PHENOLIC DUCT CONSTRUCTION STANDARDS

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

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FIRST EDITION — 2015

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FOREWORD

This is the First Edition of the SMACNA Phenolic Duct Construction Standard. It is intended to provide basic phenolic duct fabrication and installation standards to the industry.

Phenolic foam insulation is a versatile material with high thermal performance, moisture resistance, fire performance, and structural strength. Phenolic panels used for air distribution ductwork leverages these features by manufacturing the insulation into rigid panels with aluminum facings on both sides of the panel. The resulting ductwork is durable, pre-insulated, light weight, energy efficient, and low leak.

SMACNA thanks the SMACNA contractors who, as members of the Phenolic Duct Construction Task Force, volunteered their time and effort to the development of this manual. SMACNA appreciates their dedication and willingness to share their knowledge and experience in the fabrication and installation of Phenolic Duct systems.

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REFERENCES

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

ASTM C 518–10: Standard Test Method for Steady–State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

ASTM E 84–14 Standard Test Method for Surface Burning Characteristics of Building Materials

ASTM E 96 / E96M-13 Standard Test Methods for Water Vapor Transmission of Materials

NFPA 90A 2015 Edition Standard for the Installation of Air-Conditioning and Ventilating Systems

NFPA 90B 2015 Edition Standard for the Installation of Warm Air Heating and Air-Conditioning Systems

SMACNA HVAC Air Duct Leakage Test Manual, 2nd Edition, 2012

SMACNA HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition, 2005

SMACNA Fire, Smoke And Radiation Damper Installation Guide For HVAC Systems, 5th Edition, 2002

SMACNA Seismic Restraint Manual Guidelines For Mechanical Systems, 3rd Edition, 2008

UL 181 (Ed. 11) Standards for Factory-Made Air Ducts and Air Connectors

UL 181A (Ed. 4) Standard for Closure Systems for Use with Rigid Air Ducts

UL 723 (Ed. 10) Standard Test Method for Surface Burning Characteristics of Building Materials

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CHAPTER 1

MODEL PROJECT SPECIFICATIONS

1.1 DUCT CONSTRUCTION

Phenolic duct shall conform to the SMACNA Phenolic Duct Construction Standards, 1st Edition, 2015 (herein referred to as the PDCS).

Phenolic duct shall be a Class 1 Air Duct Listed and Labeled in accordance with Underwriters Laboratories (UL) and have an available Certificate of Compliance to UL 181 Standard for Safety

The thermal conductivity and R-value of Phenolic Duct panels shall be tested in accordance with ASTM C 518

The fabricator shall submit for the approval of owner's representative or the approval of local mechanical code official the following:

A. The title of the standard the fabricator chooses to comply with;

B. A list of any deviations from the selected standard and the reason(s) therefore;

C. The name and product rating of manufacturer of the phenolic panels;

D. The type of closures systems selected along with confirmation that they are acceptable to the phenolic panel manufacturer and are UL listed;

E. A schedule of duct pressure classifications and the air handling systems for which they are selected;

F. The type and spacing interval of supports selected;

1.2 GALVANIZED STEEL SHEET

For hangers, supports and accessories, zinc coating weight for all galvanized steel sheet shall be G60 (Z180) or for exterior applications, G90 (Z275).

1.3 DUCT DIMENSIONS

Duct dimensions shown in the contract drawings are for airflow area, which are interior dimensions.

1.4 DUCT PRESSURE CLASS

Duct pressure classes are to be identified on the contract drawings.

**Schedule the pressure classes here by fan system number, or portion thereof, if they are not shown on the drawings.*

1.5 DUCT SEAL CLASS

Ducts constructed in accordance with the PDCS shall be compliant with Seal Class A as defined in SMACNA *HVAC Duct Construction Standards, Metal and Flexible* (hereinafter referred to as the "*HVAC DCS*").

1.6 DUCT LEAKAGE CLASS

Phenolic duct may follow SMACNA Leakage Class 3. For duct leakage testing purposes, the duct interior dimensions shall be used for duct surface area calculations. Reference sections 2.2 and 2.3 in the PDCS.

**Consult the ANSI/SMACNA HVAC Air Duct Leakage Test Manual*.

**For duct leakage testing, the test pressure shall not exceed the duct construction pressure class. The designer must specify duct system pressure relief procedures and precautions to protect and prevent duct systems from over pressurization*.

1.7 FLEXIBLE DUCT AND CONNECTOR

Flexible duct and connector shall be in conformance with the HVAC DCS. Where the specifications for connecting and supporting these in the PDCS are more stringent or restrictive, they shall supersede.

1.8 VIBRATION ISOLATION CONNECTORS

Flexible isolation connectors shall not exceed 10 in. in length in direction of airflow and shall be made of flame-retardant fabric having a flame spread rating not over 25 and a smoke developed rating not over 50. Flexible isolation connectors to be tested in accordance with Underwriters Laboratories (UL) Standard 181 and must be installed in accordance with the conditions of their UL listing.

**Consult the applicable codes, The UL Fire Resistance Directory, references in the HVAC DCS, the Air Diffusion Council's Flexible Air Duct Performance and Installation Standards and identify the products and performance characteristics desired*.

1.9 PROPRIETARY PRODUCTS

Description of products from a proprietary or single source manufacturer shall be submitted for approval along with substantiation of fitness for the service conditions that are proposed but not already identified in the project specifications.

1.10 PENETRATIONS

All wall penetrations that require special-purpose dampers (fire, smoke, etc.) shall be shown in the contract drawings.

**Consult the SMACNA Fire, Smoke, and Radiation Damper Guide and local codes for obligations to show the location of each barrier penetration protection device on contract drawing. Designer must show all air volume control devices on the contract drawings when they are not specified to be integral with HVAC units or air terminal units. Also specify the size and location of all access doors and access panels to be used in ductwork.*

*NOTES FOR THE SPECIFIER

CHAPTER 2

DUCT PERFORMANCE CHARACTERISTICS

2.1 PHENOLIC DUCT PERFORMANCE CHARACTERISTICS

A. **Maximum static pressure in duct**. 4" w.g. (1000 Pa), positive; 3" w.g. (750 Pa) negative.

B. **Maximum air velocity in duct**. 5,000 ft./min (25.4 m/sec)

C. **Maximum allowable stress in steel members used for reinforcement or support**. 22,000 lb./in.^{2} (152 MPa) with 30,000 lb./in.^{2} (207 MPa) yield strength minimum.

D. **Vapor transmission.** The vapor retarder of the phenolic panel shall have a maximum permeance of 0.05 perm [2.87 ng/(Pa • s • m^2)] in accordance to ASTM E 96 or shall be an aluminum foil having a minimum thickness of 2 mils (0.051 mm).

E. **Temperature**. –15ºF (–26ºC) minimum inside duct. 185ºF (85ºC) maximum inside the duct, continuous operation.

F. **Corrosiveness**. Non-corrosiveness in contact with galvanized steel, aluminum or stainless steel.

G. **Closure**. Closure systems shall conform to Underwriters Laboratories Standard UL 181A installed in accordance with the manufacturer's Class 1 Air Duct listing.

H. **Safety Standards**. NFPA Standard 90A, 90B and UL 181.

I. **Phenolic Panels.** The thermal conductivity and R-value of Phenolic panels shall be tested in accordance with ASTM C 518

J. **Reinforcement testing.** Test programs have demonstrated that phenolic duct systems, including fittings such as offsets, tees, elbows, branches, transitions, and accessory items are capable of maintaining their structural integrity at 1.5 times systems 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.

K. **Restrictions**. Phenolic duct systems shall not be used in the following applications:

1. Kitchen/grease exhaust, fume exhaust, smoke exhaust or to convey solids or corrosive gases.
2. Installation in concrete or buried below grade.
3. Outdoors without mechanical or weather protection.
4. As casings or housings of built-up equipment.
5. Immediately adjacent to high temperature electric heating coils without radiation protection. Refer to NFPA Standard 90A.
6. Adjacent to any mechanical or electrical sources of extreme heat.
7. With equipment of any type which does not include automatic maximum temperature controls or where failure of automatic control equipment may give rise to extreme temperatures.
8. With coal- or wood-fueled equipment.
9. Where products of combustion readily collects inside the ductwork.
10. Where normal operating pressure or occasional over pressure would exceed the phenolic duct rating.
11. As penetrations in construction where fire dampers are required.
12. Where moisture would collect in the duct.
13. Where condensation would occur on the duct exterior.
    a) Exception: Ductwork is not prohibited in indoor locations where condensation can occur provided all duct system components exposed to the condition are of non-corrosive construction. Where corrosion is a problem for electro-galvanized or hot-dipped galvanized materials, materials of aluminum or stainless steel construction shall be utilized.

Such components include but are not limited to: fasteners, transverse joint flanges, reinforcement components, tie rod external components, accessories, miscellaneous hardware, etc.

L. **Mounting of accessories**. When mounting equipment, dampers, damper operators, control motors, etc., the duct system must be adequately reinforced and supported 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.

M. **Beam Strength of Duct Section**. A duct section between adjacent hangers must be able to carry its own weight and to resist external loads for which it is constructed. The phenolic panels, joints and support systems listed in the PDCS construction tables are not qualified for supplemental loads. Specifically, the joints and phenolic panels listed in the current construction tables are not designed to support the weight of a person.

N. **Class 1 Air Duct Rating**. When ducts must conform to NFPA Standard 90A and model codes, phenolic ducts are required to conform to the following requirements:

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

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

3. They shall not be used in air duct systems which operate continuously with an air temperature higher than 185ºF (85ºC) entering the ducts.

4. They may be directly attached to listed heating and cooling equipment designed to operate at temperatures not exceeding 185ºF (85ºC.). 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 phenolic ducts in new material conditions:

   a. Surface burning characteristics

   b. Flame penetration

   c. Burning

   d. Mold growth and humidity

   e. Temperature

   f. Puncture

   g. Static load

   h. Impact

   i. Erosion

   j. Pressure collapse

   k. Leakage

O. **Pressure sensitive tapes**. Pressure sensitive tapes that pass UL Standard 181A tests are imprinted with the manufacturer's name (or symbol), date of manufacture, product code and the wording "UL Listed 181A-P".

P. **Sealer and Adhesive**. Phenolic panel manufacturer approved sealant/caulk (hereinafter referred to as "sealer") and adhesive shall be suitable for phenolic duct construction.

2.2 DUCT SEALING

Ducts constructed in accordance with the PDCS shall be compliant with Seal Class A as defined in the *HVAC DCS*.

**For phenolic duct construction, five pressure classes exist [½ in. (125 Pa), 1 in. (250 Pa), 2 in. (500 Pa), 3 in. (750 Pa), 4 in. (1000 Pa)]. If the designer does not designate pressure class for duct construction on the contract drawings, the basis of compliance with the SMACNA Phenolic Duct Construction Standards is as follows: 2 in. wg (500 Pa) for all ducts between the supply fan and variable volume control boxes and 1 in. wg (250 Pa) for all other ducts of any application*.

**Some sealers can adversely affect the release function of breakaway connections to fire dampers; consult the damper manufacturer for installation restrictions*.

2.3 LEAKAGE TESTS

Refer to ANSI/SMACNA HVAC Air Duct Leakage Test Manual for leakage test procedures.

**For duct leakage testing, the designer must specify duct system pressure relief procedures and precautions to protect and prevent duct systems from over pressurization*.

2.4 OTHER PERFORMANCE CHARACTERISTICS

Consult design handbooks and phenolic panel manufacturers for friction loss coefficients and thermal and acoustical performance.

2.5 COMMENTARY

- Vertical ducts serving more than two adjacent stories in height shall be adequately supported consistent with good engineering practices. See *HVAC DCS* for means and methods.

- SMACNA recognizes that research continues and that future advances will lead to phenolic panels which are thicker and have higher thermal resistance than contained in the PDCS.

*NOTES FOR THE SPECIFIER

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CHAPTER 3

SPECIFICATIONS AND CLOSURE

3.1 GENERAL SPECIFICATION REQUIREMENTS

A. All ducts required to meet Class 1 Air Duct rating shall comply with Underwriters Laboratories (UL) Standard 181. All closure systems shall meet UL 181 or UL 181A-P. Aluminum pressure sensitive tapes (hereinafter referred to as "tape"), shall be imprinted with the coding 181A-P, the manufacturer's name and a date code. Sealer and adhesive shall be suitable for phenolic duct construction and be compliant with the listed phenolic duct listings by Underwriters Laboratories.

B. All phenolic duct shall be constructed so that the duct wall deflection does not exceed 1 percent of the span when pressurized at or below the rated pressure classification.

C. Construction detail(s) not otherwise required conforming to a condition of listing or a superimposed requirement in these standards shall conform to the recommendations of the phenolic panel manufacturer.

D. Sheet metal items shall be fabricated as specified in the *HVAC DCS* except as necessarily altered for incorporation in phenolic duct. Metal items shall be installed in a manner that does not cut or damage the phenolic panel surface. Metal sleeves and collars of undesignated thickness shall be of duct wall gage prescribed in the *HVAC DCS*.

E. All fastenings not otherwise identified shall be:

1. Screws to be corrosion resistant minimum #10 sheet metal screws.

2. Washers to be corrosion resistant reinforced and 3.5 in. (90 mm) minimum diameter and .04 in. (1 mm) minimum thickness (herein referred to as "reinforced washers").

3. Rivets to be corrosion resistant blind rivets with aluminum body. Minimum diameter 5/32 in. (4 mm).

F. All screws and rivets penetrating phenolic panel shall be no more than 0.5 in. (13 mm) longer than panel thickness. Washers shall be 3.5 in. (90mm) diameter minimum and .04 in. (1mm) thickness minimum and be used under screw heads or rivet 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.

G. All fastenings, reinforcements and attachments shall be non-corrosive.

H. All horizontal branches and run-outs to air terminals shall be supported independent of the main duct.

I. Main duct to branch duct extractor installations, if required by the designer's contract drawings, shall not be installed without metal sleeves on the duct interior.

J. Metal dovetail tabs shall be bent tightly onto duct interior surface and shall not be less than 0.75 in. (19 mm) length on duct interiors. Exposed phenolic insulation foam remaining after bending the metal dovetail tabs onto the phenolic duct interior surface to be covered with tape or sealed. Reference Figure 4-17.

K. Rectangular non-flanged connection fittings to mains and submains require sealer applied around the exterior perimeter of the joint. Reference Figure 4-15.

L. Provision shall be made for locking dampers in position after flow adjustment.

M. Damper fabrication and installation to be in conformance with *HVAC DCS* except as altered for incorporation in phenolic duct as noted in the PDCS. Reference Figures 7-1, 7-3 – 7-6.

N. Except for transfer ducts, all 90º square throats and square heel elbows with a duct dimension more than 8 in. (200 mm) shall be vaned. Reference Figure 4-20.

O. Splitter vane fabrication and installation shall conform to the requirements of the project plans and specifications. Reference Figures 4-4 – 4-6, 4-8 and 4-10.

P. The fabrication of various fittings requires that creases be provided. To protect the phenolic panels from damage, crease angle limits are as follows: 7/8 in. (22 mm) panels are limited to

45 degree angle creases; 1 3/16 in. (30 mm) panels are limited to 30 degrees angles creases.

Q. Metal turning vane and track assemblies shall be fabricated in accordance with PDCS. Metal turning vane and track assembly to be non-corrosive. For ducts with a greatest duct dimension to 24 in. (610 mm) or less and a duct pressure class of 2 in. w.g. (500 Pa) or less, turning vane tracks are permitted to be affixed to the duct interior with sealer. For ducts with a greatest duct dimension over 24 in. (610 mm) or a pressure class over 2 in. w.g (500 Pa), vane runners require additional mechanical fastening. Reference Figure 4-20.

R. Metal access doors shall conform to the PDCS construction detail(s). Phenolic duct opening perimeter is required to be fitted with a phenolic duct flange to accept the access door or access door frame. Access doors and matching frames require the application of sealer as indicated in the PDCS. Reference Figure 7-2.

S. Access doors shall be located at least 4 in. (100 mm) from the end of duct joints and connections.

T. Ducts shall be made as indicated in the PDCS. They shall be secured and reinforced as specified.

U. All tape shall be 3 in. (76 mm) minimum width.

1. Exception: At four bolt flanges, 2 in. (51 mm) wide tape is permitted. The purpose is to protect the phenolic panel while affixing the four bolt flange. Reference Figure 3-9.

V. All tape shall be applied in accordance with the recommendations of the tape manufacturer including but not limited to compliance to tape manufacturer's recommended application temperature range.

W. Sealer shall be suitable for phenolic duct construction and be compliant with the phenolic duct listings by Underwriters Laboratories (UL) Standard 723. Sealer application shall be in compliance to the sealer manufacturer's recommended application temperature range.

X. When the application of sealer is required by the PDCS, the sealer bead shall be minimum 5/32 in. (4 mm).

Y. Adhesive shall be suitable for phenolic duct construction and be compliant with the phenolic duct listings by Underwriters Laboratory. Adhesive application shall be in compliance to the adhesive manufacturer recommended application temperature range.

Z. Gaskets shall be suitable for phenolic duct construction.

1. For the "A", "B", "C" and "D" type flanges, gasket shall be compressible polyurethane foam, minimum thickness 5/8" (15 mm) × 5/8" (15 mm) wide.

2. For the 4-bolt flange and at other gasket applications not indicated in 3.1.Z.1, gasket shall be compressible polyurethane foam, minimum thickness 5/8" (15 mm) × 5/8" (15 mm) wide or durable materials such as soft elastomer butyl or extruded forms suitable for flanged joints/connections.

AA. Tape utilized at longitudinal seams shall be adhered to at least an approximate 1.5 in. (38 mm) wide strip of each contact surface being closed. Tapes at other closures shall be as indicated in the PDCS. The application of UL tape over phenolic duct cleated panel fasteners (herein referred to as "panel fasteners" and "panel fasteners type 2") shall not result in the panel fasteners puncturing the tape.

BB. Panel fasteners spacing shall be in conformance with the PDCS.

CC. The depth and thickness of grooving shall be appropriate for the specific phenolic panel thickness of 7/8 in. (22 mm) or 1 3/16 in. (30 mm)

DD. At shoe branch type connections, the cut opening at the main or submain requires the exposed phenolic insulation foam to be covered with tape. The shoe tap requires installation with mechanical fasteners with gasket/sealer in accordance with the PDCS. Reference Figure 4-16.

EE. Rectangular phenolic duct branch connections to mains or submains are permitted to be non-flanged provided the duct greatest dimensions does not exceed 24 in. (600 mm) and the duct pressure class does not exceed 2 in. w.g. (500 Pa). Reference Figure 4-15.

FF. Rectangular phenolic duct branch connections to mains or submains are required to be flanged if the branch duct greatest dimension is greater than 24 in. (600 mm) or the duct pressure class is greater than 2 in. w.g. (500 Pa). Reference Figure 4-14.

GG. All rectangular phenolic duct branches that connect to mains or submains that utilize a flanged connection shall be fitted with a "B" Flange. Openings in mains and submains shall be fitted with a "D" Flange. The connection between the branch "B" Flange and the main/submain "D" Flange shall include a gasket and be mechanically fastened with screws or rivets in accordance with details in the PDCS. Reference Figure 4-14.

HH. All rectangular phenolic duct branches that connect to a main or submain that do not utilize a flanged connection shall be fabricated and installed in accordance with the PDCS. Reference Figure 4-15.

Branch take-off 45 degree cut connection option to include adhesive applied inside the joint and sealer at the exterior perimeter of the joint. Inside the duct, tape is required to cover the inside corner of the joint.

Branch take-off 90 degree cut connection option requires the exposed phenolic insulation foam at the cut opening at the main or submain to be covered with tape. The branch fitting end that connects to the main or submain shall also be covered with tape. Phenolic duct fastener(s) shall be provided at the duct joint exterior with fastener spacing in accordance with the PDCS. Sealer applied to the exterior perimeter of the joint.

II. All straight duct sections and all direction change and size change fittings in positive and negative pressure systems shall be reinforced as required herein by the PDCS. Reference Chapter 5.

JJ. For phenolic ducts with a dimension up to 44 in. (1100 mm), duct length segments are permitted to be 154 ¾ in (3930 mm) in length. For phenolic ducts with a dimension of more than 44 in (1100 mm) to 80 in. (2000 mm), duct length segments are limited to 47 ¼ in (1200 mm) in length. For duct(s) with a dimension over 80 in. (2000 mm), consult with the phenolic panel manufacturer.

KK. Installation of phenolic duct mounted air inlets/outlets shall be in conformance with the PDCS. Reference Figure 7-8.

LL. Phenolic duct connections to fans, HVAC equipment and other equipment shall be in conformance with the PDCS. Reference Figures 7-1, 7-7, 7-9 and 7-10.

MM. 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.

NN. End Cap Reinforcement – Profile reinforcement may be required to withstand the pressure and limit the end cap deflection. Refer to the schedule of duct reinforcement for duct size and pressure requirements. When end cap reinforcement is required, mechanically fix end cap with reinforcing channel and fasteners in conformance with PDCS. Reference Figures 4-18 and 4-19 and Tables 4-1 and 4-2.

OO. Tie rod installations shall be in conformance with the PDCS. Reference Chapter 5.

PP. 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 by the PDCS and supported as required by the *HVAC DCS*.

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

RR. The omission of reinforcement 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 space may show reinforcement is not required.

SS. The omission of referenced figures herein that are illustrating particular features shall not be used as grounds for omitting requirements that are elsewhere and otherwise specified.

3.2 CLOSURES

3.2.1 GENERAL

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

A. Pressure sensitive aluminum foil tapes.

B. Sealer

C. Adhesive

D. Panel fasteners

E. Phenolic duct flanges

F. Four bolt flanges

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

3.2.2 JOINT AND SEAM PREPARATION

Longitudinal seams and longitudinal corners are prepared as described herein and in Figures 3-1 and 3-2. Transverse joints between two duct sections are prepared as described herein and in Figures 3-3 through 3-9.

3.2.3 SEAMS AND JOINTS CLOSURE

A. Longitudinal Seams and Longitudinal Corners:

For the purposes of the PDCS, a longitudinal seam is defined as joining of two unattached longitudinally (in the direction of airflow) oriented mitered edges of phenolic panel material occurring between two joints. A longitudinal corner is defined as joining by folding of two attached (via phenolic panel exterior facing) longitudinally (in the direction of airflow) oriented mitered edges of phenolic panel material occurring between two joints.

Adhesive/tape or panel fasteners/tape is required at all longitudinal seams. Adhesive or panel fasteners/tape is required at longitudinal corners as specified in the PDCS. Tape is always applied over panel fasteners.

The application of adhesive/tape or panel fasteners/tape is to be in conformance with the PDCS including but not limited to as indicated in Figures 3-1, 3-2 and 4-7.

Regardless of the type of construction of longitudinal seams and longitudinal corners, a continuous unbroken bead of sealer is always placed in all four interior corners extending the full length of duct.

B. Transverse Joints, Non-Flanged:

Both ends of the duct must be flat and perfectly squared. Tape is applied on both ends of the duct segments. Apply a continuous bead of sealer to one end of one segment. The two duct segments are joined together. Air stream facings are to be carefully aligned to ensure specified internal duct dimensions are achieved. Panel fasteners are placed on all four corners and on all four sides of the duct at the connection. Apply tape around the connection of the two duct segments. Refer to Figure 3-3 for details.

C. Transverse Joints, "A" Flange

For 1 3/16 in. (30 mm) panel, tape is applied to the corners at ends of both duct segments to seal the exposed insulation. Tape is not required at the corners at the ends of the 7/8 in. (22 mm) panel.

Flange sections are cut to fit and applied to the duct end with light pressure until the total flange assembly is formed. Only when one piece is properly engaged and correctly positioned, it should be firmly positioned into the final locking grip using a rubber mallet. Sealer is applied to the flange sections as indicated. Refer to Figures 3-4 – 3-7.

At the end of one segment of duct, apply a continuous gasket to effectively seal the flange and the corners. Position the two duct segments together. Use "A" flange drive cleats to connect the duct segments

D. Transverse Joints, Optional "B/C" Flange:

For 1 3/16 in. (30 mm) panel, tape is applied to the corners at ends of both duct segments to seal the exposed insulation. Tape is not required at the corners at the ends of the 7/8 in. (22 mm) panel.

Flange sections are cut to fit and applied to the duct end with light pressure until the total flange assembly is formed. Only when one piece is properly engaged and correctly positioned, it should be firmly positioned into the final locking grip using a rubber mallet. Sealer is applied to the flange sections as indicated. Refer to Figures 3-4 – 3-6 and 3-8.

At the end of one segment of duct, apply a continuous gasket to effectively seal the flange and the corners. Position the two duct segments together. Use rivets or screws fasten the duct segments.

E. Transverse Joints, 4 Bolt Flange:

Prior to insertion of the 4-Bolt Flange, the ends of the duct section are required to be sealed with UL listed aluminum tape and then gently tapered with a phenolic panel rigid Spatula. The four pieces of 4-Bolt Flange are cut to the internal dimension of the corresponding side of the duct less ¾ in. (19mm). The 4-Bolt Flange uses minimum 20 gage (1 mm) pressed steel corners. First, the four pieces of flange and corners are assembled together to form a frame, then a bead of sealer is applied inside the flange, on both internal edges of the flange. Finally, the whole frame is fitted onto the edge of the duct.

After the flange has been fully attached, apply a continuous gasket to effectively seal the flange and the corners. Note that it is only applied on one of the two duct sections being joined together. Four bolts are used to join the two duct sections together. Additional metal clips are required on the flange at 3 in. (75 mm) from the corners, further metal clips are required along the flange so that the joint is kept closed without gaps – maximum 12 in. (300mm) centers required. Reference Figure 3-9.

F. Flanged Transverse Joints ("A" Flange, Optional "B/C" Flange, 4 Bolt Flange):

***** The designer shall consider the possibility and consequences of condensation occurring on mechanical flanges and shall specify control measures.

3.2.4 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.

3.2.5 SHELF LIFE

Tapes, sealers and adhesives often have storage requirements and shelf life limitations. The installer shall verify that these conditions have not been exceeded prior to use.

NOTES:

a. *Manufacturer's closure application instructions must be followed.*

b. *See mechanical reinforcement requirements at seams and joints in the reinforcement's provisions.*

***** NOTES FOR THE SPECIFIER

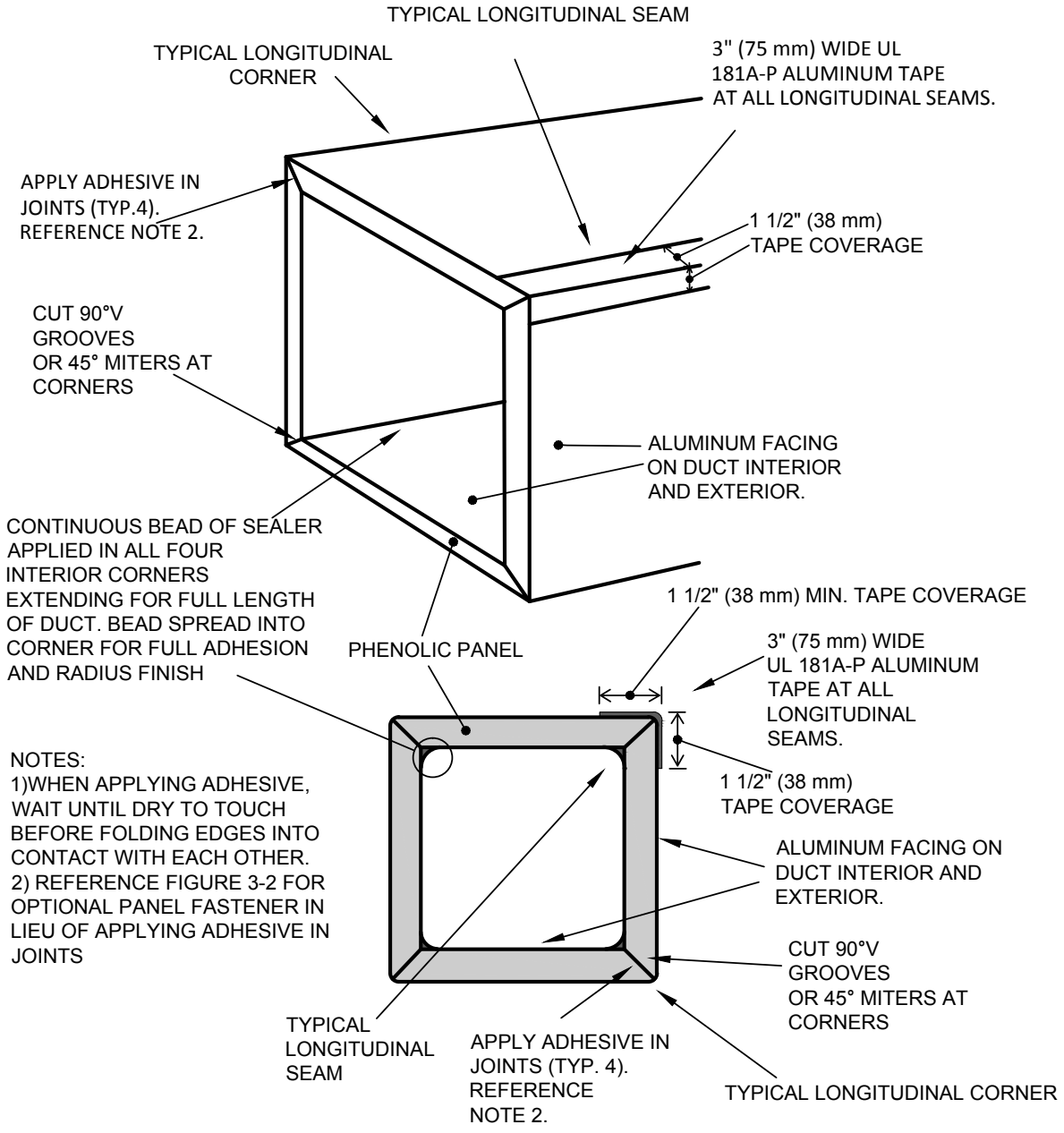
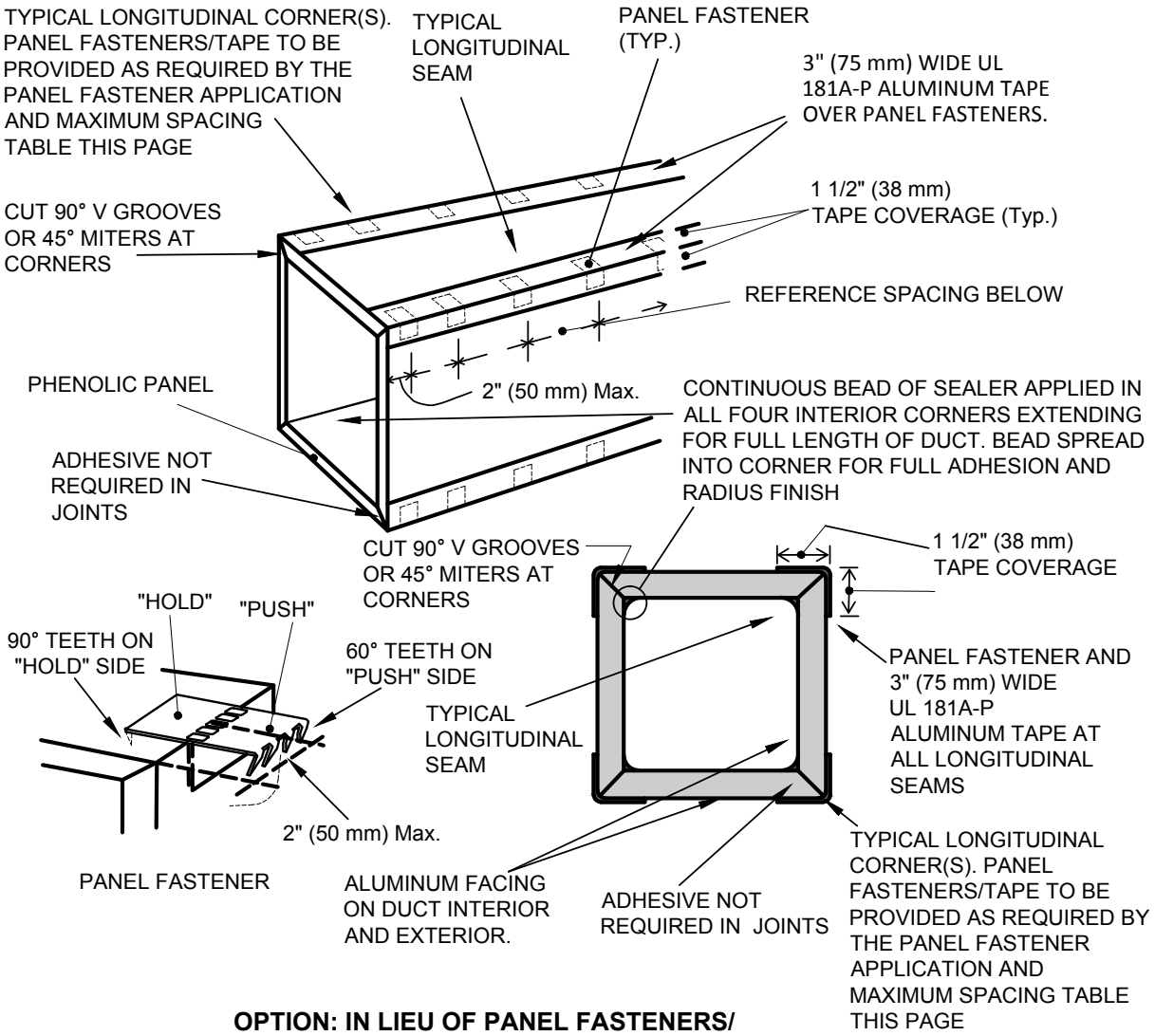


FIGURE 3-1 CLOSURES

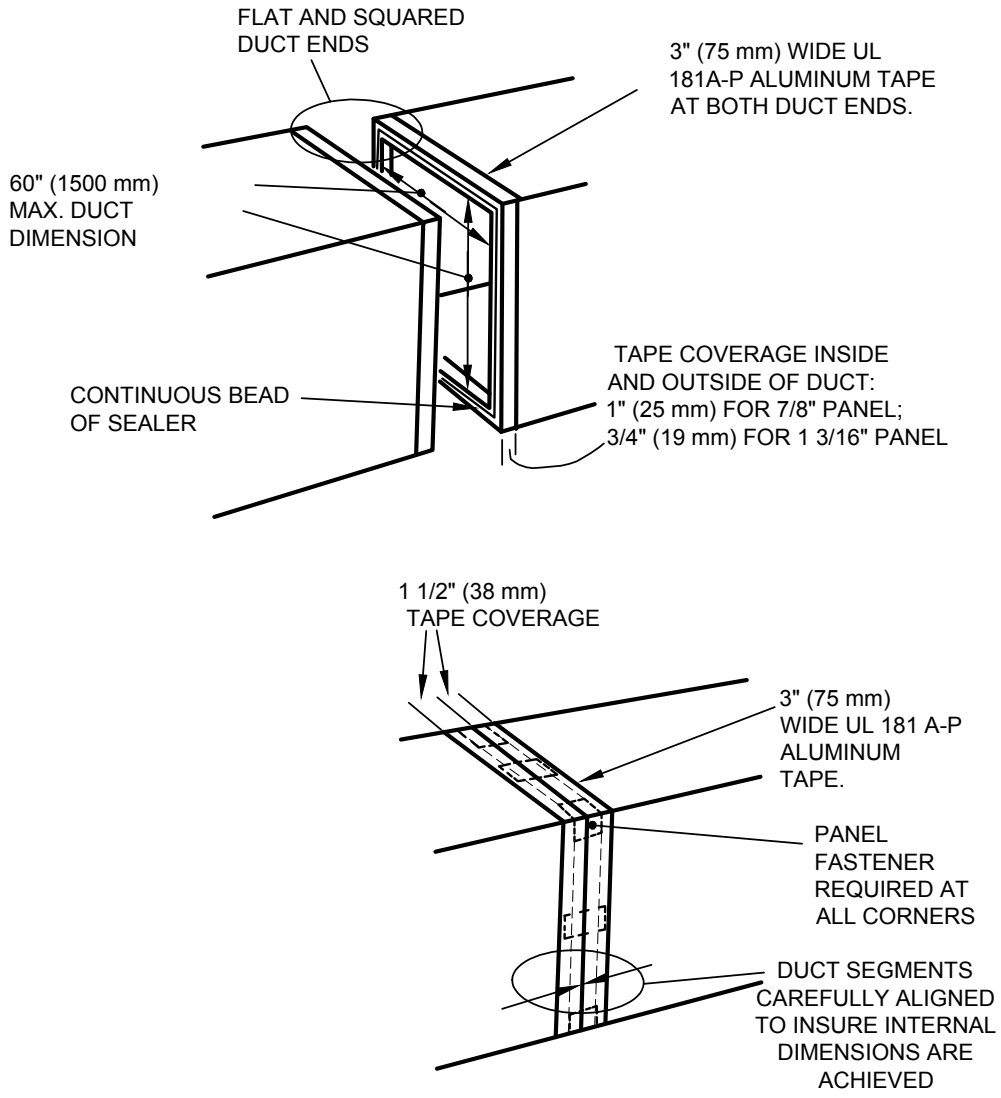


OPTION: IN LIEU OF PANEL FASTENERS/ TAPE AT LONGITUDINAL CORNERS, ADHESIVE IN THE JOINT MAY BE UTILIZED

PANEL FASTENER APPLICATION AND MAXIMUM SPACING				
PRESSURE IN. w.g.	PRESSURE Pa	DUCT DIMENSION	PANEL FASTENER MAXIMUM SPACING	APPLICATION
0.5- 2	125-500	80" (2000 mm) AND UNDER	20" (508 mm)	LONGITUDINAL SEAMS AND LONGITUDINAL CORNERS
3, [1]4	750, [1]1000	80" (2000 mm) AND UNDER	10" (254 mm)	LONGITUDINAL SEAMS AND LONGITUDINAL CORNERS
[1] POSITIVE PRESSURE ONLY NOTE: FOR DUCT OVER 80" (2000 mm), CONSULT WITH THE PHENOLIC PANEL MANUFACTURER.				

