITIONS—SLOPED PANELS

If W is greater than the maximum unreinforced duct dimension, reinforce 4" from female shiplap and continue with reinforcement per Table 3-1, or 3-1M and Detail Ⓐ below. As an alternate to Detail Ⓐ, single 2½" square washers may be glued to the facing with an adhesive system documented by the duct board manufacturer.

If facing is cut use 3" × 4" 20 gauge sheet metal plate, bent to conform to transition angle.

(Tie rod terminations *must* be made with Fasloop or pop rivet terminations. They may *not* be made using the locking cap method.) As an alternate to the steel plate, if facing is not cut, a 2½" square washer, pre-bent to conform to slope angle, may be used to secure tie rods. See Detail Ⓑ.

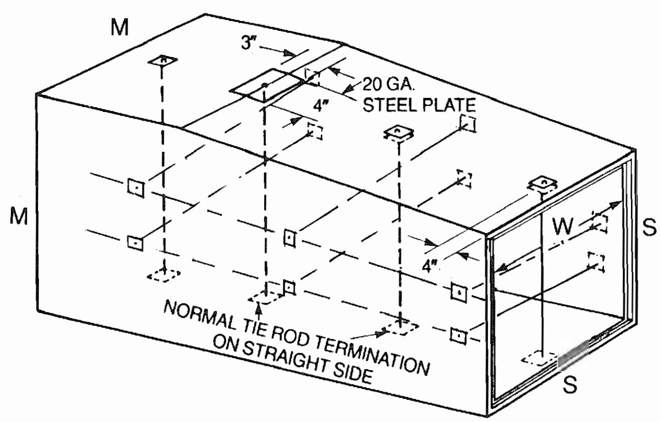
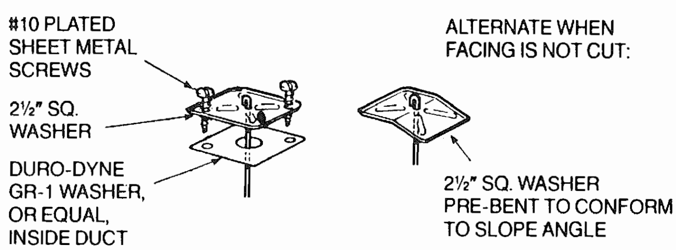


Figure 3-28 TRANSITION REINFORCEMENT, SLOPING SECTION



DETAIL Ⓐ
MUST BE USED ON SLOPES

DETAIL Ⓑ
USE ON MITER JOINT, LARGE END

FITTING REINFORCEMENT ACCESS DOORS

ACCESS DOORS—POSITIVE PRESSURE

If access door width is not greater than the maximum longitudinal reinforcement spacing from Table 3-1, or 3-1M, but interferes with reinforcement locations per Table 3-1, or 3-1M, install tie rods 4″ from both sides of door opening. Maximum reinforcement spacing must be in accordance with Table 3-1, or 3-1M, page 3.1 or 3.2.

If access door height is greater than 16″ and width is greater than maximum longitudinal reinforcement spacing shown in Table 3-1, or 3-1M, page 3.1 or 3.2, install tie rods near vertical sides of door frame per spacing in Table 3-1, or 3-1M. Install tie rods near horizontal sides of frame per spacing in Table 3-1, or 3-1M, measuring upstream from vertical tie rod location.

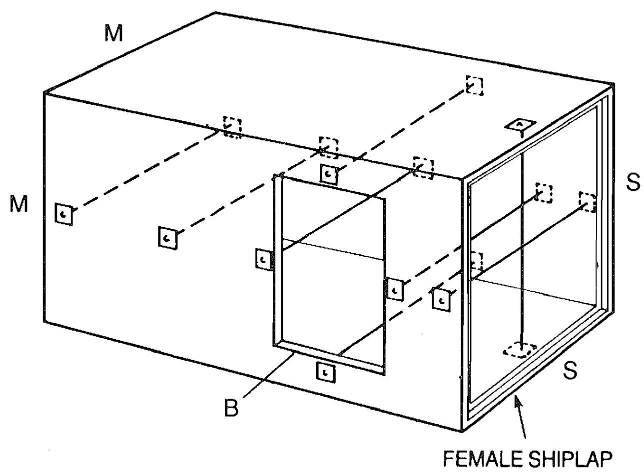


Figure 3-29 REINFORCEMENT OF ACCESS DOOR FRAMING

NOTES

1. No access door can be located less than 4″ from a transverse joint or from an end panel. All access doors require metal frames in openings.
2. Use channel reinforcement in place of tie rods between access door and fire damper where tie rods would interfere with damper access or operation.

IN	4	16
MM	102	.41 M

FITTING REINFORCEMENT END CAPS

END CAPS, SHIPLAPPED CONSTRUCTION

Channel Reinforcement—Positive or Negative Pressure

Channel reinforcement must be installed on the inside of the duct to enable the end cap to withstand the static and velocity pressures to which it will be subjected.

See Table 3-2, or 3-2M, page 3.5 or 3.6, for reinforcement channel height H and Table 3-3, or 3-3M, page 3.7 or 3.8, for channel L. Also see Table 3-3, or 3-3M for longitudinal spacing and number of attaching screws for the applicable duct span and static pressure.

IN	1/8	1 1/4	2 1/2	3	16	60	18 GA	22 GA
MM	3.2	32	63	76	.41 M	1.52 M	1.181	.7534

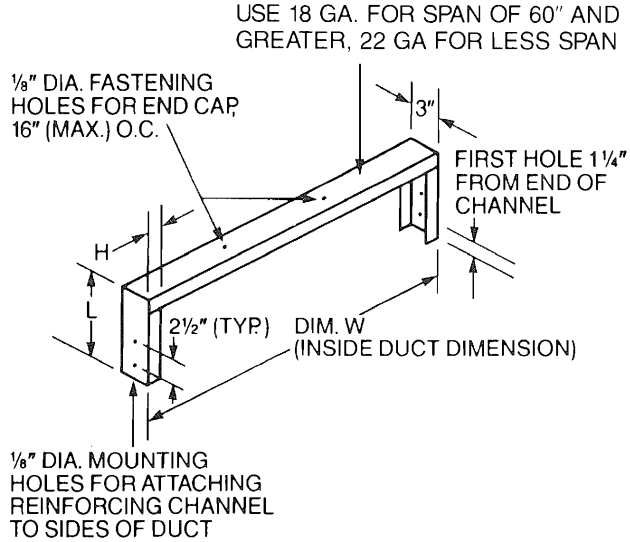
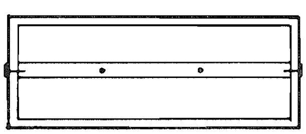


Figure 3-30 END CAP REINFORCEMENT CHANNEL

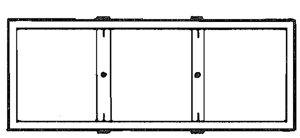
NOTES

1. End cap reinforcement may be applied either parallel to the longest inside dimension or parallel to the shortest, depending on sheet metal and fastener usage required.
2. End caps require reinforcement whenever the schedule for straight ducts of the same dimension shows reinforcement is required.

REINFORCEMENT PARALLEL TO LONG INSIDE DIMENSION



REINFORCEMENT PARALLEL TO SHORT INSIDE DIMENSION



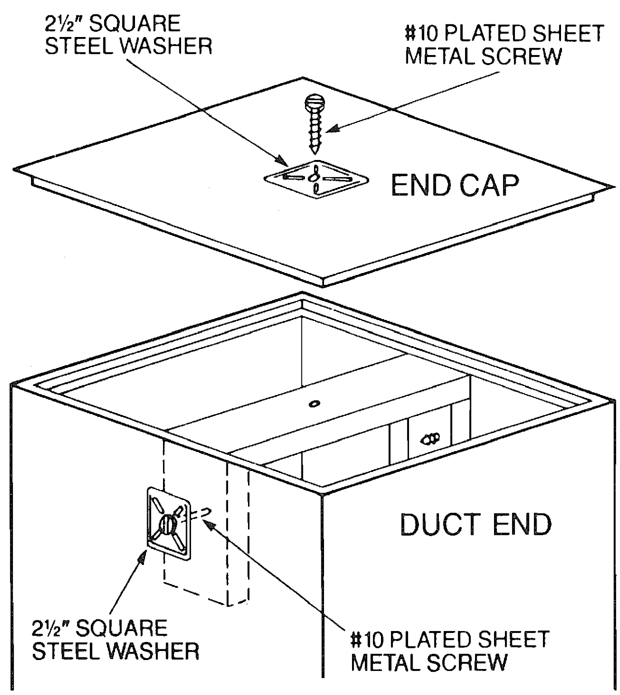


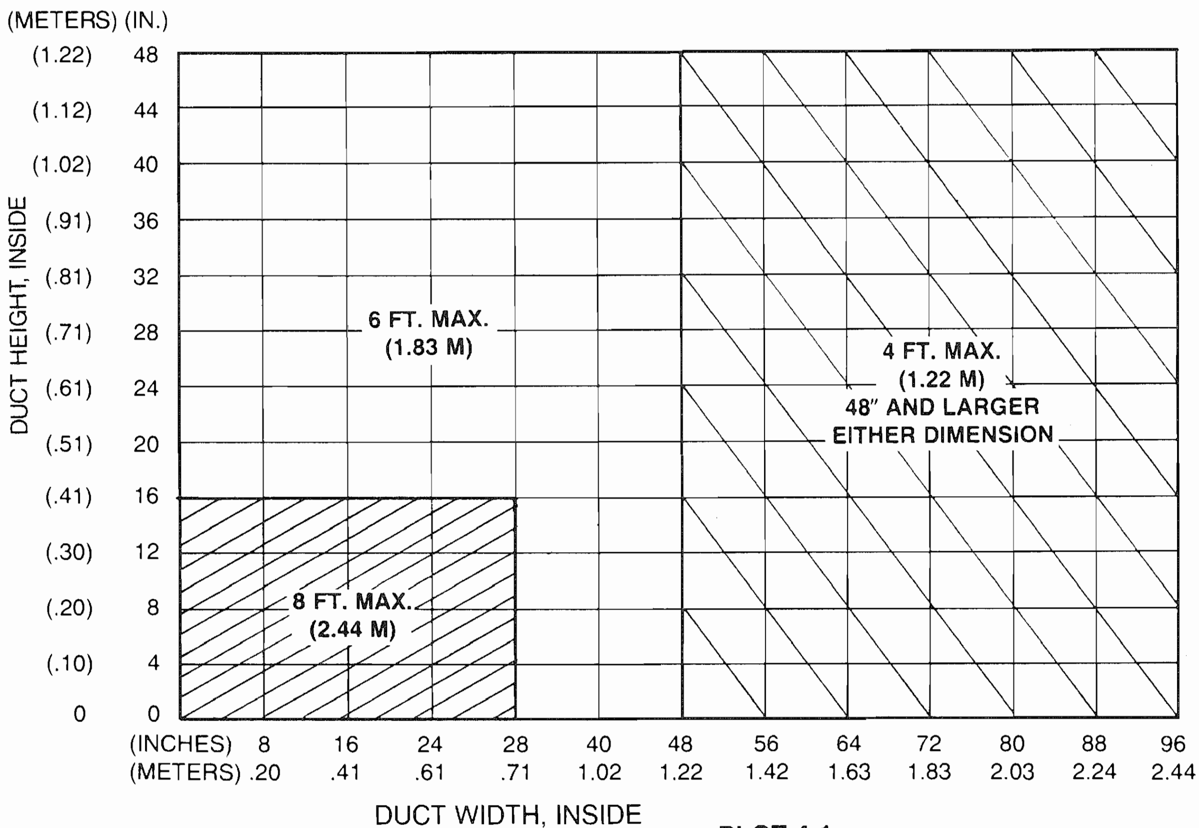
Figure 3-31 END CAP REINFORCEMENT INSTALLED

CHAPTER 4

RECTANGULAR DUCT HANGERS AND SUPPORTS

HANGERS AND SUPPORTS

ALLOWABLE HANGER SPACING, STRAIGHT DUCT, 3″ WIDE CHANNEL



PLOT 4-1
(see Table 4-1)

IN	1	6	12 GA	4 FT.	6 FT.	8 FT.
MM	25	152	2.7	1.22 M	1.83 M	2.44 M

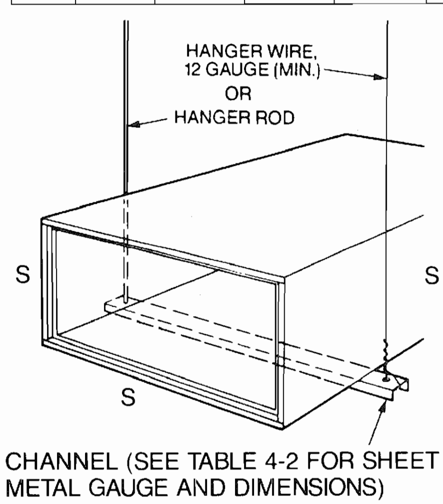


Figure 4-1

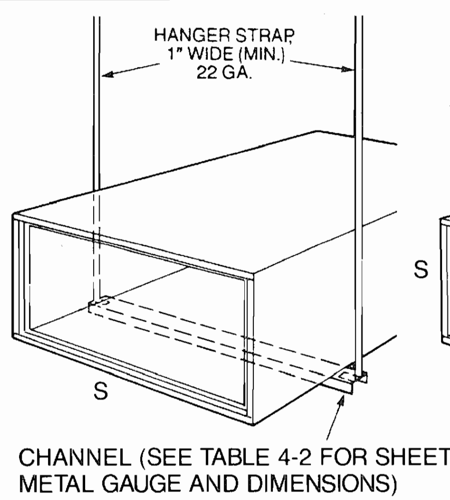


Figure 4-2

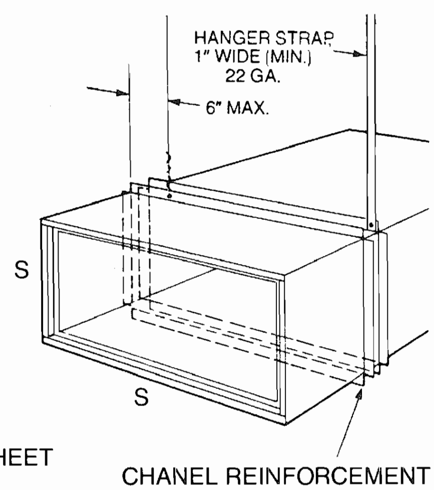


Figure 4-3

HANGERS AND SUPPORTERS *(Continued)*

STANDARD 3″ WIDE HANGERS

Hanger extension is defined as the sum of the distances between the hanging wires and the duct walls (both sides).

