HVAC DUCT CONSTRUCTION STANDARDS

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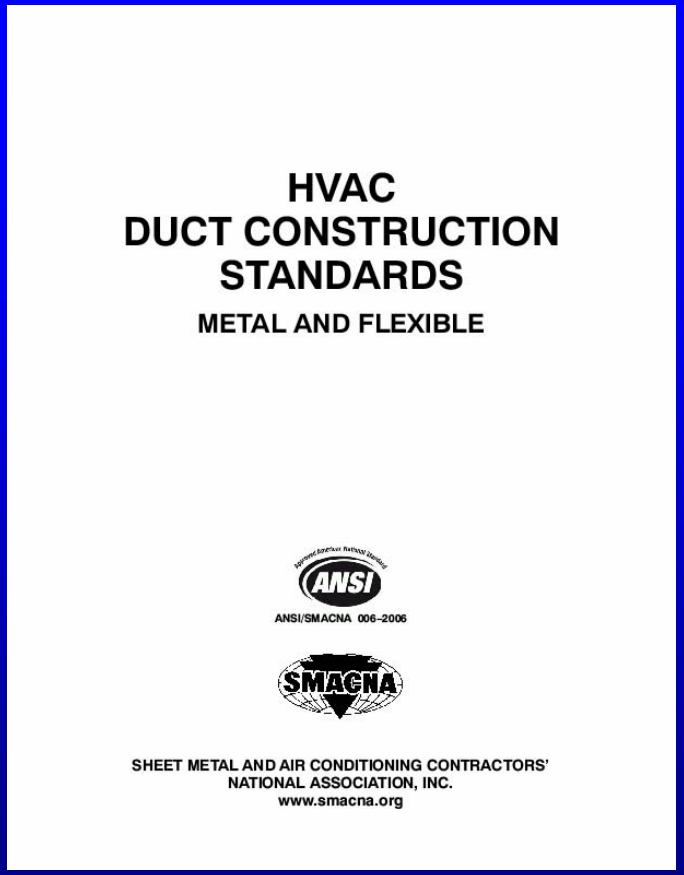
HVAC DUCT CONSTRUCTION STANDARDS METAL AND FLEXIBLE



Information Required for Duct Construction

1. A comprehensive duct layout indicating sizes, design airflows, pressure class, and routing of the duct system.
2. The types of fittings to be used based on the designer's calculations of fitting losses (i.e., square versus 45° entry taps, conical versus straight taps, etc.).

Information Required for Duct Construction

3. Use of turning vanes or splitter vanes.
4. Location of access doors.
5. Location and type of control and balancing dampers.
6. Location and types of diffusers.
7. Requirements for duct insulation.

Information Required for Duct Construction

8. Location and types of any fire protection device including fire dampers, smoke dampers, combination fire/smoke dampers, and ceiling dampers. Building codes require this information to be shown on the design documents submitted for building permit.

Information Required for Duct Construction

9. Details of offsets required to route ductwork around obstructions (columns, beams, etc.).

Information Required for Duct Construction

ENGINEER

Design Considerations:

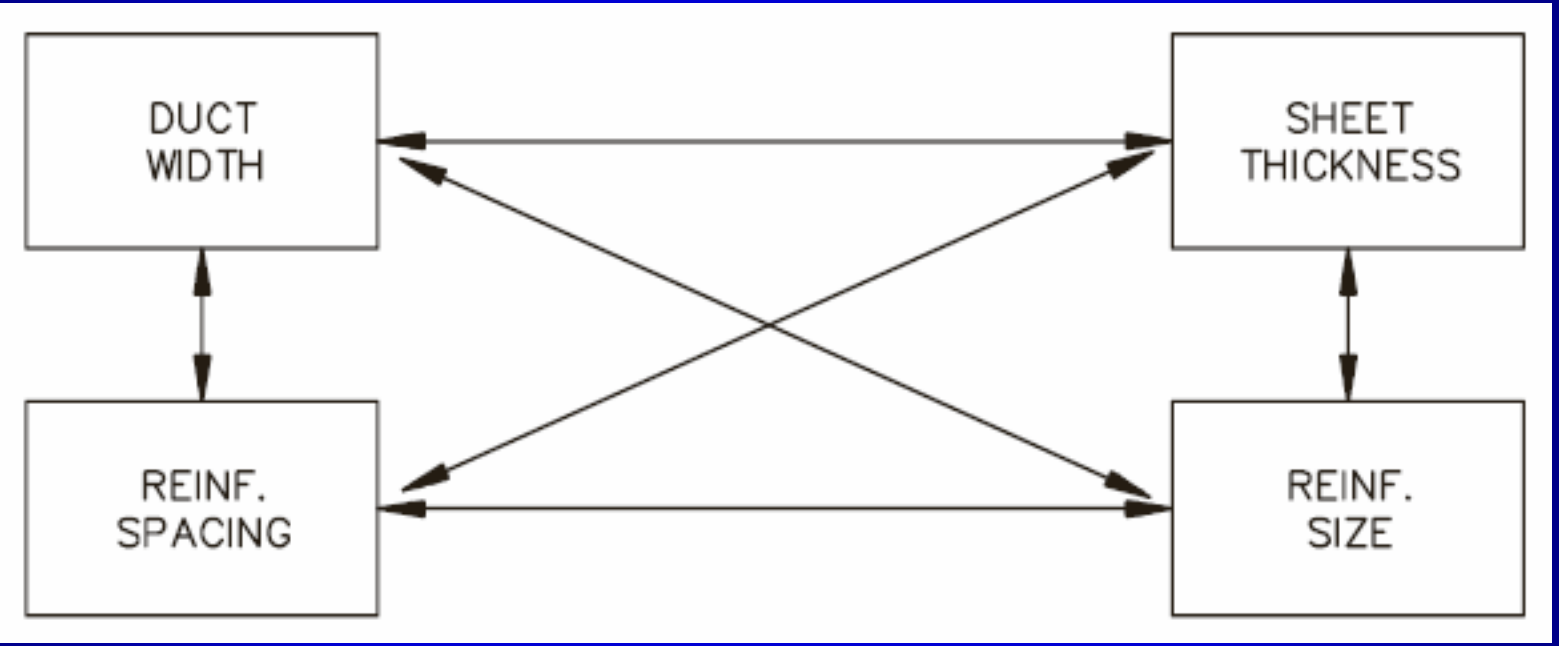
- CFM
- Static Pressure
- Duct Size
- Fitting Type
- Construction Pressure Class

CONTRACTOR

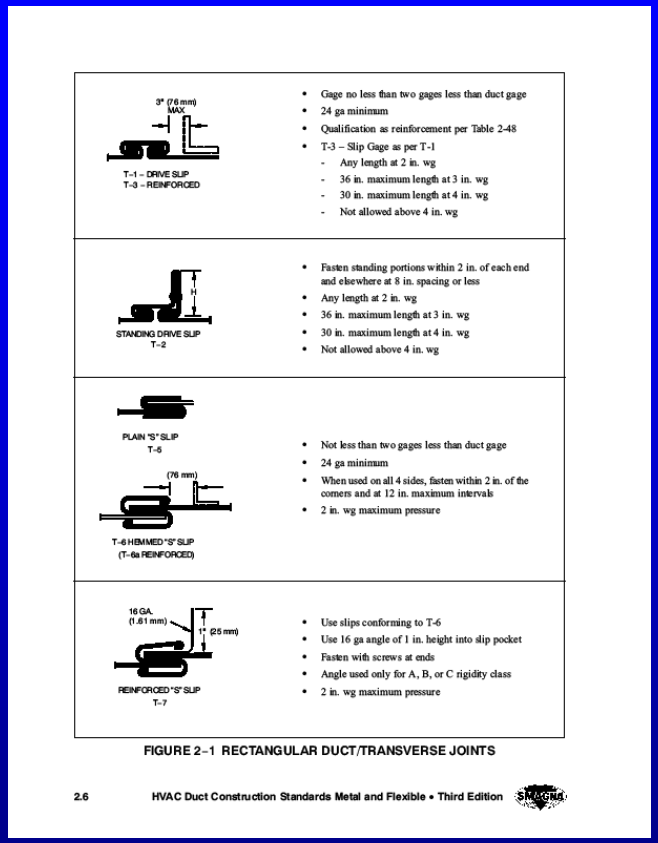
Construction Considerations:

- Pressure Class *(as specified)*
- Panel Thickness (Gage)
- Panel Width/Height
- Joint Type/Spacing
- Intermediate Reinforcement Type/Spacing

DEPENDENT VARIABLES



Rectangular Transverse Joints



3" (76 mm) MAX T-1 – DRIVE SLIP T-3 – REINFORCED	• Gage no less than two gages less than duct gage • 24 ga minimum • Qualification as reinforcement per Table 2-48 • T-3 – Slip Gage as per T-1 - Any length at 2 in. wg - 36 in. maximum length at 3 in. wg - 30 in. maximum length at 4 in. wg - Not allowed above 4 in. wg
H STANDING DRIVE SLIP T-2	• Fasten standing portions within 2 in. of each end and elsewhere at 8 in. spacing or less • Any length at 2 in. wg • 36 in. maximum length at 3 in. wg • 30 in. maximum length at 4 in. wg • Not allowed above 4 in. wg
PLAIN "S" SLIP T-5 (76 mm) T-6 HEMMED "S" SLIP (T-6a REINFORCED)	• Not less than two gages less than duct gage • 24 ga minimum • When used on all 4 sides, fasten within 2 in. of the corners and at 12 in. maximum intervals • 2 in. wg maximum pressure
16 GA. (1.61 mm) 1" (25 mm) REINFORCED "S" SLIP T-7	• Use slips conforming to T-6 • Use 16 ga angle of 1 in. height into slip pocket • Fasten with screws at ends • Angle used only for A, B, or C rigidity class • 2 in. wg maximum pressure

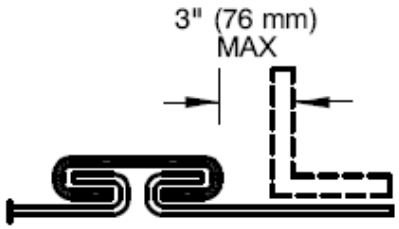
FIGURE 2–1 RECTANGULAR DUCT/TRANSVERSE JOINTS

2.6 HVAC Duct Construction Standards Metal and Flexible • Third Edition

- Figure 2-1
- Pages 2.6-2.9

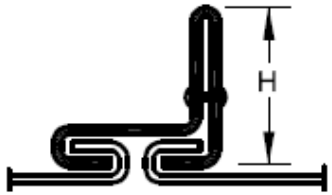
Rectangular

Rectangular Transverse Joints



T–1 – DRIVE SLIP
T–3 – REINFORCED

- Gage no less than two gages less than duct gage
- 24 ga minimum
- Qualification as reinforcement per Table 2-48
- T-3 – Slip Gage as per T-1
  - Any length at 2 in. wg
  - 36 in. maximum length at 3 in. wg
  - 30 in. maximum length at 4 in. wg
  - Not allowed above 4 in. wg

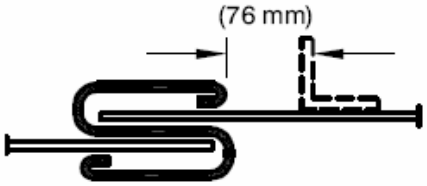


STANDING DRIVE SLIP
T–2

- Fasten standing portions within 2 in. of each end and elsewhere at 8 in. spacing or less
- Any length at 2 in. wg
- 36 in. maximum length at 3 in. wg
- 30 in. maximum length at 4 in. wg
- Not allowed above 4 in. wg

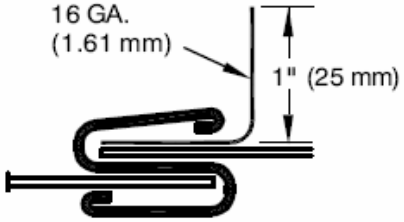
Rectangular Transverse Joints

PLAIN "S" SLIP
T–5



T–6 HEMMED "S" SLIP
(T–6a REINFORCED)

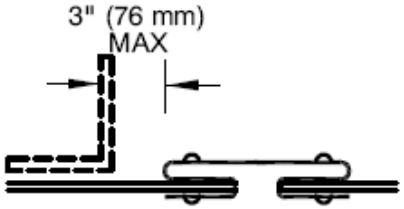
- Not less than two gages less than duct gage
- 24 ga minimum
- When used on all 4 sides, fasten within 2 in. of the corners and at 12 in. maximum intervals
- 2 in. wg maximum pressure



REINFORCED "S" SLIP
T–7

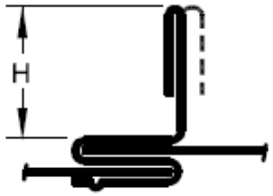
- Use slips conforming to T-6
- Use 16 ga angle of 1 in. height into slip pocket
- Fasten with screws at ends
- Angle used only for A, B, or C rigidity class
- 2 in. wg maximum pressure

Rectangular Transverse Joints

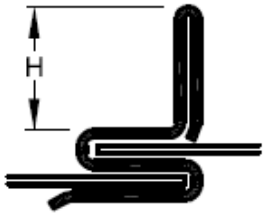


T–8 DOUBLE "S" SLIP
(T–8a REINFORCED)

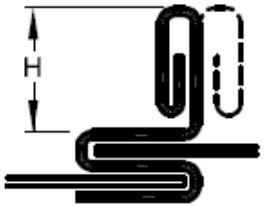
- 24 ga for 30 inch width or less
- 22 ga over 30 inch width
- Fasten to each section of the duct within 2 in. from corners and at 6 in. maximum intervals
- ⅝ in. minimum tabs to close corners



STANDING S
T–10



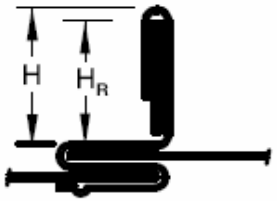
STANDING S (ALT.)
T–11



STANDING S (ALT.)
T–12

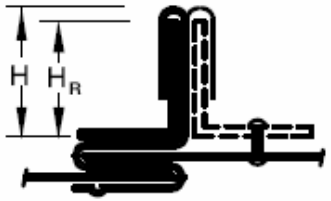
- When using S on all four sides, fasten slip to duct within 2 in. of the corner and at 12 in. maximum intervals
- Any length at 2 in. wg
- 36 in. maximum length at 3 in. wg
- 30 in. maximum length at 4 in. wg
- Not allowed above 4 in. wg

Rectangular Transverse Joints



STANDING S
(BAR REINFORCED)
T–13

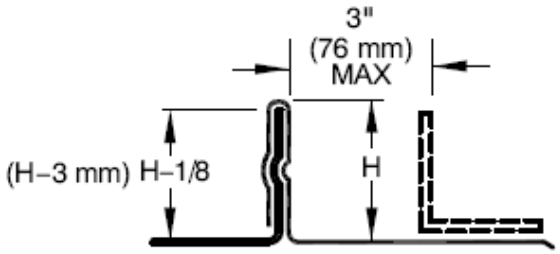
- Fasten as per Joint T-10
- Standing portion as per T-10 or T-11 to hold Flat Bar
- Fasten bar stock to the connector within 2 in. of the corner and at 12 in. maximum intervals
- Any length at 2 in. wg
- 36 in. maximum length at 3 in. wg
- 30 in. maximum length at 4 in. wg
- Not allowed above 4 in. wg



STANDING S
(ANGLE REINFORCED)
T–14

- Fasten as per Joint T-10
- Fasten angle to the connector or duct wall within 2 in. of the corner and at 12 in. maximum intervals
- Any length at 2 in. wg
- 36 in. maximum length at 3 in. wg
- 30 in. maximum length at 4 in. wg
- Not allowed above 4 in. wg

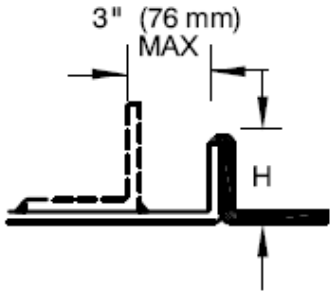
Rectangular Transverse Joints



STANDING SEAM
T–15

ANGLE REINFORCED
STANDING SEAM
T–16

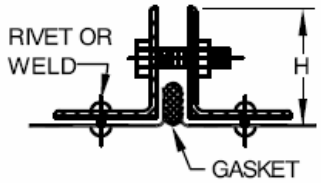
- Button punch or otherwise fasten within 2 in. of each corner and at 6 in. maximum intervals
- Seal and fold corners
- Stagger joints on adjacent sides if using standing seam on all four sides
- Hammer longitudinal seam at ends of standing seam



T–21 WELDED FLANGE
(T–21a REINFORCED W.F.)

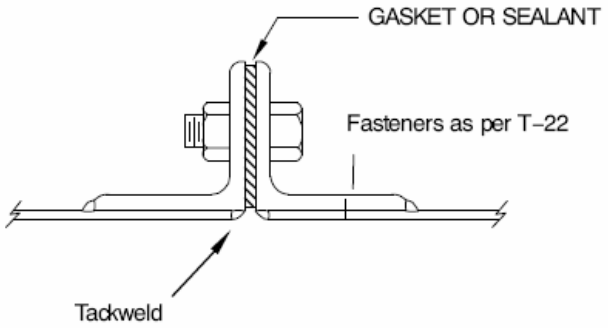
- Use ½ in. minimum flange and end weld
- Flanges larger than ⅝ in. must be spot welded, bolted, riveted or screwed to prevent separation (2 in. from ends and at 8 in. maximum intervals)
- On 24, 22 or 20 ga, brace or weld ¼ × 4 in. rod in corners or provide hangers at every joint

Rectangular Transverse Joints



COMPANION ANGLES
(CAULK OR GASKET)
T–22

- ⅜ in. minimum flange on duct
- Angles must have welded corners
- Angles must be tack welded, bolted or screwed to the duct wall at 2 in. maximum from the ends and at 12 in. maximum intervals
- Bolt Schedule:
  - 5⁄16 minimum diameter at 6 in. maximum spacing at 4 in. wg or lower
  - ⅛ in. angle requires 4 in. maximum spacing at 4 in. wg
  - 4 in. maximum spacing at higher pressures



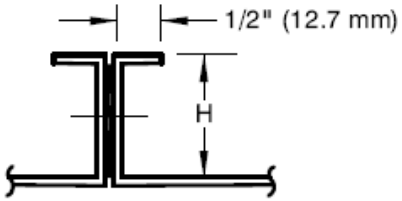
COMPANION ANGLES
T–22 ALT.

- Hold duct back ⅛ in. from vertical face of the angle and tack weld to the flange along the edge of the duct
- Fasten angle to duct as per T-22
- For additional tightness place sealant between the angle and duct or seal the weld
- If the faces of the angles are flush, thick consistency sealant may be used in lieu of gasket
- Use gasket suitable for the specific service and fit it uniformly to avoid protruding into the duct

Rectangular Transverse Joints

FLANGED
(WITH GASKET)
T–24

- Assemble per Figure 2-16
- Close corners with minimum 16 ga corner pieces and ⅜ in. bolts min.
- Lock flanges together with 6 in. long clips located within 6 in. of each corner
- Clips spaced at 15 in. maximum for 3 in. wg pressure class or lower
- Clips spaced at 12 in. maximum for 4, 6 and 10 in. wg
- Gasket to be located to form an effective seal



FLANGED
(WITH GASKET)
T–24A

- Bolt, rivet 1 in. maximum from ends and at 6 in. maximum intervals
- Limited to 2 in. wg pressure class
- *See* Figure 2-16
- Gasket to be located to form an effective seal

Rectangular Transverse Joints

FLANGED
(WITH GASKET)
T–25a

FLANGED
(WITH GASKET)
T–25b

- Assemble per Figure 2-17
- Ratings may be adjusted with EI-rated bar stock or members from Tables 2-29 and 2-30
- Supplemental members may be attached to the duct wall on both sides of the joint
- Single members may be used if they are fastened through both mating flanges
- Gasket to be located to form an effective seal

SLIP–ON
FLANGE

- Consult manufacturers for ratings established by performance documented to functional criteria in Chapter 11.

Rectangular Transverse Joints

Duct Wall	26 ga		24 ga		22 ga		20 ga or Heavier	
Static Pressure	Maximum Duct Width (W) and Maximum Reinforcement Spacing (RS)							
	W	RS	W	RS	W	RS	W	RS
½ in. wg	20 in. 18 in.	10 ft N.R.	20 in.	N.R.	20 in.	N.R.	20 in.	N.R.
1 in. wg	20 in. 14 in. 12 in.	8 ft 10 ft N.R.	20 in. 14 in.	8 ft N.R.	20 in. 18 in.	10 ft N.R.	20 in.	N.R.
2 in. wg	18 in.	5 ft	18 in. 12 in.	8 ft N.R.	18 in. 14 in.	10 ft N.R.	18 in.	N.R
3 in. wg	12 in. 10 in.	5 ft 6 ft	18 in. 10 in.	5 ft N.R.	18 in. 12 in.	5 ft N.R.	18 in. 14 in.	6 ft N.R.
4 in. wg	Not Accepted		16 in. 8 in.	5 ft N.R.	12 in. 8 in.	6 ft N.R.	12 in.	N.R.

Table 2–48 T–1 Flat Drive Accepted as Reinforcement

Figure 2-16

Corners not required up to 2 in. w.g.
Corners are required above 2 in. w.g.

