CONTROLLED SPRAYING HANDBOOK

Composites Open Molding Resin & Gel Coat Application

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Chapter 1 Controlled Spraying Training Program

1.0 Introduction

This program is designed to provide training guidelines for spray operators in the *open molding composites industry* where monomer-based resin and gel coat materials are used. This includes operations where polyester resins or gel coats are dispensed from a spray gun or flow coater to a mold surface, the surface of a molded part, tool or pattern surfaces, or other applications in which spray or flow coating application is used.

1.1 What is Controlled Spraying?

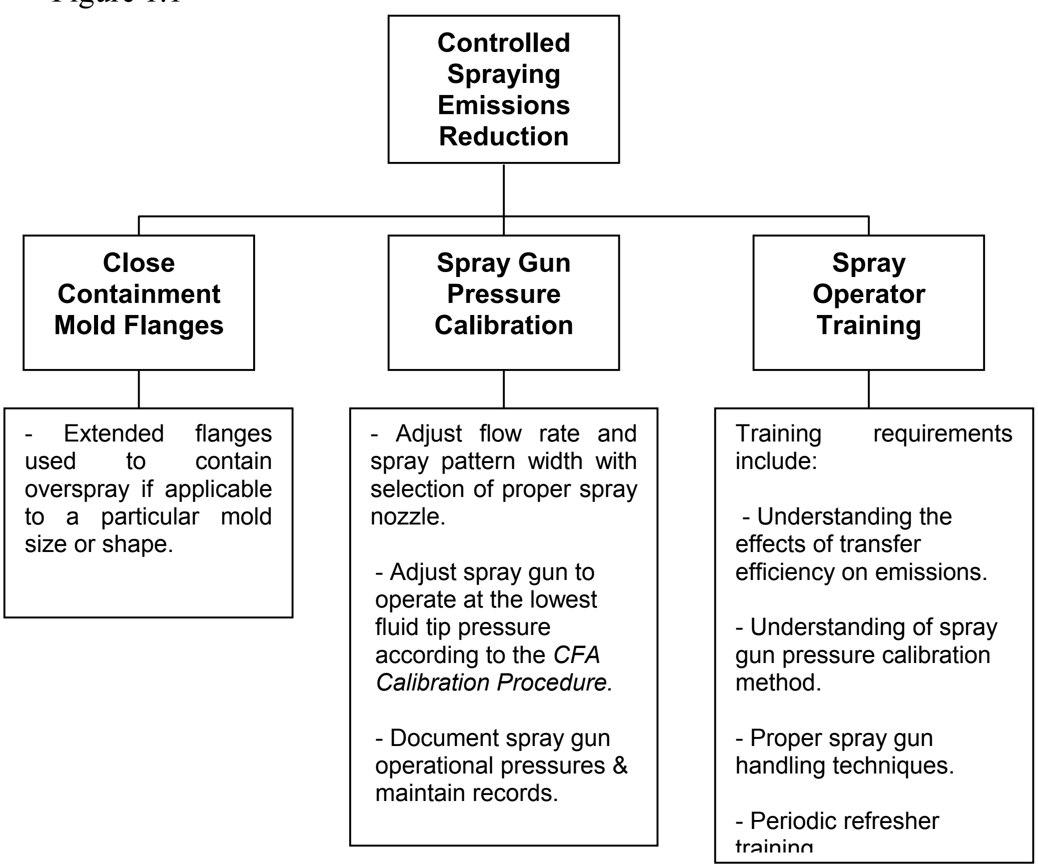
Controlled spraying is a work practice that has demonstrated effectiveness in reducing missions from the open molding process. It is a pollution prevention method that benefits the environment, the manufacturing process, plant personnel, and reduces costs. Controlled spraying minimizes emissions by increasing material transfer efficiency and reducing overspray. Transfer efficiency is the amount of material applied during the spraying process, compared to the amount retained on a mold surface There are three elements of controlled spraying that work in concert to reduce emissions.

- Operation of the spray gun at the lowest fluid tip pressure, which produces an acceptable spray pattern.
- Operator training that teaches proper spray gun handling techniques.
- The use of close containment mold flanges to minimize overspray off the mold.

1.2 Operator Training

Spray gun operator training is an important aspect of a controlled spraying program. Operators and production management are required to know how to properly set-up a spray gun (i.e., adjust fluid pressure and spray pattern), and understand

Figure 1.1



the proper methods of spray gun handling. The practical application of controlled spraying is based on training that specifies this methodology and provides the means for verifying the effectiveness of the techniques.

1.3 Where is Controlled Spraying Beneficial?

Controlled spraying should be used for all spray gun and flow coater application of monomer-based resins. This includes, polyester resins, vinyl ester resins, polyester gel coats, vinyl ester gel coats and other resins containing a volatile monomer. Controlled spraying is beneficial in all composites manufacturing processes, where materials are applied by atomized or non-atomized delivery.

This work practice technique should be used as a standard manufacturing practice in open molding facilities, or in other cases, where atomized spray or flow coater application is used.

1.4 Why is Controlled Spraying Important?

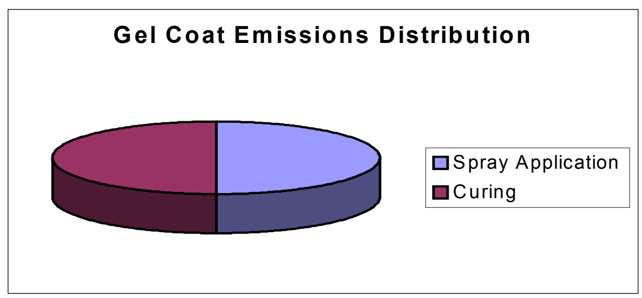
Controlled spraying can provide a substantial reduction in styrene emissions, compared to typical uncontrolled spraying. Testing[1] has demonstrated that controlled spraying can reduce gel coating emissions by up to 40%, and laminating resin emissions by up to 20%. Controlled spraying is a method of reducing emissions that is universal for the mechanical application of monomer containing polymer resins.

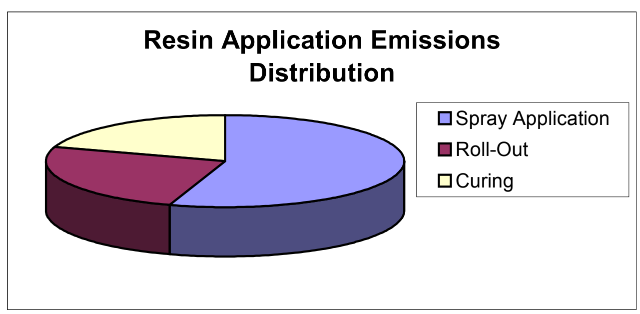
There are a number of possibilities for styrene emissions reduction in the open molding process, including: the use of low monomer content resins or gel coats; the use of vapor suppressants; non-atomized application; and controlled spraying. Low monomer materials and vapor suppressants may not be suitable for all circumstances; for example, some corrosion resistant products require high-monomer resins and vapor suppressants can not be used in certain secondary bonding applications. Likewise, the non-atomized application of gel coat may not be feasible in all cases, due to gel coat quality issues. Controlled spraying, on the other hand, can be used in all circumstances where both atomized and non-atomized application equipment is employed..

The emissions reduction, available from controlled spraying is beneficial to the environment, molding facility employees, and the manufacturing process. The total quantity of emissions released to the environment will be reduced with the implementation of controlled spraying. Worker exposure to styrene will be reduced, and plant heating and ventilation flows may be able to be adjusted accordingly. Finally, the increased transfer efficiency offered by controlled spraying reduces material loss during the process. This may provide a significant decrease in overall materials consumption, thus reducing costs. Additionally, the reduction of overspray contributes to cleaner work areas and improvesl housekeeping efforts.

1.5 Emissions During the Molding Process

During atomized application, approximately half of the total styrene emissions produced from the open molding process take place during the spray phase of the process. In the case of gel coating, 50% of the emissions occur during spraying and 50% during the curing process. With laminating





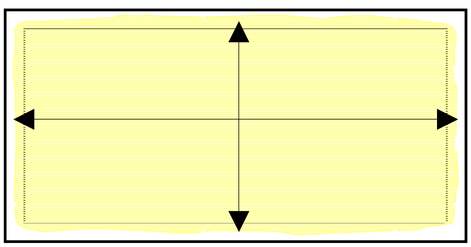
resin spray application, about 55% of the emissions occur during spraying, 25% during the laminate roll-out phase, and 20% during the curing phase. The emissions from the spraying phase are a significant contributor to the total emissions.