OPTIONAL PANEL FASTENER IN LIEU OF ADHESIVE IN LONGITUDINAL JOINTS

FIGURE 3-2 CLOSURES



PANEL FASTENER QTY FOR NON-FLANGED JOINT

DUCT DIMENSION		* PANEL FASTENER QTY	MAX. PRESSURE	
IN.	MM		IN. w.g.	Pa
4-5	100-150	0	2	500
6-11	151-300	1	2	500
12-19	301-500	2	2	500
20-39	501-1000	3	2	500
40-44	1001-1156	4	2	500
46-45	1157-1250	4	1	250
50-60	1251-1500	5	1	250

* PER SIDE; IN ADDITION TO CORNERS

FIGURE 3-3 CLOSURES – NON-FLANGED

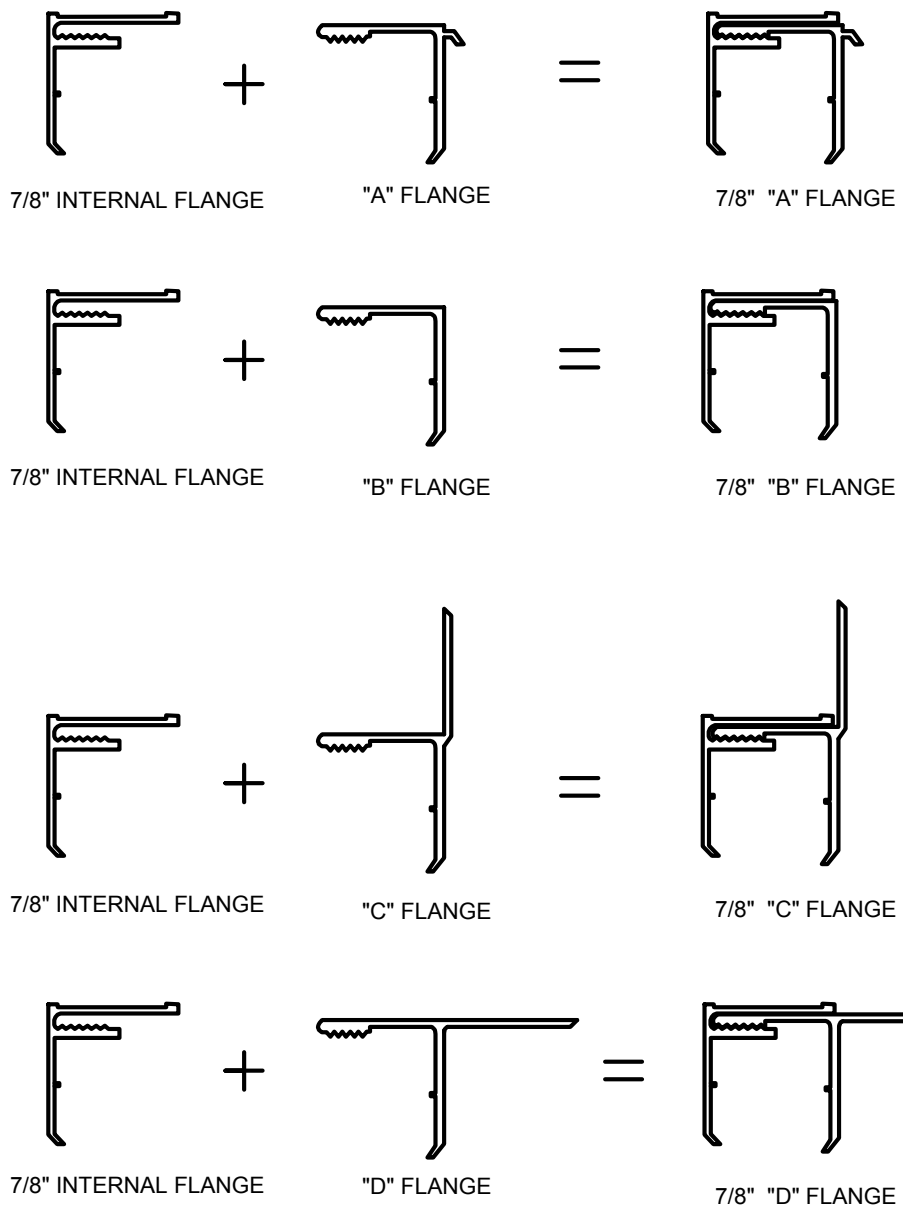


FIGURE 3-4 CLOSURE – FLANGES - 7/8 IN. (22 MM) PANEL

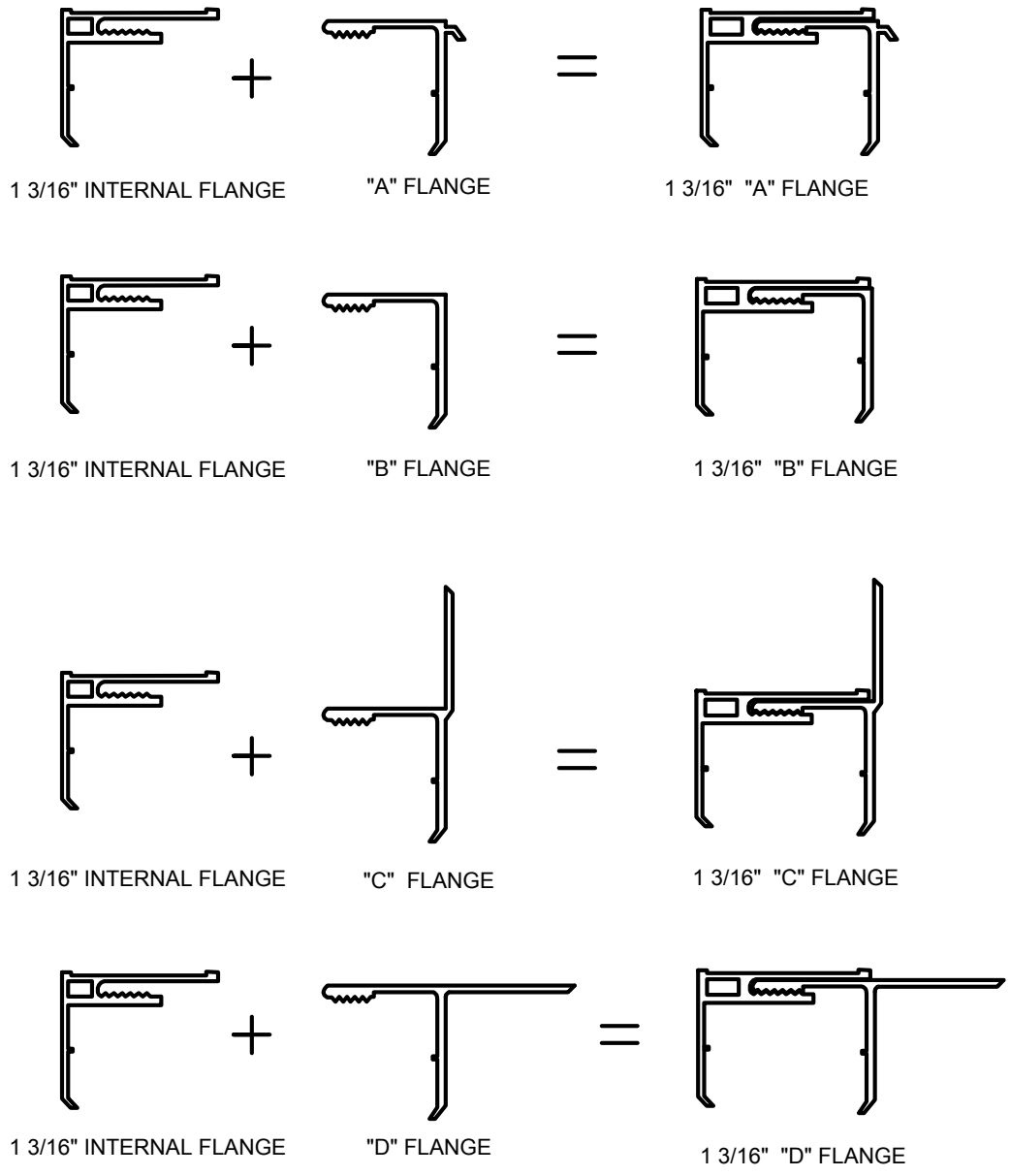
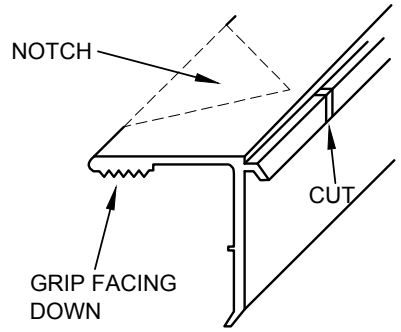
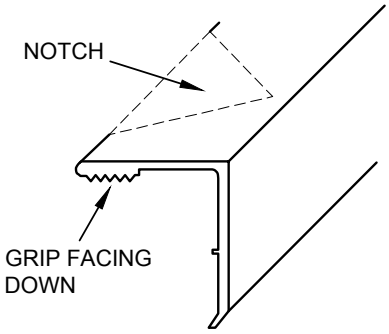


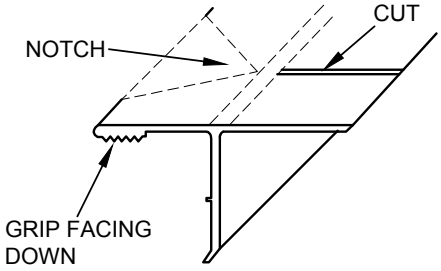
FIGURE 3-5 CLOSURES – FLANGES - 1 3/16 IN. (30 MM) PANEL



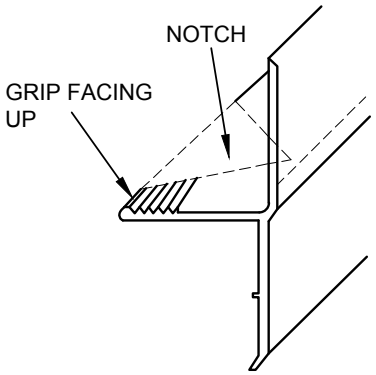
"A" FLANGE



"B" FLANGE

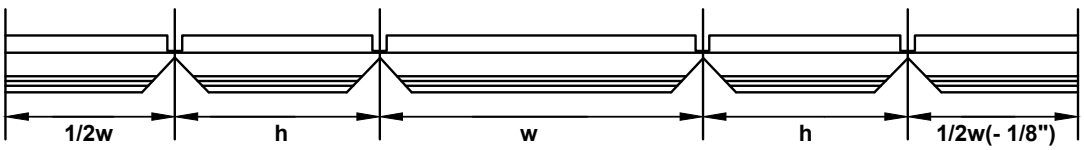


"D" FLANGE



"C" FLANGE

NOTES:
1) APPLICABLE FOR 7/8" (22 mm) AND 1 3/16" (30 mm) FLANGES
2) NOTE THAT ONLY EXTERNAL FLANGES REQUIRE NOTCHING
3) INTERNAL FLANGES - FOR EACH DUCT SEGMENT, 2 INTERNAL FLANGES ARE SQUARE CUT TO A DIMENSION EQUAL TO THE DUCT WIDTH LESS 1/8" (3 mm) AND 2 INTERNAL FLANGES ARE SQUARE CUT TO A DIMENSION EQUAL TO THE DUCT HEIGHT LESS 1/8" (3 mm).
4) ALL INTERNAL (FEMALE) PIECES ARE APPLIED WITH LIGHT PRESSURE UNTIL THE TOTAL FLANGE ASSEMBLY IS FORMED. ONLY WHEN ONE PIECE IS PROPERLY ENGAGED AND CORRECTLY POSITIONED, IT SHOULD BE FORCED INTO THE FINAL LOCKING GRIP USING A RUBBER MALLET.



EXTERNAL FLANGE STRETCH OUT. W AND H DIMENSION ARE DUCT OUTSIDE DIMENSIONS.

FIGURE 3-6 CLOSURES – FLANGES

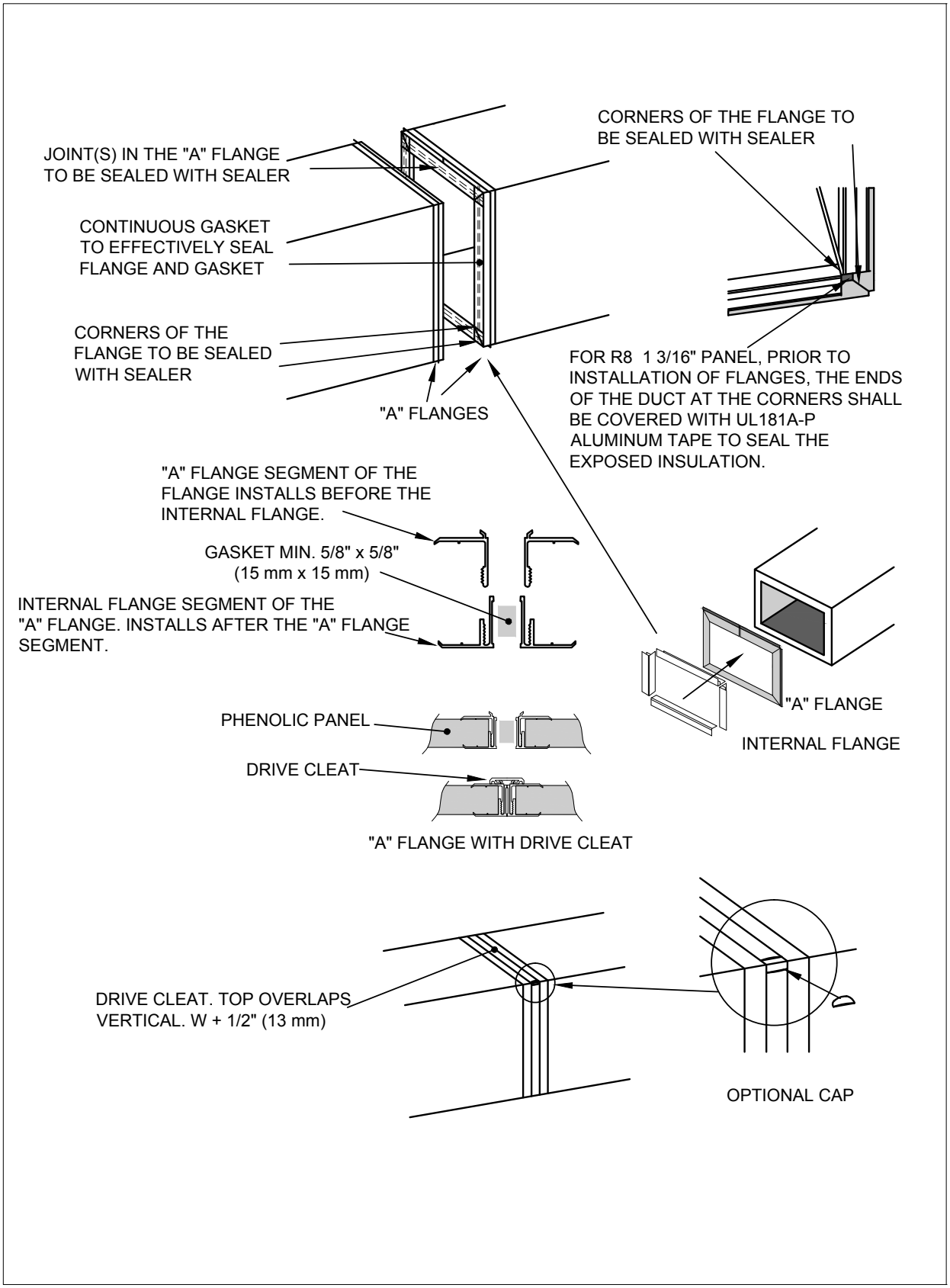


FIGURE 3-7 CLOSURES – "A" FLANGE

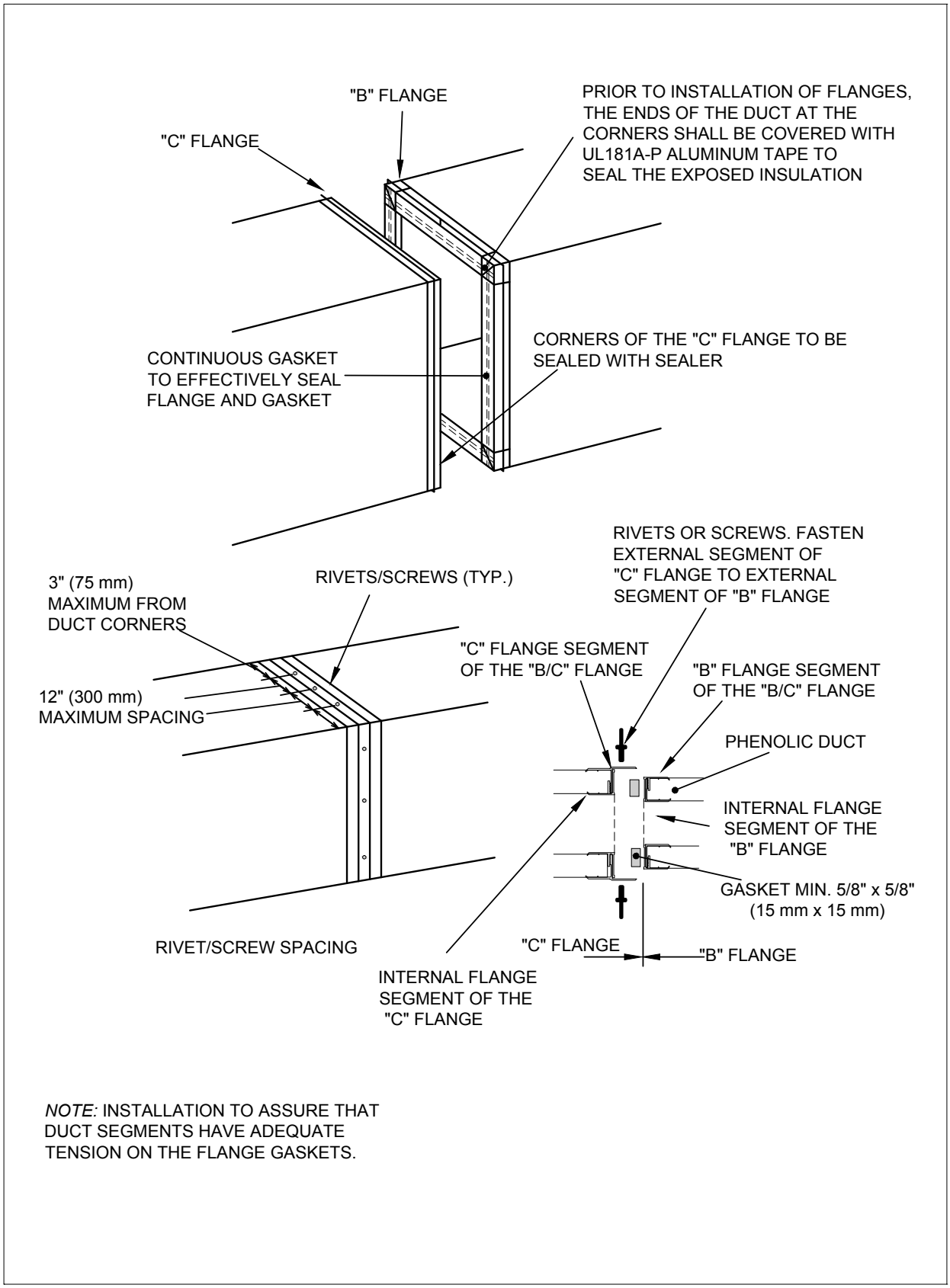


FIGURE 3-8 CLOSURES – OPTIONAL "B/C" FLANGE

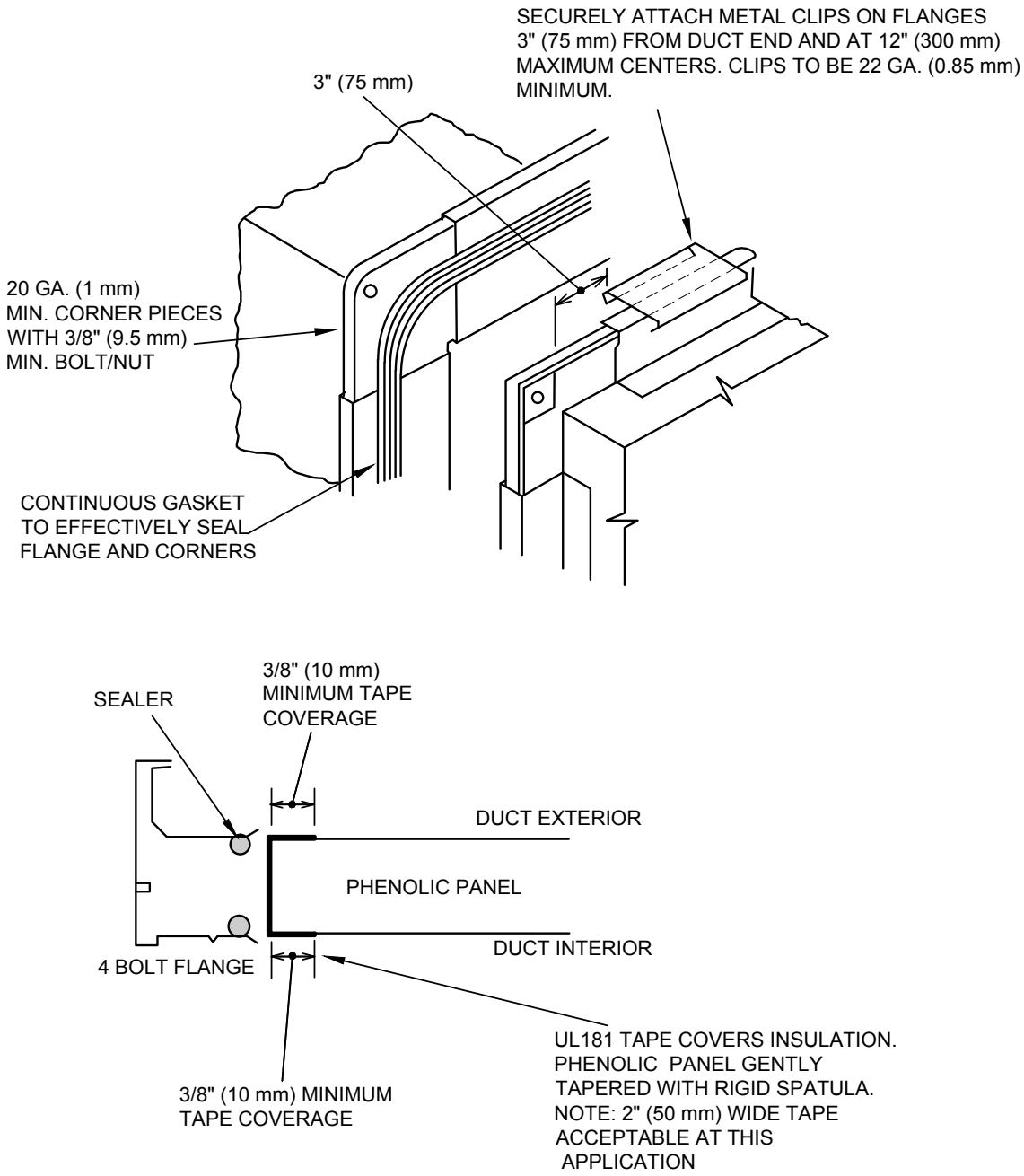
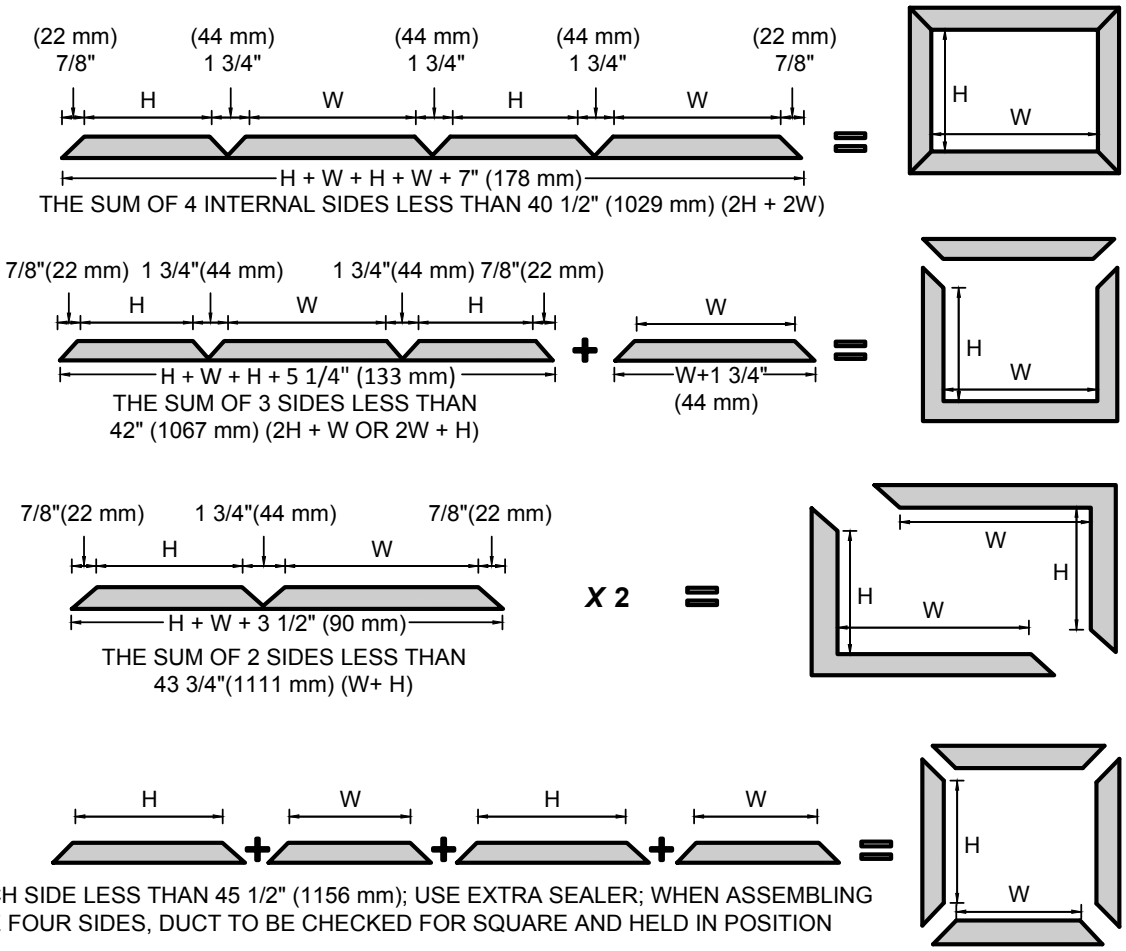


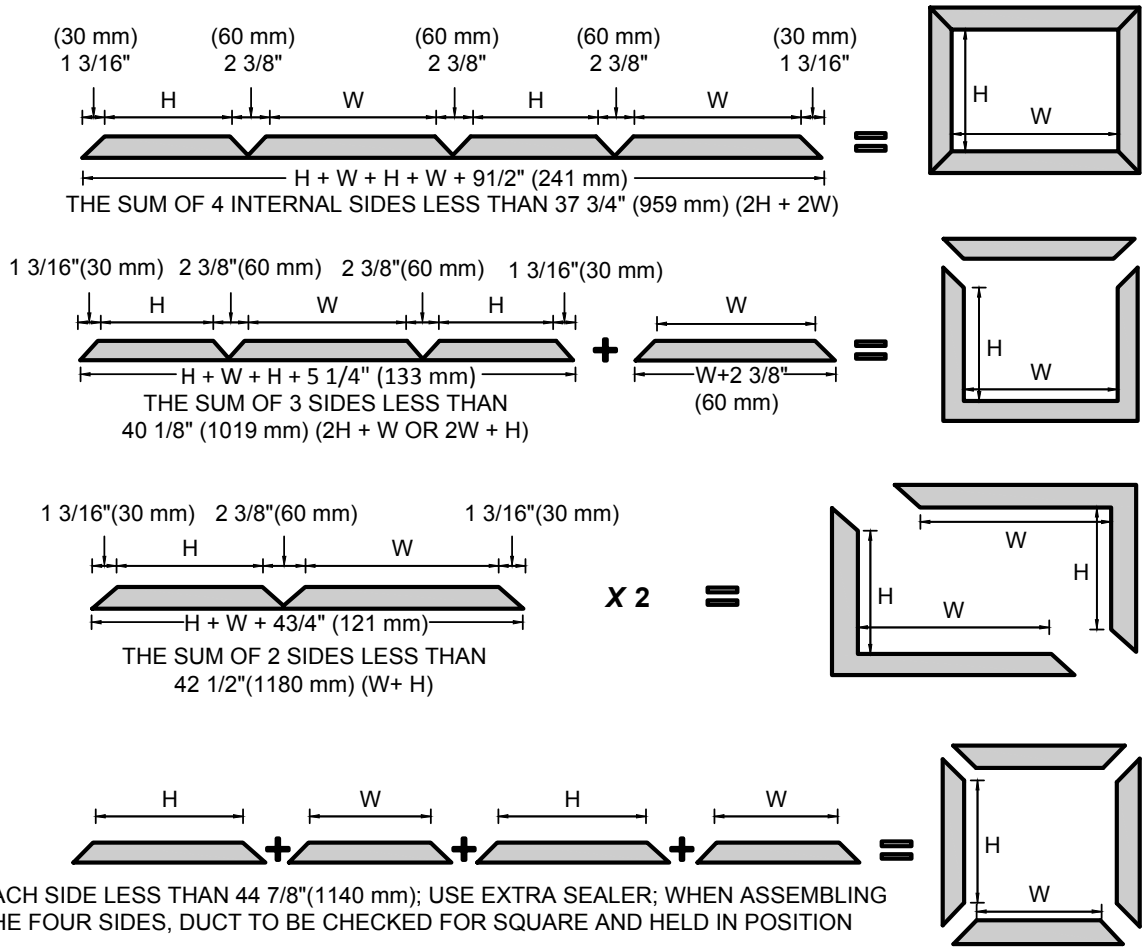
FIGURE 3-9 CLOSURES – 4 BOLT FLANGE



NOTES:

1) CUT CORNERS TO BE 90° V GROOVES OR 45° MITERS. ASSEMBLY OF CORNERS WITH SHIPLAP JOINTS IS NOT PERMITTED.
2) 3" (76 mm) WIDE UL 181A-P ALUMINUM TAPE AT ALL LONGITUDINAL SEAMS. TAPE MUST BE ESSENTIALLY FREE OF WRINKLES, UNIFORMLY ADHERED AND PRESSED SUFFICIENTLY TO SHOW DUCT FACING REINFORCEMENT IMPRESSIONS IN THE TAPE.
3) 1 1/2" (38 mm) TAPE COVERAGE AT EACH CONTACT SURFACE.
4) WHEN APPLYING ADHESIVE, WAIT UNTIL DRY TO TOUCH BEFORE FOLDING EDGES INTO CONTACT WITH EACH OTHER. USE STIFF SPATULA.
5) CONTINUOUS BEAD OF SEALER APPLIED IN ALL FOUR INTERIOR CORNERS EXTENDING FOR FULL LENGTH OF DUCT. BEAD SPREAD INTO CORNER FOR FULL ADHESION AND RADIUS FINISH.

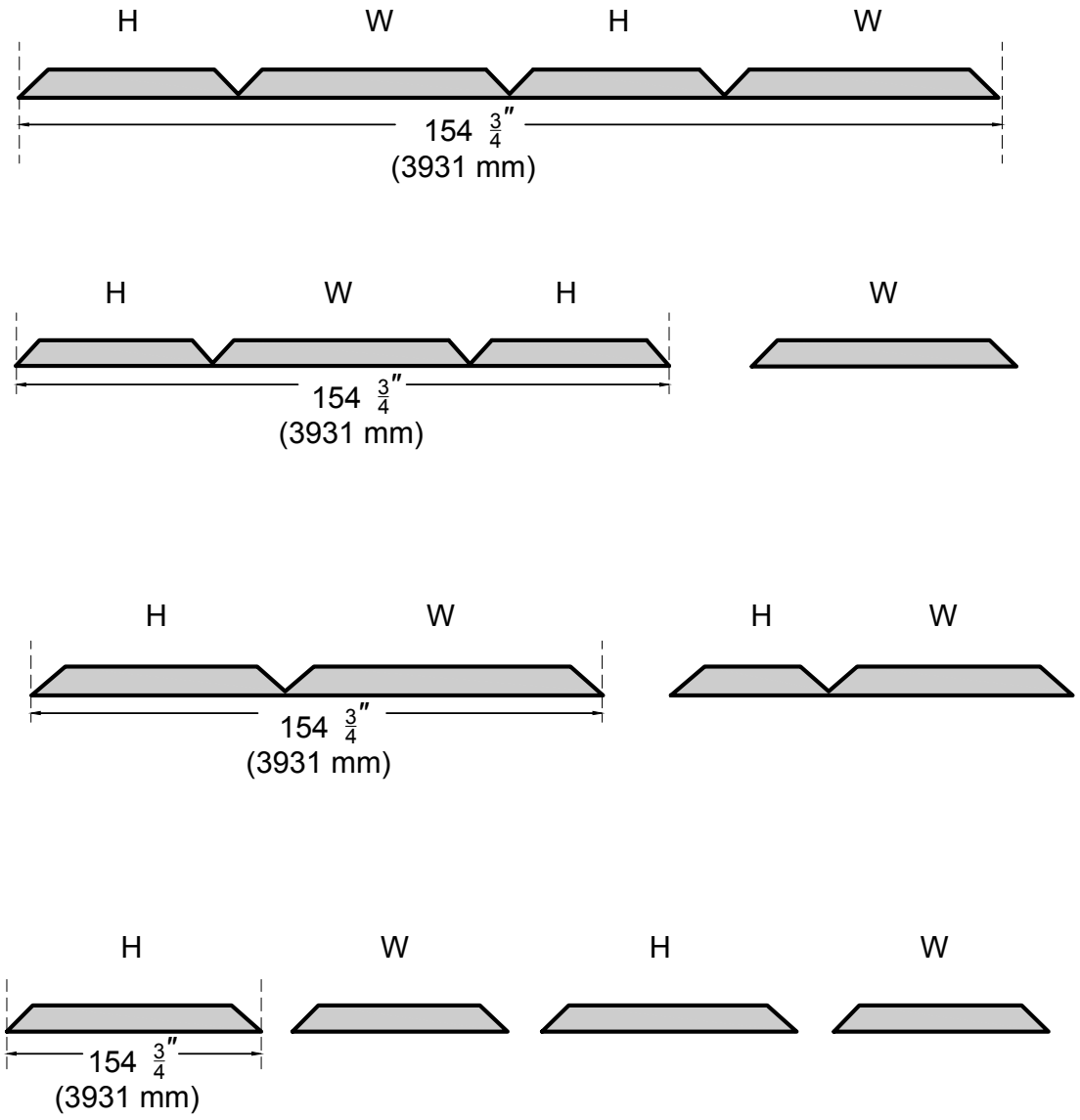
FIGURE 3-10 CLOSURES – 7/8 IN. (22 MM) PANEL



NOTES:

1) CUT CORNERS TO BE 90° V GROOVES OR 45° MITERS. ASSEMBLY OF CORNERS WITH SHIPLAP JOINTS IS NOT PERMITTED.
2) 3" (76 mm) WIDE UL 181A-P ALUMINUM TAPE AT ALL LONGITUDINAL SEAMS. TAPE MUST BE ESSENTIALLY FREE OF WRINKLES, UNIFORMLY ADHERED AND PRESSED SUFFICIENTLY TO SHOW DUCT FACING REINFORCEMENT IMPRESSIONS IN THE TAPE.
3) 1 1/2" (38 mm) TAPE COVERAGE AT EACH CONTACT SURFACE.
4) WHEN APPLYING ADHESIVE, WAIT UNTIL DRY TO TOUCH BEFORE FOLDING EDGES INTO CONTACT WITH EACH OTHER. USE STIFF SPATULA.
5) CONTINUOUS BEAD OF SEALER APPLIED IN ALL FOUR INTERIOR CORNERS EXTENDING FOR FULL LENGTH OF DUCT. BEAD SPREAD INTO CORNER FOR FULL ADHESION AND RADIUS FINISH.

FIGURE 3-11 CLOSURES – 1 3/16 IN. (30 MM) PANEL



NOTES:
1) CUTTING PARALLEL TO THE 47 1/4" (1200 mm) SIDE
2) DUCT LENGTH LIMITED TO 47 1/4" (1200 mm)

FIGURE 3-12 CLOSURES – DUCT WIDTH OR HEIGHT OVER 47 1/4 IN. (1200 MM)

LONGITUDINAL SEAMS / LONGITUDINAL CORNERS	FIGURE No.	Duct Dimension	Application Notes	in. w.g. / Pa Static				
				Positive or Negative				Pos. Only
				.50	1	2	3	4
				125	250	500	750	1000
Adhesive In longitudinal Seams and longitudinal Corners.	3-1	80 in. (2000 mm) and Under		X	X	X	X	X
Optional Panel Fasteners In Lieu Of Adhesive In longitudinal Seams And longitudinal Corners.	3-2	80 in. (2000 mm) and Under	Panel Fasteners On longitudinal Seams And longitudinal Corners. Panel Fastener Spacing 20” (500 mm)	X	X	X	Not Permitted	
Optional Panel Fasteners In Lieu Of Adhesive In longitudinal Seams And longitudinal Corners.	3-2	80 in. (2000 mm) and Under	Panel Fasteners On Longitudinal Seams And Longitudinal Corners. Panel Fastener Spacing 10” (250 mm)	X	X	X	X	X

LEGEND:

X

Permitted

Note: For duct over 80 in. (2000 mm), consult with the phenolic panel manufacturer.

Table 3-1 Longitudinal Seam And Longitudinal Corner Pressure Table

TRANSVERSE JOINTS	FIGURE No.	Duct Dimension	Application Notes	in. w.g. / Pa Static				
				Positive or Negative				Pos. Only
				.50	1	2	3	4
				125	250	500	750	1000
Non-Flanged Closure	3-3	60 in. (1500 mm) and Under	NA	X	X	Not Permitted		
Non-Flanged Closure	3-3	44 in. (1100 mm) and Under	NA	X	X	X		
"A" Flange	3-7	80 in. (2000 mm) and Under	NA	X	X	X	X	X
Optional "B/C" Flange	3-8	80 in. (2000 mm) and Under	NA	X	X	X	X	X
4 Bolt Flange	3-9	80 in. (2000 mm) and Under	NA	X	X	X	X	X

LEGEND:

X	Permitted

Note: For duct over 80 in. (2000 mm), consult with the phenolic panel manufacturer.

