

# ***Airspray Technology***

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*Concept and Theory Training*



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# Introduction

Welcome to *Airspray Technology*, a learning module in Graco's basic concept and theory sales training curriculum. Your understanding of this information provides the basis for further study on specific Graco products. Your ability to successfully promote and sell Graco's products depends in part on how well you learn the basics and then apply this knowledge to addressing your customers' needs for Graco equipment.

While this curriculum best fits the requirements of Graco and distributor sales people, it will also benefit anyone whose job function depends on knowledge of Graco's products.

## **Module Overview**

This module begins the process of helping you position Graco products appropriately. *Airspray Technology* covers the principal parts of airspray atomizers (guns), explains how they operate, and introduces specialized forms of airspray guns.

## **How to Use this Module**

The curriculum consists of a series of self-study modules. As the term self-study implies, you work through the materials on your own at a comfortable pace. Plan sufficient time (approximately 30 minutes) to complete at least one section of a module in a working session.

This module combines a variety of features that makes the learning process convenient and productive:

- Learning objectives
- Text
- Charts, illustrations
- Progress checks
- Additional resources

## **Learning Objectives**

Each section of material offers a set of learning objectives. Read the objectives and use them to guide you to the most important concepts. After you finish each section and before you complete the progress check, reread the objectives to confirm that you understand the key concepts.

## **Text**

Definitions, examples, and explanations comprise the learning module text. Read it carefully and return for review if necessary.

## **Charts, Illustrations**

An important element of any instruction is visualizing the concepts. This module contains graphics and illustrations to enhance the text material. Wherever appropriate, the module also contains charts that help you organize or summarize information.

## **Progress Checks**

Progress checks are self-tests that provide reinforcement and confirm your understanding of important topics. After completing each section of the module, return to review the objectives, and then work through each of the progress check items. Upon completion, check your answers against those provided. If you answered any incorrectly, return to the text and reread the pertinent information.

## **Additional Resources**

This module may refer you to other documents or sources that expand on the concepts covered in the module. The reference will include the name of the source and how you can obtain it.

# Airspray Fundamentals

## ***Learning Objectives***

Your effectiveness with customers depends in part on your ability to knowledgeably and confidently discuss their needs, your products, and competitors' products. Knowledge of spray gun operations form part of the foundation necessary for future learning about how to promote Graco's products features and benefits. After completing this section on airspray fundamentals, you will be able to:

- Identify the principal parts of an airspray gun; fluid nozzle, fluid needle, air cap, trigger, main and fan air valves, fluid and air inlets, and gun body.
- Describe the airspray gun trigger's lead/lag action.
- Explain the purpose of shaping air.
- Explain basic airspray gun operation.
- Characterize external-mix systems.
- List the advantages and main disadvantage of external-mix systems.
- Distinguish between bleeder and nonbleeder guns.

## ***Airspray Atomization***

Airspray atomization occurs when a slow-moving jet of fluid is surrounded by a high-speed stream of compressed air. Friction between the air and fluid disrupts the fluid stream, breaking it into fragments and then droplets. The energy source for airspray atomization is the compressed air flowing around the fluid stream.

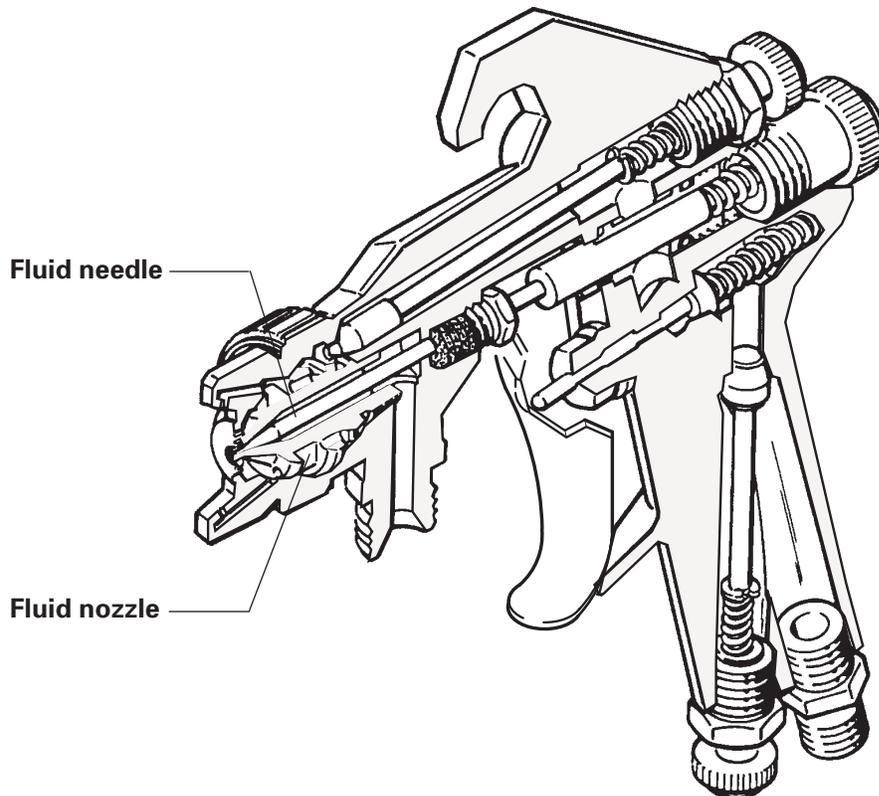
## ***Principal Parts of an Airspray Gun***

The principal parts of an airspray gun include (see Figure 5):

- Fluid nozzle
- Fluid needle
- Air cap and retaining ring
- Trigger
- Main air valve
- Fan air valve and adjustment knob
- Fluid inlet
- Air inlet
- Gun body

## Fluid Nozzle

The fluid nozzle forms the cylindrical orifice that provides a stream of fluid. The fluid nozzle is also the seat for the fluid needle, and its outer surface forms part of the atomizing air channel. The fluid nozzle is usually threaded into the gun body and held in place by a retaining ring. When the fluid needle is seated in the fluid nozzle, it extends slightly beyond the orifice to keep it clean (see Figure 1).