TABLE 4-1 MAXIMUM HANGER SPACING BY DUCT SIZE, I.D.

DUCT SIZE, INCHES	MAXIMUM HANGER SPACING
48″ Wide or greater	4 FT
Less than 48″ wide and less than 48″ deep	6 FT
Width between 28″ & 48″ and greater than 16″ deep	6 FT
Less than 28″ wide and 16″ depth or less	8 FT

TABLE 4-2 CHANNEL SELECTION

IF TOTAL EXTENSION IS NOT GREATER THAN:	MINIMUM CHANNEL GAUGE	MINIMUM CHANNEL PROFILE
6″	24	3″ X 1.5″
18″	22	3″ X 2″
30″	18	3″ X 2″

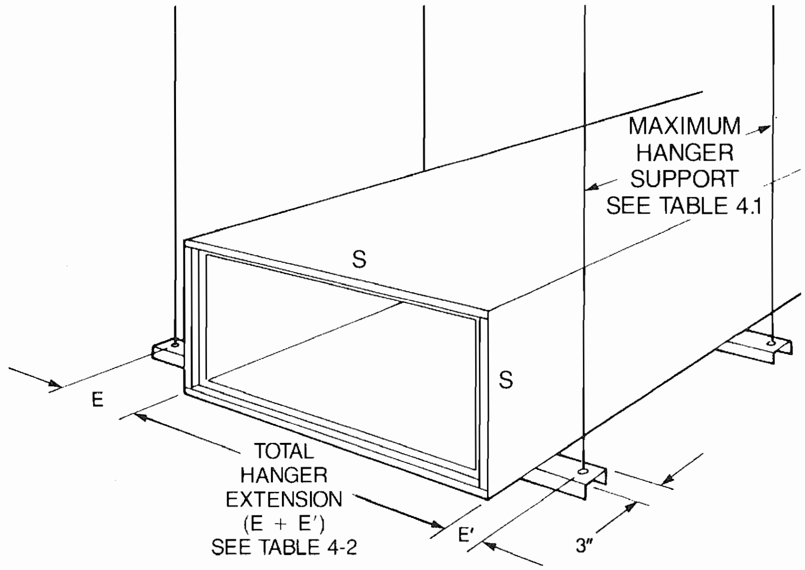


Figure 4-4 HANGER SPACING AND EXTENSION 3″ WIDE CHANNELS

USE OF 2″ WIDE HANGERS

22 gauge, 2″ × 1.5″ hangers may be substituted for 3″ hangers for ducts with widths not over 48″ and depths not over 24″ provided that not more than one joint occurs between hangers and the maximum hanger spacing is 4 ft. Exception: When duct perimeter is 80″ or less and does not require reinforcement two joints are permitted between hangers.

IN	1.5	2	3	6	16	18	24	28	30	48	80
MM	38	51	76	152	.41 M	.46 M	.61 M	.71 M	.76 M	1.22 M	2.03 M

FT	4	6	8	18 GA	22 GA	24 GA
M	1.22	1.83	2.44	1.181	.7534	.6010

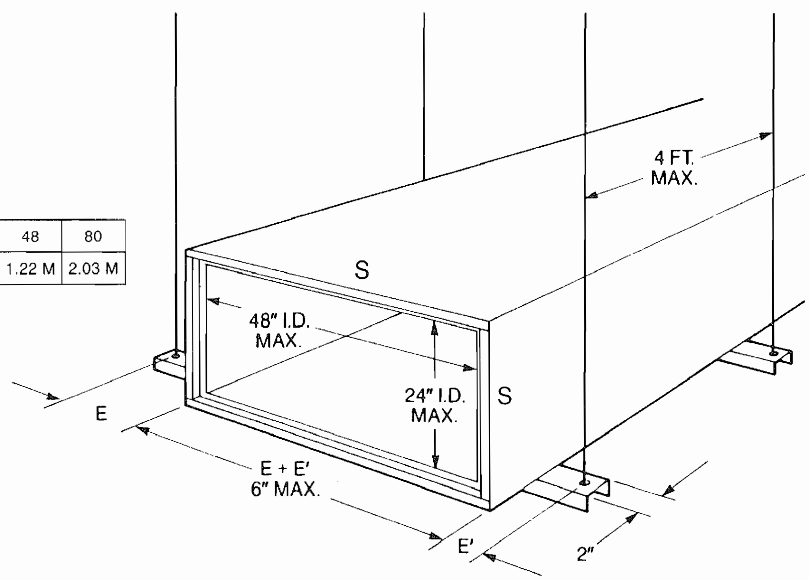


Figure 4-5 USE OF 2″ WIDE HANGER CHANNELS

HANGING FITTINGS

HANGING FIBROUS GLASS DUCT FITTINGS UP TO 48″ IN WIDTH

2/3 of the diagonal distance from throat to heel (approx.)

Required only when duct is greater than 18″ in width.

IN	12	18	48
MM	.30	.46	1.22

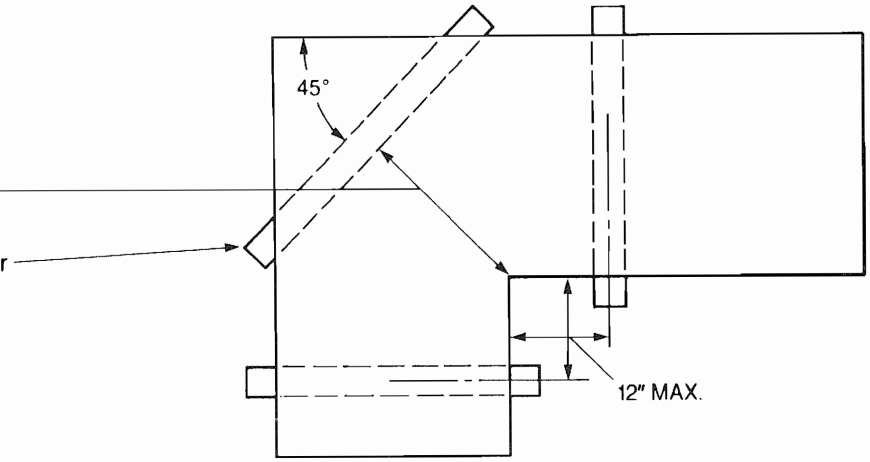


Figure 4-6 ELBOW SUPPORT

If trunk duct hanger falls where branch duct is located, add trunk hangers on either side of branch duct.

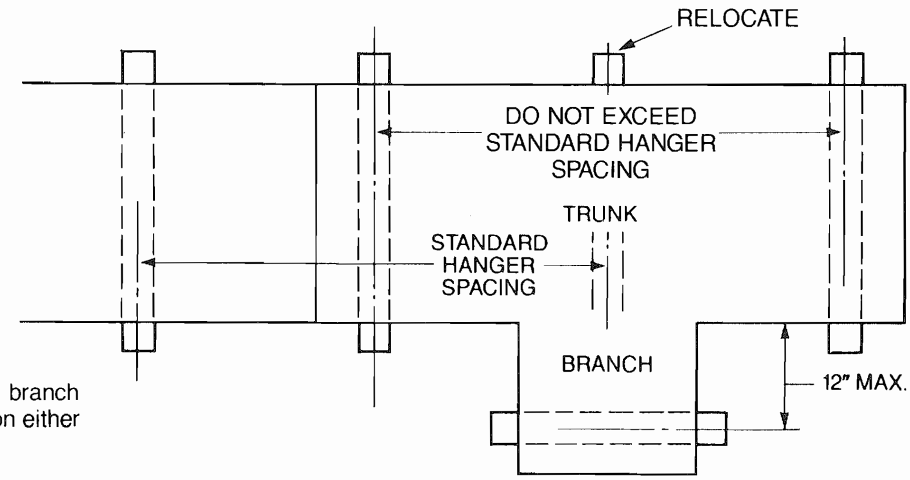


Figure 4-7 BRANCH SUPPORT

If a tee run-out hanger falls where trunk duct is located, add run-out hangers on either side of trunk.

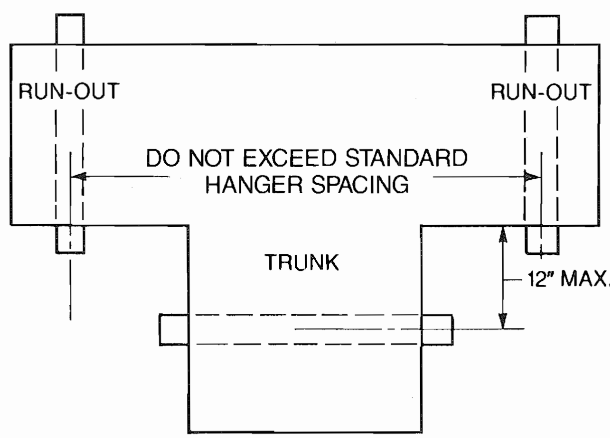


Figure 4-8 TEE SUPPORT

HANGERS AND SUPPORTS *(Continued)*

HANGING FIBROUS GLASS DUCT FITTINGS UP TO 48″ IN WIDTH

IN	1	2½	3	6	9	12	48
MM	25	64	76	152	228	.30 M	1.22 M

Required only when angled portion of offset is greater than 48″ long. Additional hangers may be required to comply with spacing. See page 4.1 or 4.2.

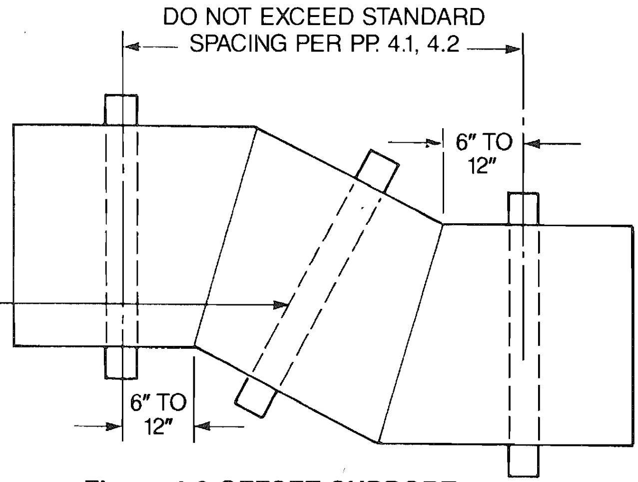


Figure 4-9 OFFSET SUPPORT (FLAT BOTTOM SURFACE)

Locate Hangers as for straight duct.

NOTE

Hanger spacing may change when transition is from one hanger size to another. Use closest spacing called for per pages 4.1 and 4.2.