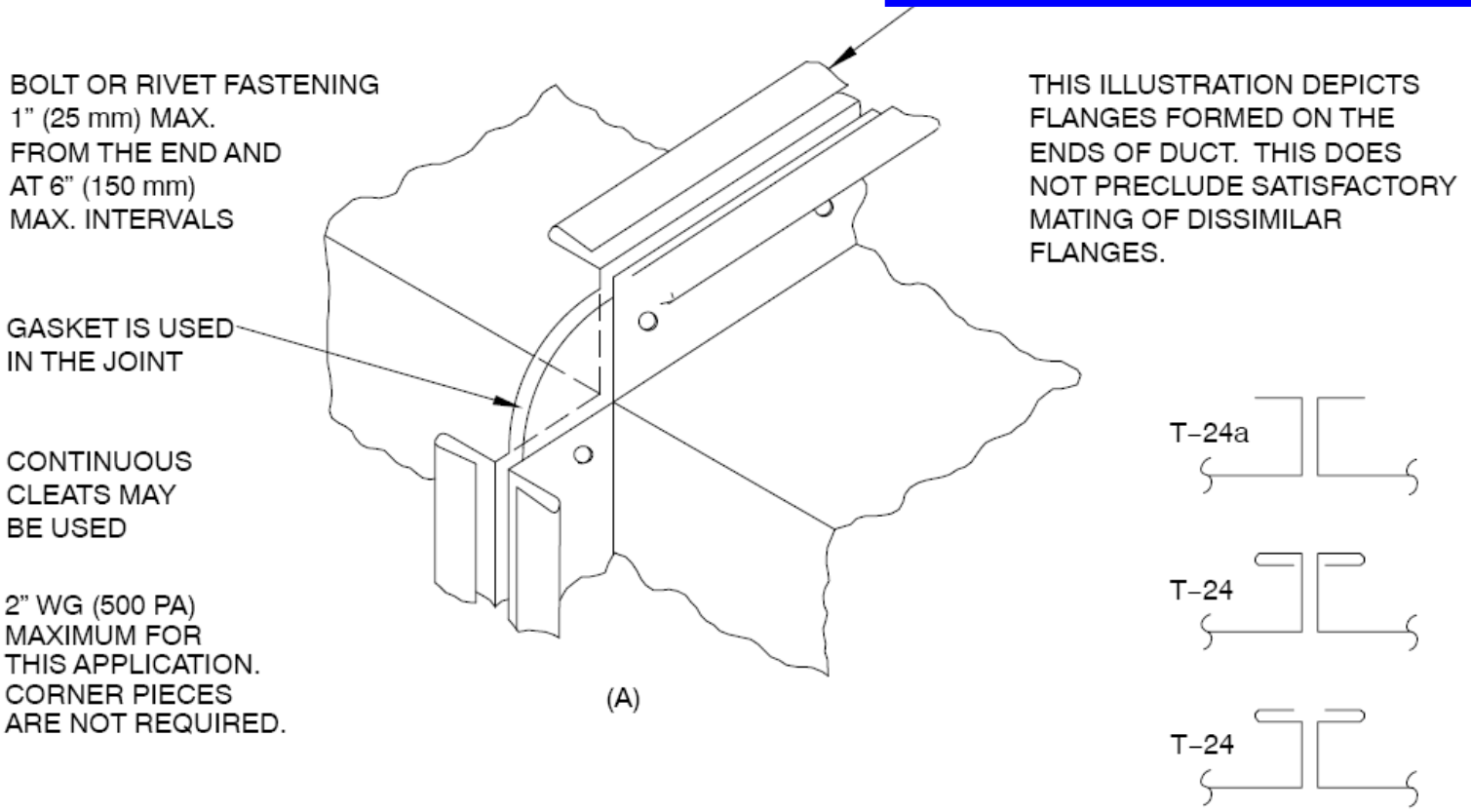
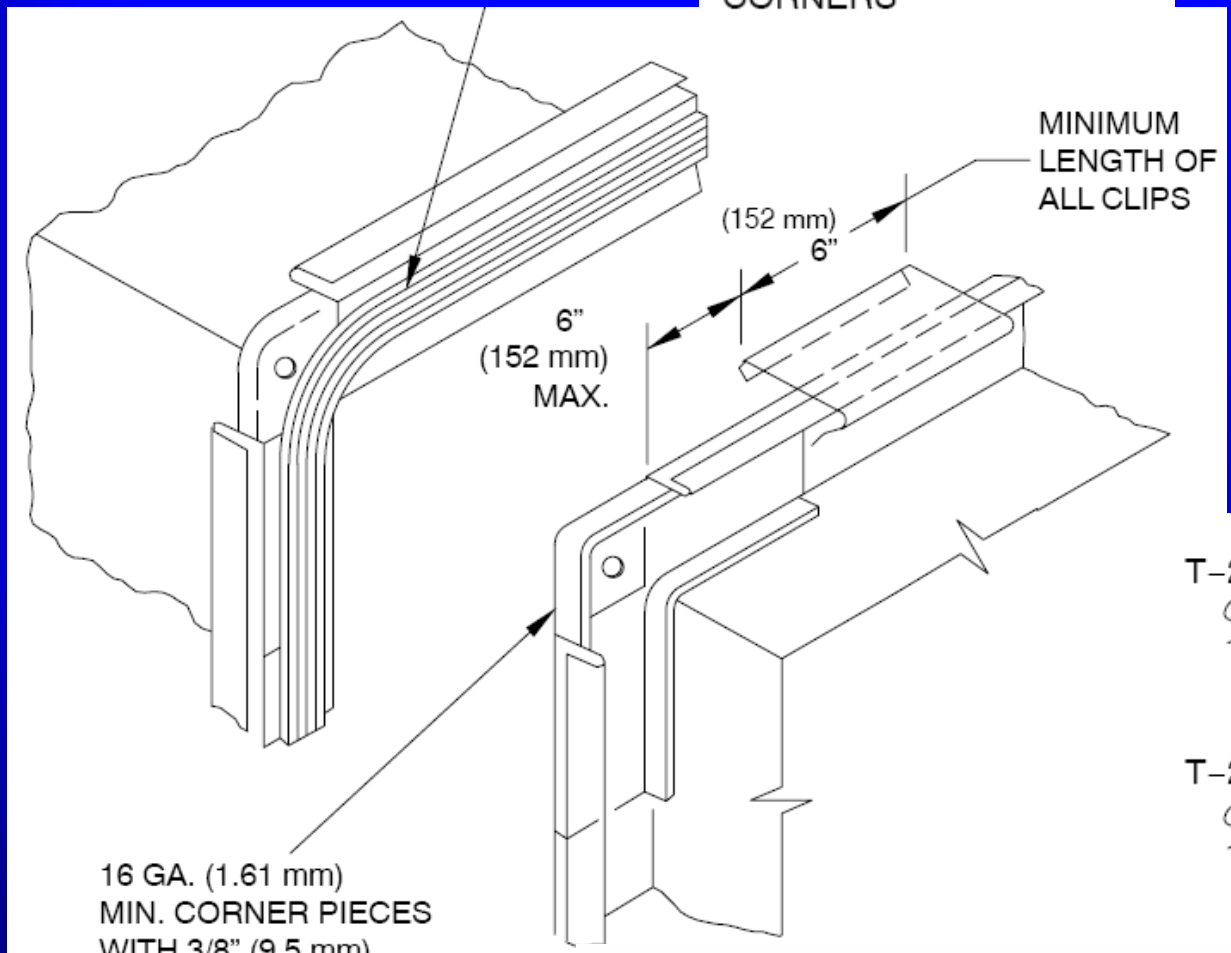
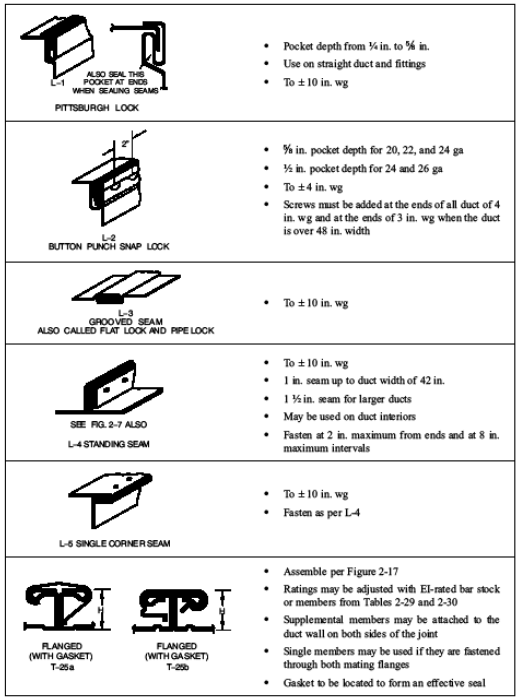


FIGURE 2–16 CORNER CLOSURES – FLANGES

Figure 2-17


CONTINUOUS GASKET TO EFFECTIVELY SEAL FLANGES AND CORNERS
SECURELY ATTACH ADDITIONAL METAL CLIPS ON FLANGES AT 15" (381 mm) MAXIMUM CENTERS FOR 3" WG (750 PA) STATIC OR LESS AND AT 12" (305 mm) MAXIMUM CENTERS FOR HIGHER PRESSURES. 22 GA. (0.85 mm) MINIMUM.
MINIMUM LENGTH OF ALL CLIPS
(152 mm) 6"
6" (152 mm) MAX.
T–25a
T–25b
TEE FLANGES
16 GA. (1.61 mm) MIN. CORNER PIECES WITH 3/8" (9.5 mm) MIN. BOLT
(B)
SCREWS MAY BE USED IN LIEU OF METAL CLIPS. INSTALL 1" (25MM) MAX. FROM END OF CORNER PIECE AND AT 6" (152 MM) MAX. INTERVALS.
EQUIVALENT FIXATION OF JOINTS MAY BE USED. CONTINUOUS CLEATS MAY BE USED.

Longitudinal Seams



L-1 PITTSBURGH LOCK (ALSO SEAL THIS POCKET AT ENDS WHEN SEALING SEAMS)	• Pocket depth from ¼ in. to ⅝ in. • Use on straight duct and fittings • To ± 10 in. wg
L-2 BUTTON PUNCH SNAP LOCK	• ⅝ in. pocket depth for 20, 22, and 24 ga • ½ in. pocket depth for 24 and 26 ga • To ± 4 in. wg • Screws must be added at the ends of all duct of 4 in. wg and at the ends of 3 in. wg when the duct is over 48 in. width
L-3 GROOVED SEAM ALSO CALLED FLAT LOCK AND PIPE LOCK	• To ± 10 in. wg
SEE FIG. 2-7 ALSO L-4 STANDING SEAM	• To ± 10 in. wg • 1 in. seam up to duct width of 42 in. • 1 ½ in. seam for larger ducts • May be used on duct interiors • Fasten at 2 in. maximum from ends and at 8 in. maximum intervals
L-5 SINGLE CORNER SEAM	• To ± 10 in. wg • Fasten as per L-4
FLANGED (WITH GASKET) T-25a; FLANGED (WITH GASKET) T-25b	• Assemble per Figure 2-17 • Ratings may be adjusted with EI-rated bar stock or members from Tables 2-29 and 2-30 • Supplemental members may be attached to the duct wall on both sides of the joint • Single members may be used if they are fastened through both mating flanges • Gasket to be located to form an effective seal

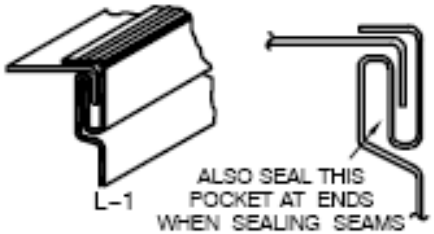
FIGURE 2–2 RECTANGULAR DUCT/LONGITUDINAL SEAMS

2.10 HVAC Duct Construction Standards Metal and Flexible • Third Edition

Rectangular

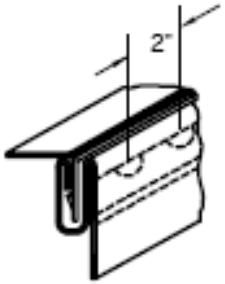
- Figure 2-17
- Page 2.10

Longitudinal Seams



PITTSBURGH LOCK

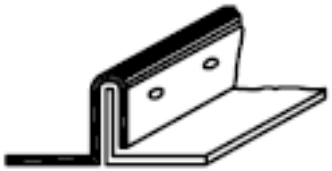
- Pocket depth from ¼ in. to ⅝ in.
- Use on straight duct and fittings
- To ± 10 in. wg



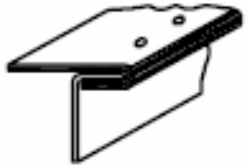
L–2
BUTTON PUNCH SNAP LOCK

- ⅝ in. pocket depth for 20, 22, and 24 ga
- ½ in. pocket depth for 24 and 26 ga
- To ± 4 in. wg
- Screws must be added at the ends of all duct of 4 in. wg and at the ends of 3 in. wg when the duct is over 48 in. width

Longitudinal Seams

 L–3 GROOVED SEAM ALSO CALLED FLAT LOCK AND PIPE LOCK	• To ± 10 in. wg
 SEE FIG. 2–7 ALSO L–4 STANDING SEAM	• To ± 10 in. wg • 1 in. seam up to duct width of 42 in. • 1 ½ in. seam for larger ducts • May be used on duct interiors • Fasten at 2 in. maximum from ends and at 8 in. maximum intervals

Longitudinal Seams



L–5 SINGLE CORNER SEAM

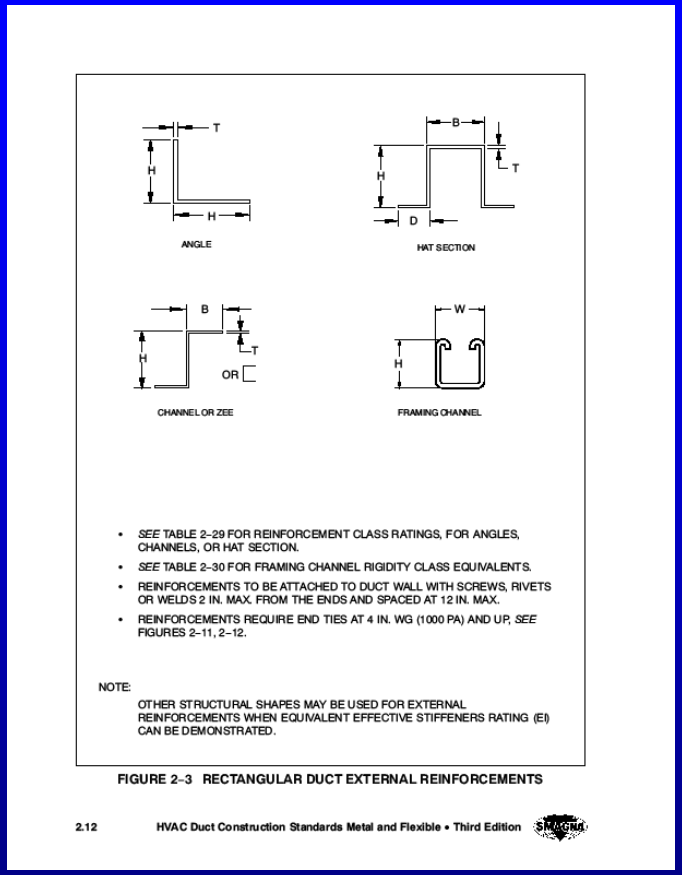
- To ± 10 in. wg
- Fasten as per L-4

FLANGED
(WITH GASKET)
T–25a

FLANGED
(WITH GASKET)
T–25b

- Assemble per Figure 2-17
- Ratings may be adjusted with EI-rated bar stock or members from Tables 2-29 and 2-30
- Supplemental members may be attached to the duct wall on both sides of the joint
- Single members may be used if they are fastened through both mating flanges
- Gasket to be located to form an effective seal

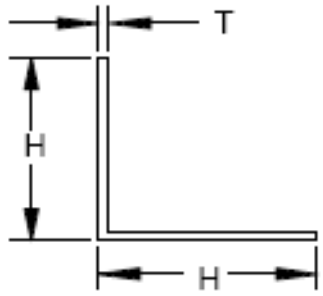
Intermediate Reinforcement



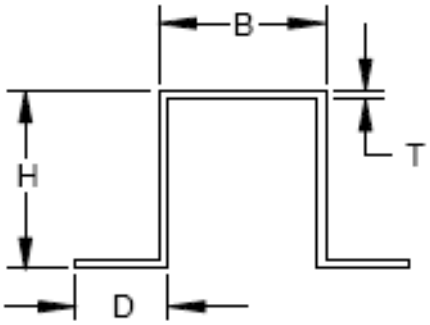
- Figure 2-3
- Page 2.12

Rectangular

Intermediate Reinforcement

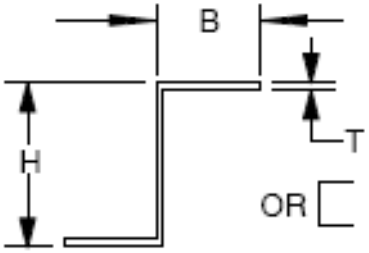


ANGLE

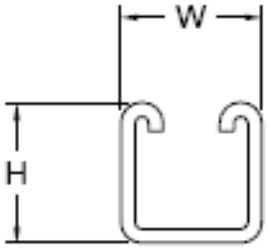


HAT SECTION

- *SEE* TABLE 2–29 FOR REINFORCEMENT CLASS RATINGS, FOR ANGLES, CHANNELS, OR HAT SECTION.
- *SEE* TABLE 2–30 FOR FRAMING CHANNEL RIGIDITY CLASS EQUIVALENTS.



CHANNEL OR ZEE

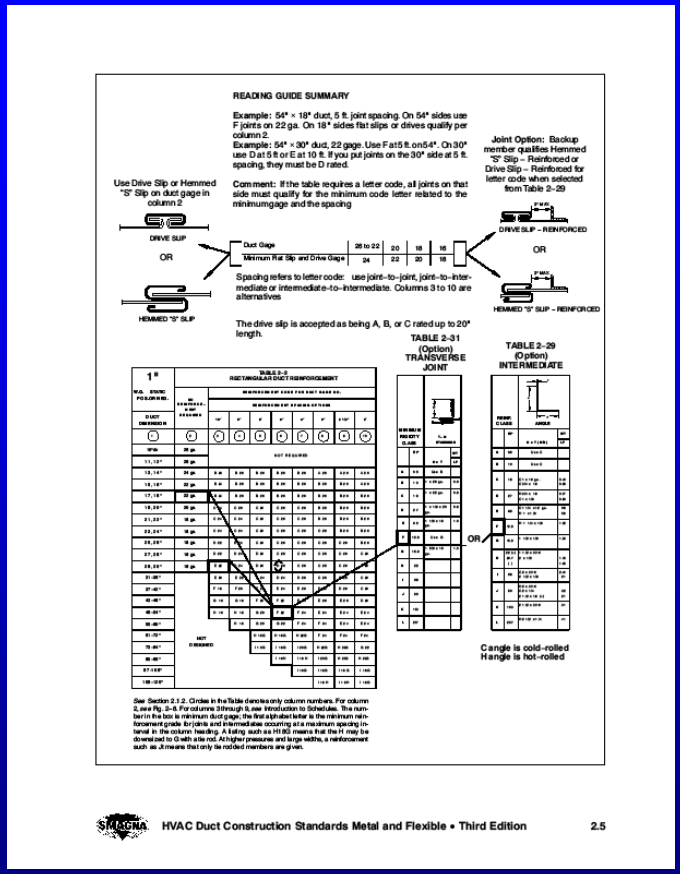


FRAMING CHANNEL

Basic Duct Construction Process

- Verify pressure class
- Check corresponding table
- Start with the larger side first
- Determine reinforcement spacing options
- Check joint reinforcement tables
- Check intermediate reinforcement tables if applicable (tie rod options)
- Repeat for the short side

Guide Summary (P 2.5)



READING GUIDE SUMMARY

Example: 54" × 18" duct, 5 ft. joint spacing. On 54" sides use F joints on 22 ga. On 18" sides flat slips or drives qualify per column 2.
Example: 54" × 30" duct, 22 gage. Use F at 5 ft. on 54". On 30" use D at 5 ft or E at 10 ft. If you put joints on the 30" side at 5 ft. spacing, they must be D rated.

Comment: If the table requires a letter code, all joints on that side must qualify for the minimum code letter related to the minimum gage and the spacing

Use Drive Slip or Hemmed "S" Slip on duct gage in column 2

DRIVE SLIP

OR

HEMMED "S" SLIP

Duct Gage	26 to 22	20	18	16
Minimum Flat Slip and Drive Gage	24	22	20	18

Spacing refers to letter code: use joint-to-joint, joint-to-intermediate or intermediate-to-intermediate. Columns 3 to 10 are alternatives

The drive slip is accepted as being A, B, or C rated up to 20" length.

Joint Option: Backup member qualifies Hemmed "S" Slip – Reinforced or Drive Slip – Reinforced for letter code when selected from Table 2–29

DRIVE SLIP – REINFORCED

OR

HEMMED "S" SLIP – REINFORCED

TABLE 2-31 (Option) TRANSVERSE JOINT

TABLE 2-29 (Option) INTERMEDIATE

Cangle is cold-rolled
Hangle is hot-rolled

TABLE 2-3 RECTANGULAR DUCT REINFORCEMENT

See Section 2.1.2. Circles in the Table denotes only column numbers. For column 2, see Fig. 2–5. For columns 3 through 9, see Introduction to Schedules. The number in the box is minimum duct gage; the first alphabet letter is the minimum reinforcement grade for joints and intermediates occurring at a maximum spacing interval in the column heading. A listing such as H18G means that the H may be downsized to G with a tie rod. At higher pressures and large widths, a reinforcement such as J means that only tie rodded members are given.

- Circles are column numbers
- Number in box is the minimum gage
- First letter is minimum reinforcement class required.
- Second letter is downsized reinforcement when used with tie rod
- Xt – t means tie rod is required

In Words…

- If the box in the table shows H-20G
- The minimum panel gage is 20
- The reinforcement required is class H at the spacing noted at the top of the column (this can be a joint or intermediate reinforcement)
- You can use G instead of H if you use a tie rod as well. (If to achieve a class G you are already required to use a tie rod then you can not use this option)

Rectangular Duct Reinforcement

2 in. wg Static Pos. or Neg. / Duct Dimension	No Reinforcement Required	Reinforcement Code for Duct Gage Number							
		Reinforcement Spacing Options							
		10 ft	8 ft	6 ft	5 ft	4 ft	3 ft	2½ ft	2 ft
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
10 in. and under	26 ga.	Not Required							
11 – 12 in.	26 ga.								
13 – 14 in.	24 ga.		B-26	B-26	B-26	B-26	B-26	B-26	B-26
15 – 16 in.	24 ga.		C-26	C-26	C-26	C-26	C-26	B-26	B-26
17 – 18 in.	22 ga.		C-26	C-26	C-26	C-26	C-26	C-26	B-26
19 – 20 in.	20 ga.	C-22	C-24	C-26	C-26	C-26	C-26	C-26	C-26
21 – 22 in.	18 ga.	D-22	D-24	D-26	D-26	C-26	C-26	C-26	C-26
23 – 24 in.	18 ga.	E-22	E-24	D-26	D-26	D-26	C-26	C-26	C-26
25 – 26 in.	18 ga.	E-22	E-22	E-24	D-26	D-26	C-26	C-26	C-26
27 – 28 in.	18 ga.	F-20	E-20	E-22	E-24	D-26	D-26	C-26	C-26
29 – 30 in.	18 ga.	F-20	F-20	E-22	E-24	E-26	D-26	D-26	C-26
31 – 36 in.	16 ga.	G-18	G-20	F-22	F-24	E-24	E-26	D-26	D-26
37 – 42 in.		H-16	H-18	G-20	G-22	F-24	E-24	E-26	E-26
43 – 48 in.			I-18	H-20	H-22	G-22	F-24	F-24	E-24
49 – 54 in.			I-16G	I-18G	H-20G	H-20G	G-24	F-24	F-24
55 – 60 in.				I-18G	I-20G	H-20G	G-22	G-24	F-24

Rectangular Duct Reinforcement

2 in. wg Static Pos. or Neg. / Duct Dimension	No Reinforcement Required	Reinforcement Code for Duct Gage Number							
		Reinforcement Spacing Options							
		10 ft	8 ft	6 ft	5 ft	4 ft	3 ft	2½ ft	2 ft
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
10 in. and under	26 ga.	Not Required							
11 – 12 in.	26 ga.								
13 – 14 in.	24 ga.		B-26	B-26	B-26	B-26	B-26	B-26	B-26
15 – 16 in.	24 ga.		C-26	C-26	C-26	C-26	C-26	B-26	B-26
17 – 18 in.	22 ga.		C-26	C-26	C-26	C-26	C-26	C-26	B-26
19 – 20 in.	20 ga.	C-22	C-24	C-26	C-26	C-26	C-26	C-26	C-26
21 – 22 in.	18 ga.	D-22	D-24	D-26	D-26	C-26	C-26	C-26	C-26
23 – 24 in.	18 ga.	E-22	E-24	D-26	D-26	D-26	C-26	C-26	C-26
25 – 26 in.	18 ga.	E-22	E-22	E-24	D-26	D-26	C-26	C-26	C-26
27 – 28 in.	18 ga.	F-20	E-20	E-22	E-24	D-26	D-26	C-26	C-26
29 – 30 in.	18 ga.	F-20	F-20	E-22	E-24	E-26	D-26	D-26	C-26
31 – 36 in.	16 ga.	G-18	G-20	F-22	F-24	E-24	E-26	D-26	D-26
37 – 42 in.		H-16	H-18	G-20	G-22	F-24	E-24	E-26	E-26
43 – 48 in.			I-18	H-20	H-22	G-22	F-24	F-24	E-24
49 – 54 in.			I-16G	I-18G	H-20G	H-20G	G-24	F-24	F-24
55 – 60 in.				I-18G	I-20G	H-20G	G-22	G-24	F-24