**Figure 1** The fluid nozzle with a fluid needle

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## Fluid Needle

The fluid needle controls the flow of fluid through the gun (see Figure 1). By careful control of the trigger, the operator can regulate needle position and hence fluid delivery. This practice is known as feathering.

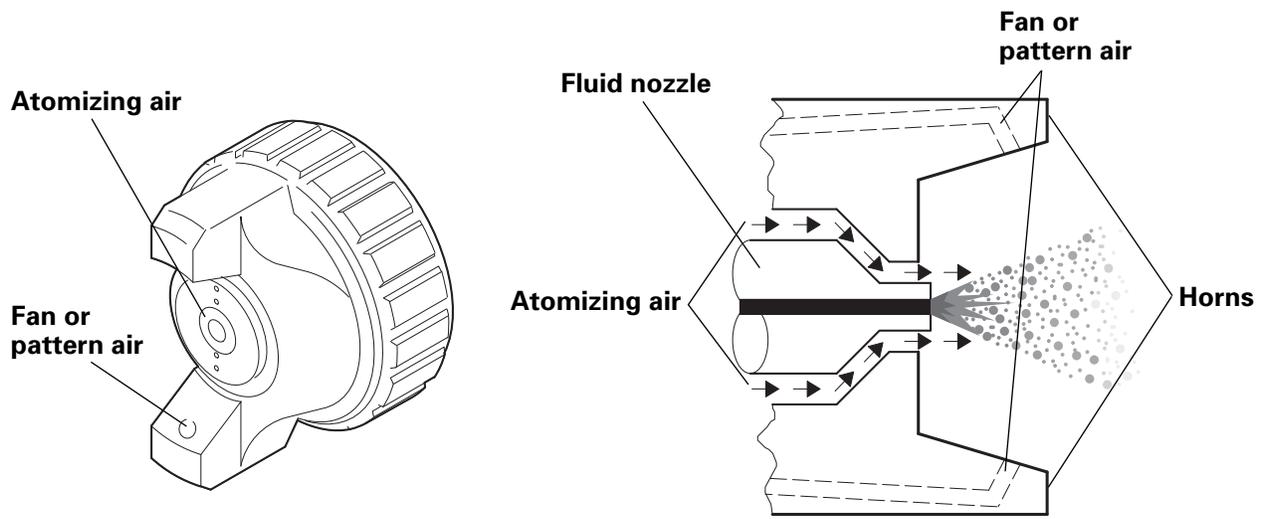
Most airspray guns have a control knob that can be adjusted to limit travel of the fluid needle to control the fluid flow rate. However, using the control knob can cause premature wear of the fluid needle and nozzle. Therefore, Graco recommends that operators achieve fluid control by regulating fluid pressure or by changing the needle and nozzle size.

## Air Cap

The air cap fits over the fluid nozzle and is held in place by a retaining ring. It has a central opening that forms an annular (ring-shaped) orifice around the nozzle for atomizing air. Air from the ring-shaped orifice atomizes the stream of liquid emerging from the fluid nozzle.

The air cap also has two extensions for shaping air known as horns. The horns are arranged to provide pattern or shaping air jets, which are directed against the emerging spray and reshape it into the desired pattern width.

The face of the air cap often has additional holes to improve atomization and to keep paint from accumulating on the air cap. See Figure 2 for a pair of illustrations that shows different views of an airspray air cap. See Figure 5 for an illustration of an airspray gun with the key parts labelled.



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**Figure 2** Two views of an airspray cap.

## Trigger

Squeezing the trigger opens both the main air valve and the fluid needle. Pulling the trigger activates the air flow prior to the fluid flow. Releasing the trigger stops the fluid flow before the air shuts off. This is called lead and lag air flow; it helps prevent spitting (nonatomized fluid) and keeps the air cap clean.

## Main Air Valve

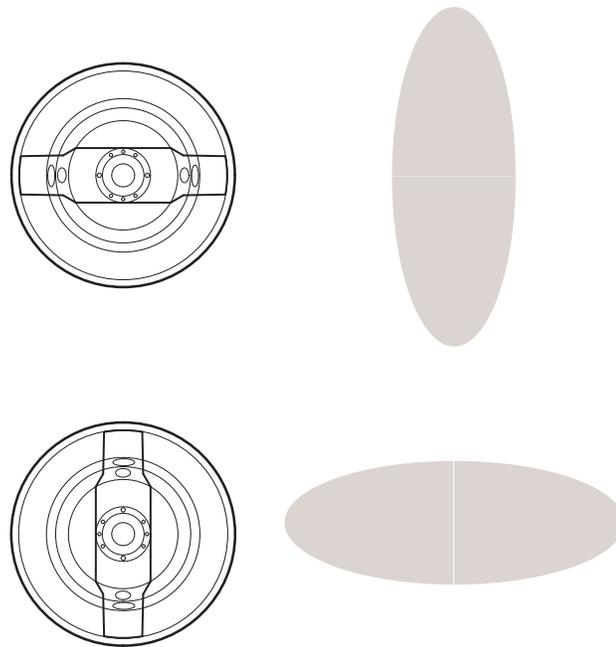
The main air valve is activated by the trigger and controls all air flow to the front of the gun. The air flow then splits into atomizing and fan or pattern air.

## Fan (Pattern) Air Valve

This valve is known by several names:

- Spreader valve
- Side port valve
- Fan adjuster

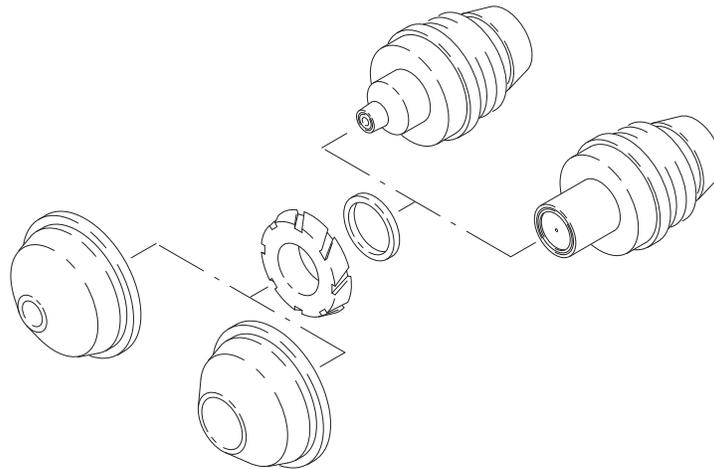
The fan air valve controls the air emerging from the air cap's horns (also known as fan or spreader air), which influences the pattern of the spray. The operator controls the width of the spray pattern by turning the adjustment knob. See Figure 3 for an illustration of spray patterns corresponding to the position of the airspray cap.