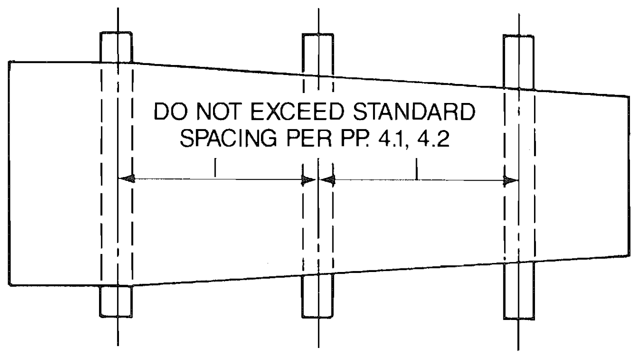
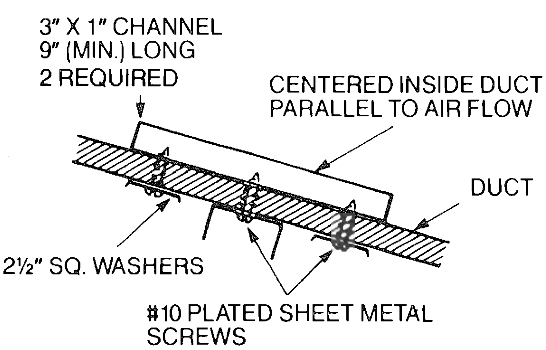


Figure 4-10 TRANSITION SUPPORT (FLAT BOTTOM SURFACE)

Required only when inclined portion of duct is greater than 48″. Hanger is attached to duct per detail, Fig. 4-11. Additional hangers may be required to comply with hanger spacing per pages 4.1 and 4.2.



DETAIL OF SUPPORT AT INCLINED BOTTOM SURFACE

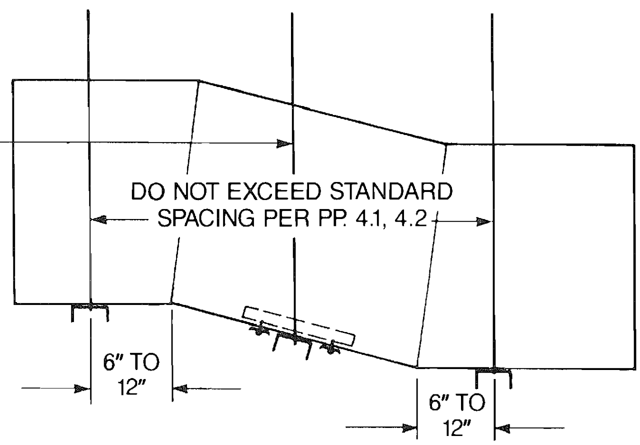


Figure 4-11 SUPPORTING OFFSETS AND TRANSITIONS WITH INCLINED BOTTOM SURFACES

VERTICAL RISER SUPPORT

Risers in fibrous glass duct systems of 8 feet or greater require the use of special support as shown in Fig. 4-12, or 4-13. This reinforcement and support are in addition to reinforcement as may be required by provisions of Chapter 3 of this manual. Vertical riser supports shall be installed at maximum spacing intervals of 12 feet.

NOTE

Riser height is limited to not more than two (2) stories.

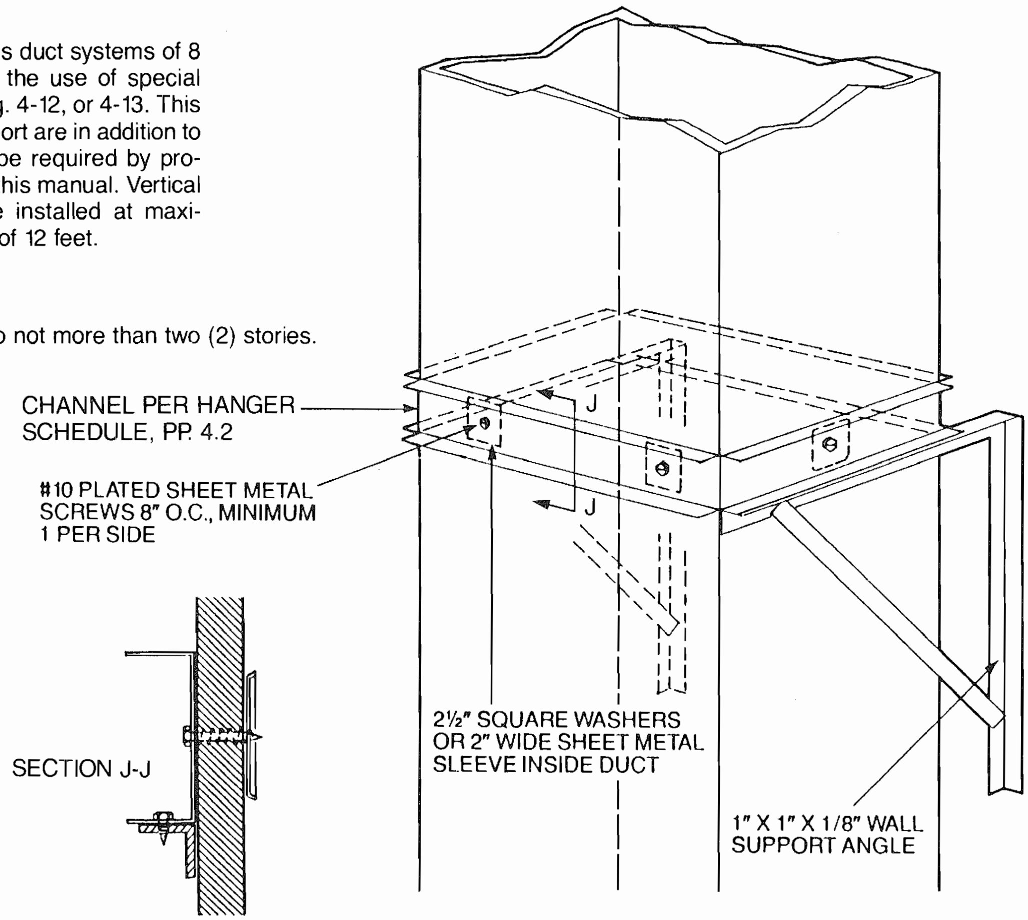
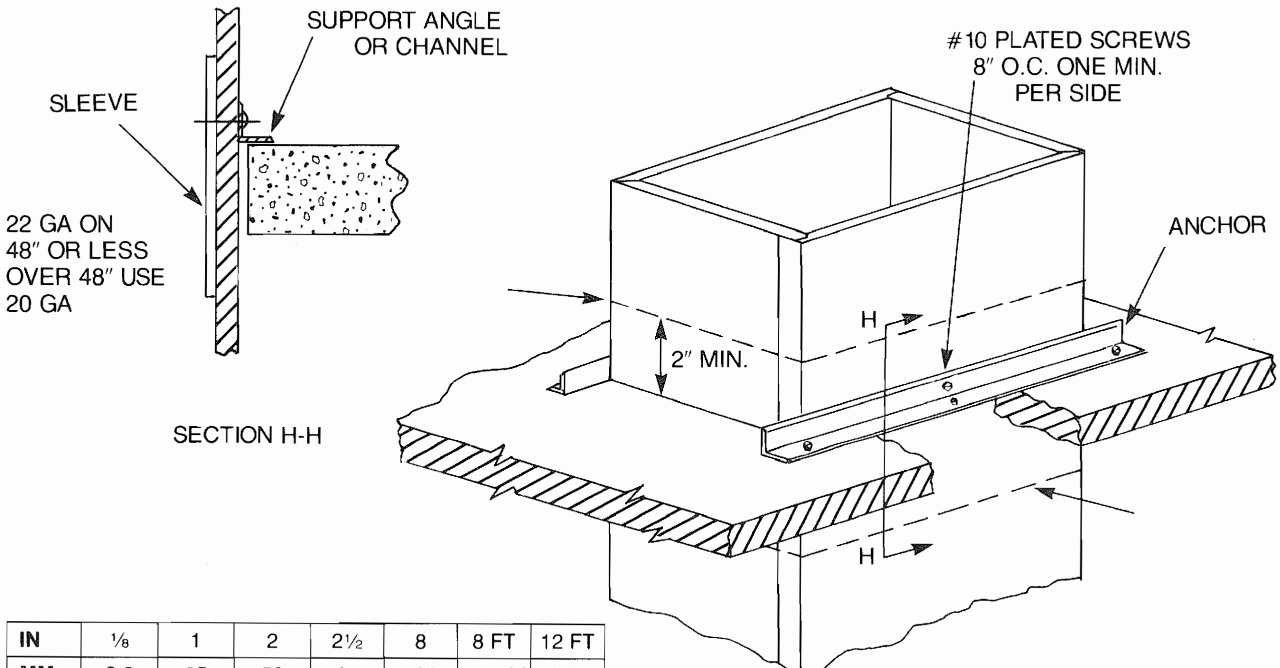


Figure 4-12 SUPPORT FROM WALL



IN	⅛	1	2	2½	8	8 FT	12 FT
MM	3.2	25	50	64	203	2.44 M	3.66 M

Figure 4-13 SUPPORT FROM FLOOR

HEATER SUPPORT

SLIP-IN ELECTRIC HEATER SUPPORT

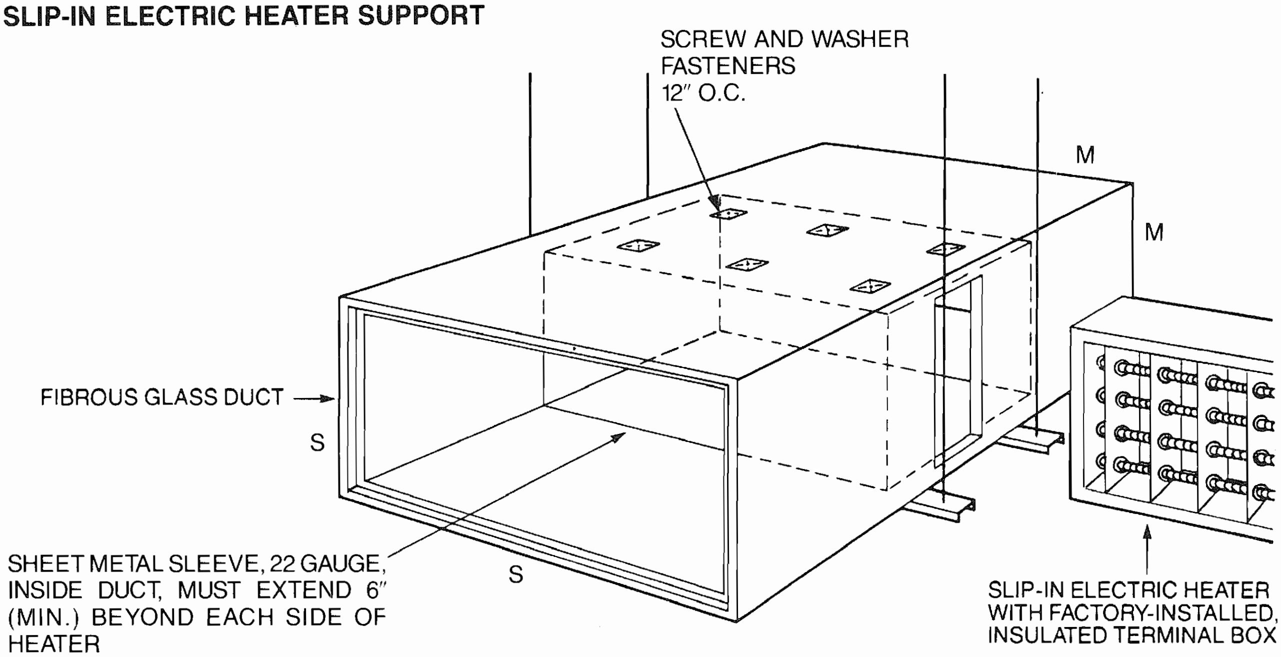


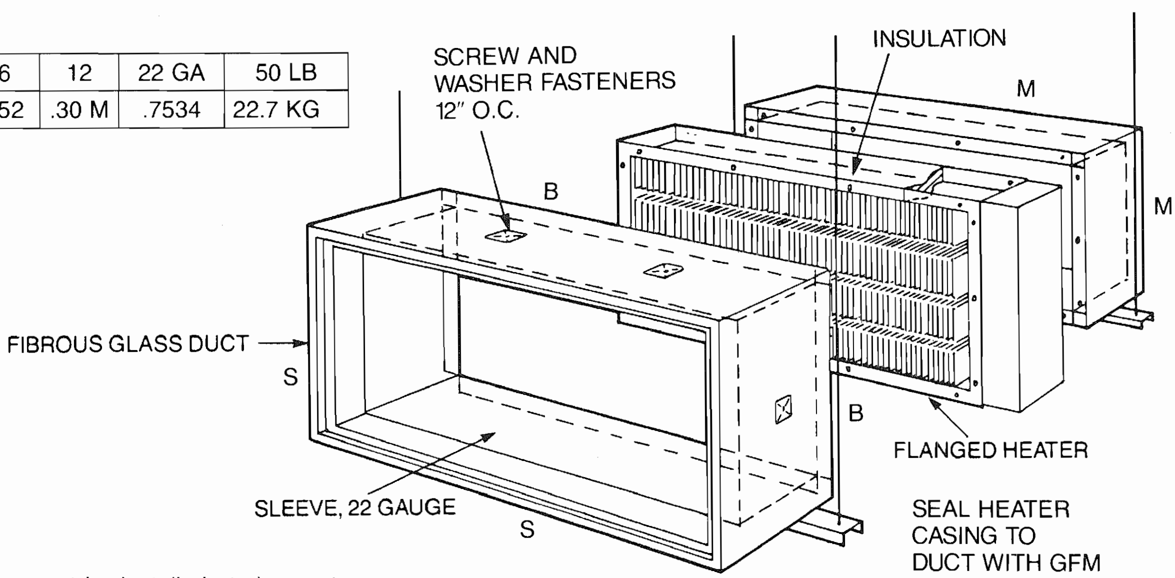
Figure 4-14

Hangers must be installed at sleeves to support weight of heater. Hang heater separately if weight exceeds 50 pounds.

