Training Overview

- Cleaning and surface preparation
- Coating types
- Application efficiency/equipment
- Equipment clean-up
- Case Study/Exercise
- Tools for providing P2 assistance

These are some of the common source codes and waste codes related to painting and coating seen in our Hazardous Waste Annual Reports.

Cleaning / Surface Prep Section Overview

- Review common cleaning / surface prep operations
- Identify types of wastes generated
- Think about "Questions to Ask"
- Review P2 applications for cleaning operations

Cleaning / Surface Prep

- Painting / coating will almost always involve some cleaning / surface prep operations
- These operations generate wastes, and should be incorporated into efforts aimed at waste minimization or P2
- When examining painting & coating operations for P2 opportunities, don't forget pretreatment !

Cleaning & Surface Prep (Pretreatment)

- Before you paint it, you have to clean it !!!
- "Pretreatment" is common term for cleaning newly manufactured work pieces prior to coating process
- Why Pretreat? Remove dirt or contaminants that interfere with adhesion properties of paint or coating
- Related to durability and/or appearance of finished part/product
- High percentage of all coating adhesion failure is directly attributable to improper surface preparation

Common Soil Types

- Oils and greases
- Polishing and buffing compounds
- Metalworking fluids, coolants
- Oxides and rust
- Adhesives, resins, inks and paints

Cleaning & Surface Prep generate wastes …

- Dirt & contaminants from work piece … but more importantly, the agents used to remove the contaminants, such as …
- Acids, bases
- Solvents
- Aqueous cleaning agents
- Wastewater

Types of Pretreatment

- Many kinds of pretreatment operations
- Appropriate cleaning method depends on substrate … metal / plastic … as well as type of contaminant to be removed
- Rationale for coating application dictates pretreatment effort

Types of Pretreatment - Solvent Cleaning

- Solvent cleaning – e.g. surface degreasing operations (TCE, MC, PERC, toluene/xylene, acetone).
- Generate spent solvents - hazardous wastes
- Aqueous cleaners may represent best alternative, however - replacement for a solvent cleaner may not be easy

Solvent Alternatives

- Flashpoint > 140ºF
- Non-HAP
- No/low VOC content
- Drop-in replacements are difficult to identify, however – the availability of solvent alternatives has improved
- Work with vendors to reformulate

Solvent Cleaning P2 ...

- Change to less regulated solvent
- Extend solvent life through filtration
- Keep solvent tank/container lids closed
- Recover spent solvent through distillation
- Two-stage cleaning
- Minimize use

Aqueous Cleaners

- Use of aqueous cleaners may require more rinsing, and cause generation of more wastewater
- Availability of aqueous cleaners is improving and cleaners are becoming more efficient

Aqueous Cleaning P2 ...

- Use heat, spray, mechanical action
- Minimize rinse water (countercurrent rinsing, flow restrictors)
- Minimize effects of drag-out
- Ensure bath maintenance (dump baths based on “criteria” not “calendar”)
- Ultrafiltration or microfiltration of cleaner bath

Types of Pretreatment – Mechanical Cleaning

- Abrasive blasting , e.g., plastic media blasting
- Dry ice (CO_2)
- Others (sand, baking soda, wheat starch)
- Most dry media used in abrasive blasting can be recycled

Mechanical Cleaning P2 ...

- Media blasting is a “line of sight operation”
- Not suitable for internal cavities or convoluted parts

Complex Pretreatment for metal work pieces ...

- Phosphating / Conversion Coating
- Usually Immersion or Spray processing
- Can be multi-stage process involving degreasing, phosphating / conversion coating, multiple rinsing, etc.
- These operations generate spent bath solutions and wastewaters

Complex Pretreatment for metal work pieces …

- P2 opportunities will involve …
- Prolonging process bath solutions
- Conservation / reuse of water and wastewater

No-Brainer P2 ...

- Stop work piece from getting dirty
- Pre-clean manually
- Proceed with dirty part

Questions to Ask ...

- What is the soil type?
- How did it get there?
- What's the part substrate and geometry?
- Why do these parts need cleaned?
- How clean is clean?
- Have you always cleaned this way?
- What are your cleaning costs?

Questions to Ask ...

- What type of cleaning and /or surface preparation is done prior to painting ?
- What are the process steps of the cleaning / surface prep operation ?
- What are the inputs (raw materials) ?
- What wastes are generated ?