Rectangular Duct Reinforcement

2 in. wg Static Pos. or Neg.	No Reinforcement Required	Reinforcement Code for Duct Gage Number							
Duct Dimension		Reinforcement Spacing Options							
		10 ft	8 ft	6 ft	5 ft	4 ft	3 ft	2½ ft	2 ft
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
10 in. and under	26 ga.	Not Required							
11 – 12 in.	26 ga.								
13 – 14 in.	24 ga.		B-26	B-26	B-26	B-26	B-26	B-26	B-26
15 – 16 in.	24 ga.		C-26	C-26	C-26	C-26	C-26	B-26	B-26
17 – 18 in.	22 ga.		C-26	C-26	C-26	C-26	C-26	C-26	B-26
19 – 20 in.	20 ga.	C-22	C-24	C-26	C-26	C-26	C-26	C-26	C-26
21 – 22 in.	18 ga.	D-22	D-24	D-26	D-26	C-26	C-26	C-26	C-26
23 – 24 in.	18 ga.	E-22	E-24	D-26	D-26	D-26	C-26	C-26	C-26
25 – 26 in.	18 ga.	E-22	E-22	E-24	D-26	D-26	C-26	C-26	C-26
27 – 28 in.	18 ga.	F-20	E-20	E-22	E-24	D-26	D-26	C-26	C-26
29 – 30 in.	18 ga.	F-20	F-20	E-22	E-24	E-26	D-26	D-26	C-26
31 – 36 in.	16 ga.	G-18	G-20	F-22	F-24	E-24	E-26	D-26	D-26
37 – 42 in.		H-16	H-18	G-20	G-22	F-24	E-24	E-26	E-26
43 – 48 in.			I-18	H-20	H-22	G-22	F-24	F-24	E-24
49 – 54 in.			I-16G	I-18G	H-20G	H-20G	G-24	F-24	F-24
55 – 60 in.				I-18G	I-20G	H-20G	G-22	G-24	F-24

Rectangular Duct Reinforcement

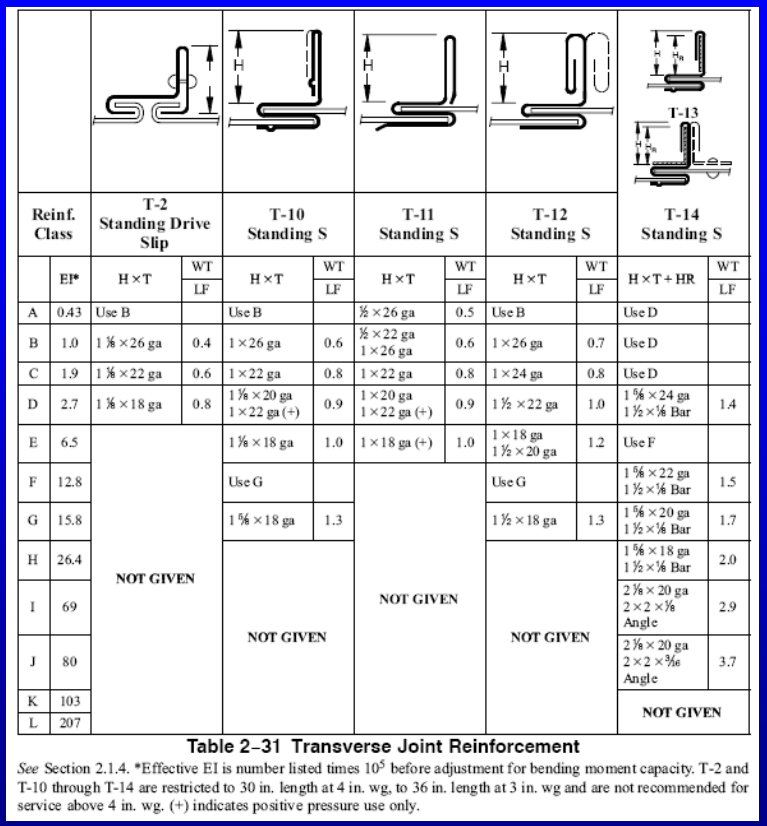
2 in. wg Static Pos. or Neg. / Duct Dimension	No Reinforcement Required	Reinforcement Code for Duct Gage Number							
		Reinforcement Spacing Options							
		10 ft	8 ft	6 ft	5 ft	4 ft	3 ft	2½ ft	2 ft
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
10 in. and under	26 ga.	Not Required							
11 – 12 in.	26 ga.								
13 – 14 in.	24 ga.		B-26	B-26	B-26	B-26	B-26	B-26	B-26
15 – 16 in.	24 ga.		C-26	C-26	C-26	C-26	C-26	B-26	B-26
17 – 18 in.	22 ga.		C-26	C-26	C-26	C-26	C-26	C-26	B-26
19 – 20 in.	20 ga.	C-22	C-24	C-26	C-26	C-26	C-26	C-26	C-26
21 – 22 in.	18 ga.	D-22	D-24	D-26	D-26	C-26	C-26	C-26	C-26
23 – 24 in.	18 ga.	E-22	E-24	E-26	D-26	D-26	C-26	C-26	C-26
25 – 26 in.	18 ga.	E-22	E-22	E-24	D-26	D-26	C-26	C-26	C-26
27 – 28 in.	18 ga.	F-20	E-20	E-22	E-24	D-26	D-26	C-26	C-26
29 – 30 in.	18 ga.	F-20	F-20	E-22	E-24	E-26	D-26	D-26	C-26
31 – 36 in.	16 ga.	G-18	G-20	F-22	F-24	E-24	E-26	D-26	D-26
37 – 42 in.		H-16	H-18	G-20	G-22	F-24	E-24	E-26	E-26
43 – 48 in.			I-18	H-20	H-22	G-22	F-24	F-24	E-24
49 – 54 in.			I-16G	I-18G	H-20G	H-20G	G-24	F-24	F-24
55 – 60 in.				I-18G	I-20G	H-20G	G-22	G-24	F-24

Rectangular Duct Reinforcement

2 in. wg Static Pos. or Neg. Duct Dimension	No Reinforcement Required	Reinforcement Code for Duct Gage Number							
		Reinforcement Spacing Options							
		10 ft	8 ft	6 ft	5 ft	4 ft	3 ft	2½ ft	2 ft
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
10 in. and under	26 ga.	Not Required							
11 – 12 in.	26 ga.								
13 – 14 in.	24 ga.		B-26	B-26	B-26	B-26	B-26	B-26	B-26
15 – 16 in.	24 ga.		C-26	C-26	C-26	C-26	C-26	B-26	B-26
17 – 18 in.	22 ga.		C-26	C-26	C-26	C-26	C-26	C-26	B-26
19 – 20 in.	20 ga.	C-22	C-24	C-26	C-26	C-26	C-26	C-26	C-26
21 – 22 in.	18 ga.	D-22	D-24	D-26	D-26	C-26	C-26	C-26	C-26
23 – 24 in.	18 ga.	E-22	E-24	D-26	D-26	D-26	C-26	C-26	C-26
25 – 26 in.	18 ga.	E-22	E-22	E-24	D-26	D-26	C-26	C-26	C-26
27 – 28 in.	18 ga.	F-20	E-20	E-22	E-24	D-26	D-26	C-26	C-26
29 – 30 in.	18 ga.	F-20	F-20	E-22	E-24	E-26	D-26	D-26	C-26
31 – 36 in.	16 ga.	G-18	G-20	F-22	F-24	E-24	E-26	D-26	D-26
37 – 42 in.		H-16	H-18	G-20	G-22	F-24	E-24	E-26	E-26
43 – 48 in.			I-18	H-20	H-22	G-22	F-24	F-24	E-24
49 – 54 in.			I-16G	I-18G	H-20G	H-20G	G-24	F-24	F-24
55 – 60 in.				I-18G	I-20G	H-20G	G-22	G-24	F-24

Joint Reinforcement

- Table 2-31
- Starts on page 2.74
- Covers all transverse joints that qualify as reinforcement except T-1 drive slip
- For T-1 drive slip see Table 2-48 on page 2.110

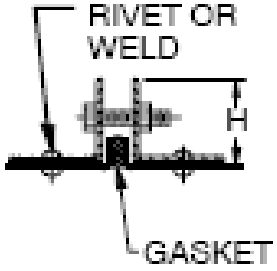
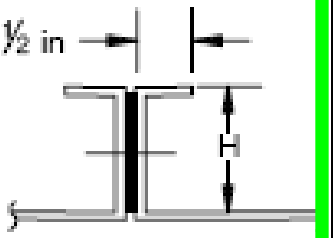


Reinf. Class		T-2 Standing Drive Slip		T-10 Standing S		T-11 Standing S		T-12 Standing S		T-14 Standing S	
	EI*	H×T	WT LF	H×T	WT LF	H×T	WT LF	H×T	WT LF	H×T+HR	WT LF
A	0.43	Use B		Use B		½×26 ga	0.5	Use B		Use D	
B	1.0	1⅛×26 ga	0.4	1×26 ga	0.6	½×22 ga 1×26 ga	0.6	1×26 ga	0.7	Use D	
C	1.9	1⅛×22 ga	0.6	1×22 ga	0.8	1×22 ga	0.8	1×24 ga	0.8	Use D	
D	2.7	1⅛×18 ga	0.8	1⅛×20 ga 1×22 ga (+)	0.9	1×20 ga 1×22 ga (+)	0.9	1½×22 ga	1.0	1⅝×24 ga 1½×⅛ Bar	1.4
E	6.5	NOT GIVEN		1⅛×18 ga	1.0	1×18 ga (+)	1.0	1×18 ga 1½×20 ga	1.2	Use F	
F	12.8			Use G		NOT GIVEN		Use G		1⅝×22 ga 1½×⅛ Bar	1.5
G	15.8			1⅝×18 ga	1.3			1½×18 ga	1.3	1⅝×20 ga 1½×⅛ Bar	1.7
H	26.4			NOT GIVEN				NOT GIVEN		1⅝×18 ga 1½×⅛ Bar	2.0
I	69									2⅛×20 ga 2×2×⅛ Angle	2.9
J	80									2⅛×20 ga 2×2×3/16 Angle	3.7
K	103									NOT GIVEN	
L	207										

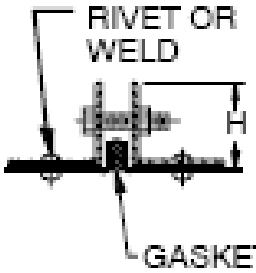
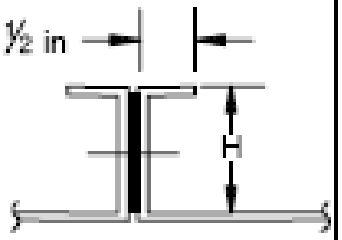
Table 2–31 Transverse Joint Reinforcement

See Section 2.1.4. *Effective EI is number listed times 10^5 before adjustment for bending moment capacity. T-2 and T-10 through T-14 are restricted to 30 in. length at 4 in. wg, to 36 in. length at 3 in. wg and are not recommended for service above 4 in. wg. (+) indicates positive pressure use only.

Joint Reinforcement

Reinf. Class		T-22 Companion Angles		T-24 Flanged		T-24a Flanged		T-25b Flanged	
				 H = 1⅝ in. (WITH GASKET)		 (WITH GASKET)		 T-25a Flanged 	
	EI*	H × T	WT LF	T (Nom.)	WT LF	H × T (Nom.)	WT LF	H × T (Nom.)	WT LF
B	1.0	Use E		Use D		Use D		Use D	
C	1.9	Use E		Use D		Use D		Use D	
D	2.7	Use E		26 ga	0.5	1 × 22 ga	0.4	26 ga	0.5

Joint Reinforcement

Reinf. Class		T-22 Companion Angles		T-24 Flanged		T-24a Flanged	T-25b Flanged		Slip-On Flange
				 H = 1⅜ in. (WITH GASKET)		 (WITH GASKET)			
I	69	1½ × ¼	3.7	20 ga (R)	1.0	SEE TIE ROD TEXT	20 ga (R)	1.0	
J	80	1½ × ¼ (+) 2 × ⅛	4.7	18 ga (R)	1.1		18 ga (R)	1.1	

The (R) means use with a tie rod

The (+) means use for positive pressure application only

Table 2-48

Duct Wall	26 ga		24 ga		22 ga		20 ga or Heavier	
Static Pressure	Maximum Duct Width (W) and Maximum Reinforcement Spacing (RS)							
	W	RS	W	RS	W	RS	W	RS
½ in. wg	20 in. 18 in.	10 ft N.R.	20 in.	N.R.	20 in.	N.R.	20 in.	N.R.
1 in. wg	20 in. 14 in. 12 in.	8 ft 10 ft N.R.	20 in. 14 in.	8 ft N.R.	20 in. 18 in.	10 ft N.R.	20 in.	N.R.
2 in. wg	18 in.	5 ft	18 in. 12 in.	8 ft N.R.	18 in. 14 in.	10 ft N.R.	18 in.	N.R
3 in. wg	12 in. 10 in.	5 ft 6 ft	18 in. 10 in.	5 ft N.R.	18 in. 12 in.	5 ft N.R.	18 in. 14 in.	6 ft N.R.
4 in. wg	Not Accepted		16 in. 8 in.	5 ft N.R.	12 in. 8 in.	6 ft N.R.	12 in.	N.R.

Table 2–48 T–1 Flat Drive Accepted as Reinforcement

Example 1

- Pressure class is positive 1/2 in. w.g.
- Dimensions are 20 in. x 12 in.
- 5 ft. joint spacing (longer if possible)
- Preferred joint type plain Slip and Drive

Example 1

½ in. wg Static Pos. or Neg. Duct Dimension	No Reinforcement Required	Reinforcement Code for Duct Gage Number — Reinforcement Spacing Options							
		10 ft	8 ft	6 ft	5 ft	4 ft	3 ft	2½ ft	2 ft
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
10 in. and under	26 ga.	Not Required							
11 – 12 in.	26 ga.								
13 – 14 in.	26 ga.								
15 – 16 in.	26 ga.								
17 – 18 in.	26 ga.								
19 – 20 in.	24 ga.	B-26	B-26	B-26	B-26	B-26	B-26	A-26	A-26
21 – 22 in.	22 ga.	B-26	B-26	B-26	B-26	B-26	B-26	B-26	A-26

Example 1 Table 2-48

Duct Wall	26 ga		24 ga		22 ga		20 ga or Heavier	
Static Pressure	Maximum Duct Width (W) and Maximum Reinforcement Spacing (RS)							
	W	RS	W	RS	W	RS	W	RS
½ in. wg	20 in. 18 in.	10 ft N.R.	20 in.	N.R.	20 in.	N.R.	20 in.	N.R.
1 in. wg	20 in. 14 in. 12 in.	8 ft 10 ft N.R.	20 in. 14 in.	8 ft N.R.	20 in. 18 in.	10 ft N.R.	20 in.	N.R.
2 in. wg	18 in.	5 ft	18 in. 12 in.	8 ft N.R.	18 in. 14 in.	10 ft N.R.	18 in.	N.R
3 in. wg	12 in. 10 in.	5 ft 6 ft	18 in. 10 in.	5 ft N.R.	18 in. 12 in.	5 ft N.R.	18 in. 14 in.	6 ft N.R.
4 in. wg	Not Accepted		16 in. 8 in.	5 ft N.R.	12 in. 8 in.	6 ft N.R.	12 in.	N.R.

Page 2.110

Table 2–48 T–1 Flat Drive Accepted as Reinforcement

Although the flat drive slip T-1 does not satisfy the EI calculation requirements for Classes A, B or C reinforcement, tests predict its suitability for use as reinforcement within the limits of the table.

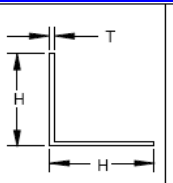
N.R. – No reinforcement is required; however, the T-1 Joint may be used.

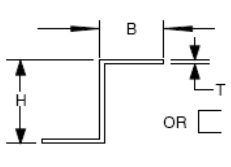
Example 1 Solutions

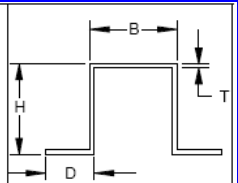
- Option 1
  - Use 24 gage
  - No reinforcement required either side
- Option 2
  - Use 26 gage
  - T-1 (plain drive) on the 20 in. side at a max spacing of 10 ft
  - No reinforcement required on the 12 in. side

Intermediate Reinforcement

- Table 2-29
- Starts on page 2.70
- Covers typical intermediate reinforcement types.
- For struts see Table 2-30 on page 2.72



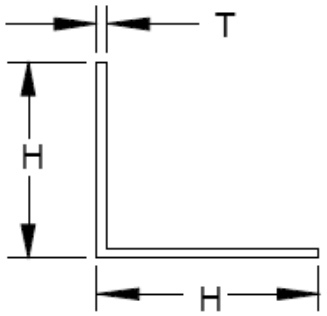


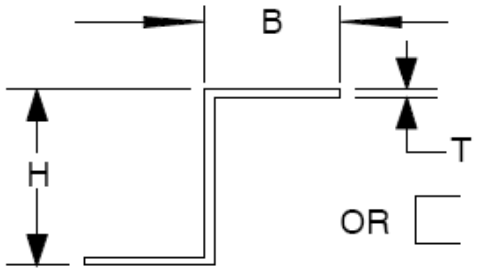


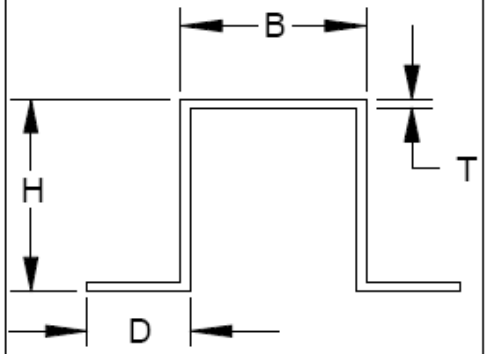
Reinf. Class	E1*	Angle H × T (MIN)	WT LF	Channel or Zee H × B × T (MIN)	WT LF	Hat Section H × B × D × T (MIN)	WT LF
A	0.43	Use C		Use B		Use F	
B	1.0	Use C		¾ × ½ × 20 ga	0.24	Use F	
C	1.9	C 1 × 16 ga C ¾ × ⅛	0.40 0.57	¾ × ½ × 18 ga 1 × ¾ × 20 ga	0.31	Use F	
D	2.7	H ¾ × ⅛ C 1 × ⅛	0.57 0.80	1 × ¾ × 18 ga	0.45	Use F	
E	6.5	C 1 ¼ × 12 ga H 1 × ⅛	0.90	2 × 1 ⅛ × 20 ga	0.60	Use F	
F	12.8	H 1 ¼ × ⅛	1.02	1 ½ × ¾ × 18 ga	0.54	1 ½ × ¾ × ⅝ × 18 ga 1 ½ × 1 ½ × ¾ × 20 ga	0.90 0.83
G	15.8	1 ½ × ⅛	1.23	1 ½ × ¾ × 16 ga	0.66	1 ½ × ¾ × ⅝ × 18 ga	0.80
H	26.4	1 ½ × 3/16 2 × ⅛	1.78 1.65	1 ½ × ¾ × ⅛	1.31	1 ½ × 1 ½ × ¾ × 18 ga 2 × 1 × ¾ × 20 ga	1.08 0.90
I	69	C 2 × 3/16 2 ½ × ⅛	2.44 2.10	2 × 1 ⅛ × 12 ga 3 × 1 ⅛ × 16 ga	1.60 1.05	2 × 1 × ¾ × 16 ga	1.44
J	80	H 2 × 3/16 C 2 × ¼ 2 ½ × ⅛ (+)	2.44 3.20 2.10	2 × 1 ⅛ × ⅛	1.85	2 × 1 × ¾ × 12 ga 2 ½ × 2 × ¾ × 18 ga	2.45 1.53
K	103	2 ½ × 3/16	3.10	3 × 1 ⅛ × 12 ga	2.00	2 ½ × 2 × ¾ × 16 ga 3 × 1 ½ × ¾ × 16 ga	1.88 2.00
L	207	H 2 ½ × ¼	4.10	3 × 1 ⅛ × ⅛	2.29	2 ½ × 2 × ¾ × ⅛ 3 × 1 ½ × ¾ × 12 ga	3.70 3.40

Table 2–29 Intermediate Reinforcement

Intermediate Reinforcement

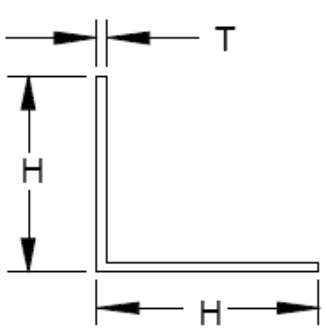


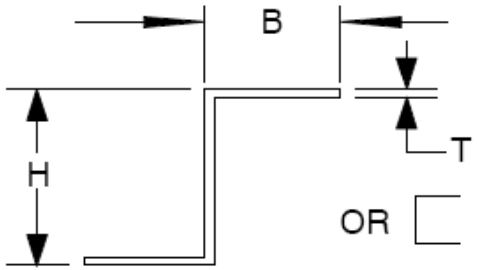


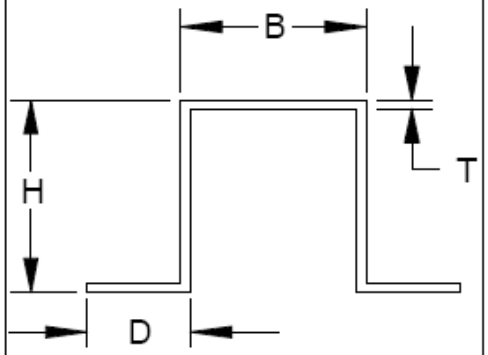


Reinf. Class		Angle		Channel or Zee		Hat Section	
	E1*	H × T (MIN)	WT LF	H × B × T (MIN)	WT LF	H × B × D × T (MIN)	WT LF
A	0.43	Use C		Use B		Use F	
B	1.0	Use C		¾ × ½ × 20 ga	0.24	Use F	
C	1.9	C 1 × 16 ga C ¾ × ⅛	0.40 0.57	¾ × ½ × 18 ga 1 × ¾ × 20 ga	0.31	Use F	
D	2.7	H ¾ × ⅛ C 1 × ⅛	0.57 0.80	1 × ¾ × 18 ga	0.45	Use F	
E	6.5	C 1 ¼ × 12 ga H 1 × ⅛	0.90	2 × 1 ⅛ × 20 ga	0.60	Use F	
F	12.8	H 1 ¼ × ⅛	1.02	1 ½ × ¾ × 18 ga	0.54	1 ½ × ¾ × ⅝ × 18 ga 1 ½ × 1 ½ × ¾ × 20 ga	0.90 0.83

Intermediate Reinforcement







Reinf. Class		Angle		Channel or Zee		Hat Section	
	E1*	H × T (MIN)	WT LF	H × B × T (MIN)	WT LF	H × B × D × T (MIN)	WT LF
A	0.43	Use C		Use B		Use F	
B	1.0	Use C		¾ × ½ × 20 ga	0.24	Use F	
C	1.9	C 1 × 16 ga C ¾ × ⅛	0.40 0.57				
D	2.7	H ¾ × ⅛ C 1 × ⅛	0.57 0.80				
E	6.5	C 1 ¼ × 12 ga H 1 × ⅛	0.90	2 × 1 ⅛ × 20 ga	0.60	Use F	
F	12.8	H 1 ¼ × ⅛	1.02	1 ½ × ¾ × 18 ga	0.54	1 ½ × ¾ × ⅝ × 18 ga 1 ½ × 1 ½ × ¾ × 20 ga	0.90 0.83

H denotes Hot formed

C denotes Cold formed

Example 2

- Pressure Class is 2 in. w.g.
- Dimensions are 60 in. x 26 in.
- 5 foot joint spacing
- TDC or TDF joint
- No internal reinforcement

The Right Table (Pressure Class)

