

# ***Airless Spray Coating Technology***

## ***Including Air-Assisted Airless Spray Technology***

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*Concept and Theory Training*



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# Introduction

Welcome to *Airless Spray Coating 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. *Airless Spray Coating Technology* discusses the basics of airless spray coating, covers the principal parts of airless spray guns, explains how they operate, and describes air-assisted airless spray coating technology.

## **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.

For this module, order the brochure, *Great Tips from Graco*, form number 300-248 on a Graco Literature Request Form, form number 317-324.

# Airless Spray Coating 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:

- Define airless spray coating.
- Describe airless spray coating atomization.
- Describe safety issues associated with airless spray coating technology.
- Identify principal parts of an airless spray gun.
- Explain basic airless spray gun operation.
- List the advantages and disadvantages of airless spray coating technology.
- Contrast air-assisted airless spray guns with airless and airspray guns.
- State the advantages and disadvantages of air-assisted airless spray coating guns.

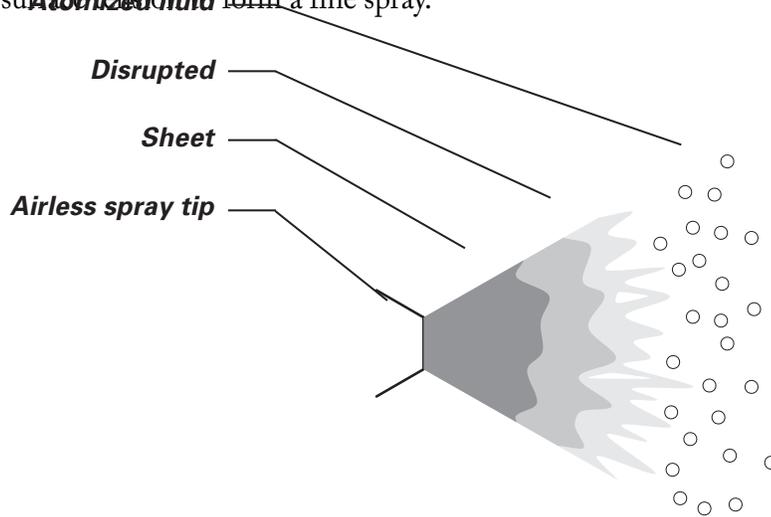
## ***Airless Spray Coating***

Spray coating is the process of coating an object with a liquid spray of paint or other fluid.

Airless spray coating technology uses a spray produced by forcing a fluid under high pressure 500-5000 psi (34-340 bar) through a small nozzle (spray tip) to atomize the fluid. The fluid emerges as a narrow sheet at a high speed. The friction between the fluid and the air disrupts the sheet, breaking it into fragments initially and ultimately into droplets. See Figure 1 for an illustration of the fluid atomization process.

The fast-moving, high-pressure liquid stream provides the energy necessary to overcome the fluid's

viscosity and surface tension of the fluid form a fine spray.



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**Figure 1:** The fluid atomization process.

The following are a few key facts to orient you further to airless spray technology before you read more in depth discussions of the technology.

