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Technical Resources Bulletin

To: SMACNA Members
SMACNA Chapter Executives

From: Technical Resources Department

Subject: **Rooftop Ductwork – Round or Rectangular?**

Introduction

When the Air Handling Unit (AHU) will be placed on a rooftop, the designer must consider the ductwork that must route across the roof as well as the duct supports. The duct designer should make a careful check of the structure's capacity to carry loads such as the weight of the duct including stiffeners, insulation and lagging, and those loads attributed to the action of wind, the accumulation of snow and ice, and maintenance loads. In fact, duct supports should be designed to carry all loads as described in Sections 4.4 and 4.13 of the *SMACNA Rectangular Industrial Duct Construction Standards - Second Edition* (Rectangular Industrial DCS) if the ductwork is rectangular, or in Sections 4.4 and 5.2 of the *SMACNA Round Industrial Duct Construction Standards - Third Edition* (Round Industrial DCS) if the ductwork is round, including both dead and live loads. The shape that is the best to use is a function of all of the design criteria.

Which Type of Ducts Should You Choose From?

Generally, the contractor can choose from rectangular duct, round longitudinal seam duct and spiral round seam duct. They should weigh the advantages of each and install the type of duct that makes the most economical sense. All types can be manufactured in carbon, galvanized, stainless, aluminum, and other types of metal.

Rectangular Duct

Ductwork is usually designed as round duct. However, rectangular duct may have to be used if the situation exists where round ductwork does not fit because of its diameter. There may be overriding reasons to use rectangular duct (or round longitudinal seam) such as very high pressures or the airstream contains abrasive components not suitable for round spiral duct, for instance. Generally, height or width restrictions are not a problem on a rooftop, but if they are, the contractor will have to convert the round dimension to rectangular dimensions using the equations for equivalent round diameters. One easy way to do this is by using Table A-2 Circular Equivalents of Rectangular Ducts for Equal Friction and Capacity Dimension in the *SMACNA HVAC Systems Duct Design - Fourth Edition*, page A.7. You can get rectangular circular equivalents of up to 100 inch diameters.



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For example, a 96 in. x 88 in. rectangular duct has a circular equivalent of 100.5 in. If larger sizes are required, the Equation for Circular Equivalent of a Rectangular Duct is given on the same page but below the table. It can be manufactured from galvanized metal, stainless steel, aluminum, and other types of metal. The **SMACNA HVAC Duct Construction Standards - Metal and Flexible - Third Edition**, typically covers HVAC indoor ductwork up to a 10 in. wg pressure class. Because of the additional loads that may apply to rooftop ductwork, rectangular ductwork is generally covered by the **SMACNA Rectangular Industrial Duct Construction Standards - Second Edition**. Rectangular ductwork can be designed for pressures of negative 150 in. wg to positive 150 in. wg. using the manual. It can also be used for all duct classes. See Chapter 2 of the Rectangular Industrial standards for a definition of each duct class, but they basically range from carrying standard air to carrying abrasives to carrying corrosive gases.

Round Duct

There are two types of round duct that can be used; longitudinal seam and spiral seam duct. Round longitudinal seam can be used for almost any diameter as long as sheets or flat plate can be rolled to the desired diameter, and welded where the rolled seams (longitudinal seams) meet. The **SMACNA Round Industrial Duct Construction Standards - Third Edition** is generally used for rooftop duct construction, again, because of the additional loads that may apply. One of the advantages of round longitudinal seam duct is that there are solutions for 22 gage to 0.500 inch thickness, so it can be designed to handle pressures from negative 30 in. wg to positive 50 in. wg. Longitudinal duct can be used for all Classes of duct (Class 1 through Class 5). The Round Industrial manual states that it can be supported at intervals not exceeding 20 ft. and includes nominal diameters of 4 to 96 in. as long as the D/t (diameter to thickness) must be less than 800 for longitudinal seam duct and less than 1800 for spiral duct. *Spiral lockseam ducts, are subject to a higher maximum (D/t) ratio of 1800 due to the greater stiffness inherent in their construction.*

Spiral Duct

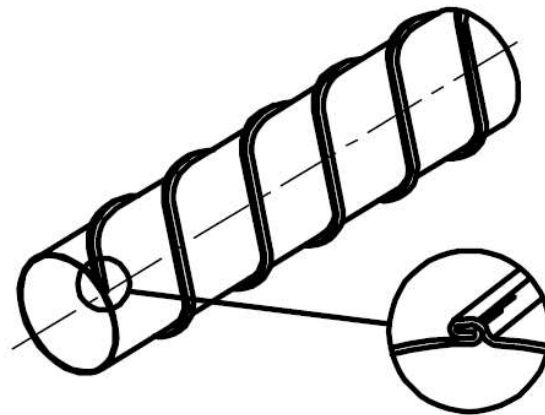
Spiral Duct can be fabricated in most metals as rectangular and longitudinal seam round duct can. It can be used for all Class 1 and 2 applications. For Class 5, spiral duct can still be used but only duct fabricated from stainless are recommended. Spiral duct is not recommended for Class 3 or Class 4 (duct with highly abrasive particulate). Spiral duct for industrial applications such as rooftop should have a minimum of 22 gage to assure satisfactory welds. For industrial applications, it can be designed to handle pressures from negative 30 in. wg up to positive 50 in. wg. The Round Industrial manual states that it can be supported at intervals not exceeding 20 ft. and includes nominal diameters of 4 to 96 in. as long as the D/t (diameter to thickness) is less than 1800. Because of the spiral seam's added strength, the D/t can be much larger. So, for example, with a 60-inch diameter, the D/t ratio for spiral, allows a minimum thickness of up to $60/t = 1800$ or $t = 60/1800 = 0.03$ inch which is 22 ga. Whereas longitudinal duct would have a minimum thickness of $t = 60/800$ or $t = 0.075$ which is 14 gage galvanized. Designers must make sure these minimum D/t ratios are met.



