

Basic Electrostatic Spray Finishing

Concept and Theory Training



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Introduction

Welcome to *Basic Electrostatic Spray Finishing*, a learning module in Graco's basic concept and theory sales training curriculum. Your understanding of the information in this module provides the basis for further study of 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 introduces basic information on electrostatic spray finishing processes, including the underlying terms, concepts, and principles. You will understand how electrostatic charging can be used with a variety of spray finishing systems to improve spray transfer efficiency.

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 make the learning process convenient and productive:

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

Learning Objectives

Each section of materials 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 learning 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 and Illustrations

An important element of any instruction is visualizing the concepts. This module contains graphics and illustrations to enhance the text material. Whenever 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 major 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.

Introduction to Electrostatic Spray Finishing

Learning Objectives

This section provides a foundation for learning about electrostatic spray finishing. The term *electrostatics* or *electrostatic spray finishing* refers to a spray finishing process in which electrical charges and electric fields are used to attract particles of atomized coating material to the target (the object to be coated). In the most common types of electrostatic systems, electrical charges are applied to the coating material and the target is grounded, creating an electric field. The charged particles of coating material are drawn by the electric field to the surface of the grounded target because of the attraction of opposing electrical charges. Other, less common types of electrostatic systems apply an electrical charge to the target and ground the coating material, or apply opposite electrical charges to the coating material and the target. After completing this introduction to electrostatic spray finishing, you will be able to:

- Define the term *electrostatics* as it applies to spray finishing.
- Discuss how electrostatic spray charging is used to improve the transfer efficiency of spray finishing.
- Name several types of spray finishing systems with which electrostatics are used.
- Recognize key terms used to discuss electrostatic spray charging.

Why Use Electrostatic Spray Finishing?

Electrostatic spray charging improves the transfer efficiency of spray finishing equipment. The transfer efficiency improvements occur because the electrostatic forces help overcome other forces, such as momentum and air flow, that can cause the atomized materials to miss the intended target.

Electrostatic methods save coating material, time, and labor. More of the material is attracted to and adheres to the target, and less material is lost in the spray booth and the surrounding environment. Electrostatic methods also lower solvent emissions into the air since less coating material is needed to coat each part.

Types of Electrostatic Systems

Electrostatic spray finishing systems can be either automatic or manual.

Automatic Electrostatic Systems

The automatic electrostatic systems include:

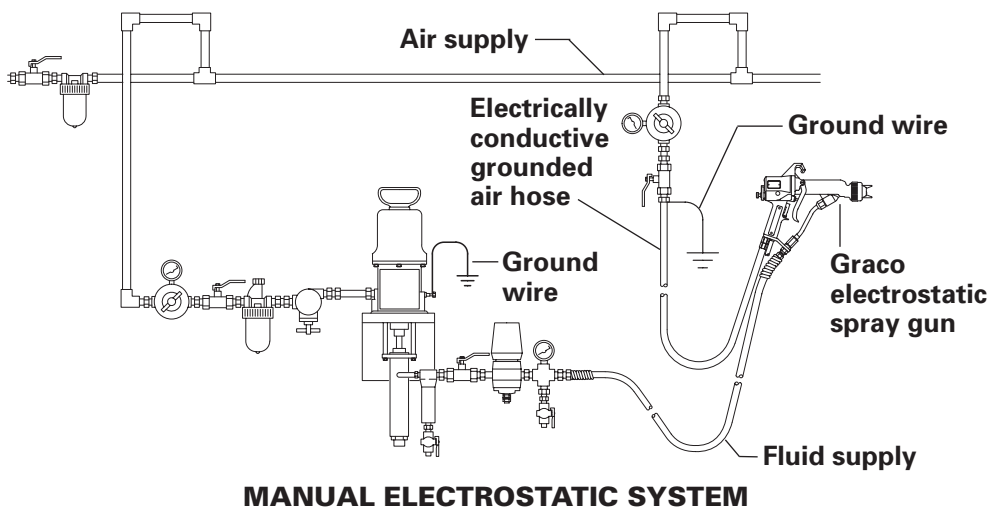
- High speed rotational (stationary or reciprocating) atomizers
- Reciprocating discs
- Automatic air spray, airless, air assisted airless, or HVLP spray guns

Manual Electrostatic Systems

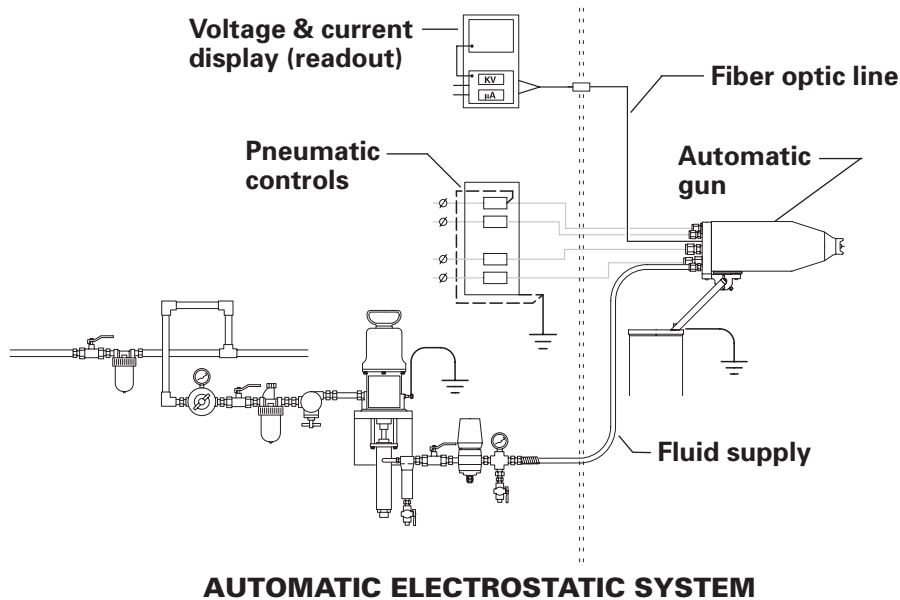
The manual electrostatic systems include:

- Airspray electrostatic hand-held spray guns
- Air-Assisted Airless electrostatic hand-held spray guns
- Airless electrostatic hand-held spray guns
- HVLP electrostatic hand-held spray guns
- Hand-held rotary atomizer systems

The manual and automatic electrostatic systems listed above are discussed in greater detail in the modules of this training that cover specific Graco products. Figure 1 shows examples of manual and automatic electrostatic systems.



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Figure 1 Manual and automatic electrostatic spray finishing systems

Key Terms

Figure 2 below provides definitions for many of the terms used to explain electrostatic spray charging. Review the definitions now. You can refer back to these definitions, as needed, while you proceed through this module or other training on Graco electrostatic products.