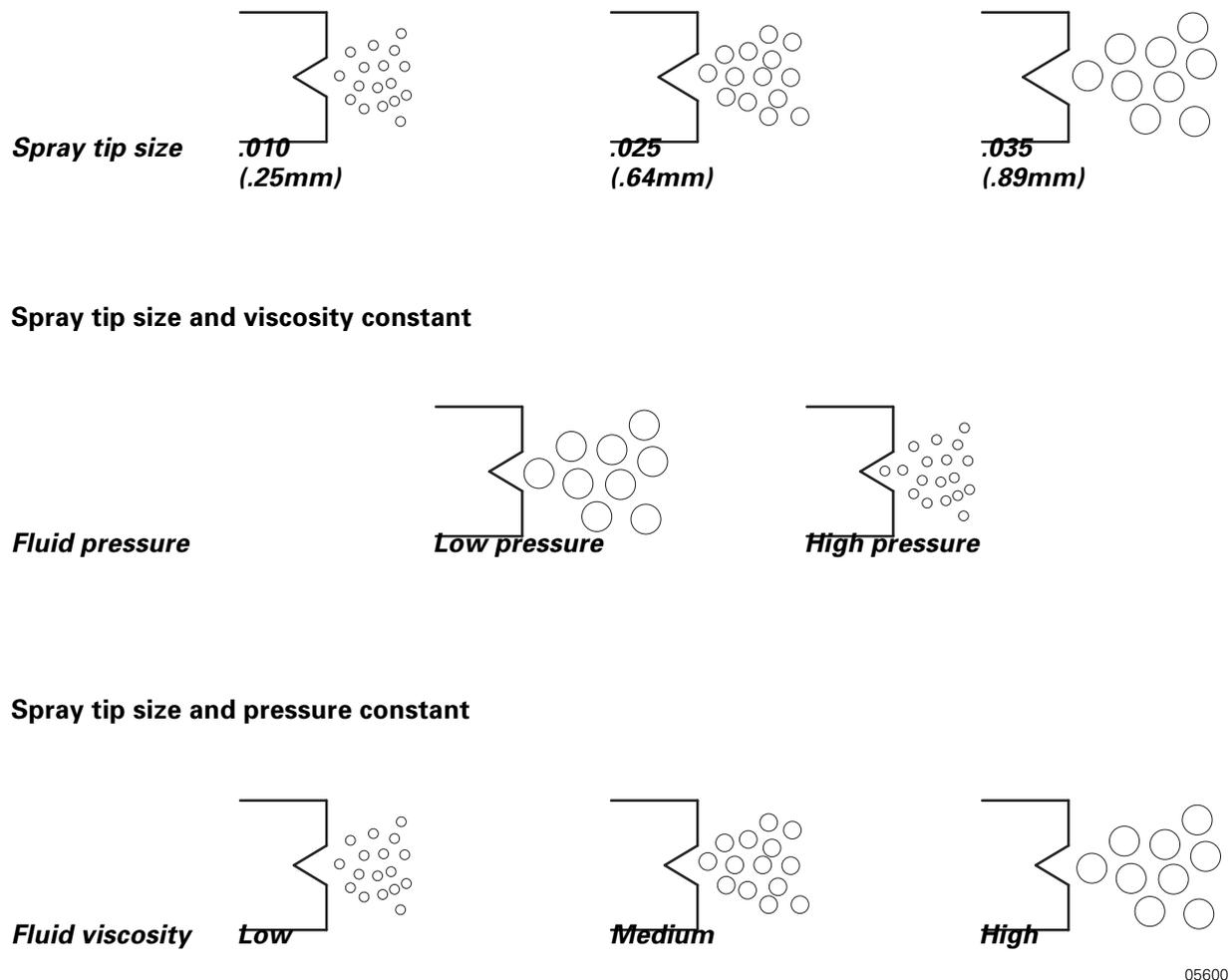
Other terms you may encounter for airless spray coating technology include hydraulic, hydrostatic, and pressure spray. In contrast to airspray coating technology, airless spray coating technology does not use compressed air to supply energy for atomization. Customers generally use airless spray coating technology to apply high volumes of fluid to large surfaces relatively quickly.

### ***Factors Affecting Droplet Size***

Factors affecting an airless spray include the atomizer orifice (spray tip) size and shape, fluid pressure and fluid viscosity. Three general rules that govern the relationship among these factors for an airless spray are:

1. For a given fluid pressure and viscosity, as the flow rate or size of the spray tip increases, the average droplet size in a spray increases.
2. For a given spray tip size and fluid viscosity, as the fluid pressure increases, the average droplet size decreases.
3. For a given spray tip size and fluid pressure, as the fluid viscosity increases, the average droplet size also increases.

See Figure 2 for a graphic representation of these relationships.



**Figure 2:** The relationship between the factors that affect droplet size.

## **Safety with Airless Spray Guns**

Since the high pressures of airless spray guns have the potential for causing skin injection injury, it is important to know about and comply with all the necessary safety precautions. In addition to avoiding skin injection injury, operators must ground the fluid hose and fluid supply to prevent static electricity buildup since static electricity can cause fire, explosion, or electric shock.

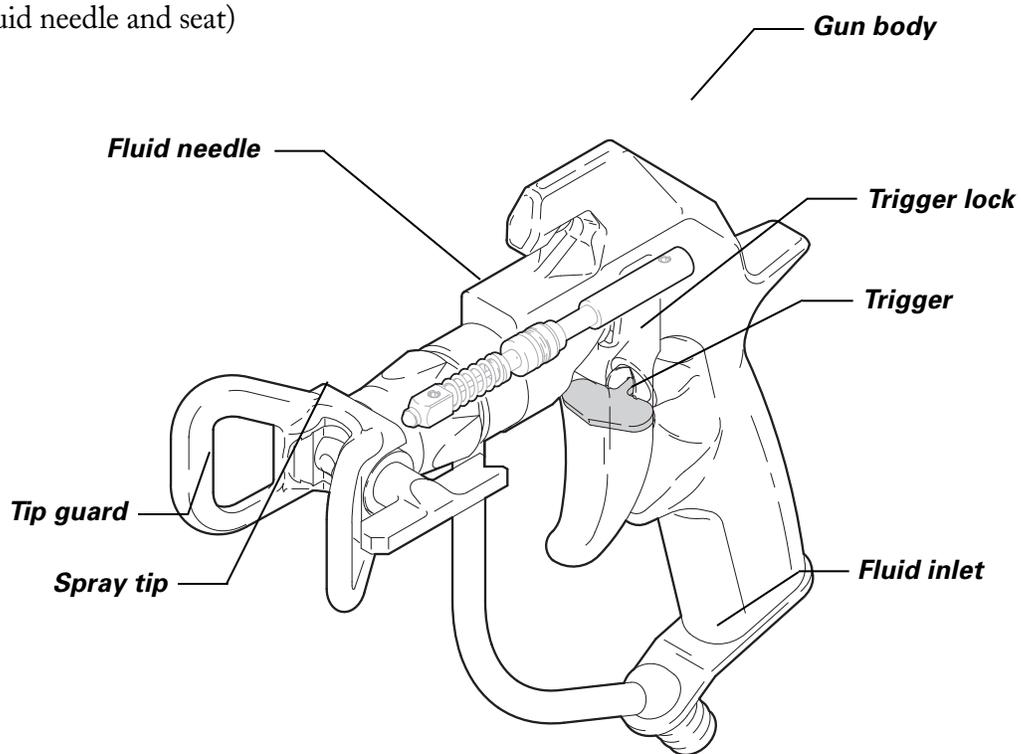
Refer to the *Safety* module from the Graco Concept and Theory Training curriculum for a thorough discussion of potential hazards and preventive actions when using Graco equipment

