



Controlled Spraying Training *Instructors Guide*

September, 1998

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Instructors Guide

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Instructors Guide

Controlled Spraying Training Program

Introduction

Chapter 1

1.0 Introduction

Concept –

This program is designed to provide training guidelines for spray operators in the *open molding composites industry*, where styrene based resin and gel coat materials are used.

Critical Knowledge –

This program applies to all operations where polyester resins or gel coats are dispensed from a spray gun.

1.1 What is Controlled Spraying?

Concept –

Controlled spraying is a workpractice that is very effective in reducing styrene emissions from the open molding process. It is a pollution prevention method which benefits the environment, the manufacturing process, and plant personnel.

Critical Knowledge –

- Controlled spraying reduces styrene emissions by increasing material transfer efficiency and reducing overspray.
- This is accomplished by minimizing spray gun atomization and reducing overspray loss.
- There are three elements of controlled spraying, which work together to reduce emissions.
 - Operation of the spray gun at the lowest fluid tip pressure.
 - 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

Concept –

Spray gun operator training is an important aspect of a controlled spraying program.

Critical Knowledge -

Operators and production management are required to know how to properly set-up a spray gun, and understand the proper methods of spray gun handling.

1.3 Where is Controlled Spraying Required?

Concept –

Controlled spraying should be used for all spray application of styrene based

Critical Knowledge –

This workpractice technique should be used as the standard manufacturing practice in open molding facilities, or in other cases, where atomized spraying is used.

1.4 Why is Controlled Spraying Important?

Concept -

Controlled spraying can provide a substantial reduction in styrene emissions, compared to typical uncontrolled spraying.

Critical Knowledge -

- Testing has demonstrated that controlled spraying can reduce gel coating emissions by up to 40%, and laminating resin emissions by up to 20%.
- Controlled spraying can be used in all circumstances where atomized spray application is required.
- Controlled spraying reduces emissions, creates a better working atmosphere, and promotes better product quality.

1.5 Emissions During the Molding Process

Concept –

About half of total emissions occur during the spraying process.

Critical Knowledge -

- Fluid stream atomization contributes to emissions during the spraying process. The greater the level of atomization (creating finer aerosol particle sizes) and the higher the fluid stream pressure, the more emissions will occur.
- 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

Concept –

Wet surface area is a key element of emissions. The thickness does not matter.

Critical Knowledge –

- The larger the surface area, the greater the evaporative loss.
- The emissions from a thin film of overspray will be almost the same as from a thick laminate.
- Reducing surface area is a key element to reducing emissions.

Definitions

Chapter 2

2.1 Atomization

Critical Knowledge –

- In order to create a useful spray pattern, it is necessary to convert a pressurized stream of resin into an elliptical shape as it exits the spray gun fluid tip.
- Atomizing the fluid is to break the fluid stream into fine aerosol particle sizes, which converts the narrow fluid stream into a 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.
- 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.

2.2 Gel Coat

Critical Knowledge -

- Gel coat is a specialized form of polyester or vinyl ester resin, which is used as an in-mold applied surface coating.
- Gel coat can only be applied by atomized spray application

2.3 Overspray

Critical Knowledge -

- Overspray is resin that is deposited off the mold surface during the spraying process.
- Overspray has the effect of increasing the resin surface area by creating an enlarged “wet footprint”, which creates more emissions.

2.4 Resin

Critical Knowledge -

- In this context, resin refers to unsaturated polyester or vinyl ester laminating resin.
- Gel coat, which is a specialized form of resin used as an in-mold coating, can be generically referred to as resin..

2.5 Spray Gun

Critical Knowledge -

- A spray gun is a fluid-handling device, which converts a stream of fluid into a useful shaped spray pattern.
- There are a number of types of spray guns, which have application in the open molding composites industry. These include:
 - Conventional Air Atomizing
 - High Pressure Airless
 - Air-Assisted Airless (AAA)
 - High Volume Low Pressure (HVLP)

Spray Equipment

Chapter 3

3.1 Types of Spray Guns

Concept –

There are a number of different types of spray guns. Some produce higher emissions than others.