2 in. wg Static Pos. or Neg. / Duct Dimension	No Reinforcement Required	Reinforcement Code for Duct Gage Number							
		Reinforcement Spacing Options							
		10 ft	8 ft	6 ft	5 ft	4 ft	3 ft	2½ ft	2 ft
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
10 in. and under	26 ga.	Not Required							
11 – 12 in.	26 ga.								
13 – 14 in.	24 ga.		B-26	B-26	B-26	B-26	B-26	B-26	B-26
15 – 16 in.	24 ga.		C-26	C-26	C-26	C-26	C-26	B-26	B-26
17 – 18 in.	22 ga.		C-26	C-26	C-26	C-26	C-26	C-26	B-26
19 – 20 in.	20 ga.	C-22	C-24	C-26	C-26	C-26	C-26	C-26	C-26
21 – 22 in.	18 ga.	D-22	D-24	D-26	D-26	C-26	C-26	C-26	C-26
23 – 24 in.	18 ga.	E-22	E-24	D-26	D-26	D-26	C-26	C-26	C-26
25 – 26 in.	18 ga.	E-22	E-22	E-24	D-26	D-26	C-26	C-26	C-26
27 – 28 in.	18 ga.	F-20	E-20	E-22	E-24	D-26	D-26	C-26	C-26
29 – 30 in.	18 ga.	F-20	F-20	E-22	E-24	E-26	D-26	D-26	C-26
31 – 36 in.	16 ga.	G-18	G-20	F-22	F-24	E-24	E-26	D-26	D-26
37 – 42 in.		H-16	H-18	G-20	G-22	F-24	E-24	E-26	E-26
43 – 48 in.			I-18	H-20	H-22	G-22	F-24	F-24	E-24
49 – 54 in.			I-16G	I-18G	H-20G	H-20G	G-24	F-24	F-24
55 – 60 in.				I-18G	I-20G	H-20G	G-22	G-24	F-24

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The Right Table (Pressure Class)

2 in. wg Static Pos. or Neg. / Duct Dimension	No Reinforcement Required	Reinforcement Code for Duct Gage Number							
		Reinforcement Spacing Options							
		10 ft	8 ft	6 ft	5 ft	4 ft	3 ft	2½ ft	2 ft
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
10 in. and under	26 ga.	Not Required							
11 – 12 in.	26 ga.								
13 – 14 in.	24 ga.		B-26	B-26	B-26	B-26	B-26	B-26	B-26
15 – 16 in.	24 ga.		C-26	C-26	C-26	C-26	C-26	B-26	B-26
17 – 18 in.	22 ga.		C-26	C-26	C-26	C-26	C-26	C-26	B-26
19 – 20 in.	20 ga.	C-22	C-24	C-26	C-26	C-26	C-26	C-26	C-26
21 – 22 in.	18 ga.	D-22	D-24	D-26	D-26	C-26	C-26	C-26	C-26
23 – 24 in.	18 ga.	E-22	E-24	D-26	D-26	D-26	C-26	C-26	C-26
25 – 26 in.	18 ga.	E-22	E-22	E-24	D-26	D-26	C-26	C-26	C-26
27 – 28 in.	18 ga.	F-20	E-20	E-22	E-24	D-26	D-26	C-26	C-26
29 – 30 in.	18 ga.	F-20	F-20	E-22	E-24	E-26	D-26	D-26	C-26
31 – 36 in.	16 ga.	G-18	G-20	F-22	F-24	E-24	E-26	D-26	D-26
37 – 42 in.		H-16	H-18	G-20	G-22	F-24	E-24	E-26	E-26
43 – 48 in.			I-18	H-20	H-22	G-22	F-24	F-24	E-24
49 – 54 in.			I-16G	I-18G	H-20G	H-20G	G-24	F-24	F-24
55 – 60 in.				I-18G	I-20G	H-20G	G-22	G-24	F-24

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The Right Table (Pressure Class)

2 in. wg Static Pos. or Neg. Duct Dimension	No Reinforcement Required	Reinforcement Code for Duct Gage Number							
		Reinforcement Spacing Options							
		10 ft	8 ft	6 ft	5 ft	4 ft	3 ft	2½ ft	2 ft
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
10 in. and under	26 ga.	Not Required							
11 – 12 in.	26 ga.								
13 – 14 in.	24 ga.		B-26	B-26	B-26	B-26	B-26	B-26	B-26
15 – 16 in.	24 ga.		C-26	C-26	C-26	C-26	C-26	B-26	B-26
17 – 18 in.	22 ga.		C-26	C-26	C-26	C-26	C-26	C-26	B-26
19 – 20 in.	20 ga.	C-22	C-24	C-26	C-26	C-26	C-26	C-26	C-26
21 – 22 in.	18 ga.	D-22	D-24	D-26	D-26	C-26	C-26	C-26	C-26
23 – 24 in.	18 ga.	E-22	E-24	D-26	D-26	D-26	C-26	C-26	C-26
25 – 26 in.	18 ga.	E-22	E-22	E-24	D-26	D-26	C-26	C-26	C-26
27 – 28 in.	18 ga.	F-20	E-20	E-22	E-24	D-26	D-26	C-26	C-26
29 – 30 in.	18 ga.	F-20	F-20	E-22	E-24	E-26	D-26	D-26	C-26
31 – 36 in.	16 ga.	G-18	G-20	F-22	F-24	E-24	E-26	D-26	D-26
37 – 42 in.		H-16	H-18	G-20	G-22	F-24	E-24	E-26	E-26
43 – 48 in.			I-18	H-20	H-22	G-22	F-24	F-24	E-24
49 – 54 in.			I-16G	I-18G	H-20G	H-20G	G-24	F-24	F-24
55 – 60 in.				I-18G	I-20G	H-20G	G-22	G-24	F-24

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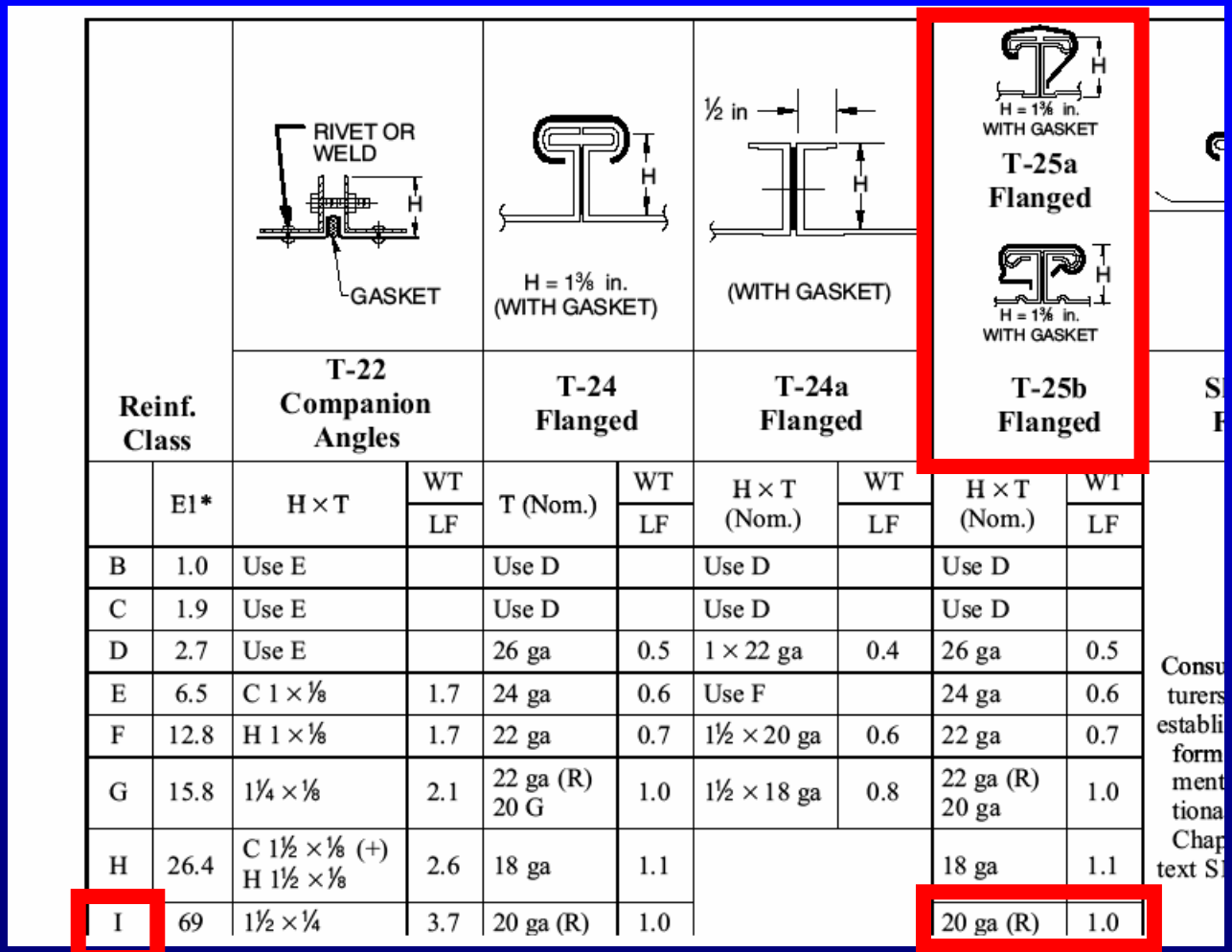
Joint Reinforcement



Reinf. Class	E1*	T-22 Companion Angles H × T	WT LF	T-24 Flanged T (Nom.)	WT LF	T-24a Flanged H × T (Nom.)	WT LF	T-25a / T-25b Flanged H × T (Nom.)	WT LF
		RIVET OR WELD, H, GASKET		H = 1⅜ in. (WITH GASKET)		½ in, H (WITH GASKET)		H = 1⅜ in. WITH GASKET	
B	1.0	Use E		Use D		Use D		Use D	
C	1.9	Use E		Use D		Use D		Use D	
D	2.7	Use E		26 ga	0.5	1 × 22 ga	0.4	26 ga	0.5
E	6.5	C 1 × ⅛	1.7	24 ga	0.6	Use F		24 ga	0.6
F	12.8	H 1 × ⅛	1.7	22 ga	0.7	1½ × 20 ga	0.6	22 ga	0.7
G	15.8	1¼ × ⅛	2.1	22 ga (R) 20 G	1.0	1½ × 18 ga	0.8	22 ga (R) 20 ga	1.0
H	26.4	C 1½ × ⅛ (+) H 1½ × ⅛	2.6	18 ga	1.1			18 ga	1.1
I	69	1½ × ¼	3.7	20 ga (R)	1.0			20 ga (R)	1.0

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Joint Reinforcement

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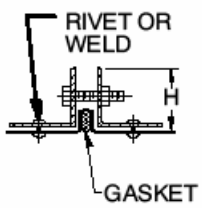
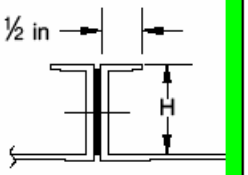
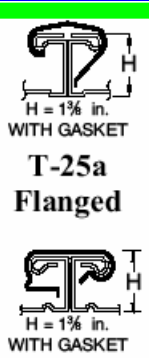
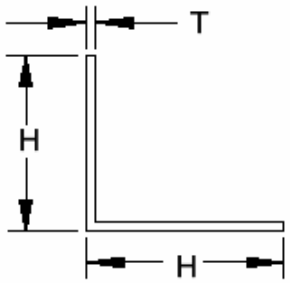
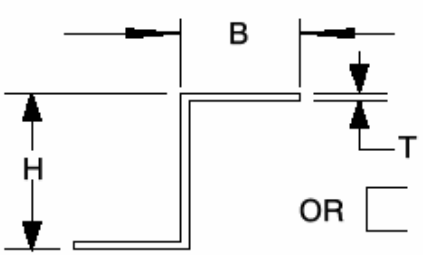
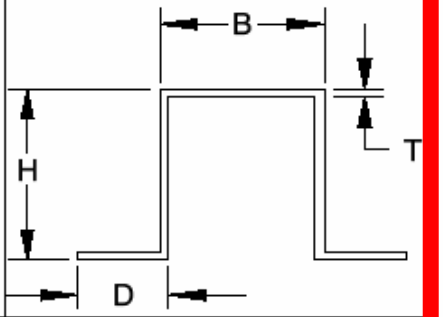
Reinf. Class	E1*	T-22 Companion Angles H × T	WT LF	T-24 Flanged T (Nom.)	WT LF	T-24a Flanged H × T (Nom.)	WT LF	T-25b Flanged H × T (Nom.)	WT LF
									
B	1.0	Use E		Use D		Use D		Use D	
C	1.9	Use E		Use D		Use D		Use D	
D	2.7	Use E		26 ga	0.5	1 × 22 ga	0.4	26 ga	0.5
E	6.5	C 1 × ⅛	1.7	24 ga	0.6	Use F		24 ga	0.6
F	12.8	H 1 × ⅛	1.7	22 ga	0.7	1½ × 20 ga	0.6	22 ga	0.7
G	15.8	1¼ × ⅛	2.1	22 ga (R) 20 G	1.0	1½ × 18 ga	0.8	22 ga (R) 20 ga	1.0
H	26.4	C 1½ × ⅛ (+) H 1½ × ⅛	2.6	18 ga	1.1			18 ga	1.1
I	69	1½ × ¼	3.7	20 ga (R)	1.0			20 ga (R)	1.0

Intermediate Reinforcement







Reinf. Class		Angle		Channel or Zee		Hat Section	
	E1*	H × T (MIN)	Wt / LF	H × B × T (MIN)	Wt / LF	H × B × D × T (MIN)	Wt / LF
A	0.43	Use C		Use B		Use F	
B	1.0	Use C		¾ × ½ × 20 ga	0.24	Use F	
C	1.9	C 1 × 16 ga C ¾ × ⅛	0.40 0.57	¾ × ½ × 18 ga 1 × ¾ × 20 ga	0.31	Use F	
D	2.7	H ¾ × ⅛ C 1 × ⅛	0.57 0.80	1 × ¾ × 18 ga	0.45	Use F	
E	6.5	C 1 ¼ × 12 ga H 1 × ⅛	0.90	2 × 1 ⅛ × 20 ga	0.60	Use F	
F	12.8	H 1 ¼ × ⅛	1.02	1 ½ × ¾ × 18 ga	0.54	1 ½ × ¾ × ⅝ × 18 ga 1 ½ × 1 ½ × ¾ × 20 ga	0.90 0.83
G	15.8	1 ½ × ⅛	1.23	1 ½ × ¾ × 16 ga	0.66	1 ½ × ¾ × ⅝ × 18 ga	0.80
H	26.4	1 ½ × 3/16	1.78	1 ½ × ¾ × ¼	1.21	1 ½ × 1 ½ × ¾ × 18 ga	1.08

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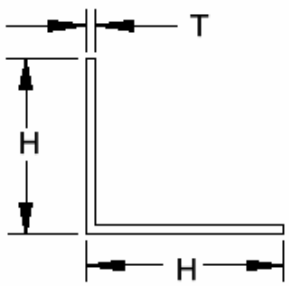
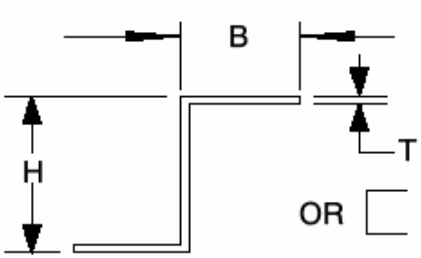
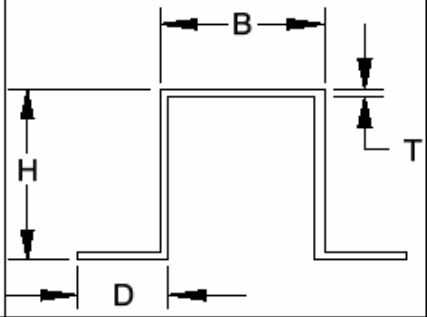
Intermediate Reinforcement







Reinf. Class	Angle			Channel or Zee		Hat Section	
	E1*	H × T (MIN)	WT LF	H × B × T (MIN)	WT LF	H × B × D × T (MIN)	WT LF
A	0.43	Use C		Use B		Use F	
B	1.0	Use C		¾ × ½ × 20 ga	0.24	Use F	
C	1.9	C 1 × 16 ga C ¾ × ⅛	0.40 0.57	¾ × ½ × 18 ga 1 × ¾ × 20 ga	0.31	Use F	
D	2.7	H ¾ × ⅛ C 1 × ⅛	0.57 0.80	1 × ¾ × 18 ga	0.45	Use F	
E	6.5	C 1 ¼ × 12 ga H 1 × ⅛	0.90	2 × 1 ⅛ × 20 ga	0.60	Use F	
F	12.8	H 1 ¼ × ⅛	1.02	1 ½ × ¾ × 18 ga	0.54	1 ½ × ¾ × ⅝ × 18 ga 1 ½ × 1 ½ × ¾ × 20 ga	0.90 0.83
G	15.8	1 ½ × ⅛	1.23	1 ½ × ¾ × 16 ga	0.66	1 ½ × ¾ × ⅝ × 18 ga	0.80
H	26.4	1 ½ × 3/16	1.78	1 ½ × ¾ × ¼	1.21	1 ½ × 1 ½ × ¾ × 18 ga	1.08

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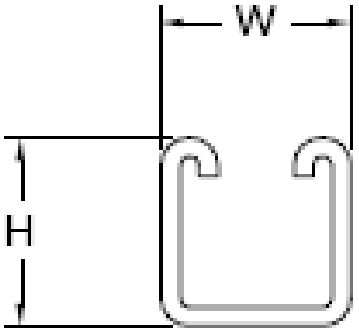
Intermediate Reinforcement

Channel (Strut)			Reinforcement Class Per Table 2-29
H	W	GA	
13/16 in.	13/16 in.	19	A, B, C
13/16 in.	1 5/8 in.	14	D
7/8 in.	1 5/8 in.	12	D, E
1 3/8 in.	1 5/8 in.	12	F, G
2 7/16 in.	1 5/8 in.	12	H, I, J
3 1/4 in.	1 5/8 in.	12	K, L

Table 2–30 Framing Channel



The Right Table (Pressure Class)

2 in. wg Static Pos. or Neg. / Duct Dimension	No Reinforcement Required	Reinforcement Code for Duct Gage Number							
		Reinforcement Spacing Options							
		10 ft	8 ft	6 ft	5 ft	4 ft	3 ft	2½ ft	2 ft
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
10 in. and under	26 ga.	Not Required							
11 – 12 in.	26 ga.								
13 – 14 in.	24 ga.		B-26	B-26	B-26	B-26	B-26	B-26	B-26
15 – 16 in.	24 ga.		C-26	C-26	C-26	C-26	C-26	B-26	B-26
17 – 18 in.	22 ga.		C-26	C-26	C-26	C-26	C-26	C-26	B-26
19 – 20 in.	20 ga.	C-22	C-24	C-26	C-26	C-26	C-26	C-26	C-26
21 – 22 in.	18 ga.	D-22	D-24	D-26	D-26	C-26	C-26	C-26	C-26
23 – 24 in.	18 ga.	E-22	E-24	D-26	D-26	D-26	C-26	C-26	C-26
25 – 26 in.	18 ga.	E-22	E-22	E-24	D-26	D-26	C-26	C-26	C-26
27 – 28 in.	18 ga.	F-20	E-20	E-22	E-24	D-26	D-26	C-26	C-26
29 – 30 in.	18 ga.	F-20	F-20	E-22	E-24	E-26	D-26	D-26	C-26
31 – 36 in.	16 ga.	G-18	G-20	F-22	F-24	E-24	E-26	D-26	D-26
37 – 42 in.		H-16	H-18	G-20	G-22	F-24	E-24	E-26	E-26
43 – 48 in.			I-18	H-20	H-22	G-22	F-24	F-24	E-24
49 – 54 in.			I-16G	I-18G	H-20G	H-20G	G-24	F-24	F-24
55 – 60 in.				I-18G	I-20G	H-20G	G-22	G-24	F-24

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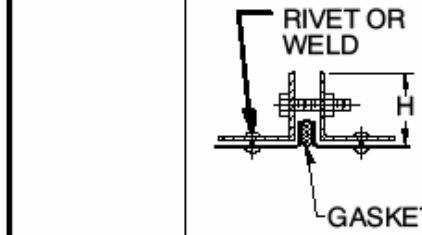
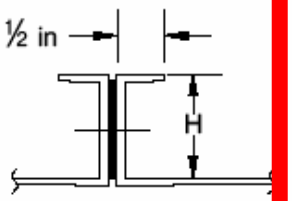
Joint Reinforcement





Reinf. Class	E1*	T-22 Companion Angles H × T	WT LF	T-24 Flanged T (Nom.)	WT LF	T-24a Flanged H × T (Nom.)	WT LF	T-25b Flanged H × T (Nom.)	WT LF
B	1.0	Use E		Use D		Use D		Use D	
C	1.9	Use E		Use D		Use D		Use D	
D	~~2.7~~	~~Use E~~		~~26 ga~~	~~0.5~~	~~1 × 22 ga~~	~~0.4~~	26 ga	0.5
E	6.5	C 1 × ⅛	1.7	24 ga	0.6	Use F		24 ga	0.6
F	12.8	H 1 × ⅛	1.7	22 ga	0.7	1½ × 20 ga	0.6	22 ga	0.7
G	15.8	1¼ × ⅛	2.1	22 ga (R) 20 G	1.0	1½ × 18 ga	0.8	22 ga (R) 20 ga	1.0
H	26.4	C 1½ × ⅛ (+) H 1½ × ⅛	2.6	18 ga	1.1			18 ga	1.1
I	69	1½ × ¼	3.7	20 ga (R)	1.0			20 ga (R)	1.0

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Page 2.76

Example 2 Solution

- Duct gage is 20
- Joint spacing is 5 feet (56 ¼ in.)
- TDC/TDF for transverse joint
- Intermediate reinforcement (2 ½ feet)
  - G class
    - Angle 1 ½ x 1 ½ x 1/8
    - Not required on the 26 in. side

Intermediate External Reinforcement

- Reinforcement Intervals do not need to coincide
- At 4 in. positive pressure and above reinforcements must be tied
- Must be fastened to the duct within 2 in. from the corner (unless tied)
- Maximum fastener spacing is 12 in.