Table 3-2 Transverse Joint Pressure Table

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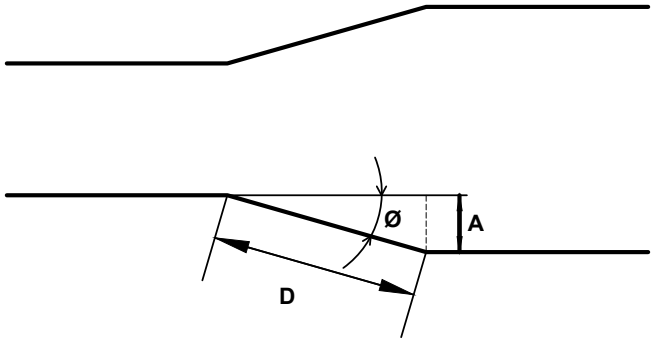
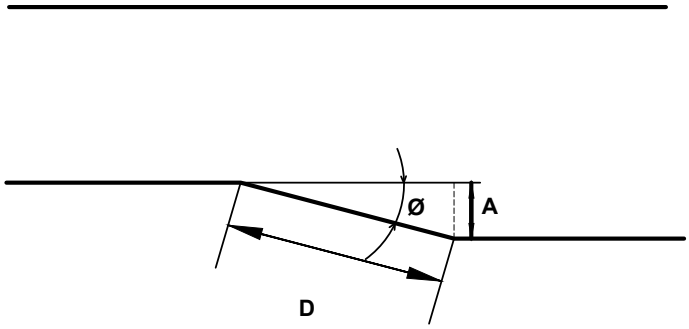
CHAPTER 4

FITTINGS AND CONNECTIONS



CONCENTRIC TRANSITION
Ø MAX . 22.5 ° (D MIN. =2.5 *X* A)



ECCENTRIC TRANSITION
Ø MAX. 22.5 ° (D MIN. =2.5 *X* A)

SPLITTERS ARE REQUIRED FOR ANGLES GREATER THAN 22.5 DEGREES

FIGURE 4-1 TRANSITIONS

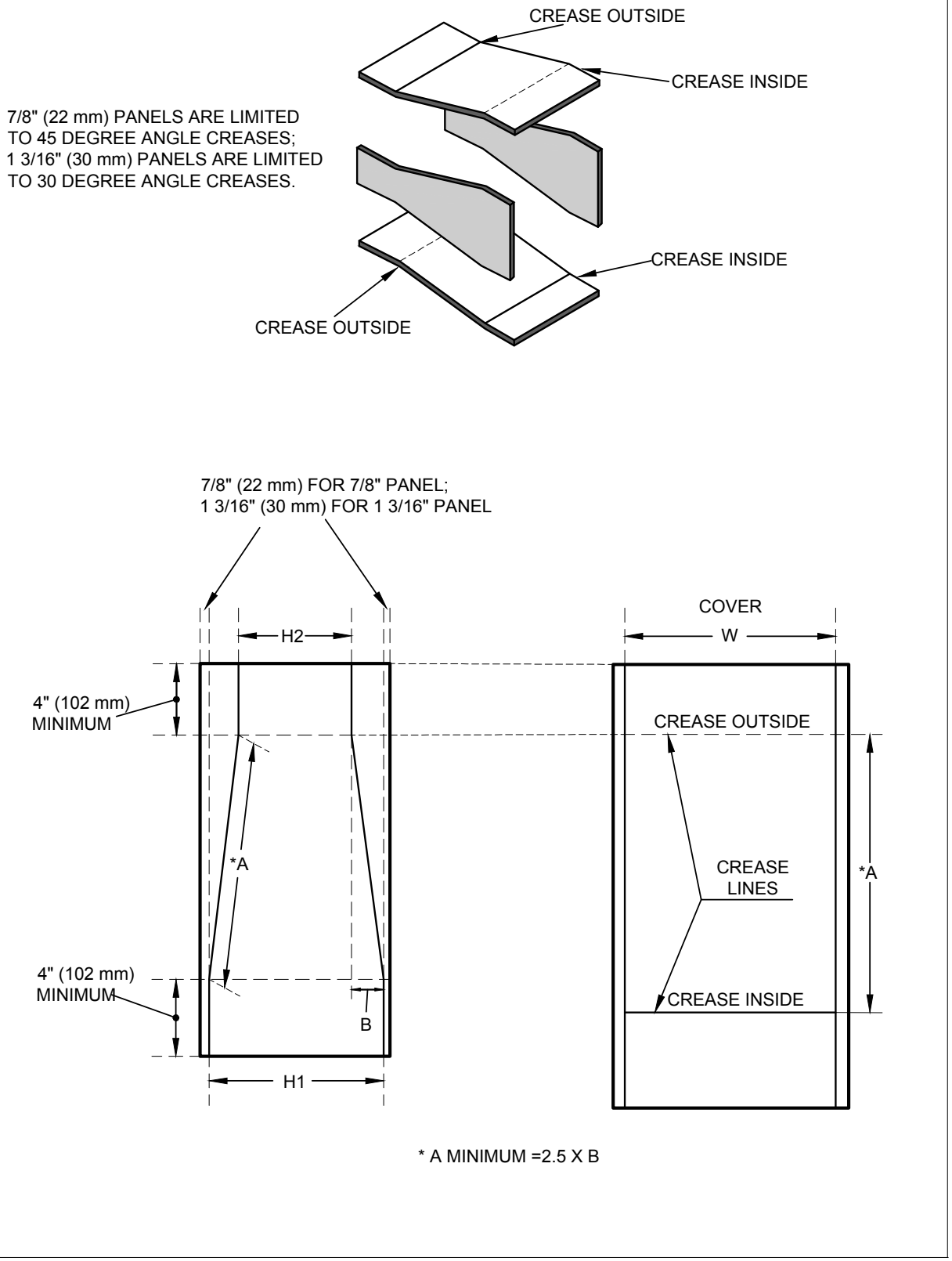


FIGURE 4-2 CONCENTRIC REDUCER

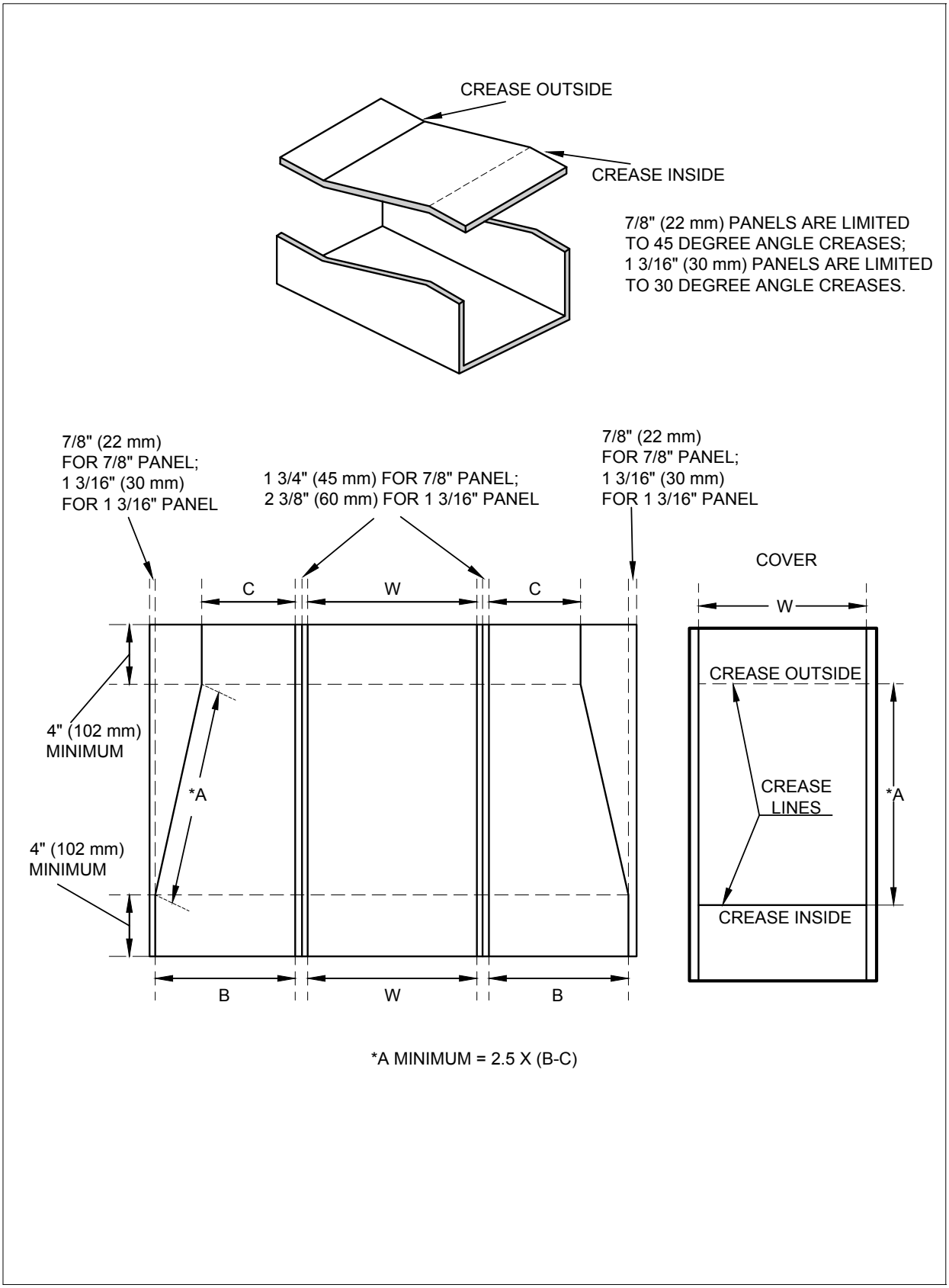
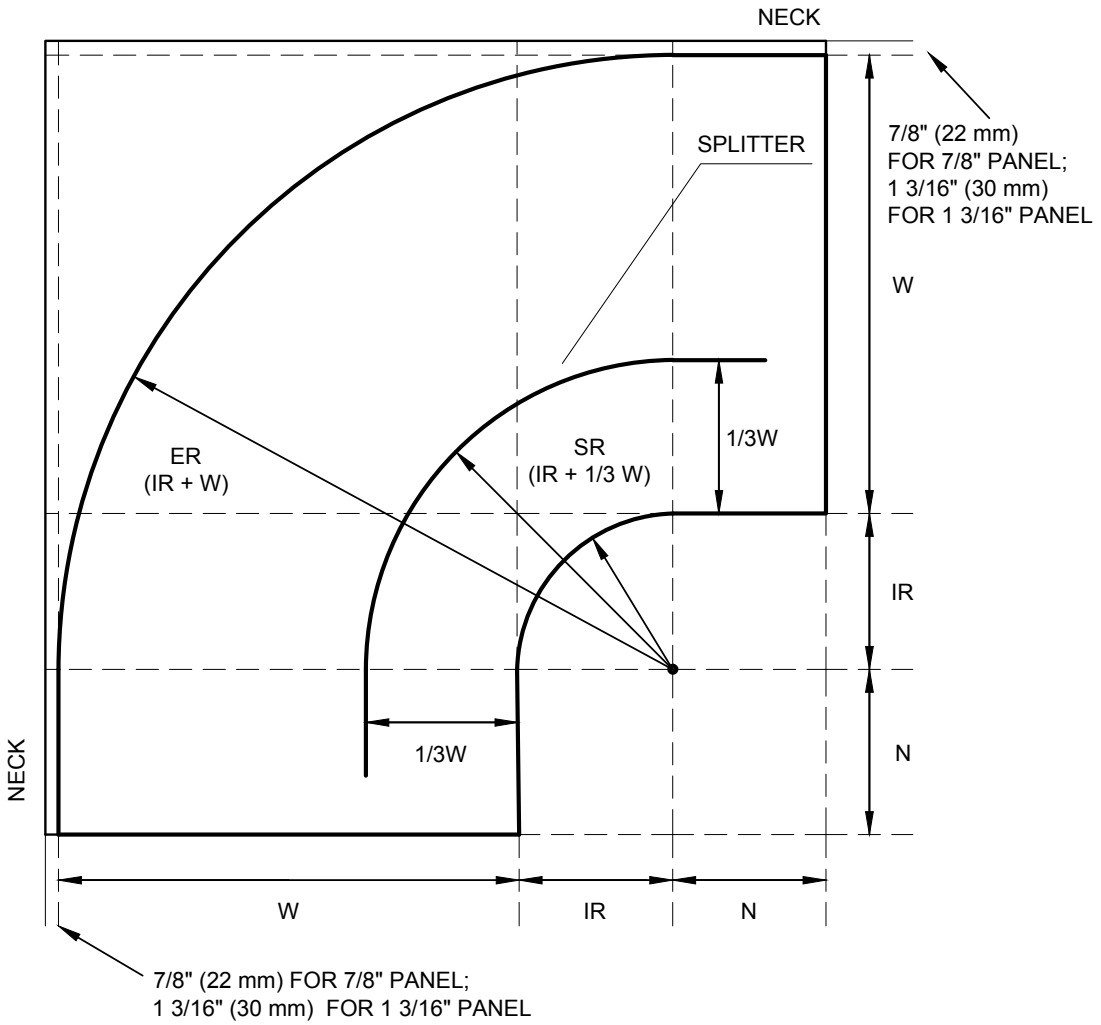


FIGURE 4-3 ECCENTRIC REDUCER



LEGEND
N = NECK
ER = EXTERNAL RADIUS
IR = INTERNAL RADIUS
SR = SPLITTER RADIUS

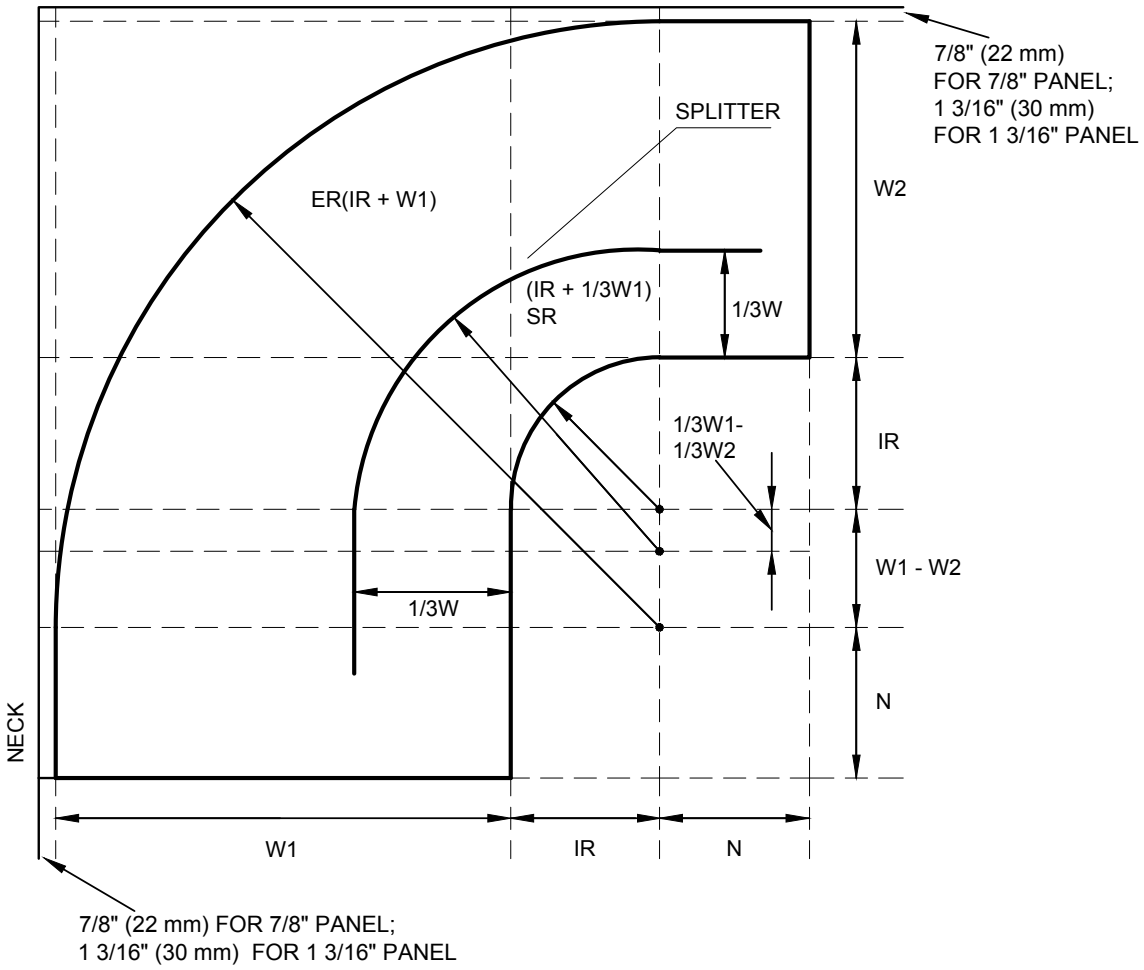
NOTES:
1) MIN. BEND RADIUS: 8" (203 mm)
2) MIN. NECK: 4" (102 mm)
3) CRIMP RADIUS PANELS: THROAT 3"(76 mm) MIN.; HEEL 4" (102 mm) MIN. REFERENCE FIGURE 4-6
4) SPLITTER VANE POSITION MEASURED FROM THE FITTING THROAT AT THE DUCT INTERIOR

SPLITTER VANES

DUCT WIDTH IN.	DUCT WIDTH MM	SPLITTER VANE(S) REQUIRED	SPLITTER VANE(S) POSITION
0 - 20	0 - 508	0	NA
> 20 - 32	> 508 - 813	1	W/3
> 32 - 64	> 813 - 1626	2	W/4, W/2
> 64	> 1626	3	W/8, W/3, W/2

1) SPLITTER VANES NOT REQUIRED IN ANGLES LESS THAN 45 DEGREES
2) OPTION - REFER TO SMACNA *HVAC DUCT CONSTRUCTION STANDARDS* FOR VANE QUANTITY SELECTION

FIGURE 4-4 ELBOW - SYMMETRIC



LEGEND
N = NECK
ER = EXTERNAL RADIUS
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SR = SPLITTER RADIUS

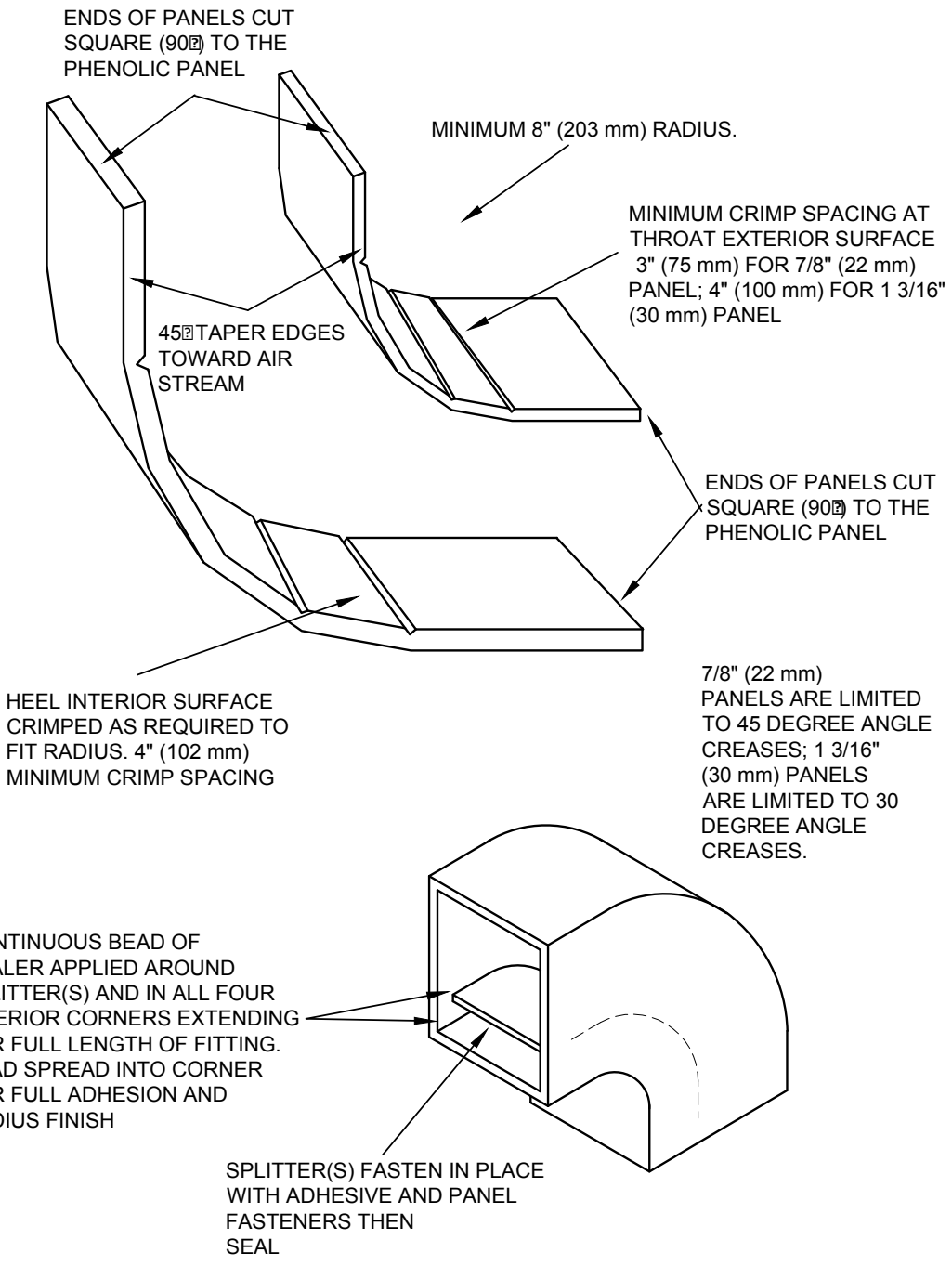
NOTES:
1) MIN. BEND RADIUS: 8" (203 mm)
2) MIN. NECK: 4" (102 mm)
3) CRIMP RADIUS PANELS: THROAT 3" (76 mm) MIN.; HEEL 4" (102 mm) MIN. REFERENCE FIGURE 4-6
4) SPLITTER VANE POSITION MEASURED FROM THE FITTING THROAT AT THE DUCT INTERIOR

SPLITTER VANES

DUCT WIDTH IN.	DUCT WIDTH MM	SPLITTER VANE(S) REQUIRED	SPLITTER VANE(S) POSITION
0 - 20	0 - 508	0	NA
> 20 - 32	> 508 - 813	1	W/3
> 32 - 64	> 813 - 1626	2	W/4, W/2
> 64	> 1626	3	W/8, W/3, W/2

1) SPLITTER VANES NOT REQUIRED IN ANGLES LESS THAN 45 DEGREES
2) OPTION - REFER TO SMACNA *HVAC DUCT CONSTRUCTION STANDARDS* FOR VANE QUANTITY SELECTION

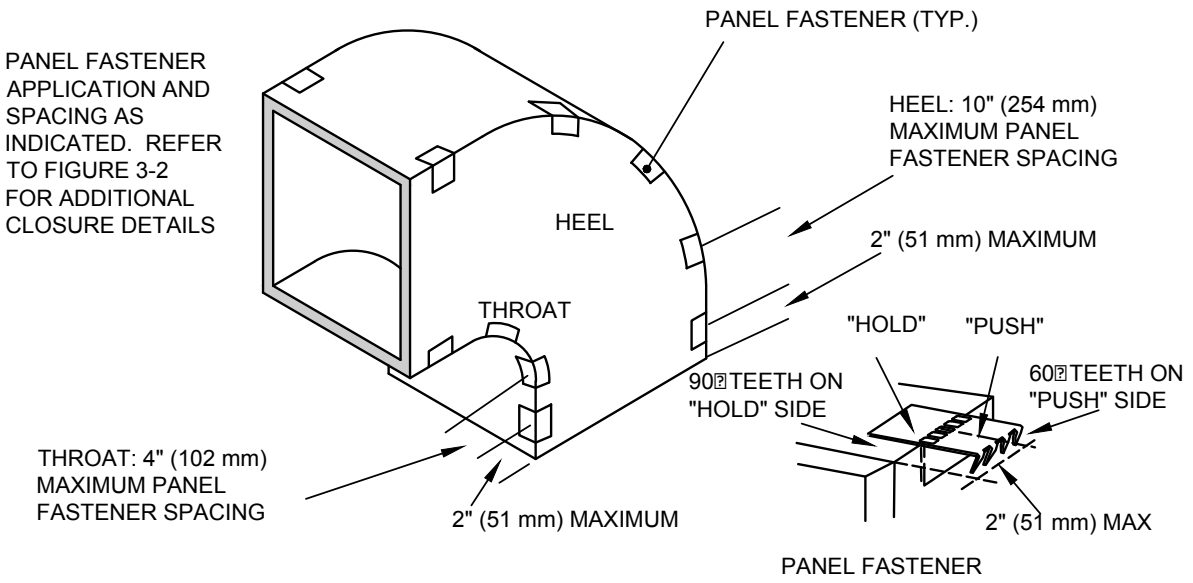
FIGURE 4-5 ELBOW - ASYMMETRIC



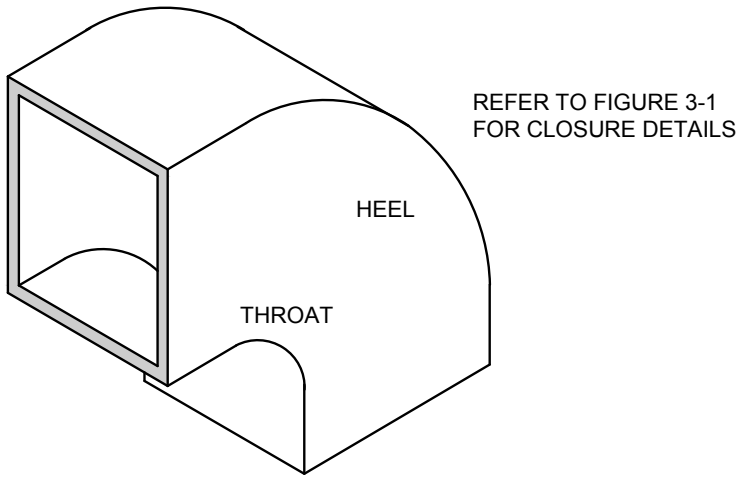
NOTES:

1) FOR SPLITTERS CONSTRUCTED OF PHENOLIC PANELS: A) PANEL FASTENERS PROVIDED ON BOTH CHEEK SIDES OF THE SPLITTER; B) PANEL FASTENERS PROVIDED ON THE FITTING CHEEK SIDES MAXIMUM 2" FROM SPLITTER VANE LEADING EDGE AND TRAILING EDGE AND MAXIMUM 10" SPACING BETWEEN PANEL FASTENERS; C) MINIMUM 3 PANEL FASTENERS PER CHEEK SIDE OF SPLITTER.
2) SPLITTERS CONSTRUCTED OF SHEET METAL TO CONFORM WITH HVAC DCS EXCEPT AS ALTERED FOR INCORPORATION IN PHENOLIC DUCT.

FIGURE 4-6 ELBOW - SYMMETRIC - ASYMMETRIC

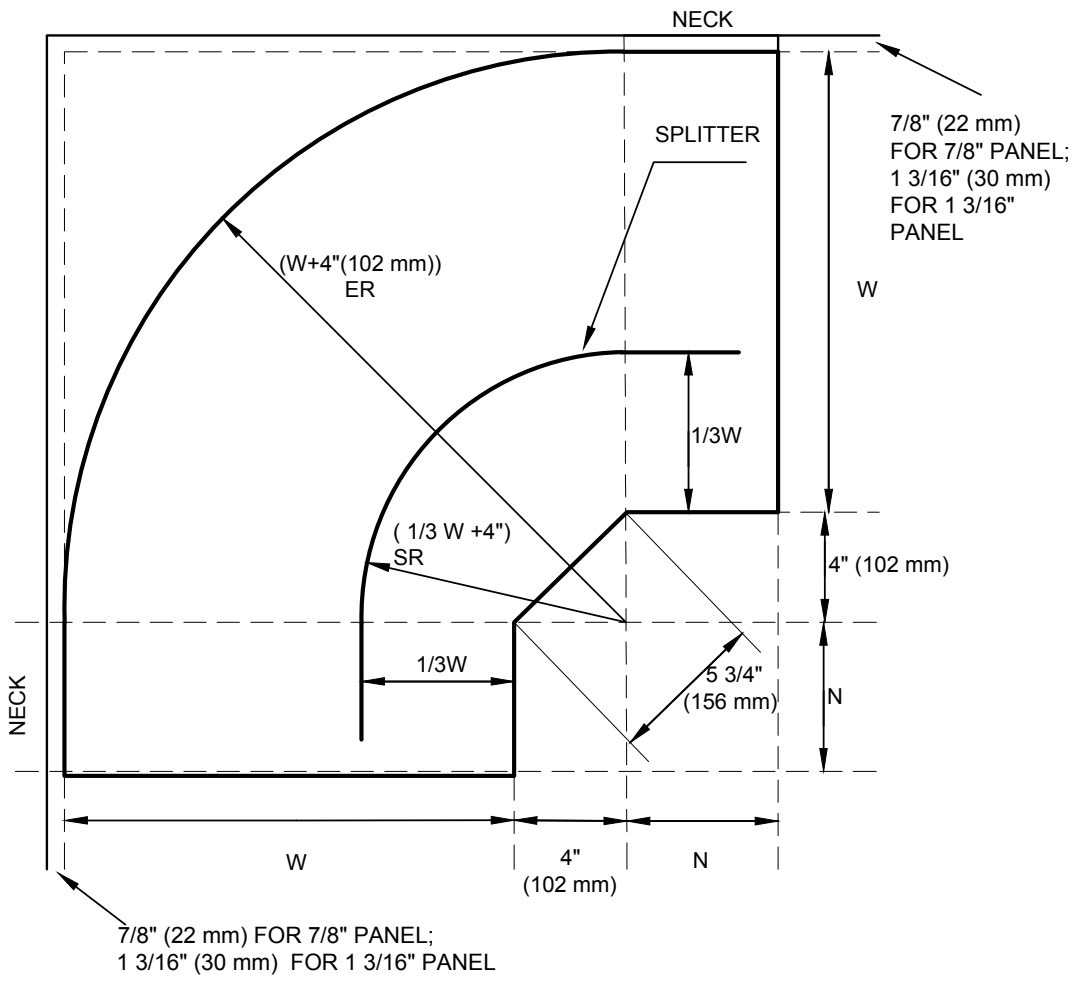


RADIUS FITTING OPTIONAL PANEL FASTENER. REFERENCE TABLE 4-3



RADIUS FITTING ADHESIVE IN LONGITUDINAL SEAMS/CORNERS. REFERENCE TABLE 4-3

FIGURE 4-7 ELBOW CLOSURE SPACING



LEGEND
N = NECK
ER = EXTERNAL RADIUS
IR = INTERNAL RADIUS
SR = SPLITTER RADIUS

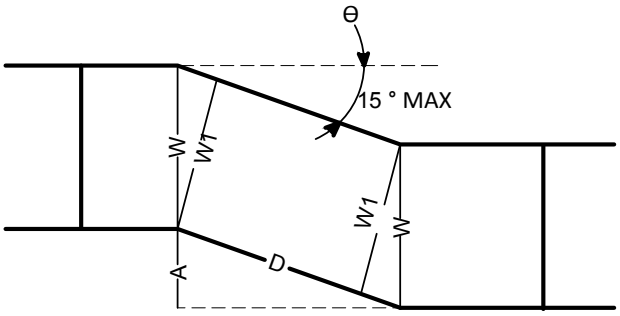
NOTES:
1) MIN. BEND RADIUS: 8" (203 mm)
2) MIN. NECK: 4" (102 mm)
3) CRIMP RADIUS PANELS: THROAT 3" (76 mm) MIN.; HEEL 4" (102 mm) MIN. REFERENCE FIGURE 4-6
4) SPLITTER VANE POSITION MEASURED FROM THE FITTING THROAT AT THE DUCT INTERIOR

SPLITTER VANES

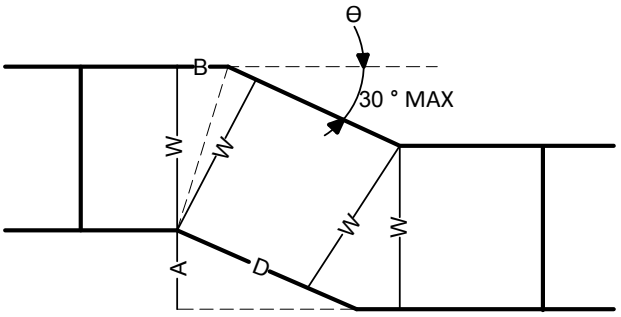
DUCT WIDTH IN.	DUCT WIDTH MM	SPLITTER VANE(S) REQUIRED	SPLITTER VANE(S) POSITION
0 - 20	0 - 508	0	NA
> 20 - 32	> 508 - 813	1	W/3
> 32 - 64	> 813 - 1626	2	W/4, W/2
> 64	> 1626	3	W/8, W/3, W/2

1) SPLITTER VANES NOT REQUIRED IN ANGLES LESS THAN 45 DEGREES
2) OPTION - REFER TO SMACNA *HVAC DUCT CONSTRUCTION STANDARDS* FOR VANE QUANTITY SELECTION

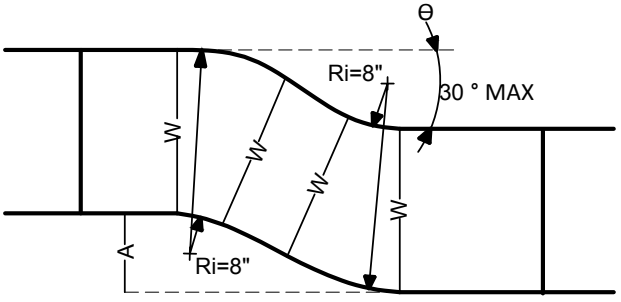
FIGURE 4-8 ELBOW 45 DEGREE THROAT - RADIUS HEEL - OPTIONAL DESIGN



ANGLED OFFSET
Θ MAX. 15 ° (D ≥ 4 x A)

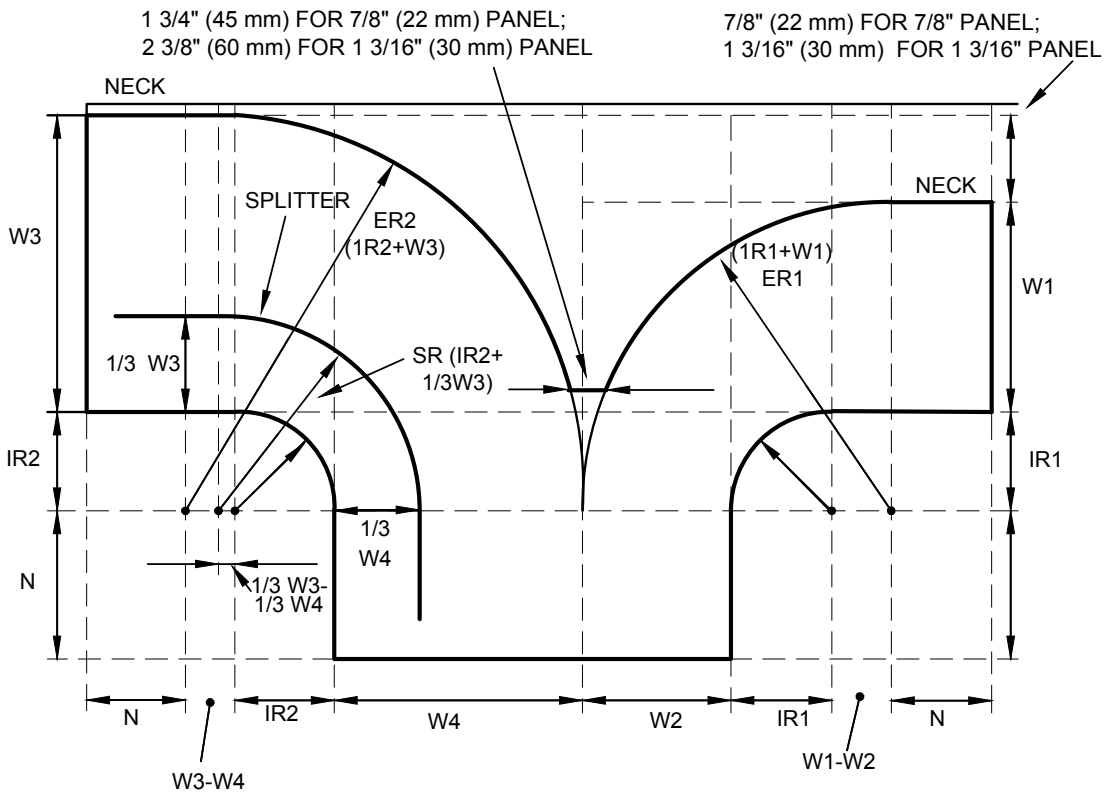


MITERED OFFSET
Θ MAX. 30 ° (D ≥ 2 x A)
(B=0.27 x W)



RADIUS OFFSET
Θ MAX. 30 °
(8" RADIUS MINIMUM)

FIGURE 4-9 OFFSETS



LEGEND
N = NECK
ER = EXTERNAL RADIUS
IR = INTERNAL RADIUS
SR = SPLITTER RADIUS

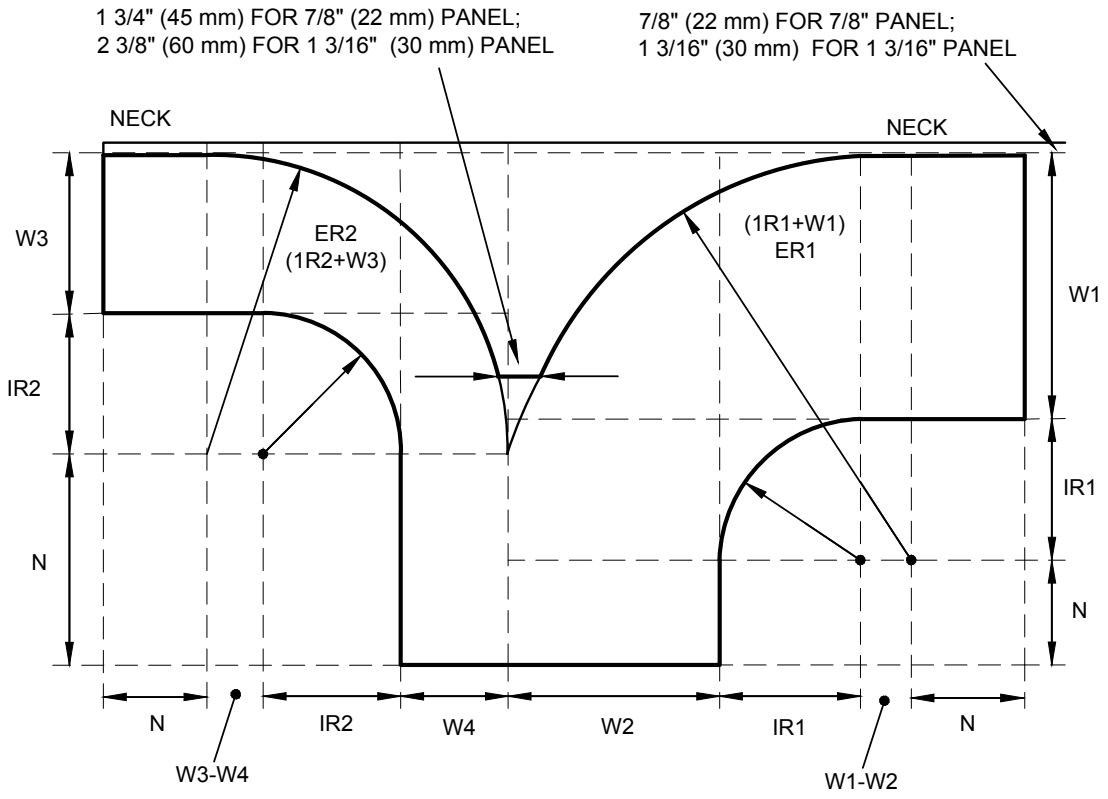
NOTES:
1) MIN. BEND RADIUS: 8" (203 mm)
2) MIN. NECK: 4" (102 mm)
3) CRIMP RADIUS PANELS: THROAT 3" (76 mm) MIN.; HEEL 4" (102 mm) MIN. REFERENCE FIGURE 4-6
4) SPLITTER VANE POSITION MEASURED FROM THE FITTING THROAT AT THE DUCT INTERIOR

SPLITTER VANES

DUCT WIDTH IN.	DUCT WIDTH MM	SPLITTER VANE(S) REQUIRED	SPLITTER VANE(S) POSITION
0 - 20	0 - 508	0	NA
> 20 - 32	> 508 - 813	1	W/3
> 32 - 64	> 813 - 1626	2	W/4, W/2
> 64	> 1626	3	W/8, W/3, W/2

1) SPLITTER VANES NOT REQUIRED IN ANGLES LESS THAN 45 DEGREES
2) OPTION - REFER TO SMACNA *HVAC DUCT CONSTRUCTION STANDARDS* FOR VANE QUANTITY SELECTION

FIGURE 4-10 TEE BRANCH (THROAT SIDES FLUSHED)



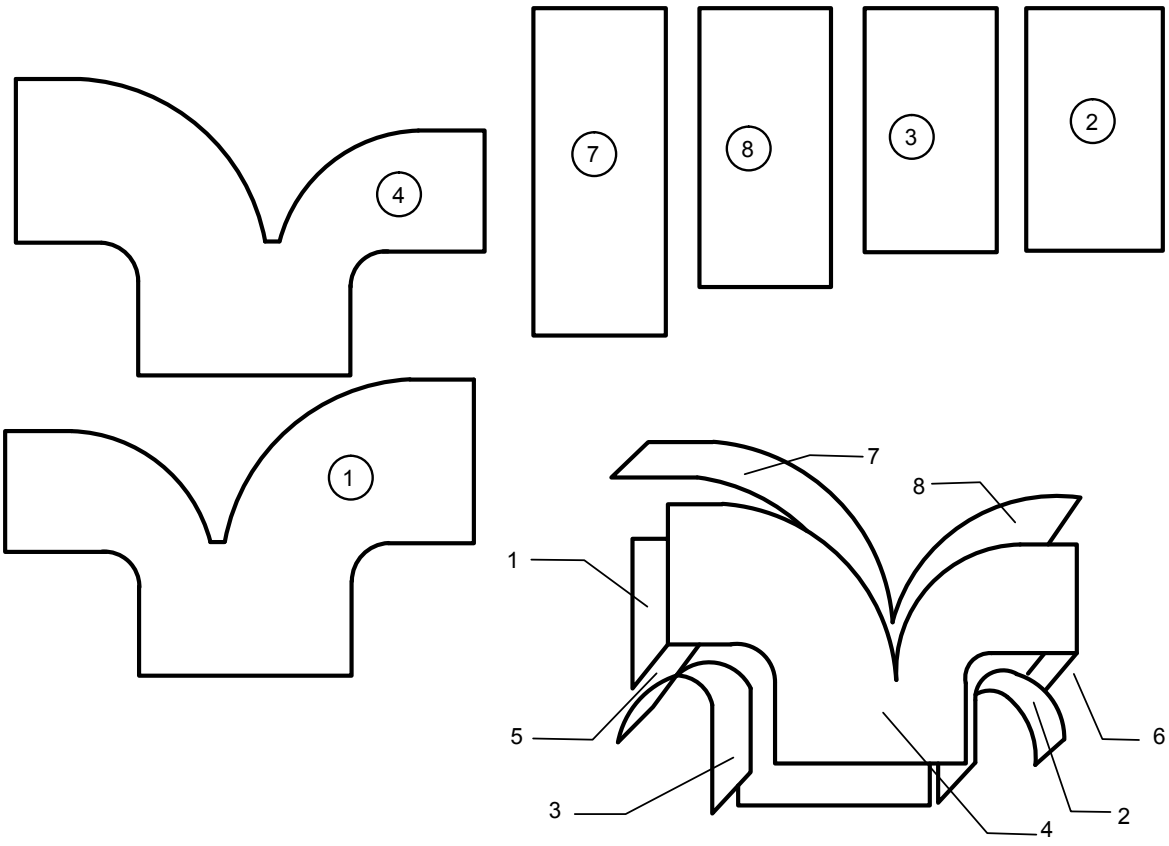
SPLITTER VANES			
DUCT WIDTH IN.	DUCT WIDTH MM	SPLITTER VANE(S) REQUIRED	SPLITTER VANE(S) POSITION
0 - 20	0 - 508	0	NA
> 20 - 32	> 508 - 813	1	W/3
> 32 - 64	> 813 - 1626	2	W/4, W/2
> 64	> 1626	3	W/8, W/3, W/2