Critical Knowledge -

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

Concept –

Air atomized spray guns deliver resin to the spray tip at low pressure and use air streams to create a fan pattern.

Critical Knowledge –

- There are several different types of air atomized spray guns.
- They produce the highest emissions of all spray guns.
- Transfer efficiency is very low, waste is high.

3.2 High-Pressure Airless Spray Guns

Concept -

Airless spray guns use a pump to deliver the resin coat to the fluid tip at high pressure.

Critical Knowledge -

- As the high-pressure stream exits the small fluid tip, the sudden reduction in pressure causes the fluid to atomize into a spray pattern.
- Airless spray tips usually require a fluid pressure of at least 1000 psi to produce an adequate fan pattern.

3.3 Air-Assisted Airless Spray Guns

Concept -

These current technology spray guns are a combination of airless and air atomized guns, drawing the benefits of both types.

Critical Knowledge -

- Air-Assisted Airless guns use a pump to deliver the resin to the fluid tip, but with much less pressure than an airless gun. The partially shaped fan pattern is then fully formed with the introduction of “shaping” air with the air-assist.

- Air-assisted airless guns produce higher transfer efficiency than airless guns with reduced emissions.
- The lower pressure spray also enhances gel coat quality.

3.4 High Volume Low Pressure (HVLP) Spray Guns

Concept -

HVLP spray guns operate at very low air pressures.

Critical Knowledge -

- They 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.

3.5 Fluid Pumps

Concept -

A fluid pump is used to deliver resin or gel coat to a spray gun.

Critical Knowledge -

- 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 gel coat out to the spray gun at high pressure.
- The power of a pump is referred to as the pump ratio.
- The input air pressure multiplied by the pump ratio determines the fluid pressure.

Spray Gun Set-Up & Pressure Calibration Chapter 4

4.1 Flow Rate

Concept -

Flow rate is the amount of material sprayed in a given period.

Critical Knowledge -

- The flow rate is controlled by:
 - The size of the spray tip
 - Pump pressure
 - Resin viscosity.

4.2 Determining the Proper Spray Gun Pressure

Concept –

Determining the ideal pump pressure for a specific combination of material and equipment is an important element of controlled spraying. The goal is to apply resin or gel coat at the lowest level of atomization, which produces a workable spray pattern.

Critical Knowledge -

- Sometimes operators feel they have to turn up the pressure to get an adequate flow rate – *this is an incorrect procedure.*
- The proper method is to maintain minimum pressure and to increase the size of the spray tip to match the required delivery rate.
- 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
 - Reduce equipment wear
 - Reduce high pressure hazards
 - Reduce static charge build-up
 - Increase product quality
- Emphasize the saying “*Minimum Pressure For Maximum Performance*”

4.3 CFA Pressure Calibration Procedure

Concept –

There is a very specific method for setting-up a spray gun to operate at the lowest pressure. This procedure is appropriate for all production spray guns.

Critical Knowledge –

This procedure must be fully understood by all employees handling spray equipment.

- Verify that the resin is the correct temperature, and has been properly mixed within the manufacturers specified period.
- Verify that the spray tip is in good condition and suitable in flow rate range and fan pattern width for the given job.
- Aim the spray gun at a disposable surface on the floor, maintaining a distance of 12” to 18” and perpendicular to the floor.
- Turn the pump pressure down to zero and pull the trigger.
- Slowly begin to increase the pressure in 10 psi increments until the fan pattern is adequate.
- Record this pressure in the spray gun set-up log..
- *Do not* increase the pressure past this point. The result will be over-atomization and increased overspray, and poor transfer efficiency..

4.4 Determining the Proper Spray Pattern

Concept –

The size of a spray pattern results from a unique combination of orifice size, tip angle and resin flow characteristics. The required fan pattern width is specific to the size and configuration of the part being sprayed.

Critical Knowledge –

- The size of the spray pattern should match the spraying requirements.
- A proper fan pattern should have a symmetrical shape, where the material is distributed evenly across the length and width of the spray pattern.

Overspray Containment Flanges

Chapter 5

5.1 The Purpose of Containment Flanges

Concept –

The purpose of overspray containment is to minimize the wet footprint of material which could be deposited off the edge of the mold.