Reinforced on Two Sides

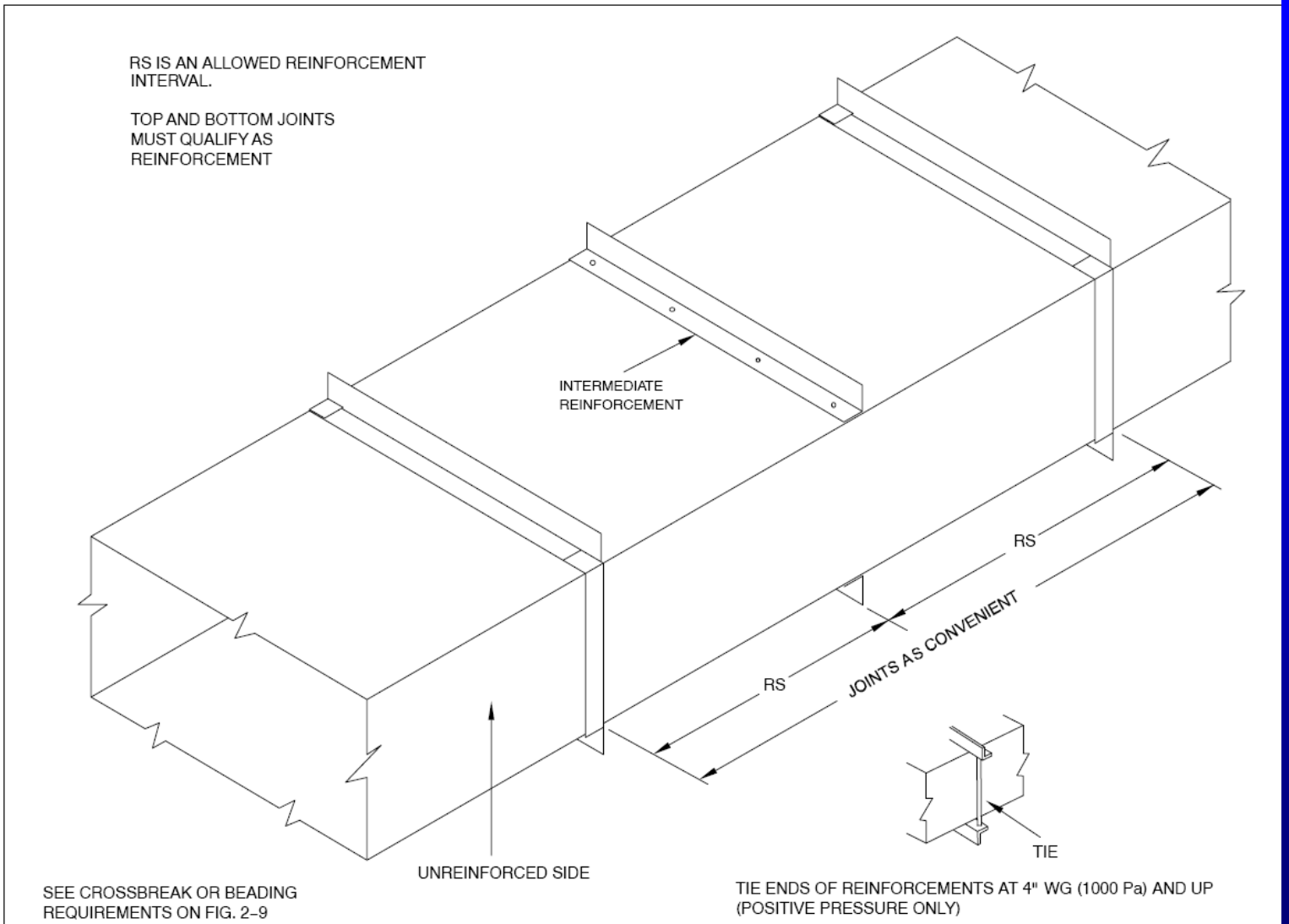
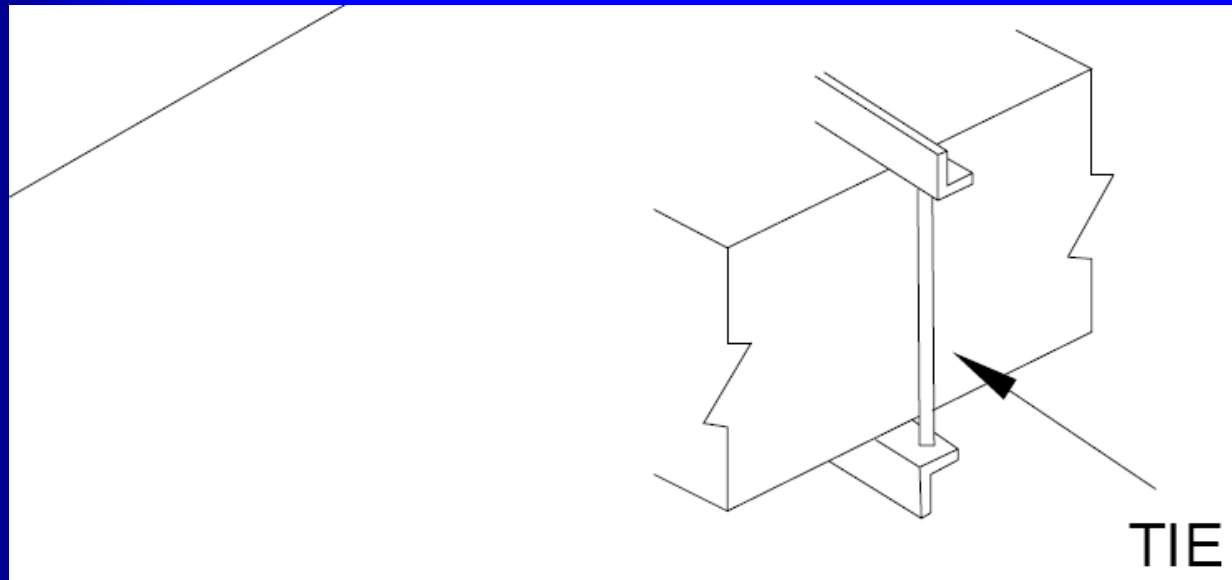


FIGURE 2–10 DUCT REINFORCED ON TWO SIDES

Reinforced on Two Sides



TIE ENDS OF REINFORCEMENTS AT 4" WG (1000 Pa) AND UP (POSITIVE PRESSURE ONLY)

Reinforced on Four Sides

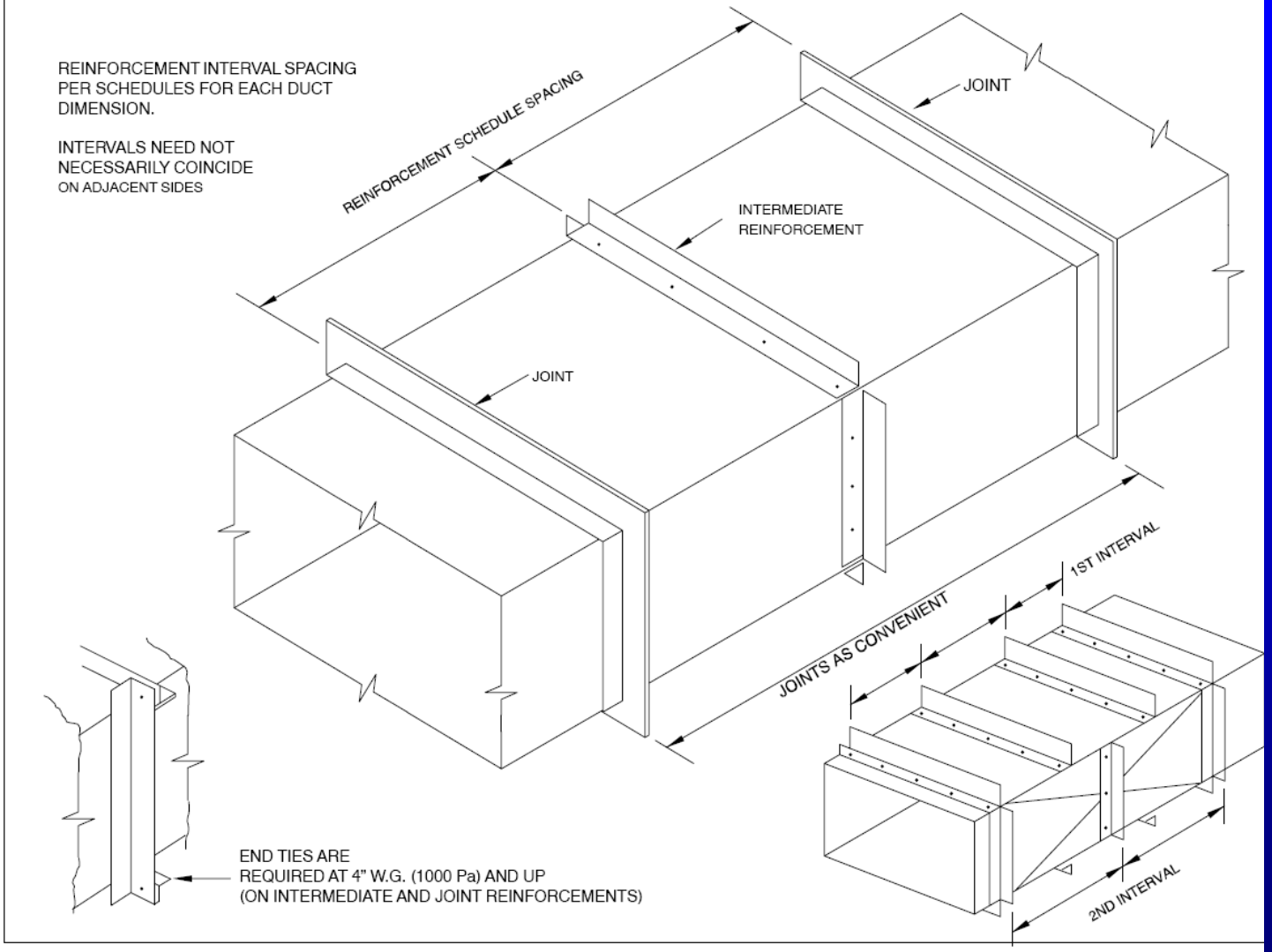
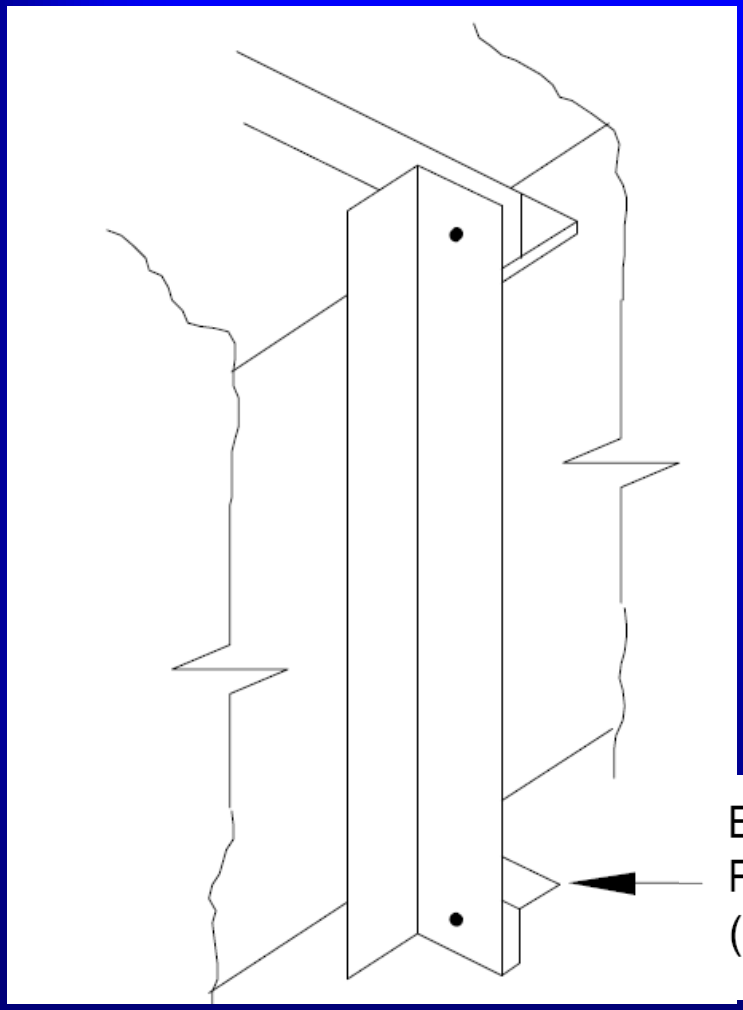


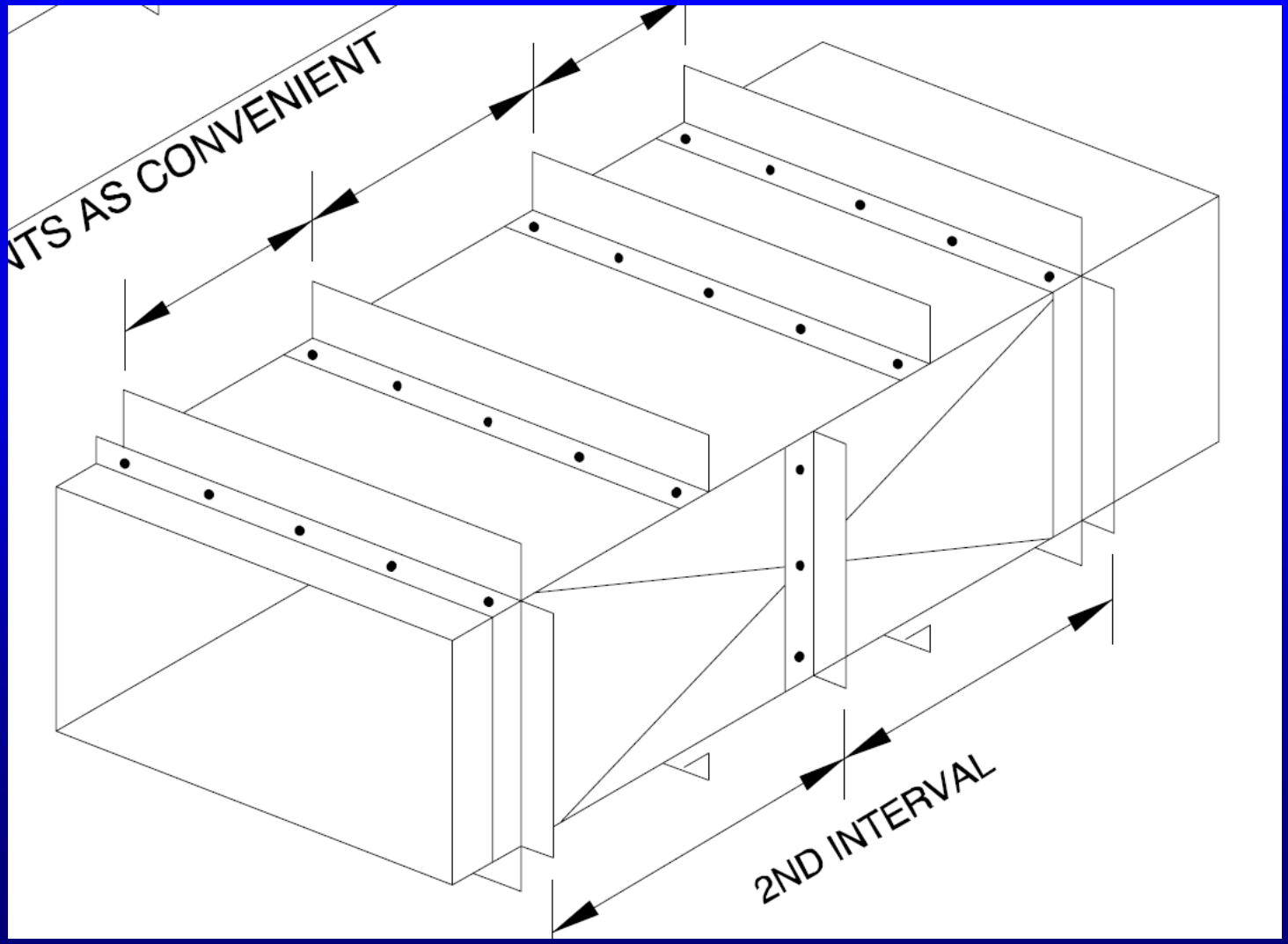
FIGURE 2–11 DUCT REINFORCED ON ALL SIDES

Reinforced on Four Sides



END TIES ARE
REQUIRED AT 4" W.G. (1000 Pa) AND UP
(ON INTERMEDIATE AND JOINT REINFORCEMENTS)

Reinforced on Four Sides



Reinforcement Attachment

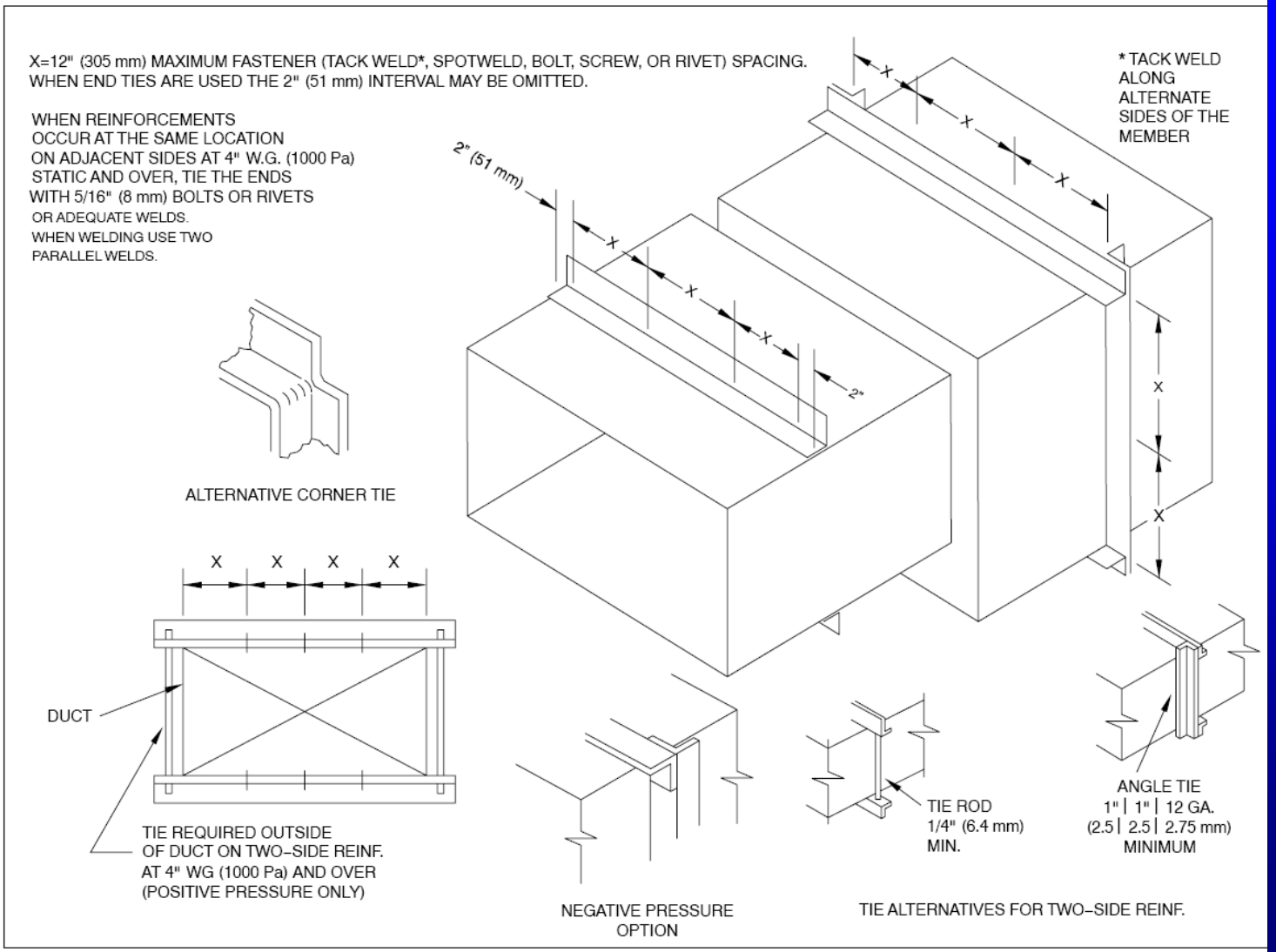


FIGURE 2-12 REINFORCEMENT ATTACHMENT

Tie Rods

- Steel Rod
  - Threaded (all thread) or partial
  - Plain
- Conduit
  - RC
  - EMT (most common type)
- Steel Pipe
- Steel Strap (positive pressure only)
  - 1 in. x 1/8 in.
- Angles (rare)

Tie Rod Attachment

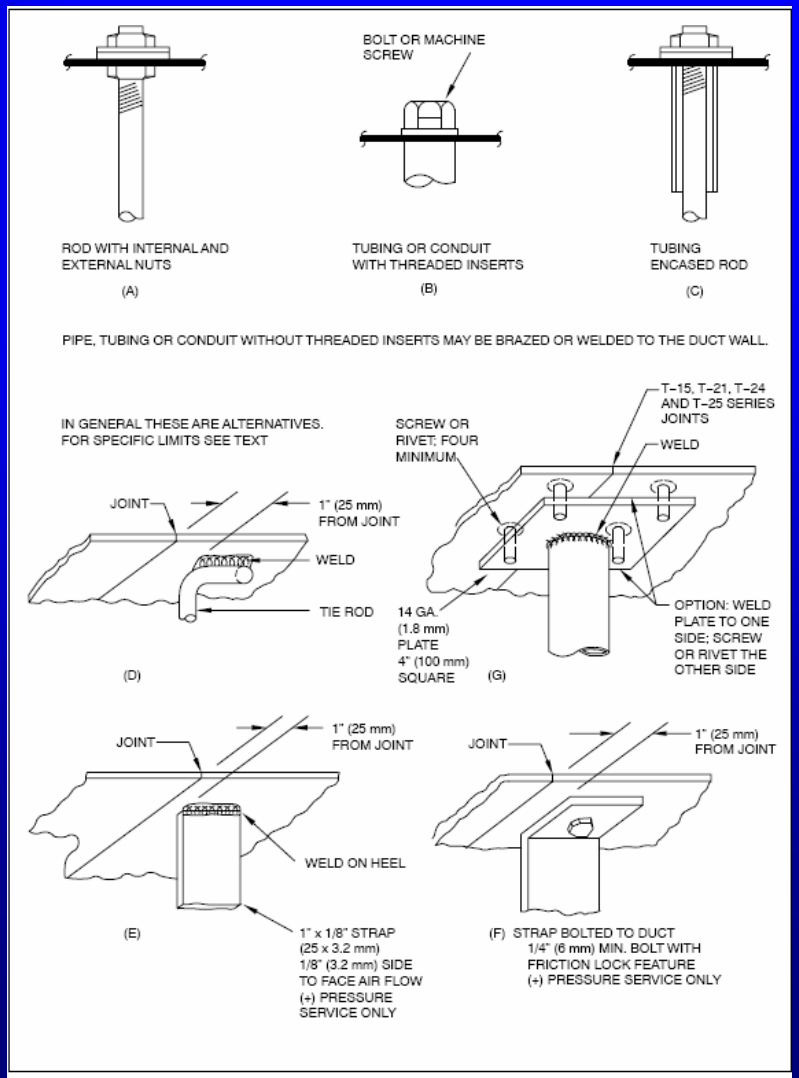
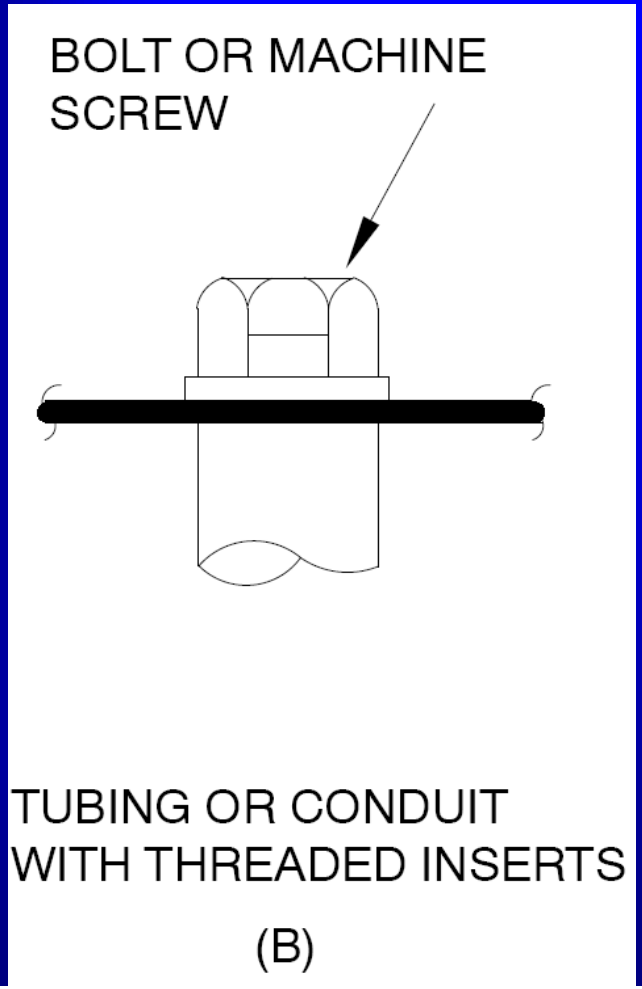


FIGURE 2–5 TIE ROD ATTACHMENTS

- Figure 2-5
- Page 2.82

Tie Rod Attachment



- Figure 2-5
- Page 2.82

PIPE, TUBING OR CONDUIT WITHOUT THREADED INSERTS MAY BE BRAZED OR WELDED TO THE DUCT WALL.