**Figure 3** Airspray patterns.

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If an application requires a round spray, the operator may choose an air cap and fluid nozzle specifically designed for a round spray pattern. This results in a relatively soft spray with a less defined round pattern. See Figure 4 for examples of round spray air caps and fluid nozzles.



**Figure 4** Round spray air caps and fluid nozzles.

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## Fluid Inlet, Air Inlet, Gun Body

Fluid and air enter the gun through the fluid and air inlets. The gun body is an L-shaped section of aluminum or plastic that serves as a frame for internal parts and as a handle for the operator to grasp. Figure 5 shows an illustration of an airspray gun with the key parts labeled. Refer to this graphic as you read through the next section on how airspray guns work.

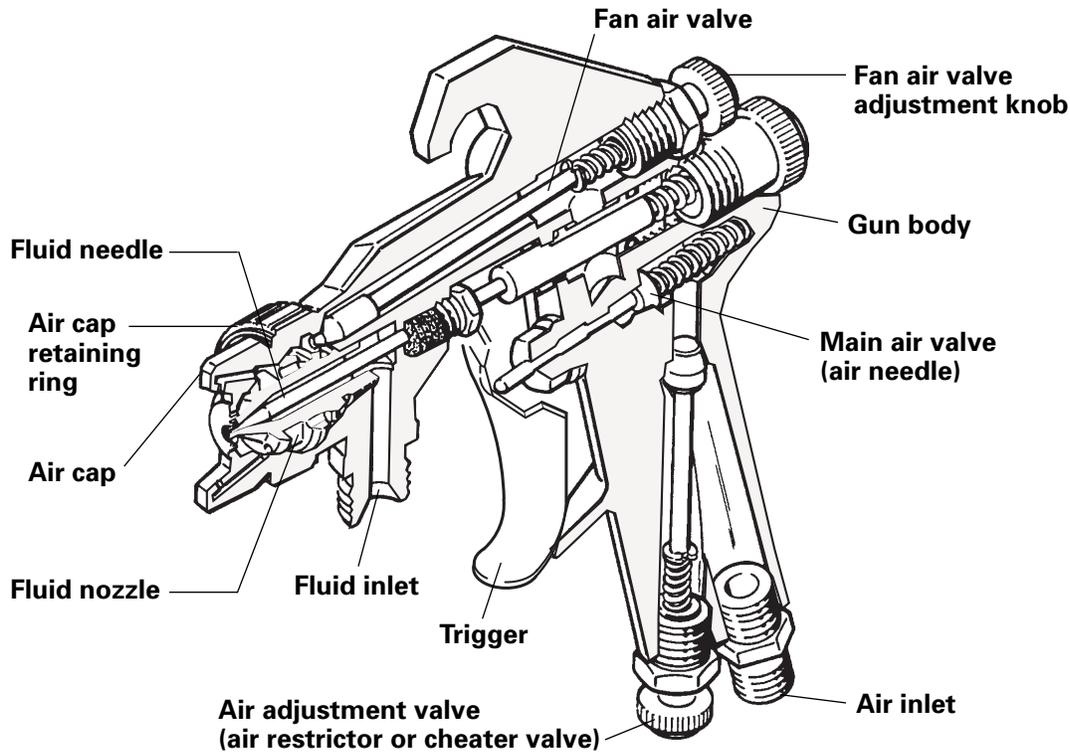


Figure 5 An airspray gun and its principal parts.

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## How Airspray Guns Work

Compressed air is supplied to the air inlet through a flexible hose. The fluid is supplied to the fluid inlet through a hose or container. Fluid flows to the front of the gun where it is stopped by the valve formed by the fluid nozzle and fluid needle.

Compressed air flows through the air passages in the handle to the air valve and stops at the closed main air valve.

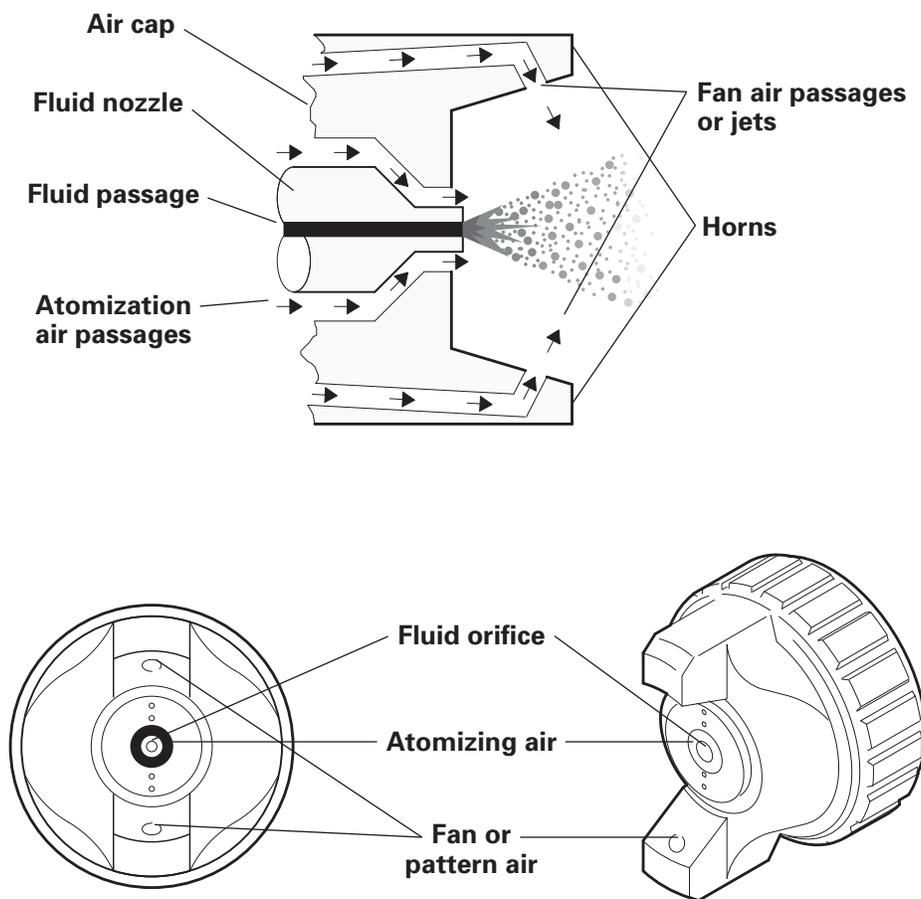
To operate the gun, the user pulls the trigger toward the handle, opening the main air valve and retracting the fluid needle. Compressed air then flows through the passages in the gun body to the air cap. Fluid then flows through the fluid nozzle and out the cylindrical fluid orifice at the front of the gun. Compressed air flowing between the fluid nozzle and the air cap causes the fluid to be atomized into a spray, and air flowing through the horns of the air cap shape the spray to its desired form.