Critical Knowledge –

- The specific configuration of the flanges may vary. As long as the flange is of a width and orientation to capture overspray, the specific configuration is of secondary importance.
- 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.

Spraying Techniques

Chapter 6

6.1 Spraying Techniques

Concept –

Operator spraying technique is an essential factor in reducing emissions as well as producing a high quality work.

Critical Knowledge –

There are basic elements of spraying technique of which contribute to effective application of resin or gel coat. These are:

- Where you aim the spray gun is important.
- Spray the perimeter of the mold first, while maintaining overspray within the boundary of the close containment flange.
- Always begin by spraying the section nearest you.
- Avoid triggering the gel coat gun on and off as you would a paint spray gun. In addition the trigger should be "full-on or full-off" to maintain the proper material ratio. Do not "throttle" the gun with a partially open trigger.
- Always attempt to keep the fan pattern at right angles (perpendicular) to the mold surface. Follow the contour of the mold as closely as possible.
- Spray into corners on a 45⁰ angle. Spray corners first, then flats.
- *Do not* assume you can apply the proper thickness by feel or experience. You must mil gauge every part, all of the time

- Applying the right film thickness is a function of time and motion. The operator must concentrate on maintaining a constant speed throughout the application.
- 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. The proper technique is to use smooth long strokes.

Operator Training and Performance Evaluation

Chapter 7

7.1 Operator Training Syllabus

Concept-

There are seven area of specific knowledge required for controlled spraying. These are listed in the syllabus:

Critical Knowledge -

The Controlled spray training program must transfer the following knowledge:

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

Concept-

Spray operators must demonstrate satisfactory performance in twelve areas.

Critical Knowledge –

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:

Fluid settings must 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 settings must be set at a level to achieve a full even spray pattern. A pattern with tails would indicate the fluid pressure is too low. Fluid pressures higher than that needed to eliminate tails will be considered excessive.

Air Assisted Airless Spray Equipment:

Fluid levels must be set only high enough to achieve an adequate spray pattern. Slight tails should be visible without the aid of shaping air. Fluid pressures higher than that needed to achieve adequate pattern shape and distribution will be considered excessive.

2. Air Pressure Setting

Air Atomized Spay 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 will 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 will be considered excessive.

3. Body Position

The operators body position must be such as to allow for even gun strokes, with minimal amount of gun angle or arcing. Body positioning that requires the operator to arc the gun, use an excessive gun angle, or spray at excessive gun distances as described in this document, will be considered unsatisfactory.

4. Spray Gun Angle

The operator should maintain a spray gun angle of 90^0 when spraying mold areas *which allow this orientation*. In areas where a 90^0 orientation is feasible, the spray gun angle should remain within 30^0 of perpendicular to the surface being sprayed at all times. A gun angle in excess of 30^0 from perpendicular will be considered excessive. 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 down the length of the radius at a 45^0 angle to the corner. A gun angle in excess of 20^0 of the bisecting angle of a corner is considered excessive.

5. Gun Stroke

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

6. Gun Distance

Spray gun distance will be predicated on the configuration and size of the mold. With large molds, or molds of complex geometry, the operator will 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.

Air Atomized Spay Equipment:

Gun distances should range between twelve to eighteen inches. Gun distances in excess of eighteen inches will be considered excessive.

Airless Spray Equipment:

Gun distances should range between eighteen to twenty-four inches. Gun distances in excess of twenty-four inches will be considered excessive.

Air Assisted Airless Spray Equipment:

Gun distances should range between twelve and eighteen to ten inches. Gun distances in excess of eighteen inches will be considered excessive.

7. Gun Speed

Gun speed should be such as to allow for complete coverage of the substrate in a uniform thickness. Gun speed should remain consistent throughout the spraying operation. Under normal conditions, the use of multiple passes to achieve complete coverage that could have been achieved in a single pass will be considered the result of excessive gun speed and therefore unsatisfactory.