Key Terms For Understanding Electrostatics	
Current	The flow of electrons. Measured in amps, milliamps, or microamps.
Voltage	The force or pressure pushing electrons. Measured in volts or kilovolts.
Circuit	A completed (circular) electrical path that permits the flow of electrons.
Ground	Within a circuit, a connection to earth potential or true earth ground.
Conductor	Material through which electrons can easily flow.
Resistor	Material through which electrons cannot easily flow, and used to control the flow of electrons in electrical circuits. Measured in ohms or megohms.
Insulator	Non-conductive, highly resistive material that stops the flow of electrons.
Ionization	The process by which molecules gain or lose electrons.
Generator	A machine that changes mechanical energy into electrical energy.
Alternator	A generator that changes mechanical energy to alternating current.
Power Supply	A device that converts one type of electrical power to a different type of electrical power—for example, from low voltage AC to high voltage DC.
Capacitance	The storage or accumulation of electrical charges on a conductive surface that is insulated from other conductive surfaces so that it will hold its electrical charge.
Capacitor	A device within an electrical circuit used to hold electrical charges.
Transfer Efficiency	The percent of coating materials that reaches the target when spraying.

Figure 2 Key terms for electrostatics

Understanding Particle Charges

Learning Objectives

To understand electrostatic spray charging, you must first be able to identify the types of charged particles that make up matter and explain how charged particles impact one another. After completing this section on electrical charges, you will be able to:

- Name the types of particle charges that make up matter.
- Explain how electrically charged particles act on other particles with the same or different charges.
- Describe the forces of electric fields.

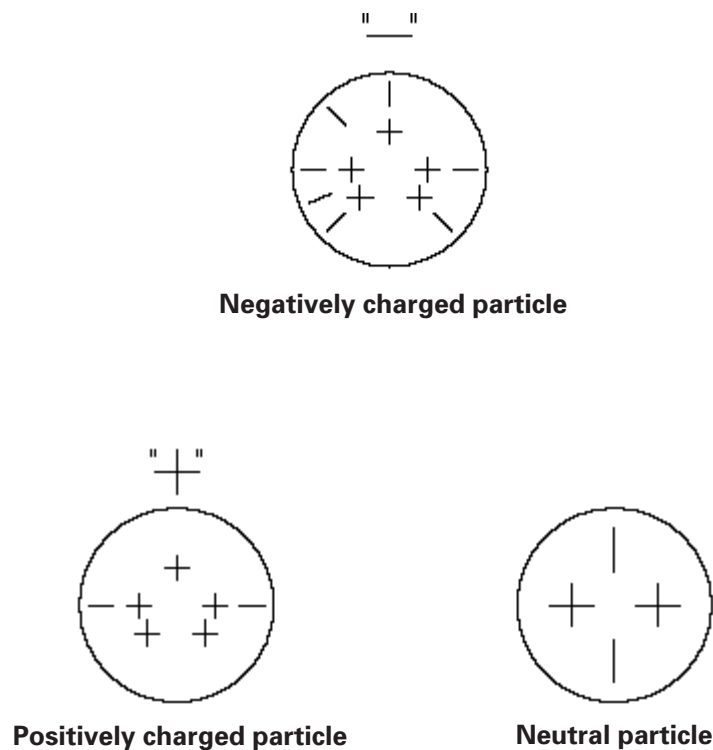
Dynamics Among Charged Particles

All matter has an electrical charge. Matter is made up of three types of electrically charged particles:

1. Negatively charged particles have excess *electrons*.
2. Positively charged particles have excess *protons*.
3. Neutral particles have a balanced number of electrons and protons.

Particles and objects with like charges repel each other, whereas particles with unlike charges attract each other. A single, isolated particle that is either negatively or positively charged will attract neutral particles. Charged particles are also attracted to the closest grounded surface.

The three types of electrically charged particles are illustrated in Figure 3.



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Figure 3 Electrically charged particles

Electric Fields

Electric (or electrostatic) *fields* are the lines of force that originate on a charged object and terminate on an oppositely charged object, or ground. Thus, there is an electric field between a charged particle (or object) and a grounded object. There is a field between the ionizing needle and the grounded object. There is also an electric field between oppositely charged particles. The field strength is measured in volts per meter.

A charged particle that enters an electrostatic field will be subjected to the force that exists in the field, just as an object with mass is subjected to a force in a gravitational field. It is this force that is used in electrostatic spray charging, as you will learn in the sections to follow.

In electrostatic spray finishing, an electric field is created by the ionizing needle. As the paint particles are charged, fields form between the particles and the grounded object. The benefits of electrostatic spray finishing are due to the electric fields between the needle and the grounded object, and the fields between the charged paint particles and the grounded object.

Progress Check

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

1. Which of the following accurately describe an electrostatic spray finishing system? (Select all that apply.)
 - a. Electrical charges are applied to the coating material, and the target is grounded.
 - b. Electrical charges are applied to the target, and the coating material is grounded.
 - c. Opposite electrical charges are applied to the coating material and the target.
 - d. The momentum of air flow is used to attract the coating material to the target.
2. The advantage of using electrostatics with spray finishing processes is:
 - a. More coating material enters the surrounding environment.
 - b. More solvent emissions are released in the air.
 - c. A greater percentage of sprayed coating material reaches the target.
 - d. More air flow impacts the spray.
3. With which of the following spray systems can electrostatics be used?
 - a. Manual systems.
 - b. Automatic systems only.
 - c. Airless and air-assisted systems only.
 - d. Both manual and automatic systems.

For items 4 through 7, match the terms with their definitions.

Terms

- a. Ionization
- b. Generator
- c. Resistor
- d. Ground

Descriptions

- ___ 4. A connection is made to earth (ground).
- ___ 5. Molecules gain or lose electrons.
- ___ 6. Controls the flow of electrons in circuits.
- ___ 7. Changes mechanical energy to electrical energy.

8. Which of the following charged particles attract each other? (Select all that apply.)
- a. Negative particles and positive particles.
 - b. Negative particles and other negative particles.
 - c. Positive particles and other positive particles.
 - d. Neutral particles and other neutral particles.
 - e. Neutral particles and positive particles.
 - f. Neutral particles and negative particles.
9. Under which of the following conditions can an electric field exist? (Select only one answer.)
- a. From a grounded object to another grounded object.
 - b. From a charged object to a similarly charged object.
 - c. From a charged object to an oppositely charged object.
 - d. From a neutral object to another neutral object.

Answers to Progress Check

1. a, b, and c. In most electrostatic spray charging systems, electrical charges are applied to the coating material and the target is grounded. Other, less common types of electrostatic systems apply an electrical charge to the target and ground the coating material, or apply electrical charges to both the coating material and the target.
2. c. The advantage of using electrostatics with other spray finishing processes is that a greater percentage of sprayed coating material reaches the target.
3. d. Electrostatics can be used with both manual and automatic spray finishing systems.
4. d. A *ground* is a connection to an earth potential or a true earth ground.
5. a. *Ionization* is when molecules gain or lose electrons.
6. c. A *resistor* is used to control the flow of electrons in circuits.
7. b. A *generator* changes mechanical energy to electrical energy.
8. a, e, and f. Negative particles and positive particles attract each other. Neutral particles are attracted to both positive particles and negative particles.
9. c. An electric field can exist between a charged object and an oppositely charged object or ground.