Case Study- Hankison International (Newport, NC)

- Manufacturer of filter products and refrigerated air dryers for compressed air industry
- 1995 - installed powder coat system to coat external surfaces of these devices
- Production process includes 5-stage cleaning line prior to coating operation

Case Study – Hankison International

- Cleaning line would consume 800gpd water/day
- No public sewer available, high cost of off-site wastewater disposal prohibitive
- Solution = water conservation strategies including counter current rinsing between rinse tanks and installation of ultrafiltration system on 1st cleaning rinse
- Solution = use of innovative evaporation system utilizing waste heat from the powder coater oven

Case Study- Hankison International

- Waste reduction activities resulted in 450,000 gal water conserved annually
- Total capital costs were $40,500
- Total cost savings were $277,550
- Payback period on investment was very fast, in fact, less than 2 months

Cleaning Resources

- Solvent Alternative Guide (SAGE) provides P2 info on solvent and process alternatives for parts cleaning and degreasing. http://clean.rti.org/
- OCAPP's Parts Cleaning Info on their web site: http://www.epa.state.oh.us/opp/parts-cleaning.html

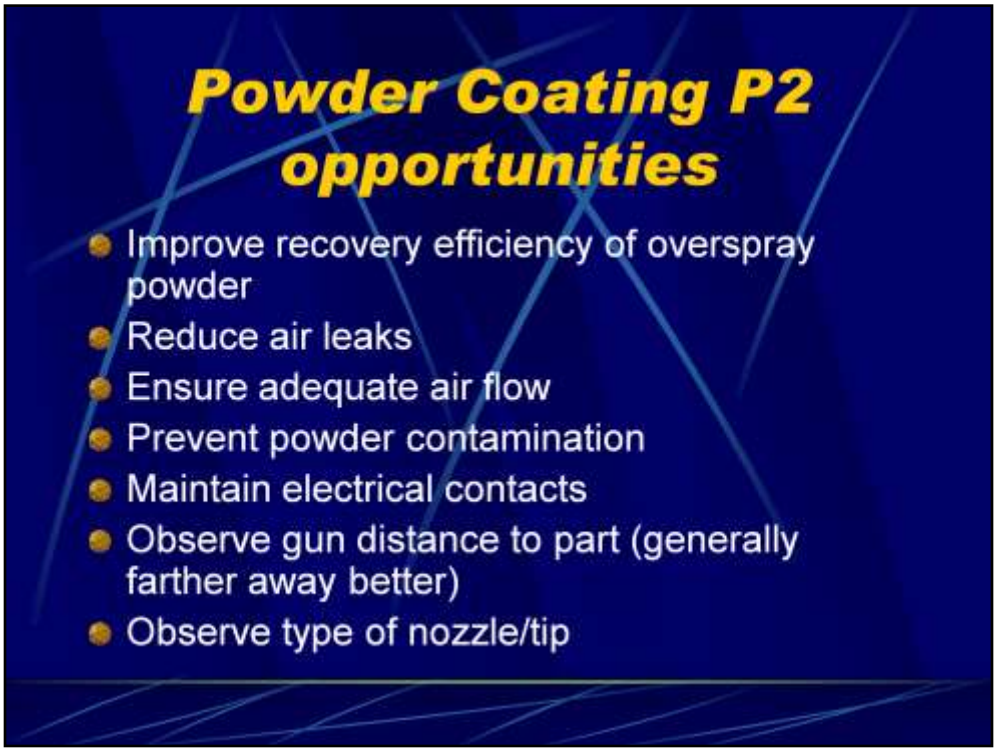
P2 Opportunities for Painting and Coating Processes

- Change the Material (select another coating or cleaner)
- Change the Operating Process (Operator Training)
- Change the Technology (Equipment Selection)

Powder Coating

- Advantages
- High TE (90-99%)
- Can reuse powder
- Minimal wastes generated (brick disposal)
- Filters can be cleaned to reused
- No VOCs

- Disadvantages
- Need very clean parts
- Need curing oven (may limit substrate, energy cost)
- Color changes not practical
- Capital costs ($100K-$1million includes cleaning system, booth, and bake oven)



Many people assume powder coating has a high rate of transfer efficiency. This is not always the case and there may still be P2 opportunities.

Selecting the right nozzle based on the shape of the part to be coated can help improve transfer efficiency.

Powder Coating

- P2 Questions to ask
- What is your recovery rate of powder overspray ?
- Do you have an over spray recovery system? (if not TE can be 20-50%)
- What is your maintenance schedule on the system? (hanger cleaning, electrical contact checks, air flow checks etc.)

These are the various types of spray guns used.