Fluid stream atomization contributes to emissions during the spraying process. The greater the level of atomization (creating finer aerosol particles) and the higher the fluid stream velocity, the more emissions will be generated. Because a large portion of emissions occurs during the spray phase of application, spray gun pressure is of primary importance. The lowest pressure that produces an adequate spray pattern will produce the lowest emissions.

1.6 Relationship Between Overspray and Emissions

Another aspect of emissions involves the wet surface area of resin or gel coat. Once the material has covered the surface of the mold and surrounding area, emissions are a function of surface area evaporation. Therefore, a larger the surface area creates a greater the evaporative loss from the surface. Since styrene evaporates from the surface only, the thickness of the laminate of gel coat film is not a factor once the material is in the static state on the surface. In this condition, the amounts of styrene lost from the surface of a thin film of overspray, and a thick laminate, may be almost the same. Therefore, reducing the surface area by minimizing overspray is a critical aspect of reducing overall styrene loss.

Figure 1.4 Controlled



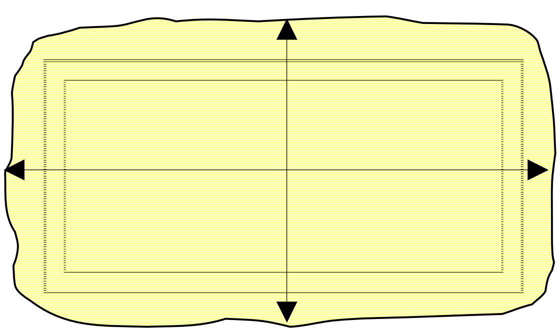
Wet Area Dimensions:

4.5 ft. x 8.5 ft. = 38.25 ft^2 wet area

8 grams/ft^2 x 38.25 ft^2 = 306 grams emissions during the curing stage

In this example a mold has dimensions of 4 ft. X 8 ft. (or 32 ft^2) plus a 6 in. perimeter flange. Emissions equal 8 grams per ft^2 during curing phase, based on surface area calculations

Figure 1.5 Uncontrolled Spray



Wet Area Dimensions:

7 ft. x 11 ft. = 77 ft^2 wet area

8 grams/ft^2 x 77 ft^2 = 616 grams emissions during the curing stage

The result of overspray is that the wet surface area for uncontrolled application is almost twice as large compared to the controlled application. Emissions increase correspondingly with the increase in surface area. A small amount of perimeter overspray can have a large impact on

Chapter 2 Definitions

2.1 Atomization

In order to create a useful spray pattern (with a traditional spray gun), it is necessary to convert a pressurized stream of resin into an elliptical shape as it exits the spray gun fluid tip. This elliptical fluid stream is termed a fan pattern or spray pattern.

Atomizing the fluid describes breaking the fluid stream into fine aerosol particle sizes, which converts the narrow high velocity fluid stream into a lower velocity shaped spray pattern. In many cases the spray pattern also provides the means for external mixing of an initiator (catalyst) component with the resin stream.

In order to achieve an acceptable fan pattern, a particular level of atomization is required for application equipment that primarily relies on atomization to shape the spray pattern. The required level of atomization will vary and is dictated by the rheology (flow characteristics) of the resin, resin temperature, spray gun type, fluid tip orifice size, the required spray gun distance from the mold, the mold configuration, and other variables. There is however, an ideal minimum level of atomization for each combination of factors. (Note: Non-atomized fluid delivery uses the physical characteristics of the fluid orifice to form a low pressure fluid stream into the required fan shape, rather than the addition of shaping air or high pressure flow.)

Any additional atomization beyond that required level to form an adequate fan pattern should be considered excessive. Over-atomization results in an increase in emissions from increased monomer evaporation and decreased transfer efficiency associated with enlarging the “wet footprint” of overspray.

The objective of *minimizing atomization* is to insure that atomization greater than required to produce an adequate fan pattern does not take place. This is accomplished by operating a spray gun at the lowest possible pressure at, which it develops a proper fan pattern.

2.2 Gel Coat

Gel coat is a specialized form of polyester or vinyl ester resin that is used as an in-mold applied surface coating. Gel coat provides the cosmetic finish and weathering resistance to many composites products. Currently, when used as an in-mold coating gel coat is typically applied by atomized spray application, although non-atomized application may be used in certain circumstances. The finished product quality of gel coat is critical and may be impacted by non-atomized application. Non-atomized application methods are currently under development.

2.3 Resin

The term *resin* may be used generically to refer to unsaturated polyester, vinyl ester, other thermoset laminating resin, or gel coat materials. When used specifically, the term “resin” refers to laminating resin that is used to saturate fiber reinforcement, forming a molded composite. Resin may be applied by a number of methods, including; manual bucket and brush application; mechanical application using a pressure roller;, or by spray application using atomized or non-atomized equipment.

2.4 Overspray

Overspray is considered to be resin or gel coat that is deposited off the mold surface during the application process. This directly relates to transfer efficiency; which is the amount of material dispensed by the spray gun, compared to the amount deposited and retained on the mold.

Overspray has the effect of increasing the resin surface area by creating an enlarged “wet footprint”, greater than the actual mold surface area. This increase in surface area contributes to an increase in emissions.

2.5 Spray Pattern (Fan Pattern)

In order to dispense resin or gel coat from a spray gun or flow coater in a useful manner a fluid stream must be converted into a flat, symmetrical shape. This shape is termed a fan pattern or a spray pattern. The fan pattern is configured by the geometry of the fluid tip and in some cases by the use of impinging air flow over the fluid stream, known as atomizing air. (See 2.1 Atomization)

2.6 Atomized Applicators

A spray gun is a fluid dispensing device that converts a stream of fluid into a shaped spray pattern. An atomized spray gun uses atomization as the *primary* means to form a spray pattern. In the course of shaping the spray pattern the fluid is atomized or broken into fine aerosol particles. There are a number of types of atomized spray guns that are used in the open molding composites industry. These include:

- **Conventional Air Atomizing**
  Low pressure fluid stream that uses impinging atomizing air as the primary method of shaping the spray pattern.
- **High Pressure Airless**
  High pressure fluid stream that relies on the abrupt pressure drop when exiting the fluid orifice to form a spray pattern.
- **Air-Assisted Airless (AAA)**
  A hybrid system that uses an under-developed airless fluid stream that is shaped by low pressure at impingement air flow.

2.7 Non-Atomized Applicators

Non-atomized applicators use specialized fluid tips as the *primary* means to shape the fluid stream into a fan pattern, without the need of atomization. There are several fluid tips designs for non-atomized applicators, these include; multiple-orifice, mono-orifice; and fluid impingement. These delivery systems are also referred to as flow coaters or flow applicators. The term “spray gun” or simply “gun” may be used generically to refer to both non-atomized and atomized applicators.

- Multiple-orifice flow coaters use a number of holes in the fluid tip to produce a showerhead-like pattern of resin streams.

- Mono-orifice flow coaters employ a single large fluid orifice where a low pressure fluid stream is converted into a flat pattern.

- Fluid impingement guns produce two intersecting streams of resin that merge, a short distance from the fluid nozzle. The “impingement” of the two merging fluid streams forms a flat fan-like pattern of fluid.

- External mix designs introduce the initiator (catalyst) component outside of the fluid tip and may require a small amount of atomizing air to blend the catalyst stream into the resin stream. External catalyst mix configurations may meet non-atomized criteria if properly configured and set-up.

- Internal mix configurations introduce the initiator (catalyst) component within the gun head and do not require the use of additional mixing outside the fluid tip.

2.8 Non-Atomized Definition

The Unified Emission Factors (UEF) model for open molding of composites provides factors for the non-atomized mechanical application of resin and gel coat. ACMA (formerly CFA) testing has shown that non-atomized applicators, when properly operated, reliably produce lower emission rates compared to traditional atomizing guns.