FLANGED HEATER SUPPORT

Flanged sheet metal sleeve 6" (min.) long, 22 gauge, screwed to heater flange with suitable fasteners inserted into ends of duct.

IN	6	12	22 GA	50 LB
MM	152	.30 M	.7534	22.7 KG



Hangers must be installed at sleeves to support heater weight. Hang heater separately if weight exceeds 50 pounds.

Figure 4-15

VOLUME DAMPER INSTALLATION

Attach operator mounting brackets with #10 × 1¼″ sheet metal screws, 12″ bracket and min. 2 per side.

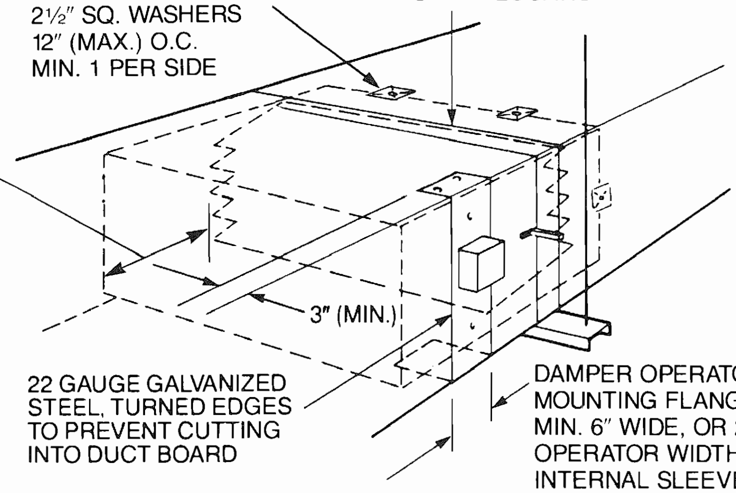


Figure 4-16

DUCT SPAN, INCHES	SHEET METAL GAUGE
Less than 12	26
13 to 30	24
31 to 54	22

IN	1¼	2	3	6	12	13	30	34	54	22 GA	24 GA	26 GA
MM	32	51	76	152	.30 M	.33 M	.76 M	.86 M	1.37 M	.7534	.6010	.4712

CHAPTER 5

APPENDIX

CONTRIBUTORS TO FORMER EDITIONS OF THE SMACNA FIBROUS GLASS DUCT CONSTRUCTION STANDARDS

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Keith Thomas
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Denver, Colorado

INSPECTION CHECKLIST FOR FIBROUS GLASS DUCT SYSTEM INSTALLATION

References

SMACNA Standards

North American Installation Manufacturers Association (NAIMA)*

Board Manufacturer's Standards

*Formerly Thermal Insulation Manufacturers Association (TIMA) Standards

General	YES	NO
1. Is the duct used within its service limitations?	☐	☐
2. Is system operating within the design limitations for which it was built?	☐	☐
3. Are all sheet metal accessory items galvanized?	☐	☐
4. Is the EI rating printed on the board facing?	☐	☐
5. Is the UL label present on much of the duct surface?	☐	☐
6. Is the system free from visual signs of duct board facing delamination?	☐	☐
Fabrication and Installation		
7. Are turning vanes installed in accordance with the Standards? (Pressing your hand into the cheek of the ell will reveal if specified vanes are being used.)	☐	☐
8. When metal parts are attached, are 2½" (minimum) square steel washers used on 16" (maximum) centers?	☐	☐
9. When staples can't be used, are 8" cross tabs of approved closure being used in place of staples? (Tab spacing requirements are 12" O.C., minimum one per side)	☐	☐
10. Is the system completely free from tears or punctures in the facing?	☐	☐
11. Is the system free from areas where excessive amounts of closure materials, such as several wraps around a joint, may have been used to conceal potential problem areas?	☐	☐
12. Are all system joints tight, free from bulges, with taped joints showing good workmanship?	☐	☐
13. Are all fittings fabricated in accordance with the Standards and do they demonstrate good workmanship?	☐	☐
14. Have offsets been installed so duct sections aren't forced to bend around obstructions?	☐	☐
15. Are all panels in any fitting at least 4" long, including male or female joints?	☐	☐
Electric Heaters		
16. Is interior sleeve present, properly attached with screws and washers 16" on centers?	☐	☐
17. Is heater separately supported?	☐	☐
Dampers		
18. If a motorized damper operator is being used, is the sheet metal sleeve extended so the operator is mounted on the same sleeve with the damper?	☐	☐
19. On a manual volume damper, does the quadrant move a full 90 degrees?	☐	☐
Fire Dampers		
20. Is sheet metal sleeve present? (Fibrous duct stops at barrier)	☐	☐
21. Is duct properly attached to sleeve with screws and washers 16" on centers?	☐	☐
Access Doors		
22. Is installation in accordance with the Standards?	☐	☐
Grilles, Diffusers, Registers		
23. Is the extra weight of the item being separately supported and not dependent on the duct alone for support? (Exception: Registers not greater than 150 square inches in area may be attached to the duct with metal channel without other support.)	☐	☐
Equipment Unit Connection		
24. Are sheet metal screws and washers used to secure duct system to flange extensions? (Mechanical fasteners must be used!)	☐	☐
Closure		
25. Are all joints in the system properly sealed?	☐	☐
26. Are closure materials of a listed type as evidenced by presence of UL instruction sheet in duct board carton? Is tape imprinted?	☐	☐

IN	2½	4	8	12	16
MM	64	101	203	.30 M	.41 M

	YES	NO
27. Are there staples or cross tabs, properly spaced, on circumferential joints?	☐	☐
28. Are staples, if used, of the correct type and size, and spaced in proper intervals as recommended by the duct board manufacturer?	☐	☐
29. Are all pressure-sensitive tape closures rubbed down adequately, with staples or scrim in facing clearly visible through the tape?	☐	☐
30. If heat-sealable tape closure was used, was it applied correctly, as evidenced by dot color change?	☐	☐
31. If glass fabric and mastic are used, is the mesh of the glass fabric completely filled with mastic?	☐	☐
Reinforcement		
32. Is reinforcement system of recommended type (formed metal, tie rod, or combination)?	☐	☐
33. Is tie rod wire 12 gauge or heavier?	☐	☐
34. Is tie rod spacing correct according to duct span, board type and static pressure?	☐	☐
35. Are tie rod washers 2½" square and proper gauge by type?	☐	☐
36. Do tie rod washers have turned edges facing away from duct board so they won't cut into it?	☐	☐
37. If tie rods reinforce a butt joint, are rods used on both sides of butt joint?	☐	☐
38. Is wire termination one of those in the Standards?	☐	☐
39. Are anti-sag devices used on ducts 48" span or greater, to support top panel of ducts?	☐	☐
40. Do tie rods run straight through ducts and not at angles?	☐	☐
41. Are heels of tees, elbows and end caps reinforced (formed sheet metal channel, tie rod, combination)?	☐	☐
42. When formed sheet metal channel reinforcement is used, are sheet metal gauges, dimensions, and spacing correct?	☐	☐
43. On supply ducts, is reinforcing member on the female side of the shiplap?	☐	☐
44. On return ducts, are sheet metal channel reinforcements attached to ducts with screws and 2½" square washers or 2" × 6" clips?	☐	☐
45. On return ducts, is the reinforcing member attached to the male shiplap side of the joint?	☐	☐
46. For the heels of tees, elbows, end caps, and any other fittings where a panel faces an opening on the opposite side, is correct reinforcing member (type: sheet metal channel, tie rod, or combination) applied?	☐	☐
Hangers and Supports		
47. Are hangers installed in accordance with the Standards	☐	☐
48. Are hanger designs in accordance with the Standards?	☐	☐
49. Are accessories that add weight to the duct system separately supported so as not to stress the system? (consult the standards)	☐	☐
50. Are vertical risers limited to two stories and supported on 12 foot (maximum) centers?	☐	☐
51. If formed sheet metal reinforcements are used as hangers, are attachments within 6 of duct sides?	☐	☐
52. Are all fittings supported by hangers in accordance with the standards?	☐	☐

IN	2	2½	6	48	12 FT	12 GA
MM	51	64	152	1.22 M	3.66 M	2.68

PROCEDURE FOR RATING DUCT CONSTRUCTION METHODS RELATIVE TO THE SMACNA CONSTRUCTION TABLES

METHOD 1

Show by *written analysis and commentary* that the features that are different in the reinforcement and assembly scheme will not produce:

a) a system that satisfies the general requirements for all ducts to a lesser extent than the published assembly scheme it is being introduced in, nor
b) noncompliance with the functional standards outlined.

METHOD 2

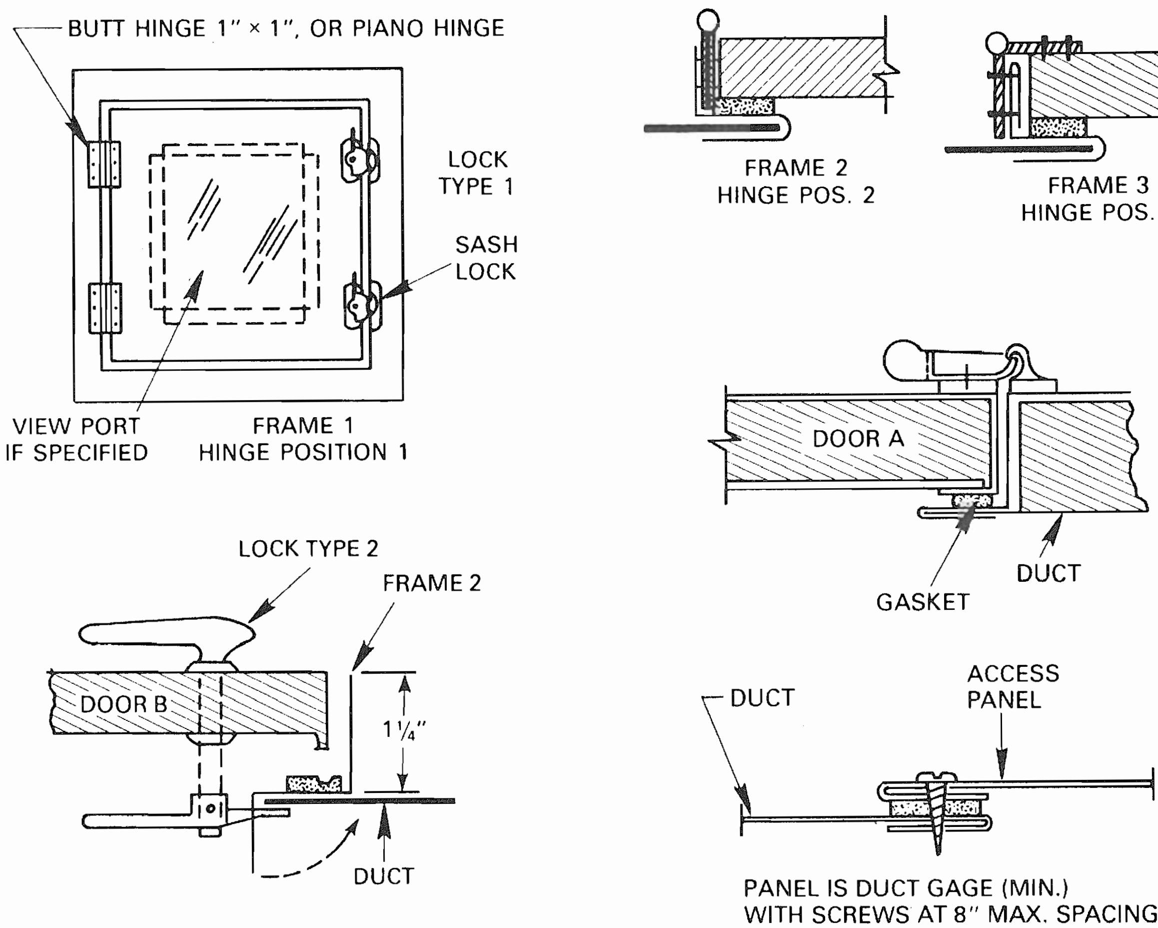
Present substantial *evidence of historical acceptability* for the use intended and that the record of use confirms subjection to the pressures, velocity levels, and other conditions for which rating is desired.