Electrostatic Spray Finishing Equipment

Learning Objectives

This section explains how electrostatic spray charging equipment uses the charges and the force of an electric field to improve the efficiency of spray finishing. After completing this section on electrostatic spray charging equipment, you will be able to:

- Identify the basic parts of an electrostatic spray finishing system.
- Explain how electrostatics impact the transfer efficiency of spray finishing processes.
- Identify the electrostatic charging methods.
- Describe the wraparound effect of electrostatic spray charging.
- Describe the key characteristics of electrostatic spray charging equipment.
- Explain the optimal conditions and applications for electrostatic spray charging.

The Electrostatic Spray Charging Process

The illustration in Figure 4 shows the basic components of electrostatic spray equipment. Among these basic components are:

- A spray gun or atomizer
- Particles of atomized coating material, which are emerging from the gun in a spray pattern
- An ionizing needle located in or near the stream of coating material
- The target, or object, to be coated

The equipment components illustrated in Figure 4 work together as an electrostatic spray finishing system. In the example in Figure 4, the ionizing needle applies an electrical charge to the particles of material. (In an electrostatic system, the coating material may be charged either before or after it is atomized.)

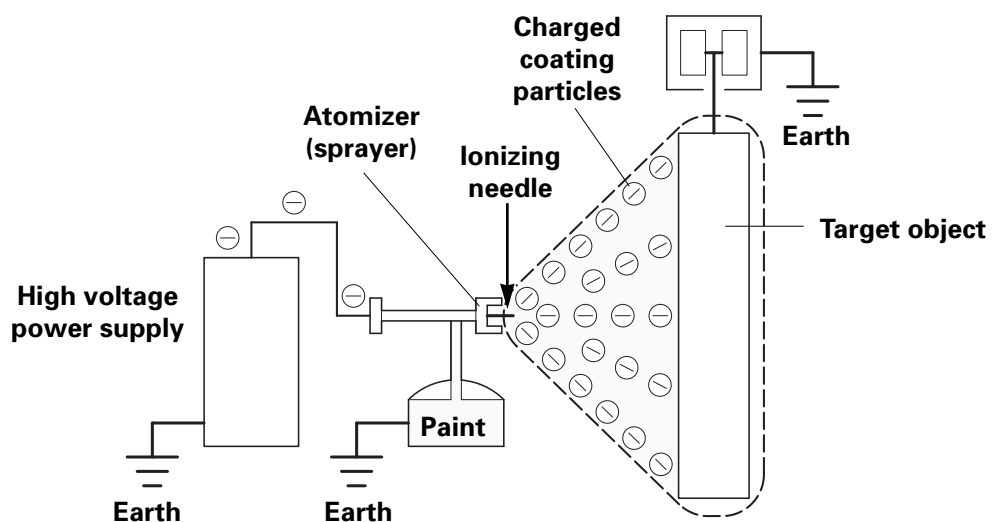
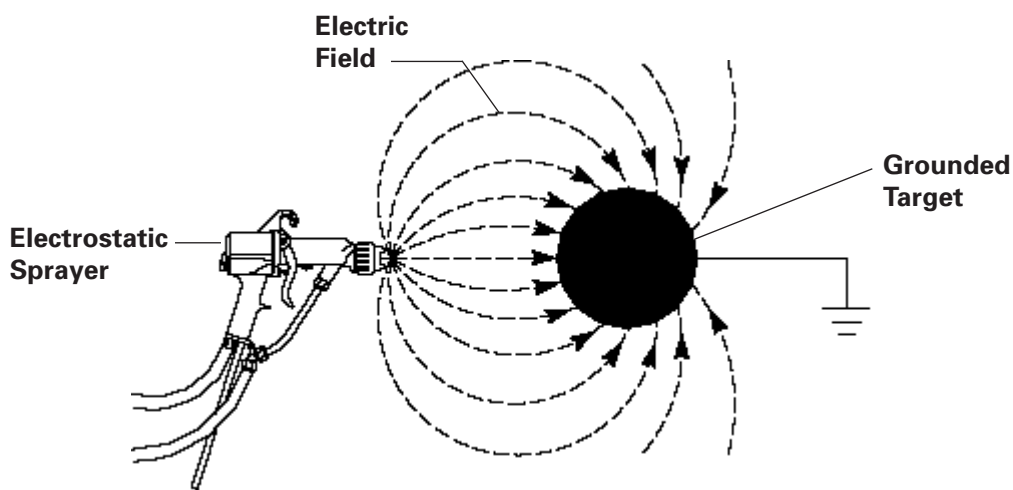


Figure 4 Basic components of electrostatic spray equipment

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As illustrated in Figure 5, the electrical field between the ionizing needle and the grounded object helps drive the charged spray particles to the grounded target. The force of the electrostatic field causes a greater percentage of the charged spray particles to reach the grounded object, rather than miss the target or be swept away by surrounding air flow. In other words, the transfer efficiency of the spray finishing process is improved through electrostatics because the electrical field draws an increased number of particles to the target.



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Figure 5 The electric field of an electrostatic system

Electrostatic Charging Methods

There are four types of electrostatic charging methods. The four electrostatic charging methods are:

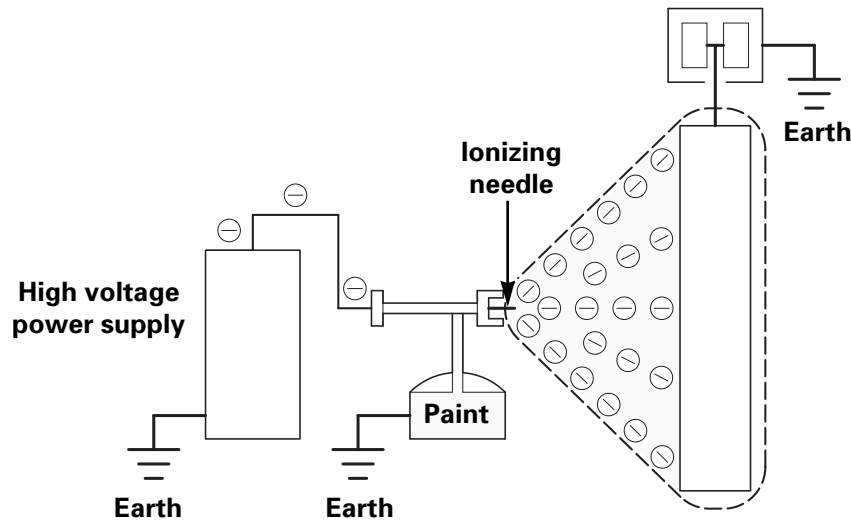
- *Corona charging*
- *Contact charging*, (also called conduction charging)
- *Induction charging*, (also called non-contact charging)
- *Frictional charging*, (also called tribo charging)

Of these methods, corona and contact (conduction) charging are the two primary methods used in liquid electrostatic spray finishing.

The four charging methods are explained and illustrated on the pages to follow.

Corona Charging

The *corona charging* method utilizes a pointed or sharply curved electrode that is raised to a high electrical potential. The intense electric field at the electrode breaks down the surrounding air and creates ions, which are then free to attach themselves to the atomized coating material.