The Indiana Department of Environmental Management "styrene rule" (Rule 25) for composites manufacturing reads as shown:

> *Non-atomized application equipment means the devices where resin or gel coat flows from the applicator, in a steady state in a observable coherent flow, without droplets, for a minimum distance of three (3) inches from the applicator orifices.*

In the Composites MACT Standard, the US EPA adopted the following definition:

> *Mechanical non-atomized application means the use of a device for applying resin or gel coat that a) has been provided by the device manufacturer with documentation showing that use of the device results in HAP emissions that are no greater than the emissions predicted by the applicable non-atomized application equation(s) in Table 1 to Subpart WWWW of Part 63 [the MACT*

rule]; and b) is operated according to the manufacturer's directions, including instructions to prevent the operation of the device at excessive spray pressures.

To use emission factors for non-atomized application, the gun or other application device must be operated according to at least one of these definitions. If the operations do not comply with either of the definitions, the non-atomized emission factors should not be used.

Chapter 3 Application Equipment

3.1 Types of Application Guns

There are a variety of application guns, both atomized and non-atomized, that are used for composites production. For laminating resin application, the spray-up (or chopping) method involves spray delivery of resin and chopped glass fiber simultaneously, using a *chopper* gun. In the case of gel coat application, atomized spraying has traditionally been the only acceptable method of application. This is due to the critical nature of gel coat film thickness distribution. Recently, non-atomized application of gel coat has been under development and is being used in certain applications.

There are a number of types of atomized spray guns that may be used for gel coat or resin application. The general categories of spray equipment include:

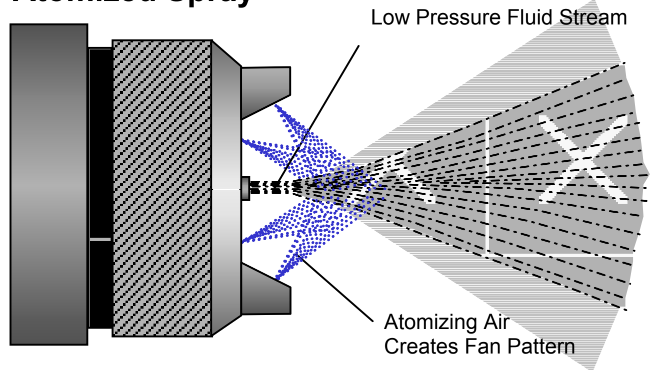
- Conventional Air-Atomized Spray Guns
    - Siphon Cup Gun
    - Gravity Feed Gun
    - Pressure Pot Gun
- High Pressure Airless Gun
- Air-Assist Airless Gun
- High Volume Low Pressure (HVLP) Gun

3.2 Conventional Air Atomized Spray Gun Configurations

With an air-atomized spray gun, the resin is delivered to the spray tip at low pressure. As the fluid stream exits the spray nozzle, atomizing air is directed across the liquid stream causing it to form a fan pattern. Siphon cup gun draws liquids up the siphon tube using the venturi effect. The material is then pulled along with the atomizing air at the spray tip. The gravity feed gun has a material cup mounted on top of the spray gun. The liquid flows down into the gun head and is mixed with atomizing air at the spray tip. A pressure pot gun uses a pressurized container (pot) to force the fluid flow to the gun head. The fluid then exits the spray tip in a straight stream, which is then formed into a fan pattern by the atomizing air.

Air atomized spray guns are generally not used for production resin or gel coating application for several reasons. First, the flow rates produced by this type of gun are lower than required for most production applications. Second, air atomized spray guns produce the highest rate of emissions of all spray guns. The transfer efficiency (which is the amount of material sprayed compared to the amount which is retained on the mold) of air atomized spray equipment is very low. Because of this, material waste and emissions are higher then with other types of spray equipment.

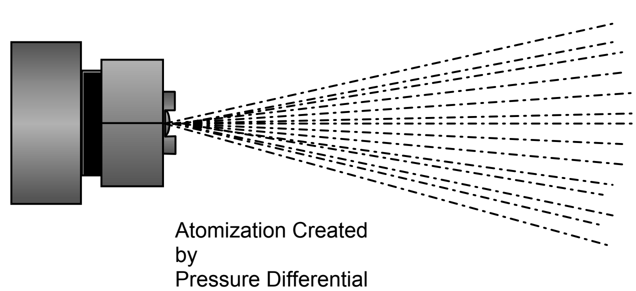
Atomized Spray



3.3 High-Pressure Airless Spray Guns

Airless spray guns use a pump to deliver resin to the fluid tip at high pressure. As the high-pressure stream exits the small fluid tip, the sudden reduction in pressure causes the fluid to atomize into a spray pattern. Developed in the 1970's, airless spray improved the transfer efficiency over the older air atomized application equipment. Airless spray tips usually require a fluid pressure of at least 1000 psi to produce an adequate fan

Airless Spray

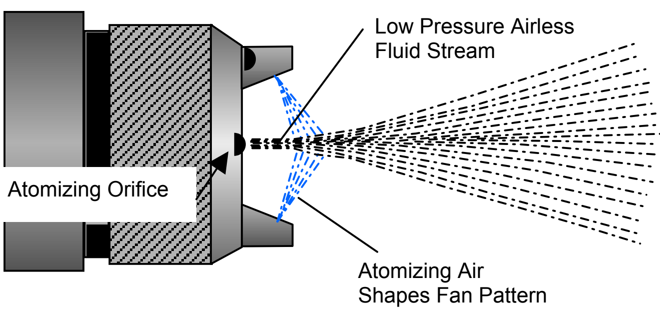


pattern.

3.4 Air-Assisted Airless Spray Guns

These current technology atomized spray guns are a combination of airless and air atomized guns, drawing the benefits of both types. Air-Assisted Airless guns use a pump to deliver the resin to the fluid tip, but at a lower pressure then an airless gun. The partially shaped fan pattern is then fully formed with the introduction of "shaping" air with the air-assist. The combination allows for reduced pressure operation with control over the fan pattern shape. Air-assisted airless guns produce higher transfer efficiency then airless guns with reduced emissions. The lower pressure spray also enhances gel coat quality.

Air-Assisted Airless Spray



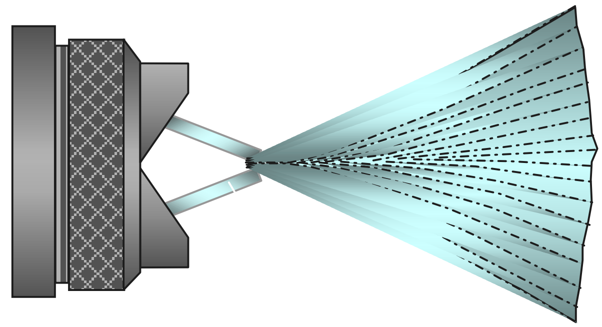
3.5 High Volume Low Pressure (HVLP) Spray Guns

HVLP spray guns have been used in the spray painting industry for some time. While similar to the air-assisted airless guns in many ways, these units operate with air atomizing pressures of 10 psi or less. The low air pressure is replaced with a high volume of airflow, which results in reduced emissions, and better transfer efficiency. HVLP spray using plural component delivery (resin and initiator) are not commonly available for composites production.

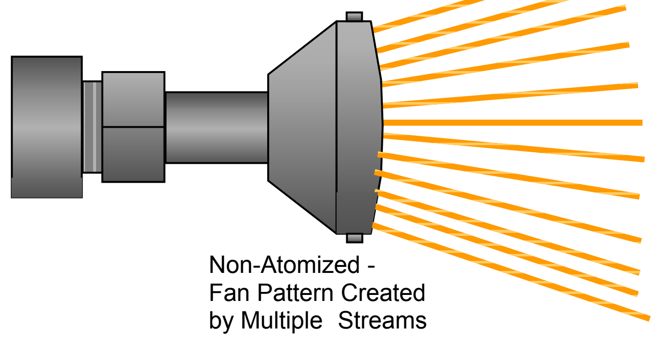
3.6 Non-Atomized Applicators

Non-atomized equipment falls into three categories: Multiple-orifice, mono-orifice, and fluid impingement technology. These applicators dramatically reduce emissions by virtue of avoiding fine atomization of resin or gel coat. Multiple orifice fluid tips use as many as twenty small openings in a "shower head" type

Fluid Impingement Flow Coater



Multiple Orifice Flow

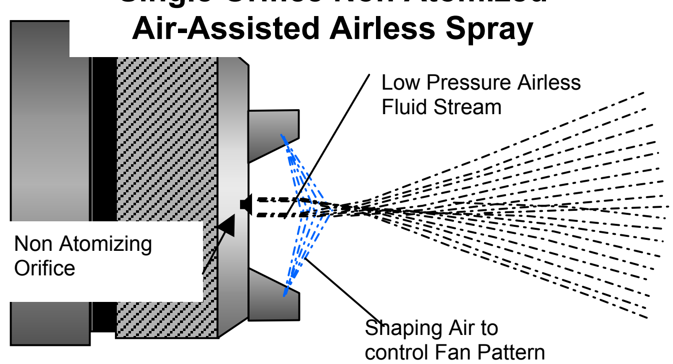


configuration. The configuration of the fluid tip directs each flow stream to form a fan pattern. Mono-orifice fluid tips use orifice geometry to spread the fluid stream into a flat pattern. Fluid impingement tips direct two streams of fluid to an impingement point, where they merge to form a flat sheet of fluid.