Tie Rod Attachment

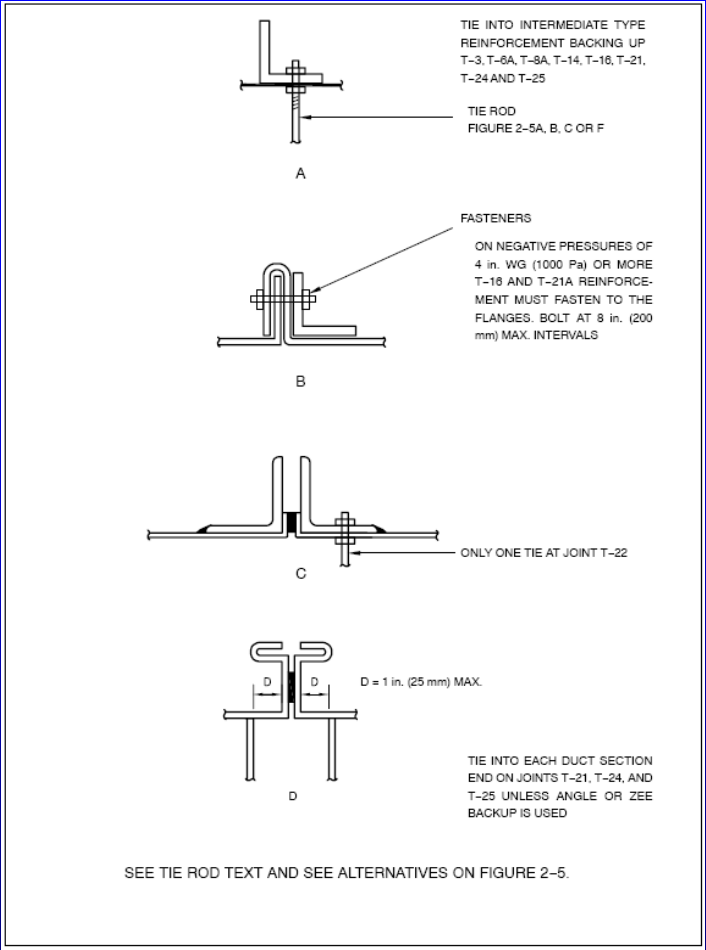
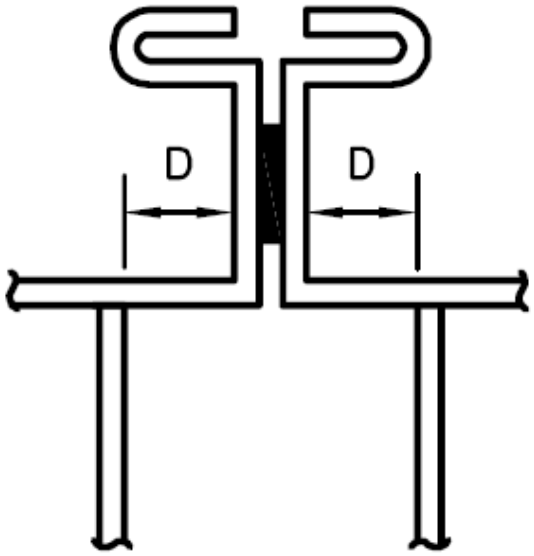


FIGURE 2–6 TIE ROD ATTACHMENTS

- Figure 2-6
- Page 2.83

Tie Rod Attachment

- Figure 2-6
- Page 2.83

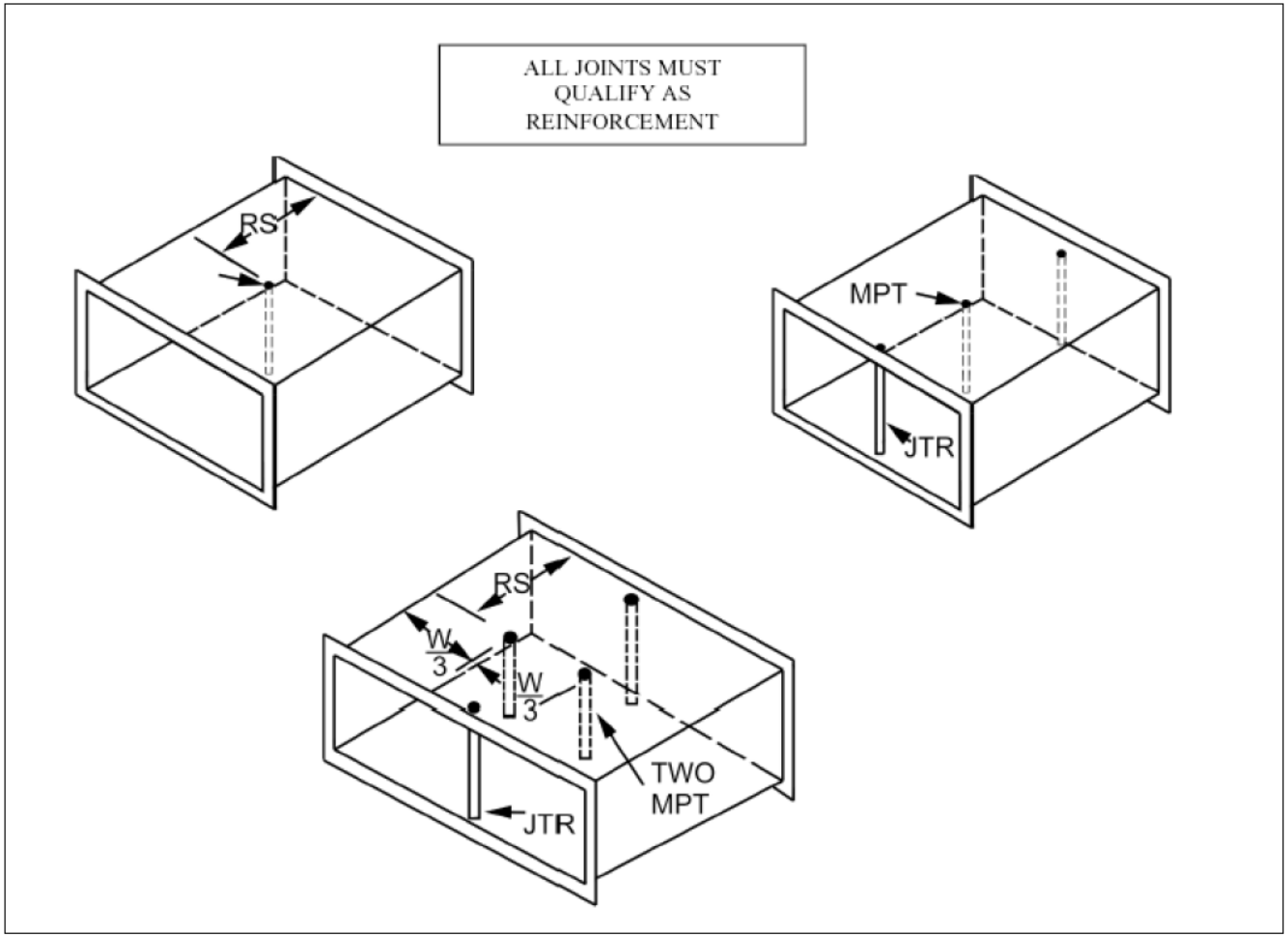


D = 1 in. (25 mm) MAX.

D

TIE INTO EACH DUCT SECTION END ON JOINTS T–21, T–24, AND T–25 UNLESS ANGLE OR ZEE BACKUP IS USED

Tie Rod Layout p 2.98



Mid-Panel Tie Rods

- Do not use in underground/slab apps
- Do not use if air velocity > 2500 fpm
- Do not use where grease or condensation can collect
  - Unless no penetration is made
  - Or penetration is sealed water tight
- If tie rods occur in 2 directions in the same vicinity they must: (applies to JTR and MPT)
  - Be prevented from touching
  - Or be permanently attached

Example 3

- Pressure class is positive 4 in. w.g.
- Dimensions are 36 in. x 24 in.
- 5 ft. joint spacing
- Transverse joint TDC/TDF
- Use tie rod(s) where possible

The Right Table (Pressure Class)

Page 2.22

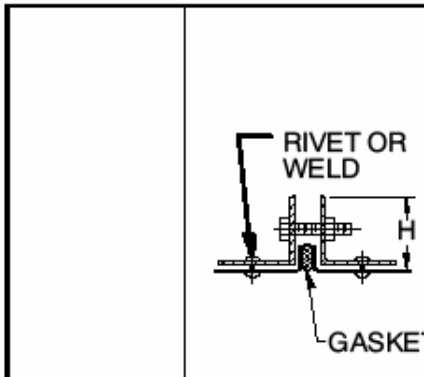
4 in. wg Static Pos. or Neg. Duct Dimension	No Reinforcement Required	Reinforcement Code for Duct Gage Number							
		Reinforcement Spacing Options							
		10 ft	8 ft	6 ft	5 ft	4 ft	3 ft	2½ ft	2 ft
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
8 in. and under	24 ga.	Not Required		B-26	B-26	B-26	B-26	B-26	B-26
9 – 10 in.	22 ga.			B-24	B-26	B-26	B-26	B-26	B-26
11 – 12 in.	22 ga.		B-24	C-24	C-26	C-26	C-26	B-26	B-26
13 – 14 in.	20 ga.		C-22	C-22	C-24	C-26	C-26	C-26	C-26
15 – 16 in.	20 ga.		D-22	D-22	C-24	C-26	C-26	C-26	C-26
17 – 18 in.	18 ga.		D-22	D-22	D-24	D-26	C-26	C-26	C-26
19 – 20 in.	18 ga.		E-20	E-22	E-24	D-24	D-26	C-26	C-26
21 – 22 in.	18 ga.		E-20	E-20	E-24	E-24	D-26	D-26	C-26
23 – 24 in.	18 ga.		F-20	F-20	E-22	E-24	E-26	D-26	D-26
25 – 26 in.	16 ga.	G-18	G-18	F-20	F-22	E-24	E-26	E-26	D-26
27 – 28 in.	16 ga.	H-18G	G-18	G-20	F-22	F-24	E-26	E-26	D-26
29 – 30 in.	16 ga.	H-18G	H-18G	G-18	G-22	F-24	E-26	E-26	E-26
31 – 36 in.		J-16H	I-16G	H-18G	H-20	G-22	F-24	F-26	E-26
37 – 42 in.			J-16H	I-16G	I-18G	H-20G	G-22	G-24	F-26
43 – 48 in.				I-16H	I-18G	I-18G	H-22G	H-24G	G-24

The Right Table (Pressure Class)

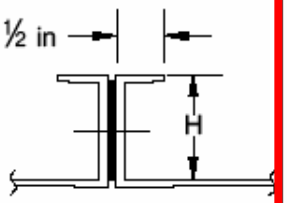
Page 2.22

4 in. wg Static Pos. or Neg. Duct Dimension	No Reinforcement Required	Reinforcement Code for Duct Gage Number							
		Reinforcement Spacing Options							
		10 ft	8 ft	6 ft	5 ft	4 ft	3 ft	2½ ft	2 ft
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
8 in. and under	24 ga.	Not Required		B-26	B-26	B-26	B-26	B-26	B-26
9 – 10 in.	22 ga.			B-24	B-26	B-26	B-26	B-26	B-26
11 – 12 in.	22 ga.		B-24	C-24	C-26	C-26	C-26	B-26	B-26
13 – 14 in.	20 ga.		C-22	C-22	C-24	C-26	C-26	C-26	C-26
15 – 16 in.	20 ga.		D-22	D-22	C-24	C-26	C-26	C-26	C-26
17 – 18 in.	18 ga.		D-22	D-22	D-24	D-26	C-26	C-26	C-26
19 – 20 in.	18 ga.		E-20	E-22	E-24	D-24	D-26	C-26	C-26
21 – 22 in.	18 ga.		E-20	E-20	E-24	E-24	D-26	D-26	C-26
23 – 24 in.	18 ga.		F-20	F-20	E-22	E-24	E-26	D-26	D-26
25 – 26 in.	16 ga.	G-18	G-18	F-20	F-22	E-24	E-26	E-26	D-26
27 – 28 in.	16 ga.	H-18G	G-18	G-20	F-22	F-24	E-26	E-26	D-26
29 – 30 in.	16 ga.	H-18G	H-18G	G-18	G-22	F-24	E-26	E-26	E-26
31 – 36 in.		J-16H	I-16G	H-18G	H-20	G-22	F-24	F-26	E-26
37 – 42 in.			J-16H	I-16G	I-18G	H-20G	G-22	G-24	F-26
43 – 48 in.				I-16H	I-18G	I-18G	H-22G	H-24G	G-24

Joint Reinforcement



H = 1⅜ in.
(WITH GASKET)



(WITH GASKET)

H = 1⅜ in.
WITH GASKET

T-25a Flanged

H = 1⅜ in.
WITH GASKET

Reinf. Class		T-22 Companion Angles		T-24 Flanged		T-24a Flanged		T-25b Flanged	
	E1*	H × T	WT LF	T (Nom.)	WT LF	H × T (Nom.)	WT LF	H × T (Nom.)	WT LF
B	1.0	Use E		Use D		Use D		Use D	
C	1.9	Use E		Use D		Use D		Use D	
D	2.7	Use E		26 ga	0.5	1 × 22 ga	0.4	26 ga	0.5
E	6.5	C 1 × ⅛	1.7	24 ga	0.6	Use F		24 ga	0.6
F	12.8	H 1 × ⅛	1.7	22 ga	0.7	1½ × 20 ga	0.6	22 ga	0.7
G	15.8	1¼ × ⅛	2.1	22 ga (R) 20 G	1.0	1½ × 18 ga	0.8	22 ga (R) 20 ga	1.0
H	26.4	C 1½ × ⅛ (+) H 1½ × ⅛	2.6	18 ga	1.1			18 ga	1.1
I	69	1½ × ¼	3.7	20 ga (R)	1.0			20 ga (R)	1.0

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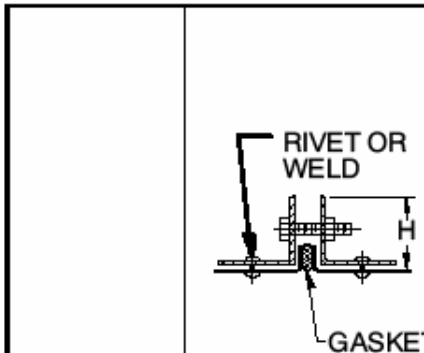
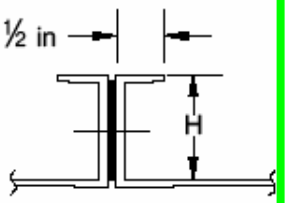
Joint Reinforcement





Reinf. Class		T-22 Companion Angles		T-24 Flanged		T-24a Flanged		T-25b Flanged	
	E1*	H × T	WT LF	T (Nom.)	WT LF	H × T (Nom.)	WT LF	H × T (Nom.)	WT LF
B	1.0	Use E		Use D		Use D		Use D	
C	1.9	Use E		Use D		Use D		Use D	
D	2.7	Use E		26 ga	0.5	1 × 22 ga	0.4	26 ga	0.5
E	6.5	C 1 × ⅛	1.7	24 ga	0.6	Use F		24 ga	0.6
F	12.8	H 1 × ⅛	1.7	22 ga	0.7	1½ × 20 ga	0.6	22 ga	0.7
G	15.8	1¼ × ⅛	2.1	22 ga (R) 20 G	1.0	1½ × 18 ga	0.8	22 ga (R) 20 ga	1.0
H	26.4	C 1½ × ⅛ (+) H 1½ × ⅛	2.6	18 ga	1.1			18 ga	1.1
I	69	1½ × ¼	3.7	20 ga (R)	1.0			20 ga (R)	1.0

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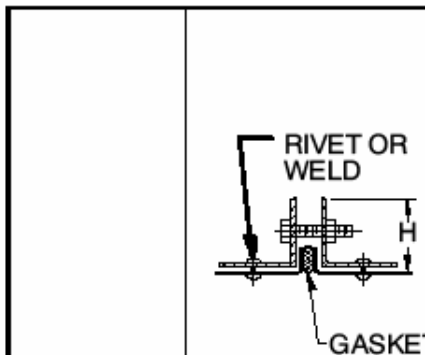
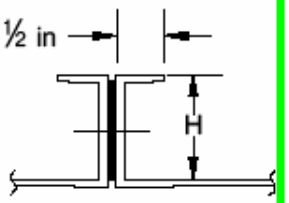
Joint Reinforcement



H = 1⅜ in.
(WITH GASKET)



(WITH GASKET)

H = 1⅜ in.
WITH GASKET

T-25a Flanged

H = 1⅜ in.
WITH GASKET

Reinf. Class		T-22 Companion Angles		T-24 Flanged		T-24a Flanged		T-25b Flanged	
	E1*	H × T	WT LF	T (Nom.)	WT LF	H × T (Nom.)	WT LF	H × T (Nom.)	WT LF
B	1.0	Use E		Use D		Use D		Use D	
C	1.9	Use E		Use D		Use D		Use D	
D	2.7	Use E		26 ga	0.5	1 × 22 ga	0.4	26 ga	0.5
E	6.5	C 1 × ⅛	1.7	24 ga	0.6	Use F		24 ga	0.6
F	12.8	H 1 × ⅛	1.7	22 ga	0.7	1½ × 20 ga	0.6	22 ga	0.7
G	15.8	1¼ × ⅛	2.1	22 ga (R) 20 G	1.0	1½ × 18 ga	0.8	22 ga (R) 20 ga	1.0
H	26.4	C 1½ × ⅛ (+) H 1½ × ⅛	2.6	18 ga	1.1			18 ga	1.1
I	69	1½ × ¼	3.7	20 ga (R)	1.0			20 ga (R)	1.0

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Mid Panel Tie Rod Schedule

	RS	16 ga	18 ga	20 ga	22 ga	24 ga	26 ga
±½ in. wg	3 ft				To 96(1)	To 84(1)	To 60(1)
	2 ½ ft				To 96(1)	To 84(1)	To 60(1)
	2 ft				To 96(1)	To 84(1)	To 60(1)
±1 in. wg	3 ft		To 96(1)*	To 84(1)*	To 72(1)*	To 60(1)	To 48(1)
				85-96(2)	73-84(2)	61-72(2)	
	2 ½ in.		To 96(1)*	To 84(1)*	To 72(1)*	To 60(1)	To 48(1)
				85-96(2)	73-84(2)	61-72(2)	
	2 ft		To 96(1)*	To 84(1)*	To 72(1)	To 72(1)	To 48(1)
				85-96(2)	73-96(2)		
±2 in. wg	3 ft		To 84(1)*	To 60(1)*	To 48(1)*	To 42(1)	To 36(1)
			To 96(2)	61-84(2)	49-72(2)	43-54(2)	
	2 ½ ft		To 84(1)*	To 72(1)*	To 60(1)*	To 54(1)	To 42(1)
			85-96(2)	73-96(2)	61-84(2)	55-60(2)	
	2 ft		To 96(1)*	To 72(1)*	To 60(1)	To 60(1)	To 42(1)
				73-96(2)	61-96(2)	61-72(2)	
±3 in. wg	3 ft		To 72(1)*	To 54(1)*	To 48(1)	To 42(1)	To 30(1)
			73-84(2)	55-72(2)	49-54(2)		
	2 ½ ft		To 72(1)*	To 60(1)*	To 54(1)*	To 42(1)	To 36(1)
			To 96(2)	61-84(2)	55-72(2)	43-54(2)	
	2 ft		To 84(1)*	To 72(1)*	To 60(1)*	To 54(1)	To 42(1)
			85-96(2)	73-96(2)	61-84(2)	55-72(2)	
±4 in. wg	3 ft	To 84(2)	To 60(1)*	To 54(1)*	To 48(1)	To 36(1)	To 30(1)
			61-72(2)	55-60(2)			
	2 ½ ft		To 72(1)*	To 60(1)*	To 48(1)	To 48(1)	To 36(1)
			73-96(2)	61-72(2)	49-60(2)		
	2 ft		To 84(1)*	To 60(1)*	To 60(1)	To 48(1)	To 42(1)
			85-96(2)	61-96(2)	61-72(2)	49-60(2)	
	3 ft	To 72(2)	To 54(1)*	To 42(1)	To 36(1)	N/A	N/A

Tie Rod Load

Static Pressure Class, in. wg								
W	RS	½ "	1"	2"	3"	4"	6"	10"
37"	36	25	49	99	148	198	296	494
	30	21	41	82	124	165	247	412
	28	19	38	77	115	154	231	384
	24	17	33	66	99	132	198	329
	22	15	30	60	91	121	181	302
	20	14	27	55	82	110	165	274
42"	36	27	55	109	164	218	328	546
	30	23	46	91	136	182	273	455
	28	21	43	85	127	170	255	425
	24	18	36	73	109	146	218	364
	22	17	33	67	100	134	200	334
	20	15	30	61	91	121	182	303

Static Pressure Class, in. wg								
W	RS	½"	1"	2"	3"	4"	6"	10"
72"	36	47	94	187	281	374	562	936
	30	39	78	156	234	312	468	780
	28	36	73	146	218	291	437	728
	24	31	62	125	187	250	374	624
	22	29	57	114	172	229	343	572
	20	26	52	104	156	208	312	520
78"	36	51	101	203	304	406	608	1014
	30	43	85	169	254	338	507	845
	28	39	79	158				789
	24	34	68	135				676
	22	31	62	124				620
	20	28	56	113				563

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Table 2-46

Mid Panel Tie Rod Size

- EMT conduit positive pressure
- ½ in. 900 lbs
- ¾ in. 1,340 lbs
- 1 in. 1,980 lbs
- HVAC DCS p2.80 S1.19.4

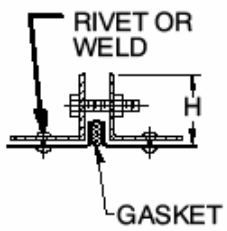
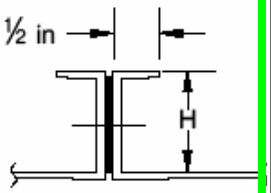
The Right Table (Pressure Class)

4 in. wg Static Pos. or Neg. Duct Dimension	No Reinforcement Required	Reinforcement Code for Duct Gage Number							
		Reinforcement Spacing Options							
		10 ft	8 ft	6 ft	5 ft	4 ft	3 ft	2½ ft	2 ft
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
8 in. and under	24 ga.	Not Required		B-26	B-26	B-26	B-26	B-26	B-26
9 – 10 in.	22 ga.			B-24	B-26	B-26	B-26	B-26	B-26
11 – 12 in.	22 ga.		B-24	C-24	C-26	C-26	C-26	B-26	B-26
13 – 14 in.	20 ga.		C-22	C-22	C-24	C-26	C-26	C-26	C-26
15 – 16 in.	20 ga.		D-22	D-22	C-24	C-26	C-26	C-26	C-26
17 – 18 in.	18 ga.		D-22	D-22	D-24	D-26	C-26	C-26	C-26
19 – 20 in.	18 ga.		E-20	E-22	E-24	D-24	D-26	C-26	C-26
21 – 22 in.	18 ga.		E-20	E-20	E-24	E-24	D-26	D-26	C-26
23 – 24 in.	18 ga.		F-20	F-20	E-22	E-24	E-26	D-26	D-26
25 – 26 in.	16 ga.	G-18	G-18	F-20	F-22	E-24	E-26	E-26	D-26
27 – 28 in.	16 ga.	H-18G	G-18	G-20	F-22	F-24	E-26	E-26	D-26
29 – 30 in.	16 ga.	H-18G	H-18G	G-18	G-22	F-24	E-26	E-26	E-26
31 – 36 in.		J-16H	I-16G	H-18G	H-20	G-22	F-24	F-26	E-26
37 – 42 in.			J-16H	I-16G	I-18G	H-20G	G-22	G-24	F-26
43 – 48 in				I-16H	I-18G	I-18G	H-22G	H-24G	G-24

Page 2.22

Joint Reinforcement

Page 2.76

Reinf. Class		T-22 Companion Angles		T-24 Flanged		T-24a Flanged		T-25b Flanged	
				 H = 1⅜ in. (WITH GASKET)		 (WITH GASKET)		 T-25b Flanged	
	E1*	H × T	WT LF	T (Nom.)	WT LF	H × T (Nom.)	WT LF	H × T (Nom.)	WT LF
B	1.0	Use E		Use D		Use D		Use D	
C	1.9	Use E		Use D		Use D		Use D	
D	2.7	Use E		26 ga	0.5	1 × 22 ga	0.4	26 ga	0.5
E	6.5	C 1 × ⅛	1.7	24 ga	0.6	Use F		24 ga	0.6
F	12.8	H 1 × ⅛	1.7	22 ga	0.7	1½ × 20 ga	0.6	22 ga	0.7
G	15.8	1¼ × ⅛	2.1	22 ga (R) 20 G	1.0	1½ × 18 ga	0.8	22 ga (R) 20 ga	1.0
H	26.4	C 1½ × ⅛ (+) H 1½ × ⅛	2.6	18 ga	1.1			18 ga	1.1
I	69	1½ × ¼	3.7	20 ga (R)	1.0			20 ga (R)	1.0

Example 3 Solution

- Duct gage is 22
- Joint spacing is 5 feet (56 ¼ in.)
- TDC/TDF for transverse joint
- Intermediate reinforcement (2 ½ feet)
  - 1 MPT
    - ½ in. EMT Conduit
  - Not required on the 24 in. side
- Could use 20 gage and JTR also

Mid Panel Tie Rods

- Negative pressure uses special tables
- Concern is buckling
- Table 2-38 in HVAC DCS for EMT
- P 2.91

				Compression Stress Allowed (PSI)							
				9000	8000	7000	6000	5200	7400	4200	3700
		r_g	L/r_g=	130	140	150	160	170	180	190	200
Dia.	Type										
½ in.	EMT	0.235	LEN.	30 in.	32 in.	34 in.	36 in.	40 in.	42 in.	44 in.	46 in.
			LBS.	792	704	616	528	458	414	370	325
¾ in.	EMT	0.309	LEN.	40 in.	42 in.	46 in.	48 in.	52 in.	54 in.	58 in.	62 in.
			LBS.	1206	1072	938	804	697	630	563	496
1 in.	EMT	0.371	LEN.	48 in.	52 in.	54 in.	58 in.	62 in.	66 in.	70 in.	74 in.
			LBS.	1782	1584	1386	1188	1030	930	831	732
1¼ in.	EMT	0.511	LEN.	66 in.	72 in.	76 in.	82 in.	86 in.	92 in.	96 in.	102 in.
			LBS.	2655	2360	2065	1770	1534	1386	1239	1091
1½ in.	EMT	0.592	LEN.	76 in.	82 in.	88 in.	94 in.	100 in.	106 in.	112 in.	118 in.
			LBS.	3078	2736	2394	2052	1778	1607	1436	1265
2 in.	EMT	0.754	LEN.		106 in.	112 in.	120 in.	128 in.	136 in.	142 in.	150 in.
			LBS.		3480	3045	2610	2262	2044	1827	1609

Table 2–38 Internal EMT Conduit Size (–) Pressure

NOTES:

The table gives maximum length and maximum load; *see* Table 2-34 for assumed loads. Blank spaces are not economical.