Application Equipment

Atomization: the breaking up up of paint into fine particles or droplets

Air atomization- atomization with air energy-usually compressed air

- Conventional
- High Volume Low Pressure (HVLP)

Hydraulic atomization- atomization using hydraulic pressure-fluid pressures 500-5000 psi

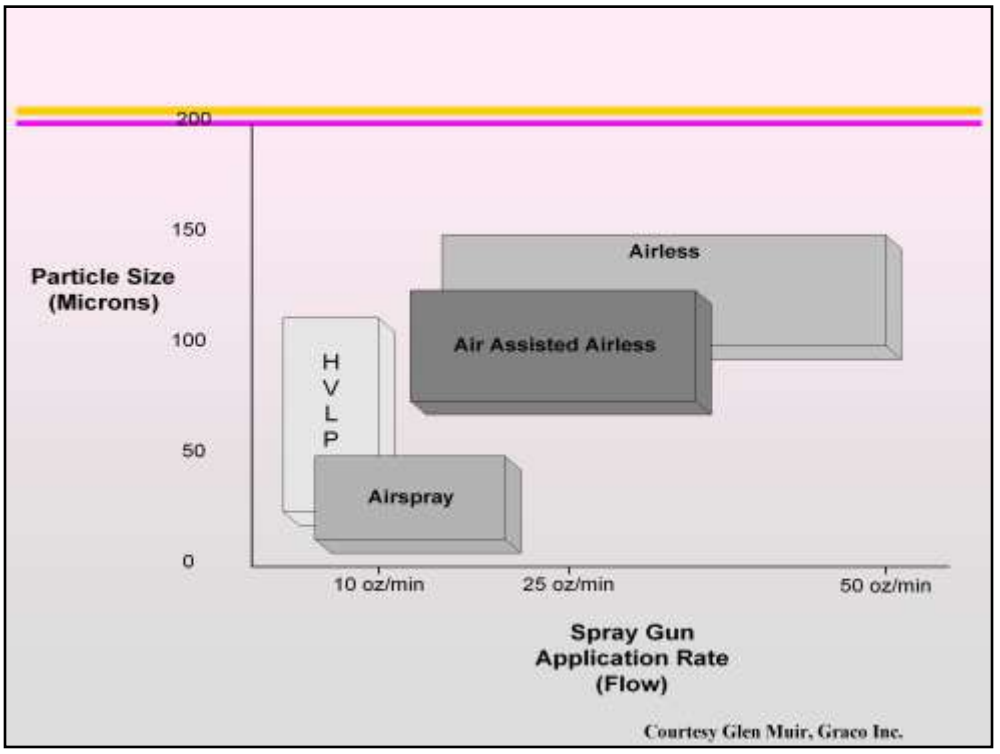
- Airless
- Air-assisted airless

Airspray Gun Feed Systems

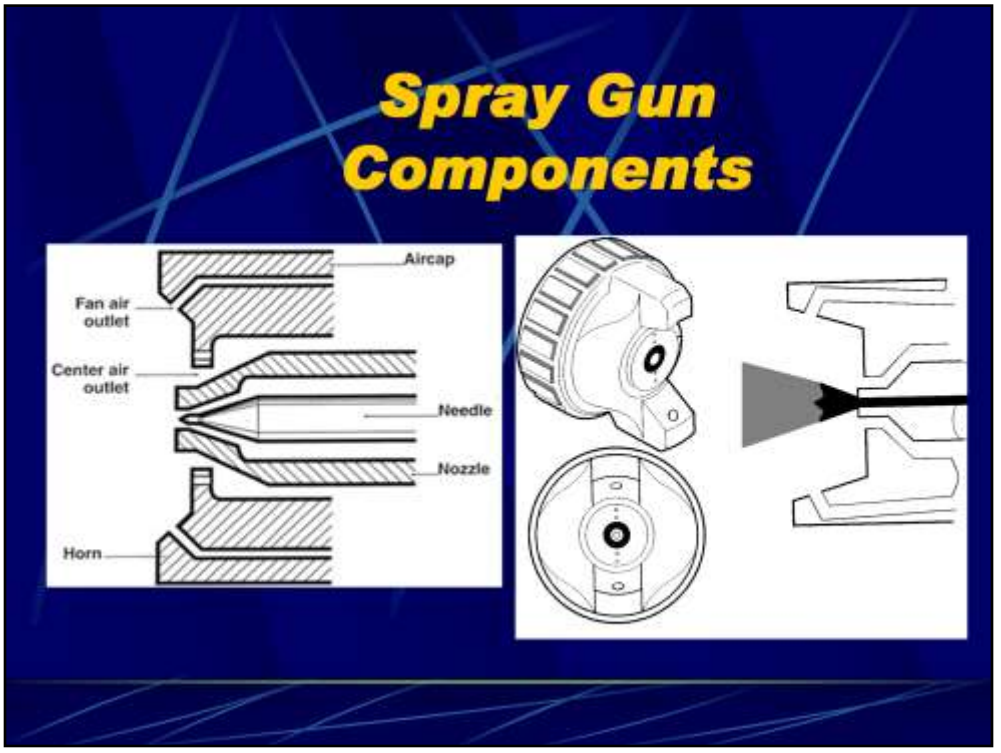
Devilbiss website: http://www.devilbiss.com/

Relationships to remember

- Finer atomization = smoother finish
- Higher viscosity – high solids coatings generally require higher atomization energies
- Higher production rates require higher atomization energies



This diagram shows the application rates and particle size produced by various types of spray guns.