(Form No. 321-034).

## **Principal Parts of an Airless Spray Gun**

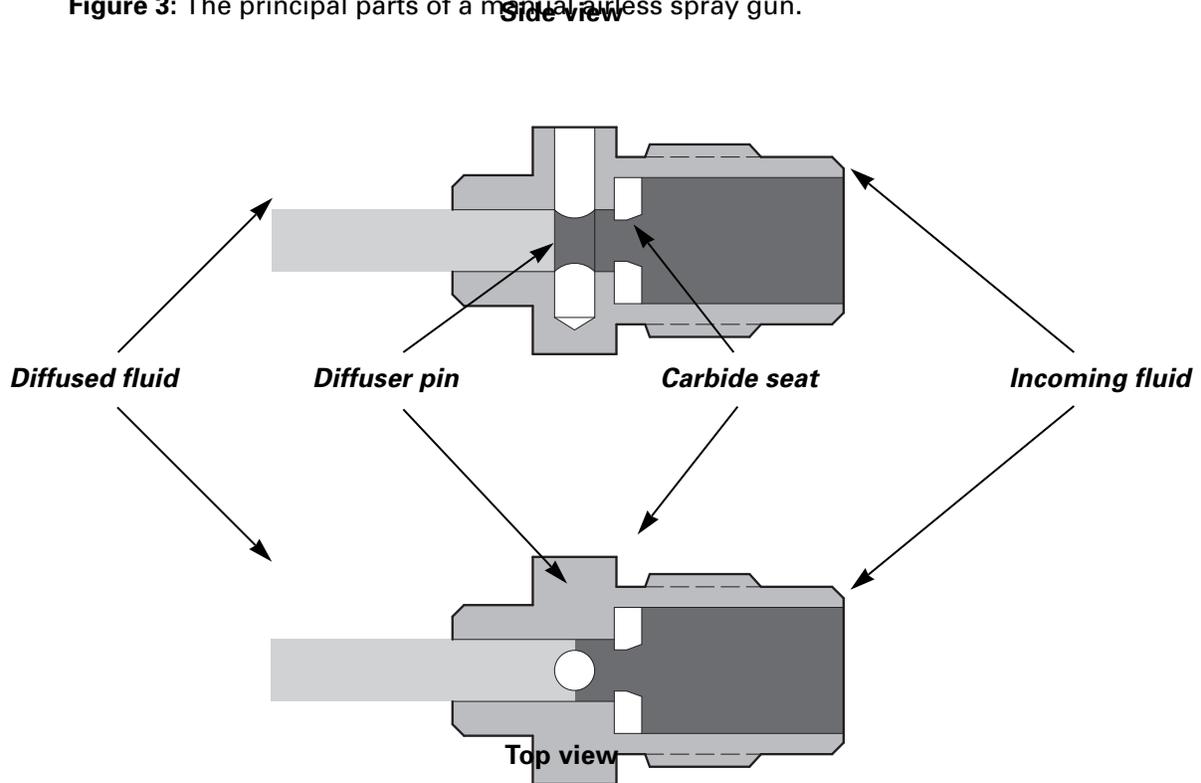
The principal parts of an airless spray gun include (see Figures 3 and 4):

- Spray tip
- Tip guard
- Diffuser
- Fluid valve (fluid needle and seat)
- Trigger
- Trigger lock
- Fluid inlet
- Gun body



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**Figure 3:** The principal parts of a manual airless spray gun.