METHOD 3

Construct, *test and rate specimens* of the contemplated design.

Method 3A–Test only the component being substituted or test the component plus any contingently related components in a manner that will simulate the actual loading and will correlate with performance on the duct and show that this approach will not impair or reduce the performance of the entire assemblage.

Method 3B–Test a full specimen. Construct a specimen using the desired scheme of sheet thickness, joint type, intermediate stiffener, sealant, fasteners, etc. Conduct tests in the positive or negative mode of pressurization as desired. Use instrumentation and follow procedures that will produce laboratory accuracy. Record proceedings and observations. Write conclusions showing equivalence to the construction tables published by SMACNA. Include a diagram of the specimen tested.



	Door Size	No. Hinges	No. Locks	Metal Gage		
				Frame	Door	Back
2" w.g. Static and Less	12" × 12" 16" × 20" 24" × 24"	2 2 3	1-S 2-S 2-S	24 22 22	26 24 22	26 26 26
3" w.g. Static	12" × 12" 16" × 20" 24" × 24"	2 2 3	1-S 1-S, 1-T, 1-B 2-S, 1-T, 1-B	22 20 20	22 20 20	26 26 24
4" w.g. to 10" w.g.	12" × 12" 16" × 20" 24" × 24"	2 3 3	1-S, 1-T, 1-B 2-S, 1-T, 1-B 2-S, 2-T, 2-B	20 20 18	20 18 18	26 24 24
S = Side opposite hinges, T = Top, B = Bottom						

CONSTRUCTION AND AIRTIGHTNESS MUST BE SUITABLE FOR THE DUCT PRESSURE CLASS USED.

Figure 2-12 DUCT ACCESS DOORS

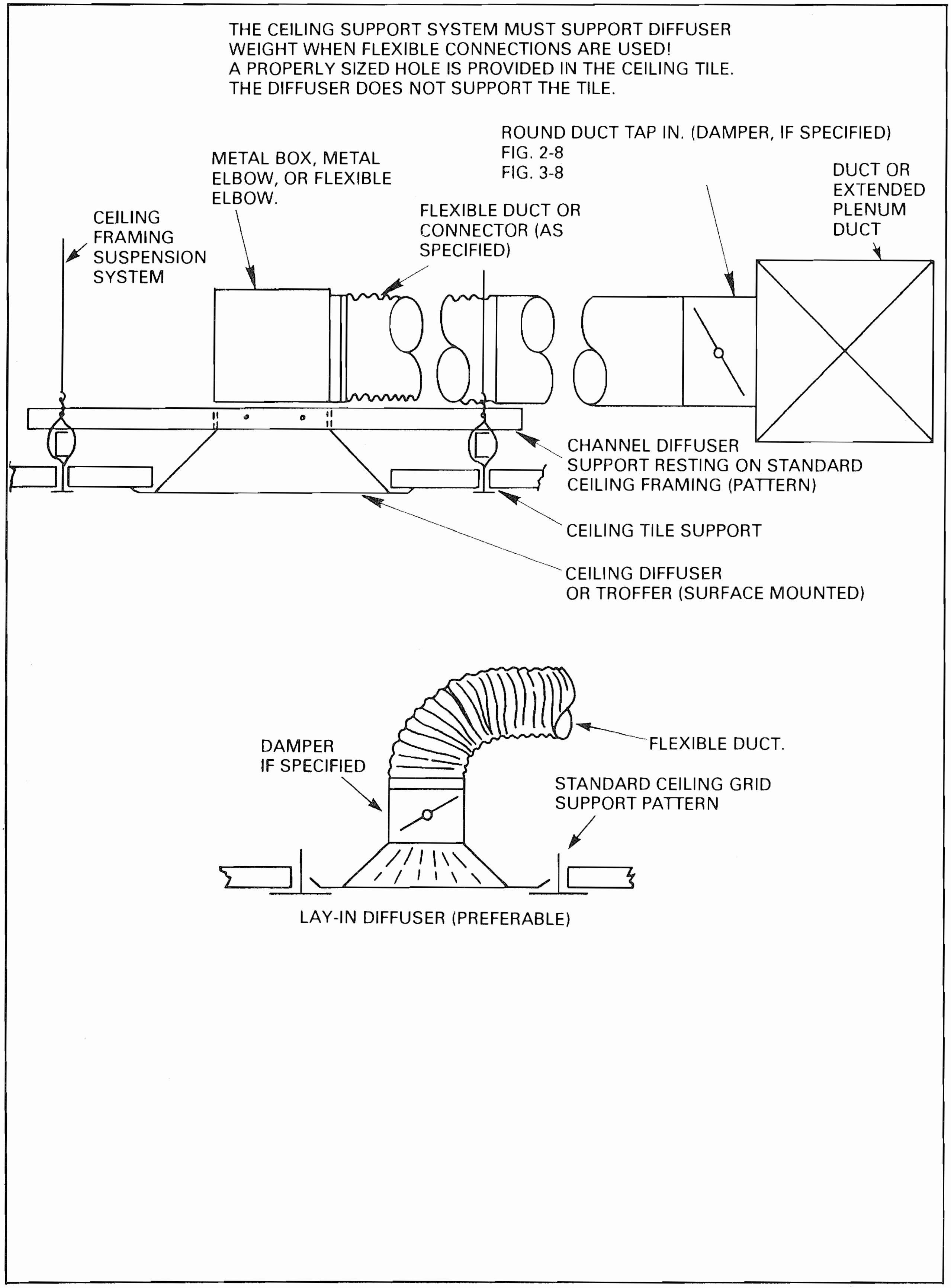


Figure 2-17 CEILING DIFFUSER BRANCH DUCTS

RECOMMENDED MINIMUM SLEEVE THICKNESS FOR FIRE DAMPERS

Type of Connection	Duct	Duct Dimension	Sleeve Gauge
Rigid	Round- Rectangular	24" maximum diameter 24" maximum height and 36" maximum width	16
Rigid	Round- Rectangular	over 24" diameter over 24" height over 36" width	14
Breakaway (See Pages 2-4 and 2-5)	Round or Rectangular	12" down 13"-30" 31"-54" 55"-84" 85" up	26 24 22 20 18

By U.L. Standard 555, all ducts are required to terminate at the fire damper sleeves or the damper frames. Sleeve thickness is contingent on type of connection. All U.L. listed dampers also have maximum dimensions associated with the test rating. Contingent on sleeve thickness a rigid connection may be used in lieu of a breakaway connection. Sleeves may be omitted where dampers are designed to be in nonducted air passages or where damper housing permits attachment of retaining angles to the housing. Attachment of retaining angles must not restrict operation of the fire damper. Certain U.L. approved designs do not require retaining angles.

Where the fire damper sleeve is exposed to the airstream, the metal sleeve will be of the same material as the duct system. A steel sleeve, of the type or finish specified by the system designer, will be used for fibrous glass ductwork and where the fire damper sleeve is not exposed to the airstream.

*See Pages 2-4 and 2-5 for details and exceptions. (Fire Damper Guide, Fourth Edition)

IN	12	13	24	30	31	36	54	55	84	85
M	.30	.33	.61	.76	.79	.91	1.37	1.40	2.13	2.16

GA	14	16	18	20	22	24	26
MM	1.784	1.463	1.181	.906	.7534	.6010	.4712

TYPICAL INSTALLATION DETAILS

(A) Retaining Angles:
Minimum 1½" x 1½" x 0.054 (16 ga.)
Retaining angles must overlap structure opening 1" minimum and cover corners of openings as shown.

(B) Clearance: ⅛" Per Linear Foot
Both Dimensions (see Note 1 below)

(C) Steel Sleeve: See Schedule 2

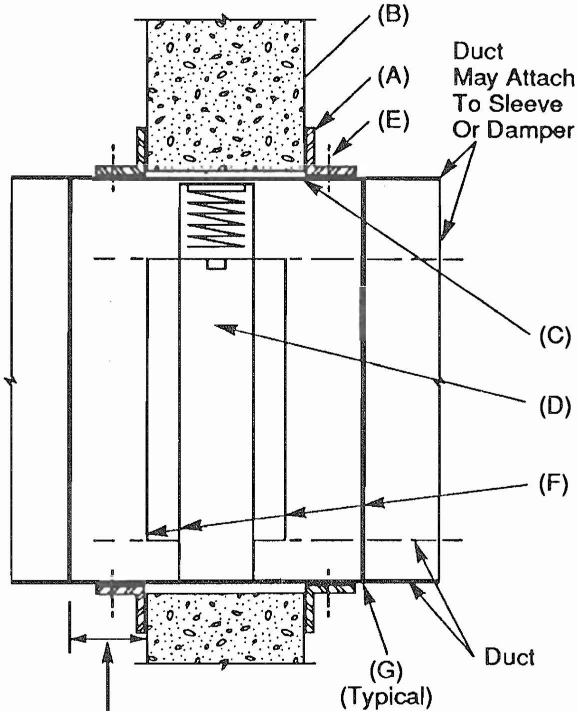
(D) Approved Fire Damper (curtain or blade type)

(E) Secure Retaining Angles To Sleeve *Only*, On 8" Centers With:
1. ½" long Welds *Or*
2. ¼" Bolts And Nuts, *Or*
3. No. 10 Steel Screws, *Or*
4. Minimum ³⁄₁₆" Steel Rivets

(F) Secure Damper To Sleeve On 8" Centers With:
1. ½" long Welds *Or*
2. ¼" Bolts And Nuts, *Or*
3. No. 10 Steel Screws, *Or*
4. Minimum ³⁄₁₆" Steel Rivets

(G) Connect Duct To Sleeve As Shown On Pages 2-4 and 2-5 and as outlined on Table 2.2

(H) Install access door or panel as shown in Figure 6.1.



- Six inches on each side for dampers intended for use without an actuator or a factory installed access door in the sleeve.
- Six inches on one side and sixteen inches on the opposite side for dampers intended for use with an actuator and/or a factory installed access door, on the longer side.
- Sixteen inches on each side for dampers intended for use with an actuator on one side and a factory installed access door on the other side.

Vertical position is shown: horizontal installation is similar. Follow installation instruction for fusible links.

NOTES:

1. FIRE DAMPER SLEEVE CLEARANCE WITHIN WALL OPENING

Clearance requirements for damper sleeves within a wall opening are based on ⅛ inch per foot of width (or height) unless otherwise stated in the listing of the assembly. The sleeve may rest on the bottom of the opening, and need not be centered. (Fractional dimensions shall be taken as the next largest whole foot.)

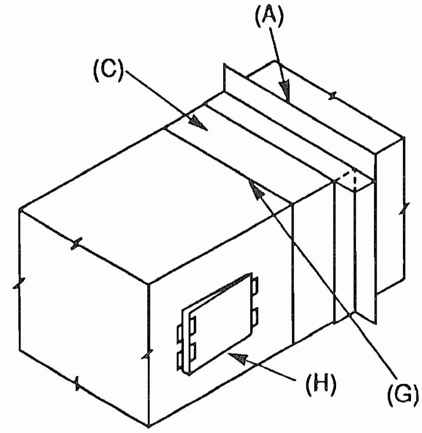
Example: A 30 inch x 24 inch fire damper sleeve is installed in a wall opening. The opening shall be 30⅜ inches wide (⅛ inch x 3 feet) by 24¼ inches high (⅛ inch x 2 feet.)

The sleeve is retained in the wall opening by the use of steel retaining angles (A). These must over-lap the edge of the framing by a minimum of one (1) inch over and beyond all material in the opening. This means that the minimum width of the retaining angle would be 1⅜ inches (good practice calls for an additional safety factor by making the angle in this case 1½ inches wide.)

The dimensions required for the opening shall be those remaining after the opening has been framed and fire resistive materials provided where required (see Figure 3.1). The fire resistive material shall be equal to the requirements for fire resistive material used in the constructed wall so that a continuous rating exists at the wall penetration. *The contractor erecting the wall is responsible for providing the fire resistive material and correct size openings to achieve the required clearance.*

2. MANUFACTURERS' INSTALLATION DETAILS

The fire damper manufacturers' installation details and instructions as tested and approved by UL *must* be used in lieu of the above details where applicable.