3.7 Fluid Pumps

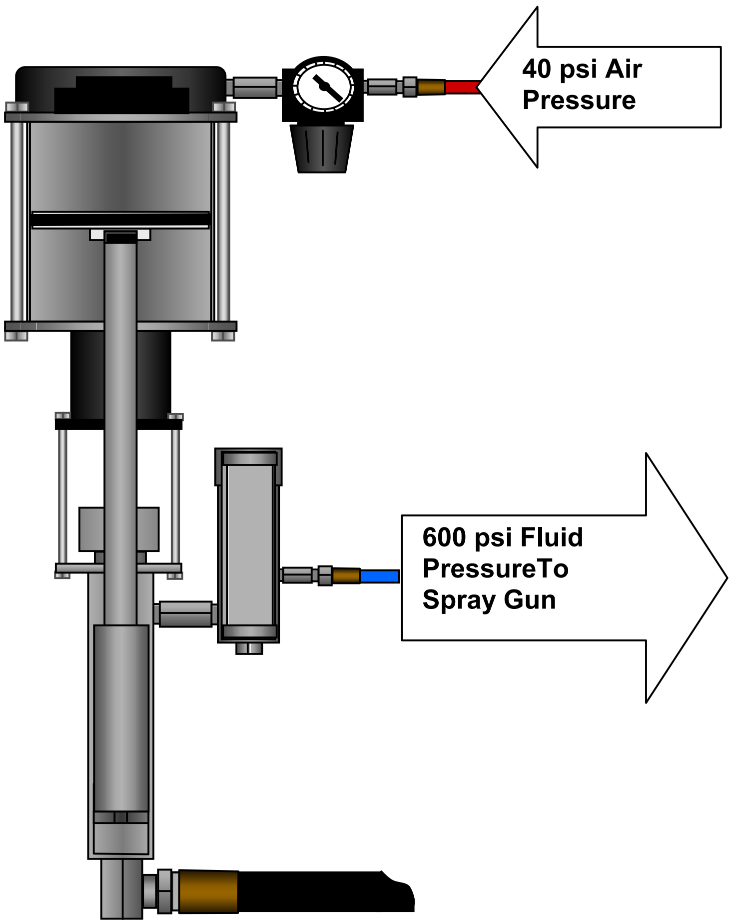
The most common type of resin pump is termed an "air over fluid pump". An air driven piston drives a fluid piston, which forces the material out to the spray gun at high pressure. The difference

Single Orifice Non Atomized Air-Assisted Airless Spray



between the diameter of the air piston and the fluid piston is termed the *pump ratio*. Pump ratios usually range from about 11:1 up to 33:1. By multiplying the air input pressure by the pump ratio the fluid pressure at the spray tip can be determined.

Determining Fluid Pressure



<u>Pump Ratio 15:1</u>

40 psi air pressure x 15 =
600 psi fluid pressure

Example:

- Pump Ratio = 15:1
(15 psi of fluid pressure for every 1 psi of air pressure)

- Pump air pressure set at 40 psi

- Multiply: Pump Ratio x Pump Pressure Setting to determine the tip pressure

- 15 psi x 40 psi = 600 psi fluid tip pressure

Chapter 4 Spray Gun Set-Up & Pressure Calibration

(Atomized & Non-Atomized Application Equipment)

4.1 Flow Rate

Flow rate is the amount of material sprayed in a given period. The flow rate is primarily controlled by the size of the spray tip, pump pressure, resin viscosity and resin temperature. Flow rate considerations include:

- Large parts, requiring large amounts of resin or gel coat, are usually sprayed with larger size tips. Smaller parts, or parts with more detailed shapes, may be easier to spray with lower flow rates using smaller orifice fluid tips.

- The viscosity (thickness) of gel coat or resin will affect both the flow rate and fan pattern.

- The formulated viscosity is normally adjusted by the material manufacturer, but is affected by temperature. Cooler material will be thicker and will reduce the flow rate; where warmer gel coat is lower in viscosity and flows at a higher rate.

4.2 Determining Proper Fluid Pressure

Determining the ideal pump pressure for a specific combination of material and equipment is an important element of controlled spraying. *Because of the many variables in the materials delivery system there is not a specific set pressure for a spray gun, nor can a specific pressure limitation be set.* These variables require that each spray unit, with a specific material, operated under specific conditions be adjusted to produce an ideal spray pattern. There are a myriad of variables that affect the optimal pressure setting of any given application unit. These variables include:

Equipment design

- Fluid pump ratio (air input pressure to fluid pressure generated)
- Fluid tip design and configuration
- Design of filter and fluid lines
- Number of fittings or elbows in fluid lines
- Requirement for a surge chamber
- Internal or external initiator mixing

Material

- Inherent resin rheology
- Formulated viscosity
- Use of filled systems

Operating Conditions

- Material temperature
- Residual build-up in fluid lines
- Condition of pump packings
- State of filter particle accumulation
- Required spray distance from mold
- Geometry of mold (i.e., highly contoured or flat)
- Size of mold
- Accuracy and wear of pressure gauges and air pressure regulators

Equipment Set-up

- Fluid tip orifice size
- Length of fluid lines
- ID of fluid lines
- Size of filter screen mesh
- Height of fluid lines with overhead boom
- Adjustment of spray gun fluid needles
- Adjustment of spray gun trigger
- Required flow rate
- Required fan pattern width

4.2.1 The Objective of Spraying at Low Pressure

The objective of this spray gun pressure calibration method is to determine the lowest pressure at which any application unit will operate, while acknowledging that the pressure range may vary widely based on the combination of complex variables. It is always an advantage to spray at the lowest possible pressure. The lowest pressure will:

- Reduce Styrene Emissions
- Minimize overspray
- Create better working conditions
- Enhance catalyst mixing
- Reduce material usage / cost
- Reduce equipment wear
- Reduce high pressure hazards
- Reduce static charge build-up

- Increase product quality

In all cases, with resin and gel coat application equipment, *minimum pressure provides maximum performance* in terms of; transfer efficiency, emissions, and finished product quality.

4.3 Pressure Calibration Procedure

The spray gun pressure calibration procedure is a simple and straightforward approach to determining the proper fluid pressure for any combination of equipment, material, and conditions. This procedure is appropriate for all atomized and non-atomized application equipment, including both internal and external initiator delivery systems.

Step 1 - Verify that the resin or gel coat is the correct temperature, and has been properly mixed according to the manufacturers recommendations.

Step 2 - Verify that the fluid tip is in good condition (without excess wear and capable of producing an acceptable spray pattern); and the orifice size is within a suitable in flow rate range and fan pattern width for the given job.

Step 3 - Reduce the pump air input pressure down the level where the pump will no longer stroke.

Step 4 - If the unit uses external assist air, set the air assist pressure in the middle of the normal range and according to the manufacturers' recommendations.

Step 5 - Aim the spray gun at a disposable surface covering on the floor, maintaining a distance of 12" to 18" and perpendicular to the floor.

Step 6 - Increase the pump pressure to the point where the pump just begins to stroke. Quickly pull and release pull the trigger to provide a "snapshot" spray pattern.

Step 7 - Record the results on the Spray Gun Calibration Worksheet.