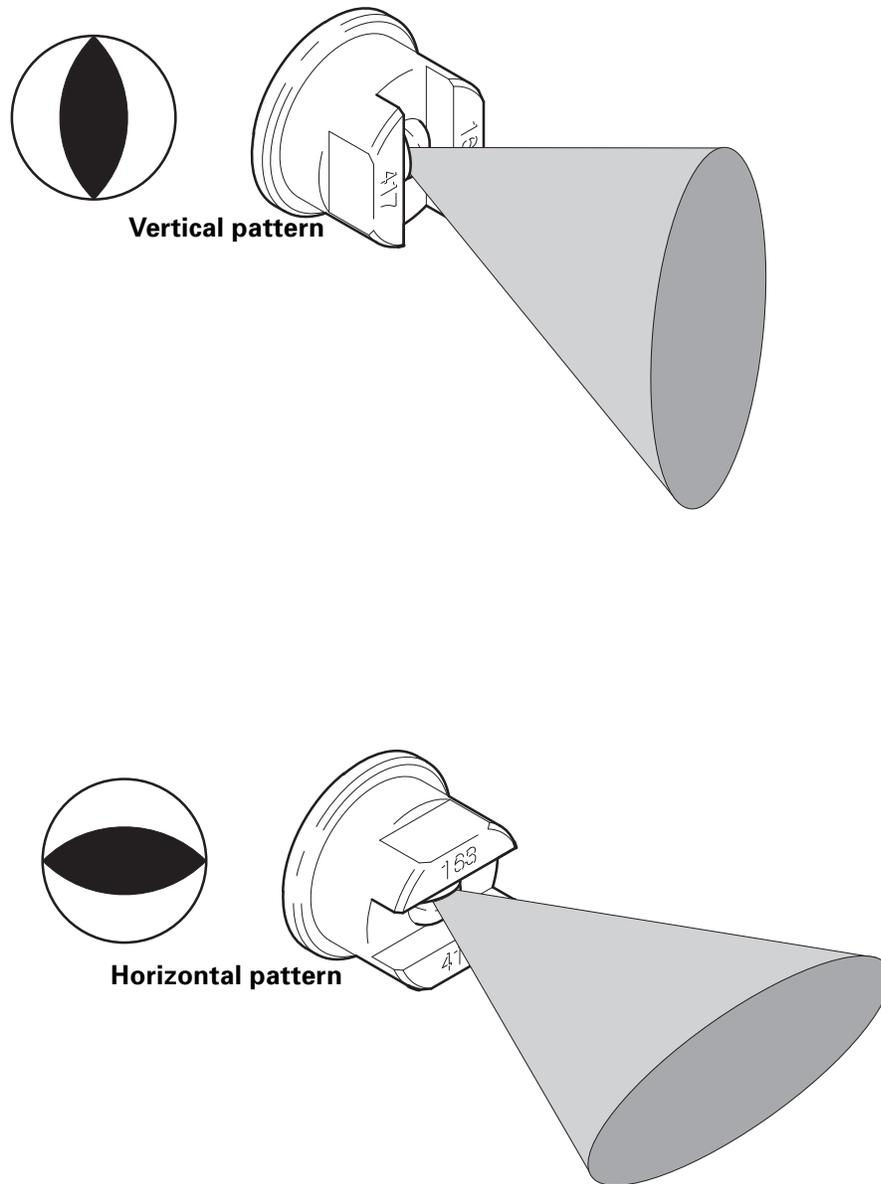
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**Figure 4:** The diffuser.

### Spray Tip

The spray tip controls the fluid flow rate and creates back pressure in the system. The spray tip also defines the spray pattern by the size and shape of the orifice. Typically a small orifice is used for low viscosity (lighter) fluids and a larger orifice for higher viscosity (heavier) fluids. The fluid tip can be

rotated to any position for ease of operation. See figure 5 for an illustration of the relationship between the orifice and fan pattern of the airless spray tip.



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**Figure 5:** Graphic of an airless spray tip showing two views of spray patterns

See the separate section on airless spray tips following this overview of principal parts for additional

details on tips.

### **Tip Guard**

The tip guard consists of two protrusions on either side of the spray tip. The tip guard warns the operator to stay clear of the tip to prevent skin injection injuries.

### **Fluid Valve (fluid needle and seat)**

The fluid valve consists of the fluid needle and seat. This valve controls the flow of fluid to the spray tip with an off/on ball seat valve, and is mechanically actuated by squeezing the trigger. The needle connects the trigger to the ball.

### **Trigger**

Squeezing the trigger activates the fluid valve, which permits fluid to flow to the spray tip. Airless guns do not have a variable valve as do air spray guns so “feathering” is not possible.

### **Trigger Lock (trigger safety)**

The trigger lock is a safety feature that prevents the trigger from activating accidentally. The trigger lock should be engaged any time the gun is not in use.

### **Fluid Inlet**

The fluid connector serves as the attachment for the high pressure fluid supply hose.