When the operator releases the trigger, springs return the fluid needle and air valve to their closed positions.

### External-Mix Airspray Guns

External-mix airspray guns are **the** industry standard. External-mix guns combine air and fluid beyond (outside) the air cap. Figure 6 illustrates an external-mix air cap and how atomization occurs beyond the cap. It also shows the functions of the air holes on the cap.

Note that all gun references in this module thus far are to external-mix airspray guns.



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**Figure 6** An external-mix air cap with a cross section showing how the air and fluid mix beyond the air cap.

External-mix airspray guns offer the following advantages:

- Good operator control
- A range of droplet sizes in a high-velocity stream, resulting in fine atomization for a high quality finish
- Relatively low cost

However, due to the high level of air turbulence and the small size of droplets, fewer droplets reach the substrate. Therefore, external-mix airspray guns may have a relatively low transfer efficiency. Transfer efficiency may be improved by using the lowest possible air flow to achieve the desired atomization.

### **Bleeder and Nonbleeder Guns**

External-mix guns, the most common type of gun for production finishing, are generally pressure feed. They may be either *bleeder* or *nonbleeder* guns. Bleeder guns have no air valve; air flow is always present. The gun trigger controls the fluid flow only. Bleeder guns are not as common as nonbleeder guns.

Nonbleeder guns have an air valve that shuts off the air flow when the trigger is released. Industrial markets employ external-mix, nonbleeder airspray guns almost exclusively.

# Progress Check

Directions: After answering the following questions, compare your answers with those provided in the answer key following this progress check. If you respond to any items incorrectly, return to the text and review the appropriate topics.

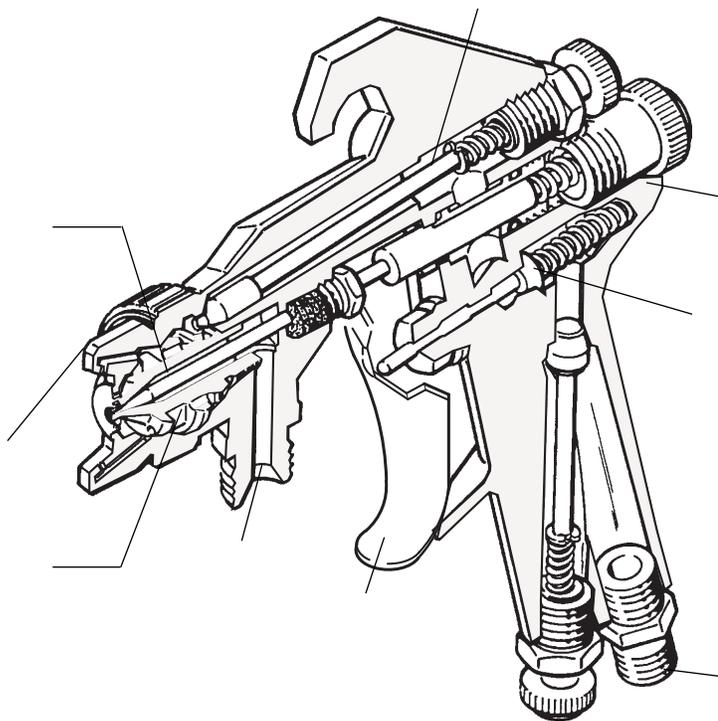
For items 1-4, match the airspray gun parts with their descriptions.

## Parts

- |                 |                   |
|-----------------|-------------------|
| a. Fluid nozzle | d. Fluid needle   |
| b. Air cap      | e. Fan air valve  |
| c. Trigger      | f. Main air valve |

## Descriptions

- \_\_\_ 1. Fits over the fluid nozzle, has a central opening for atomization air and may have shaping air horns.
  - \_\_\_ 2. Adjusting this part controls the width of the spray pattern.
  - \_\_\_ 3. Provides variable fluid delivery.
  - \_\_\_ 4. Regulates both the main air valve and the fluid needle.
5. Label the parts indicated on the illustration below.



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6. What are the two advantages of the lead/lag air flow feature of the trigger?

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7. Which airspray gun is most commonly used in industrial finishing applications?