Step 8 - Repeat the procedure, increasing pump pressure in 5 psi increments until the spray pattern is fully developed.

Step 9 - If using air-assist equipment, once a fully-developed spray pattern is attained, fine-tune the assist pressure for final shaping of the fan pattern. Use the lowest air-assist pressure that produces a symmetrical spray pattern.

Step 10 - Do not increase the pressure past this point. Any increase in pump pressure past the point of creating a fully-developed spray pattern will result in an over-developed spray pattern.

Step 11 - Record this pressure the final pump pressure and air-assist pressure on the spray gun calibration worksheet.

4.4 Determining the Proper Spray Pattern

The size and shape of a fan pattern results from a unique combination of orifice size, fluid tip geometry, and resin flow characteristics. The required fan pattern width is specific to the size and configuration of the part being sprayed. The size of the spray pattern should match the spraying requirements. For example, spraying a large flat part benefits from producing a wide fan pattern. A small part or one with a complex shape may require a narrow fan pattern. There is, however, one trait all spray patterns have in common; a symmetrical shape where the material is distributed evenly across the length and width of the spray pattern.

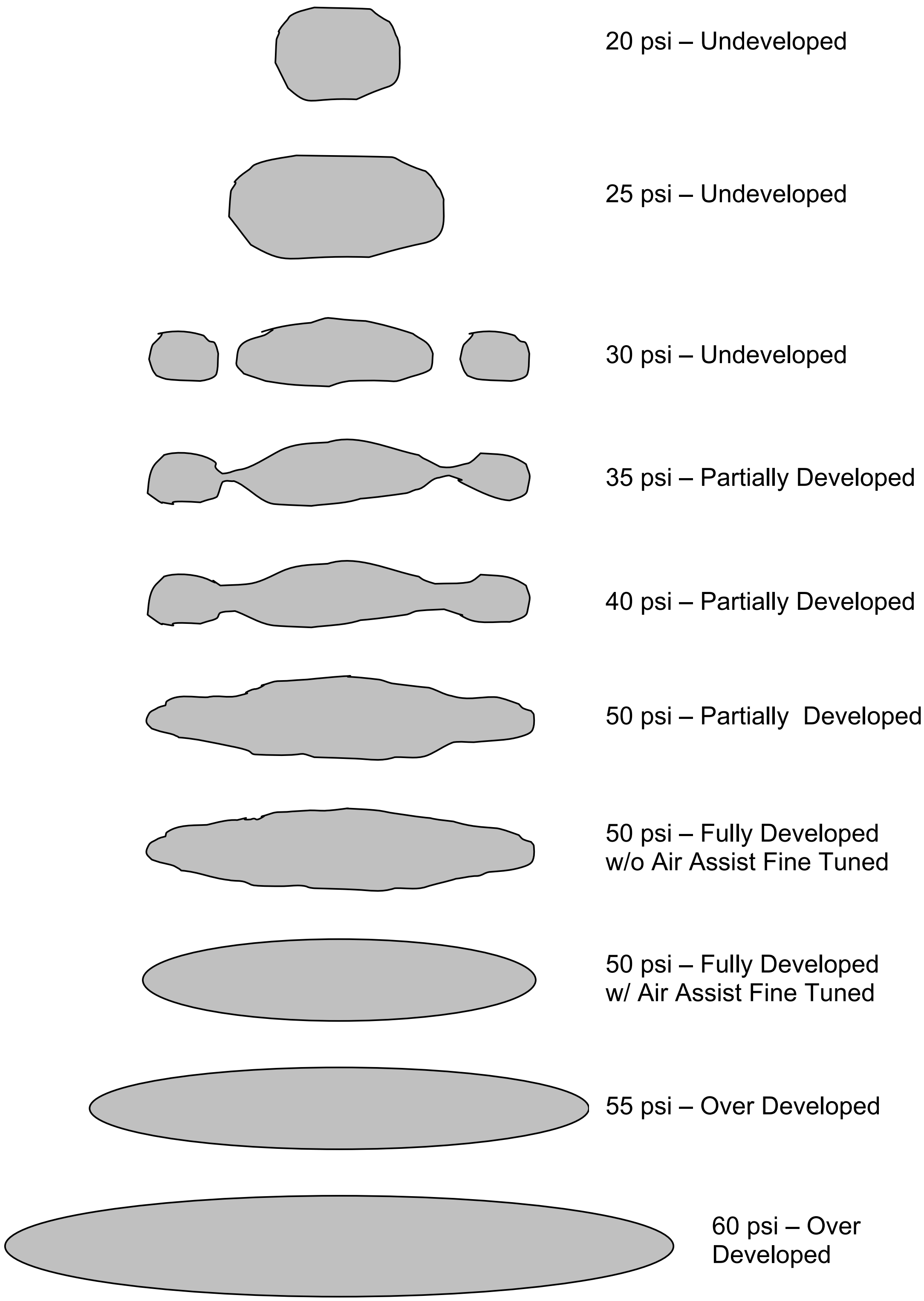
Fan patterns develop from a straight stream of resin, produced at very low fluid pressures, to an elongated oval pattern with increasing pressure. An *under-developed* spray pattern does not exhibit an oval configuration. A *partially-developed* spray pattern may have an irregular oval shape. A *fully-developed* spray pattern will be a uniform oval shape of the proper working width. An *over-developed* spray pattern presents a uniform oval shape that is wider than a fully-developed pattern, and produces increased atomization resulting from increased tip fluid pressure. This excess atomization is apparent by the increase in overspray surrounding the spray pattern.

As the fluid pressure reaches a specific optimum level for a specific combination of factors, a symmetrical elliptical shaped spray pattern develops. This pattern may need slight fine-tuning, with incremental pressure adjustments; or in the case of an air-assist spray gun, may refined with additional air-assist pressure adjustments. The goal of air-assist/fluid pressure adjustments is to determine the combination that requires the lowest pressures, while producing a workable spray pattern.

Pump pressures and/or air-assist pressures set to greater than required levels to produce a fully-developed uniform spray pattern are considered excessive.

Note: These pressures are for illustration purposes only. Actual pressures will vary with specific equipment, resin, spray tip size & angle, material temperature, and other factors

Examples of Spray Pattern Development



Spray Gun Pressure Calibration Worksheet

Date: _________ Operator: ____________________________________

Spray Unit Designation: ______________________________________

Resin Designation: ____

Spray Tip Size & Angle: ______________________________________

Spray Tip Condition: [ ] New [ ] Used

Spray Gun Pressure Calibration Record				
Pump Pressure Setting	**Air Assist Pressure Setting**	**Spray Pattern Development**		
		Under Developed	**Partially Developed**	**Fully Developed**
10 psi				
15 psi				
20 psi				
25 psi				
30 psi				
35 psi				
40 psi				
45 psi				
50 psi				
55 psi				
60 psi				
65 psi				
70 psi				
75 psi				
80 psi				
85 psi				
90 psi				
100 psi				

Final Pump Pressure Setting: _________ psi

Initial Air Assist Pressure Setting: _________ psi

Final Air Assist Pressure Setting: _________ psi

Signature: __________________________________

8.3 Operator Training

Operator training should include the following elements:

Application gun operators should be documented as having received which includes the following workpractice elements:

1. Explanation of the importance of controlled spraying
2. Explanation of how overspray contributes to emissions.
3. The requirement to operate the spray gun at the lowest applicable pressure.
4. Proper spraying techniques including:
   a. General technique
   b. Spray gun orientation perpendicular to the mold
   c. Establishing a proper coverage pattern
   d. Spraying the mold perimeter
   e. Spraying corners
   f. Spraying large and small molds
   g. Spraying male and female mold configurations
   h. Spraying flat surfaces
   i. Spraying curved surfaces

8.4 Close Containment of Overspray

Containment of overspray is influenced by the size and shape of a mold and in some cases the need for extended flanges.

Containment flanges may include:

1. An extended built-in mold perimeter flange.
2. A removable flange extension around the mold perimeter
3. Extended masking around the mold perimeter

On some larger molds the use of extended flanges may not be necessary due to the configuration of the mold perimeter. Containment flanges are only needed where overspray is difficult to control.