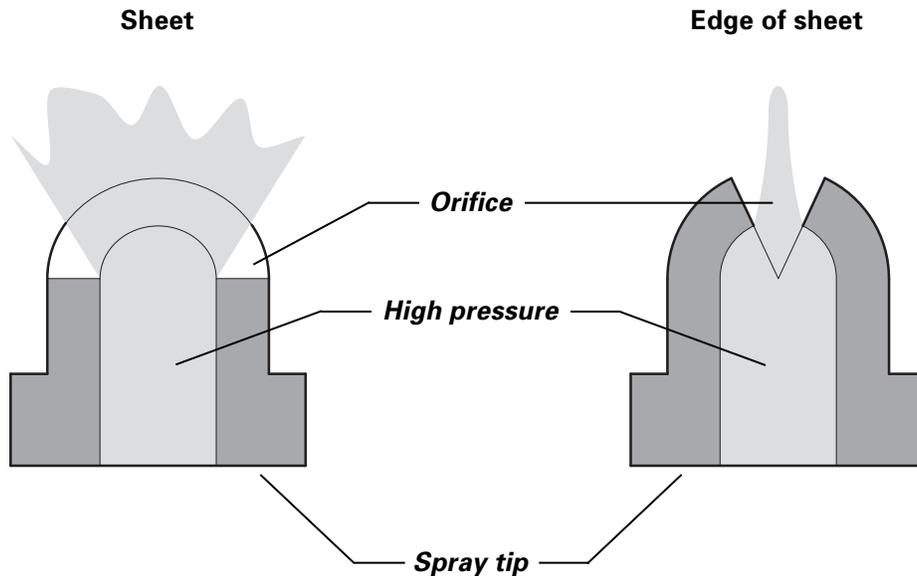
### **Gun Body**

The gun body is an ergonomically-designed aluminum or plastic housing that serves as a frame for internal parts, a container for fluid passages, and as a handle for the operator.

## ***Airless Spray Tips***

Coating fluids under high pressure can be highly abrasive. Key parts of airless spray guns such as the fluid valve, fluid needle, seat and the spray tip are made from tungsten carbide or other hard materials to provide an acceptable service life.

Spray tips for airless spray coating have a unique design causing them to form a fan-shaped spray with high pressure fluid. The tip orifice is formed by cutting a V-shaped groove in the front end of the tip deeply enough to extend into the internal cavity of the tip. This design allows fluid to emerge in a thin sheet (see Figure 6).



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**Figure 6:** Airless spray tip design.

## Spray Tip Sizing Conventions

Airless spray tips are not adjustable. Each nozzle produces a spray with a characteristic fan pattern width and flow capacity. Spray gun suppliers offer a range of tips with different fan sizes and flow capacities to suit a wide range of applications. While the spray fan is sometimes stated in degrees, it is more often stated in terms of fan pattern width in inches at some distance from the substrate. Flow capacity is usually stated in terms of gallons or liters per minute. The orifice size is generally stated in thousandths of an inch or millimeters.

## Spray Tip Selection

The user typically will select a tip with the desired fan size and then experiment with different orifice sizes to find the one that best suits the job. If the orifice size is too large, the flow rate will be too high or the pressure will be too low to form a good spray pattern. Typically there will be tails in the pattern. Conversely, if the orifice is too small, the fluid flow will be too low to maintain acceptable productivity. Read *Great Tips from Graco* (Form No. 300-248) for a thorough presentation of the variety of airless spray tips Graco offers, how to select the best tip for the job, and factors to consider in extending the life of spray tips.

## ***How Airless Spray Guns Work***

Fluid is pumped to the gun under high pressure. It is transmitted by the fluid hose, and enters the gun via the fluid inlet and flows to the fluid valve. The fluid valve controls the fluid flow. When the valve is closed, fluid cannot flow any further; when the valve is open, fluid flows under pressure to the spray tip.

To operate the gun, the user pulls the trigger toward the handle, which opens the fluid valve. Fluid travels past the diffuser to the spray tip via internal passages in the gun body. Fluid flows out the spray tip at high velocities; as fluid is released from the orifice, it atomizes into small droplets and travels to the substrate under its own initial momentum.

When the operator releases the trigger, springs close the fluid valve, stopping the fluid flow.

## ***Advantages and Disadvantages of Airless Spray Coating Technology***

While airless spray coating technology offers several advantages, there are also some disadvantages.

### **Advantages**

One major advantage is the high rate of fluid delivery, which permits greater production rates. Airless spraying is especially appropriate for applying highly viscous protective coating to large exterior surfaces, such as bridges or storage tanks. Another advantage is that atomization is established by the tip selection, thus minimizing opportunities for operators to misadjust the units.

Airless guns can produce good quality finishes if pressures are kept low in applications where special tips are used. Lower viscosity materials spray quite well at these lower pressures.

Also, airless spray coating technology causes less overspray or bounce back than airspray guns. And because of the high velocity of fluid emanating from the tip during operation, airless spray guns achieve good penetration on recessed areas of work pieces.

### **Disadvantages**

A serious concern with airless spray technology is the potential risk of injection injury (mentioned earlier in this module). Another issue is that the operator has no control over the amount of fluid flow; the trigger activates an all-or-none fluid flow (no feathering, as is possible with airspray guns). This requires greater operator skill on smaller parts.

Also, airless spray coating technology is generally not considered capable of providing a very high finish quality. The initial investment with this technology is relatively high due to the need for a high pressure pump. A final limitation is increased part wear since the necessary high pressures cause abrasive fluids to wear out key parts very rapidly.