TABLES OF METRIC CONVERSION UNITS

FRACTIONAL INCHES		MM
	0	
.0156	1/64	0.397
.0312	1/32	0.794
.0469	3/64	1.191
.0625	1/16	1.588
.0781	5/64	1.984
.0938	3/32	2.381
.1094	7/64	2.778
.1250	1/8	3.175
.1406	9/64	3.572
.1563	5/32	3.969
.1719	11/64	4.366
.1875	3/16	4.762
.2031	13/64	5.159
.2188	7/32	5.556
.2344	15/64	5.953
.2500	1/4	6.350
.2656	17/64	6.747
.2813	9/32	7.144
.2968	19/64	7.541
.3125	5/16	7.938
.3281	21/64	8.334
.3434	11/32	8.731
.3594	23/64	9.128
.3750	3/8	9.525
.3906	25/64	9.922
.4063	13/32	10.32
.4218	27/64	10.72
.4375	7/16	11.11
.4531	29/64	11.51
.4688	15/32	11.91
.4844	31/64	12.30
.5000	1/2	12.70
.5156	33/64	13.10
.5312	17/32	13.49
.5468	35/64	13.89
.5625	9/16	14.29
.5781	37/64	14.68
.5938	19/32	15.08
.6094	39/64	15.48
.6250	5/8	15.88
.6406	41/64	16.27
.6563	21/32	16.67
.6719	43/64	17.07
.6875	11/16	17.46
.7031	45/64	17.86
.7188	23/32	18.26
.7344	47/64	18.65
.7500	3/4	19.05
.7656	49/64	19.45
.7813	25/32	19.84
.7969	51/64	20.24
.8125	13/16	20.64
.8281	53/64	21.03
.8438	27/32	21.43
.8594	55/64	21.83
.8750	7/8	22.23
.8906	57/64	22.62
.9063	29/32	23.02
.9219	59/64	23.42
.9375	15/16	23.81
.9531	61/64	24.21
.9688	31/32	24.61
.9844	63/64	25.00

WHOLE INCHES	METRES	FEET	METRES
0	—	0	—
1	0.025	1	0.305
2	0.051	2	0.610
3	0.076	3	0.914
4	0.102	4	1.219
5	0.127	5	1.524
6	0.152	6	1.829
7	0.178	7	2.134
8	0.203	8	2.438
9	0.229	9	2.743
10	0.254	10	3.048
11	0.279	11	3.353
12	0.305	12	3.658
13	0.330	13	3.962
14	0.356	14	4.267
15	0.381	15	4.572
16	0.406	16	4.877
17	0.432	17	5.182
18	0.457	18	5.486
19	0.483	19	5.791
20	0.508	20	6.096
21	0.533	21	6.401
22	0.559	22	6.706
23	0.584	23	7.010
24	0.610	24	7.315
25	0.635	25	7.620
26	0.660	26	7.925
27	0.686	27	8.230
28	0.711	28	8.534
29	0.737	29	8.839
30	0.762	30	9.144
31	0.787	31	9.449
32	0.813	32	9.754
33	0.838	33	10.06
34	0.864	34	10.36
35	0.889	35	10.67
36	0.914	36	10.97
37	0.940	37	11.28
38	0.965	38	11.58
39	0.991	39	11.89
40	1.016	40	12.19
41	1.041	41	12.50
42	1.067	42	12.80
43	1.092	43	13.11
44	1.118	44	13.41
45	1.143	45	13.72
46	1.168	46	14.02
47	1.194	47	14.33
48	1.219	48	14.63
49	1.245	49	14.94
50	1.270	50	15.24
51	1.295	51	15.55
52	1.321	52	15.85
53	1.346	53	15.15
54	1.372	54	16.46
55	1.397	55	16.76
56	1.422	56	17.07
57	1.448	57	17.37
58	1.473	58	17.68
59	1.499	59	17.98
60	1.524	60	18.29
61	1.549	61	18.59
62	1.575	62	18.90
63	1.600	63	19.20
64	1.626	64	19.51
65	1.651	65	19.81
66	1.676	66	20.12
67	1.702	67	20.42
68	1.727	68	20.73
69	1.753	69	21.03
70	1.778	70	21.34
71	1.803	71	21.64
72	1.829	72	21.95
73	1.854	73	22.25
74	1.880	74	22.56
75	1.905	75	22.86
76	1.930	76	23.17
77	1.956	77	23.47
78	1.981	78	23.77
79	2.007	79	24.08
80	2.032	80	24.38
81	2.057	81	24.69
82	2.083	82	24.99
83	2.108	83	25.30
84	2.134	84	25.60
85	2.159	85	25.91
86	2.184	86	26.21
87	2.210	87	26.52
88	2.235	88	26.82
89	2.261	89	27.13
90	2.286	90	27.43
91	2.311	91	27.74
92	2.337	92	28.04
93	2.362	93	28.35
94	2.388	94	28.65
95	2.413	95	28.96
96	2.438	96	29.26
97	2.464	97	29.57
98	2.489	98	29.87
99	2.515	99	30.18

ft^2	m^2	m^2	ft^2
1	0.093	1	10.76
2	0.186	2	21.53
3	0.279	3	32.29
4	0.372	4	43.06
5	0.465	5	53.82
6	0.557	6	64.58
7	0.650	7	75.35
8	0.743	8	86.11
9	0.836	9	96.88
10	0.929	10	107.6
11	1.022	11	118.4
12	1.115	12	129.2
13	1.208	13	139.9
14	1.301	14	150.7
15	1.394	15	161.5
16	1.486	16	172.2
17	1.579	17	183.0
18	1.672	18	193.8
19	1.765	19	204.5
20	1.858	20	215.3
21	1.951	21	226.0
22	2.044	22	236.8
23	2.137	23	247.6
24	2.230	24	258.3
25	2.323	25	269.1
26	2.415	26	279.9
27	2.508	27	290.6
28	2.601	28	301.4
29	2.694	29	312.2
30	2.787	30	322.9
31	2.880	31	333.7
32	2.973	32	344.4
33	3.066	33	355.2
34	3.159	34	366.0
35	3.252	35	376.7
36	3.345	36	387.5
37	3.437	37	398.3
38	3.530	38	409.0
39	3.623	39	419.8
40	3.716	40	430.6
41	3.809	41	441.3
42	3.902	42	452.1
43	3.995	43	462.8
44	4.088	44	473.6
45	4.181	45	484.4
46	4.274	46	495.1
47	4.366	47	505.9
48	4.459	48	516.7
49	4.552	49	527.4
50	4.645	50	538.2
51	4.738	51	549.0
52	4.831	52	559.7
53	4.924	53	570.5
54	5.017	54	581.3
55	5.110	55	592.0
56	5.203	56	602.8
57	5.295	57	613.5
58	5.388	58	624.3
59	5.481	59	635.1
60	5.574	60	645.8
61	5.667	61	656.6
62	5.760	62	667.4
63	5.853	63	678.1
64	5.946	64	688.9
65	6.039	65	699.7
66	6.132	66	710.4
67	6.225	67	721.2
68	6.317	68	731.9
69	6.410	69	742.7
70	6.503	70	753.5
71	6.596	71	764.2
72	6.689	72	775.0
73	6.782	73	785.8
74	6.875	74	796.5
75	6.968	75	807.3
76	7.061	76	818.1
77	7.154	77	828.8
78	7.246	78	839.6
79	7.339	79	850.3
80	7.432	80	861.1
81	7.525	81	871.9
82	7.618	82	882.6
83	7.711	83	893.4
84	7.804	84	904.2
85	7.897	85	914.9
86	7.990	86	925.7
87	8.083	87	936.5
88	8.175	88	947.2
89	8.268	89	958.0
90	8.361	90	968.8
91	8.454	91	979.5
92	8.547	92	990.3
93	8.640	93	1001
94	8.733	94	1012
95	8.826	95	1023
96	8.919	96	1033
97	9.012	97	1044
98	9.105	98	1055
99	9.197	99	1066
100	9.290	100	1076

METRIC CONVERSION CHART

INCHES INTO MILLIMETRES

INCHES	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"
		25.4	50.8	76.2	101.6	127.0	152.4	177.8	203.2	228.6	254.0	279.4
1/16"	1.6	27.0	52.4	77.8	103.2	128.6	154.0	179.4	204.8	230.2	255.6	281.0
1/8"	3.2	28.6	54.0	79.4	104.8	130.2	155.6	181.0	206.4	231.8	257.2	282.6
3/16"	4.8	30.2	55.6	81.0	106.4	131.8	157.2	182.6	208.0	233.4	258.8	284.2
1/4"	6.4	31.8	57.2	82.6	108.0	133.4	158.8	184.2	209.6	235.0	260.4	285.8
5/16"	7.9	33.3	58.7	84.1	109.5	134.9	160.3	185.7	211.1	236.5	261.5	287.3
3/8"	9.5	34.9	60.3	85.7	111.1	136.5	161.9	187.3	212.7	238.1	263.5	288.1
7/16"	11.1	36.5	61.9	87.3	112.7	138.1	163.5	188.9	214.3	239.7	265.1	290.5
1/2"	12.7	38.1	63.5	88.9	114.3	139.7	165.1	190.5	215.9	241.3	266.7	292.1
8/16"	14.3	39.7	65.1	90.5	115.9	141.3	166.7	192.1	217.5	242.9	268.3	293.7
5/8"	15.9	41.3	66.7	92.1	117.5	142.9	168.3	193.7	219.1	244.5	269.9	295.3
11/16"	17.5	42.9	68.3	93.7	119.1	144.5	169.9	195.3	220.7	246.1	271.5	296.9
3/4"	19.1	44.5	69.9	95.3	120.7	146.1	171.5	196.9	222.3	247.7	273.1	298.5
13/16"	20.6	46.0	71.4	96.8	122.2	147.6	173.0	198.4	223.8	249.2	274.6	300.0
7/8"	22.2	47.6	73.0	98.4	123.8	149.2	174.6	200.0	225.4	250.8	276.2	301.6
15/16"	23.8	49.2	74.6	100.0	125.4	150.8	176.2	201.6	227.0	252.4	277.8	303.2

FEET TO METRES (1 METRE = 1000 MILLIMETRES)

1'-0"	2'-0"	3'-0"	4'-0"	5'-0"	6'-0"	7'-0"	8'-0"	9'-0"	10'-0"	11'-0"	12'-0"	13'-0"
0.3048	0.6096	0.9144	1.2192	1.5240	1.8288	2.1336	2.4384	2.7432	3.0480	3.3528	3.6576	3.9624
14'-0"	15'-0"	16'-0"	17'-0"	18'-0"	19'-0"	20'-0"	21'-0"	22'-0"	23'-0"	24'-0"	25'-0"	26'-0"
4.2672	4.5720	4.8768	5.1816	5.4864	5.7912	6.0960	6.4008	6.7056	7.0104	7.3152	7.6200	7.9248
27'-0"	28'-0"	29'-0"	30'-0"	31'-0"	32'-0"	33'-0"	34'-0"	35'-0"	36'-0"	37'-0"	38'-0"	39'-0"
8-2296	8.5344	8.8392	9.1440	9.4488	9.75.36	10.0584	10.3632	10.6680	10.9728	11.2776	11.5824	11.8872

CHAPTER 6

INDEX

SMACNA

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION

CURRENT SAFETY AND HEALTH ISSUES IN FIBERGLASS

SMACNA

SAFETY AND HEALTH PROGRAM

CURRENT SAFETY AND HEALTH ISSUES IN FIBERGLASS

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FOREWORD

The Safety Committee of the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) has developed *Current Safety and Health Issues in Fiberglass.* This reference guide is intended to provide contractors with information relating to working with or around fiberglass.

SMACNA accepts no liability for the consequences of reliance on the contents of this booklet.

SMACNA would like to acknowledge CNA Insurance for its assistance in the development of this material.

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EXECUTIVE SUMMARY

There have been no clear-cut answers to date on whether fiberglass is carcinogenic to humans. Studies of the potential for fiberglass to cause cancer in laboratory animals or humans have produced inconsistent results, preventing a generally accepted conclusion about its carcinogenicity. However, the continuing availability of new studies and conclusions may change this summary. In the meantime, it is recommended that workers be cautious when handling fiberglass products. The following paragraphs summarize good work practices for handling fiberglass materials.

Health Canada recommends that, since fiberglass is a known skin, eye, and throat irritant, any person working with fiberglass should follow the manufacturer's instructions during the installation process: wear a breathing mask, wear clothing that covers the entire body, and use gloves and eye protection (Health Canada 1995).

NIOSH recommends that workers subject to fiberglass exposure have comprehensive pre-placement medical examinations, with an emphasis on skin susceptibility and prior exposure in dusty workplaces. Subsequent annual examinations should pay particular attention to the skin and respiratory system (NTP 1994).

SMACNA recommends the following:

- The MSDS specific to the product being handled should be reviewed, and all recommendations on it should be carefully followed.
- Personal Protective Equipment (PPE) including:
    - safety goggles
    - a respirator, if needed, to reduce worker irritation and or exposure level*
    - leather or cotton gloves, and/or barrier creams
    - long-sleeved shirts and loose-fitting clothing
    - local exhaust ventilation for cutting operations**
    - general dilution ventilation as necessary**
    - wash exposed skin areas with warm water and soap after exposure to fiberglass
    - wash clothing separately from other clothes, followed by running the washing machine empty for a complete cycle

* - consult a Certified Industrial Hygienist or respirator manufacturer for appropriated mask and/or cartridge type.