Chapter 5 OVERSPRAY CONTAINMENT FLANGES

5.1 The Purpose of Containment Flanges

The purpose of overspray containment is to minimize the wet footprint of material that may otherwise be deposited off the edge of the mold. Wide perimeter flanges accomplish this by capturing potential overspray at the edge of the mold, and preventing it from spreading to the floor or walls.

Containment flanges are not a required component of controlled spraying, but can enhance an operator's ability to reduce overspray.

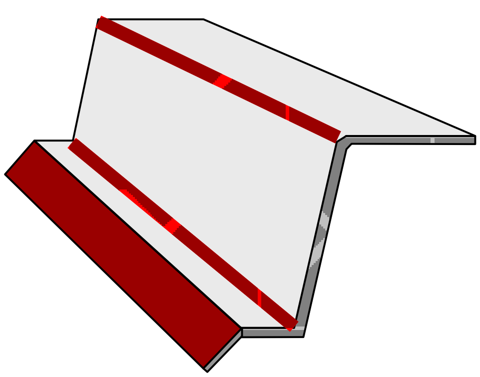
With some large molds, containment flanges have less of an effect than with smaller molds. This is due to the mold perimeter to surface area ratio. Smaller molds have a greater ratio of perimeter distance to total surface area when compared to larger molds.

If a mold configuration is such that it can be sprayed with little escaping overspray, wide flanges may not be necessary.

5.2 Permanent and Temporary Flanges

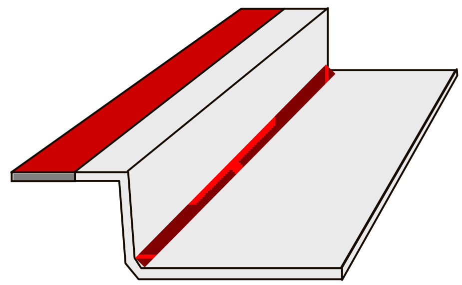
While extended flanges are an element of controlled spraying, the specific configuration of the flanges may vary. If the flange is of a width and orientation to capture overspray, the specific configuration is of secondary importance. In other words, the purpose of the extended flange is to meet a performance objective, therefore the con

Male Mold 45^0 Flange



figuration, flange material or attachment method may vary, as long as the flange serves the intended purpose.

Female Mold Horizontal Flange



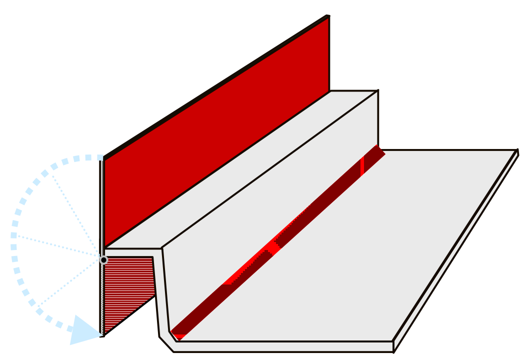
Extended flanges may be built into the mold as permanent extensions of existing flanges, or as an integral part of a mold designed specifically for controlled spraying.

Perimeter masking may also be used to capture overspray. In this case, masking paper, plastic strips, cardboard or other materials are temporarily positioned around the mold perimeter during spraying operations.

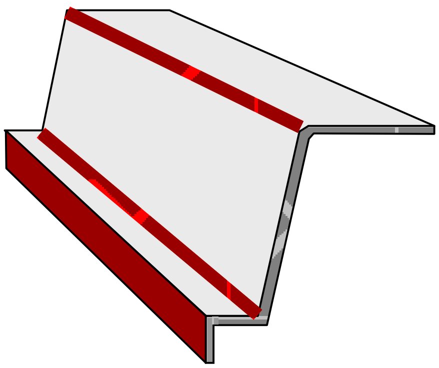
5.3 Containment Flange Configurations

The configuration of the extended flange must take into account the geometry of a female or male mold and part removal considerations.

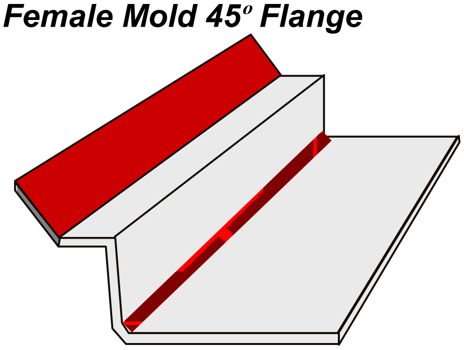
Female Mold Hinged Vertical



Male Mold Vertical Flange

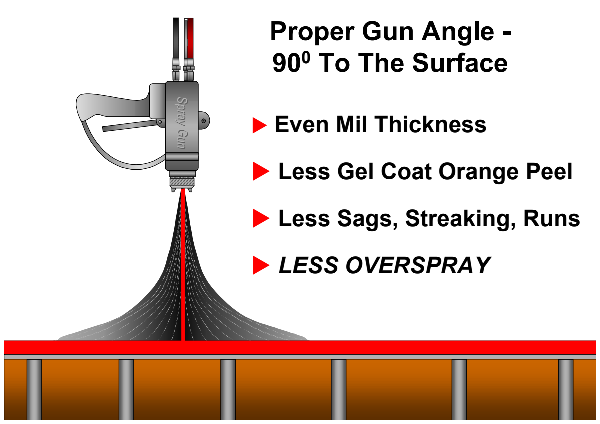


Female Mold 45° Flange



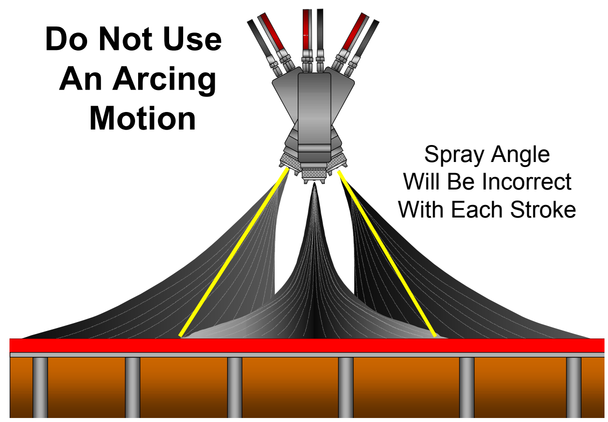
6.1 Spraying Techniques

Operator spraying technique is an essential factor in reducing emissions as well as producing a high quality work. There are basic elements of spraying technique of which contribute to effective application of resin or gel coat.



1. Where you aim the spray gun is important. The object of controlled spraying is to minimize overspray. Always attempt to hold the gun perpendicular (90^0) to the surface. As the spray gun assumes a lower angle in relation the surface, overspray will increase.

2. Spray the perimeter of the mold first, while keeping overspray within the boundary of the close containment flange. When spraying the interior of the mold, work out to the material previously applied to the perimeter and stop short of going off the mold edge.



3. Always begin by spraying the section nearest you. The reason for this is to prevent a momentary off-ratio burst of material from spraying on the mold surface. By starting with the closest area of the mold and working outward, you will minimize the likelihood of raw catalyst falling on exposed mold surface and possibly damaging the mold.

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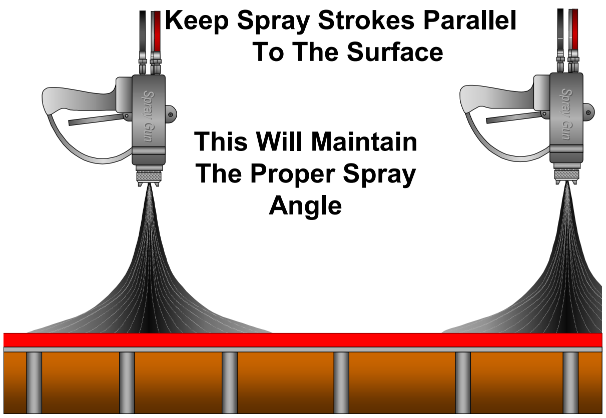


4. Avoid triggering the gel coat gun on and off as you would a paint spray gun. The gun trigger should be either *full-on or full-off* to maintain the proper material ratio. Do not "throttle" the gun with a partially open trigger.