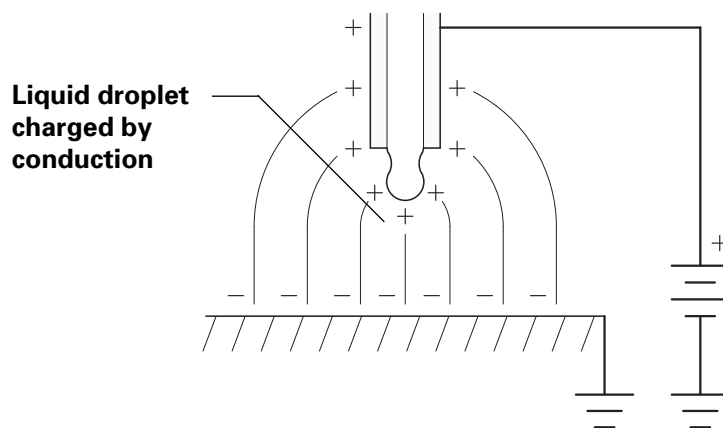


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Figure 6 Corona charging

Contact Charging

The *contact charging (or conduction)* method utilizes a direct charge transfer, rather than ionization. In this method, an electric charge flows from a source of high potential (voltage) to the coating material that has come into contact with the source.



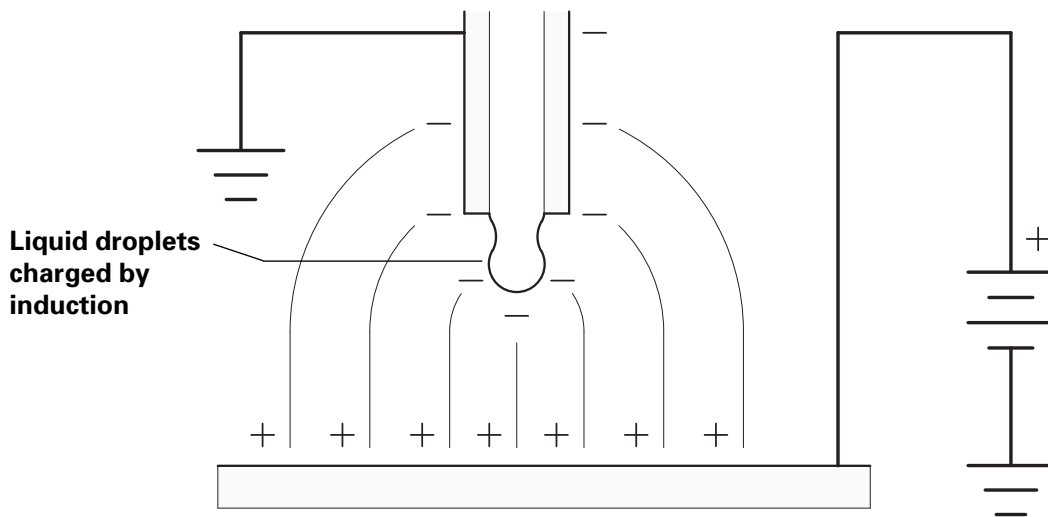
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Figure 7 Contact or conduction charging

A limitation of contact charging is that it is not easily used to apply an electrostatic charge to insulating coating materials. It is limited to relatively conductive coatings.

Induction Charging

The *induction charging* method uses an electric field to induce charge onto an earthed (grounded) object that is near a charged surface. If the ground is removed from the object, the induced charge cannot be dissipated, and the object retains its charge. Induction charging is also limited to relatively conductive coatings.



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Figure 8 Induction charging

Frictional Charging

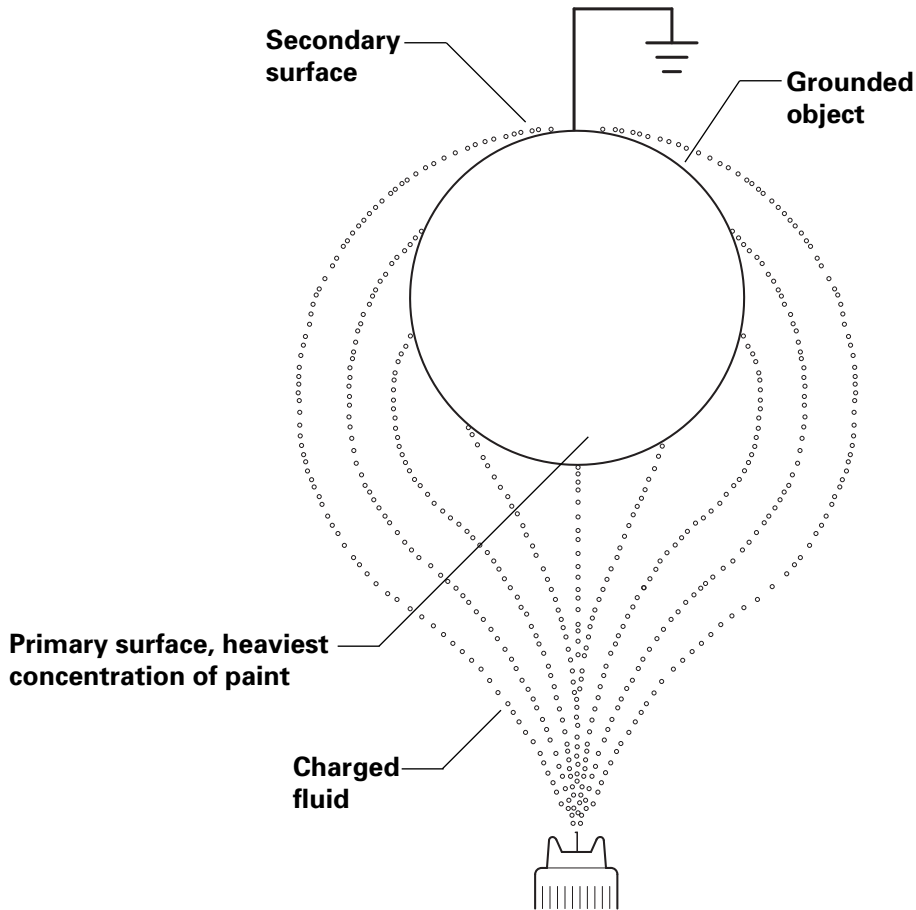
Frictional charging is familiar to many people, yet often misunderstood. In frictional charging, contact or friction between two unlike materials generates a charge. The amount of charge that is generated depends on the nature of the contact, the electrical properties of the materials, and the conditions of humidity and temperature.

Efficiency of Electrostatic Spray Charging

Electrostatics can be used with any atomization spray application process to improve its transfer efficiency. However, the addition of electrostatics does not make the spray application process 100 percent efficient. For example, a spray gun without electrostatics may have an efficiency of 25 percent transfer of paint to the object. By adding electrostatics, transfer efficiency may be increased significantly.

The Wraparound Effect

Wraparound is the effect of electrostatic spray charging in which the spray is directed at only one side of the object, yet more than one side of the object is coated. This wraparound effect occurs when spray particles that have moved past the targeted surface are drawn back to the object by the electrostatic forces.