# Air-Assisted Airless Spray Guns

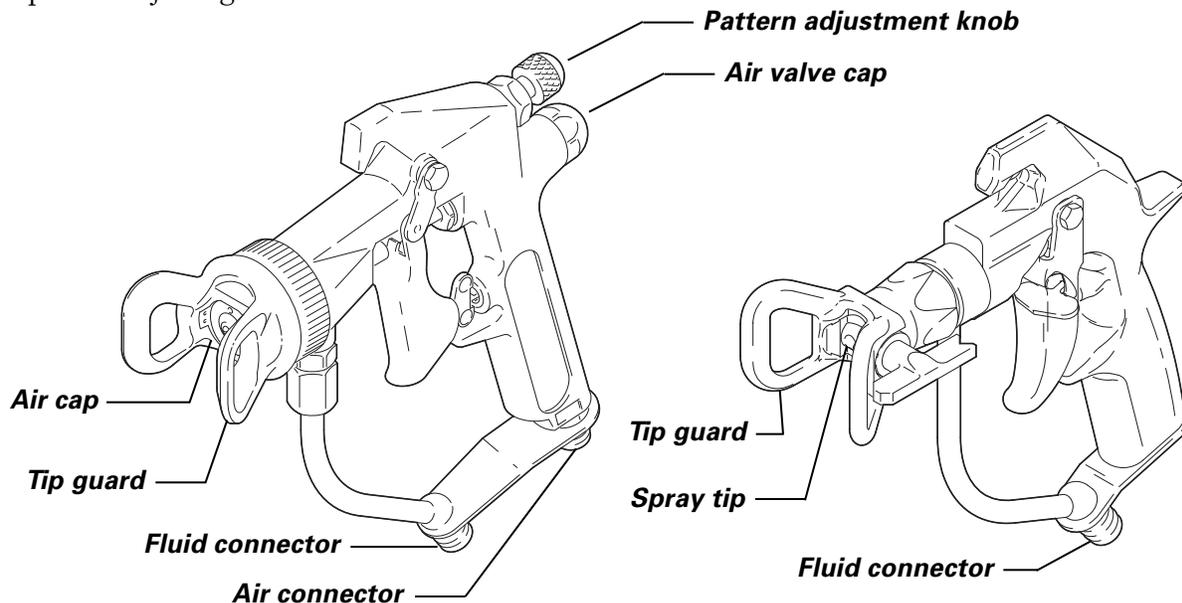
## Learning Objectives

Air-assisted airless guns are similar to airless spray guns. After completing this section on air-assisted airless spray guns, you will be able to:

- Describe how air-assisted airless spray guns combine the features of airless and airspray guns
- State the advantages and disadvantages of using air-assisted airless guns

## A Hybrid Spray Gun

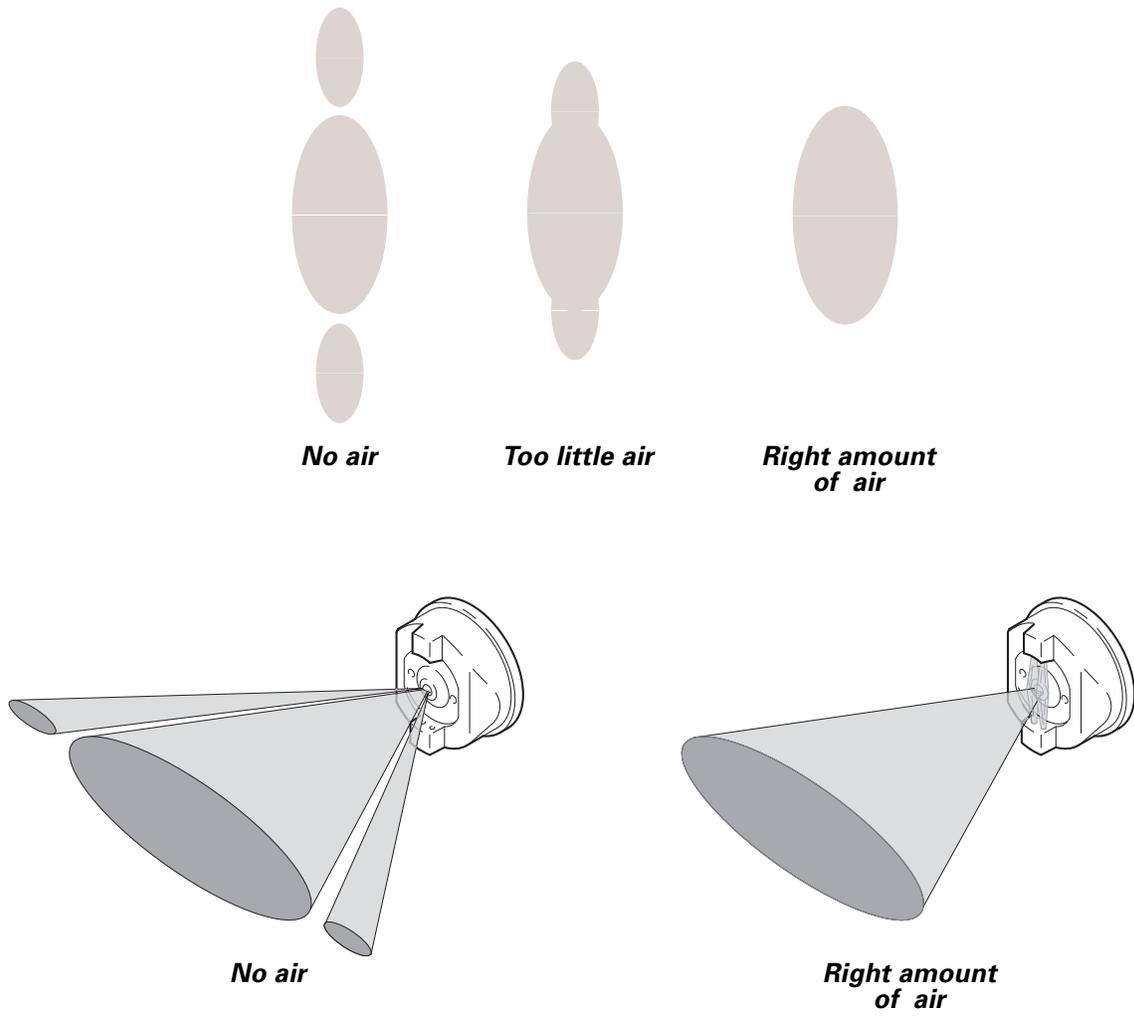
Air-assisted airless spray guns are a hybrid combining the features of airless and airspray guns. They blend the high fluid pressure of airless spray guns with the low-pressure atomizing air of airspray guns. In other words, air-assisted airless airspray guns employ the principle of airless atomization with the addition of a concentrated airflow to atomize the pattern tails and complete the pattern. See Figure 7 for a picture of both an air-assisted airless and an airless spray gun. Notice that the air-assisted airless gun is similar to the airless gun with the exception of the air inlet for the atomizing air, the air cap, and the pattern adjusting valve.