- a. Bleeder
- b. Nonbleeder

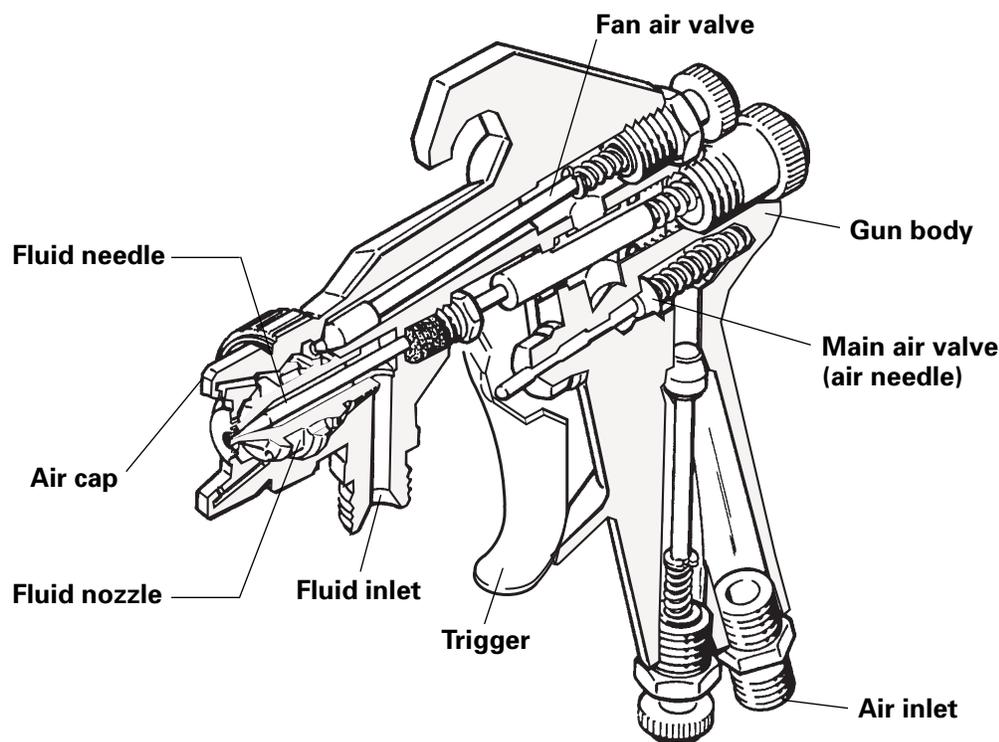
8. What's the disadvantage of external-mix airspray guns?

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## Answers to Progress Check

1. b. The **air cap** fits over the fluid nozzle. The central opening emits atomizing air and other openings emit air for shaping patterns.
2. e. The **fan air valve** influences the pattern of the spray by controlling the air emerging from the air cap's horns.
3. d. The **fluid needle** seats in the fluid nozzle permitting or restricting the flow of fluid through the gun. It is controlled by the trigger.
4. c. The **trigger** opens and closes both the main air valve and the fluid needle.
5. The principal parts of an airspray gun are labeled below.



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6. The two advantages of the lead/lag air flow feature of the trigger are keeping the cap clean and prevention of spitting (non-atomized spray).
7. b. External-mix, nonbleeder guns dominate industrial markets.
8. The disadvantage of external-mix guns is that they have a relatively low transfer efficiency due to the high level of air turbulence.

# Fluid Supply Options

## ***Learning Objectives***

The fluid supply for airspray guns is usually low pressure, from 1 to 50 psi. This section of the module explains three options for supplying fluid to the spray gun:

- Siphon feed
- Gravity feed
- Pressure feed

After completing this section on fluid-supply options, you will be able to:

- Characterize each of the three material supply options.
- Match guns according to their fluid supply and appropriate applications.

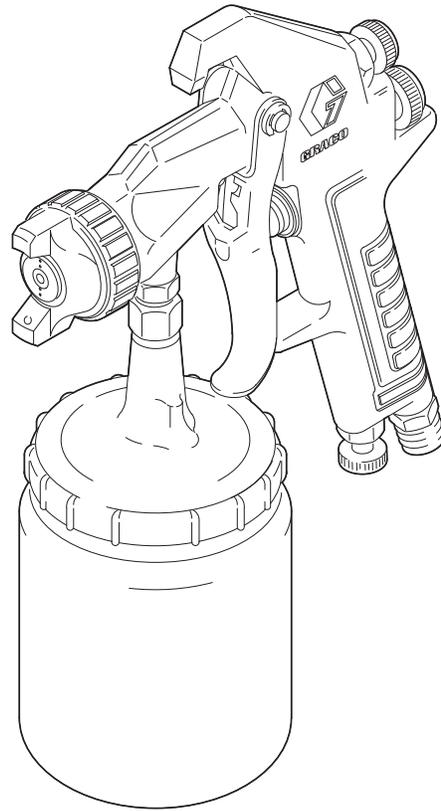
## ***Siphon Feed***

Siphon airspray guns characteristically have a cup mounted below the front of the gun. See Figure 7 for an illustration of a siphon-feed gun. Suction is created by air flowing from the air cap, which draws paint from the cup through the fluid nozzle. The air pressure, fluid viscosity, and fluid nozzle size determine the fluid flow rate.

Siphon-feed guns may also be known as vacuum, suction or cup guns. However, the term cup guns may also refer to pressure-and gravity-feed guns.

Siphon-feed guns are used for handling small amounts of fluid, frequent small volume color changes, and low production rates. They require specially-designed air caps and fluid nozzles. They are capable of spraying up to ten ounces or more of fluid per minute of low viscosity fluids, such as lacquer or wood stain or slightly heavier fluids like primers.

Although air pressures of up to 80 psi have been used with siphon-feed guns, these higher pressures tend to waste fluid due to over atomization, resulting in lower transfer efficiency. Pressures of 40 to 60 psi are optimal for good efficiency and finish.



**Figure 7** Siphon-feed gun.

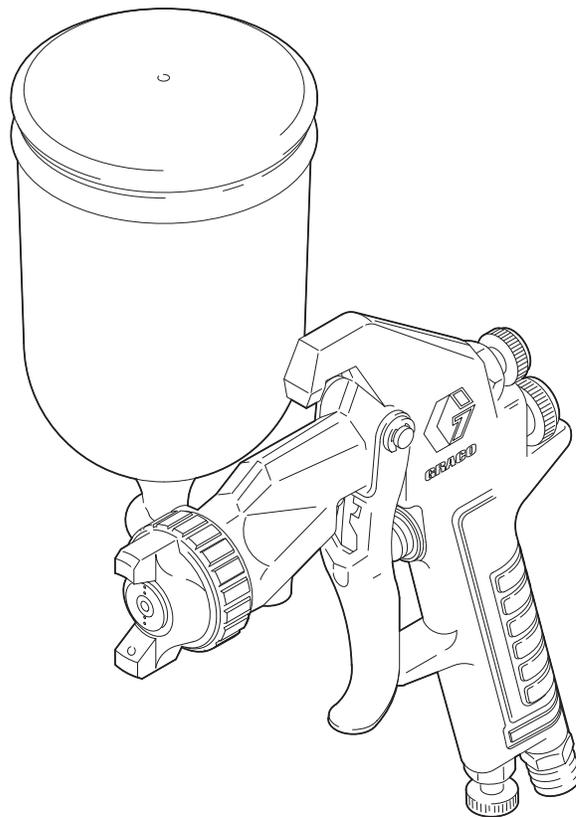
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## **Gravity Feed**