8. Overlap

Pattern overlap should be 50% for all resin application or gel coating operations. Less than 50% will be considered unsatisfactory. Likewise, overlap in excess of 75% will be considered unsatisfactory. Inconsistent overlapping on any one surface will also be considered unsatisfactory.

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 is considered excessive.

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 will be considered unsatisfactory. The operator should use a spray sequence that allows for a complete coverage of the substrate, without multiple passes on any one area of the part during a single spray sequence. Spray sequences in which any one area of the part is sprayed more than twice during that sequence will be considered unsatisfactory. The same spray sequence should be used on all parts of like geometry. Significant variations in spray sequence on like geometry parts will be considered unsatisfactory.

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.

12. Thickness Measurement

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

Controlled Spraying 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: _____

Controlled Spraying Verification and Compliance

Chapter 8

8.1 Controlled Spraying Compliance

Concept-

Controlled spraying has specific requirements considered to be both effective and in compliance.

Critical Knowledge -

- Spray gun is operating at the lowest pressure which produces a symmetrical fan pattern.
- Pressure settings are documented in a daily log; Pressure settings are recorded and displayed on or near spray unit.
- Spray gun operators are documented as receiving required training in controlled spraying techniques.
- Close containment flanges are in place at mold perimeters.

8.2 Verification - Operation of spray gun at lowest applicable pressure setting.

Concept-

There is a specific procedure to determine spray gun pressure settings. *This procedure applies to all airless, air-assisted airless and HVLP spray equipment using fluid pump material delivery to the spray gun:*

Critical Knowledge –

Spray gun set-up procedure – spray operators must know this procedure:

- Select fluid tip.
- Set fluid pump pressure to “0”
- Position spray gun 12-18” and at a perpendicular orientation to a disposable surface
- Pull and hold trigger while increasing pump pressure in 10 psi increments, until a symmetrical spray pattern is developed.
- Release trigger. Record fluid pump pressure.
- 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.
- An adequate fan pattern is symmetrical in shape and presents a width and length appropriate for the application.
- If required, adjust and refine the fan pattern by repeating steps 2,3,4 & 5.
- Record final pressure setting in daily log.

8.3 Verification – Operator Training

Concept –

Operator training must be documented in order to verify individual competency.

Critical Knowledge -

- Spray gun operators should be documented as receiving training, which includes the following workpractice elements:
 - Explanation of the importance of controlled spraying
 - Explanation of how overspray contributes to emissions.
 - The requirement to operate the spray gun at the lowest applicable pressure.
 - Proper spraying techniques including:

- General technique:
 - Spray gun orientation perpendicular to the mold
 - Establishing a proper coverage pattern
 - Spraying the mold perimeter
 - Spraying corners
 - Spraying large and small molds
 - Spraying male and female mold configurations
 - Spraying flat surfaces
 - Spraying curved surfaces

8.4 Verification - Close Containment of overspray

Concept –

Close containment flanges are a critical element of reducing overspray.