EMT Conduit Data				
Dia.	EMT Conduit			Weight
	O.D. in.	t in.	A in^2	lbs/ft
½ in.	0.71	0.042	0.088	0.29
¾ in.	0.92	0.049	0.134	0.45
1 in.	1.16	0.057	0.198	0.65
1¼ in.	1.51	0.065	0.295	0.96
1½ in.	1.74	0.065	0.342	1.11
2 in.	2.2	0.065	0.435	1.41

Mid Panel Tie Rods Neg. Pressure

				Compression Stress Allowed (PSI)							
				9000	8000	7000	6000	5200	7400	4200	3700
		r_g	L/r_g=	130	140	150	160	170	180	190	200
Dia.	Type										
½ in.	EMT	0.235	LEN.	30 in.	32 in.	34 in.	36 in.	40 in.	42 in.	44 in.	46 in.
			LBS.	792	704	616	528	458	414	370	325
¾ in.	EMT	0.309	LEN.	40 in.	42 in.	46 in.	48 in.	52 in.	54 in.	58 in.	62 in.
			LBS.	1206	1072	938	804	697	630	563	496
1 in.	EMT	0.371	LEN.	48 in.	52 in.	54 in.	58 in.	62 in.	66 in.	70 in.	74 in.
			LBS.	1782	1584	1386	1188	1030	930	831	732
1¼ in.	EMT	0.511	LEN.	66 in.	72 in.	76 in.	82 in.	86 in.	92 in.	96 in.	102 in.
			LBS.	2655	2360	2065	1770	1534	1386	1239	1091
1½ in.	EMT	0.592	LEN.	76 in.	82 in.	88 in.	94 in.	100 in.	106 in.	112 in.	118 in.
			LBS.	3078	2736	2394	2052	1778	1607	1436	1265
2 in.	EMT	0.754	LEN.		106 in.	112 in.	120 in.	128 in.	136 in.	142 in.	150 in.
			LBS.		3480	3045	2610	2262	2044	1827	1609

Table 2–38 Internal EMT Conduit Size (–) Pressure

Tie Rod Loads

- Table 2-46 p. 2.100 is for mid panel tie rods (100% load)
- Table 2-34 p. 2.84 is for tie rods used to back up joints or external reinforcement (75% Load)

- 1 in. w.g. = 5.2 lbf/ft^2

Tie Rod Loads

- Given information:
  - 48” wide, RS = 28” (TDC/TDF) @ 4 in. w.g.
- Area = 48” x 28” = 1344 in^2
- Convert to ft^2 1344/144 = 9.33 ft^2
- 4 in. w.g. x 5.2 lbs/ft^2/in. w.g. x 9.33 ft^2
- 194 lbf
- If backing up a joint or external reinforcement 194 lbf x .75 = 146 lbf

An Easier Way?

- Newest addition are the TDC/TDF tables
- Tables based on
  - Pressure class
  - Joint length

Example 3 (revisited)

- 4 in. w.g.
- TDC/TDF
- 5 ft. joint spacing
- 36 in. x 24 in.

4 in. wg Static Pos. or Neg. Duct Dimension	5 ft Joints			5 ft Joints w/2 ½ ft Reinf. Spacing				
				Joints/Reinf.			Int. Reinf.	
	Min ga	Joint Reinf.	Alt. Joint Reinf.	Min ga	Joint Reinf.	Alt. Joint Reinf.	Tie Rod	Alt. Reinf.
8	26	N/R	N/R	Use 5 ft Joints				
	26	N/R	N/R					
	26	N/R	N/R					
13 – 14 in.	24	N/R	N/R	26	N/R	N/R	MPT	C
15 – 16 in.	24	N/R	N/R	26	N/R	N/R	MPT	C
17 – 18 in.	24	N/R	N/R	26	N/R	N/R	MPT	C
19 – 20 in.	24	N/R	N/R	26	N/R	N/R	MPT	C
21 – 22 in.	24	N/R	N/R	26	N/R	N/R	MPT	D
23 – 24 in.	22	N/R	N/R	26	N/R	N/R	MPT	D
25 – 26 in.	22	N/R	N/R	24	N/R	N/R	MPT	E
27 – 28 in.	22	N/R	N/R	24	N/R	N/R	MPT	E
29 – 30 in.	20	N/R	N/R	24	N/R	N/R	MPT	E
31 – 36 in.	20	JTR	(2) E	22	N/R	N/R	MPT	F
37 – 42 in.	18	JTR	(2) H	22	JTR	(2) C	MPT	G
				20	N/R	N/R	MPT	G
43 – 48 in.	18	JTR	(2) H	20	JTR	(2) E	MPT	H
				18	N/R	N/R	MPT	H

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4 in. wg Static Pos. or Neg.	5 ft Joints			5 ft Joints w/2 ½ ft Reinf. Spacing				
				Joints/Reinf.			Int. Reinf.	
Duct Dimension	Min ga	Joint Reinf.	Alt. Joint Reinf.	Min ga	Joint Reinf.	Alt. Joint Reinf.	Tie Rod	Alt. Reinf.
8	26	N/R	N/R	Use 5 ft Joints				
	26	N/R	N/R					
	26	N/R	N/R					
13 – 14 in.	24	N/R	N/R	26	N/R	N/R	MPT	C
15 – 16 in.	24	N/R	N/R	26	N/R	N/R	MPT	C
17 – 18 in.	24	N/R	N/R	26	N/R	N/R	MPT	C
19 – 20 in.	24	N/R	N/R	26	N/R	N/R	MPT	C
21 – 22 in.	24	N/R	N/R	26	N/R	N/R	MPT	D
23 – 24 in.	22	N/R	N/R	26	N/R	N/R	MPT	D
25 – 26 in.	22	N/R	N/R	24	N/R	N/R	MPT	E
27 – 28 in.	22	N/R	N/R	24	N/R	N/R	MPT	E
29 – 30 in.	20	N/R	N/R	24	N/R	N/R	MPT	F
31 – 36 in.	20	JTR	(2) E	22	N/R	N/R	MPT	F
37 – 42 in.	18	JTR	(2) H	22	JTR	(2) C	MPT	G
				20	N/R	N/R	MPT	G
43 – 48 in.	18	JTR	(2) H	20	JTR	(2) E	MPT	H
				18	N/R	N/R	MPT	H

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4 in. wg Static Pos. or Neg.	5 ft Joints			5 ft Joints w/2 ½ ft Reinf. Spacing				
				Joints/Reinf.			Int. Reinf.	
Duct Dimension	Min ga	Joint Reinf.	Alt. Joint Reinf.	Min ga	Joint Reinf.	Alt. Joint Reinf.	Tie Rod	Alt. Reinf.
8	26	N/R	N/R	Use 5 ft Joints				
	26	N/R	N/R					
	26	N/R	N/R					
13 – 14 in.	24	N/R	N/R	26	N/R	N/R	MPT	C
15 – 16 in.	24	N/R	N/R	26	N/R	N/R	MPT	C
17 – 18 in.	24	N/R	N/R	26	N/R	N/R	MPT	C
19 – 20 in.	24	N/R	N/R	26	N/R	N/R	MPT	C
21 – 22 in.	24	N/R	N/R	26	N/R	N/R	MPT	D
23 – 24 in.	22	N/R	N/R	26	N/R	N/R	MPT	D
25 – 26 in.	22	N/R	N/R	24	N/R	N/R	MPT	E
27 – 28 in.	22	N/R	N/R	24	N/R	N/R	MPT	E
29 – 30 in.	20	N/R	N/R	24	N/R	N/R	MPT	E
31 – 36 in.	20	JTR	(2) E	22	N/R	N/R	MPT	F
37 – 42 in.	18	JTR	(2) H	22	JTR	(2) C	MPT	G
				20	N/R	N/R	MPT	G
43 – 48 in.	18	JTR	(2) H	20	JTR	(2) E	MPT	H
				18	N/R	N/R	MPT	H

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Example 3 (revisited) Solution

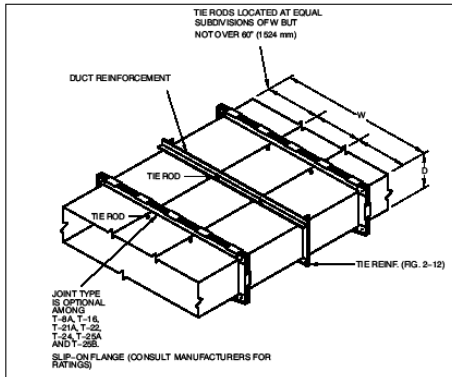
- Option 1
  - 20 gage
  - JTR on 36 in. side
  - No additional reinforcement on 24 in. side
- Option 2
  - 22 gage
  - MPT for 36 in. side
  - No additional reinforcement on 24 in. side

Example 3 (revisited) Solution

- Option 3
  - 20 gage
  - (2) E class reinforcements at the joints for 36 in. side
  - No additional reinforcement on 24 in. side
- Option 4
  - 22 gage
  - F class reinforcement at the mid-panel for 36 in. side
  - No additional reinforcement on 24 in. side

Duct over 120 inches

- Figure 2-13 in HVAC DCS
- Use standard tables for sizes < 120 in.
- P 2.117



Duct Pressure Class

wg (Pa)	½ in. (125 Pa)	1 in. (250 Pa)	2 in. (500 Pa)	3 in. (750 Pa)	4 in. (1000 Pa)	6 in. (1500 Pa)	10 in. (2500 Pa)
Panel Ga (mm)	18 (1.31 mm)	18 (1.31 mm)	18 (1.31 mm)	18 (1.31 mm)	18 (1.31 mm)	18 (1.31 mm)	16 (1.61 mm)
Reinf. Size	It	It	It	It	Jt	Kt	Lt
Reinf. Spacing ft (m)	2 ½ ft (0.75 m)	2 ½ ft (0.75 m)	2 ½ ft (0.75 m)	2 ½ ft (0.75 m)	2 ½ ft (0.75 m)	2 (0.60 m)	2 (0.60 m)
Max. Tie Rod Spacing ft (m)	5 (1.50 m)	5 (1.50 m)	5 (1.50 m)	5 (1.50 m)	5 (1.50 m)	5 (1.50 m)	4 (1.20 m)

Table 2–49 Duct Over 120 in. (3000 mm) Duct Construction

a. See tie rod text.

b. See Reinforcement Attachment in Figure 2-12.

c. See Figure 5-7 for large duct supports. Duct over 100 in. (2540 mm) width may require other internal supports for shape retention.

FIGURE 2–13 DUCT OVER 120 IN. (3000 MM) WIDE

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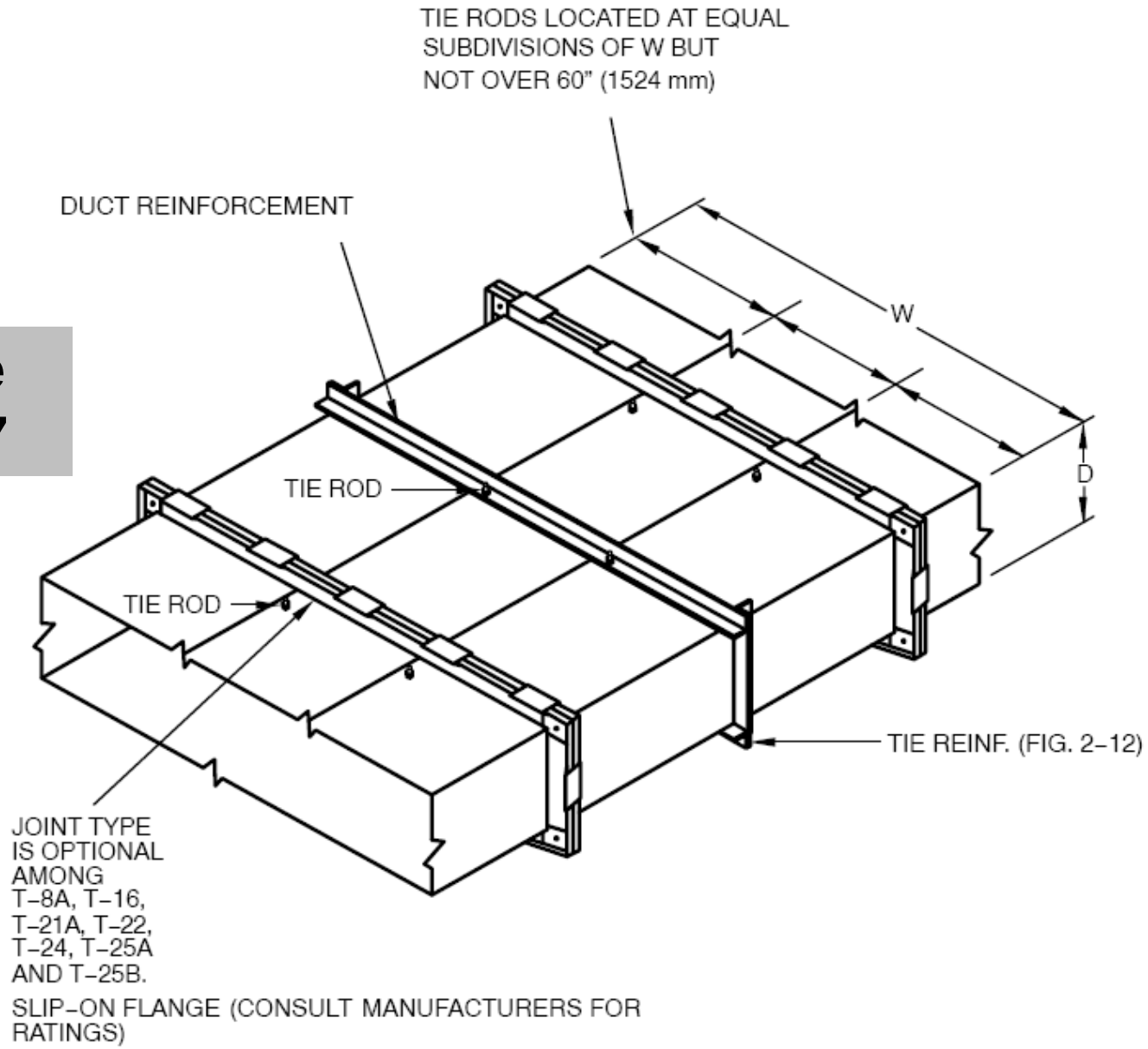
TIE RODS LOCATED AT EQUAL SUBDIVISIONS OF W BUT NOT OVER 60" (1524 mm)
DUCT REINFORCEMENT
W
D
TIE ROD
TIE ROD
TIE REINF. (FIG. 2–12)
JOINT TYPE IS OPTIONAL AMONG T–8A, T–16, T–21A, T–22, T–24, T–25A AND T–25B.
SLIP–ON FLANGE (CONSULT MANUFACTURERS FOR RATINGS)

Duct over 120 inches

Duct Pressure Class

wg (Pa)	½ in. (125 Pa)	1 in. (250 Pa)	2 in. (500 Pa)	3 in. (750 Pa)	4 in. (1000 Pa)	6 in. (1500 Pa)	10 in. (2500 Pa)
Panel Ga (mm)	18 (1.31 mm)	18 (1.31 mm)	18 (1.31 mm)	18 (1.31 mm)	18 (1.31 mm)	18 (1.31 mm)	16 (1.61 mm)
Reinf. Size	It	It	It	It	Jt	Kt	Lt
Reinf. Spacing ft (m)	2 ½ (0.75 m)	2 ½ (0.75 m)	2 ½ (0.75 m)	2 ½ (0.75 m)	2 ½ (0.75 m)	2 (0.60 m)	2 (0.60 m)
Max. Tie Rod Spacing ft (m)	5 (1.50 m)	5 (1.50 m)	5 (1.50 m)	5 (1.50 m)	5 (1.50 m)	5 (1.50 m)	4 (1.20 m)

Table 2–49 Duct Over 120 in. (3000 mm) Duct Construction

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Example 4

- Duct is 140 x 70 inches at negative 2 in. w.g.

Duct over 120 inches

Duct Pressure Class

wg (Pa)	½ in. (125 Pa)	1 in. (250 Pa)	2 in. (500 Pa)	3 in. (750 Pa)	4 in. (1000 Pa)	6 in. (1500 Pa)	10 in. (2500 Pa)
Panel Ga (mm)	18 (1.31 mm)	18 (1.31 mm)	18 (1.31 mm)	18 (1.31 mm)	18 (1.31 mm)	18 (1.31 mm)	16 (1.61 mm)
Reinf. Size	It	It	It	It	Jt	Kt	Lt
Reinf. Spacing ft (m)	2 ½ (0.75 m)	2 ½ (0.75 m)	2 ½ (0.75 m)	2 ½ (0.75 m)	2 ½ (0.75 m)	2 (0.60 m)	2 (0.60 m)
Max. Tie Rod Spacing ft (m)	5 (1.50 m)	5 (1.50 m)	5 (1.50 m)	5 (1.50 m)	5 (1.50 m)	5 (1.50 m)	4 (1.20 m)

Table 2–49 Duct Over 120 in. (3000 mm) Duct Construction

Page 2.117

Duct over 120 inches

- You need 2 tie rods across the width at every joint and at every reinforcement.
- 140/60 = 2.33 (round down) to 2
- Need 3 at widths beyond 180”
- 140/(2+1) = 140/3 = 46 5/8” spacing
- The joint length will be 5 ft. (56 inches using TDC/TDF) and the reinforcement spacing will be 2 ½ ft (28 inches using TDC/TDF).

Duct over 120 inches

- Determine the tie rod load:
- Tip- You can figure the load on a duct of half of the width using Table 2-46 and then double the load.
- 140/2 = 70 inches
- RS = 28 inches

Duct over 120 inches

Static Pressure Class, in. wg								
W	RS	½"	1"	2"	3"	4"	6"	10"
	36	47	94	187	281	374	562	936
	30	39	78	156	234	312	468	780
72"	28	36	73	146	218	291	437	728
	24	31	62	125	187	250	374	624
	22	29	57	114	172	229	343	572
	20	26	52	104	156	208	312	520

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Duct over 120 inches

- The load is 146 lbs (load for 70 inches) x 2 = 292 lbs for 140 inches
- The load per tie rod is 292 lbs/2 = 146 lbs
  - (75% - Rule)

What size does the tie rod need to be?