Gravity-feed or gravity guns are similar to siphon-feed guns in that fluid flows from a cup. The gravity-feed gun cup is mounted above the centerline of the gun and gravity enhances the fluid flow (see Figure 8). If the trigger is activated with the air disconnected, fluid flows as a result of gravity. The size of the fluid nozzle, the air pressure, the fluid level, and the fluid viscosity determine the fluid flow rate.

Gravity-feed guns may be used with higher viscosity fluids than siphon-feed guns.

Siphon- and gravity-feed guns are best suited to jobs using smaller quantities of fluid, such as for touchup or repair. A wide range of fluid nozzles are available for these guns (.020-.125). A range of air caps is available to provide different pattern sizes and levels of atomizing power.



**Figure 8** Gravity-feed gun.

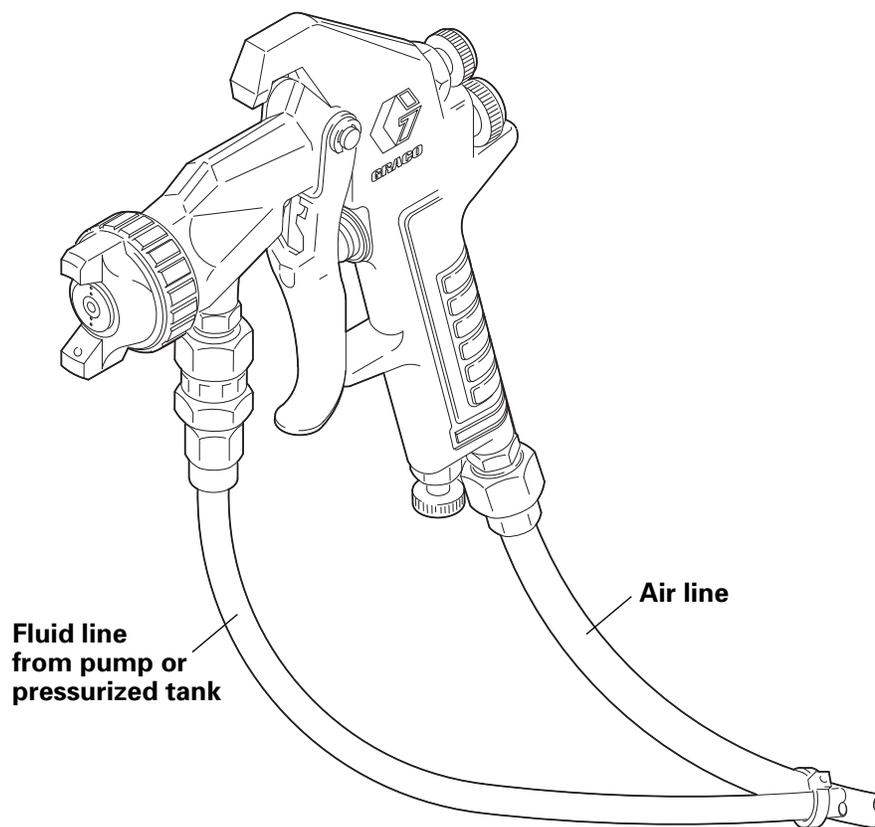
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## **Pressure Feed**

In contrast to siphon- or gravity-feed guns, fluid pressure for pressure-feed guns is provided by an external source. The fluid supply to pressure-feed guns is usually through a hose from a pressure tank, although fluid may also flow from a pressurized cup or pump. See Figure 9 for an illustration of a pressure-feed gun.

Except for very heavy materials, pressure at the fluid nozzle is rarely more than 10 to 15 psi. The size of the fluid nozzle, the fluid viscosity, and the fluid pressure all govern the fluid flow rate.

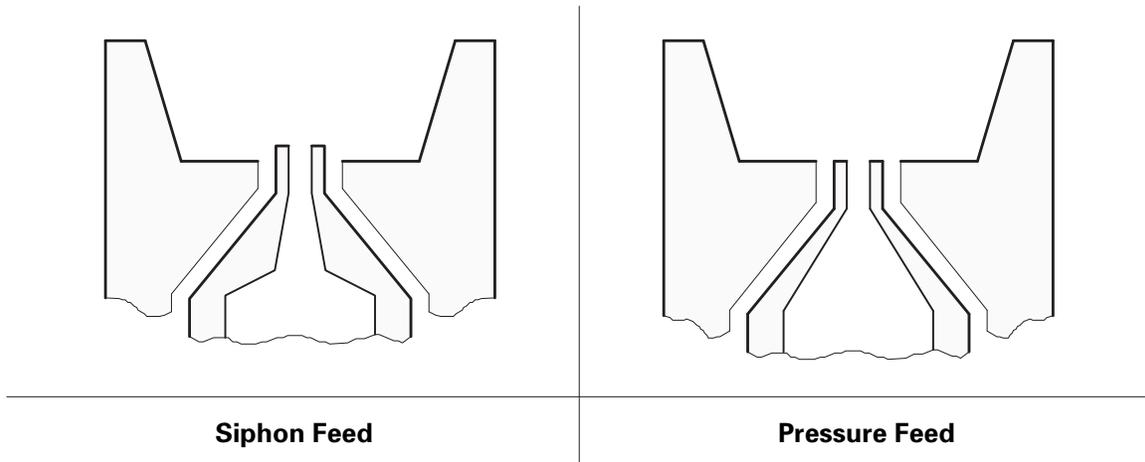
Pressure-feed guns support the vast majority of industrial applications since they can move large amounts of fluid through the system. They are more likely to be used for steady production finishing since they do not require constant refilling of the paint cup. Nozzles of 0.030 to 0.125 inches in diameter are available to deliver materials from thin lacquers to heavy fillers at rates of from two or three ounces per minute up to about 25 ounces per minute.