Critical Knowledge -

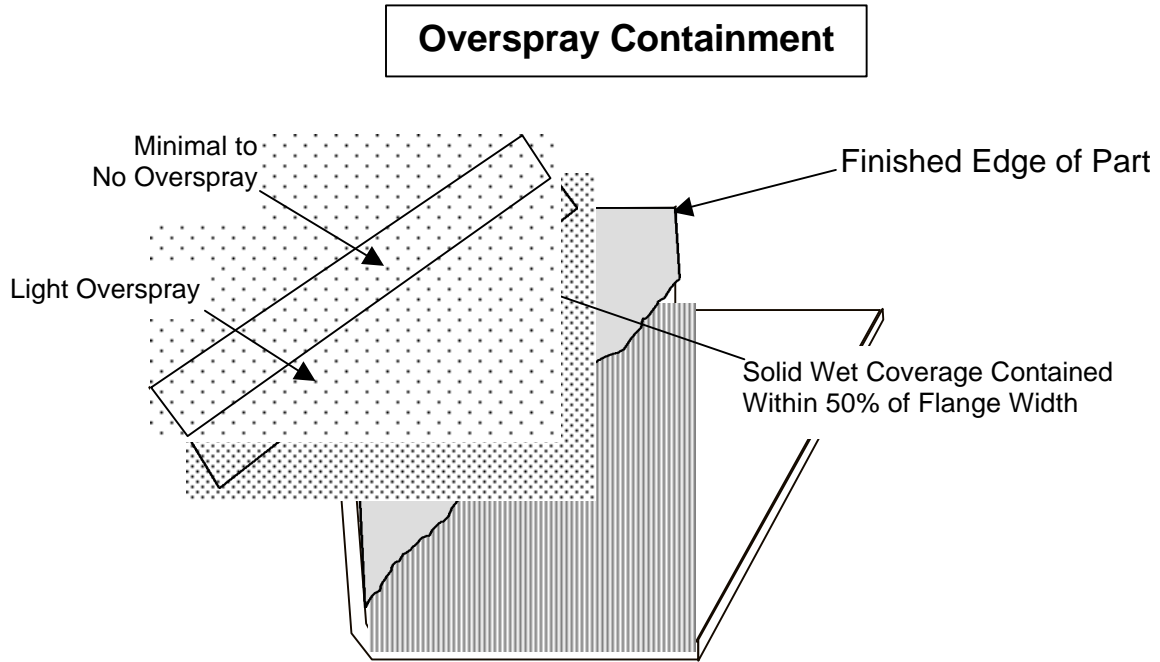
- Close containment is considered to be in compliance if any of the following configurations are in place, and solid (100% coverage) wet resin spray is terminated within one half of the width of the extended mold flange:
 - Extended built-in mold perimeter flange
 - Removable flange extension around the mold perimeter
 - Extended masking around the mold perimeter

Concept –

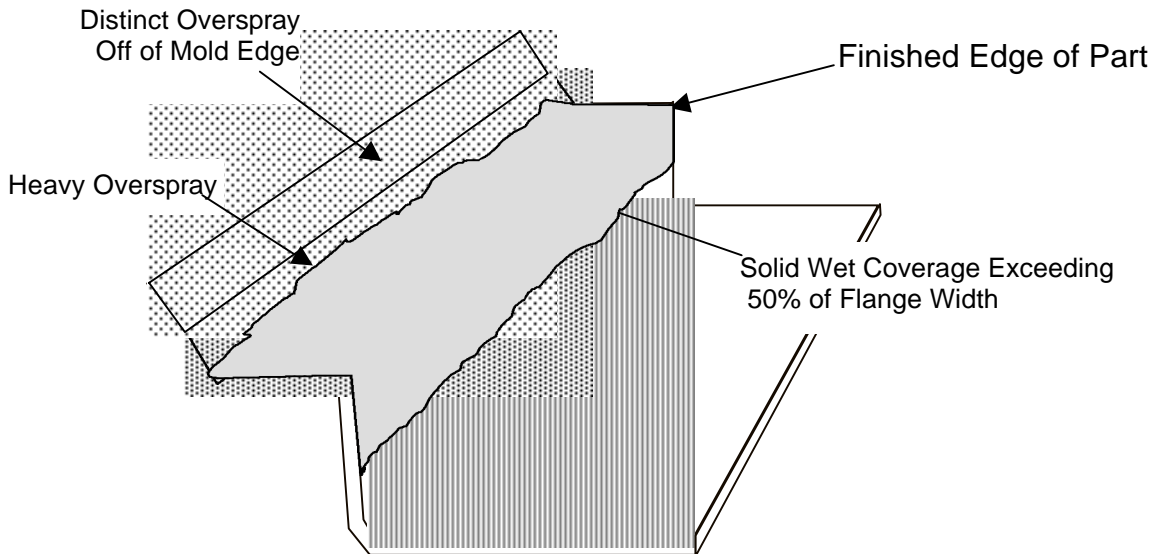
It is vital for a spray operator to understand the practical aspects of overspray and limitations of spraying to the mold edge.

Critical Knowledge –

Solid wet resin or gel coat coverage should end as close to the finished edge of the part as possible. Wet coverage cannot exceed $\frac{1}{2}$ the width of the flange, and no substantial amount of overspray should reach the outer edge of the flange.



Acceptable Overspray Containment



Unacceptable Overspray Containment