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**Figure 7:** The difference between an air-assisted airless gun and an airless spray gun.

See Figure 8 for a graphic of a spray pattern as the atomizing air from an air-assisted airless gun is adjusted properly, thus eliminating the pattern tails.



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**Figure 8:** Air assisted airless spray patterns.  
Top: Typical patterns as sprayed on a surface.  
Bottom: How the atomizing air from an air-assisted airless gun eliminates pattern tails.

## ***Advantages and Disadvantages of Air-Assisted Airless Spray Coating Technology***

Although air-assisted spray guns build on the advantages of airless technology, there are some disadvantages.

### **Advantages**

An important selling point for these guns is their ability to produce a finish quality approaching that of airspray guns due to their ability to operate at lower fluid pressures than airless guns. Compared with airspray technology, air-assisted airless spray guns deliver fluid at a higher rate and therefore afford faster coverage. These guns also have better transfer efficiency than airspray guns since there is less bounce-back or overspray.

Another advantage concerns the reduction in equipment wear due to the lower fluid pressure compared to airless spray guns.

### **Disadvantages**

With air-assisted airless technology, the operator must select an appropriate tip to control the fluid flow and adjust the air supply for optimal atomization, which introduces an opportunity for operator error. In addition, the risk of skin injection injury also exists for these guns. Finally, air-assisted airless spray guns cost approximately twice as much as airless spray guns.

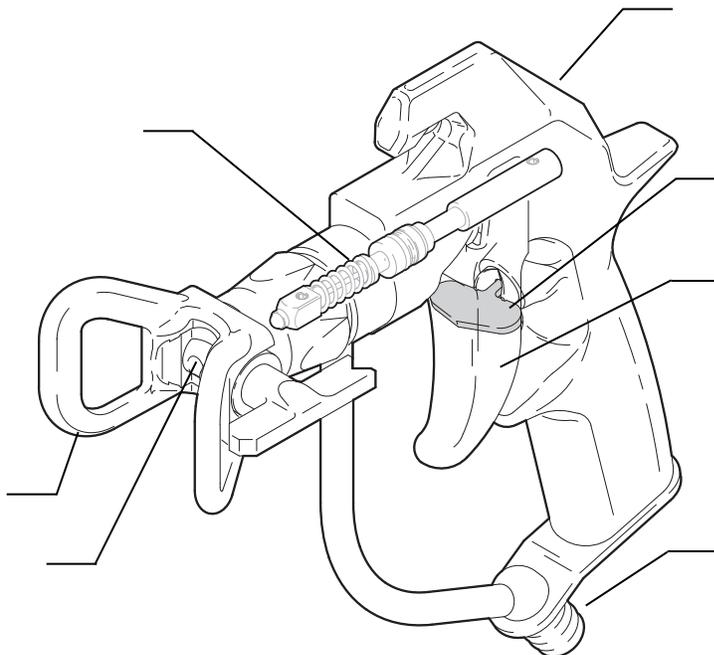
# Progress Check

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.

1. What causes fluid to atomize as it emerges from the spray tip of an airless spray gun?
  - a. Sheeting action
  - b. High fluid pressures being forced through a narrow orifice
  - c. A combination of the fluid's viscosity and surface tension
  - d. The friction between the fluid and air

For items 2-4, write an "I" for increase and a "D" for decrease to complete the statements correctly.