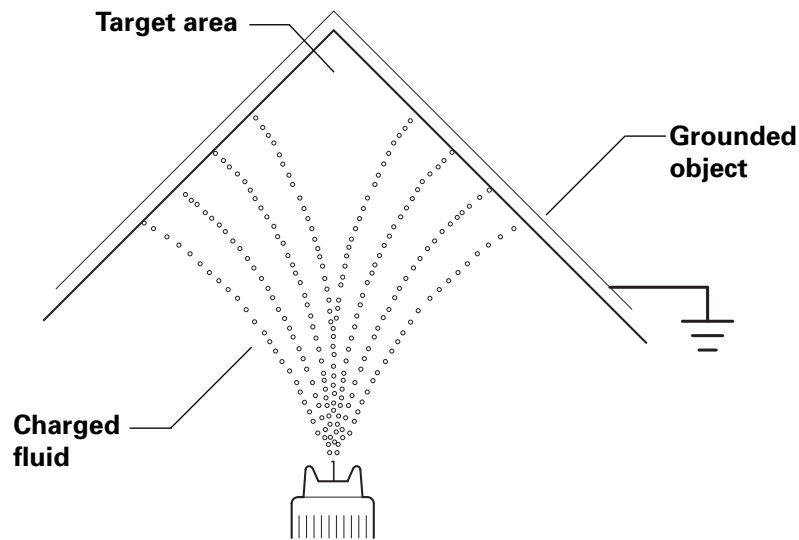
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Figure 9 The wraparound effect

While the wraparound effect may contribute to the increased efficiency of electrostatic methods, wraparound is not the primary source of increased transfer efficiency. Rather, the main benefit of electrostatics is the improved transfer efficiency of paint to the primary surface.

The Faraday Cage Effect

The wraparound effect may be a disadvantage in some spray finishing applications. For example, objects with deep cavities are not ideal for electrostatic spray finishing processes. This is because the paint is drawn to the outermost points of the object, which can lead to uneven coating. This type of uneven coating is the result of the Faraday cage effect, as illustrated in Figure 10.



05054

Figure 10 The Faraday cage effect

Optimal Electrostatic Applications

Electrostatic spray charging works best when the spray particles are small and light because the electrostatic forces can more easily overcome the momentum forces on the particles. Electrostatic spray charging has the greatest positive impact in directing and controlling particles that are moving at a low velocity. Extraneous forces, such as excess air movement, should be eliminated as much as possible to aid the electrostatic process, while still meeting OSHA requirements. In addition, the object to be coated must be conductive or have a conductive backing or coating. The target must also be well grounded.

The Faraday cage effect comes into play when an electrostatic process is used to finish parts or objects with deep cavities. These types of objects are not ideal for electrostatic applications because the paint is drawn to the outermost points of the object's surface, leading to uneven coating. However, good operator technique can overcome most Faraday cage effect situations. For example, with Graco electrostatic spray gun technology, the operator can easily turn the voltage down or off to overcome the problem.

Key Equipment Characteristics

Terms that are often used to describe the qualities of electrostatic systems or equipment are *stiff* (or uninhibited) and *resistive*. In electrostatic applications, the terms stiff and resistive are used as antonyms (or opposites).

Stiff Systems

Stiff systems are also called *uninhibited systems*. These terms describe automatic electrostatic finishing equipment that places little or no resistance in the path of the electrical power that is charging the spray application tool. Stiff systems provide relatively constant voltage output, regardless of current draw.

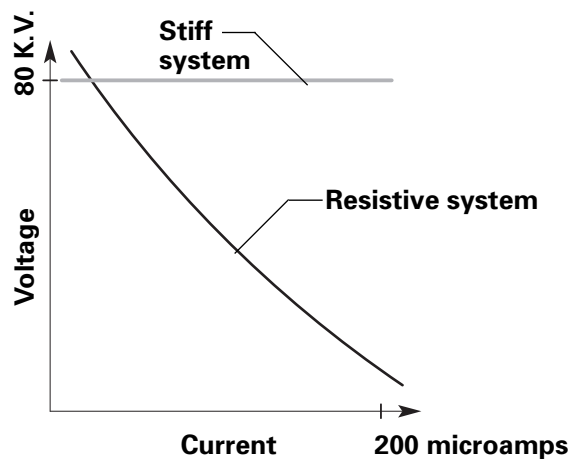
Stiff systems are capable of current levels and discharges that can ignite flammable vapors, and may provide a significant electric shock hazard to humans. Therefore, stored energy must be *bled off* the equipment to ground before the operator approaches the equipment.

Resistive Systems

You may recall from an earlier section (defining electrostatic terms) that the term *resistive* refers to material through which electrons cannot easily flow. *Resistive systems* are safer than stiff systems, but the energy release from arcing the charge system to ground still may ignite flammable vapors. Resistive systems may be manual or automatic.

In resistive systems, the voltage drops off significantly when excess current is drawn. The maximum current output (short circuit) of a resistive system would typically not exceed 200 microamps, whereas a stiff system might deliver 5000 microamps or more of current.

The chart in Figure 11 shows the voltage and current of resistive and stiff systems.



05055

Figure 11 Resistive and stiff electrostatic systems

Nonincendive Systems

The term *nonincendive* is also used to describe some resistive manual and automatic equipment. Discharges from a device or system that is nonincendive is incapable of igniting the flammable vapors from typical paint solvents.

Nonincendive systems minimize the energy release from the high voltage system by minimizing the capacitance of the charging system and utilizing proper spray gun design. In many cases, local fire codes or regulations require that electrostatic sprayers meet nonincendive requirements, or standards.

To summarize the key characteristics of electrostatic spray equipment, you need to remember that:

- *Stiff systems* have current levels and discharges that can ignite flammable vapors
- *Resistive systems* are safer than stiff systems, but still may ignite flammable vapors
- Only *nonincendive systems* are incapable of igniting typical paint solvent vapors

High Voltage Power Supplies

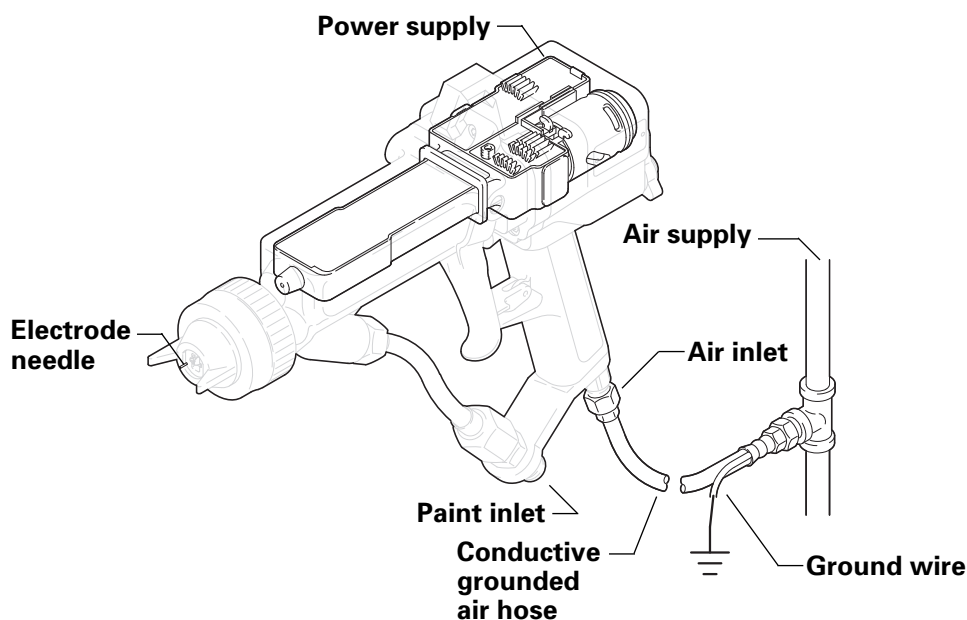
In electrostatic spray charging, some systems may use cables to bring the power or charge to the spray gun. Graco electrostatic spray guns do not use cables because they have an internal power supply. In electrostatic systems, the cable types, and alternatives to cables, are:

- High voltage cable
- Low voltage cable
- Graco systems with internally generated power (and no cables)

In systems that use a *high voltage cable*, the power supply is remote from the sprayer and uses a high voltage cable to transmit voltage to the spray gun.

With a *low voltage cable*, the power supply is also remote from the sprayer, but the cable is low voltage and smaller in diameter. In these systems, voltage is increased inside the spray gun through a transformer and a cascade multiplier.

Graco electrostatic spray guns have internally generated power, and therefore do not require cables, as shown in Figure 12. In Graco systems, voltage is generated and multiplied through an internal power supply within the spray gun barrel. Graco systems use air power to spin an alternator to generate voltage. Therefore, the device does not need cables or an external power supply.



05056

Figure 12 Internally generated power in Graco electrostatic spray guns

Voltage isolation units, as pictured in Figure 13, prevent the spraying voltage from being depleted to ground through the paint supply. This method is used only with highly conductive, non-flammable water borne coating materials.

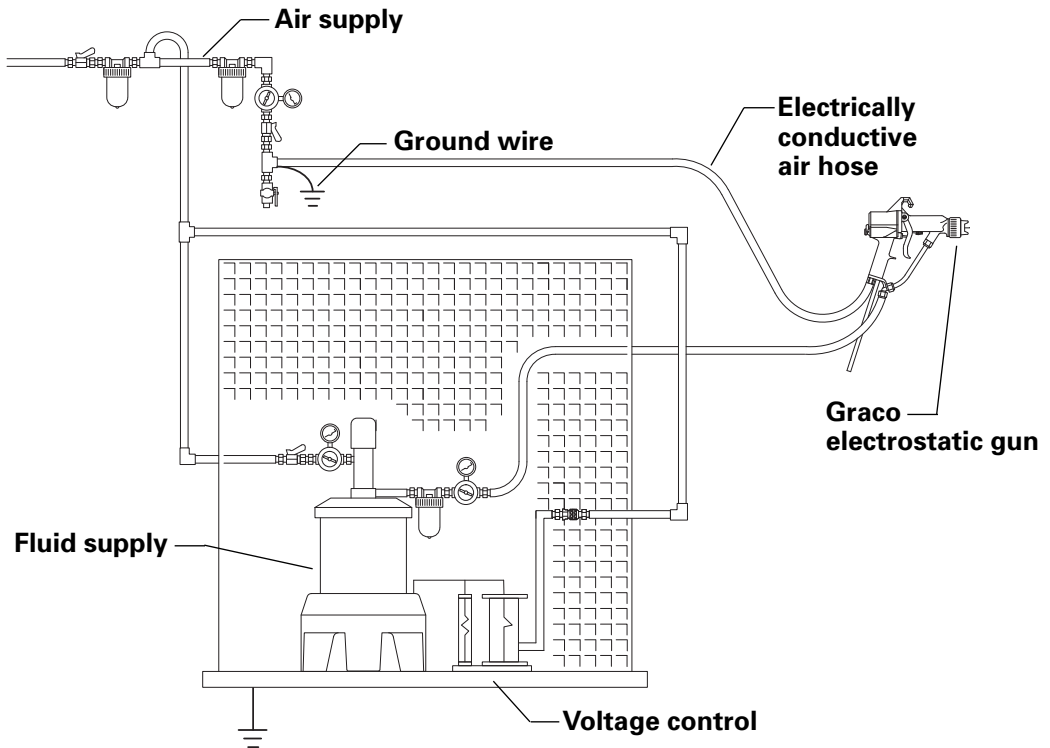


Figure 13 Voltage isolation unit

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Electrostatic Accessories

The accessories that are commonly used with electrostatic spray charging equipment are:

- *A high voltage probe and meter* to measure voltage output from the spray gun
- *A paint resistivity meter* to measure the resistivity or conductivity of the coating material
- *A megohm meter* to check electrical grounding, as well as electrical continuity within the system
- *A microamp meter* to measure the current flow in the system

Progress Check

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

1. Which of the following statements accurately describes how a Graco electrostatic spray charging system improves transfer efficiency? (Select only one answer.)
 - a. Neutral particles are driven by an electric field to the positively charged target.
 - b. Neutral particles are driven by an electric field to the negatively charged target.
 - c. Charged particles are driven by an electric field to the grounded target.
 - d. Grounded particles are driven by an electric field to the charged target.

2. Which of the following are electrostatic charging methods? (Select all that apply.)
 - a. Corona
 - b. Contact
 - c. Conduction
 - d. Induction
 - e. Non-contact
 - f. Frictional.

3. Which of the following statements about the wraparound effect are true? (Select all that apply.)
 - a. Wraparound coats all sides of an object evenly.
 - b. Wraparound is effective for grooved surfaces.
 - c. Wraparound accounts for the primary efficiency gain of electrostatics.
 - d. Wraparound means particles that have passed the front surface of the target are drawn back to other surfaces.

4. Which of the following electrostatic spray charging systems may potentially ignite typical paint solvent vapors when discharging to ground? (Select all that apply.)
 - a. Stiff systems
 - b. Resistive systems
 - c. Nonincendive systems.

5. Which of the following methods of delivering power to the applicator are used in Graco electrostatic spray guns? (Select all that apply.)
 - a. High voltage cable
 - b. Low voltage cable
 - c. Internally generated power.

6. Which conditions are most optimal for electrostatic spray charging?
 - a. Small, light particles moving at a high velocity
 - b. Small, light particles moving at a low velocity
 - c. Large, heavy particles moving at a high velocity
 - d. Large, heavy particles moving at a low velocity.

Answers to Progress Check

1. c. In a Graco electrostatic spray charging system, charged particles are driven by an electric field to the grounded target to improve transfer efficiency.
2. a, b, c, d, e, and f. The names of the four types of electrostatic charging methods are corona, contact or conduction, induction or non-contact, and frictional.
3. d. Wraparound means particles that have passed the target are drawn back. The other statements are false.
4. a and b. Stiff systems have current levels and discharges that can ignite flammable vapors. Resistive systems are safer than stiff systems, but still may ignite flammable vapors. Only nonincendive system discharges are incapable of ignition.
5. c. Graco electrostatic spray guns use internally generated power, and therefore they have no cables.
6. b. In electrostatic spray charging, the optimal conditions have small, light particles moving at a low velocity.