1) SPLITTER VANES NOT REQUIRED IN ANGLES LESS THAN 45 DEGREES
2) OPTION - REFER TO SMACNA *HVAC DUCT CONSTRUCTION STANDARDS* FOR VANE QUANTITY SELECTION

LEGEND
N = NECK
ER = EXTERNAL RADIUS
IR = INTERNAL RADIUS
SR = SPLITTER RADIUS

NOTES:
1) MIN. BEND RADIUS: 8" (203 mm)
2) MIN. NECK: 4" (102 mm)
3) CRIMP RADIUS PANELS: THROAT 3" (76mm) MIN.; HEEL 4" (102 mm) MIN. REFERENCE FIGURE 4-6
4) SPLITTER VANE POSITION MEASURED FROM THE FITTING THROAT AT THE DUCT INTERIOR

FIGURE 4-11 TEE BRANCH (HEEL SIDES FLUSHED)



1) PLACE SECTION 1 ON TABLE
2) JOIN SECTION 2 AND 3 ONLY THE NECK SECTION
3) ADD HOLDER PLACES (SCRAPS) 5 AND 6 WITH TAPE ONLY AND NO ADHESIVE
4) INSTALL BIGGER CIRCUMFERENCE SECTION WITH COVER 7
5) INSTALL SECTION 8
6) REMOVE SECTION 5 AND ADHESIVE SECTION 3
7) REMOVE SECTION 6 AND ADHESIVE SECTION 2

FIGURE 4-12 TEE BRANCH ASSEMBLY

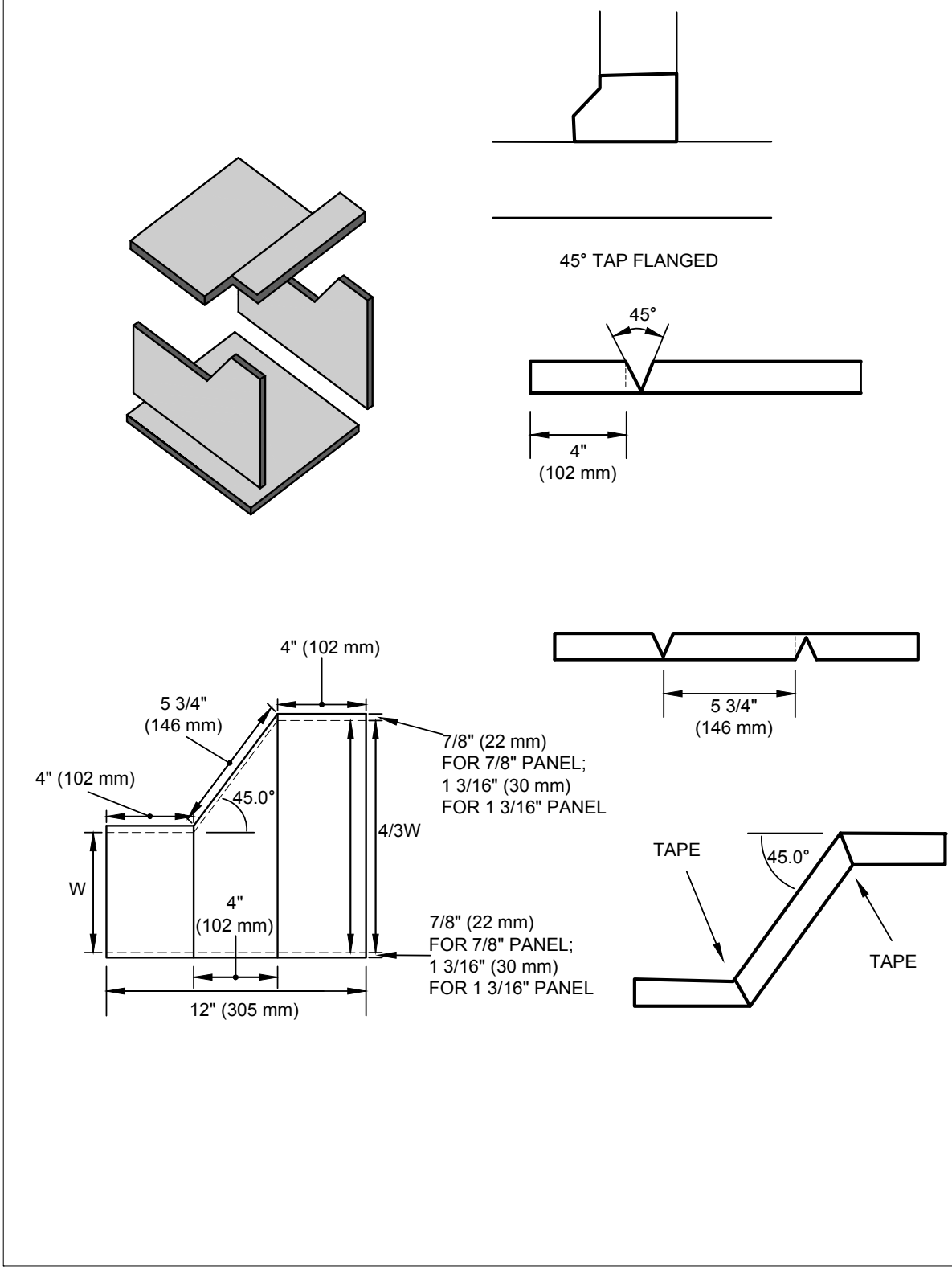


FIGURE 4-13 BRANCH CONNECTION - 45 DEGREE TAP - FLANGED

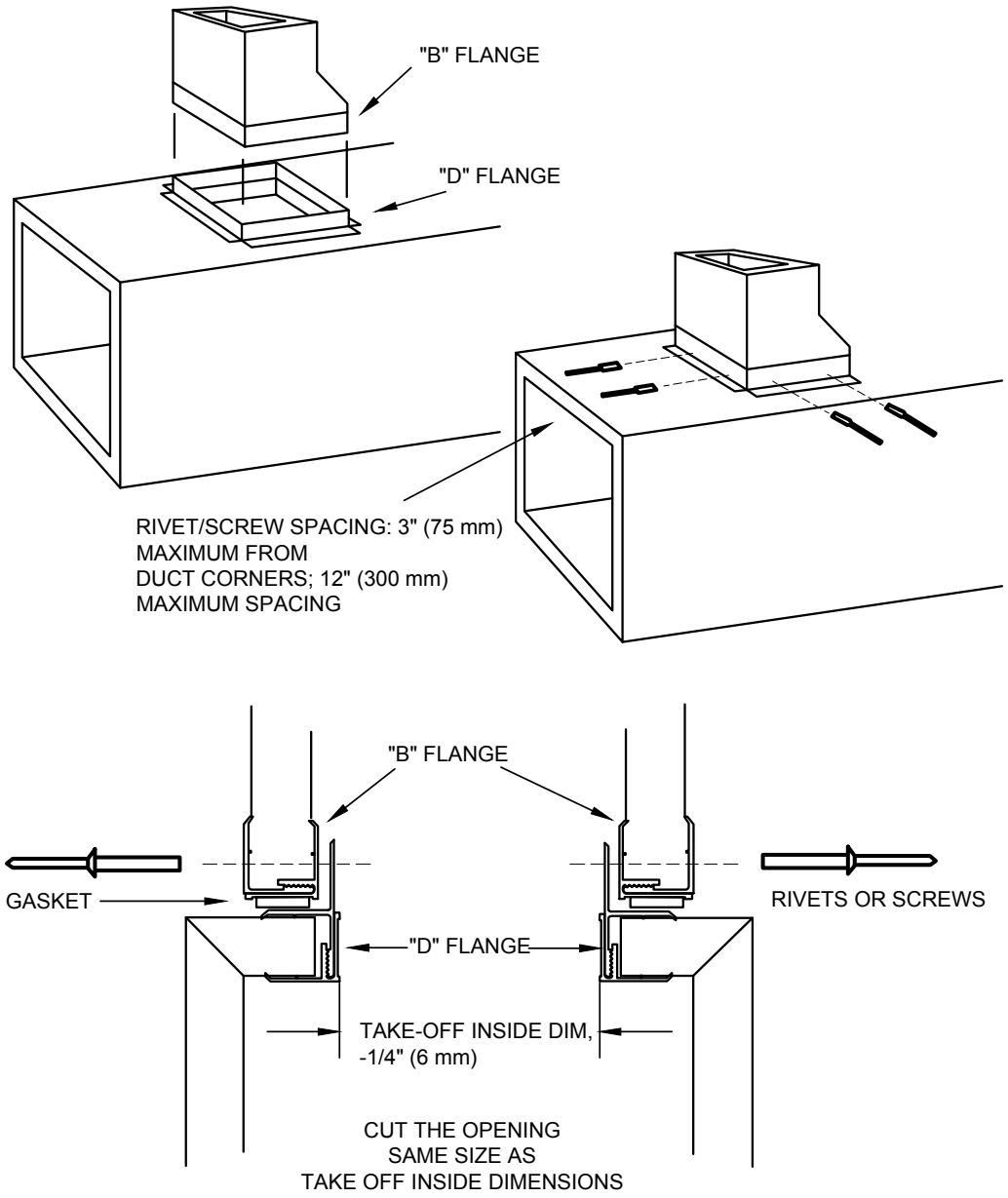
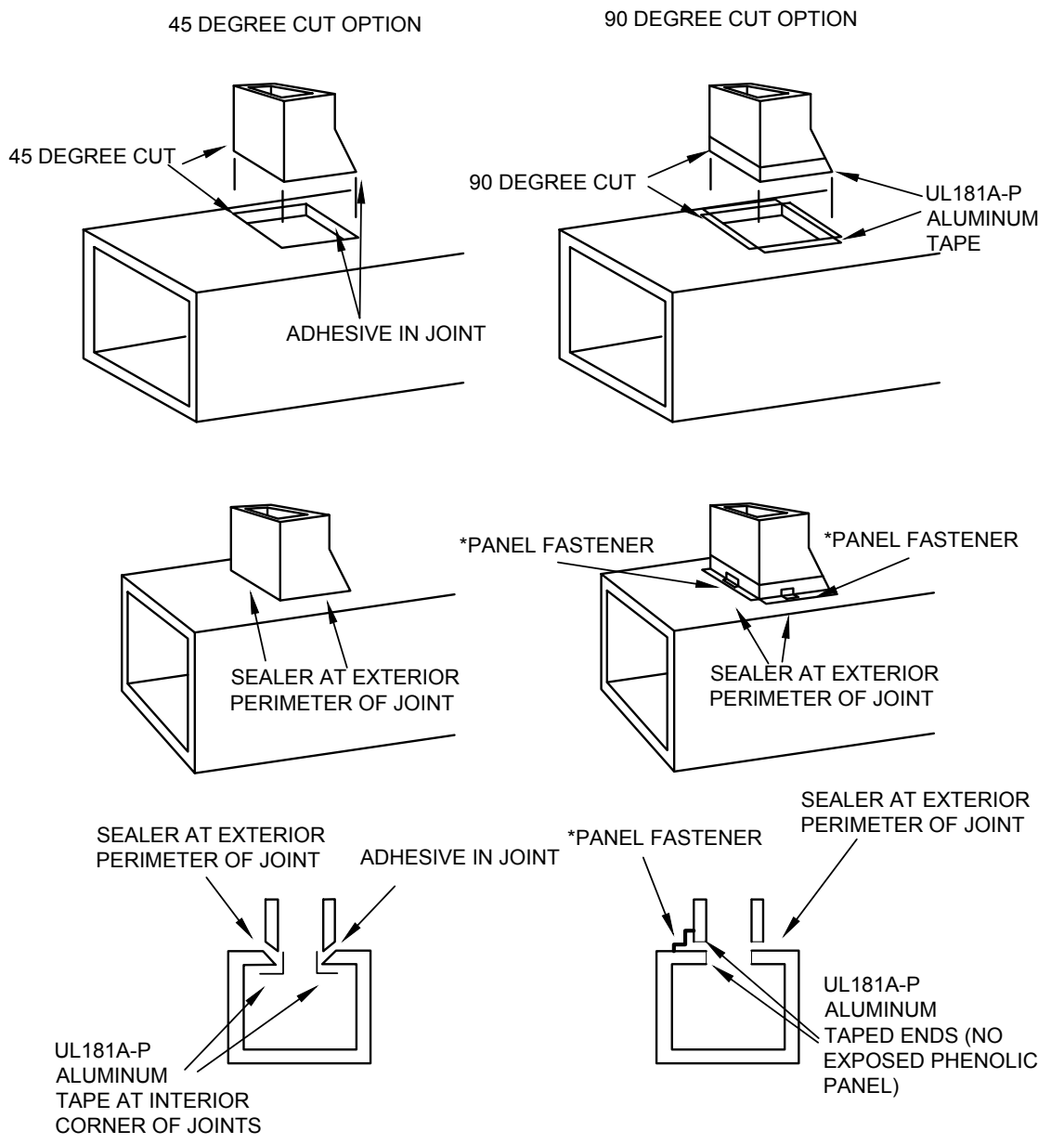


FIGURE 4-14 BRANCH CONNECTION - 45 DEGREE TAP - FLANGED



NOTE: NON-FLANGED TAKE-OFF APPLICABLE TO MAXIMUM 24" (610 mm) AND 2 IN. W.G. (500 PA) PRESSURE CLASS

DUCT DIMENSION		PANEL FASTENER QTY PER SIDE
IN.	MM	
4 - 5	100 - 150	1
6 - 11	151 - 300	2
12 - 19	301 - 500	3
20 - 24	501 - 600	4

FIGURE 4-15 BRANCH CONNECTION NON-FLANGED

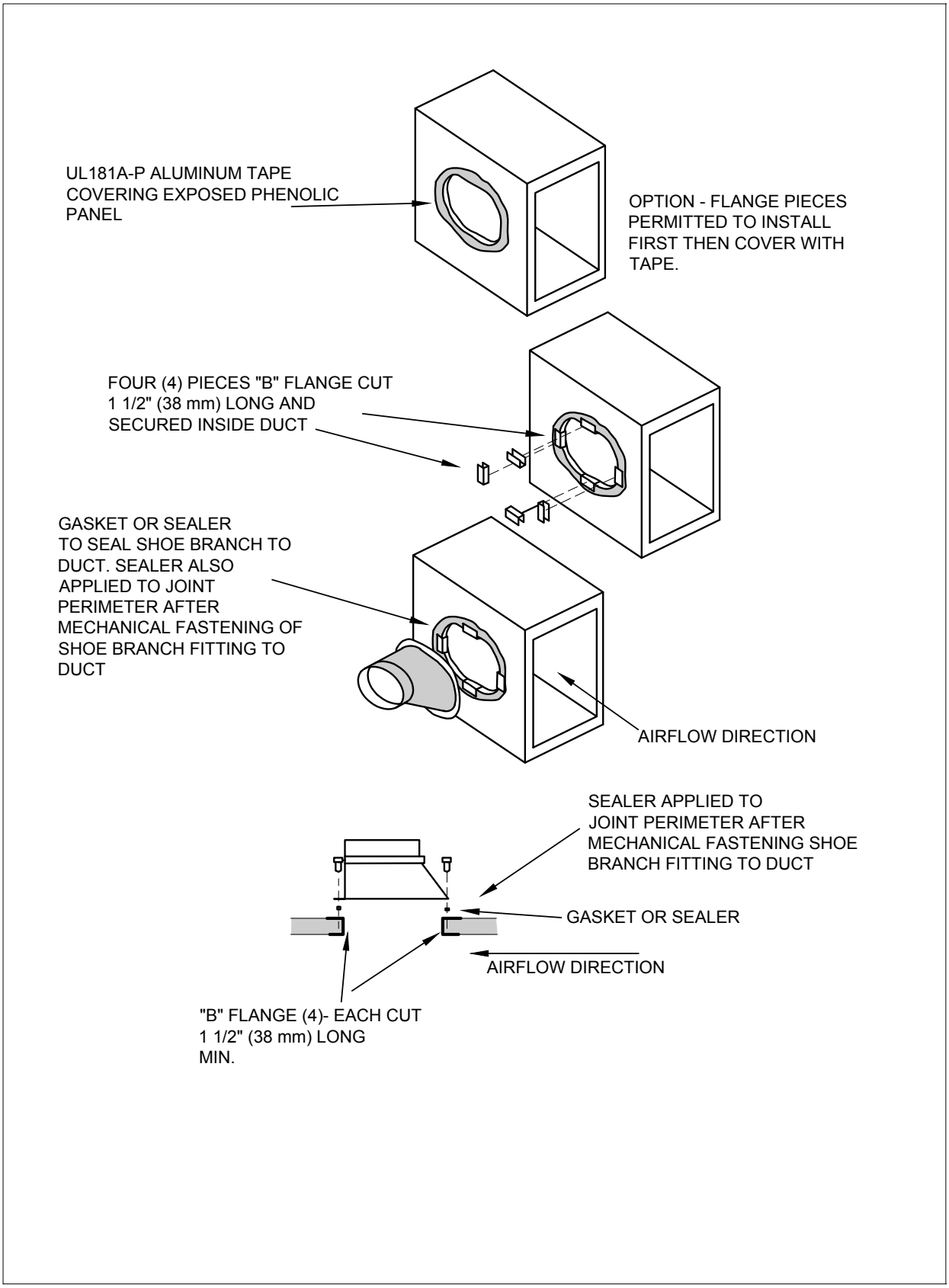


FIGURE 4-16 BRANCH CONNECTION - SHOE TYPE - MECHANICAL CONNECTION

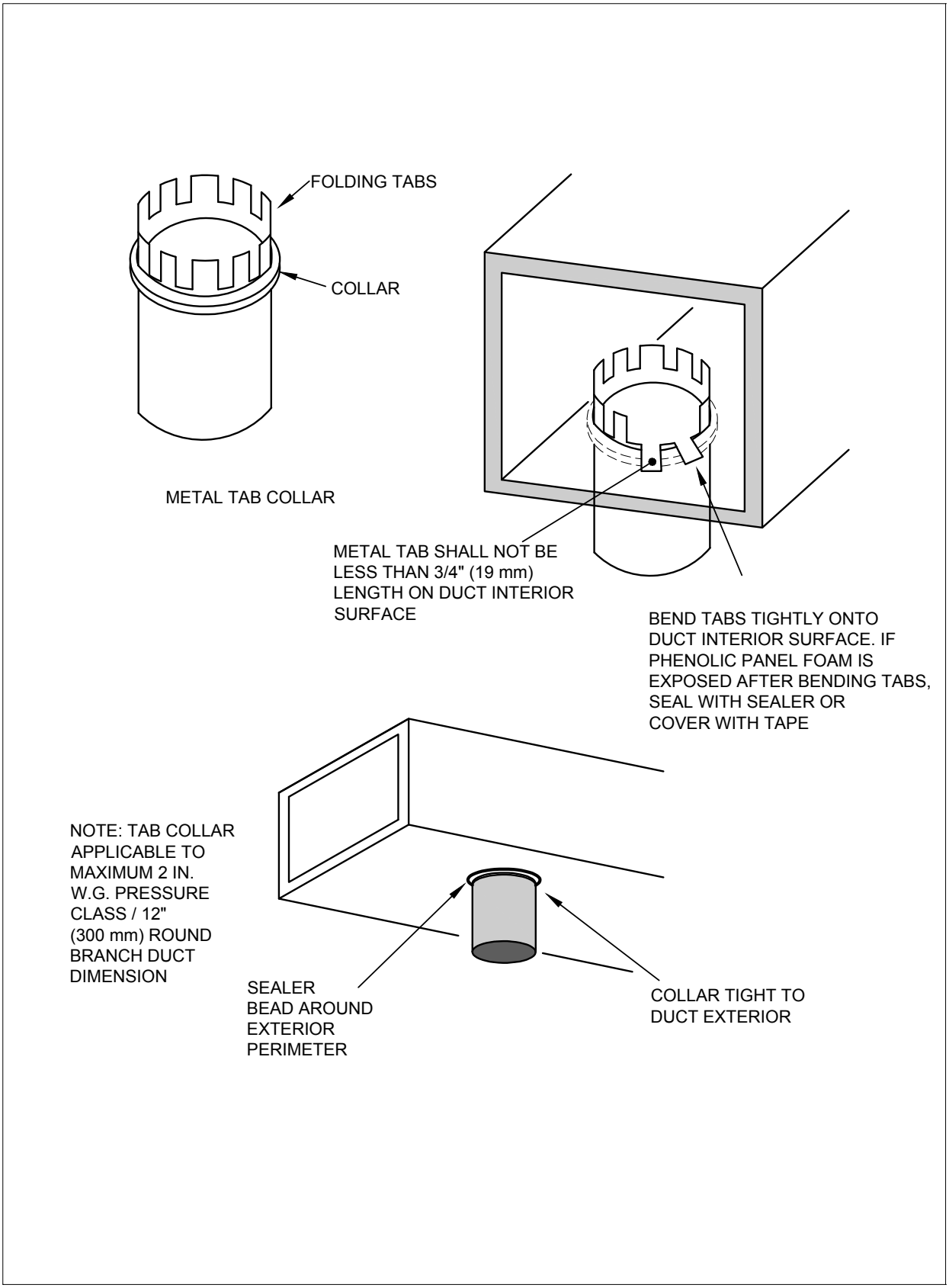


FIGURE 4-17 BRANCH CONNECTION - TAB COLLAR

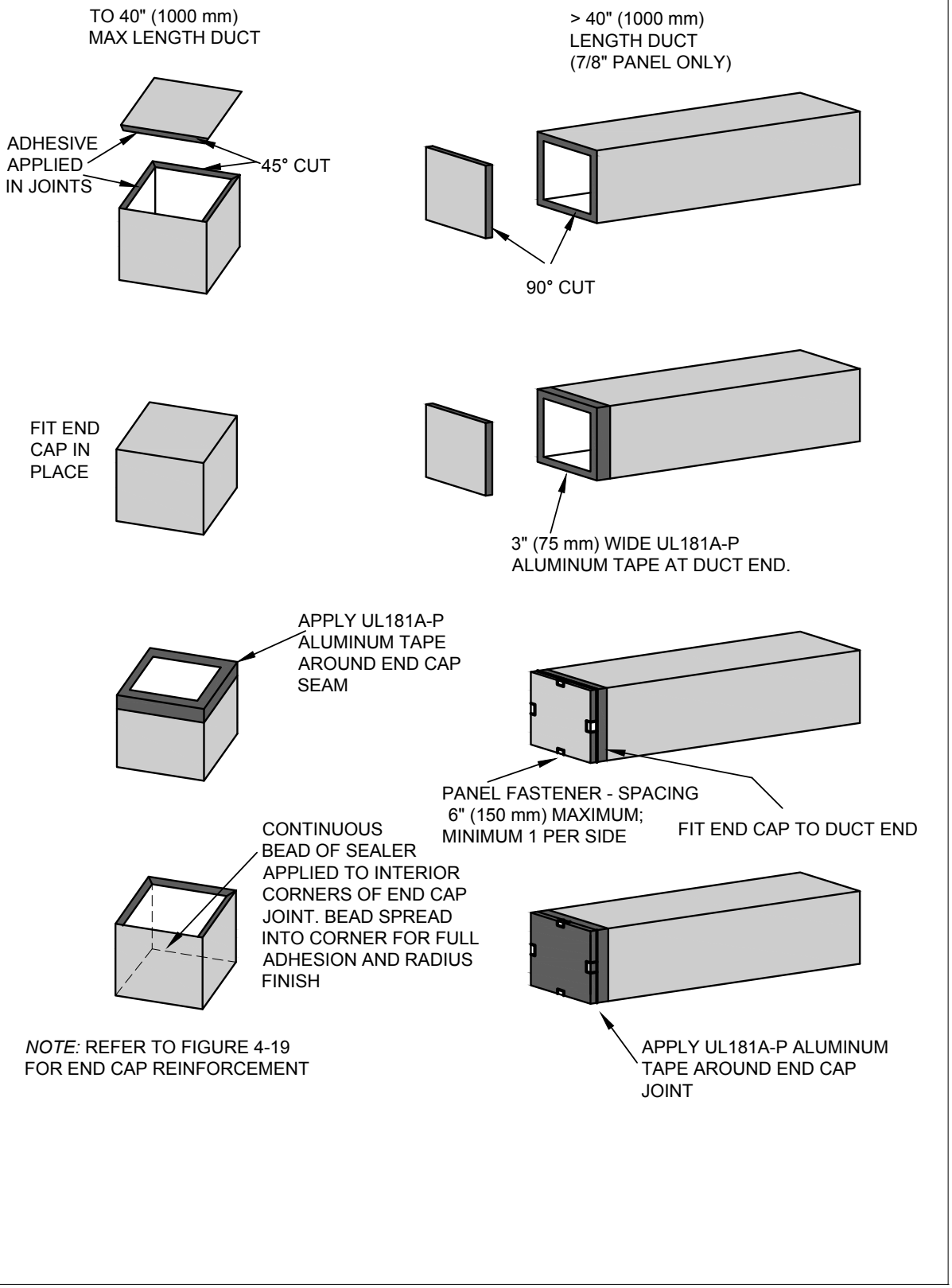
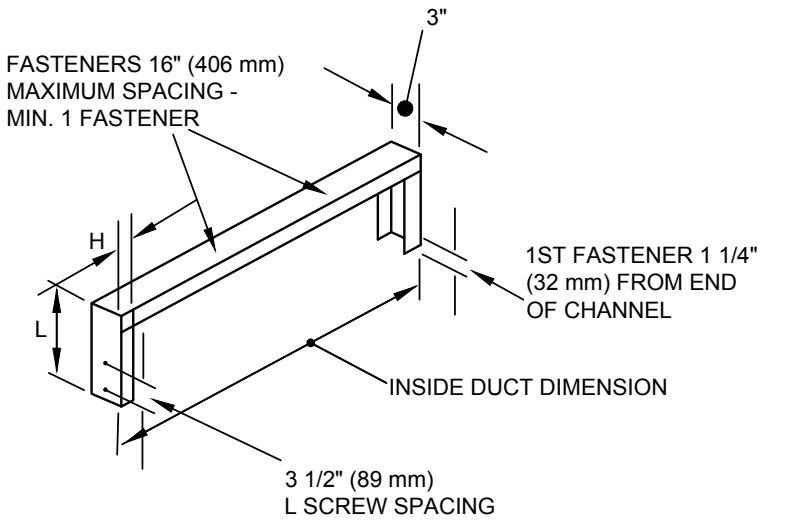


FIGURE 4-18 END CAP



NOTES:
1) SEE TABLE 4-1 AND 4-2 FOR CHANNEL H AND L DIMENSIONS AND CHANNEL SPACING.
2) 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.
3) END CAPS REQUIRE REINFORCEMENT WHENEVER THE SCHEDULE FOR STRAIGHT DUCTS OF THE SAME DIMENSION SHOWS REINFORCEMENT IS REQUIRED.

REFERENCE FIGURE 4-18 FOR END CAP JOINT CONSTRUCTION

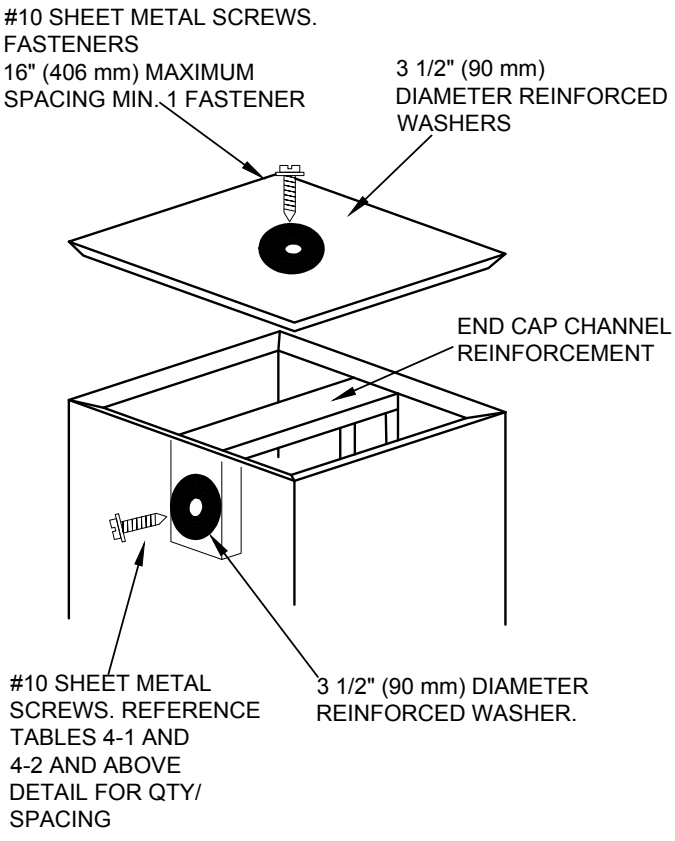


FIGURE 4-19 END CAP CHANNEL REINFORCEMENT

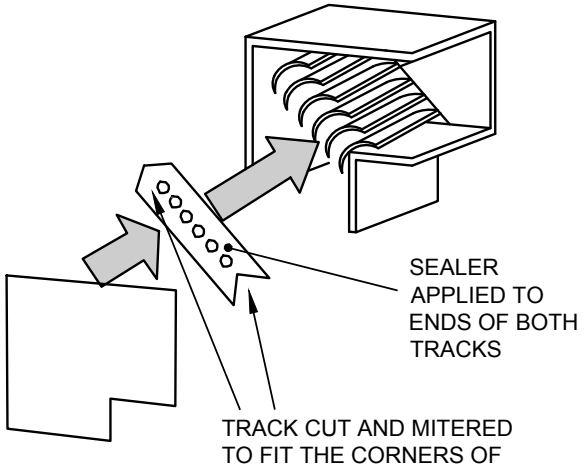
End Cap Channel Reinforcement						
Pressure Class in. w.g.	**Duct Dimension in.**	**Maximum Channel Spacing in.**	**Channel Gage**	**H Dimension in.**	**L Dimension in.**	**Fasteners Per Ea L Side**
.50	0 – 68	Not Required				
.50	> 68	68	18	1 1/4	13	4
1	0 – 36	Not Required				
1	> 36	36	22	1	7	2
2	0 – 28	Not Required				
2	> 28	28	22	1	10	3
3	0 – 20	Not Required				
3	> 20	20	22	1	7	2
4	0 – 20	Not Required				
4	> 20	20	22	1	10	3

Table 4-1 End Cap Channel System Reinforcement (I-P)

End Cap Channel Reinforcement (mm)						
Pressure Class Pa	**Duct Dimension mm**	**Maximum Channel Spacing mm**	**Channel Thickness mm**	**H Dimension mm**	**L Dimension mm**	**Fasteners Per Ea L Side**
125	0 – 1727	Not Required				
125	> 1727	1727	1.31	32	330	4
250	0 – 900	Not Required				
250	> 900	900	0.85	25	178	2
500	0 – 711	Not Required				
500	> 711	711	0.85	25	254	3
750	0 – 508	Not Required				
750	> 508	508	0.85	25	178	2
1000	0 – 508	Not Required				
1000	> 508	508	0.85	25	254	3

Table 4-2 End Cap Channel System Reinforcement (SI)

APPLICABLE TO MAXIMUM
2 IN. W.G. PRESSURE CLASS
AND 24" (610 mm)
DUCT SIZE



APPLICABLE TO ALL PHENOLIC
DUCT PRESSURE CLASSES.

- OPTION 1 (SHOWN) - 24
GA (.7 mm), 1" (25 mm)
WIDE MINIMUM
METAL STRIP FASTENED TO
BOTH TRACKS. SCREW/
RIVET 6" (150 mm)
MAXIMUM SPACING,
MINIMUM THREE
FASTENERS
- OPTION 2 - 3.5" (90 mm)
REINFORCED
WASHERS AT EACH SCREW/
RIVET. SCREW/RIVET 6"
(150 mm) MAXIMUM
SPACING, MINIMUM THREE
FASTENERS

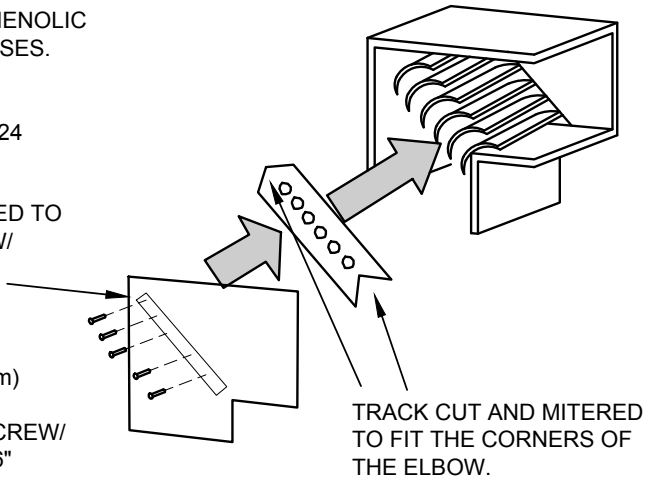


FIGURE 4-20 TURNING VANES

FITTINGS AND CONNECTIONS	FIGURE No.	Duct Dimension	Application Notes	in. w.g. / Pa Static				
				Positive or Negative				Pos.
				.50	1	2	3	4
				125	250	500	750	1000
Fittings – Adhesive In Longitudinal Seam(s) and Longitudinal Corners.	3-1, 4-1 - 4-18	80 in. (2000 mm) and Under		X	X	X	X	X
Fittings – Optional Panel Fasteners In Lieu Of Adhesive In Longitudinal Seams and Longitudinal Corners.	3-2, 4-1 - 4-18	80 in. (2000 mm) and Under	Panel Fasteners On Longitudinal Seams And Longitudinal Corners. Radius Fittings Panel Fasteners Spacing: 4" (102 mm) Throat; 10" (254 mm) Heel	X	X	X	X	X
Branch Connection 45^0 Tap – Flanged	4-13, 4-14	80 in. (2000 mm) and Under		X	X	X	X	X
Branch Connection 45^0 Tap – Non-Flanged	4-15	24 in. (600 mm) and Under		X	X	X	Not Permitted	
Shoe Branch, Mechanical Connection	4-16	All Sizes		X	X	X	X	X
Tab Collar	4-17	12 in. (300 mm) and Under		X	X	X	Not Permitted	
End Cap	4-18	80 in. (2000 mm) and Under	Refer To Figure 4-19 and Tables 4-1 and 4-2 For End Cap Reinforcement	X	X	X	X	X
Turning Vanes Without Mechanical Fasteners	4-20	24 in. (600 mm) and Under		X	X	X	Not Permitted	
Turning Vanes With Mechanical Fasteners	4-20	80 in. (2000 mm) and Under	External Mechanical Fasteners Required	X	X	X	X	X

LEGEND:

X

Permitted

Note: For duct over 80 in. (2000 mm) consult with the phenolic panel manufacturer.

Table 4-3 Fittings and Connections Pressure Table

CHAPTER 5

REINFORCEMENT

5.1 PHENOLIC DUCT REINFORCEMENT

Duct reinforcement is required to ensure that the true rectangular cross section of the duct is maintained.

A. Reinforcement Requirements:

1. The ductwork may require reinforcement, check the following:

a. Duct Size (both width and height)

b. System Pressure inside ductwork.

c. Transverse Joint Construction

B. Installation of Duct Reinforcement

1. Reinforcing bars, both positive and negative Pressure, any duct side

C. Areas where over pressure may exceed design pressure

1. Operating pressure shall not exceed the duct construction pressure class. The designer must specify duct system pressure relief procedures and precautions to protect and prevent duct systems from over pressurization.

D. Large Ductwork

1. For ductworks larger than those covered by the Schedule of duct reinforcement in this manual, consult with the panel manufacturer.

E. Tie Rod Reinforced Washers

1. Reinforced washers shall equal in area to 3.5 in. (90 mm) diameter minimum and be .04 in. (1 mm) thickness minimum. Specific to reinforcement, the PDCS requires washers to be used:

A. Between tie rod push-on fasteners and phenolic panels

B. Between tie rod bolts and nuts and phenolic panels

C. Between phenolic panels and: rigid conduit (RC); electrical metallic tubing (EMT); aluminum tubing; or steel pipe.

F. Tie Rod Push On Fasteners

1. Push-on fastener for 13/32 in. (10 mm) aluminum reinforcement tube – When push-on fasteners are utilized, the push-on fastener shall be complete with a cap and be made of zinc plated steel 0.012 in. (0.305 mm) minimum thickness. The push-on fastener cap shall be made of electro plated steel and be minimum 0.3 in. (7.7 mm) deep. The fastener to be complete with 6 legs minimum designed to retain 13/32 in. (10 mm) tube diameter which is the diameter of the 13/32 in. (10 mm) aluminum reinforcement tube tie rod.

G. Aluminum Reinforcement Tube

1. 9/16 in. (14 mm) aluminum reinforcement tube – Shall be 9/16 in. (14 mm) outside diameter minimum and 7/16 in. (11 mm) inside diameter minimum and have a wall thickness of 1/16 in. (1.5 mm) minimum

2. 13/32 in. (10 mm) aluminum reinforcement tube – Shall be 13/32 in. (10 mm) outside diameter minimum and 1/4 in. (6 mm) inside diameter minimum and have a wall thickness of 5/64 in. (2 mm) minimum

H. Tie Rod Installations

1. The term “tie rod” applies to a variety of galvanized steel shapes (i.e., rod, pipe and tube).

2. Internal ties shall be one of the methods shown in Figure 5-1 or 5-2. The restraining member and its connections shall be capable of sustaining a load equal to 100 percent of the duct construction pressure class load applied as 5.2 pounds per square foot per inch of water gage (101.63 kg per square meter per kPa) over an area equal to the width of the duct times the reinforcement interval. When more than one tie rod is used at a cross-section of the duct, the design load may be proportionately reduced.

3. For tie rod quantity and placement, reference Tables 5-1 through 5-12 and Figures 5-3 and 5-4.

4. For positive pressure tie rod selection refer to Tables A, B, C and D within Table 5-13 for tie rod selection.

   Steel pipe is not indicated within Table 5-13 due to other options considered more economical. Specifically, steel piping is not prohibited.