**Figure 9** Pressure-feed gun.

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In Figure 10, note the difference between the fluid nozzles for siphon- and pressure-feed guns.



**Figure 10** Siphon-feed and pressure-feed fluid nozzles.

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# Specialized Types of Airspray Guns

## ***Learning Objectives***

Beyond the basic airspray guns, there are some distinct forms of guns of which you must be aware to round out your knowledge of basic airspray technology. These guns include:

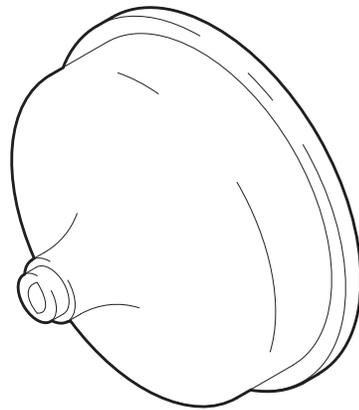
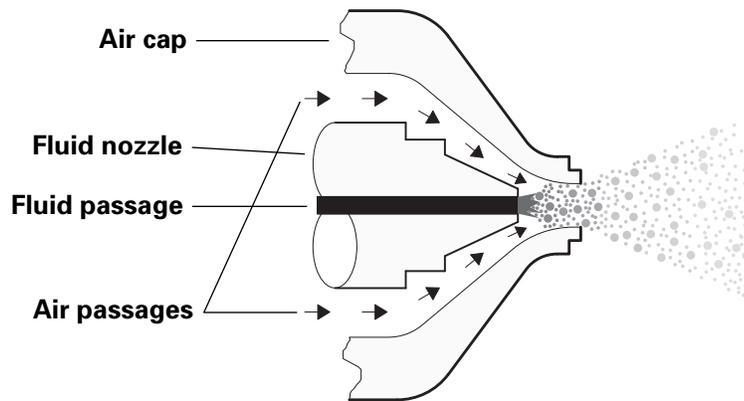
- Internal mix airspray
- HVLP
- Electrostatic airspray

After completing this section on specialized airspray guns you will be able to:

- Describe an internal-mix airspray gun.
- Characterize HVLP technology.
- List advantages and disadvantages of HVLP.
- Describe the principal advantage of an electrostatic airspray gun.

## ***Internal-Mix Airspray Guns***

Internal-mix guns combine the air and fluid within the air cap before the mixture is discharged (see Figure 11). Internal-mix guns require pressure feeding and the balance between the air and fluid pressures must be carefully maintained.



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**Figure 11** An internal-mix air cap.

Since internal-mixing equipment is often hard to keep clean, it tends to be used for slow-drying or viscous materials. More rapidly drying fluids would collect in and plug the gun cap's orifice.

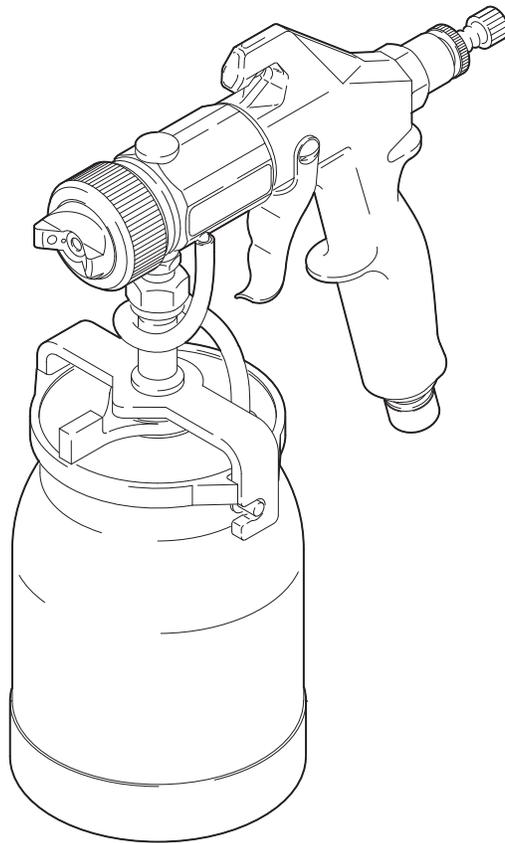
Internal-mix guns afford limited operator control. The shape of the cap's exit hole dictates the spray pattern, and the operator has little control over the fluid flow.

Internal-mix guns are only appropriate for applications **not** requiring a fine finish and for those demanding a heavy-bodied, difficult-to-atomize coating, such as ceiling texture spray and mastic roof coatings.

## **HVLP**

HVLP stands for *high volume low (air) pressure*. There are two air supply options. One option is an outgrowth of spray guns designed to operate with blower motors that deliver large volumes of air at very low pressure. It is a portable painting outfit that includes an electric-powered blower and compressor operating at two to four psi air pressure. The fluid is fed from a cup pressurized with the same air supply. This product is widely used for painting interior trim in home construction and similar applications. This method provides a portable, clean, dry air supply and a high level of control of overspray.

The second HVLP option uses compressed air at up to 100 psi from a normal shop air supply. The high pressure shop air is reduced in the gun, or by an external regulator to a maximum of ten psi for atomization at the air cap. These guns have a wide range of nozzles and air caps for high to medium production with lighter fluids. In contrast to standard airspray guns, air caps for these guns have much larger orifices. See Figure 12 for an illustration of an HVLP gun.