- If we use EMT conduit check Table 2-38

What size reinforcement is a class I

- Check Tables 2-29 or 2-30

Mid Panel Tie Rods Neg. Pressure

				Compression Stress Allowed (PSI)							
				9000	8000	7000	6000	5200	7400	4200	3700
		r_g	L/r_g=	130	140	150	160	170	180	190	200
Dia.	Type										
½ in.	EMT	0.235	LEN.	30 in.	32 in.	34 in.	36 in.	40 in.	42 in.	44 in.	46 in.
			LBS.	792	704	616	528	458	414	370	325
¾ in.	EMT	0.309	LEN.	40 in.	42 in.	46 in.	48 in.	52 in.	54 in.	58 in.	62 in.
			LBS.	1206	1072	938	804	697	630	563	496
1 in.	EMT	0.371	LEN.	48 in.	52 in.	54 in.	58 in.	62 in.	66 in.	70 in.	74 in.
			LBS.	1782	1584	1386	1188	1030	930	831	732
1¼ in.	EMT	0.511	LEN.	66 in.	72 in.	76 in.	82 in.	86 in.	92 in.	96 in.	102 in.
			LBS.	2655	2360	2065	1770	1534	1386	1239	1091
1½ in.	EMT	0.592	LEN.	76 in.	82 in.	88 in.	94 in.	100 in.	106 in.	112 in.	118 in.
			LBS.	3078	2736	2394	2052	1778	1607	1436	1265
2 in.	EMT	0.754	LEN.		106 in.	112 in.	120 in.	128 in.	136 in.	142 in.	150 in.
			LBS.		3480	3045	2610	2262	2044	1827	1609

Table 2–38 Internal EMT Conduit Size (–) Pressure

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Example 4 mid-panel reinforcement

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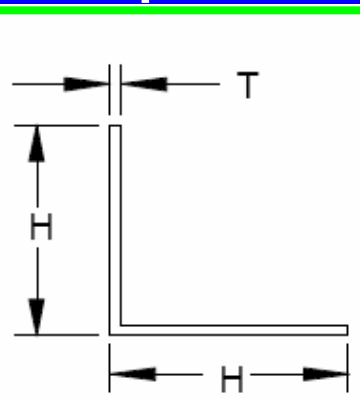

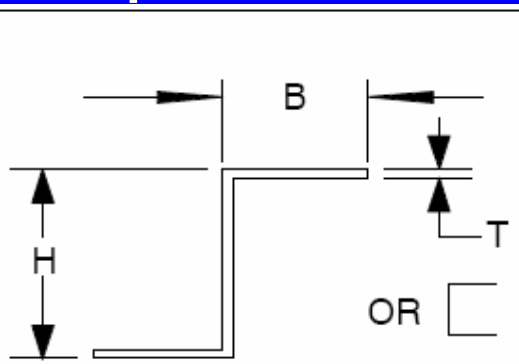

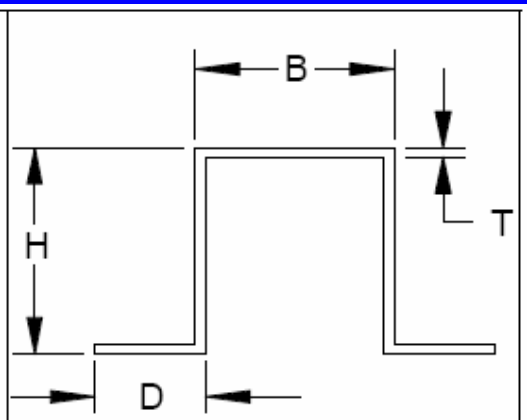

Reinf. Class		Angle		Channel or Zee		Hat Section	
	E1*	H × T (MIN)	WT LF	H × B × T (MIN)	WT LF	H × B × D × T (MIN)	WT LF
A	0.43	Use C		Use B		Use F	
H	26.4	1 ½ × 3/16 2 × ⅛	1.78 1.65	1 ½ × ¾ × ⅛	1.31	1 ½ × 1 ½ × ¾ × 18 ga 2 × 1 × ¾ × 20 ga	1.08 0.90
I	69	C 2 × 3/16 2 ½ × ⅛	2.44 2.10	2 × 1 ⅛ × 12 ga 3 × 1 ⅛ × 16 ga	1.60 1.05	2 × 1 × ¾ × 16 ga	1.44
J	80	H 2 × 3/16 C 2 × ¼ 2 ½ × ⅛ (+)	2.44 3.20 2.10	2 × 1 ⅛ × ⅛	1.85	2 × 1 × ¾ × 12 ga 2 ½ × 2 × ¾ × 18 ga	2.45 1.53

Duct over 120 inches

- Check the short side using the tables for duct less than 120 inches.
- In this case since we are using TDC/TDF we can use those specific tables.
- Table 2-17 on page 2.46

Duct over 120 inches

2 in. wg Static Pos. or Neg.	5 ft Joints			5 ft Joints w/2 ½ ft Reinf. Spacing				
				Joints/Reinf.			Int. Reinf.	
Duct Dimension	Min ga	Joint Reinf.	Alt. Joint Reinf.	Min ga	Joint Reinf.	Alt. Joint Reinf.	Tie Rod	Alt. Reinf.
10 in. and under	26	N/R	N/R					
49 – 54 in.	20	JTR	(2) E	22	N/R	N/R	MPT	F
	18	N/R	N/A					
55 – 60 in.	20	JTR	(2) H	22	JTR	(2) C	MPT	G
61 – 72 in.	18	JTR	(2) H	20	JTR	(2) E	MPT	H

Example 4 mid-panel reinforcement

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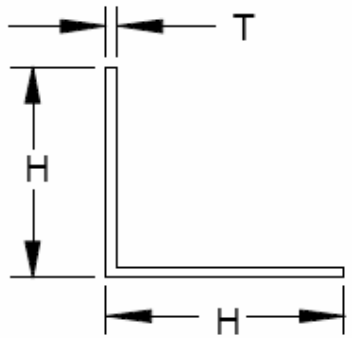

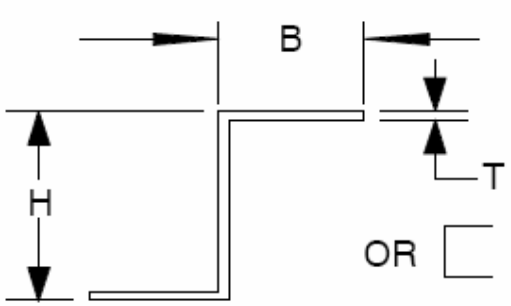

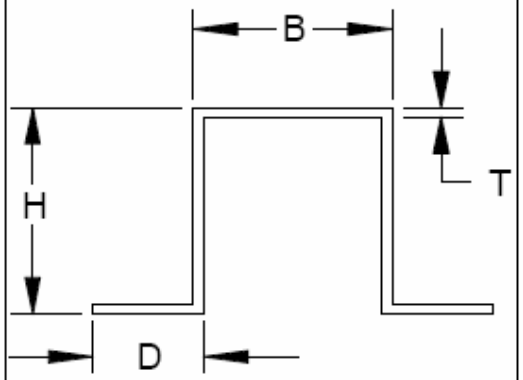

Reinf. Class		Angle		Channel or Zee		Hat Section	
	E1*	H × T (MIN)	WT LF	H × B × T (MIN)	WT LF	H × B × D × T (MIN)	WT LF
A	0.43	Use C		Use B		Use F	
H	26.4	1 ½ × 3/16 2 × ⅛	1.78 1.65	1 ½ × ¾ × ⅛	1.31	1 ½ × 1 ½ × ¾ × 18 ga 2 × 1 × ¾ × 20 ga	1.08 0.90
I	69	C 2 × 3/16 2 ½ × ⅛	2.44 2.10	2 × 1 ⅛ × 12 ga 3 × 1 ⅛ × 16 ga	1.60 1.05	2 × 1 × ¾ × 16 ga	1.44
J	80	H 2 × 3/16 C 2 × ¼ 2 ½ × ⅛ (+)	2.44 3.20 2.10	2 × 1 ⅛ × ⅛	1.85	2 × 1 × ¾ × 12 ga 2 ½ × 2 × ¾ × 18 ga	2.45 1.53

Example 4 solution

- The duct will be 18 gage
- The joints will be TDC/TDF
- The joint length is 56 inches
- The 140 inch side will be supported by 1” EMT conduit spaced 46 5/8” across the width and will be at each side of the joint and backing up the mid-panel reinforcement.
- The mid-panel reinforcement for the 140 inch side will be 2 ½ x 2 ½ x 1/8 and will be tied using 1 x 1 x 12 gage

Example 4 solution

- The 70 inch side will be reinforced using only external reinforcement
- The reinforcement will be 2 x 2 x 1/8 and installed on both sides of each joint
- This reinforcement will not be tied
- No mid-panel reinforcement is required

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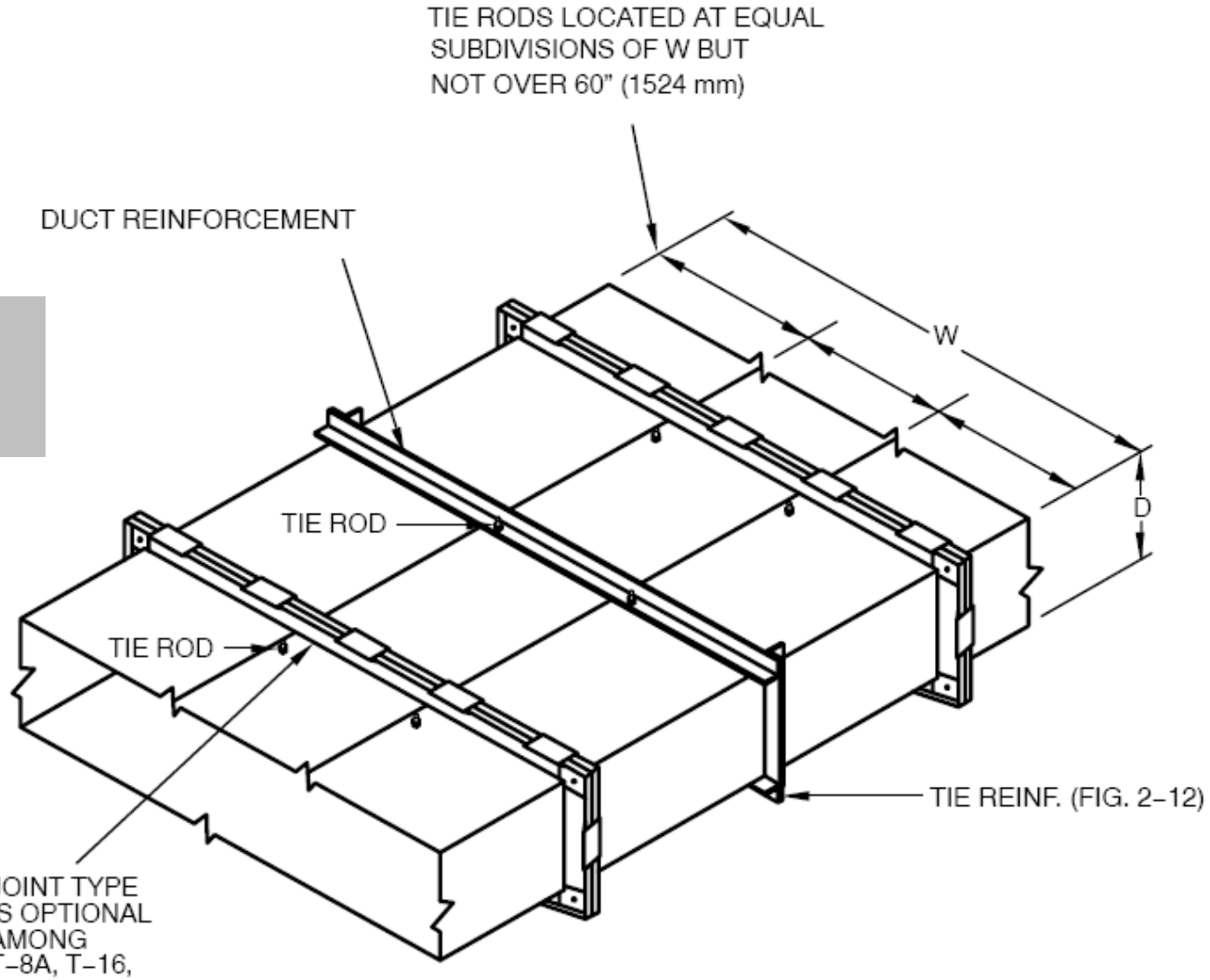

TIE RODS LOCATED AT EQUAL SUBDIVISIONS OF W BUT NOT OVER 60" (1524 mm)
DUCT REINFORCEMENT
W
D
TIE ROD
TIE ROD
TIE REINF. (FIG. 2–12)
JOINT TYPE IS OPTIONAL AMONG T–8A, T–16, T–21A, T–22, T–24, T–25A AND T–25B.
SLIP–ON FLANGE (CONSULT MANUFACTURERS FOR RATINGS)

Example 5 Round Duct

- Positive 10 in. w.g.
- 24 in. diameter
- Long seam or spiral
- Table 3-5 in HVAC DCS
  - Applies to positive pressure up through 10 in. w.g.

Table 3-5 Page 3.8
Unreinforced Round Duct to Positive 10 in. w.g.

Diameter, in.	Longitudinal Seam	Spiral Seam
4	28	28
6	28	28
8	28	28
10	28	28
12	28	28
14	28	28
16	26	26
18	26	26
20	24	26
22	24	26
24	24	26
30	22	24
36	22	24
42	22	24

Table 3-5 Page 3.8
Unreinforced Round Duct to Positive 10 in. w.g.

Diameter, in.	Longitudinal Seam	Spiral Seam
4	28	28
6	28	28
8	28	28
10	28	28
12	28	28
14	28	28
16	26	26
18	26	26
20	24	26
22	24	26
24	24	26
30	22	24
36	22	24
42	22	24

Example 6 Round Duct

- Negative 10 in. w.g.
- 24 in. diameter
- Long seam Spiral
- Table 3-9 in HVAC DCS for long seam
- Table 3-13 in HVAC DCS for spiral

Neg. Pressure 10 in. wg	Stiffener Spacing											
	Unstiff.		20 ft		12 ft		10 ft		6 ft		5 ft	
Diameter, in.	GA	R	GA	R	GA	R	GA	R	GA	R	GA	R
4	28	NR	28	A	28	A	28	A	28	A	28	A
				A	28	A	26	A	28	A	28	A
				A	26	A	26	A	28	A	28	A
				A	24	A	26	A	28	A	28	A
12	22	NR	22	A	24	A	24	A	26	A	28	A
14	20	NR	22	A	24	A	24	A	26	A	26	A
16	18	NR	20	A	22	A	24	A	24	A	26	A
18	18	NR	20	A	22	A	22	A	24	A	24	A
20	18	NR	20	A	22	A	22	A	24	A	24	A
22	16	NR	18	A	20	A	22	A	24	A	24	A
24	16	NR	18	A	20	A	20	A	22	A	24	A
30	N/A	NR	18	B	18	A	20	A	22	A	22	A
36	N/A	NR	16	C	18	B	18	B	20	A	22	A
42	N/A	NR	16	C	18	B	18	B	20	B	20	B
48	N/A	NR	N/A	E	16	C	18	C	18	B	20	B
54	N/A	NR	N/A	E	16	D	16	C	18	C	18	B
60	N/A	NR	N/A	F	16	E	16	E	18	C	18	C
66	N/A	NR	N/A	G	N/A	E	16	E	18	D	18	C
72	N/A	NR	N/A	G	N/A	F	16	E	18	E	18	D
78	N/A	NR	N/A	G	N/A	G	N/A	F	16	E	18	E

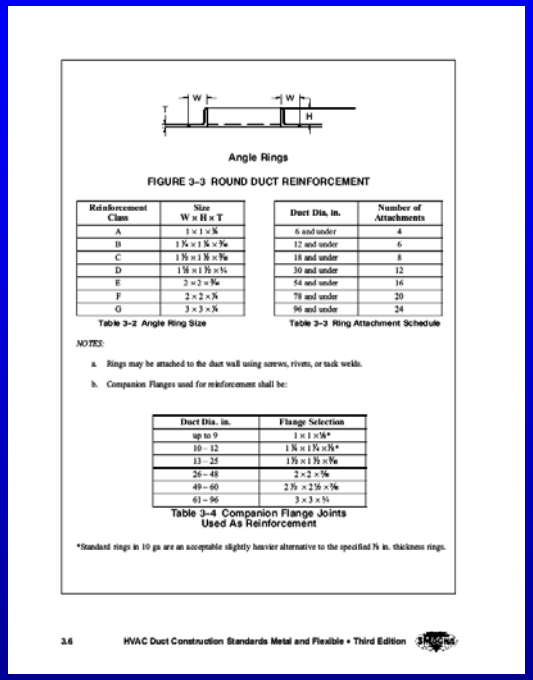
Longitudinal Seam
Page 3.16

Spiral Seam
P 3.24

Neg. Pressure 10 in. wg	Stiffener Spacing											
	Unstiff.		20 ft		12 ft		10 ft		6 ft		5 ft	
Diameter, in.	GA	R	GA	R	GA	R	GA	R	GA	R	GA	R
		NR	28	A	28	A	28	A	28	A	28	A
		NR	28	A	28	A	28	A	28	A	28	A
		NR	26	A	28	A	28	A	28	A	28	A
10	26	NR	26	A	28	A	28	A	28	A	28	A
12	24	NR	24	A	26	A	28	A	28	A	28	A
14	22	NR	24	A	26	A	26	A	28	A	28	A
16	22	NR	24	A	24	A	26	A	28	A	28	A
18	20	NR	22	A	24	A	24	A	26	A	28	A
20	18	NR	22	A	24	A	24	A	26	A	26	A
22	18	NR	22	A	24	A	24	A	26	A	26	A
24	18	NR	20	A	22	A	24	A	24	A	26	A
30	16	NR	20	B	22	A	22	A	24	A	24	A
36	N/A	N/A	18	C	20	B	22	B	22	A	24	A
42	N/A	N/A	18	C	20	B	20	B	22	B	22	B
48	N/A	N/A	18	E	18	C	20	C	22	B	22	B
54	N/A	N/A	18	E	18	D	18	C	20	C	22	B
60	N/A	N/A	16	F	18	E	18	E	20	C	20	C
66	N/A	N/A	16	G	18	E	18	E	20	D	20	C
72	N/A	N/A	16	G	18	F	18	E	20	E	20	D
78	N/A	N/A	16	G	16	G	18	F	18	E	20	E

Round Reinforcement

- Tables in the HVAC DCS
  - 3-2 Reinforcement
  - 3-3 Attachment Schedule
  - 3-4 Rings Used as Companion Flanges
  - P 3.6



Angle Rings

FIGURE 3–3 ROUND DUCT REINFORCEMENT

Reinforcement Class	Size W × H × T
A	1 × 1 × ⅛
B	1¼ × 1 ⅛ × 5⁄16
C	1½ × 1 ⅛ × 5⁄16
D	1⅞ × 1 ½ × ¼
E	2 × 2 × 5⁄16
F	2 × 2 × ¼
G	3 × 3 × ¼

Table 3–2 Angle Ring Size

Duct Dia, in.	Number of Attachments
6 and under	4
12 and under	6
18 and under	8
30 and under	12
54 and under	16
78 and under	20
96 and under	24

Table 3–3 Ring Attachment Schedule

NOTES:

a. Rings may be attached to the duct wall using screws, rivets, or tack welds.

b. Companion Flanges used for reinforcement shall be:

Duct Dia. in.	Flange Selection
up to 9	1 × 1 × 5⁄16*
10 – 12	1 ⅛ × 1 ⅛ × ⅛*
13 – 25	1½ × 1 ⅛ × 5⁄16
26 – 48	2 × 2 × 5⁄16
49 – 60	2½ × 2⅛ × 5⁄16
61 – 96	3 × 3 × ¼

Table 3–4 Companion Flange Joints Used As Reinforcement

*Standard rings in 10 ga are an acceptable slightly heavier alternative to the specified ⅛ in. thickness rings.

Round Reinforcement

Reinforcement Class	Size W × H × T
A	1 × 1 × 1/8
B	1 1/4 × 1 1/4 × 3/16
C	1 1/2 × 1 1/2 × 3/16
D	1 1/2 × 1 1/2 × 1/4
E	2 × 2 × 3/16
F	2 × 2 × 1/4
G	3 × 3 × 1/4

Table 3–2 Angle Ring Size

Duct Dia, in.	Number of Attachments
6 and under	4
12 and under	6
18 and under	8
30 and under	12
54 and under	16
78 and under	20
96 and under	24

Table 3–3 Ring Attachment Schedule

NOTES:

a. Rings may be attached to the duct wall using screws, rivets, or tack welds.

Round Reinforcement

b. Companion Flanges used for reinforcement shall be:

Duct Dia. in.	Flange Selection
up to 9	1 × 1 × 1/8*
10 – 12	1 1/4 × 1 1/4 × 1/8*
13 – 25	1 1/2 × 1 1/2 × 3/16
26 – 48	2 × 2 × 3/16
49 – 60	2 1/2 × 2 1/2 × 3/16
61 – 96	3 × 3 × 1/4

Table 3–4 Companion Flange Joints Used As Reinforcement

Oval Duct

- Approved for positive pressure only
  - Can be used for negative pressure with special designs
- Table 3-15 for gage
- Reinforce like rectangular
  - Based on the flat span
    - Flat span = major – minor
  - Based on reinforcement spacing
  - Use at least one tie rod (Figure 3-7 p 3.32)

Oval Duct

Major Dimension Duct Width (in)	Longitudinal Seam	Spiral Seam	Fitting Gage
To 24	20	24	20
30	20	22	20
36	20	22	20
42	18	22	18
48	18	22	18
54	18	20	18
60	18	20	18
66	16	20	16
71 and up	16	18	16

Table 3–15 Flat Oval Duct Gage
Positive Pressure To 10 in. wg

Example 7 Oval Duct

- Flat Oval Duct 20” x 46” @+10 in. w.g.
  - Major dimension = 46”
  - Minor dimension = 20”
  - Flat span (Major – Minor) = 26” (46” - 20”)
- First step determine gage
  - Use Table 3-15
  - Use Major dimension

Example 7 Oval Duct

Major Dimension Duct Width (in)	Longitudinal Seam	Spiral Seam	Fitting Gage
To 24	20	24	20
30	20	22	20
36	20	22	20
42	18	22	18
48	18	22	18
54	18	20	18
60	18	20	18
66	16	20	16
71 and up	16	18	16

Table 3–15 Flat Oval Duct Gage
Positive Pressure To 10 in. wg

Example 7 Oval Duct

- Next determine the reinforcement
  - Based on the flat span (26”)
  - Use the correct rectangular table
  - Pick reinforcement spacing
  - Determine reinforcement class

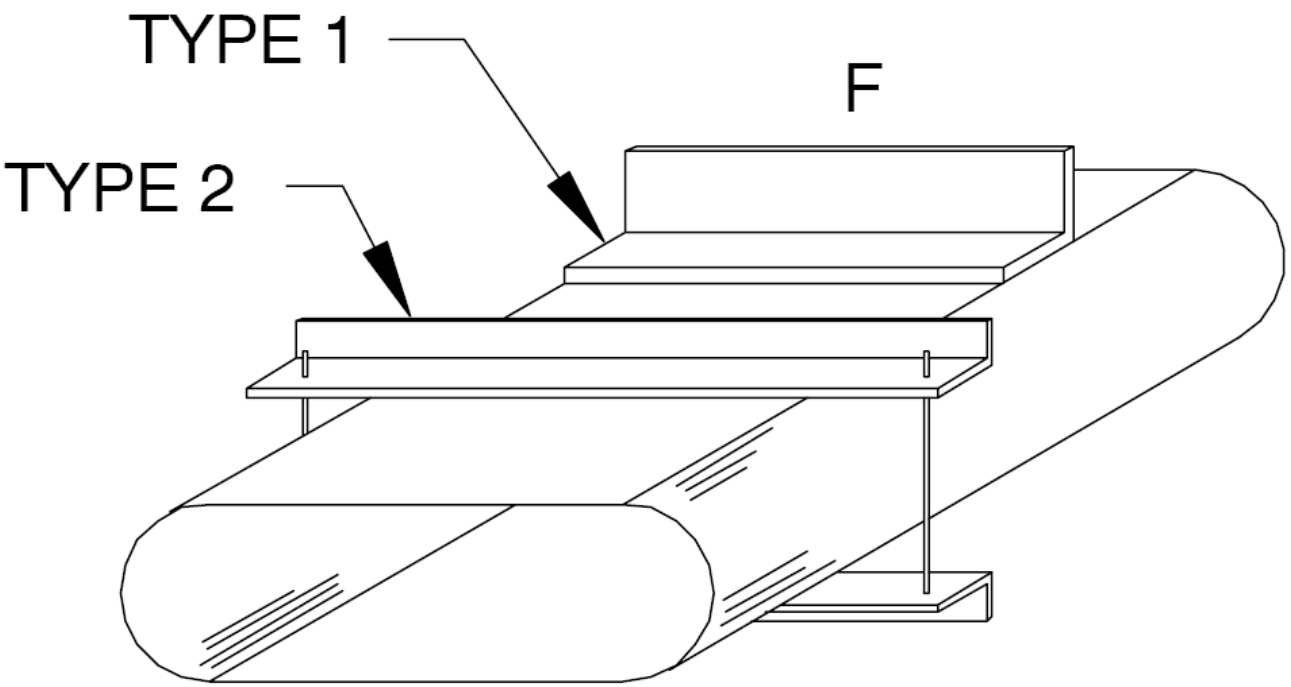
Example 7 Oval Duct

10 in. wg Static Pos. or Neg. / Duct Dimension	No Reinforcement Required	Reinforcement Code for Duct Gage Number							
		Reinforcement Spacing Options							
		10 ft	8 ft	6 ft	5 ft	4 ft	3 ft	2½ ft	2 ft
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
8 in. and under	22 ga.	Not Required		C-20	C-24	C-26	C-26	C-26	C-26
9 – 10 in.	20 ga.			C-20	C-22	C-24	C-26	C-26	C-26
11 – 12 in.	18 ga.		C-20	D-20	D-22	D-24	C-26	C-26	C-26
13 – 14 in.	18 ga.		D-20	E-20	E-20	D-22	D-24	D-26	C-26
15 – 16 in.	16 ga.	E-18	E-18	E-18	E-20	E-20	E-24	D-24	D-26
17 – 18 in.	16 ga.	F-18	F-18	F-18	F-20	F-20	E-24	E-24	D-26
19 – 20 in.		G-16	G-18	G-18	G-18	F-20	F-22	F-24	F-24
21 – 22 in.		H-16G	H-18G	H-18G	G-18	G-20	F-22		
23 – 24 in.		I-16G	I-18G	H-18G	H-18G	H-20G	G-22	F-24	F-24
25 – 26 in.			J-16G	I-16G	H-18G	H-20G	G-22	F-24	F-24

Page 2.26

Example 7 Oval Duct Solution

- Using spiral duct
  - Build the duct from 22 gage material
  - Reinforce the duct every 5 feet
  - Use a G class reinforcement
    - 1 ½ x 1 ½ x 1/8 angle
  - Use either type 1 or type 2 option for tie rod
    - Figure 3-7 page 3.32



TYPE 1 HAS AN
INTERNAL TIE ROD

Questions?

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- Click on technical services (left side)
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