5. For negative pressure tie rod selection refer to Tables A, B and C within Table 5-14 and Tables D and E within Table 5-15 for tie rod selection

6. Tie rods shall be limited to duct velocities up to 2500 fpm (12.7 m/s) maximum.

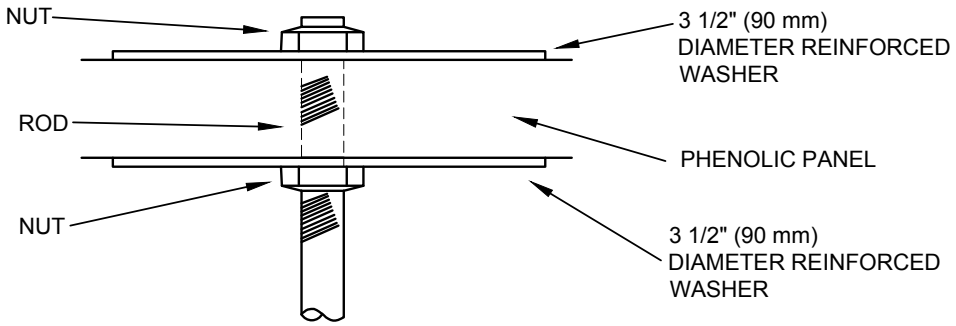
7. Holes made in the duct wall for tie rod passage shall be of minimum size and shall be sealed with sealer as may be required.

8. Tie Rod Material:

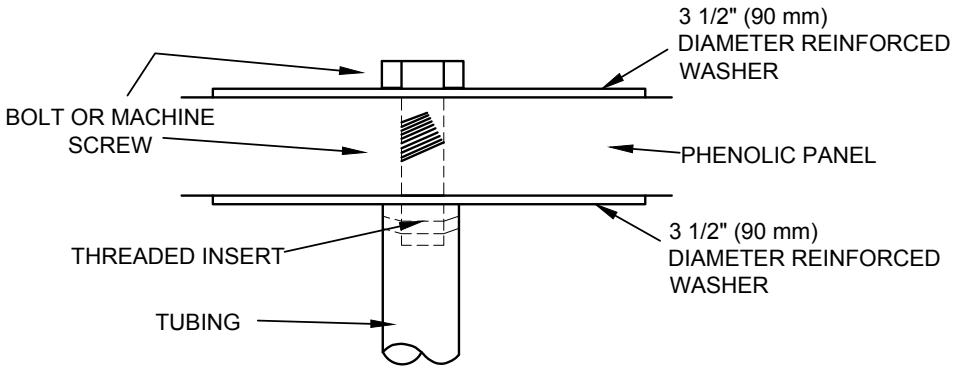
   A. All internal ties, whether of rod, tube or pipe shall be of material having corrosion resistance.

9. Ties rods shall be attached so that they will not loosen or detach at 150 percent of the selected duct pressure class. For positive pressure, threaded inserts placed in pipes and tubes shall be rated at 200 percent of the load.

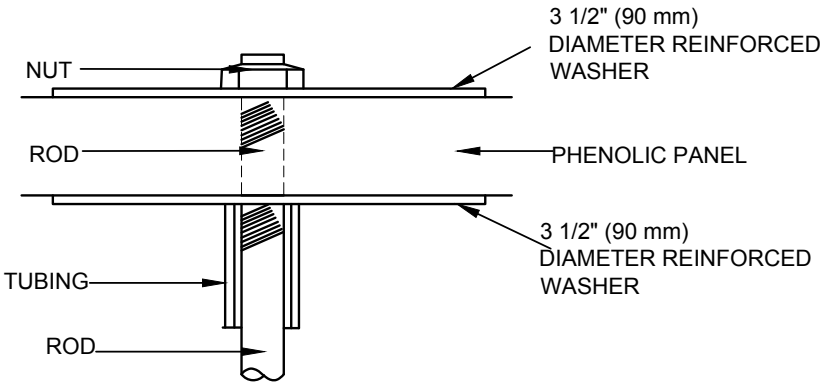
10. When ties occur in two directions in the same vicinity, they shall either be prevented from contacting or be permanently fastened together.



ROD WITH INTERNAL AND EXTERNAL NUTS

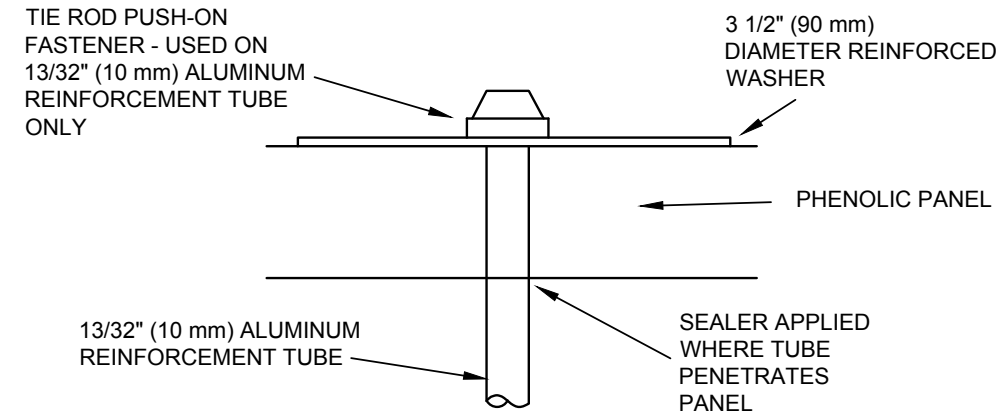


TUBING OR CONDUIT WITH THREADED INSERTS

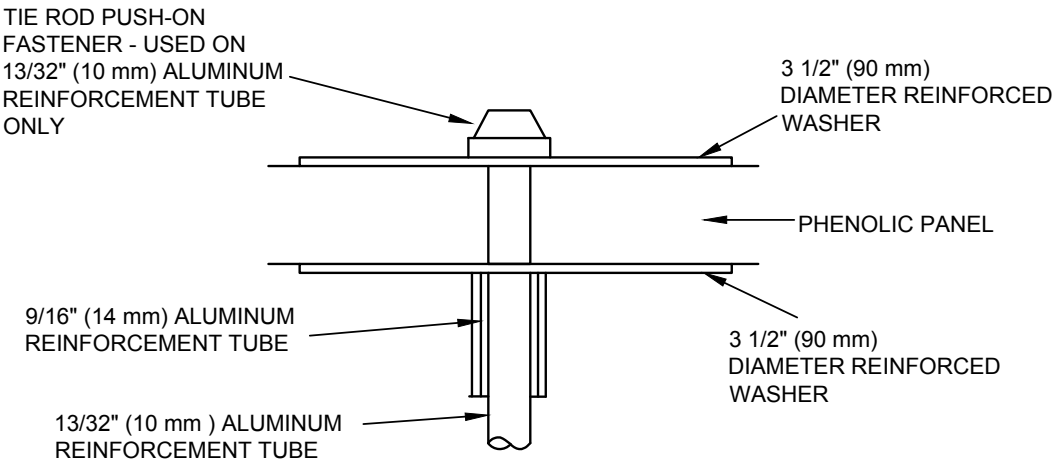


TUBING ENCASED ROD

FIGURE 5-1 TIE ROD ATTACHMENTS



ALUMINUM REINFORCEMENT TUBE- POSITIVE PRESSURE ONLY



ALUMINUM REINFORCEMENT - TUBE ENCASED TUBE

FIGURE 5-2 TIE ROD ATTACHMENTS

Duct Dimension Inches	Max. Duct Segment Length	in. w.g. Static Pos. or Neg.				in. w.g. Static Pos. Only
		.50	1	2	3	4
4 – 8	154 3/4 in.	Not Required				
9 – 12	154 3/4 in.					
13 – 16	154 3/4 in.					
17 – 20	154 3/4 in.					
21 – 24	154 3/4 in.			1 @ Joint		
25 – 28	154 3/4 in.		1 @ Joint	1 @ Joint		
29 – 32	154 3/4 in.	1 @ Joint	1 @ Joint	1 @ 36 in.		
33 – 36	154 3/4 in.	1 @ Joint	1 @ Joint	1 @ 36 in.		
37 – 40	154 3/4 in.	1 @ Joint	1 @ 36 in.	1 @ 36 in.		
41 – 44	154 3/4 in.	1 @ Joint	1 @ 36 in.	1 @ 36 in.		
45 – 48	47 1/4 in.	1 @ 24 in.	1 @ 24 in.	Not Designed		
49 – 52	47 1/4 in.	1 @ 24 in.	1 @ 24 in.			
53 – 56	47 1/4 in.	1 @ 24 in.	1 @ 24 in.			
57 – 60	47 1/4 in.	1 @ 24 in.	1 @ 24 in.			
61 – 64	47 1/4 in.					
65 – 68	47 1/4 in.					
69 – 72	47 1/4 in.					
73 – 76	47 1/4 in.					
77 – 80	47 1/4 in.					
Over 80”						

LEGEND:

1 @ Joint	Tie Rod Placed Maximum 12 in. From Each Joint
1 @ 36 in.	Tie Rod Longitudinal Spacing Maximum 36 in.; First and Last Ties Rods Maximum 12 in. From Joints
1 @ 24 in.	Tie Rod Longitudinal Spacing Maximum 24 in.

Table 5-1 Duct Reinforcement Table (I-P) 7/8 IN. Panel Non-Flanged Transverse Joints (FIGURE 3-3)

Note: Reinforcement Requirements Applicable To Both Duct Width And Height

Duct Dimension mm	Max. Duct Segment Length mm	Pa. Static Pos. or Neg.				Pa. Static Pos. Only
		125	250	500	750	1000
100 – 200	3930	Not Required				
201 – 300	3930					
301 – 400	3930					
401 – 500	3930					
501 – 600	3930			1 @ Joint		
601 – 700	3930		1 @ Joint	1 @ Joint		
701 – 800	3930	1 @ Joint	1 @ Joint	1 @ 900 mm		
801 – 900	3930	1 @ Joint	1 @ Joint	1 @ 900 mm		
901 – 1000	3930	1 @ Joint	1 @ 900 mm	1 @ 900 mm		
1001 – 1100	3930	1 @ Joint	1 @ 900 mm	1 @ 900 mm		
1101 – 1200	1200	1 @ 600 mm	1 @ 600 mm	Not Designed		
1201 – 1300	1200	1 @ 600 mm	1 @ 600 mm			
1301 – 1400	1200	1 @ 600 mm	1 @ 600 mm			
1401 – 1500	1200	1 @ 600 mm	1 @ 600 mm			
1501 – 1600	1200					
1601 – 1700	1200					
1701 – 1800	1200					
1801 – 1900	1200					
1901 – 2000	1200					
Over 2000						

LEGEND:

1 @ Joint	Tie Rod Placed Maximum 300 mm From Each Joint
1 @ 900 mm	Tie Rod Longitudinal Spacing Maximum 900 mm; First and Last Ties Rods Maximum 300 mm From Joints
1 @ 600 mm	Tie Rod Longitudinal Spacing Maximum 600 mm

Table 5-2 Duct Reinforcement Table (SI) 22 MM Panel Non-Flanged Transverse Joints (FIGURE 3-3)

Note: Reinforcement Requirements Applicable To Both Duct Width And Height

Duct Dimension Inches	Max. Duct Segment Length	in. w.g. Static Pos. or Neg.				in. w.g. Static Pos. Only
		.50	1	2	3	4
4 – 8	154 3/4 in.	Not Required				
9 – 12	154 3/4 in.					
13 – 16	154 3/4 in.					
17 – 20	154 3/4 in.					
21 – 24	154 3/4 in.				1 @ 36 in.	1 @ 36 in.
25 – 28	154 3/4 in.				1 @ 36 in.	1 @ 36 in.
29 – 32	154 3/4 in.			1 @ 36 in.	1 @ 36 in.	1 @ 24 in.
33 – 36	154 3/4 in.			1 @ 36 in.	1 @ 36 in.	2 @ 24 in.
37 – 40	154 3/4 in.		1 @ 36 in.	1 @ 36 in.	1 @ 24 in.	2 @ 24 in.
41 – 44	154 3/4 in.		1 @ 36 in.	1 @ 36 in.	1 @ 24 in.	2 @ 24 in.
45 – 48	47 1/4 in.			1 @ 24 in.	1 @ 24 in.	2 @ 24 in.
49 – 52	47 1/4 in.			1 @ 24 in.	2 @ 24 in.	2 @ 24 in.
53 – 56	47 1/4 in.		1 Centered	1 @ 24 in.	2 @ 24 in.	2 @ 24 in.
57 – 60	47 1/4 in.		1 Centered	1 @ 24 in.	2 @ 24 in.	3 @ 24 in.
61 – 64	47 1/4 in.		1 Centered	2 @ 24 in.	2 @ 24 in.	3 @ 24 in.
65 – 68	47 1/4 in.		1 @ 24 in.	2 @ 24 in.	2 @ 24 in.	3 @ 24 in.
69 – 72	47 1/4 in.	1 Centered	1 @ 24 in.	2 @ 24 in.	2 @ 24 in.	3 @ 24 in.
73 – 76	47 1/4 in.	1 Centered	1 @ 24 in.	2 @ 24 in.	3 @ 24 in.	3 @ 24 in.
77 – 80	47 1/4 in.	1 Centered	1 @ 24 in.	2 @ 24 in.	3 @ 24 in.	3 @ 24 in.
Over 80”	Consult With The Phenolic Panel Manufacturer					

LEGEND:

1 @ 36 in.	Tie Rod Longitudinal Spacing Maximum 36 in.; First and Last Tie Rods Maximum 18 in. From Joints
1 Centered	One Tie Rod Centered Equal Distance Between Joints
1 @ 24 in.	Tie Rod Longitudinal Spacing Maximum 24 in.; First and Last Ties Rods Maximum 12 in. From Joints
2 @ 24 in.	Two Tie Rods Longitudinal Spacing Maximum 24 in.; First and Last Row of Tie Rods Maximum 12 in. From Joints
3 @ 24 in.	Three Tie Rods Longitudinal Spacing Maximum 24 in.; First and Last Row of Tie Rods Maximum 12 in. From Joints

Table 5-3 Duct Reinforcement Table (I-P) 7/8 IN. Panel “A” Flange (FIGURE 3-7) and Optional “B/C” Flange (FIGURE 3-8) Transverse Joints

Note: Reinforcement Requirements Applicable To Both Duct Width And Height

Duct Dimension mm	Max. Duct Segment Length mm	Pa. Static Pos. or Neg.				Pa. Static Pos. Only
	125	250	500	750	1000	
100 – 200	3930					
201 – 300	3930					
301 – 400	3930					
401 – 500	3930		Not Required			
501 – 600	3930				1 @ 900 mm	1 @ 900 mm
601 – 700	3930				1 @ 900 mm	1 @ 900 mm
701 – 800	3930			1 @ 900 mm	1 @ 900 mm	1 @ 600 mm
801 – 900	3930			1 @ 900 mm	1 @ 900 mm	2 @ 600 mm
901 – 1000	3930		1 @ 900 mm	1 @ 900 mm	1 @ 600 mm	2 @ 600 mm
1001 – 1100	3930		1 @ 900 mm	1 @ 900 mm	1 @ 600 mm	2 @ 600 mm
1101 – 1200	1200			1 @ 600 mm	1 @ 600 mm	2 @ 600 mm
1201 – 1300	1200			1 @ 600 mm	2 @ 600 mm	2 @ 600 mm
1301 – 1400	1200		1 Centered	1 @ 600 mm	2 @ 600 mm	2 @ 600 mm
1401 – 1500	1200		1 Centered	1 @ 600 mm	2 @ 600 mm	3 @ 600 mm
1501 – 1600	1200		1 Centered	2 @ 600 mm	2 @ 600 mm	3 @ 600 mm
1601 – 1700	1200		1 @ 600 mm	2 @ 600 mm	2 @ 600 mm	3 @ 600 mm
1701 – 1800	1200	1 Centered	1 @ 600 mm	2 @ 600 mm	2 @ 600 mm	3 @ 600 mm
1801 – 1900	1200	1 Centered	1 @ 600 mm	2 @ 600 mm	3 @ 600 mm	3 @ 600 mm
1901 – 2000	1200	1 Centered	1 @ 600 mm	2 @ 600 mm	3 @ 600 mm	3 @ 600 mm
Over 2000	Consult With The Phenolic Panel Manufacturer					

LEGEND:

1 @ 900 mm	Tie Rod Longitudinal Spacing Maximum 900 mm; First and Last Tie Rods Maximum 450 mm From Joints
1 Centered	One Tie Rod Centered Equal Distance Between Joints
1 @ 600 mm	Tie Rod Longitudinal Spacing Maximum 600 mm; First and Last Ties Rods Maximum 300 mm From Joints
2 @ 600 mm	Two Tie Rods Longitudinal Spacing Maximum 600 mm.; First and Last Row of Tie Rods Maximum 300 mm From Joints
3 @ 600 mm	Three Tie Rods Longitudinal Spacing Maximum 600 mm.; First and Last Row of Tie Rods Maximum 300 mm From Joints

Table 5-4 Duct Reinforcement Table (SI) 22 MM Panel "A" Flange (FIGURE 3-7) and Optional "B/C" Flange (FIGURE 3-8) Transverse Joints

Note: Reinforcement Requirements Applicable To Both Duct Width And Height

Duct Dimension Inches	Max. Duct Segment Length	in. w.g. Static Pos. or Neg.				in. w.g. Static Pos. Only
		.50	1	2	3	4
4 – 8	154 3/4 in.	Not Required				
9 – 12	154 3/4 in.					
13 – 16	154 3/4 in.					
17 – 20	154 3/4 in.					
21 – 24	154 3/4 in.				1 @ 36 in.	1 @ 36 in.
25 – 28	154 3/4 in.				1 @ 36 in.	1 @ 36 in.
29 – 32	154 3/4 in.			1 @ 36 in.	1 @ 36 in.	1 @ 24 in.
33 – 36	154 3/4 in.			1 @ 36 in.	1 @ 36 in.	2 @ 24 in.
37 – 40	154 3/4 in.		1 @ 36 in.	1 @ 36 in.	1 @ 24 in.	2 @ 24 in.
41 – 44	154 3/4 in.		1 @ 36 in.	1 @ 36 in.	1 @ 24 in.	2 @ 24 in.
45 – 48	47 1/4 in.			1 Centered	2 Centered	2 @ 24 in.
49 – 52	47 1/4 in.			1 Centered	2 Centered	2 @ 24 in.
53 – 56	47 1/4 in.			1 Centered	2 @ 24 in.	2 @ 24 in.
57 – 60	47 1/4 in.			1 Centered	2 @ 24 in.	3 @ 24 in.
61 – 64	47 1/4 in.		1 Centered	2 Centered	2 @ 24 in.	3 @ 24 in.
65 – 68	47 1/4 in.		1 Centered	2 Centered	2 @ 24 in.	3 @ 24 in.
69 – 72	47 1/4 in.		1 Centered	2 Centered	2 @ 24 in.	3 @ 24 in.
73 – 76	47 1/4 in.		1 Centered	2 Centered	3 @ 24 in.	3 @ 24 in.
77 – 80	47 1/4 in.		1 Centered	2 Centered	3 @ 24 in.	3 @ 24 in.
Over 80”	Consult With The Phenolic Panel Manufacturer					

LEGEND:

1 @ 36 in.	Tie Rod Longitudinal Spacing Maximum 36 in.
1 Centered	One Tie Rod Centered Equal Distance Between Joints
2 Centered	Two Tie Rods In Row Centered Equal Distance Between Joints
1 @ 24 in.	Tie Rod Longitudinal Spacing Maximum 24 in.; First and Last Ties Rods Maximum 12 in. From Joints
2 @ 24 in.	Two Tie Rods In Row Longitudinal Spacing Maximum 24 in.; First and Last Row of Tie Rods Maximum 12 in. From Joints
3 @ 24 in.	Three Tie Rods In Row Longitudinal Spacing Maximum 24 in.; First and Last Row of Tie Rods Maximum 12 in. From Joints

Table 5-5 Duct Reinforcement Table (I-P) 7/8 IN. Panel 4 Bolt Flange (FIGURE 3-9) Transverse Joints

Note: Reinforcement Requirements Applicable To Both Duct Width And Height

Duct Dimension mm	Max. Duct Segment Length mm	Pa. Static Pos. or Neg.				Pa. Static Pos. Only
		125	250	500	750	1000
100 – 200	3930	Not Required				
201 – 300	3930					
301 – 400	3930					
401 – 500	3930					
501 – 600	3930				1 @ 900 mm	1 @ 900 mm
601 – 700	3930				1 @ 900 mm	1 @ 900 mm
701 – 800	3930			1 @ 900 mm	1 @ 900 mm	1 @ 600 mm
801 – 900	3930			1 @ 900 mm	1 @ 900 mm	2 @ 600 mm
901 – 1000	3930		1 @ 900 mm	1 @ 900 mm	1 @ 600 mm	2 @ 600 mm
1001 – 1100	3930		1 @ 900 mm	1 @ 900 mm	1 @ 600 mm	2 @ 600 mm
1101 – 1200	1200			1 Centered	2 Centered	2 @ 600 mm
1201 – 1300	1200			1 Centered	2 Centered	2 @ 600 mm
1301 – 1400	1200			1 Centered	2 @ 600 mm	2 @ 600 mm
1401 – 1500	1200			1 Centered	2 @ 600 mm	3 @ 600 mm
1501 – 1600	1200		1 Centered	2 Centered	2 @ 600 mm	3 @ 600 mm
1601 – 1700	1200		1 Centered	2 Centered	2 @ 600 mm	3 @ 600 mm
1701 – 1800	1200		1 Centered	2 Centered	2 @ 600 mm	3 @ 600 mm
1801 – 1900	1200		1 Centered	2 Centered	3 @ 600 mm	3 @ 600 mm
1901 – 2000	1200		1 Centered	2 Centered	3 @ 600 mm	3 @ 600 mm
Over 2000	Consult With The Phenolic Panel Manufacturer					

LEGEND:

1 @ 900 mm	Tie Rod Longitudinal Spacing Maximum 900 mm
1 Centered	One Tie Rod Centered Equal Distance Between Joints
2 Centered	Two Tie Rods In Row Centered Equal Distance Between Joints
1 @ 600 mm	Tie Rod Longitudinal Spacing Maximum 600 mm; First and Last Ties Rods Maximum 300 mm From Joints
2 @ 600 mm	Two Tie Rods In Row Longitudinal Spacing Maximum 600 mm.; First and Last Row of Tie Rods Maximum 300 mm From Joints
3 @ 600 mm	Three Tie Rods In Row Longitudinal Spacing Maximum 600 mm; First and Last Row of Tie Rods Maximum 300 mm From Joints

Table 5-6 Duct Reinforcement Table (SI) 22 MM Panel 4 Bolt Flange (FIGURE 3-9) Transverse Joints

Note: Reinforcement Requirements Applicable To Both Duct Width And Height

Duct Dimension Inches	Max. Duct Segment Length	in. w.g. Static Pos. or Neg.				in. w.g. Static Pos. Only
		.50	1	2	3	4
4 – 8	154 3/4 in.	Not Required			Not Designed	
9 – 12	154 3/4 in.					
13 – 16	154 3/4 in.					
17 – 20	154 3/4 in.					
21 – 24	154 3/4 in.					
25 – 28	154 3/4 in.			1 @ Joint		
29 – 32	154 3/4 in.		1 @ Joint	1 @ 36 in.		
33 – 36	154 3/4 in.	NR	1 @ Joint	1 @ 36 in.		
37 – 40	154 3/4 in.	1 @ Joint	1 @ 36 in.	1 @ 36 in.		
41 – 44	154 3/4 in.	1 @ Joint	1 @ 36 in.	1 @ 36 in.		
45 – 48	47 1/4 in.	1 @ 24 in.	1 @ 24 in.			
49 – 52	47 1/4 in.	1 @ 24 in.	1 @ 24 in.			
53 – 56	47 1/4 in.	1 @ 24 in.	1 @ 24 in.			
57 – 60	47 1/4 in.	1 @ 24 in.	1 @ 24 in.			
61 – 64	47 1/4 in.					
65 – 68	47 1/4 in.					
69 – 72	47 1/4 in.					
73 – 76	47 1/4 in.					
77 – 80	47 1/4 in.					
Over 80”						

LEGEND:

1 @ Joint	Tie Rod Placed Maximum 12 in. From Each Joint
1 @ 36 in.	Tie Rod Longitudinal Spacing Maximum 36 in.; First and Last Ties Rods Maximum 12 in. From Joints
1 @ 24 in.	Tie Rod Longitudinal Spacing Maximum 24 in.; First and Last Ties Rods Maximum 12 in. From Joints

Table 5-7 Duct Reinforcement Table (I-P) 1 3/16 IN. Panel Non-Flanged Transverse Joints (FIGURE 3-3)

Note: Reinforcement Requirements Applicable To Both Duct Width And Height

<table>
<tr><th rowspan="2">Duct Dimension mm</th><th rowspan="2">Max. Duct Segment Length mm</th><th colspan="4">Pa. Static Pos. or Neg.</th><th>Pa. Static Pos. Only</th></tr>
<tr><th>125</th><th>250</th><th>500</th><th>750</th><th>1000</th></tr>
<tr><td>100 – 200</td><td>3930</td><td colspan="3" rowspan="6">Not Required</td><td colspan="2" rowspan="16">Not Designed</td></tr>
<tr><td>201 – 300</td><td>3930</td></tr>
<tr><td>301 – 400</td><td>3930</td></tr>
<tr><td>401 – 500</td><td>3930</td></tr>
<tr><td>501 – 600</td><td>3930</td></tr>
<tr><td>601 – 700</td><td>3930</td><td colspan="2"></td><td>1 @ Joint</td></tr>
<tr><td>701 – 800</td><td>3930</td><td rowspan="2"></td><td>1 @ Joint</td><td>1 @ 900 mm</td></tr>
<tr><td>801 – 900</td><td>3930</td><td>1 @ Joint</td><td>1 @ 900 mm</td></tr>
<tr><td>901 – 1000</td><td>3930</td><td>1 @ Joint</td><td>1 @ 900 mm</td><td>1 @ 900 mm</td></tr>
<tr><td>1001 – 1100</td><td>3930</td><td>1 @ Joint</td><td>1 @ 900 mm</td><td>1 @ 900 mm</td></tr>
<tr><td>1101 – 1200</td><td>1200</td><td>1 @ 600 mm</td><td>1 @ 600 mm</td><td colspan="2" rowspan="4"></td></tr>
<tr><td>1201 – 1300</td><td>1200</td><td>1 @ 600 mm</td><td>1 @ 600 mm</td></tr>
<tr><td>1301 – 1400</td><td>1200</td><td>1 @ 600 mm</td><td>1 @ 600 mm</td></tr>
<tr><td>1401 – 1500</td><td>1200</td><td>1 @ 600 mm</td><td>1 @ 600 mm</td></tr>
<tr><td>1501 – 1600</td><td>1200</td><td colspan="4" rowspan="6"></td></tr>
<tr><td>1601 – 1700</td><td>1200</td></tr>
<tr><td>1701 – 1800</td><td>1200</td></tr>
<tr><td>1801 – 1900</td><td>1200</td></tr>
<tr><td>1901 – 2000</td><td>1200</td></tr>
<tr><td>Over 2000</td><td colspan="6"></td></tr>
<tr><td colspan="7">LEGEND:
1 @ Joint — Tie Rod Placed Maximum 300 mm From Each Joint
1 @ 900 mm — Tie Rod Longitudinal Spacing Maximum 900 mm; First and Last Ties Rods Maximum 300 mm From Joints
1 @ 600 mm — Tie Rod Longitudinal Spacing Maximum 600 mm; First and Last Ties Rods Maximum 300 mm From Joints</td></tr>
</table>

Table 5-8 Duct Reinforcement Table (SI) 30 MM Panel Non-Flanged Transverse Joints (FIGURE 3-3)

Note: Reinforcement Requirements Applicable To Both Duct Width And Height

Duct Dimension Inches	Max. Duct Segment Length	in. w.g. Static Pos. or Neg.				in. w.g. Static Pos. Only
		.50	1	2	3	4
4 – 8	154 3/4 in.	Not Required				
9 – 12	154 3/4 in.					
13 – 16	154 3/4 in.					
17 – 20	154 3/4 in.					
21 – 24	154 3/4 in.				1 @ 36 in.	1 @ 36 in.
25 – 28	154 3/4 in.				1 @ 36 in.	1 @ 36 in.
29 – 32	154 3/4 in.			1 @ 36 in.	1 @ 36 in.	1 @ 24 in.
33 – 36	154 3/4 in.			1 @ 36 in.	1 @ 36 in.	1 @ 24 in.
37 – 40	154 3/4 in.		1 @ 36 in.	1 @ 36 in.	1 @ 36 in.	1 @ 24 in.
41 – 44	154 3/4 in.		1 @ 36 in.	1 @ 36 in.	1 @ 36 in.	1 @ 24 in.
45 – 48	47 1/4 in.			1 Centered	1 @ 24 in.	2 @ 24 in.
49 – 52	47 1/4 in.			1 Centered	1 @ 24 in.	2 @ 24 in.
53 – 56	47 1/4 in.		1 Centered	1 @ 24 in.	2 @ 24 in.	2 @ 24 in.
57 – 60	47 1/4 in.		1 Centered	1 @ 24 in.	2 @ 24 in.	2 @ 24 in.
61 – 64	47 1/4 in.		1 Centered	1 @ 24 in.	2 @ 24 in.	2 @ 24 in.
65 – 68	47 1/4 in.		1 Centered	2 @ 24 in.	2 @ 24 in.	2 @ 24 in.
69 – 72	47 1/4 in.	1 Centered	1 @ 24 in.	2 @ 24 in.	2 @ 24 in.	3 @ 24 in.
73 – 76	47 1/4 in.	1 Centered	1 @ 24 in.	2 @ 24 in.	2 @ 24 in.	3 @ 24 in.
77 – 80	47 1/4 in.	1 Centered	1 @ 24 in.	2 @ 24 in.	2 @ 24 in.	3 @ 24 in.
Over 80”	Consult With The Phenolic Panel Manufacturer					

LEGEND:

1 @ 36 in.	Tie Rod Longitudinal Spacing Maximum 36 in.; First and Last Tie Rods Maximum 18 in. From Joints
1 Centered	One Tie Rod Centered Equal Distance Between Joints
1 @ 24 in.	Tie Rod Longitudinal Spacing Maximum 24 in.; First and Last Ties Rods Maximum 12 in. From Joints
2 @ 24 in.	Two Tie Rods In Row Longitudinal Spacing Maximum 24 in.; First and Last Row of Tie Rods Maximum 12 in. From Joints
3 @ 24 in.	Three Tie Rods In Row Longitudinal Spacing Maximum 24 in.; First and Last Row of Tie Rods Maximum 12 in. From Joints

Table 5-9 Duct Reinforcement Table (I-P) 1 3/16 IN. Panel “A” Flange (FIGURE 3-7) and Optional “B/C” Flange (FIGURE 3-8) Transverse Joints

Note: Reinforcement Requirements Applicable To Both Duct Width And Height

Duct Dimension mm	Max. Duct Segment Length mm	Pa. Static Pos. or Neg.				Pa. Static Pos. Only
		125	250	500	750	1000
100 – 200	3930	Not Required				
201 – 300	3930					
301 – 400	3930					
401 – 500	3930					
501 – 600	3930				1 @ 900 mm	1 @ 900 mm
601 – 700	3930				1 @ 900 mm	1 @ 900 mm
701 – 800	3930			1 @ 900 mm	1 @ 900 mm	1 @ 600 mm
801 – 900	3930			1 @ 900 mm	1 @ 900 mm	1 @ 600 mm
901 – 1000	3930		1 @ 900 mm	1 @ 900 mm	1 @ 900 mm	1 @ 600 mm
1001 – 1100	3930		1 @ 900 mm	1 @ 900 mm	1 @ 900 mm	1 @ 600 mm
1101 – 1200	1200			1 Centered	1 @ 600 mm	2 @ 600 mm
1201 – 1300	1200			1 Centered	2 @ 600 mm	2 @ 600 mm
1301 – 1400	1200		1 Centered	1 Centered	2 @ 600 mm	2 @ 600 mm
1401 – 1500	1200		1 Centered	1 @ 600 mm	2 @ 600 mm	2 @ 600 mm
1501 – 1600	1200		1 Centered	1 @ 600 mm	2 @ 600 mm	2 @ 600 mm
1601 – 1700	1200		1 Centered	2 @ 600 mm	2 @ 600 mm	2 @ 600 mm
1701 – 1800	1200		1 Centered	2 @ 600 mm	2 @ 600 mm	3 @ 600 mm
1801 – 1900	1200	1 Centered	1 @ 600 mm	2 @ 600 mm	2 @ 600 mm	3 @ 600 mm
1901 – 2000	1200	1 Centered	1 @ 600 mm	2 @ 600 mm	2 @ 600 mm	3 @ 600 mm
Over 2000	Consult With The Phenolic Panel Manufacturer					

LEGEND:

1 @ 900 mm	Tie Rod Longitudinal Spacing Maximum 900 mm; First and Last Tie Rods Maximum 450 mm From Joints
1 Centered	One Tie Rod Centered Equal Distance Between Joints
1 @ 600 mm	Tie Rod Longitudinal Spacing Maximum 600 mm; First and Last Ties Rods Maximum 300 mm From Joints
2 @ 600 mm	Two Tie Rods In Row Longitudinal Spacing Maximum 600 mm.; First and Last Row of Tie Rods Maximum 300 mm From Joints
3 @ 600 mm	Three Tie Rods In Row Longitudinal Spacing Maximum 600 mm.; First and Last Row of Tie Rods Maximum 300 mm From Joints

Table 5-10 Duct Reinforcement Table (SI) 30 MM Panel "A" Flange (FIGURE 3-7) and Optional "B/C" Flange (FIGURE 3-8) Transverse Joints

Note: Reinforcement Requirements Applicable To Both Duct Width And Height

Duct Dimension Inches	Max. Duct Segment Length	in. w.g. Static Pos. or Neg.				in. w.g. Static Pos. Only
		.50	1	2	3	4
4 – 8	154 3/4 in.	Not Required				
9 – 12	154 3/4 in.					
13 – 16	154 3/4 in.					
17 – 20	154 3/4 in.					
21 – 24	154 3/4 in.				1 @ 36 in.	1 @ 36 in.
25 – 28	154 3/4 in.				1 @ 36 in.	1 @ 36 in.
29 – 32	154 3/4 in.			1 @ 36 in.	1 @ 36 in.	1 @ 24 in.
33 – 36	154 3/4 in.			1 @ 36 in.	1 @ 36 in.	1 @ 24 in.
37 – 40	154 3/4 in.		1 @ 36 in.	1 @ 36 in.	1 @ 36 in.	1 @ 24 in.
41 – 44	154 3/4 in.		1 @ 36 in.	1 @ 36 in.	1 @ 36 in.	1 @ 24 in.
45 – 48	47 1/4 in.			1 Centered	1 Centered	2 Centered
49 – 52	47 1/4 in.			1 Centered	1 Centered	2 @ 24 in.
53 – 56	47 1/4 in.			1 Centered	2 Centered	2 @ 24 in.
57 – 60	47 1/4 in.			1 Centered	2 Centered	2 @ 24 in.
61 – 64	47 1/4 in.		1 Centered	2 Centered	2 Centered	2 @ 24 in.
65 – 68	47 1/4 in.		1 Centered	2 Centered	2 Centered	2 @ 24 in.
69 – 72	47 1/4 in.		1 Centered	2 Centered	2 @ 24 in.	3 @ 24 in.
73 – 76	47 1/4 in.		1 Centered	2 Centered	2 @ 24 in.	3 @ 24 in.
77 – 80	47 1/4 in.		1 Centered	2 Centered	2 @ 24 in.	3 @ 24 in.
Over 80”	Consult With The Phenolic Panel Manufacturer					

LEGEND:

1 @ 36 in.	Tie Rod Longitudinal Spacing Maximum 36 in.
1 Centered	One Tie Rod Centered Equal Distance Between Joints
2 Centered	Two Tie Rods In Row Centered Equal Distance Between Joints
1 @ 24 in.	Tie Rod Longitudinal Spacing Maximum 24 in.; First and Last Ties Rods Maximum 12 in. From Joints
2 @ 24 in.	Two Tie Rods In Row Longitudinal Spacing Maximum 24 in.; First and Last Row of Tie Rods Maximum 12 in. From Joints
3 @ 24 in.	Three Tie Rods In Row Longitudinal Spacing 24 in.; First and Last Row of Tie Rods Maximum 12 in. From Joints

Table 5-11 Duct Reinforcement Table (I-P) 1 3/16 IN. Panel 4 Bolt Flange (FIGURE 3-9) Transverse Joints

Note: Reinforcement Requirements Applicable To Both Duct Width And Height

Duct Dimension mm	Max. Duct Segment Length mm	Pa. Static Pos. or Neg.				Pa. Static Pos. Only
		125	250	500	750	1000
100 – 200	3930	Not Required				
201 – 300	3930					
301 – 400	3930					
401 – 500	3930					
501 – 600	3930				1 @ 900 mm	1 @ 900 mm
601 – 700	3930				1 @ 900 mm	1 @ 900 mm
701 – 800	3930			1 @ 900 mm	1 @ 900 mm	1 @ 600 mm
801 – 900	3930			1 @ 900 mm	1 @ 900 mm	1 @ 600 mm
901 – 1000	3930		1 @ 900 mm	1 @ 900 mm	1 @ 900 mm	1 @ 600 mm
1001 – 1100	3930		1 @ 900 mm	1 @ 900 mm	1 @ 900 mm	1 @ 600 mm
1101 – 1200	1200			1 Centered	1 Centered	2 Centered
1201 – 1300	1200			1 Centered	1 Centered	2 @ 600 mm
1301 – 1400	1200			1 Centered	2 Centered	2 @ 600 mm
1401 – 1500	1200			1 Centered	2 Centered	2 @ 600 mm
1501 – 1600	1200		1 Centered	2 Centered	2 Centered	2 @ 600 mm
1601 – 1700	1200		1 Centered	2 Centered	2 Centered	2 @ 600 mm
1701 – 1800	1200		1 Centered	2 Centered	2 @ 600 mm	3 @ 600 mm
1801 – 1900	1200		1 Centered	2 Centered	2 @ 600 mm	3 @ 600 mm
1901 – 2000	1200		1 Centered	2 Centered	2 @ 600 mm	3 @ 600 mm
Over 2000	Consult With Phenolic Panel Manufacturer					

LEGEND:

1 @ 900 mm	Tie Rod Longitudinal Spacing Maximum 900 mm
1 Centered	One Tie Rod Centered Equal Distance Between Joints
2 Centered	Two Tie Rods In Row Centered Equal Distance Between Joints
1 @ 600 mm	Tie Rod Longitudinal Spacing Maximum 600 mm; First and Last Tie Rods Maximum 300 mm From Joints
2 @ 600 mm	Two Tie Rods In Row Longitudinal Spacing Maximum 600 mm.; First and Last Row of Tie Rods Maximum 300 mm From Joints
3 @ 600 mm	Three Tie Rods In Row Longitudinal Spacing Maximum 600 mm; First and Last Row of Tie Rods Maximum 300 mm From Joints

Table 5-12 Duct Reinforcement Table (SI) 30 MM Panel 4 Bolt Flange (FIGURE 3-9) Transverse Joints

Note: Reinforcement Requirements Applicable To Both Duct Width And Height

Table A – Threaded Rod Maximum Length			
Rod Spec. in.	**Max. Length in.**	**Rod Spec mm.**	**Max. Length mm**
1/4 in. – 20	36	6.4 mm – .078	900
5/16 in. – 18	36	7.9 mm – .071	900
3/8 in. – 16	84	9.5 mm – 0.63	2134

Rod specification is diameter and threads per inch/mm.