5. With the exception of spraying corners, always attempt to keep the fan pattern perpendicular (90^0) to the mold surface and avoid an arcing motion with the gun. Follow the contour of the mold as closely as possible. Avoid spraying at a low angle. It will be difficult to control overspray and the material thickness will taper off further away from the gun. In the case of an arcing spray movement, the change in spray angle at the end of the stroke will make overspray difficult to control.

6. Although it may not be possible to maintain a 90^0 spray gun angle at all times due to the shape of the mold, the objective is to maximize the time spent spraying at 90^0 to the surface.

7. Note: On large molds it may not be possible to spray at a 90^0 angle in

the center of the mold because of limitations in the operator's reach. In this case, spray from each side into the middle of the mold. Even though the spray angle is not ideally perpendicular, overspray falls into the interior of the mold, and does not constitute an emissions problem.

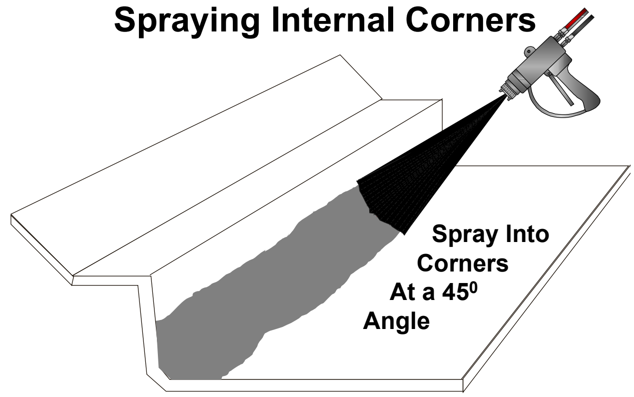
8. *Do not* assume you can apply the proper thickness by feel or experience. There are a number of variables, such as tip size and condition, pump pressure, viscosity and temperature that can affect the delivery rate. Because of this it is essential for even experienced operators to use a wet film gauge (mil gauge) on every part.

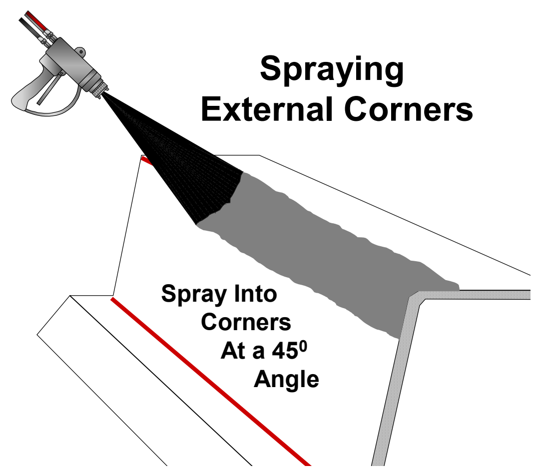
9. Applying the right film thickness is a function of time and motion. The spray gun delivers a specific amount of material in a given amount of time. How thick the material is applied is a matter of how fast the gun covers a given area. The operator must concentrate on maintaining a constant stroke speed throughout the application.

10. It is best to spray an area about as large as a comfortable arm swing. Avoid pivoting the gun with the wrist and do not bounce the spray pattern with quick wrist movements. The proper technique is to use smooth long strokes, while keeping track of spray bands.

11. Operator training should include specific instructions for spraying various configurations, including:

    - Spraying corners
    - Spraying large and small molds
    - Spraying male and female mold configurations
    - Spraying flat surfaces
    - Spraying curved surfaces





Chapter 7 Operator Training and Performance Evaluation

7.1 Operator Training Syllabus

Controlled spraying training should include the following elements:

1. Understanding of the importance of controlled spraying.
2. Recognition of the effects of overspray on styrene emissions.
3. Recognition of the effects of spray gun pressure on emissions.
4. Understanding of the procedure to establish proper spray gun pressure.
5. Understanding of spraying techniques.
6. Understanding of the purpose of overspray containment flanges.
7. Completion of a performance evaluation.

7.2 Performance Evaluation Criteria

Spray operators should be evaluated for demonstrated performance in specific aspects of controlled spraying. Criteria for satisfactory performance include:

7.2.1. Fluid Pressure Setting

Fluid settings of all spray equipment must be set at the lowest possible settings while achieving a symmetrical spray pattern with uniform distribution of the resin or gel coat across the spray pattern. For this evaluation, an adequate spray pattern will be defined as symmetrical shape with uniform material distribution throughout the spray pattern.

Air Atomized Spay Equipment:
Air pressure settings should be set at a level to achieve a full even spray pattern. A spray pattern with a heavy fluid concentration in the center indicates too much fluid pressure. A spray pattern with a light concentration of fluid in the center and heavy at the ends indicates the fluid pressure has been set too low.

Airless Spray Equipment:
Fluid pressure setting should be adjusted to a level to achieve a full even spray pattern. A pattern with tails (or fingers on the outer edges) would indicate the fluid pressure is too low. Fluid pressures higher than that required to eliminate tails will be considered excessive.

Air Assisted Airless Spray Equipment:
Pressure levels must be set only high enough to achieve an adequate spray pattern. Slight tails should be visible without the aid of shaping air. Assist air should than be used to fine-tune the pattern shape. Fluid pressures higher than required to achieve adequate spray pattern shape will be considered excessive.

Non-Atomized Application Equipment:
Fluid pressure level must be set only high enough to achieve an adequate flow pattern. A coherent flow stream should be visible exiting the fluid tip. Fluid pressure that causes visible atomization within the region of the fluid tip is considered excessive.

7.2.2. Air Pressure Setting

Air Atomized Spray Equipment:
Air pressure settings should be set only high enough to achieve adequate shaping of the spray pattern. Higher air pressure settings, those beyond what is needed to achieve adequate shape should be considered excessive.

Air Assisted Airless Spray Equipment:
Air pressure settings should be set only high enough to eliminate tails from the spray pattern. Higher air pressure settings should be considered excessive.

7.2.3. Body Position

The operator's body position should allow for even gun strokes, with minimal amount of spray stroke arcing. If the operators positioning causes the operator to arc the gun, use an excessive gun angle, or spray at excessive gun distances as described in this document, it should be considered unsatisfactory and requires further training.

7.2.4. Spray Gun Angle

The operator should maintain a spray gun angle of 90^0 when spraying mold areas *that allow this orientation.* In areas where a 90^0 orientation is feasible, the spray gun angle should remain reasonability close to perpendicular to the surface being sprayed at all times. In areas where a 90^0 orientation is not possible, the operator should maintain a gun angle as close to 90^0 as feasible for that circumstance. Corners should sprayed at a 45^0 angle into the corner.

7.2.5. Gun Stroke

The operator should establish a gun stroke that is approximately an arm swing in width, without acring the spray gun at the beginning and end of the stroke. Small or medium sized surfaces should be sprayed in one stoke when possible. Larger surfaces need to be sprayed in multiple strokes. The use of multiple strokes on surfaces that could be sprayed in a single stroke should be considered unsatisfactory. Likewise, long gun strokes that result in gun arcing will also be considered unsatisfactory.

7.2.6. Gun Distance

Spray gun distance is determined by the configuration and size of the mold. With large molds, or molds of complex geometry, the operator should maintain a minimum distance from the surface as circumstances dictate. Given a mold of a size and configuration that the operator can reach within an arm length, the following gun distances from the mold will be considered satisfactory.(Note: Larger molds will require a greater distance from the spray gun.)

- Air Atomized Spay Equipment – 12" to 18"
- Airless Spray Equipment – 18" to 24"
- Air Assisted Airless Spray Equipment – 12" to 18"
- Non-Atomized Flow Coaters – 12" to 18"

7.2.7. Gun Speed

Gun speed should be such as to allow for complete coverage of the surface in a uniform thickness. Gun speed should remain consistent throughout the spraying operation. A uniform gun speed should provide a uniform material distribution across the surface.

7.2.8. Overlap

Spray strokes should produce a pattern overlap of approximately 50% for resin, chop and gel coat application. Less than 50% overlap or more than a 75% overlap should be considered unsatisfactory.

7.2.9. Edge Control

The operator should demonstrate control of the spray pattern when spraying the mold perimeter. The spray pattern should be contained within the mold overspray containment flange. Solid wet resin coverage exceeding 50% of the flange width should be considered excessive.