Coating Materials

Learning Objectives

After completing this section on coating materials, you will be able to:

- Describe the key electrostatic properties of coating materials—resistivity and conductivity.
- Explain how to safely handle flammable and non-flammable coating materials.

When the term *coating materials* is used in reference to electrostatic spray charging, it refers to the materials (or paint) used to coat the object or surface. Like all matter, coating materials have electrical properties. The key qualities of the coatings used in electrostatic spray charging are resistivity, conductivity, and flammability.

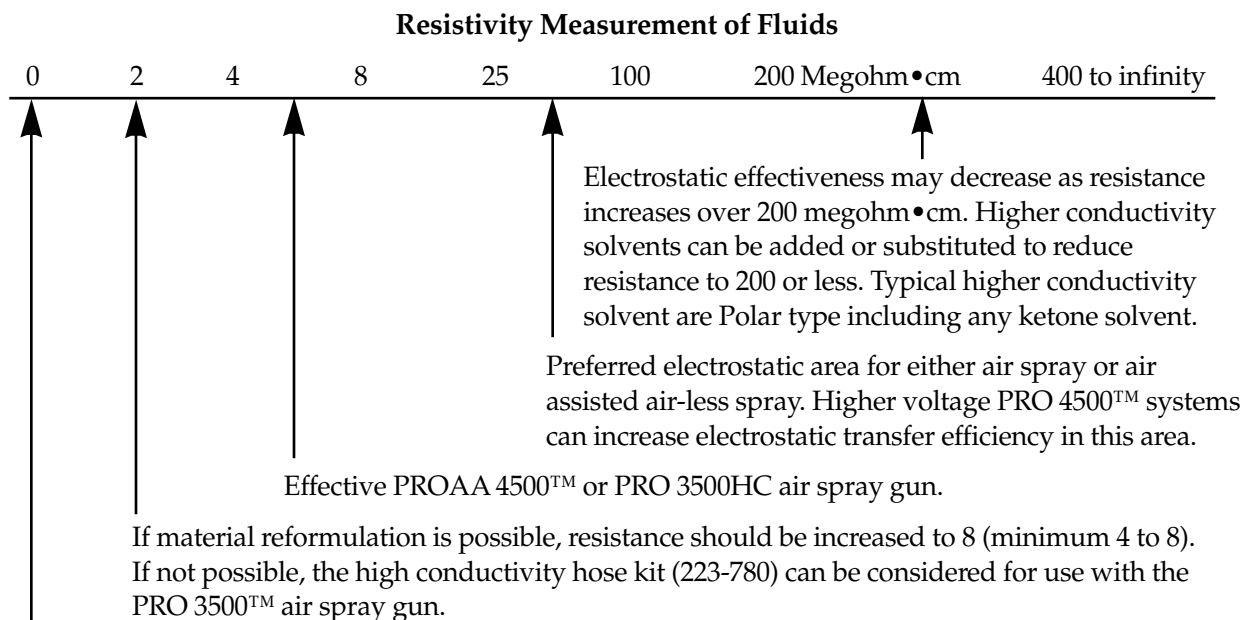
Resistivity and Conductivity

You learned previously that resistivity is the degree to which matter, in this case coating material, resists the flow of current. Highly resistive coating materials are commonly referred to as *dead* materials.

The conductivity of coating materials is the degree to which they conduct the flow of current. Highly conductive materials are said to be *hot*.

Coating materials that are too resistive may work poorly in electrostatic spray charging. Highly resistive coatings can usually be easily reformulated to work well with electrostatics. (However, this is not true of highly conductive coatings.) Coating materials that are too conductive may require special methods to prevent loss of charging voltage.

Figure 14 shows the resistivity measurements of coating materials.



Conductivity form 0-2 should be reformulated. High conductivity hose kit (223-780) and the PRO 3500™ gun are recommended for readings of 2 or more.

- **A number of meters have been developed to measure the resistivity of fluids. Graco measures resistivity in units called megohm•cm.**
- **Generally, a resistivity reading of 20 to 200 megohm•cm sprays best.**
- **Lower resistivity materials may require special fluid tube or hose configurations.**

Figure 14 Resistivity measurement of coating materials

Resistivity is the most important measurement or aspect of coating materials in electrostatic spray charging. Resistivity is generally measured in megohms•cm, although not all meters for resistivity use this standard of measurement. The range of 20 to 200 megohm•cm of resistivity is generally best for electrostatic spray charging processes, as represented in the chart in Figure 14.

When coating materials are too conductive, (that is, not sufficiently resistive), they *short out*. This means the coating material draws excess current and lowers the voltage below an effective level. While highly resistive coatings can usually be reformulated to work well with electrostatics, this is not the case with highly conductive coatings.

You can take certain measures to prevent conductive coatings from shorting out. If the coating material is non-flammable, one approach is to electrically isolate it from the ground so that the material supply is not grounded. Another approach is to lengthen the fluid tube or hose line, thereby lengthening the path from the high voltage back to where the fluid is grounded. Another option is to externally charge the fluid so that the point of high voltage is isolated from the material.

Keep in mind that resistivity measurements are only a reference tool, and when higher voltage is applied, the properties of materials may change. For example, metal flake paints will often measure as high resistivity, but change to very low resistivity when high voltage is applied in the spray gun.

Flammability

All coating materials and solvents have a flashpoint temperature rating to indicate the temperature at which vapors from the material are flammable. Another important factor is how easily these vapors can be ignited. Agencies from around the world classify materials based on their ignitability. Graco electrostatic spray guns are approved for spraying Class I, Group D materials as defined by NFPA, the National Fire Protection Agency.

Non-flammable coating materials do not present a fire hazard and therefore can be isolated for electrostatic spraying. However, the possibility of electrostatic shock is still an issue and must be addressed in the system design and operating procedures. Materials can be considered non-flammable, and therefore used in an isolated system, if the flashpoint is greater than 140°F (60°C) and the materials contain less than 20 percent organic solvent.

Flammable materials may ignite if an uncontrolled electrical discharge occurs. Flammable coating materials should not be electrically isolated when spraying, because the fluid and supply system can store up energy that can discharge and ignite the vapors.

Other aspects of electrostatic safety are covered in the next section of this module.

Electrostatic Equipment Safety

Learning Objectives

Safety measures are even more critical in electrostatic spray charging because of the added electrical charges. The primary hazards with electrostatic spray equipment are electrostatic shock, flash fires, unintended pressure release, and skin injection (with high-pressure systems only). Therefore, this section covers safety measures you must take when using electrostatic spray charging equipment. After completing this section on safe use of electrostatic equipment, you should be able to:

- Explain the basic safety measures necessary for safe operation of electrostatic spray finishing equipment.
- Describe safe methods for spraying flammable and non-flammable coating materials with electrostatic spray finishing equipment.
- Respond appropriately to safety approval information.