Table B – Rigid Conduit (RC) Maximum Length			
RC Size in.	**Max. Length in.**	**RC Size mm**	**Max. Length mm**
1/2 in.	84	12.7 mm	2134
3/4 in.	84	19.1 mm	2134

Table C – Electrical Metallic Tubing (EMT) Maximum Length			
EMT Size in.	**Max. Length in.**	**EMT Size mm**	**Max. Length mm**
1/2 in.	84	12.7 mm	2134
3/4 in.	84	19.1 mm	2134

Table D – 13/32 in. (10 mm) OD Aluminum Reinforcement Tube Maximum Length			
Tube Size in.	**Max. Length in.**	**Tube Size mm**	**Max. Length mm**
13/32 in	84	10 mm	2134

Table 5-13 Tie Rod Selection Positive Pressure

Note: For Duct Over 80 in. (2000 mm) Consult the Phenolic Panel manufacturer

Table A – Threaded Rod Maximum Length			
Rod Spec. in.	**Max. Length in.**	**Rod Spec mm.**	**Max. Length mm**
5/16 in. – 18	12	7.9 mm – .071	305
3/8 in. – 16	12	9.5 mm – 0.63	305
1/2 in. – 12	18	12.7 mm – 0.47	457
5/8 in. – 11	24	15.9 mm – 0.43	610
3/4 in. – 10	24	19.1 mm – 0.39	610
7/8 in. – 9	36	22.2 mm – 0.35	914
1 in. – 8	36	25 mm – 0.31	1066

Rod specification is diameter and threads per inch/mm.

Table B – Rigid Conduit (RC) Maximum Length			
RC Size in.	Max. Length in.	RC Size mm	Max. Length mm
1/2 in.	52	12.7 mm	1320
3/4 in.	66	19.1 mm	1676
1 in.	84	25 mm	2134

Table C – Electrical Metallic Tubing (EMT) Maximum Length			
EMT Size in.	Max. Length in.	EMT Size mm	Max. Length mm
1/2 in.	46	12.7 mm	1168
3/4 in.	62	19.1 mm	1575
1 in.	74	25 mm	1880
1 1/4 in.	102	31.8 mm	2591

Table 5-14 Tie Rod Selection Negative Pressure

Note: For Duct Over 80 in. (2000 mm) Consult the Phenolic Panel manufacturer

The Maximum Lengths Indicated Above Are Established to Limit The Compression Stress to That Associated With a Maximum Radius of Gyration Ratio to 200 L/r_g

Table D – Steel Pipe Maximum Length			
Pipe Size in.	**Max. Length in.**	**Pipe Size mm**	**Max. Length mm**
1/4 in.	33	6.4 mm	838
3/8 in.	42	9.5 mm	1067
1/2 in.	52	12.7 mm	1321
3/4 in.	67	19.1 mm	1702
1 in.	84	25 mm	2134

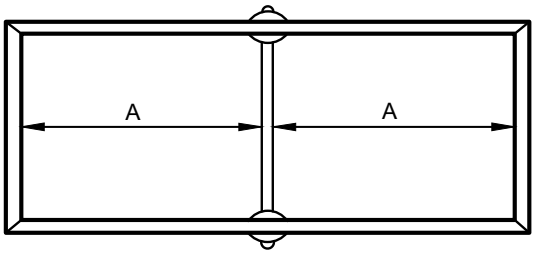
Galvanized steel pipe is of ASTM A53, A106, or A120 grade. Ends are considered pinned.

Table E – 9/16 in. (14 mm) OD Aluminum Reinforcement Tube Maximum Length			
Tube Size in.	**Max. Length in.**	**Tube Size mm**	**Max. Length mm**
9/16 in.	36	14 mm	914

Table 5-15 Tie Rod Selection Negative Pressure

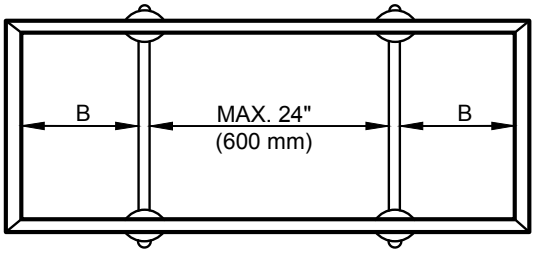
Note: For Duct Over 80 in. (2000 mm) Consult the Phenolic Panel manufacturer

The Maximum Lengths Indicated Above Are Established to Limit The Compression Stress to That Associated With a Maximum Radius of Gyration Ratio to 200 L/r_g



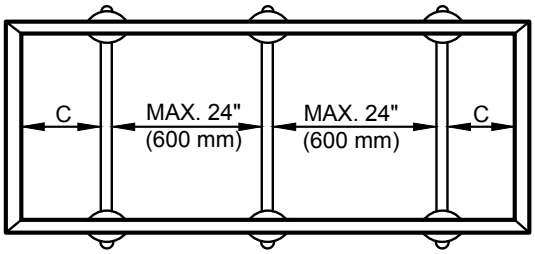
A DIMENSIONS ARE EQUAL

TYPICAL SPACING FOR 1 TIE ROD



B DIMENSIONS ARE EQUAL

TYPICAL SPACING FOR ROW OF 2 TIE RODS



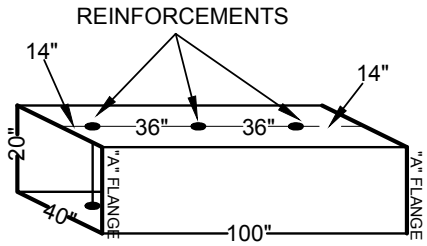
C DIMENSIONS ARE EQUAL

TYPICAL SPACING FOR ROW OF 3 TIE RODS

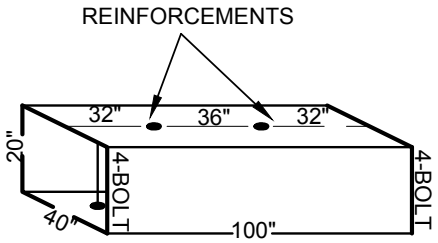
FIGURE 5-3 TIE ROD CROSS-SECTION SPACING

EXAMPLE 1: 7/8" (22 mm), PHENOLIC PANEL
PRESSURE CLASS: 1 IN. W.G. (250 PA)
DUCT SIZE: 40" (1016 mm) X 20" (508 mm)
DUCT SECTION LENGTH: 100" (2500 mm)

14" = 355 mm
18" = 457 mm
36" = 914 mm



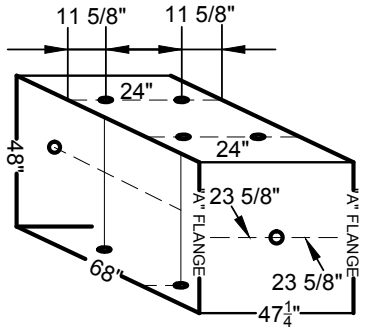
7/8" (22 mm) PANEL WITH "A" FLANGE
(SEE TABLE 5-3):
SIDE 40": 1@36", TIE ROD MAX 18" FROM JOINT
SIDE 20": NO REINFORCEMENT



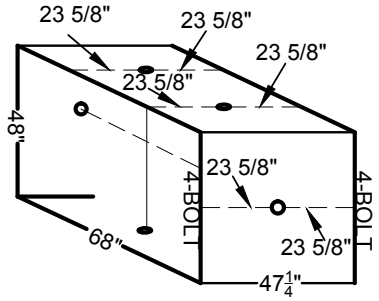
7/8" (22 mm) PANEL WITH 4-BOLT FLANGE
(SEE TABLE 5-5):
SIDE 40": 1@36", TIE ROD MAX 36" FROM JOINT
SIDE 20": NO REINFORCEMENT

EXAMPLE 2: 1 3/16" (30 mm), PHENOLIC PANEL
PRESSURE: 2" W.G. (500 PA)
DUCT SIZE: 68" (1727 mm) X 48" (1219 mm)
DUCT SECTION LENGTH: 47 1/4" (1200 mm)

11 5/8 " = 295 mm
23 5/8 " = 600 mm
24" = 610 mm



1 3/16" (30 mm) PANEL WITH "A" FLANGE AND
DRIVE CLEAT JOINT (SEE TABLE 5-9):
SIDE 68": 2@24", TIE ROD MAX 12" FROM JOINT
SIDE 48": 1 CENTERED



1 3/16" (30 mm) PANEL WITH 4-BOLT
FLANGE (SEE TABLE 5-11):
SIDE 68": 2 CENTERED
SIDE 48": 1 CENTERED

FIGURE 5-4 DUCT REINFORCEMENT EXAMPLES

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CHAPTER 6

HANGERS AND SUPPORTS

6.1 HANGING AND SUPPORTING SYSTEMS

6.1.1 Requirements

Rectangular Phenolic ducts shall be installed with support systems indicated. They shall be installed as required to maintain alignment. Horizontal ducts shall have a support within 2 ft. (0.61 m) of each elbow and within 4 ft. (1.2 m) of each branch intersection. Upper attachments to structures shall have an allowable load not less than one–fourth of the failure (proof test) load but are not limited to the specific methods shown here.

6.2 COMMENTARY

The duct hanging system is composed of three elements, the upper attachment to the building, the hanger itself, and the lower attachment to the duct. The manufacturer's load ratings and application data should be followed for all devices and materials.

6.2.1 Concrete Inserts

Concrete inserts must be installed before the concrete is poured. They are used primarily where: A) the duct layout is simple and there is enough lead time to determine accurate placement; B) BIM efforts facilitate exacting hanger locations. The simplest insert is a piece of bent flat bar. Manufactured inserts are available individually or in long lengths; the latter are generally used where many hangers will be installed in a small area, or where individual inserts cannot be precisely located at the time of placing the concrete.

6.2.2 Concrete Fasteners

Concrete fasteners are installed after the concrete has been poured and the forms have been removed. There are several variations of powder–actuated fasteners, which are installed with powder–actuated tools and booster cartridges. Gas driven fasteners are also used for upper attachments. Powder–actuated or gas driven fasteners should be used within the manufacturer's published application limits. Load capacities are based on tests in representative base materials in accordance with ASTM E1190.

6.2.3 Structural Steel Fasteners

Several types of beam clamps are available. Some should be used with a retaining clip. Powder–actuated and gas driven fasteners or threaded studs may also be used on steel. Welded studs may be installed using special welding equipment.

6.2.4 Cellular Metal Deck

Buildings can be constructed with a cellular steel deck that carries the electrical and communication systems and is covered with concrete fill. The wiring in the cells and the concrete above the deck preclude the use of fasteners, such as sheet metal screws, that must pierce the deck. Some manufacturers of this type of deck now offer an integral hanging system. In cases where there are no integral hangers at the required hanging points, install the rod or strap hangers before concrete placement, or install welded studs after concrete placement. In all cases, the upper attachments to the decking should be in place before the application of fireproofing materials.

6.2.5 Upper Attachment

Upper attachment methods should be selected with care. A safety factor of 4 (based on ultimate failure) is practical unless it can be shown that few unpredictable variables exist and that quality control is disciplined.

6.2.6 Hangers

Hangers for phenolic ducts are usually strips of galvanized steel or round steel rod or round galvanized wire or cable. For hangers made of round steel rod, use uncoated hot–rolled steel except where the installation is in a corrosive atmosphere. Where corrosion is a problem, hanger rods should be electro–galvanized all–thread rods or hot–dipped galvanized rods. Where corrosion is a problem for electro–galvanized or hot–dipped galvanized materials, materials of aluminum or stainless steel construction shall be utilized.

6.2.7 Lower Attachment

The lower attachment is the connection between the hanger and the duct section. For duct with a greatest dimension to 28 in. (700 mm), fasteners that penetrate the duct may be panel support fasteners. Reference Figure 6-5.

6.2.8 Hanger Spacing

A straight duct section is actually a box section beam of considerable strength. As in many structures, the joint is the weakest point, so that is where the

support is. Duct segments up to 154 ¾ in. (3930 mm) in length with a dimension to 44 in. (1118 mm) are normally strong enough to permit maximum hanger spacing at 13 ft. (4 m). Duct segments up to 47 ¼ in. (1200 mm) in length with a dimension larger than 44 in. (1118 mm) are normally strong enough to permit maximum hanger spacing at 6 ft. (1.8 m).

Very wide ducts may require closer hanger spacing in order to limit individual hanger loads to safe values. They also may require intermediate hangers to prevent the upper portion of the duct from sagging. For ducts with dimensions over 80 in. (2032 mm) consult the phenolic panel manufacturer.

6.2.9 Trapeze Selection

Trapeze members must be selected with careful attention to the position of the loads on the horizontal bar. Reference Figure 6-6.

6.2.10 Riser Supports

Rectangular risers should be supported by angles, channels or framing channel (strut) secured through the sides of the duct with sheet metal screws, blind rivets or phenolic duct panel hanger rod attachments. A sheet metal sleeve inside of the phenolic duct is required whenever screws or other fasteners pass through both sides of the phenolic panel. Riser support intervals should be at one or two story intervals, *i.e.*, 12 ft. (3.66 m) to 24 ft. (7.32 m), as suitable for loading. Reference Figure 6-10.

6.2.11 Hanging System Selection

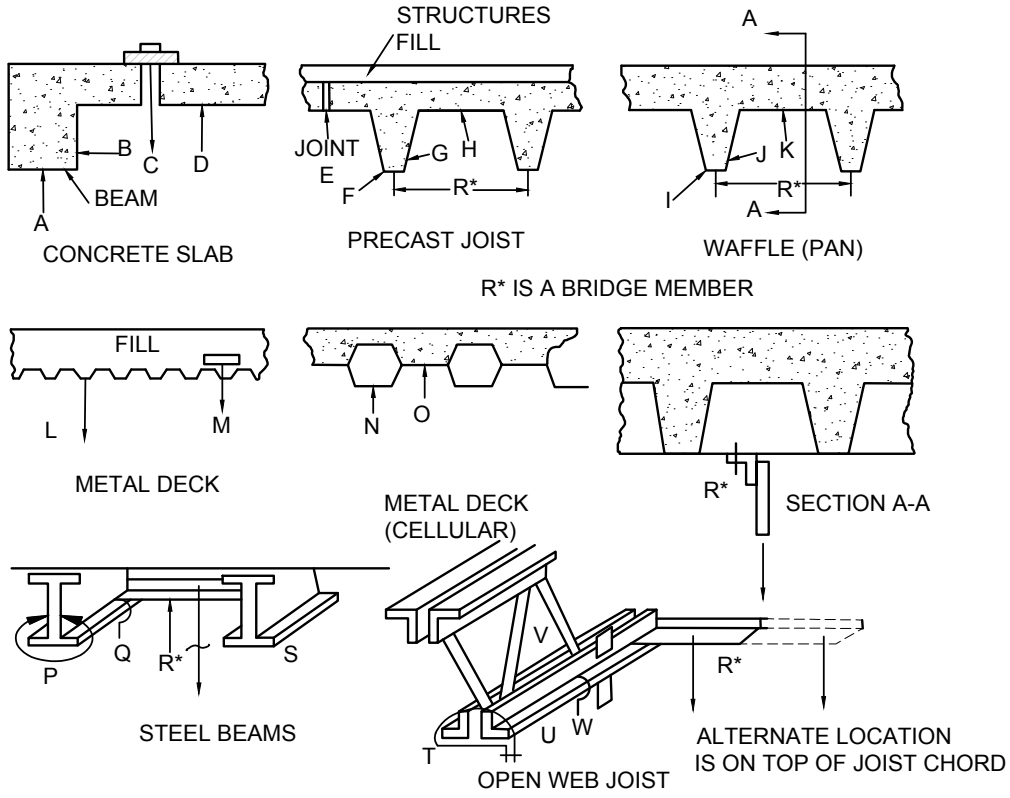
The selection of a hanging system should not be taken lightly not only because it involves a significant portion of the erection labor, but also because an inadequate hanging system can be disastrous. In any multiple hanger system, the failure of one hanger transfers its load to adjacent hangers. If one of these fails, an even greater load is transferred to the next. The result is a cascading failure in which an entire run of duct might fall.

There are many hanger alternatives, especially in the upper attachments. Besides structural adequacy, the contractor's choice of hanging system must also take into account the particulars of the building structure, the skills of the workmen, the availability of tooling, and the recommendations of the fastener manufacturer. Because of these variables, it is suggested that the hanging system be the contractor's choice, subject to the approval of the mechanical engineer.

Figures in this manual show typical hanger construction. When special conditions require high safety factors or the ability to withstand vibrations, individual concrete or steel attachments can be specified to be capable of supporting test loads equal to the minimum rating listed when they are tested in accordance with methods described by Underwriters' Laboratories, Inc., for Pipe Hanger Equipment, Bulletin UL 203, latest edition.

The supports discussed here are not seismically qualified. Refer to SMACNA's *Seismic Restraint Manual Guidelines For Mechanical Systems* for additional reinforcement required by earthquake hazards.

ALPHABET LETTER ONLY INDICATES AN ALTERNATIVE LOCATION OR SITUATION THAT MAY BE PERMITTED OR RESTRICTED BY DESIGN DOCUMENTS. ILLUSTRATIONS OF CONCRETE AND STEEL DO NOT PRECLUDE ATTACHMENTS TO WOOD.



CONVENTIONAL HANGER METHODS AND DEVICES

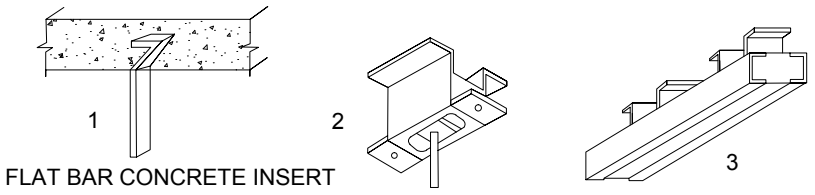
CONCRETE SCREW ANCHORS
CONCRETE INSERTS, SINGLE
CONCRETE INSERTS, SLOTTED
POWDER ACTUATED FASTENERS
GAS DRIVEN FASTENERS
"C" CLAMPS
WELDED STUDS
FRICTION CLAMPS
STRAP
ROD, THREADED, UNTHREADED
BRIDGE
BEAM CLAMP, HALF FLANGE
BEAM CLAMP, FULL FLANGE
EYE BOLT (OR ROD)
TOGGLE BOLTS
DRILLED HOLE AND BOLT
STANCHION
SELF TAPPING SCREWS PLUS STRAPS
DROP IN EXPANSION ANCHORS
KNEE BRACKET FROM WALL
LAG SCREW EXPANSION ANCHOR
NAILED PIN FASTENERS
RIVETS
SWAY BRACING
"FISH" PLATE OR WASHER AND ROD
HOOK OR LOOP
VIBRATION ISOLATOR
WIRE

NOTE: CABLE HANGING SYSTEMS WITH ADJUSTABLE MECHANICAL DEVICE SELECT HANGERS FOR TYPE OF STRUCTURE AND SUSPENSION. DO NOT EXCEED ALLOWABLE OR SPECIFIED LOAD LIMITS.

ALLOWABLE LOAD ON UPPER ATTACHMENT IS 1/4 OF FAILURE LOAD

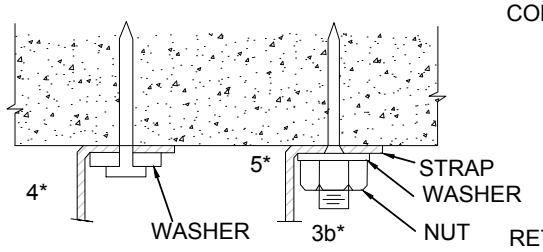
FIGURE 6-1 HANGER ATTACHMENTS TO STRUCTURES

UNLESS OTHERWISE APPROVED ALLOWABLE LOAD ON UPPER ATTACHMENT IS 1/4 OF FAILURE LOAD.
UPPER ATTACHMENTS MAY BE TO WOOD STRUCTURES ALSO.

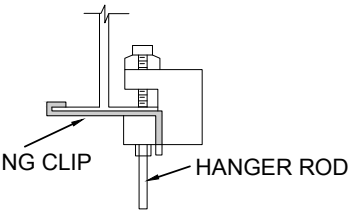


FLAT BAR CONCRETE INSERT

MANUFACTURED
CONCRETE INSERTS

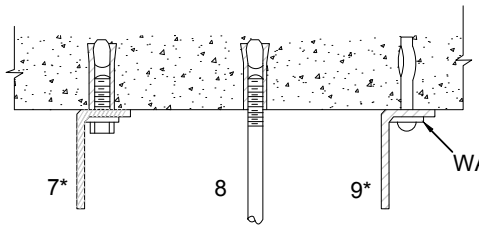


WASHER MAY BE OMITTED WITH
100LB (45KG) MAX LOAD ON
22GA (0.85 mm) STRAP WHEN
FOLDED



6a C - CLAMP W/ RETAINING CLIP OR
6b C - CLAMP W/ LOCK NUT (OPTIONAL)

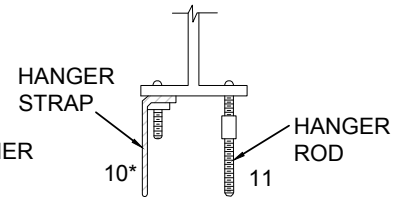
A HANGER STRAP MAY ALSO BE C
CLAMPED TO THE STRUCTURAL FLANGE



EXPANSION SHIELDS

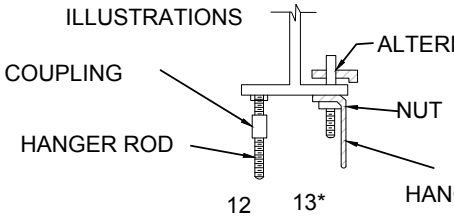
EXPANSION NAIL

CONCRETE ANCHORS

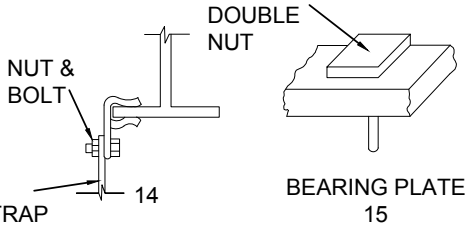


POWER ACTUATED
STUDS INTO STEEL
(STRUCTURE OR DECK)

WIRE USE IS NOT
PRECLUDED BY THESE
ILLUSTRATIONS



WELDED STUDS



BEARING PLATE
15

FRICTION CLAMPS

* IMPORTANT! PREVENT BENDING OF
STRAP AT 90° BEND UNDER LOAD.

THE NUMBERS ASSOCIATED WITH THE ART ARE
ONLY FOR CONVENIENT REFERENCE.

FIGURE 6-2 UPPER ATTACHMENT DEVICES

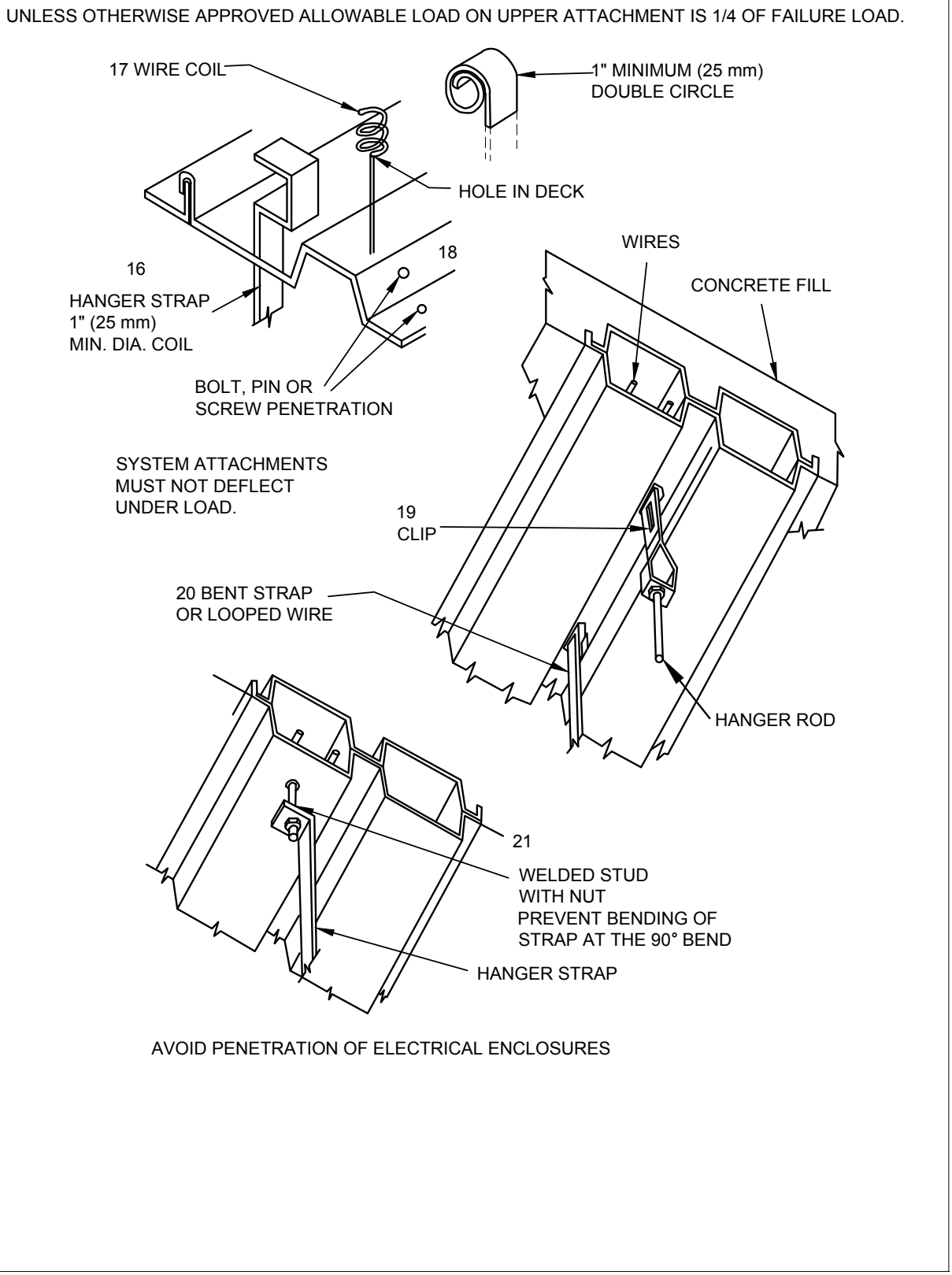


FIGURE 6-3 TYPICAL UPPER ATTACHMENTS

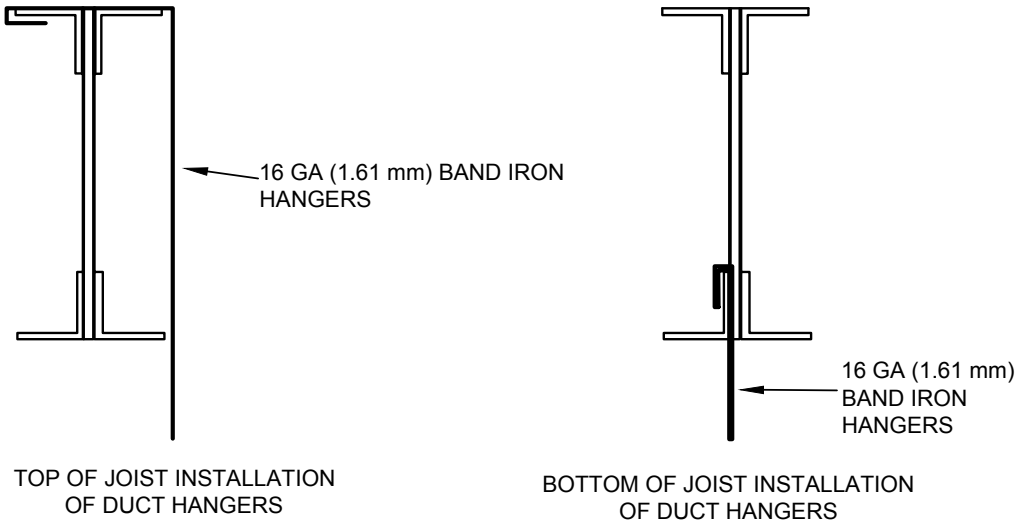


FIGURE 6-4 ALTERNATE JOIST ATTACHMENTS

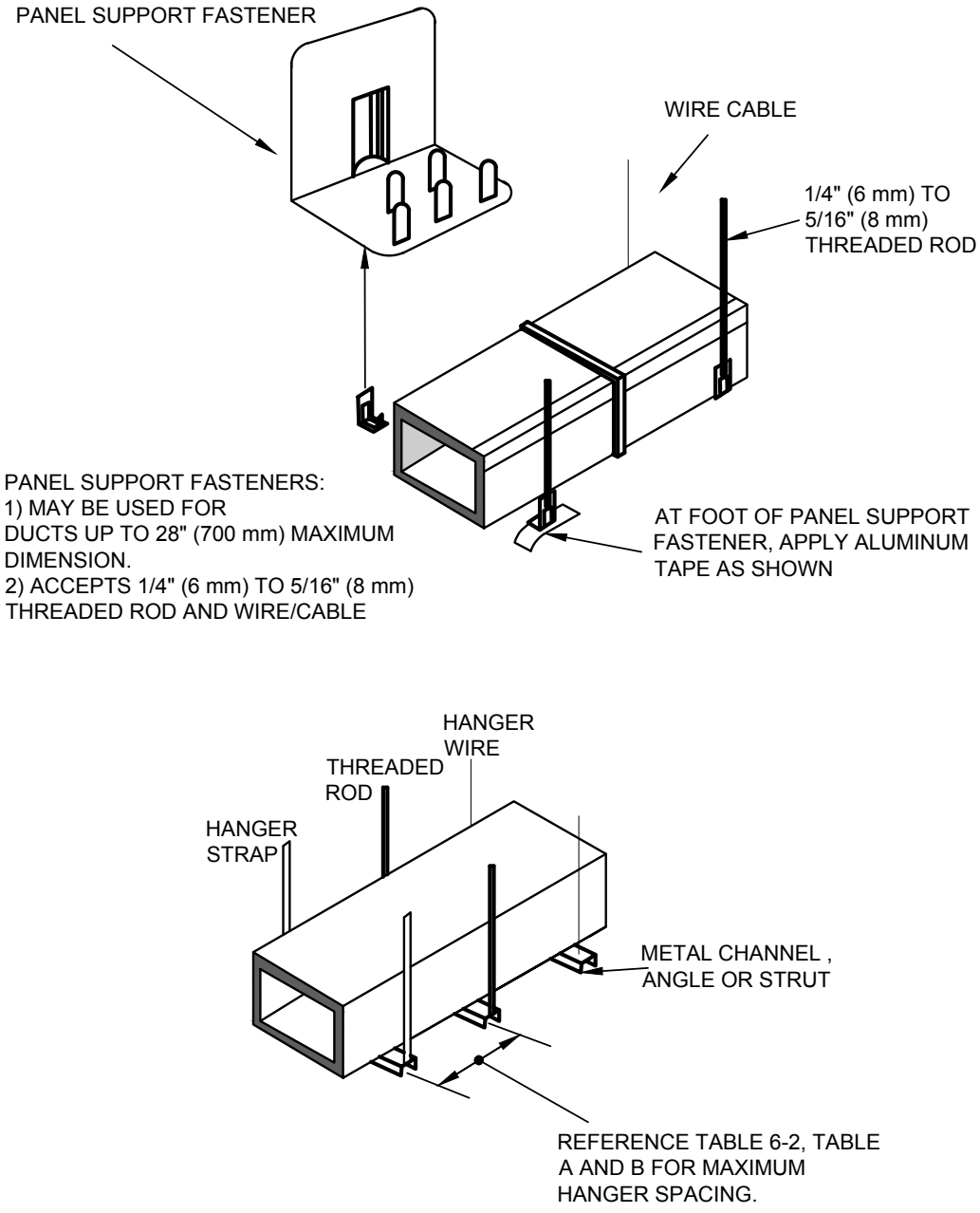


FIGURE 6-5 HANGERS DUCT

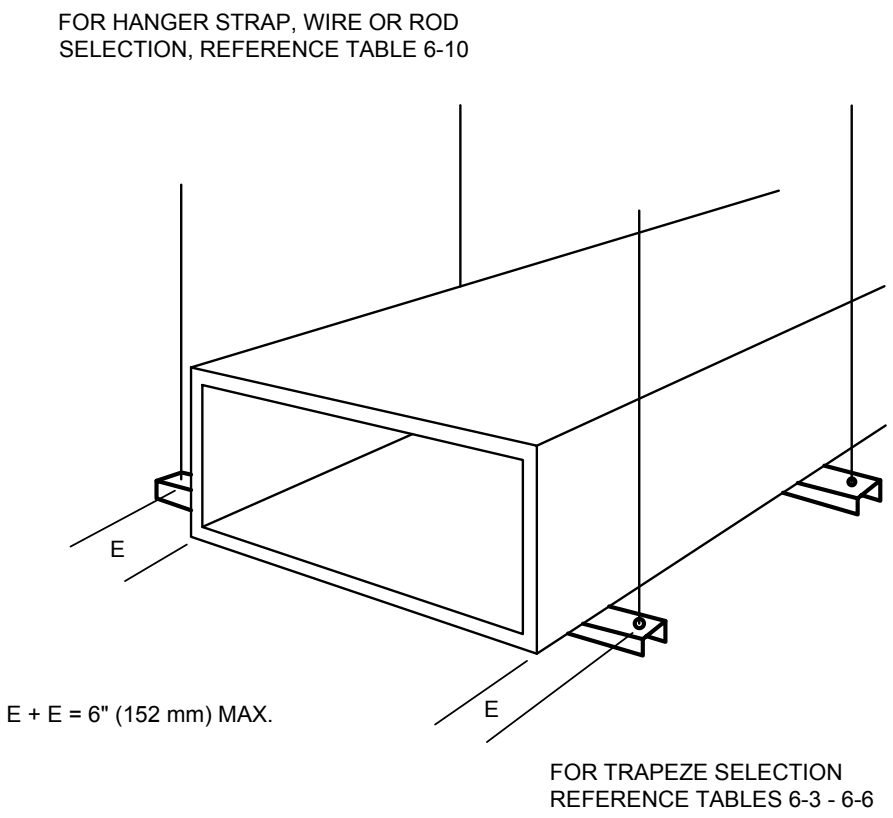
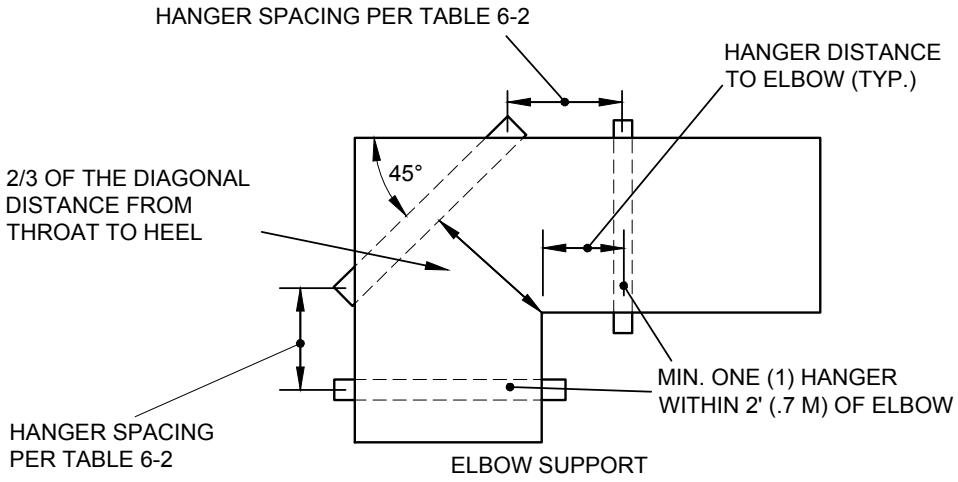
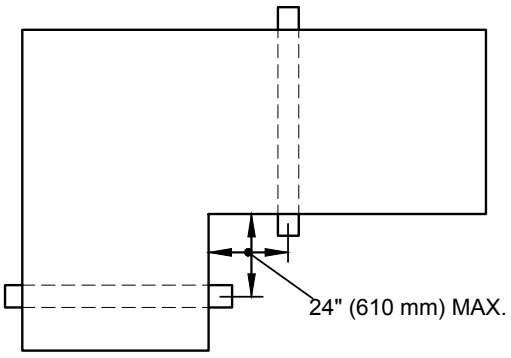
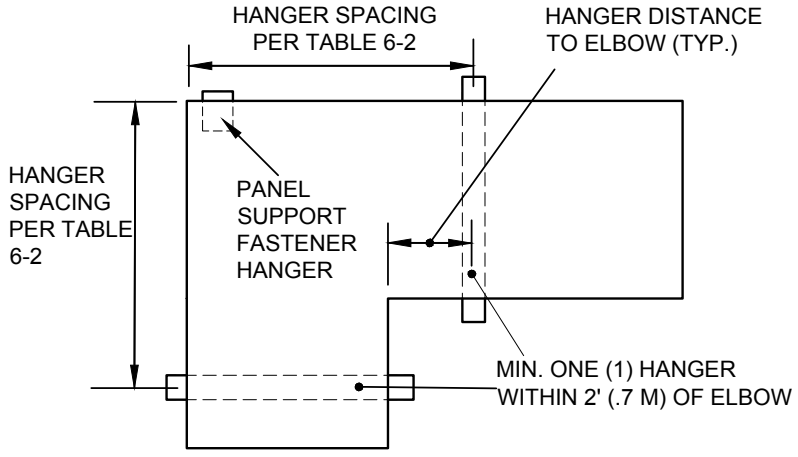


FIGURE 6-6 HANGERS DUCT



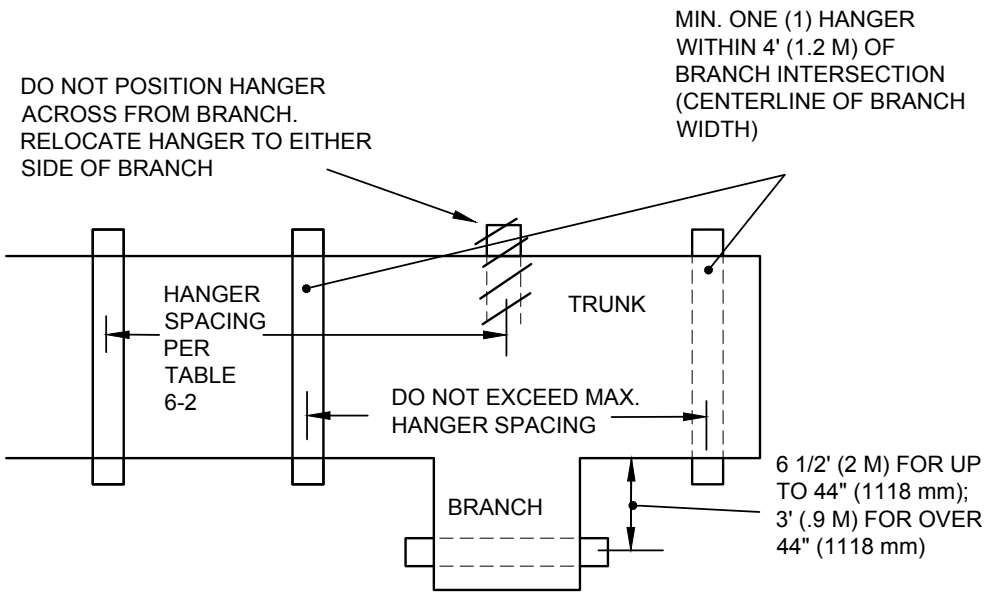


ELBOW SUPPORT OPTION FOR DUCT UP TO 18" (457 mm)

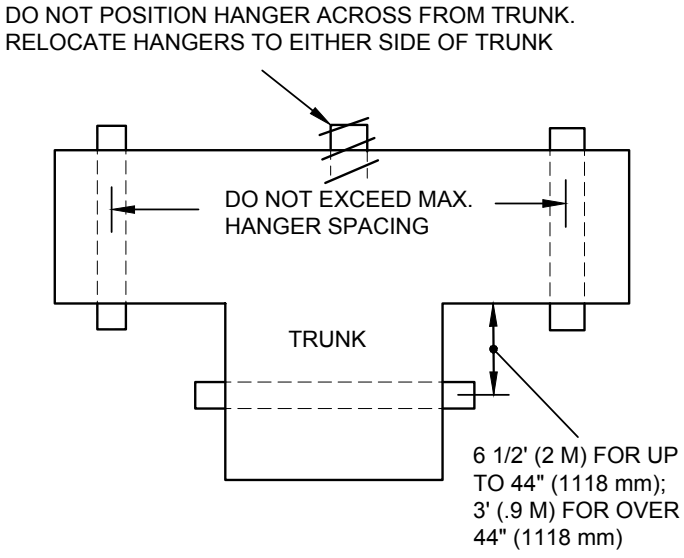


ELBOW SUPPORT OPTION FOR DUCT UP TO 28" (700 mm)