** - as specified by a Certified Industrial Hygienist.

Section 1: INTRODUCTION

In recent years, SMACNA contractors and others who work with fiberglass products may have become aware of health questions regarding this material, particularly whether it may cause lung impairments, including cancer. Individuals may be concerned about their own health, employers require information to help protect their employees, and customers may ask questions based on what they have heard. To address all these needs, SMACNA has prepared this overview and summary of the requirements, health studies, perspectives, and current recommendations for working with fiberglass.

1.1 What is Fiberglass?

Fiberglass, also called fibrous glass or glasswool, was first made in the U.S. in the 1930s. Fiberglass belongs in a category of substances known as man-made mineral fibers (MMMFs) or man-made vitreous fibers (MMVFs):

- *Fiberglass* is a manufactured fiber in which the fiber-forming substance is glass. Much of the fiberglass used in the world is formed from borosilicates. Fiberglass fibers are generally 3 to 8 micrometers (μm) in diameter. *Special purpose fiberglass* is also produced for certain uses; these fibers are usually less than 1 μm in diameter.

- *Mineral wool* comes in two types: *rock wool* and *slag wool*. Rock wool is produced from melting igneous rock containing calcium and magnesium. Slag wool is produced from the by-products of metal smelting.

- *Refractory ceramic fibers* (RCFs) are made from kaolin clay or the oxides of silicon, alumina, or other metals.

This report focuses on fiberglass. Fiberglass is produced by drawing, centrifuging, or blowing molten glass. The fibers are then coated with a binder and lubricant according to the intended use. A phenol-formaldehyde resin is commonly used as a binder in fiberglass that is used in insulation products. Mineral oil is typically used as a lubricant.

1.2 Uses of Fiberglass

Most fiberglass is used for thermal and acoustical insulation in building construction and shipbuilding. Loose fiberglass may be blown in or hand-placed into the walls and attics of buildings. Fiberglass can be formed into sheets, or batts, which are used for the same purposes.

Fiberglass is also used to make filters for furnaces and air-conditioning systems, and filters for use in manufacturing beverages, pharmaceuticals, and other materials. It is used as a reinforcing material in plastics, piping, cement, and textiles. *Fiberglass reinforced plastics* (FRP) has been used for various types of process equipment in the chemical industry, pulp and paper industry, power mining, municipal sewer treatment and water treatment, as well as many other associated industries handling corrosive equipment. Special purpose fiberglass may be used for high-performance insulation and filtration applications.

SMACNA contractors are likely to encounter fiberglass that is used to insulate air-handling systems, either as a blanket over the sheet metal duct that insulates the flow of heated or cooled air, or as a duct lining. Fiberglass exposure may also occur during duct cleaning, duct liner encapsulation, duct removal, working with fiberglass duct (board), insulating pipes and equipment, and other activities.

1.3 Routes of Exposure

The impact that any substance may have on health depends on how it comes in contact with the body. There are three possible routes of entry into the body. These routes are inhalation, ingestion, and absorption.

The most common route of entry for most substances is inhalation. For fiberglass to be inhaled into the lungs, the fibers must be released into the air, usually by a mechanical action such as blowing applications or cutting batts. Fiberglass duct board and other rigid forms should not release respirable fibers or dust unless they are cut, broken, or grinded upon.

The ingestion route usually occurs simultaneously with inhalation. Again, the fibers must be airborne, then enter into the mouth and be swallowed. Although this can be irritating to throat and stomach tissues, it alone is not associated with a significant health hazard.

Finally, the chemicals may be absorbed through the skin from either a solid or liquid state. Fiberglass dust and fibers are known to be irritating to the skin but are not absorbed into the body this way.

Section 2: CURRENT LAWS, REGULATIONS, AND CRITERIA

This section summarizes the regulation of fiberglass in the U.S., as well as voluntary criteria and recommendations from scientific and research agencies.

CURRENT LAWS AND REGULATIONS

- OSHA has set a Permissible Exposure Limit for "Particles not otherwise regulated":
  - 15 mg/m^3 for nonrespirable fibers
  - 5 mg/m^3 for respirable fibers
- OSHA Hazard Communication Standard requires a warning label that fiberglass is a potential carcinogen.
- EPA air and water quality regulations apply to fiberglass manufacturing facilities.
- California requires a warning before exposing anyone to fiberglass during the course of doing business.

2.1 OSHA Requirements

The U.S. Occupational Safety and Health Administration (OSHA) regulates worker exposure to fiberglass under the standard for "particles not otherwise regulated." The permissible exposure limit (PEL) is 15 mg/m^3 for nonrespirable fibers and 5 mg/m^3 for respirable fibers (29 CFR 1910.1000).

In 1992, OSHA proposed PELs of 1 fiber per cubic centimeter (f/cm^3)as an 8-hour time-weighted average for fiberglass, RCFs, and mineral wool for the construction, agriculture, and maritime industries, as part of a larger effort to update OSHA's PELs. However, this rulemaking was dropped, and there is no current OSHA standard specifically for fiberglass or other MMMFs (OSHA 1996). OSHA states that they are developing an action plan to reduce worker exposures to fiberglass (due to risks of respiratory effects), but have not initiated a new rulemaking.

Under OSHA's Hazard Communication Standard, all fiberglass products must carry a warning label stating that the material is a potential carcinogen (OSHA 1991). OSHA also requires that material safety data sheets (MSDSs) provide information on the chronic health effects of fiberglass exposure, including the results of studies to determine whether it may cause cancer. These requirements do not mean that OSHA regulates fiberglass as if they have concluded that it is a carcinogen. Instead, the Hazard Communication Standard's requirements reflect a determination of health effects that is to be made by the manufacturer, not as a result of an evaluation by OSHA. OSHA's Hazard Communication Standard states specifically that the International Agency for Research on Cancer (IARC) is one source to be consulted for determining the carcinogenic potential of a substance. Since fiberglass has been classified as a potential human carcinogen by IARC (see Section 3.1.1), OSHA's Hazard Communication Standard requires that this information appear on the warning label.

2.2 EPA Requirements

The U.S. Environmental Protection Agency (EPA) only regulates fiberglass in relation to air and wastewater emissions from facilities that manufacture the material, under the Clean Air Act and Clean Water Act. Fiberglass is not considered a hazardous waste under the Resource Conservation and Recovery Act.

2.3 State and Local Laws

Research for this report revealed only one regulation relevant to fiberglass at the state level, and none at the local level.

In California, the Safe Drinking Water and Toxic Enforcement Act (enacted by Proposition 65) prohibits contaminating drinking water with chemicals known to cause cancer or reproductive toxicity, and requires a warning before exposure to chemicals known to cause cancer or reproductive toxicity during the course of doing business (California Health and Welfare Agency 1986). Airborne particles of respirable size of glasswool fibers are included on the list of "Chemicals known to the state to cause cancer" (22 CCR 12000). A person responsible for such exposure is exempt from the warning requirement if they can demonstrate that lifetime exposure to the level in question poses no significant risk. The uncertainty and inconsistency that currently exist among scientific opinions of fiberglass's carcinogenicity (see Section 3.0) would make it prudent for responsible persons to follow the warning requirement, to ensure compliance with this state law.

It is possible that there are other existing or planned state laws relevant to the use of fiberglass products by sheet metal contractors. In addition, local jurisdictions, such as counties, cities, or regional authorities, may also set environmental requirements. It is essential that SMACNA contractors be familiar with the requirements in their area(s) of operation. The "Government" listings in the telephone book generally include the state, county, and local environmental, public health, and occupational health agencies. These agencies should be contacted with questions on local laws and regulations.

2.4 Criteria and Recommendations

The American Conference of Governmental Industrial Hygienists recommends that workplace exposure to total dust be limited to 10 mg/m^3, and assigns this same level to limit exposure to fibrous glass dusts (ACGIH 1996).

The National Institute for Occupational Safety and Health (NIOSH) recommends that occupational exposure to fiberglass be limited to 3 million fibers per cubic meter of air as a 10-hour time-weighted average in a 40-hour work week, when fibers are considered that have a length of 10 µm or more and a diameter of 3.5 µm or less. This level is equivalent to 3 f/cm^3 of air.

As stated in Section 2.1, IARC considers fiberglass to be a potential human carcinogen. IARC concluded that there is sufficient evidence for the carcinogenicity of fiberglass in laboratory animals. Therefore, even though they state there is inadequate evidence of the carcinogenicity of fiberglass in humans, IARC considers fiberglass to be potentially carcinogenic in humans, as a result of their review of animal data.

The National Toxicology Program (NTP), part of the U.S. Department of Health and Human Services, also reviewed studies of fiberglass to judge whether it is carcinogenic in humans (NTP 1994). NTP included the studies that had been looked at by IARC, as well as an additional laboratory animal inhalation study, which showed no association between fiberglass and tumors. However, NTP concluded that respirable size fiberglass may reasonably be anticipated to be a carcinogen.

Most fiberglass manufacturers recommend an exposure limit of 1 $f/cm.^3$ The North American Insulation Manufacturers Association (NAIMA) has produced a video, "Work Smart," which includes recommendations (summarized in Section 4.1 of this report) for protecting worker health when handling fiberglass (NAIMA 1993).

Section 3: HEALTH STUDIES AND TECHNICAL REVIEWS

There are many studies that have been conducted with the goal of characterizing the toxicity of fiberglass to humans. In particular, there are many studies that attempt to determine whether it may cause adverse health effects, including cancer. Some of these studies were conducted in laboratory animals, where the amount and duration of exposure can be carefully controlled. The short lifetime of laboratory animals (compared to humans) allows researchers to determine chronic effects. Other studies on fiberglass are epidemiological studies, which look for patterns of disease in human populations with particular characteristics, such as employment in a manufacturing facility for fiberglass.

STUDY RESULTS

- Workplace exposures are generally below the levels expected to pose a risk of non-cancer health effects.
- Indoor concentrations are similar to outdoor concentrations of airborne fibers in most cases.
- Fiberglass is a known skin, eye, and throat irritant.

3.1 Studies in Animals

IARC reviewed all the studies that had been conducted in animals on fiberglass, to develop a conclusion about whether it is carcinogenic to animals and possibly humans. Five of the studies used inhalation as the route of exposure, which is the route of concern for humans. IARC reported that, in these studies, fiberglass was not shown to be associated with higher tumor rates than the tumor rates in animals who were not treated.

Bunn et al. (1993) summarized eight inhalation studies of fiberglass in laboratory animals, including some that had been reviewed by IARC. These studies used hamsters and three different strains of rats. Exposure levels ranged as high as 3,000 f/cm.^{3} In none of these studies were there statistically significant increases in tumors compared to controls.

Four additional studies reviewed by IARC used routes of exposure other than inhalation. Studies in which fibers were implanted into the trachea or injected into the abdominal cavity resulted in a variety of cancers.

Because inhalation is the route of exposure to fiberglass that is of concern for possible carcinogenicity, animal studies that use inhalation are preferred. However, there are many technical problems in designing animal inhalation studies of fibers that can be directly related to the effects that humans might experience. These difficulties relate to the differences in the size and structure of our airways and lungs, compared to those of animals, which cause differences in the way that particles or fibers of a given size are filtered, deposited, and retained in the respiratory system (NTP 1994). Correcting for these differences by exposing the animals to higher concentrations doesn't work well, because at higher concentrations the fibers tend to aggregate together, causing another difference from the types of exposures that humans may have to fiberglass. These issues led researchers to consider studies that use other routes of exposure (like injection into the peritoneum or placement in the trachea) to make predictions of fiberglass's potential to be carcinogenic to humans. However, there are issues with this approach also, since these types of "implantation" studies bypass the body's normal defense mechanisms, and artificially create biological availability of fibers in a manner not observed in manufacturing or routine use of fiberglass products (Bunn et al. 1993).

In a study currently underway on hamsters, Research Consulting Company is investigating the effects of inhalation exposure to building insulation fiberglass and special purpose fiberglass, at a level of 250 f/cm^3 for 6 hours per day, 5 days per week, for 18 months (McConnell 1996). Preliminary results have been reported for the first 6 months of the study. Fiberglass building insulation produced "inflammatory lesions consistent with the introduction of high levels of a foreign body particulate into the lung." However, there was no pulmonary fibrosis or changes that were not considered reversible. Special purpose fiberglass caused a greater degree of inflammation, and also some fibrosis; no lung tumors or mesotheliomas were observed. Subsequent to the preparation of this interim report, a hamster exposed to the special purpose fibers died, and was discovered to have mesothelioma (cancer of the lining of the lung) (NAIMA 1996).

3.2 Epidemiological Studies and Reviews

An epidemiology study is a study of disease patterns in human populations that have a known association with a substance of interest, for example, those who have worked in a facility that manufactures that substance.