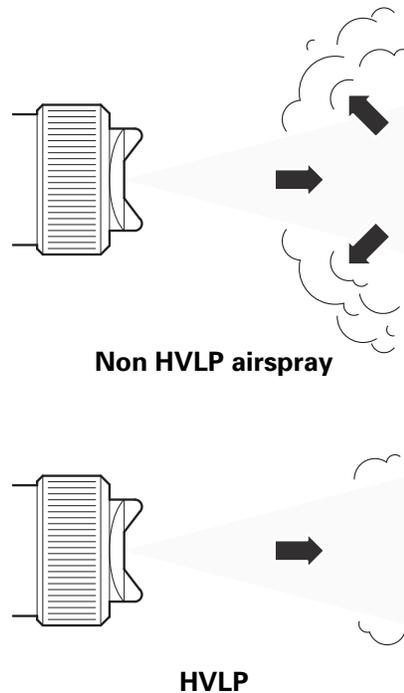


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**Figure 12** An HVLP gun with a pressurized fluid cup.

HVLP guns are capable of high transfer efficiency, a good quality finish and a high level of operator control. Figure 13 illustrates reduced overspray, which may or may not be visible during application.

One disadvantage of HVLP is a low production rate. A disadvantage for the portable blower-powered units is that they produce a dry, heated air supply that may overatomize volatile fluids. Disadvantages for the shop-air supplied units include a “wetter” spray and possible difficulty atomizing some coatings.



**Figure 13** An HVLP gun’s spray compared to non HVLP airspray technology.

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## ***Electrostatic Airspray Guns***

Electrostatic airspray guns are equipped to electrically charge fluid droplets. The droplets are attracted to the work surface which enhances transfer efficiency without sacrificing fluid flow rate (production rate) or finish quality. Electrostatic airspray guns are compliant with air quality regulations.

# Progress Check

Directions: After answering the following questions, compare your answers with those provided in the answer key. If you respond to any items incorrectly, return to the text and review the appropriate topics.

For items 1-3, match the supply options with their descriptions.

## Supply Options

- a. Gravity feed
- b. Siphon feed
- c. Pressure feed

## Descriptions

- \_\_\_ 1. The cup is mounted above the airspray gun and fluid flow is assisted by the natural force of the earth's pull.
  - \_\_\_ 2. The cup is mounted below the front of the airspray gun and fluid is suctioned from the cup up through the fluid nozzle.
  - \_\_\_ 3. Pressure to move fluid is external to the airspray gun.
4. Complete the chart by listing what governs the fluid flow rate for each fluid-supply option.

Fluid-Supply Option	Factor(s) Governing the Fluid Flow Rate
Gravity feed	
Siphon feed	
Pressure feed	

For items 5-8, match the fluid-supply option with appropriate applications.

### Supply Options

- a. Gravity feed
- b. Siphon feed
- c. Pressure feed

### Applications

- \_\_\_ 5. Steady production finishing.
  - \_\_\_ 6. A wide range of fluid viscosities.
  - \_\_\_ 7. Frequent small-volume color changes.
  - \_\_\_ 8. Low production rates.
9. What part is characteristically different between an internal- and an external-mix gun?
- a. Fluid nozzle
  - b. Trigger
  - c. Air cap
  - d. Fan air valve
10. What does the high volume/low pressure of HVLP refer to?
- a. High volume of fluid/low air pressure.
  - b. High volume of air/low fluid pressure.
  - c. High volume of air/low air pressure.
  - d. High volume of fluid/low fluid pressure.
11. Choose statements describing the advantages of HVLP. (Select all that apply.)
- a. Compliant
  - b. High volume delivery
  - c. High level of operator control
12. What is the main advantage of electrostatic airspray guns?
-

## Answers to Progress Check

1. a. A **gravity-feed** gun has a cup mounted above the airspray gun and gravity enhances the fluid flow.
2. b. **Siphon-feed** guns have a cup mounted below the front of the airspray gun and suction draws fluid into the gun.
3. c. **Pressure-feed** guns are usually supplied through a hose from a pressure tank.
- 4.

Fluid-Supply Option	Factor(s) Governing the Fluid Flow Rate
Gravity feed	Fluid nozzle size, air pressure, fluid viscosity, and fluid level
Siphon feed	Air pressure, fluid nozzle size and fluid viscosity
Pressure feed	Fluid pressure, fluid nozzle size, and fluid viscosity

5. c. Steady production finishing is characteristic of pressure-feed systems.
6. c. Pressure-feed guns accommodate a wide range of fluid viscosities.
7. a,b. Frequent, small-volume color changes are accommodated best by gravity- and siphon-feed systems.
8. a,b. Due to the restrictions imposed by the fluid cups, either gravity- or siphon-feed guns are usually used for low production rates.
9. c. The air cap is remarkably different to accommodate the external versus internal atomization. Refer back to Figures 2 and 11.
10. c. The HVLP abbreviation refers to high volume low pressure of air.
11. a,c. HVLP offers compliance and a high level of operator control.
12. Electrostatic airspray guns are more transfer efficient since the fluid droplets are electrically attracted to the substrate.



# Module Evaluation

*The purpose of this Module Evaluation is to help the Graco Technical Communications department determine the usefulness and effectiveness of the module.*

*Instructions: Please complete the evaluation, tear it on the perforation, and return it Graco Technical Communications Department, P.O. Box 1441, Minneapolis, MN 55440-1441, USA.*

1. *Based on the objectives, this module:*

- Significantly exceeded my expectations
- Exceeded my expectations
- Met my expectations
- Was below my expectations
- Was significantly below my expectations

2. *Why did you select the above rating?*

3. *How do you plan to use the module information in your job?*

4. *How do you think the module could be improved?*

*I verify that I have successfully completed Module No. 321-033*

*Title: Airspray Technology*

*Signature* \_\_\_\_\_

*Date* \_\_\_\_\_



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*The Graco Concept and Theory Training program consists of the following topics:*

Fluid Basics  
Atomization  
Electrostatic Spray Finishing  
Safety  
Airspray Technology  
Fluid Types: Paints and Other Coatings  
Fluid Types: Lubricants  
Fluid Types: Sealants and Adhesives  
Airless Atomization  
Spraying Techniques  
Transfer Efficiency  
Fluid Movement  
Fluid Controls  
Pumps  
Motors and Power Sources  
Plural Component Paint Handling  
Plural Component Sealant and Adhesive Handling  
Paint Circulating Systems  
Automatic Finishing  
Lube Reels and Dispense Valves  
Lube Metering Systems  
Electronic Fluid Management Systems