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When spiral duct is considered for rooftop ductwork, the designer should refer to Chapter 11 of the Round Industrial DCS. The Helical spiral lockseams (notated are RL-1 in the below figure):



SPIRAL SEAM
RL-1

The spiral seams are exempt from sealant requirements. In fact, applying sealant in a spiral seam can result in poor seam closure. Spiral duct can be manufactured in carbon, galvanized, stainless, aluminum and other materials in 28 gage to 14 gage or heavier, with the right spiral machine that has that capacity. Spiral duct operating temperatures should be limited to 250°F as SMACNA has not conducted any high temperature testing of spiral duct. Otherwise, see Table 3-12 Material Properties and Temperature Limits in the Round Industrial DCS.

Choosing Ductwork for Rooftop Applications

One of the main concerns for installing ductwork on the roof of a building is the weather. That is, wind, rain, snow and ice, and temperature need to be considered. Let us look at these individually:

- Wind - Because of its curved structure, round spiral duct has a force correction factor of 0.8 compared to rectangular duct.
- Rain - When rain falls on rectangular duct, water can accumulate on flat surfaces. The weight of the water can cause the ductwork to depress resulting in pooling of the water. If the pooling is near a joint, the water can potentially seep in if the joint is not well constructed. The contractor should consider pitching rectangular ducts on rooftops, or adding a pitched covering to avoid the water pooling. The water will just run off of a round longitudinal or spiral duct. For spiral duct, the tightness of the spiral lockseams will prevent any water seepage. Longitudinal seam duct should be waterproofed. Good joint connections should be installed on all rooftop duct systems, so that they are essentially waterproofed against seepage. The ductwork could also be lagged to avoid water seepage as long as the lagging is sealed tight or waterproofed.
- Snow and ice - Will accumulate on rectangular flat surfaces far easier than they will on round duct creating additional loading on the top panel. Localized side wall buckling is dependent more on the loading of the top rectangular panel than on the side or bottom panels. It will vary with the duct aspect ratio and stiffener spacing.



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Installed cost of the round spiral ductwork may be less than for rectangular duct. Round spiral duct can be manufactured in much longer lengths than rectangular duct reducing the number of joints needed. Spiral duct is often manufactured in 10, 12 or 20 ft. lengths, but can be manufactured in even longer lengths. Round longitudinal seam and rectangular duct, on the other hand, are typically manufactured in 4, 5 or 6 ft. lengths, meaning 2 - 3 times as many joints. These joints must be well sealed to avoid the weather getting inside of the duct unless the duct is lagged and well sealed.

Round duct be sized to have the same friction loss as the rectangular duct. If the contractor has a rectangular duct design for rooftop duct, they may want to ask to convert using the equivalent round size (same friction loss as the rectangular duct). The equivalent round diameter of the rectangular duct will have less surface area so there will be less potential for heat gain or loss.

The leakage of spiral duct seams is virtually zero. With less joints and proper sealing, it will have less leakage than its rectangular equivalent.

Noise control can be a concern or be beneficial if rectangular duct is used versus round spiral duct. Rectangular duct can allow fan noise to breakout on the roof where it may not be a problem. But if it is above a CEO's office, that breakout noise may be heard, causing complaints from the top guy. Round spiral duct will contain the noise and if the interior of the duct is insulated, help attenuate and control the noise before it enters the building. Properly installed so no through metal exist, double-wall round duct can both attenuate the fan noise as well as insulate the duct from heat gains or losses.

Summary

When deciding on which ductwork to use on a rooftop, rectangular, longitudinal seam or spiral duct, there are several things to be considered:

1. If a spiral design will work it may be more economical than rectangular or longitudinal seam round ductwork. By manufacturing longer lengths, round spiral duct will be easier and less costly to install, while keeping out the weather easier than rectangular and at least as well as the round longitudinal duct, while not increasing the pressure loss.
2. Round duct will not allow as much snow or ice to accumulate and wind will not have as much of an effect.
3. If there is not room for the round ductwork, the equivalent round size of rectangular duct should be used.
4. If the ductwork is carrying abrasive particulate, Class 3 or 4 rectangular or round longitudinal seam should be used.
5. If breakout noise will be a problem, round ductwork should be used to contain the noise until it can be treated. If breakout noise is not a problem but you need some attenuation, rectangular duct could be considered as a noise control method by allowing the noise to breakout on the roof.
6. If the temperature is above 250°F then spiral duct should not be considered; use longitudinal seam round duct or rectangular.
7. Spiral can be designed for thinner wall as round is inherently stronger. Spiral duct can have D/t up to 1800 while for round longitudinal seam round the D/t should not exceed 800.

From a performance, fabrication, installation and overall economic considerations, the right choice may be round spiral duct for rooftop air-handling units, but make sure it the right application.



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