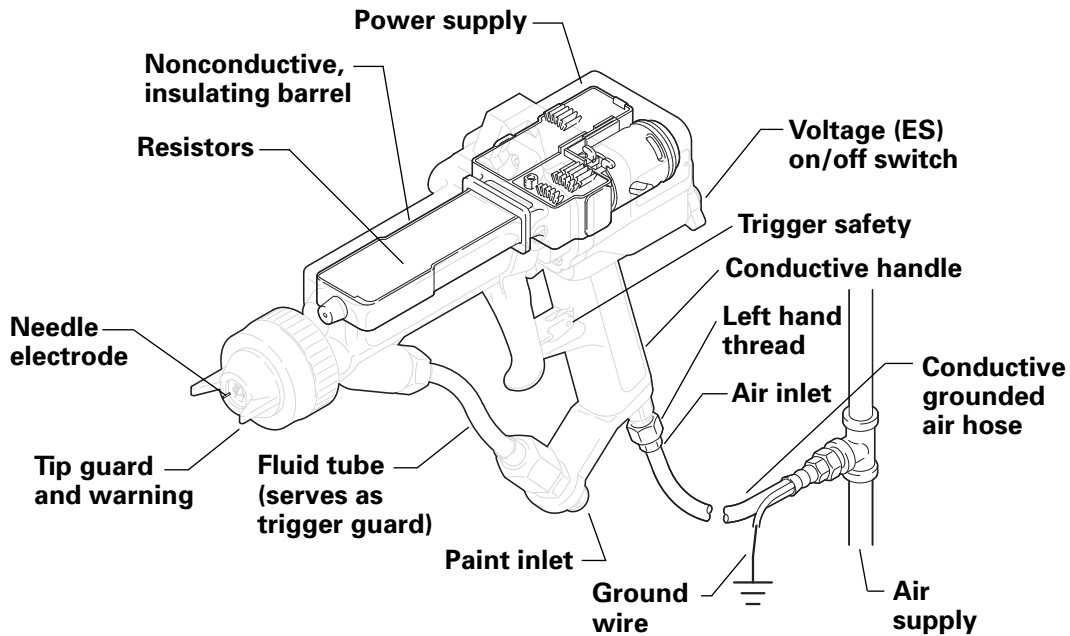
Preventing Electrical Hazards

In electrostatic spray charging, coating materials are often flammable. The spray finishing device utilizes high voltage, creating the potential for an arc. Therefore, flash fires can occur when equipment is used improperly or when the operator does not follow proper grounding procedures.

Grounding is a key component of electrostatic safety. This means that operators of electrostatic spray finishing equipment must:

- Ground all conductive objects in the spray area, including all persons. (A good operator practice is to have the palm of a hand in contact with the gun handle.)
- Stay clear of electrostatic charged equipment.
- Ensure that any electrostatic charge has been dissipated before approaching the device for any reason, such as for cleaning and maintenance.
- Never immerse electrostatic spray equipment in solvent for cleaning, because solvents can cause electric shorts or damage electrostatic spray equipment.
- Use only coating materials for which the electrostatic spray equipment has been approved.
- Never isolate flammable materials.
- Check grounding frequently.
- Perform flushing and cleaning operations with the voltage off.
- Stop spraying immediately if there are any shocks or arcing.

The illustration in Figure 15 points out the key safety features of electrostatic spray charging equipment.



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Figure 15 The safety features of electrostatic spray charging equipment

Graco electrostatic spray guns are grounded through special air hoses which are conductive and have left-hand threads to match the spray gun's air inlet threads.

Preventing Non-Electrical Hazards

For non-electrical hazards, electrostatic safety procedures are similar to those used with other types of spray finishing equipment. Users of electrostatic spray finishing equipment must:

- Avoid approaching the front of the spray gun when it is pressurized.
- Never point the gun at yourself or another person.
- Be aware that the electrode (needle) is sharp and can cause injury.
- Always follow pressure relief procedures before servicing the equipment.
- Follow coating and solvent manufacturers' recommendations for safe handling of materials.
- Make sure that all operators are properly trained.

Handling Flammable Coating Materials

Operators must follow several rules to safely handle flammable coating materials with electrostatic systems. First of all, do not electrically isolate flammable coating materials. This applies to any fluid with a flash point of less than 140°F (60°C), or containing more than 20 percent organic solvents. Always use approved nonincendive spray equipment for flammable coating materials whenever possible.

Handling Non-Flammable Coating Materials

With electrostatic systems using nonflammable coating materials, including many water borne coatings, the fire hazard is essentially eliminated.

However, water borne materials are highly conductive, and they are often isolated so that a charge can be applied to them. When the coating material and supply system are raised to a high voltage, they store up sufficient energy to provide an uncomfortable electrostatic shock if approached by an operator. For this reason, the supply system is designed to prevent access to any charged surfaces or objects. However, the front of the gun remains accessible and will release an electric discharge, or arc, if it is approached when it is charged.

With isolated systems, you must make sure the voltage is discharged before approaching the front of the gun. Operators must also make sure the voltage is discharged before servicing the coating material supply system.

Understanding Safety Approvals

For electrostatic spray charging systems, there are approval agencies around the world that examine, test, and approve nonincendive electrostatic spray equipment for use in hazardous locations. These agencies examine and test the equipment against safety standards, including tests that verify that the equipment will not ignite the coating materials that are approved for use with that equipment. Approvals are based on the ignitability of the coating materials that can be used with the equipment. In other words, equipment approval specifies the class and division of coating materials that can be used with the equipment. Graco nonincendive equipment can be used to spray coating materials that are classified as Class 1, Group D or safer.

Progress Check

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

1. Which of the following types of coating materials can be described as dead? (Select all that apply.)
 - a. Highly resistive coating materials
 - b. Highly conductive coating materials
 - c. Non-flammable coating materials
 - d. Coating materials that will not wrap.

2. Which coating materials should be electrically isolated for safe electrostatic spraying?
 - a. Non-flammable coating materials
 - b. Flammable coating materials
 - c. Both non-flammable and flammable coating materials.

3. Which of the following are potential hazards of electrostatic equipment? (Select all that apply.)
 - a. Electrostatic shock
 - b. Flash fires
 - c. Skin injection
 - d. Needle puncture.

4. What does equipment approval information tell you? (Select only one answer.)
 - a. The equipment can be safely used by untrained operators.
 - b. The equipment can be immersed for cleaning.
 - c. Properly used equipment is not capable of igniting any materials.
 - d. Properly used equipment will not ignite specified coating material vapors.

Answers to Progress Check

1. a. Highly resistive coating materials are described as dead. The others are not.
2. a. Only non-flammable coating materials can be electrically isolated.
3. a, b, c, and d. The hazards of electrostatic equipment include electric shock, flash fires, skin injection, and needle puncture injury. Note that these hazards apply to all spray processes, not just electrostatic.
4. d. Equipment approval information tells you that the equipment will not ignite approved coating materials.

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. 321-028

Title: Basic Electrostatics

Signature _____

Date _____

Graco

Technical Communications Dept.

P.O. Box 1441

Minneapolis, MN 55440-1441 U.S.A.

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This module was developed by the Graco Technical Communications Department with assistance from the following individuals:

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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