3.2.1 Review by Harvard Researchers

Lee et al. (1995), of Harvard Medical School and Harvard School of Public Health, reviewed 16 epidemiology studies of MMVFs and their potential to cause respiratory disease or cancer in humans. These studies were conducted in the U.S., Canada, and Europe. Some studies included workers from only one plant, while other studies included workers from up to seventeen facilities. Two types of studies were conducted: case-control and cohort.

Case-Control Studies. In the case-control studies conducted of fiberglass effects, individuals who have respiratory diseases were identified, and aspects of their behavior and exposures were compared to individuals who did not have respiratory disease, in an attempt to identify factors that are different in the two groups and which may explain the occurrence of disease in those who have it. Five case-control studies of men with malignant and non-malignant respiratory disease who were employed in fiberglass, rock wool, and slag wool plants were reviewed by Lee et al. (1995). The reviewers concluded that:

- There was no association in the studies between exposure to fiberglass and respiratory system cancer.
- These conclusions are strengthened by the high participation rates, availability of work history data, and, in four of the five studies, by the fact that the researchers controlled for cigarette smoking, which is a significant confounding variable in studies of respiratory disease.
- These conclusions are limited by the use of indirect methods to estimate the levels of exposure to fibers, and also by the generally small size of the sample groups.

The reviewers believe that these case-control studies indicate that it is unlikely there are any risks of great magnitude associated with fiberglass, but that the small sample sizes may not have revealed any small to moderate levels of risk.

Cohort Studies. In a cohort study, a group of people are selected for observation and followed over time, to see if disease develops and in what patterns. Lee et al. (1995) also reviewed 11 cohort studies of exposure to MMVFs and the incidence of respiratory cancer. In three of the 11 studies, cancer was associated with fiberglass exposure. However, there are some significant limitations to these findings. The researchers did not control for smoking cigarettes or exposure to other carcinogens in any of the three studies. Also, in one of the three studies, workers exposed only to fiberglass did not show an increased cancer rate, but workers exposed to both fiberglass and rock/slag wool had increased mortality; however, there was no trend for higher cancer rates with longer employment in the fiberglass industry.

When all the epidemiological studies were considered together, Lee et al. concluded that, even given the limitations of the existing studies, they appear to indicate that there are no risks of large magnitude associated with occupational exposure to fiberglass.

3.2.2 Tulane Study

Hughes et al. (1993), of Tulane University School of Medicine, evaluated the effects of fiberglass exposure on the respiratory systems of workers in fiberglass manufacturing facilities. They found no adverse clinical, functional, or radiographic signs of effects from exposures to MMVFs in the workers.

3.2.3 OSHA Review

OSHA (1996) reviewed the available studies on fiberglass. They stated that several epidemiologic studies have demonstrated statistically significant elevations in the risk of lung cancer and other respiratory system cancers among workers employed in fibrous glass and mineral wool manufacturing facilities. As noted by Lee et al., there is some uncertainty about the implications of these studies, since different approaches to evaluating the data lead to inconsistent conclusions. For example, accounting for cigarette smoking and using local instead of national lung cancer death rates can change the interpretation of results from epidemiological studies like these. However, OSHA stated that the most recent follow-up of a study of U.S. fiberglass workers still demonstrated a significant excess when their rates of death from lung cancer were compared to the lung cancer death rates in their local areas. OSHA also considered the animal studies reviewed by IARC and NTP. OSHA did not present any conclusions based on their review as to whether fiberglass would be considered a potential carcinogen by the agency in regulation of worker health. However, OSHA lists fiberglass as a priority, among 18 other substances, for review of health and safety hazards.

3.2.4 Review by Health Canada

To comply with the Canadian Environmental Protection Act, scientists at Health Canada (1995) reviewed the available studies of risks posed by different man-made vitreous fibers. For glasswool, Health Canada stated that studies show that long-term exposure to glasswool during installation has not caused cancer in humans or animals, the largest human studies show no significant increase in tumors among glasswool production workers, and there was no significant increase in tumors during recent studies where glasswool fibers were clearly shown to reach the lungs of laboratory animals. They stated that data from other countries besides Canada suggest that glasswool insulation does not pose a risk to the general population.

3.3 Other Studies Related to Potential Carcinogenic Effects

Owens Corning (1996a) reported the results of several new studies on removal of glass fibers from the lungs. The persistence of fiberglass in the lungs is a key factor in the development of chronic health effects. These studies showed that the composition of a glass fiber determines the rate at which it dissolved in a solution that simulated the fluids found in the lungs; and that fibers in the lungs from concentrations much greater than workplace exposures would be expected to dissolve in two months or less.

The Insulation Contractors Association of America is currently funding a risk assessment for installers of blown glass fiber (ICAA 1996). The stated objectives for this assessment are to provide a sensible, balanced document that may be presented to government agencies which may be uninformed about risk, to put into quantifiable terms the risk which the blown wool installation installer incurs, and to put this risk into perspective with other workplace risks and risks to society in general.

3.4 Other Health Effects

Fiberglass is irritating to the skin, eyes, and upper respiratory system (NTP 1994).

Breathing fiberglass dust may cause a scratchy throat, congestion, and slight coughing. Itching, rash, or redness may result from getting dust or fibers on the skin (Schuller 1996). This skin or upper respiratory tract irritation is a mechanical reaction due to the sharp, broken ends of fibers that are embedded in or rubbing against the skin or mucous membranes (Schuller 1992). Coughing and wheezing may result from accidental exposures to high concentrations of airborne fiberglass, but should subside soon after exposure ends (Schuller 1992).

3.5 Studies of Exposure Levels

The airborne fiber concentration in any setting is dependent on a number of site specific factors. These factors include, the rate at which fibers are released, the volume of available dilution ventilation, the proximity of workers to fiber sources, air currents and drafts, room layout, temperature, humidity, etc. Therefore it is difficult to predict the airborne levels or worker exposure levels in any given setting. Air sampling is the only way to quantify and document fiber exposure levels. Information of some measured exposure levels is provided for review.

According to IARC (1988, as cited in NTP 1994), studies indicate that exposures of users of fiberglass products may be higher than exposures of production workers making fiberglass. In one study where airborne glass fibers were measured at four fiberglass insulation manufacturers and one glass textile product manufacturer, worker exposures were reported to be negligible.

Schuller (1992) reported the results of industrial hygiene monitoring within its manufacturing facilities over a 2-year period. For production of glasswool, employee exposure averaged 0.13 $f/cm.^3$ Exposure was higher (0.81 f/cm^3) for workers in small diameter production, but was still less than the company's limit of 1 f/cm^3 for protection of worker health.

The Thermal Insulation Manufacturers Association conducted studies of exposure during installation of fiberglass products (Schuller 1992). They found average exposures of 0.06 f/cm^3 for workers installing fiberglass batts, 0.15 f/cm^3 for installers of blowing wool that contained a binder, and 1.96 f/cm^3 for installers of blowing wool without binder.

A 1996 study by the University of Nevada at Las Vegas found that, in an experimental room with fiberglass duct board in the air handling system, the airborne fiber concentrations were at or below the levels found in outdoor ambient air (NAIMA 1996b). NAIMA also reported that these results agree with data from previous studies of plants, homes, and public buildings, which showed fiber levels in the air similar to or less than the levels found outdoors.

Health Canada (1995) reported that even during installation, the highest levels of glasswool fibers in the air are well below the levels which cause minimal respiratory problems in animals. In two studies, the levels of total fibers were 0.04 f/cm^3 or less and 0.4 f/cm^3 or less during installation of glasswool insulation (Health Canada 1993).

3.6 Microorganism Contamination of Fiberglass Insulation

If insulation becomes wet or dirty, conditions exist that promote the growth of bacteria, mold, and fungus. These microorganisms can result in decreased indoor air quality, particularly when present in fiberglass that lines air handling systems, where microbes can be introduced into the air of ventilated rooms. Use of an appropriate filter and proper maintenance are important to keeping ductwork clean. If an area of duct lining becomes contaminated with microbiological growth, it must be replaced. ANSI/ASHRAE Standard 62-1989 states that adequate precautions must be taken to prevent the accumulation of liquid water, condensation, and moisture at levels conducive to microbial growth (ASHRAE 1994). EPA (1991) also provides specific guidelines for proper maintenance of duct lining.

Section 4: INDUSTRY AND INTEREST GROUP PERSPECTIVES ON FIBERGLASS SAFETY

As can be seen from the scientific data, some of the currently available information on the toxicity and health risks of fiberglass does not agree with other information. Some of the studies have weaknesses that may have caused questionable results. In the U.S., there is no regulation, or even published consensus, within the federal government regarding the potential health risks posed by fiberglass. This section presents the perspectives and opinions of the groups who represent the two sides of the debate over whether fiberglass is ultimately safe when used properly, or if it presents an unrecognized health hazard to people at work and in their homes.

ONGOING DEBATE

- Industry: Fiberglass is safe when properly installed and maintained, and when recommended work practices are followed.
- Public interest groups: There are risks to workers and the public that have not been adequately addressed.

4.1 Fiberglass Industry

The North American Insulation Manufacturers Association (NAIMA) states that fiberglass is safe to manufacture and use when recommended work practices are followed (NAIMA 1993). NAIMA recommends the following practices:

- keep your work area clean (minimize airborne dust)
- wear appropriate clothing: gloves, loose-fitting clothing, long-sleeved shirts, a cap or hard hat, and long pants
- wash work clothes separately, and rinse and wipe the washing machine afterwards
- do not scratch skin: wash the area with soap and warm water
- wear a respirator if necessary, in accordance with the manufacturer's recommended work practices

- wear eye protection

Regarding the possible implications of fiberglass health concerns for indoor air quality in the workplace, NAIMA (1994a) states that the existing studies of fiberglass toxicity "conclusively show that fiber glass, slag and rock wool insulations, when properly installed and maintained, do not materially increase the airborne fiber concentrations in buildings. Clearly, these products can be used with confidence to enhance indoor environmental quality and worker comfort." NAIMA also states that some anecdotal evidence, which raised concerns for the contribution of fiberglass to indoor air fiber levels and microbial growth, was a result of situations in which proper operation and maintenance did not occur (NAIMA 1994b).

The position of the various fiberglass manufacturers is well-represented by Schuller (1992), who state that "The absence of disease in the vast majority of workers exposed to fiberglass during the last fifty years suggests that fiberglass products pose little, if any, health risk to humans." Schuller's recommended work practices are the same as those of NAIMA (listed above), with the addition of medical surveillance, including a pre-employment physical exam, annual evaluation of the ability to wear respiratory protection if required for the job, and follow-up pulmonary function tests and chest x-rays on a 5-year basis for all employees.

Some manufacturers may offer their direct customers a written indemnification, addressing the issue of strict liability for health and safety effects of fiberglass products. For example, Schuller agrees to "indemnify and hold you harmless for the payment of judgments, settlements made with our concurrence, and reasonable legal expenses...incurred in connection with claims made in the United States or Canada...which allege bodily injury resulting from inhalation of glass fibers from Schuller products" (Schuller undated).

4.2 Public Interest Groups

The Natural Resources Defense Council, a non-profit environmental organization, has reviewed the health issues raised by fiberglass. Their recommendations and conclusions are as follows (NRDC 1996):

- Until OSHA establishes safety guidelines that are specific to installers of insulation, building developers and construction managers should assure that those installing insulation do so using comprehensive protective gear. When working with blown-in insulation of any kind, and especially blown-in fiberglass, protective gear should include respirators.

- Until and unless manufacturers of fiberglass develop a safer product, they should assist in assuring that all installers of their product be adequately protected, especially those who install blown-in fiberglass.

- OSHA should expeditiously develop worker protection standards (including the use of respirators) for those who work with or install loose-fill fiberglass and other types of insulation.

- People should not frequent areas where loose fill insulation of any kind has been blown in. Parents and others responsible for child care should be especially careful in assuring that children do not play in areas where there is loose-fill insulation.

- There is no documented threat to the public from already-installed batts of fiberglass insulation. Despite the health risks, people should not remove fiberglass insulation in their homes. Removing fiberglass can result in higher exposure to fiberglass fibers.

Another non-profit group, Victims of Fiberglass (VOF), calls for more attention to the hazards of fiberglass, citing risks to workers and to occupants of buildings and homes that have fiberglass insulation. VOF states that economic pressures, social pressures, and biased media coverage contribute to (1) difficulty in obtaining justice for those who believe they have been harmed by fiberglass exposure, (2) an undeserved public image that the material is relatively safe, and (3) reluctance to address this issue on the part of regulators and politicians (VOF 1995). VOF has set up a Fiberglass Information Network, through which they express concerns that the current debate among the scientific, industry, and regulatory communities about the health hazards of fiberglass may not be a fully open and honest process. VOF cites the results of the NTP review, and describe cases of respiratory illness in fiberglass workers and in members of the public with defective home air handling systems that led to high exposures in the home. VOF calls for a candid discussion of the relative merits and hazards of the insulation products on the market (VOF 1996).

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