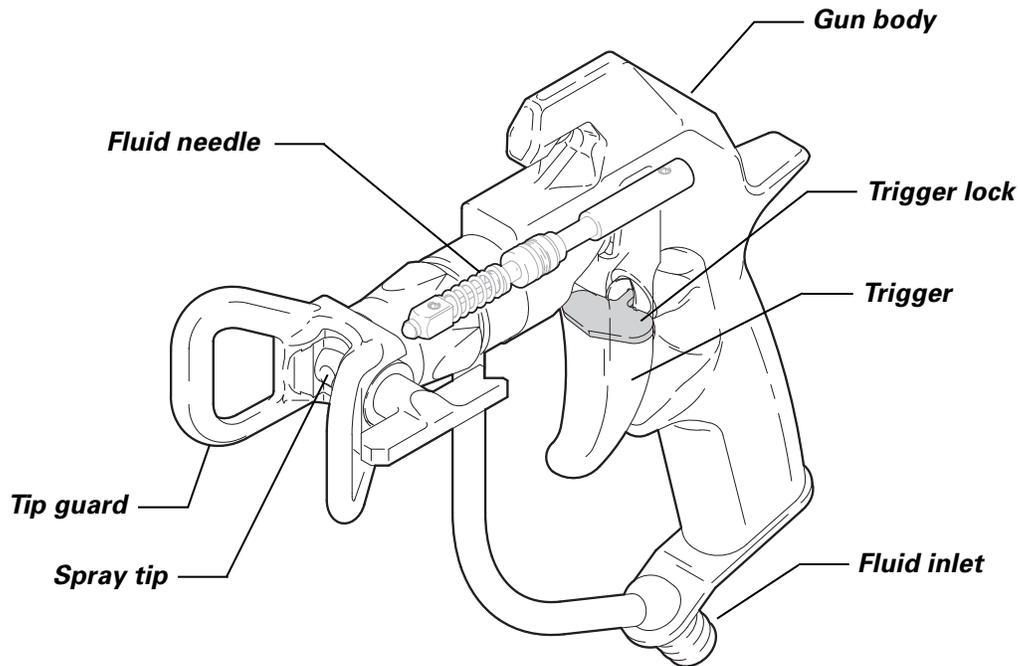
- \_\_\_ 2. For a given spray tip size and fluid pressure, as the fluid viscosity increases, the average droplet size \_\_\_\_\_.
  - \_\_\_ 3. For a given spray tip size and fluid viscosity, as the fluid pressure increases, the average droplet size \_\_\_\_\_.
  - \_\_\_ 4. For a given fluid pressure and viscosity, as the diameter or size of the spray tip increases, the average droplet size \_\_\_\_\_.
5. Label the parts indicated on the illustration below.



6. The primary difference between airless and air-assisted airless spray guns is that one adds compressed air to complete the spray pattern.
- True
  - False
7. A customer is applying a heavier fluid. As a general rule, will you recommend a larger or smaller airless spray tip?
- 
8. Select the statements that correctly characterize airless spray tips and their selection.
- Operators can fine tune the adjustment of airless spray tips.
  - Each spray tip has a characteristic fan pattern width and flow capacity.
  - Often operators choose a tip with the desired fan size, but must determine orifice size through trial-and-error.
  - Spray tip selection depends only on the desired flow rate.
9. What's the benefit of the fact that airless spray tip selection dictates atomization?
- 
10. What two limitations do the high fluid pressures of airless spray guns present?
- 
- 
11. Select the statements that correctly characterize air-assisted airless spray guns.
- These guns are useful for spraying heavy protective coatings on very large substrates.
  - They offer essentially the same transfer efficiency as do airless spray guns.
  - The fluid pressure is considerably less than with airless spray guns.
  - They deliver fluid at a faster rate (higher production) than do airspray guns.

## **Answers to Progress Check**

1. D. The friction between the fluid and air causes the fluid to atomize as it emerges from the spray tip.
2. I. For a given spray tip size and fluid pressure, as the fluid viscosity increases, the average droplet size increases.
3. D. For a given spray tip size and fluid viscosity, as the fluid pressure increases, the average droplet size decreases.
4. I. For a given fluid pressure and viscosity, as the diameter or size of the spray tip increases, the average droplet size increases.
- 5.



6. a. True. Air assisted airless spray guns have a concentrated airflow that atomizes the pattern tails and completes the spray pattern.
7. **Larger** airless spray tips are generally recommended for heavier (higher viscosity) fluids.
8. b. Each spray tip has a characteristic fan pattern width and flow capacity.  
and  
c. Often operators choose a tip with the desired fan size, but must determine orifice size through trial-and-error.
9. Having the atomization dictated by the tip selection reduces the opportunity for misadjustment by an operator.
10. The high fluid pressures necessary for airless spray guns cause fluids to wear out gun parts and also pose the risk of skin injection injury.
11. a. These guns are useful for spraying heavy protective coatings on very large substrates (air-assisted airless may be used in some industries where finish quality is important).  
c. The fluid pressure is considerably less than with airless spray guns.  
d. They deliver fluid at a faster rate (higher production) than do airspray guns.

# 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. 321-035*

*Title Airless Spray Coating 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