FIGURE 6-7 HANGERS FITTINGS



BRANCH SUPPORT



TEE SUPPORT

FIGURE 6-8 HANGERS FITTINGS

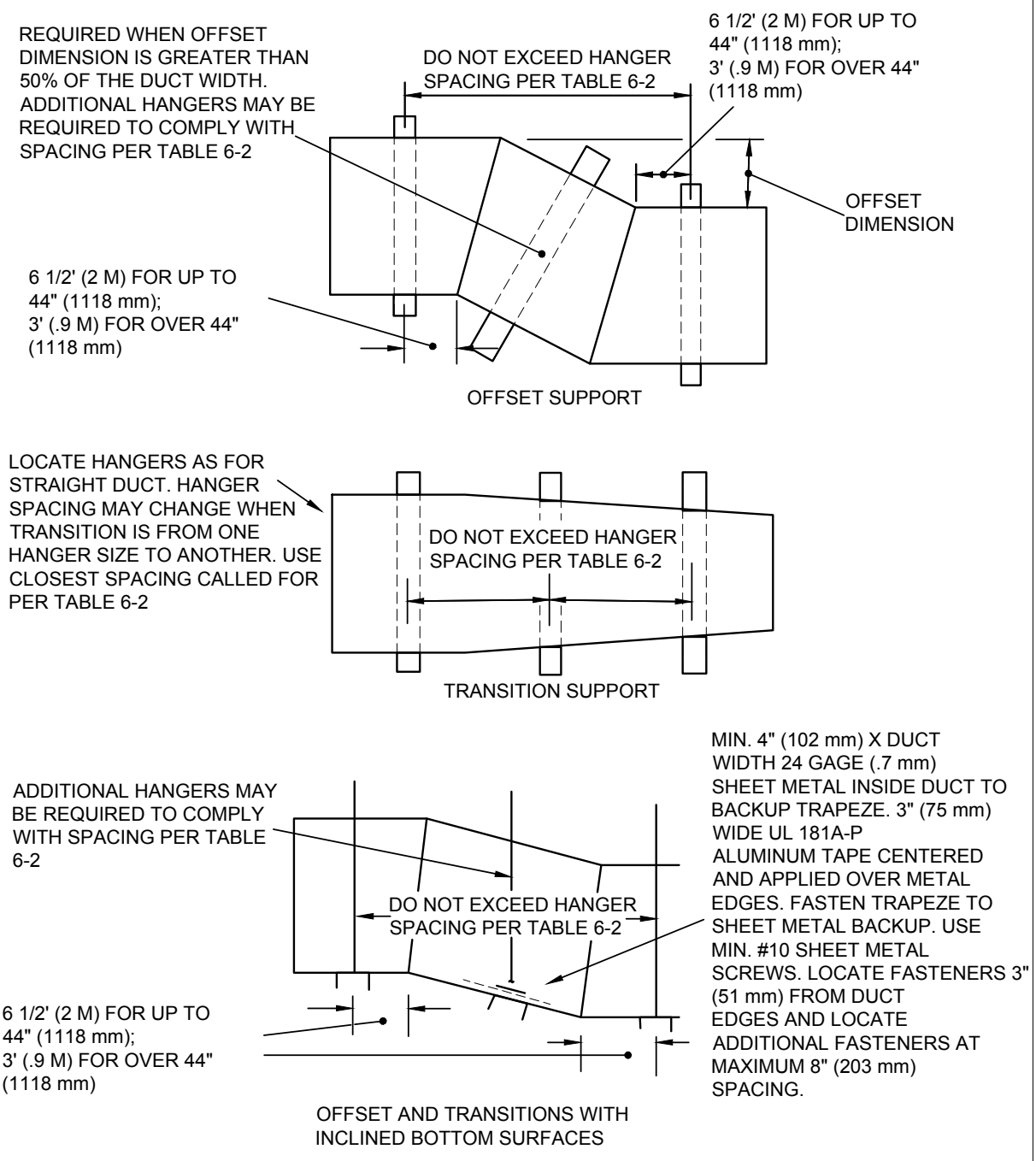


FIGURE 6-9 HANGERS FITTINGS

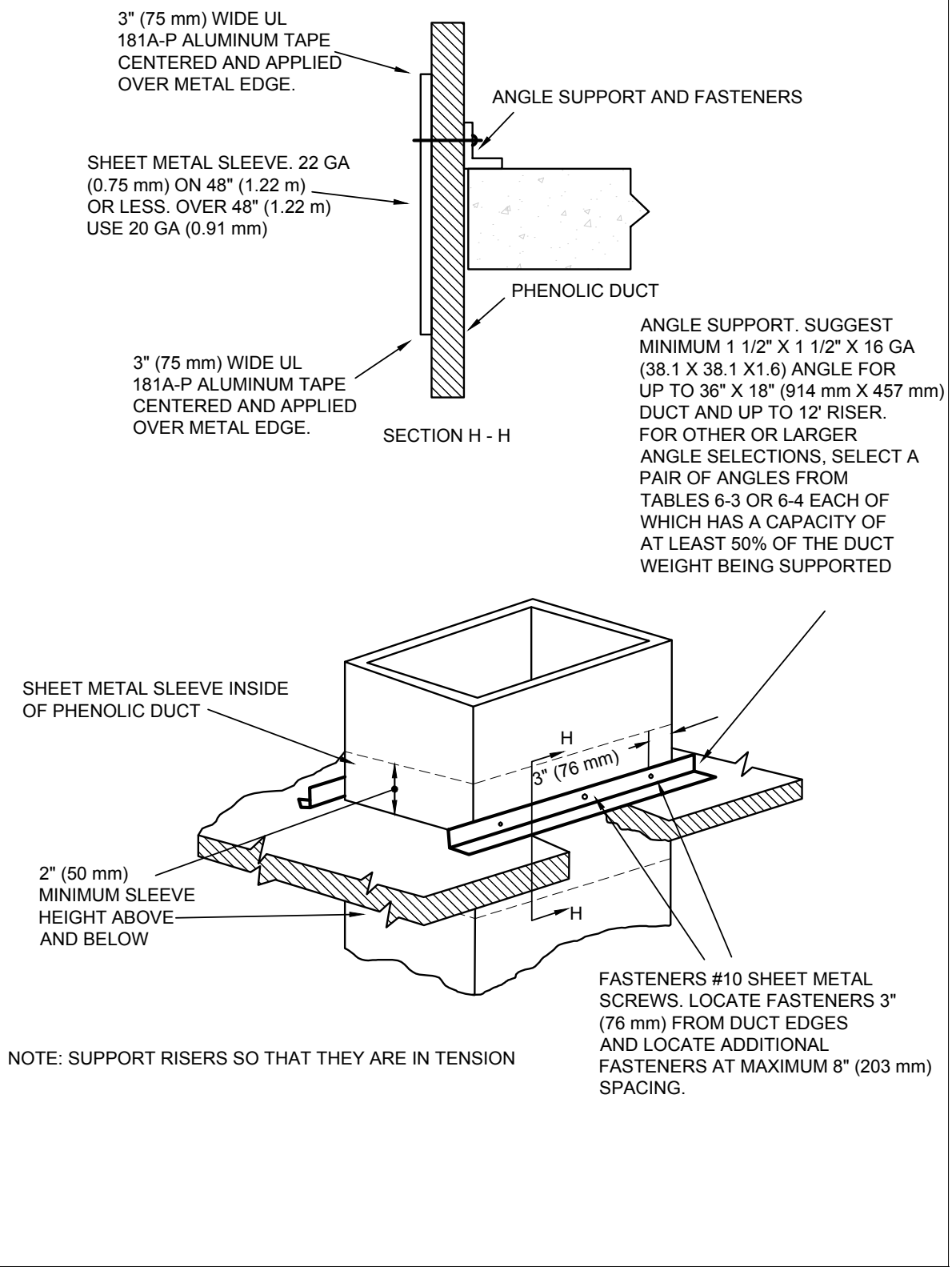


FIGURE 6-10 RISER SUPPORT

Table A – ft. / in.										
Largest Duct Side	Duct Segment Maximum Length	Pair at 13 Ft. Spacing			Pair at 6 Ft. Spacing			Pair at 4 Ft. Spacing		
		Strap	Wire	Rod	Strap	Wire	Rod	Strap	Wire	Rod
36 in.	154 3/4 in.	1 in × 22 GA	12 GA	1/4 in	1 in × 22 GA	12 GA	1/4 in	1 in × 22 GA	12 GA	1/4 in
44 in.	154 3/4 in.	1 in × 22 GA	10 GA	1/4 in	1 in × 22 GA	12 GA	1/4 in	1 in × 22 GA	12 GA	1/4 in
60 in.	47 1/4 in.	Not Designed			1 in × 22 GA	12 GA	1/4 in	1 in × 22 GA	12 GA	1/4 in
80 in.	47 1/4 in.	Not Designed			1 in × 22 GA	10 GA	1/4 in	1 in × 22 GA	12 GA	1/4 in
Over 80 in.	Consult With Phenolic Panel Manufacturer									

When Straps Are Lap Joined Use These Minimum Fasteners:	Single Hanger Maximum Allowable Load	
	Strap	Wire or Rod
1 in. × 22 GA – Two #10 Screws or One 1/4 in. Bolt/Nut 1 in. × 20 GA – Two # 10 Screws or One 1/4 in. Bolt/Nut	1 in × 22 GA – 260 Lbs. 1 in × 20 GA – 320 Lbs.	.106 in. / 12 GA – 80 Lbs. .135 in. / 10 GA – 120 Lbs. .162 in. / 8 GA – 160 Lbs. 1/4 in. – 270 Lbs.

Table B – m / mm										
Largest Duct Side	Duct Segment Maximum Length	Pair at 4 m Spacing			Pair at 1.8 m Spacing			Pair at 1.2 m Spacing		
		Strap	Wire	Rod	Strap	Wire	Rod	Strap	Wire	Rod
914	4 m	25.4 × 0.85	2.7	6.4	25.4 × 0.85	2.7	6.4	25.4 × 0.85	2.7	6.4
1118	4 m	25.4 × 0.85	3.2	6.4	25.4 × 0.85	2.7	6.4	25.4 × 0.85	2.7	6.4
1524	1.2 m	Not Designed			25.4 × 0.85	2.7	6.4	25.4 × 0.85	2.7	6.4
2032	1.2 m	Not Designed			25.4 × 0.85	3.2	6.4	25.4 × 0.85	2.7	6.4
Over 2032	Consult With Phenolic Panel Manufacturer									

When Straps Are Lap Joined Use These Minimum Fasteners:	Single Hanger Maximum Allowable Load	
	Strap	Wire or Rod
25.4 × 0.85 mm – One 6.4 Bolt/Nut 25.4 × 1.00 mm – One 6.4 Bolt	25.4 × 0.85 – 118 Kg. 25.4 × 1.00 – 145 Kg.	2.7 – 36 Kg. 3.2 – 54 Kg. 4.1 – 73 Kg. 6.4 – 122 Kg.

Table 6-1 Rectangular Duct Hanger Minimum Size

NOTES:

1) Tables Allow For Duct Weight And .5 Lb./sf (2.44 kg./m2) Normal Reinforcement And Trapeze Weight, But No External Loads.
2) For Custom Design of Hangers, Designers May Consult the *HVAC DCS*, SMACNA *Rectangular Industrial Duct Construction Standards*; the *AISI Cold Formed Steel Design Manual* And The *AISC Steel Construction Manual*.
3) Straps Are Galvanized Steel; Other Materials Are Uncoated Steel. Reference Section 6.2.6
4) Allowable Loads For Duct Sizes Assume That Ducts Are 1 3/16 in. (30 mm) Phenolic Panels. Additionally, when maximum duct dimension is over 60 in. (1520 mm) then Largest Dimension is 1.25.
5) For Upper Attachments See Figures 6-1 – 6-4
6) For Lower Attachments See Figures 6-5 – 6-9
7) For Trapeze Sizes See Table 6-3 – 6-6
8) Wire Is Steel Of Black Annealed, Bright Basic, Or Galvanized Type. Reference Section 6.2.6
9) Cable Hanging Systems with Adjustable Mechanical Device.

Table A – Maximum Hanger Spacing by Duct Size Ft. / in.		
Largest Duct Side	**Duct Section Length**	**Maximum Spacing**
44 in.	154 3/4 in.	13 Ft.
80 in.	47 1/2 in.	6 Ft.
Over 80 in.	Consult Phenolic Panel Manufacturer	

Table B – Maximum Hanger Spacing by Duct Size m / mm		
Largest Duct Side	**Duct Section Length**	**Maximum Spacing**
1118 mm	3931 mm	4 m
2032 mm	1207 mm	1.8 m
Over 2032 mm	Consult Phenolic Panel Manufacturer	

Table 6-2 Rectangular Duct Hanger Spacing

Trapeze		Angles							
		A	B	C	D	E	F	G	H
Length, in.		**1" × 1" × 16 ga**	**1" × 1" × 1/8"**	**1 1/2" × 1 1/2" × 16 ga**	**1 1/2" × 1 1/2" × 1/8"**	**1 1/2" × 1 1/2" × 3/16"**	**1 1/2" × 1 1/2" × 1/4"**	**2" × 2" × 1/8"**	**2" × 2" × 3/16"**
18		80	150	180	350	510	650	650	940
24		75	150	180	350	510	650	650	940
30		70	150	180	350	510	650	650	940
36		60	130	160	340	500	620	620	920
42		40	110	140	320	480	610	610	900
48		–	80	110	290	450	580	580	870
54		–	–	–	250	400	540	540	840
60		–	–	–	190	350	490	490	780
66		–	–	–	100	270	400	400	700
72		–	–	–	–	190	320	320	620
78		–	–	–	–	80	210	210	500
84		–	–	–	–	–	75	75	380
96		–	–	–	–	–	–	–	40
Section Properties	Ix	0.012	0.022	0.041	0.078	0.110	0.139	0.190	0.272
	Z	0.016	0.031	0.037	0.072	0.104	0.13	0.130	0.190
	A	0.120	0.234	0.180	0.359	0.527	0.688	0.484	0.715
	lb/ft	0.440	0.800	0.660	1.230	1.800	2.340	1.650	2.440

Table 6-3 Allowable Loads in Pounds for Trapeze Bars

NOTES:

1) It is assumed that steel with a yield strength of 30,000 psi or greater is used.
2) Loads above assume that a hanger rod is 6 in. max distance from the duct side for lengths of 96 in. or less, and 3 in. for greater lengths.
3) Sheet Metal Channel and Framing Struts *see* Table 6-5 and 6-6. Other steel shapes having equal or greater (Ix and Z) properties may be used in place of listed shapes. Ix is in $in.^4$, Z is in $in.^3$, and A is in $in.^2$
4) *See* Table 6-1 for rod and strap load limits.

Trapeze		Angles							
		A	B	C	D	E	F	G	H
Length (mm)		25 × 25 × 1.61	25 × 25 × 3.2	38.1 × 38.1 × 1.61	38.1 × 38.1 × 3.2	38.1 × 38.1 × 4.8	38.1 × 38.1 × 6.4	51 × 51 × 3.2	51 × 51 × 3.8
450		36	68	81	159	231	295	295	426
600		34	68	81	159	231	295	295	426
760		32	68	81	159	231	295	295	426
900		27	59	72	154	227	281	281	417
1060		18	50	63	145	218	277	277	408
1220		–	36	50	132	204	263	263	395
1370		–	–	–	113	181	245	245	381
1520		–	–	–	86	159	222	222	354
1670		–	–	–	45	122	181	181	318
1830		–	–	–	–	86	145	145	281
2010		–	–	–	–	36	95	95	227
2130		–	–	–	–	–	34	34	454
2440		–	–	–	–	–	–	–	18
Section Properties	Ix	0.494	0.906	1.69	3.21	4.53	3.72	7.82	11.2
	Z	0.262	0.508	0.606	1.18	1.70	2.13	2.13	3.11
	A	77.4	151	116	232	340	444	312	461
	kg/m	0.65	1.20	0.98	1.83	2.66	3.48	2.46	3.63

Table 6-4 Allowable Loads in Kilograms for Trapeze Bars

NOTES:

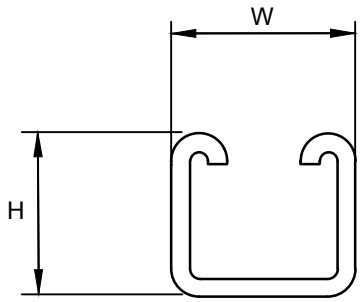
1) It is assumed that steel with a yield strength of 172.4 MPa or greater is used.
2) Loads above assume that a hanger rod is 152 mm max distance from the duct side for lengths of 2440 mm or less, and 76 mm for greater lengths.
3) Sheet Metal Channel and Framing Struts *see* Table 6-5 and 6-6. Other steel shapes having equal or greater (Ix and Z) properties may be used in place of listed shapes. Ix is in in.^{4}, Z is in in.^{3}, and A is in in.^{2}
4) *See* Table 6-1 for rod and strap load limits.

FRAMING CHANNEL (STRUT) MAY BE USED AS AN ALTERNATIVE TO THE TRAPEZE ANGLES SHOWN IN TABLE 6-3 and 6-4 AS FOLLOWS:

Channel (Strut)			Section Modulus (Z)	Moment of Inertia (I)	Trapeze
W	H	GA	$in.^3$	$in.^4$	Table 6-3
1 5/8 in.	1 in.	12	0.0923	0.0533	A, B, C
1 5/8 in.	1 3/8 in.	12	0.1559	0.1209	D, E
1 5/8 in.	1 5/8 in.	12	0.2042	0.1850	F, G
1 5/8 in.	2 7/16 in.	12	0.3927	0.5203	H

Channel (Strut)			Section Modulus (Z)	Moment of Inertia (I)	Trapeze
W (mm)	H (mm)	MM	mm^3	mm^4	Table 6-4
41.3	25.4	2.45	1500	22,200	A, B, C
41.3	34.9	2.45	2600	50,300	D, E
41.3	41.3	2.45	3300	77,000	F, G
41.3	61.9	2.45	6400	216,000	H

Table 6-5 Channel (Strut) Used as Trapeze

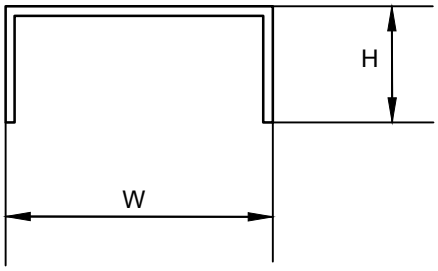


CHANNEL MAY BE USED AS AN ALTERNATIVE TO THE TRAPEZE ANGLES SHOWN IN TABLE 6-3 and 6-4 AS FOLLOWS:

Channel			Section Modulus (Z)	Moment of Inertia (I)	Trapeze
W	H	GA	$in.^3$	$in.^4$	Table 6-3
3 in.	1 1/2 in.	24	0.0339	0.0378	A, B
3 in.	2 in.	22	0.0700	0.0998	C, D
3 in.	2 in.	18	0.1072	0.1511	E

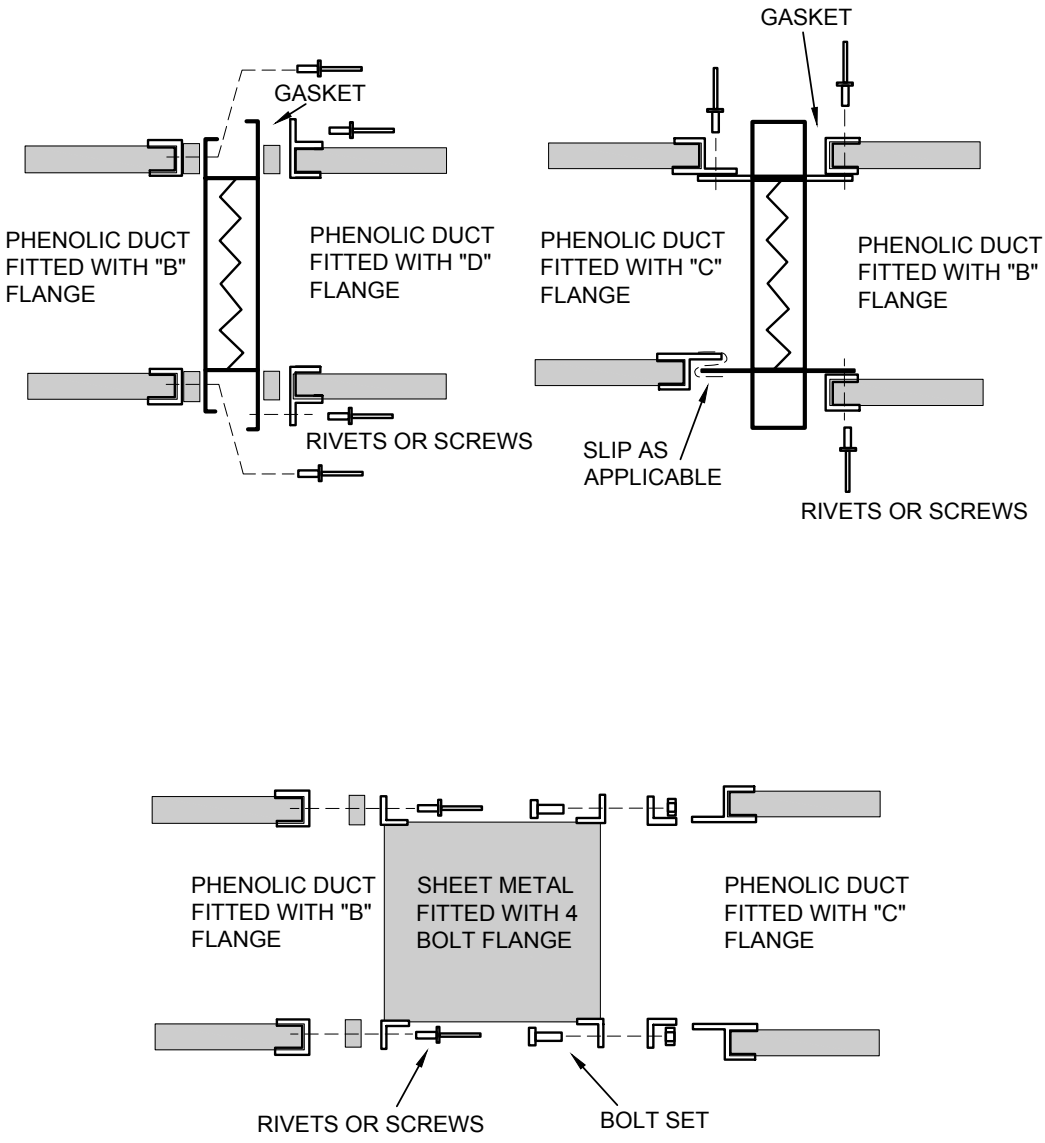
Channel			Section Modulus (Z)	Moment of Inertia (I)	Trapeze
W (mm)	H (mm)	MM	mm^3	mm^4	Table 6-4
76.0	38.0	0.70	555	15,732	A, B
76.0	51.0	0.85	1147	41,537	C, D
76.0	51.0	1.31	1757	62,888	E

Table 6-6 Channel Used as Trapeze



CHAPTER 7

ACCESSORIES



NOTE: SHEET METAL ITEMS SHALL BE FABRICATED AS SPECIFIED IN THE *HVAC DCS* EXCEPT AS NECESSARILY ALTERED FOR INCORPORATION IN PHENOLIC DUCT.

FIGURE 7-1 COMPONENT CONNECTION

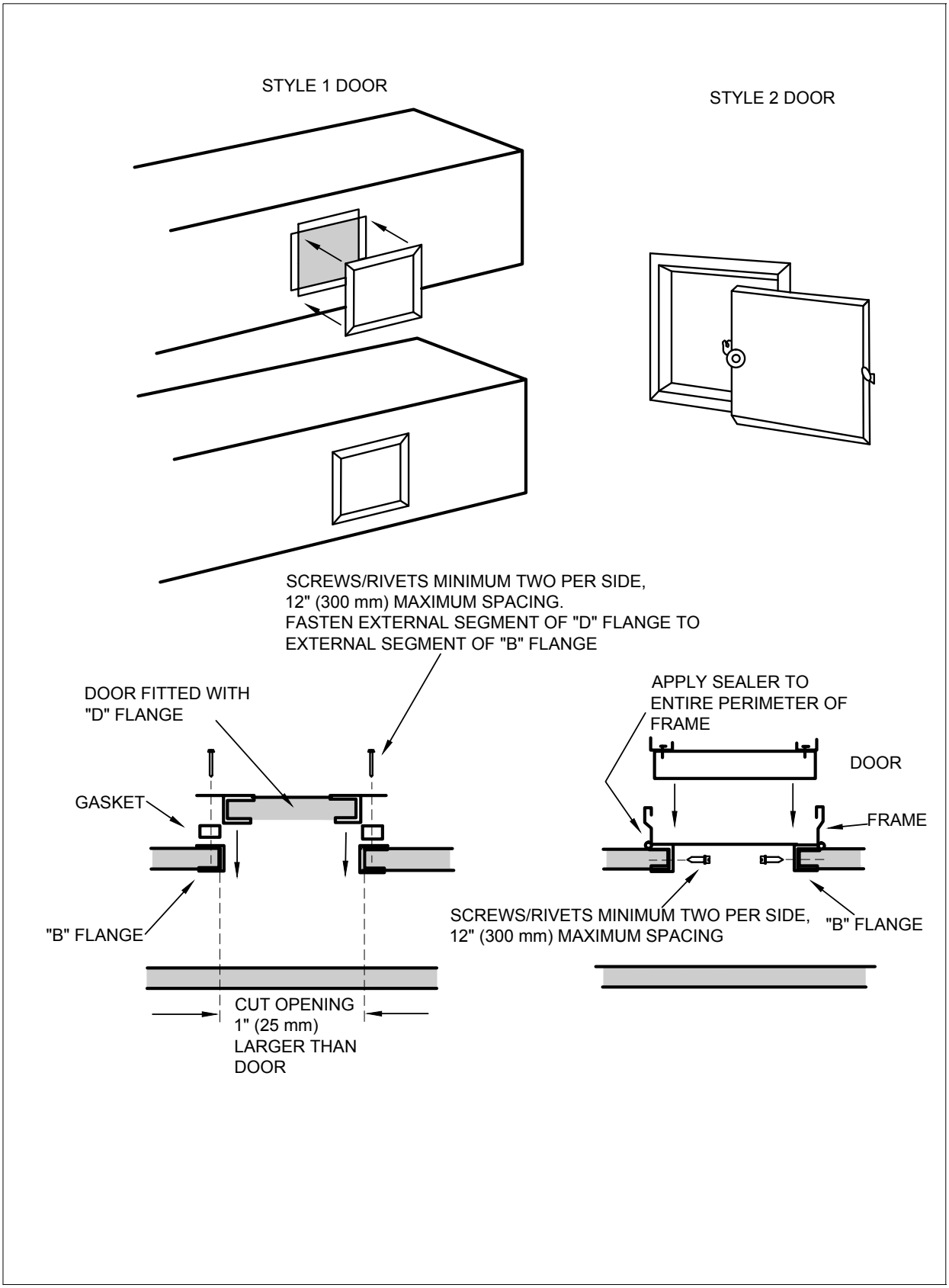
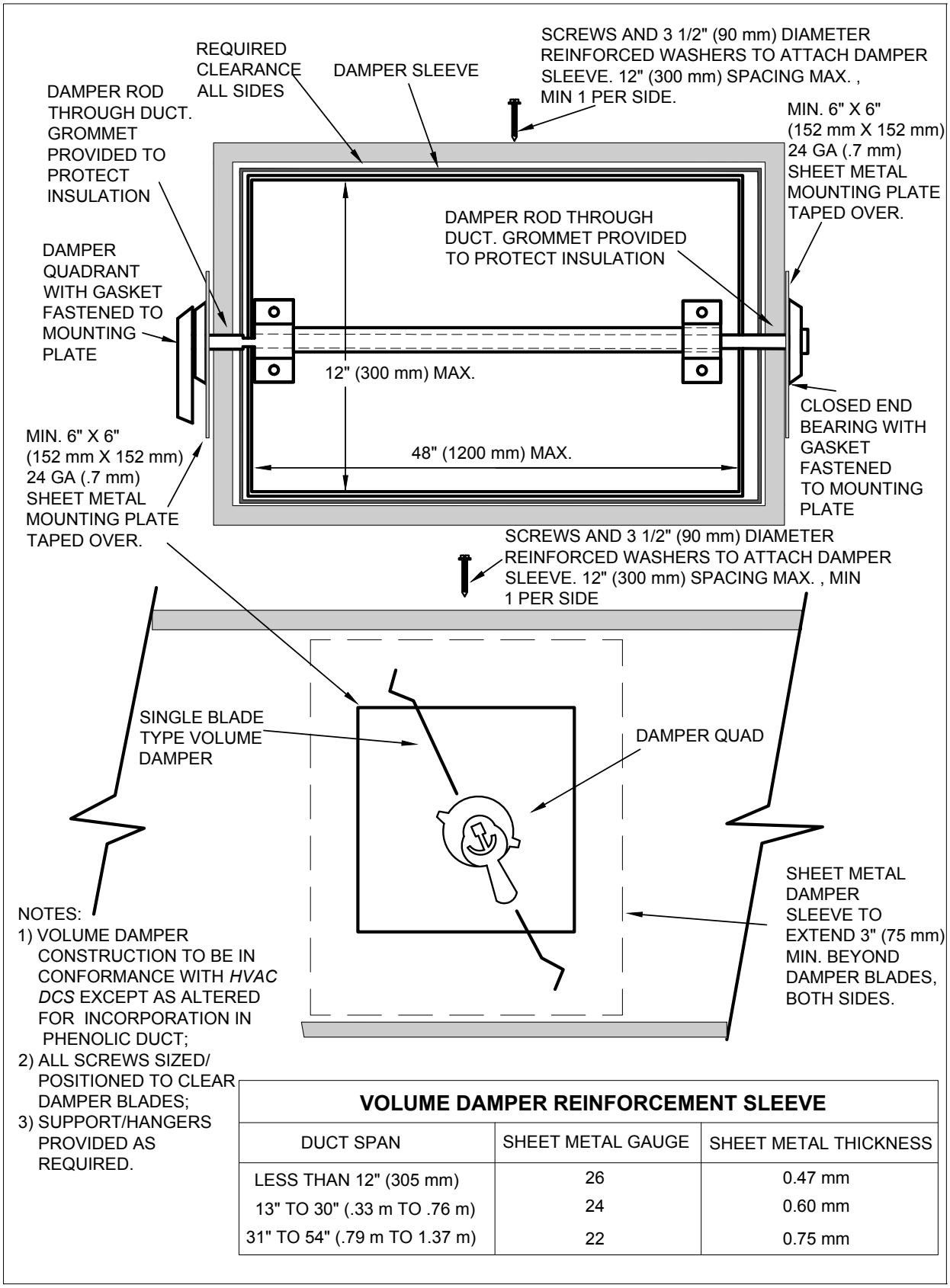


FIGURE 7-2 MECHANICAL ACCESS DOORS

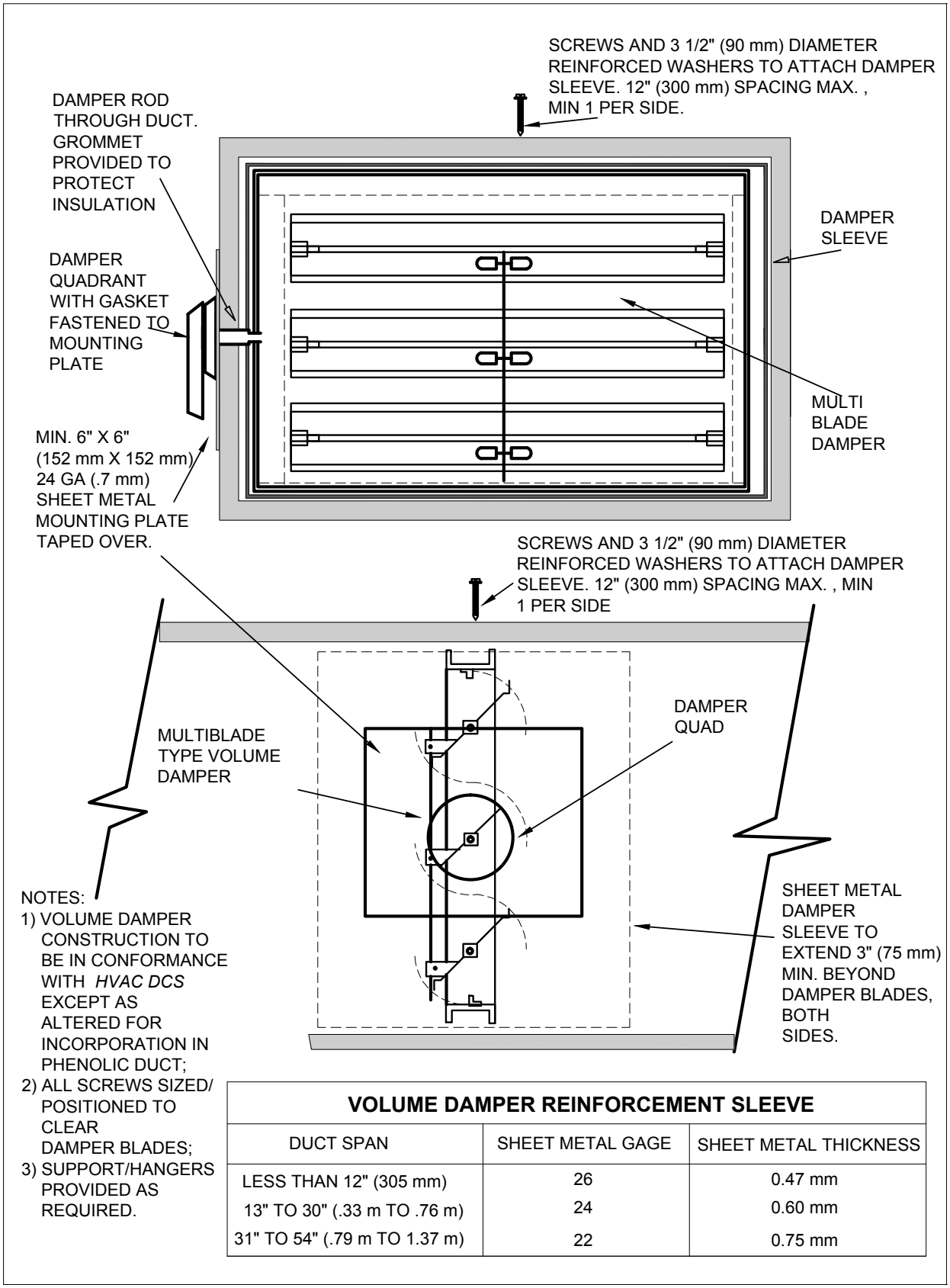


NOTES:
1) VOLUME DAMPER CONSTRUCTION TO BE IN CONFORMANCE WITH *HVAC DCS* EXCEPT AS ALTERED FOR INCORPORATION IN PHENOLIC DUCT;
2) ALL SCREWS SIZED/ POSITIONED TO CLEAR DAMPER BLADES;
3) SUPPORT/HANGERS PROVIDED AS REQUIRED.

VOLUME DAMPER REINFORCEMENT SLEEVE

DUCT SPAN	SHEET METAL GAUGE	SHEET METAL THICKNESS
LESS THAN 12" (305 mm)	26	0.47 mm
13" TO 30" (.33 m TO .76 m)	24	0.60 mm
31" TO 54" (.79 m TO 1.37 m)	22	0.75 mm

FIGURE 7-3 VOLUME DAMPER – IN DUCT – SINGLE BLADE TYPE

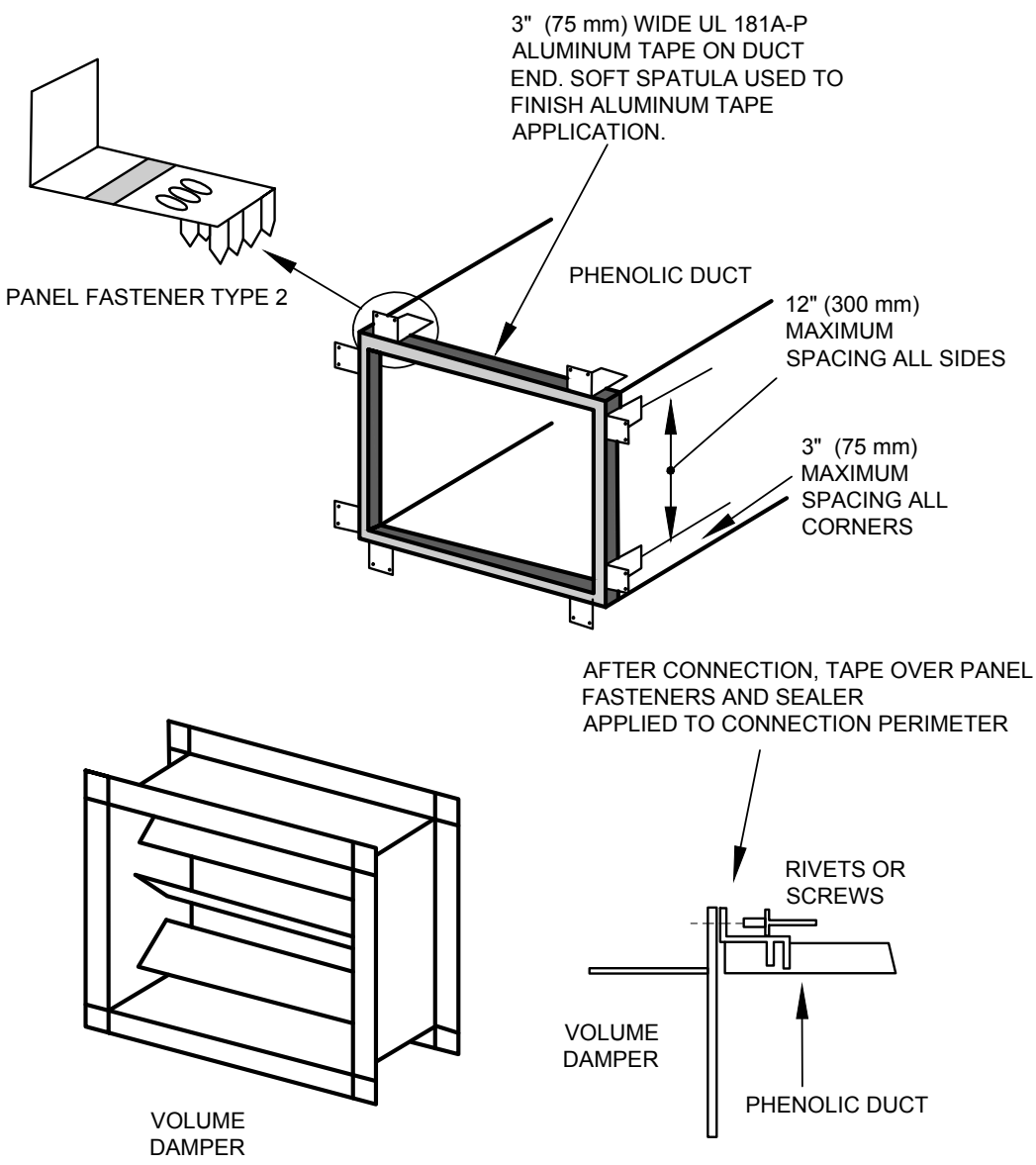


NOTES:
1) VOLUME DAMPER CONSTRUCTION TO BE IN CONFORMANCE WITH *HVAC DCS* EXCEPT AS ALTERED FOR INCORPORATION IN PHENOLIC DUCT;
2) ALL SCREWS SIZED/ POSITIONED TO CLEAR DAMPER BLADES;
3) SUPPORT/HANGERS PROVIDED AS REQUIRED.