7.2.10. Spray Sequence

The spray band pattern should begin with spraying the perimeter of the mold, followed by filling in the interior sections, using a 50% overlap on each stroke. Spraying the interior of the mold before banding the perimeter is considered unsatisfactory. The operator should use a spray sequence that allows for a complete and uniform coverage of the substrate. The same spray sequence should be used on all parts of similar shape and size. Significant variations in spray sequence on similar molds should be considered unsatisfactory.

7.2.11. Gun Triggering

Operators must pull the gun trigger to the full *on* position and release to the full *off* position. Throttling of the spray gun is considered unsatisfactory.

7.2.12. Thickness Gauging

Operators must demonstrate the use of a wet film (mil gauge) or a chop thickness gauge to measure material thickness. Failure to measure laminate or gel coat thickness is unsatisfactory.

Controlled Spraying - Operator Performance Evaluation

Employee Name: ______________________________

Company: ___________________________________ Facility: _____________________

Instructor: ___________________________________ Date: ________________________

Qualification For: Gel Coat Application [ ] Resin or Chop Application [ ] Both [ ]

Parameter	Performance Rating	
	Unsatisfactory	**Satisfactory**
Fluid Pressure Setting		
Air Pressure Setting		
Body Position		
Spray Gun Angle		
Gun Stroke		
Gun Distance		
Gun Speed		
Overlap		
Edge Control		
Spray Sequence		
Gun Triggering		
Thickness Gauging		

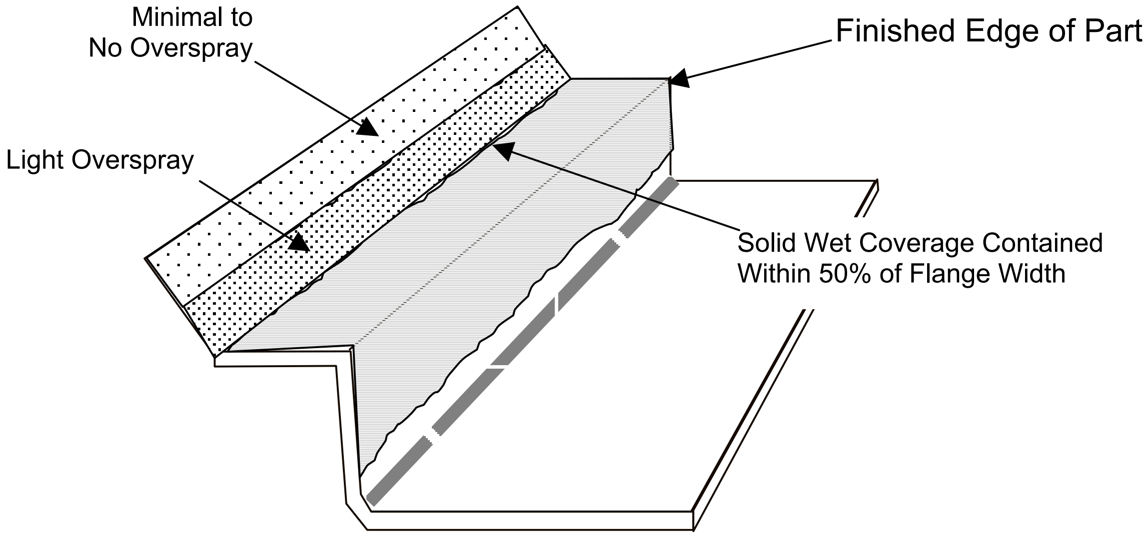
The employee named above has demonstrated satisfactory performance in demonstrating proficiency in each of the essential elements of controlled spraying.

Yes [ ] No [ ]

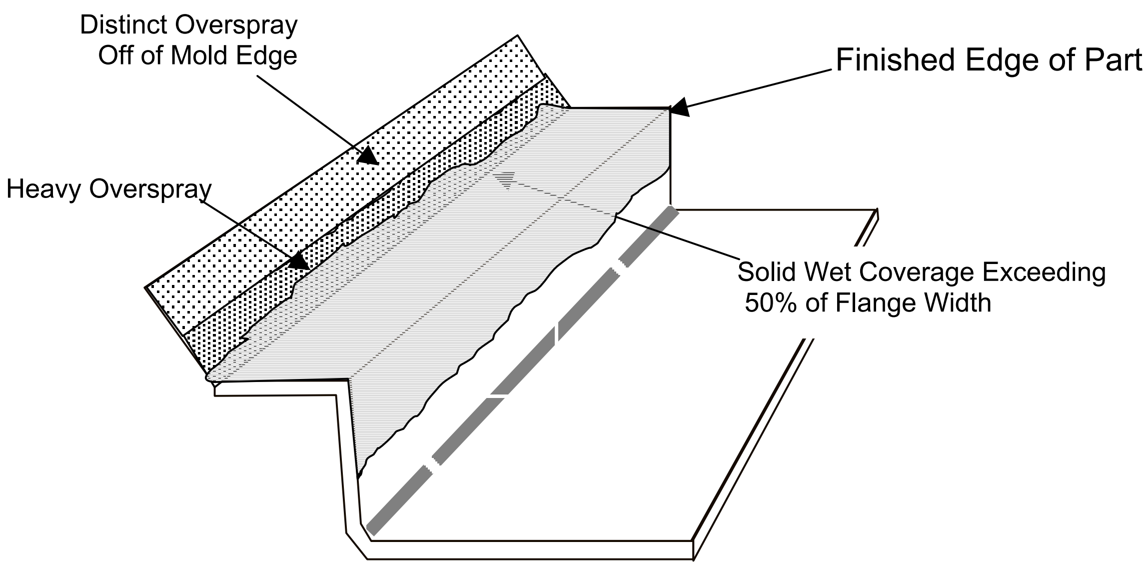
If "No" re-training and evaluation will be scheduled on: Date __________

Instructor:______________________________________ Date: _____________________

Overspray Containment



Ideal Overspray Containment



Inefficient Overspray Containment

Controlled Spraying Summary

Chapter 8

8.1 Controlled Spraying Overview

The full benefits of controlled spraying are available if the following elements are in place:

1. Spray gun is operating at the lowest pressure that produces a symmetrical fan pattern.
2. Pressure settings are documented on a pressure calibration sheet.
3. Spray gun operators have received training in controlled spraying techniques.
4. Close containment flanges are used where appropriate.

8.2 Operation of spray gun or flow coater at the lowest applicable pressure setting.

Application gun pressure settings are calibrated using the following procedure:

[This procedure applies to all airless, air-assisted airless, and flow coaters using fluid pump material delivery to the spray gun:

1. Select fluid tip.
2. Set fluid pump pressure to the point where the pump no longer operates.
3. Position spray gun 12-18" and at a perpendicular orientation to a disposable surface.
4. Pull and hold trigger while increasing pump pressure in 5 psi increments, until a symmetrical spray pattern is developed.
5. Release trigger. Record fluid pump pressure.
6. Test the fan pattern. Position the spray gun over a clean disposable surface and quickly pull and release trigger to produce a "snapshot" of the spray pattern shape.
7. An adequate fan pattern is symmetrical in shape and presents a width and length appropriate for the application.
8. If required, adjust and refine the fan pattern by repeating steps 2,3,4 & 5.
9. Record final pressure setting in daily log.

8.3 Operator Training

Operator training should include the following elements:

Application gun operators should be documented as having received which includes the following workpractice elements:

1. Explanation of the importance of controlled spraying
2. Explanation of how overspray contributes to emissions.
3. The requirement to operate the spray gun at the lowest applicable pressure.
4. Proper spraying techniques including:
   a. General technique
   b. Spray gun orientation perpendicular to the mold
   c. Establishing a proper coverage pattern
   d. Spraying the mold perimeter
   e. Spraying corners
   f. Spraying large and small molds
   g. Spraying male and female mold configurations
   h. Spraying flat surfaces
   i. Spraying curved surfaces

8.4 Close Containment of Overspray

Containment of overspray is influenced by the size and shape of a mold and in some cases the need for extended flanges.

Containment flanges may include:

1. An extended built-in mold perimeter flange.
2. A removable flange extension around the mold perimeter
3. Extended masking around the mold perimeter

On some larger molds the use of extended flanges may not be necessary due to the configuration of the mold perimeter. Containment flanges are only needed where overspray is difficult to control.