VOLUME DAMPER REINFORCEMENT SLEEVE

DUCT SPAN	SHEET METAL GAGE	SHEET METAL THICKNESS
LESS THAN 12" (305 mm)	26	0.47 mm
13" TO 30" (.33 m TO .76 m)	24	0.60 mm
31" TO 54" (.79 m TO 1.37 m)	22	0.75 mm

FIGURE 7-4 VOLUME DAMPER – IN DUCT – MULTI BLADE TYPE



NOTE:
-VOLUME DAMPER CONSTRUCTION TO BE IN CONFORMANCE WITH *HVAC DCS* EXCEPT AS ALTERED FOR INCORPORATION IN PHENOLIC DUCT.
-APPLICABLE TO MAXIMUM 1 IN. W.G. (250 PA) PRESSURE CLASS / 24" (600 mm) DUCT GREATEST DIMENSION

FIGURE 7-5 VOLUME DAMPER – EXTERNAL TO DUCT – NON-FLANGED

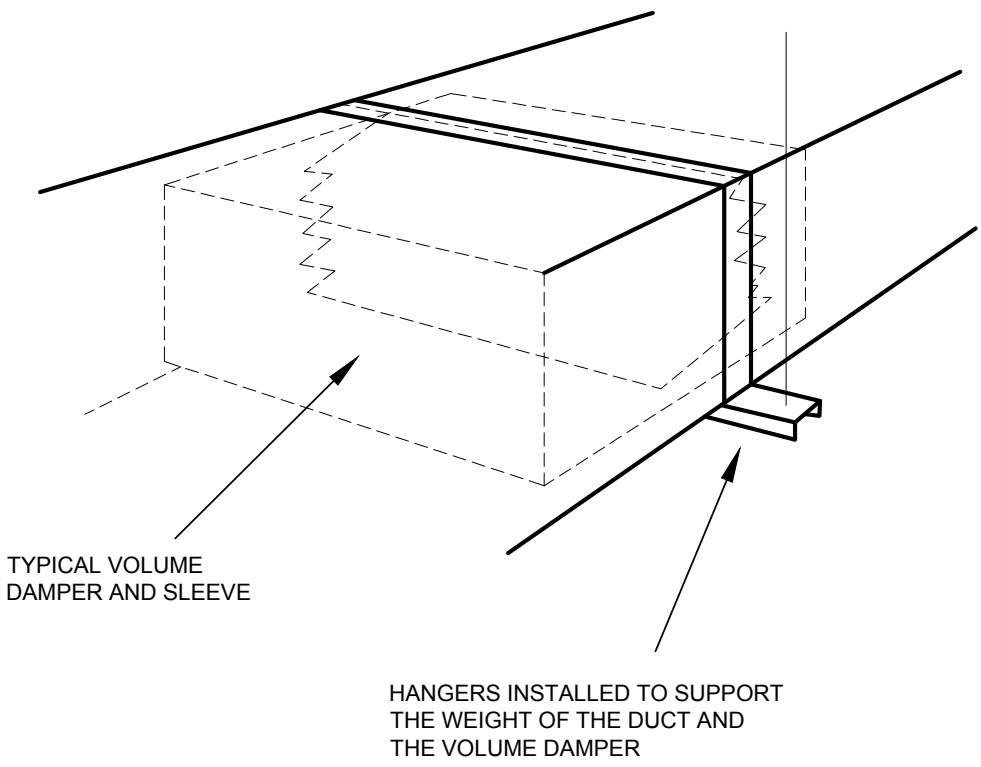


FIGURE 7-6 VOLUME DAMPER SUPPORT

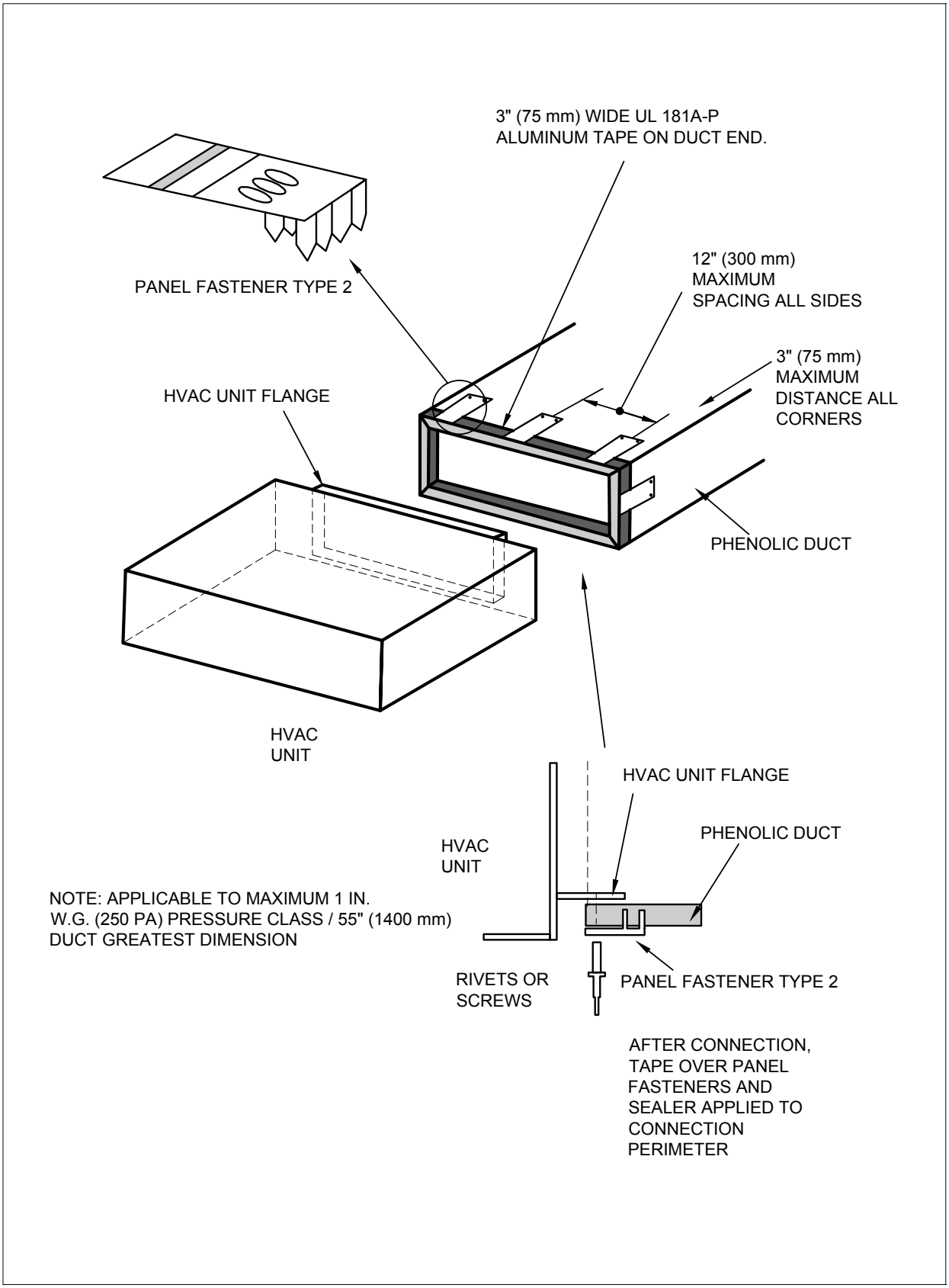


FIGURE 7-7 HVAC EQUIPMENT CONNECTIONS – NON-FLANGED

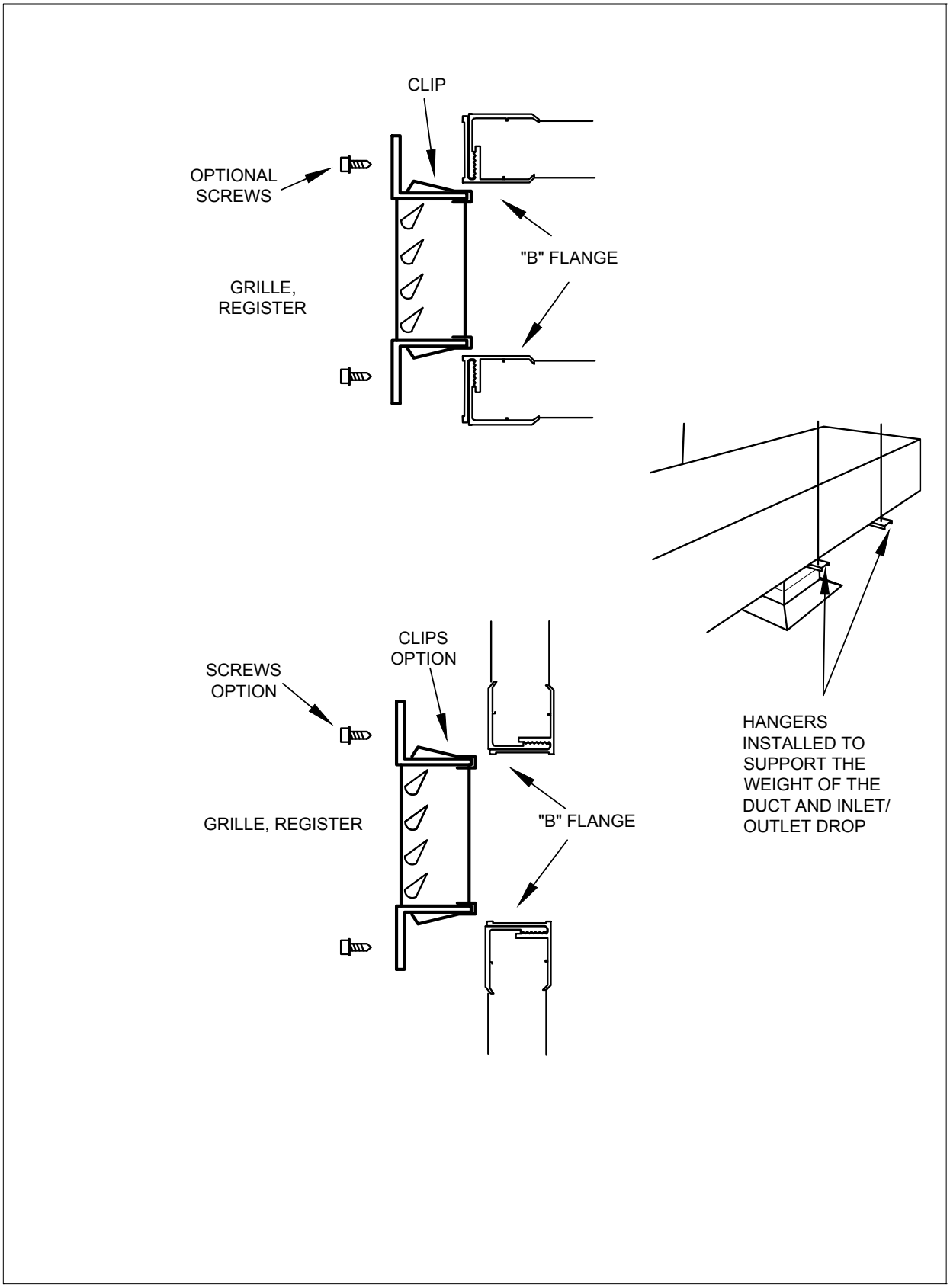


FIGURE 7-8 INLET/OUTLET PHENOLIC DUCT MOUNTED

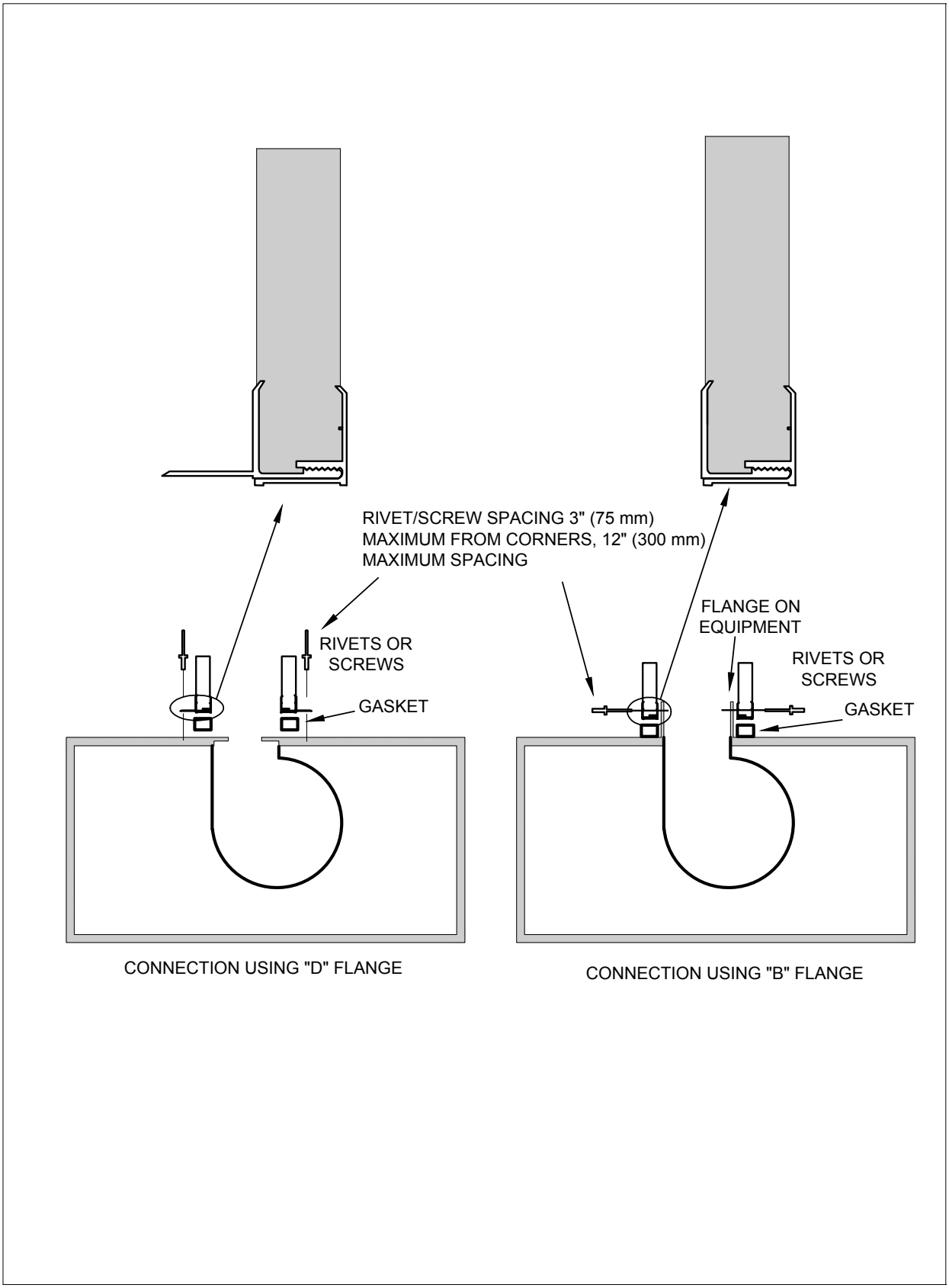
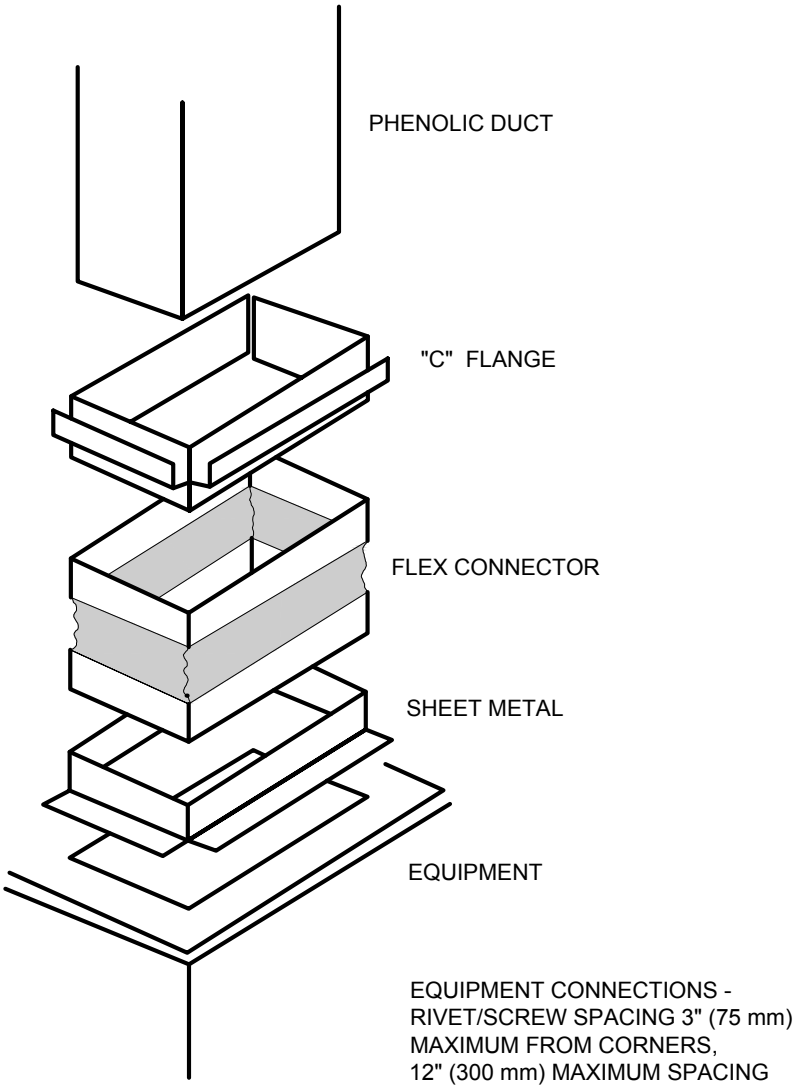
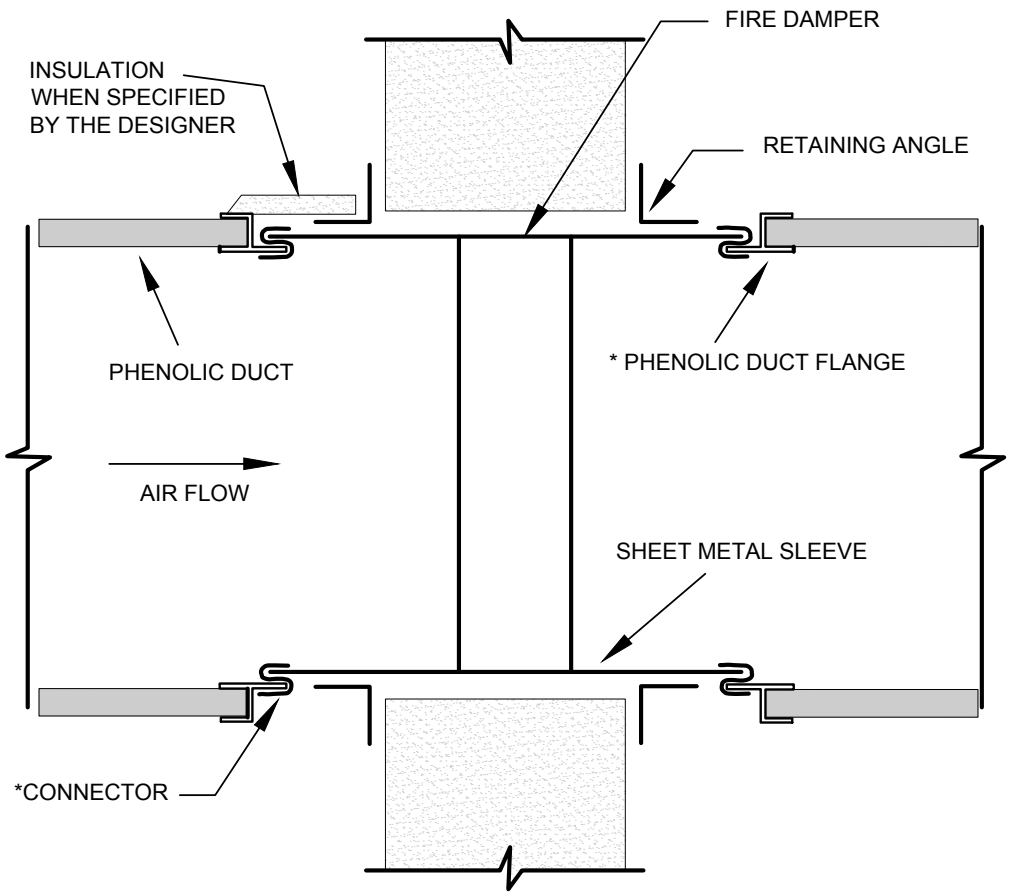


FIGURE 7-9 HVAC EQUIPMENT CONNECTIONS



NOTE: FLEX CONNECTOR AND SHEET METAL CONSTRUCTION TO BE IN CONFORMANCE WITH *HVAC DCS* EXCEPT AS ALTERED FOR INCORPORATION IN PHENOLIC DUCT

FIGURE 7-10 HVAC EQUIPMENT CONNECTIONS



INTERRUPTION OF INTERNAL INSULATION AT THE FIRE DAMPER IS REQUIRED BY NFPA STANDARD 90A. WHERE 90A IS APPLICABLE INSTALLATION SHOULD BE MADE AS SHOWN AND SHOULD OTHERWISE CONFORM TO THE SMACNA *HVAC DCS*.

THE DESIGNER SHOULD SPECIFY EXTERNAL INSULATION AS SHOWN TO PREVENT CONDENSATION OCCURRING ON UNLINED METAL AT PENETRATIONS. WHERE THE PROVISIONS OF NFPA 90A AS APPLICABLE, NEITHER INSULATION NOR LINER CAN EXTEND THROUGH THE WALLS OF FLOORS.

* S SLIP IS ILLUSTRATED; SEE SMACNA FIRE, SMOKE AND RADIATION DAMPER MANUAL FOR RANGE OF APPROVED TYPES OF CONNECTOR.

FIGURE 7-11 PHENOLIC DUCT INTERRUPTION

ACCESSORIES	FIGURE No.	Duct Dimension	Application Notes	in. w.g. / Pa Static				
				Positive or Negative				Pos. Only
				.5	1	2	3	4
				125	250	500	750	1000
Flanged Component Connections	7-1	80 in. (2032 mm) and Under		X	X	X	X	X
Mechanical Access Doors	7-2	All Sizes	Flanged Construction	X	X	X	X	X
Volume Damper – In Duct – Single Blade Type	7-3	48 in. (1200 mm) Width, 12 in. (300 mm) Height	Sleeved	X	X	X	X	X
Volume Damper – In Duct – Multi Blade Type	7-4	80 in. (2000 mm) and Under	Sleeved	X	X	X	X	X
Flanged Volume Damper External To Duct – Non-Flanged Connection	7-5	24 in. (600 mm) and Under	Using Panel Fastener Type 2 Connection	X	Not Permitted			
Grille, Register Phenolic Duct Mount	7-8	All Sizes	Flanged Construction	X	X	X	X	X
HVAC Unit Connection – "D" Flange, "B" Flange	7-9	80 in. (2000 mm) and Under	Flanged Construction	X	X	X	X	X
HVAC Unit Connection – Flex Connector / "C" Flange	7-10	80 in. (2000 mm) and Under	Flanged Const.; Flex Connector And Sheet Metal per SMACNA *HVAC DCS*	X	X	X	X	X
HVAC Unit Connection – Non-Flanged	7-7	55 in. (1400 mm) and Under	Using Panel Fastener Type 2 Connection	X	Not Permitted			
Phenolic Duct Interruption	7-11	80 in. (2000 mm) and Under	Sheet Metal per SMACNA *HVAC DCS*	X	X	X	X	X

LEGEND:

X

Permitted

Note: For duct over 80 in. (2000 mm), consult with the phenolic panel manufacturer.

Table 7-1 Accessories Pressure Table

APPENDICES

7/8 IN. Phenolic Duct Pounds Per Linear Foot																			
8	1.5																		
12	1.7	2.0																	
16	2.0	2.3	2.6																
20	2.3	2.6	2.8	3.1															
24	2.6	2.8	3.1	3.4	3.7														
28	2.8	3.1	3.4	3.7	3.9	4.2													
32	3.2	3.5	3.8	4.1	4.4	4.7	5.1												
36	3.5	3.8	4.1	4.4	4.7	5.0	5.4	5.7											
40	3.8	4.1	4.4	4.7	5.0	5.3	5.6	5.9	6.2										
44	4.1	4.4	4.7	4.9	5.2	5.5	5.9	6.2	6.5	6.8									
48	5.6	5.9	6.3	6.7	7.1	7.5	7.9	8.3	8.7	9.1	9.5								
52	5.9	6.3	6.7	7.1	7.5	7.9	8.2	8.7	9.1	9.5	9.9	10.3							
56	6.3	6.7	7.0	7.4	7.8	8.2	8.6	9.0	9.4	9.8	10.2	10.6	11.0						
60	6.6	7.0	7.4	7.8	8.2	8.6	9.0	9.4	9.8	10.2	10.6	11.0	11.4	11.8					
64	7.0	7.4	7.8	8.1	8.5	8.9	9.3	9.7	10.1	10.5	10.9	11.3	11.7	12.1	12.5				
68	7.5	7.9	8.3	8.8	9.2	9.6	10.0	10.5	10.9	11.3	11.8	12.2	12.6	13.1	13.5	14.0			
72	7.8	8.3	8.7	9.1	9.5	10.0	10.4	10.8	11.3	11.7	12.1	12.6	13.0	13.4	13.8	14.3	14.8		
76	8.2	8.6	9.0	9.5	9.9	10.3	10.7	11.2	11.6	12.0	12.5	12.9	13.3	13.8	14.2	14.7	15.1	15.5	
80	8.6	9.0	9.4	9.8	10.2	10.7	11.1	11.6	12.0	12.4	12.9	13.3	13.7	14.1	14.5	15.0	15.5	15.9	16.3
W/H	**8**	**12**	**16**	**20**	**24**	**28**	**32**	**36**	**40**	**44**	**48**	**52**	**56**	**60**	**64**	**68**	**72**	**76**	**80**

Appendix A1 – Weight Table 7/8 IN. Panel Duct

NOTES:

1) Based on “A” Flange
2) Reinforcement Based on 2 in w.g. Pressure Class
3) Up To 44 in. Size Based On 154 3/4” in. Long Duct Sections. Over 44 in. Size Based On 47 1/4 in. Long Duct Sections
4) Over 80 in. Size Consult Phenolic Panel Manufacturer

22 mm Phenolic Duct Kilograms Per lineal Meter																			
203	2.2																		
305	2.5	3.0																	
406	3.0	3.4	3.9																
508	3.4	3.9	4.2	4.6															
610	3.9	4.2	4.6	5.1	5.5														
711	4.2	4.6	5.1	5.5	5.8	6.3													
813	4.8	5.2	5.7	6.1	6.5	7.0	7.6												
914	5.2	5.7	6.1	6.5	7.0	7.4	8.0	8.5											
1016	5.7	6.1	6.5	7.0	7.4	7.9	8.3	8.8	9.2										
1118	6.1	6.5	7.0	7.3	7.7	8.2	8.8	9.2	9.7	10.1									
1219	8.3	8.8	9.4	10.0	10.6	11.2	11.8	12.4	12.9	13.5	14.1								
1321	8.8	9.4	10.0	10.6	11.2	11.8	12.2	12.9	13.5	14.1	14.7	15.3							
1422	9.4	10.0	10.4	11.0	11.6	12.2	12.8	13.4	14.0	14.6	15.2	15.8	16.4						
1524	9.8	10.4	11.0	11.6	12.2	12.8	13.4	14.0	14.6	15.2	15.8	16.4	17.0	17.6					
1626	10.4	11.0	11.6	12.1	12.6	13.2	13.8	14.4	15.0	15.6	16.2	16.8	17.4	18.0	18.6				
1727	11.2	11.8	12.4	13.1	13.7	14.3	14.9	15.6	16.2	16.8	17.6	18.2	18.8	19.5	20.1	20.8			
1829	11.6	12.4	12.9	13.5	14.1	14.9	15.5	16.1	16.8	17.4	18.0	18.8	19.3	19.9	20.5	21.3	22.0		
1930	12.2	12.8	13.4	14.1	14.7	15.3	15.9	16.7	17.3	17.9	18.6	19.2	19.8	20.5	21.1	21.9	22.5	23.1	
2032	12.8	13.4	14.0	14.6	15.2	15.9	16.5	17.3	17.9	18.5	19.2	19.8	20.4	21.0	21.6	22.3	23.1	23.7	24.3
W/H	**203**	**305**	**406**	**508**	**610**	**711**	**813**	**914**	**1016**	**1118**	**1219**	**1321**	**1422**	**1524**	**1626**	**1727**	**1829**	**1930**	**2032**

Appendix A2 – Weight Table 22 MM Panel Duct

NOTES:

1) Based on “A” Flange
2) Reinforcement Based on 500 Pa Pressure Class
3) Up To 1118 mm Size Based On 3931 mm Long Duct Sections. Over 1118 mm Size Based On 1200 mm Long Duct Sections
4) Over 2032 mm Size Consult Phenolic Panel Manufacturer

1 3/16 IN. Phenolic Duct Pounds Per Linear Foot																			
8	1.7																		
12	2.0	2.3																	
16	2.3	2.6	2.9																
20	2.6	2.9	3.2	3.5															
24	2.9	3.2	3.5	3.8	4.1														
28	3.2	3.5	3.8	4.1	4.4	4.7													
32	3.6	4.0	4.3	4.6	4.9	5.2	5.6												
36	3.9	4.2	4.6	4.9	5.2	5.5	5.9	6.2											
40	4.2	4.5	4.9	5.2	5.5	5.8	6.2	6.5	6.8										
44	4.5	4.8	5.2	5.5	5.8	6.1	6.5	6.8	7.1	7.5									
48	6.2	6.6	7.0	7.4	7.8	8.3	8.7	9.1	9.6	10.0	10.4								
52	6.5	7.0	7.4	7.8	8.2	8.7	9.1	9.5	10.0	10.4	10.8	11.3							
56	6.9	7.4	7.8	8.2	8.6	9.0	9.5	9.9	10.3	10.8	11.2	11.6	12.1						
60	7.3	7.7	8.2	8.6	9.0	9.4	9.8	10.3	10.7	11.1	11.6	12.0	12.4	12.9					
64	7.7	8.1	8.6	9.0	9.4	9.8	10.2	10.7	11.1	11.5	12.0	12.4	12.8	13.2	13.7				
68	8.3	8.7	9.2	9.6	10.1	10.5	11.0	11.5	11.9	12.4	12.9	13.3	13.8	14.2	14.7	15.2			
72	8.6	9.1	9.6	10.0	10.5	10.9	11.4	11.9	12.3	12.8	13.3	13.7	14.2	14.6	15.1	15.6	16.1		
76	9.0	9.5	10.1	10.4	10.8	11.3	11.7	12.2	12.7	13.1	13.6	14.1	14.5	15.0	15.5	16.0	16.4	16.9	
80	9.4	9.9	10.5	10.8	11.2	11.7	12.1	12.6	13.1	13.5	14.0	14.5	14.9	15.4	15.8	16.2	16.8	17.3	17.7
W/H	**8**	**12**	**16**	**20**	**24**	**28**	**32**	**36**	**40**	**44**	**48**	**52**	**56**	**60**	**64**	**68**	**72**	**76**	**80**

Appendix A3 – Weight Table 1 3/16 IN. Panel Duct

NOTES:

1 Based on “A” Flange

2 Reinforcement Based on 2 in w.g. Pressure Class

3) Up To 44 in. Size Based On 154 3/4” in. Long Duct Sections. Over 44 in. Size Based On 47 1/4 in. Long Duct Sections

4) Over 80 in. Size Consult Phenolic Panel Manufacturer

30 mm Phenolic Duct Kilograms Per lineal Meter																			
203	2.5																		
305	3.0	3.4																	
406	3.4	3.9	4.3																
508	3.9	4.3	4.8	5.2															
610	4.3	4.8	5.2	5.7	6.1														
711	4.8	5.2	5.7	6.1	6.5	7.0													
813	5.4	6.0	6.4	6.8	7.3	7.7	8.3												
914	5.8	6.3	6.8	7.3	7.7	8.2	8.8	9.2											
1016	6.3	6.7	7.3	7.7	8.2	8.6	9.2	9.7	10.1										
1118	6.7	7.1	7.7	8.2	8.6	9.1	9.7	10.1	10.6	11.2									
1219	9.2	9.8	10.4	11.0	11.6	12.4	12.9	13.5	14.3	14.9	15.5								
1321	9.7	10.4	11.0	11.6	12.2	12.9	13.5	14.1	14.9	15.5	16.1	16.8							
1422	10.3	11.0	11.6	12.2	12.8	13.4	14.1	14.7	15.3	16.1	16.7	17.3	18.0						
1524	10.9	11.5	12.2	12.8	13.4	14.0	14.6	15.3	15.9	16.5	17.3	17.9	18.5	19.2					
1626	11.5	12.1	12.8	13.4	14.0	14.6	15.2	15.9	16.5	17.1	17.9	18.5	19.0	19.6	20.4				
1727	12.4	12.9	13.7	14.3	15.0	15.6	16.4	17.1	17.7	18.5	19.2	19.8	20.5	21.1	21.9	22.6			
1829	12.8	13.5	14.3	14.9	15.6	16.2	17.0	17.7	18.3	19.0	19.8	20.4	21.1	21.7	22.5	23.2	24.0		
1930	13.4	14.1	15.0	15.5	16.1	16.8	17.4	18.2	18.9	19.5	20.2	21.0	21.6	22.3	23.1	23.8	24.4	25.1	
2032	14.0	14.7	15.7	16.1	16.7	17.4	18.0	18.8	19.5	20.1	20.8	21.6	22.2	22.9	23.5	24.1	25.0	25.7	26.3
W/H	**203**	**305**	**406**	**508**	**610**	**711**	**813**	**914**	**1016**	**1118**	**1219**	**1321**	**1422**	**1524**	**1626**	**1727**	**1829**	**1930**	**2032**

Appendix A4 – Weight Table 30 MM Panel Duct

NOTES:

1) Based on “A” Flange
2) Reinforcement Based on 500 Pa Pressure Class
3) Up To 1118 mm Size Based On 3931 mm Long Duct Sections. Over 1118 mm Size Based On 1200 mm Long Duct Sections
4) Over 2032 mm Size Consult Phenolic Panel Manufacturer

PDCS Appendix B

PHENOLIC DUCT INSPECTION CHECKLIST

PROJECT:_____ ***AREA:***_____

FABRICATOR (Co.):_____ ***INSTALLER (Co.):***_____

SYSTEM:_____ ***DESIGN MAX VELOCITY:***_____

DESIGN PRESSURE:_____ ***PHENOLIC DUCT PANEL THICKNESS:***_____

STANDARDS:

1) Manufacturer's Installation Instructions

2) SMACNA Phenolic Duct Construction Standards, 1st Edition, 2015 (PDCS)

3) SMACNA *HVAC Duct Construction Standards, Metal and Flexible*

FABRICATION CHECKLIST

	Panel Thickness	**Yes**	**No**	**ACTION**
1	Is the thickness of the phenolic panel in compliance for the application?	☐	☐	_____
Duct Design				
2	Has all measuring been performed on the internal, airside of the duct?	☐	☐	_____
3	Radius fittings: Are all internal radiuses at least 8" (200 mm) long?	☐	☐	_____
4	Radius fittings: Are splitter vanes installed (number and position of splitter vanes based on duct size) in accordance with the PDCS?	☐	☐	_____
5	Square elbows: Are turning vanes installed in accordance with the PDCS?	☐	☐	_____
6	Reducers / offsets: Is the angle according to the specifications?	☐	☐	_____
7	Fitting neck: Are all necks of reducers, elbows and offsets at least 4" (100 mm) long?	☐	☐	_____
8	Branch Connections: Excluding tab collars, do all branch connections have a 45º max. entry?	☐	☐	_____
Fabrication				
9	Assembly: Are panel fasteners used in accordance with the PDCS?	☐	☐	_____
10	Assembly: When PDCS required the application of adhesive, was it applied in all longitudinal corners as well as longitudinal seams?	☐	☐	_____
11	Tape: Has manufacturer approved 3" wide (75 mm) aluminum tape labeled 181A-P and 181B-FX been used?	☐	☐	_____

		Yes	No	
12	Tape: Is the tape applied anywhere the external surface of the aluminum facing has been cut?	☐	☐	_____
13	Sealer: Has suitable and UL listed sealer been used?	☐	☐	_____
14	Sealer: Are all ducts sealed inside with a generous and continuous sealer bead?	☐	☐	_____
Flanges / Connectors				
15	Are all duct edges constructed with the proper flange / connector?	☐	☐	_____
16	Are 4 bolt flanges complete with metal clips on the flanges and spaced in accordance with the PDCS?	☐	☐	_____
17	Are all flanges properly constructed and sealed for minimum air leakage?	☐	☐	_____
End Caps				
18	Are all end caps constructed, sealed and reinforced in conformance with the PDCS?	☐	☐	_____
Reinforcement				
19	Are all ducts fabricated to proper pressure class?	☐	☐	_____
20	Are the number of reinforcements in accordance with the PDCS?	☐	☐	_____
21	Based on pressure class and duct size, is the spacing between reinforcements in conformance with the PDCS?	☐	☐	_____
22	Are reducers, elbows and all other fittings properly reinforced?	☐	☐	_____
Finish / Weatherproofing				
23	In the event ducts are painted, is the paint compatible with aluminum and is the project team mindful of fire performance of the duct?	☐	☐	_____
24	Are all ducts subjected to outdoor conditions complete with weather protection?	☐	☐	_____
Storage Before Installation				
25	Has fabricated ductwork been handled and protected in conformance with the project requirements or otherwise SMACNA Standards?	☐	☐	_____
Overview				
26	Are all ducts free from damage, punctures and tears in the facing?	☐	☐	_____
27	Quality: Do the ducts fabricated demonstrate good workmanship?	☐	☐	_____

Fabrication Notes:

_____

_____

INSTALLATION CHECKLIST

	GENERAL	Yes	No	
28	Are ducts free from visual damage?	☐	☐	_____
29	Are ducts free from sagging and visible misalignment?	☐	☐	_____
	Pressure Class			
30	Is the duct system operating within the design pressure class?	☐	☐	_____
	Transverse Joints (Duct to Duct Connections)			
31	Are all duct to duct joints properly made?	☐	☐	_____
32	Are non-flanged joints employed in conformance with the PDCS?	☐	☐	_____
	Rectangular – Duct Branch / Take-Off			
33	Is the duct properly connected to all accessories (fire dampers, volume dampers, etc.)?	☐	☐	_____
34	Are all rectangular non-flanged branch connections limited to 2" w.g. (500 Pa) pressure class and 24" (610 mm) greatest dimension?	☐	☐	_____
	Metal Round Fittings			
35	Are tab collars properly sealed?	☐	☐	_____
	Metal Shoe Branch			
36	Are all shoe type branch connections mechanically fastened with screws to flange pieces on the main duct?	☐	☐	_____
	Mechanical Access Doors			
37	Are Mechanical Access Doors installed per the PDCS?	☐	☐	_____
	HANGERS / SUPPORTS			
38	Is the maximum spacing of hangers in conformance with the PDCS?	☐	☐	_____
39	Are all duct accessories properly supported?	☐	☐	_____
40	Are hangers and supports free of vibration?	☐	☐	_____
41	Is the hanger connection to phenolic duct free tears or damage?	☐	☐	_____
42	Supports: Are fittings supported in conformance with the PDCS?	☐	☐	_____

43 Notes: Type of fittings to the building structure (if available):

_____

_____

44 Type and size of hangers (e.g. threaded rod, metal strap, wire):

_____

_____

45 Type and size of hanger lower attachment (e.g. panel support fasteners, angle, channel, unistrut):

_____

_____

46 Are vertical ducts supported in conformance with the PDCS? **Yes ☐ No ☐**

Installation Notes:

_____

_____

_____

_____

Inspected By:_____ ***Inspection Date:***_____

Inspector Signature:_____

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