This shows a close up of the nozzle and cap.

AIR SPRAY

- Compressed air - 3 functions
  - Forms droplet size
  - Shapes the spray pattern
  - Guides the paint to the part
- KEY:
- Proper proportioning of fluid delivery and atomizing air pressure

3-28

Conventional Spray Gun

- TE: 25% (can go up to 65%)
- Cost: $500-$1500
- Fluid pressure: 10-20 psi
- Air Pressure: 40-80 psi
- Most popular gun
- Can adjust air and fluid pressures

Devilbiss web site: http://www.devilbiss.com/

Conventional Spray Gun

Advantages

- High production rates
- High quality finish
- Good operator control

Disadvantages

- Lots of overspray (75%)
- High booth/filter clean-up costs
- High VOC emissions

High Volume Low Pressure (HVLP) Gun

- TE: 40-70%
- Air pressure: .5 – 10 psi
- Fluid Pressure:<10 psi
- Paint delivery: 10 oz/ per min
- Cost: $500-1500

Devilbiss web site:
http://www.devilbiss.com/

High Volume Low Pressure (HVLP) Gun

Advantages

- Sprays well in recesses
- Lower overspray(~35%)
- Reduced paint use
- Lower booth/filter clean-up costs
- Lower emissions/wastes
- Can be used for many types of coatings (waterborne, high solids)

Disadvantages

- Atomization poor for fine finishes
- Lower production rates
- High solids hard to spray, may need heater
- Requires more operator training
- Maintenance cost for turbine

Hydraulic Atomization

- Atomization and fluid delivery rate are a function of:
  - Fluid tip;
  - Fluid pressure setting; and
  - Fluid viscosity
- Tips have specific orifice diameters and spray fan angles
  - Orifice diameters range from 0.007" to 0.036"
  - Included angle controls size of spray pattern
- Consider part geometry, coating, production speed, finish quality, and required film build when selecting fluid tip and operating pressures

3-13

Airless Spray Gun

- TE: 35-65%
- Fluid pressure: 500-6500 psi
- Paint delivery: 5-6 gal/min application
- Cost: $3500-7,000

Graco, Inc.: http://www.graco.com/

Airless Spray Gun

Advantages

- Better TE
- Improved flow/higher output
- Can apply higher viscosity coating
- Fast application
- No air hose, easier handling

Disadvantages

- Poor atomization
- Higher maintenance (tip and nozzle replacement)
- Risk of skin injection
- Less operator control on fluid pressure
- Can't be used to coat small objects

Air-Assisted Airless Gun

- TE: 60-70%
- Cost: $2,500-$5,000
- Fluid Pressure: 150 – 800 psi
- Air pressure: 5 -30 psi
- Cost: $3,100 - $4,750

Graco Inc.: http://www.graco.com/

Air-Assisted Airless Gun

Advantages

- Good atomization
- Varied fluid delivery
- Low bounce-back

Disadvantages

- Cost higher
- Potential for skin injection
- More operator training required
- Requires more maintenance

Electrostatic Guns

- Paint is charged at gun tip (negative), part is grounded
- TE: 20-40% (generally improves TE)
- Conventional, HVLP, airless and air-assisted airless guns
- Cost: $5,000-7,500

Electrostatic Guns

TE Influenced by:

- Voltage of spray gun
- Air velocity in booth (need lower)
- Ground efficiency of the part
- Polarity of coating
- Velocity of the coating
- Gun-to target distance
- Humidity
- Part configuration
- Racking
- Conductivity of the part

Electrostatic Guns

Advantages

- Higher TE
- Wraps around part
- Uses less materials, emits less VOCs
- Can use variety of coating(solvent, water, high solid, radiation cured)
- Uniform thickness

Disadvantages

- Safety issues (shock, fire)
- Not suitable for all substrates, part must be conductive
- May need humidity control
- Higher Maintenance costs
- Faraday cage effects (recessed areas not coated)
- Paint attracted to grounded objects (conveyors, paint booth, spray gun)

Electrostatic guns can pose some additional safety hazards.

Electrostatic Maintenance Tips

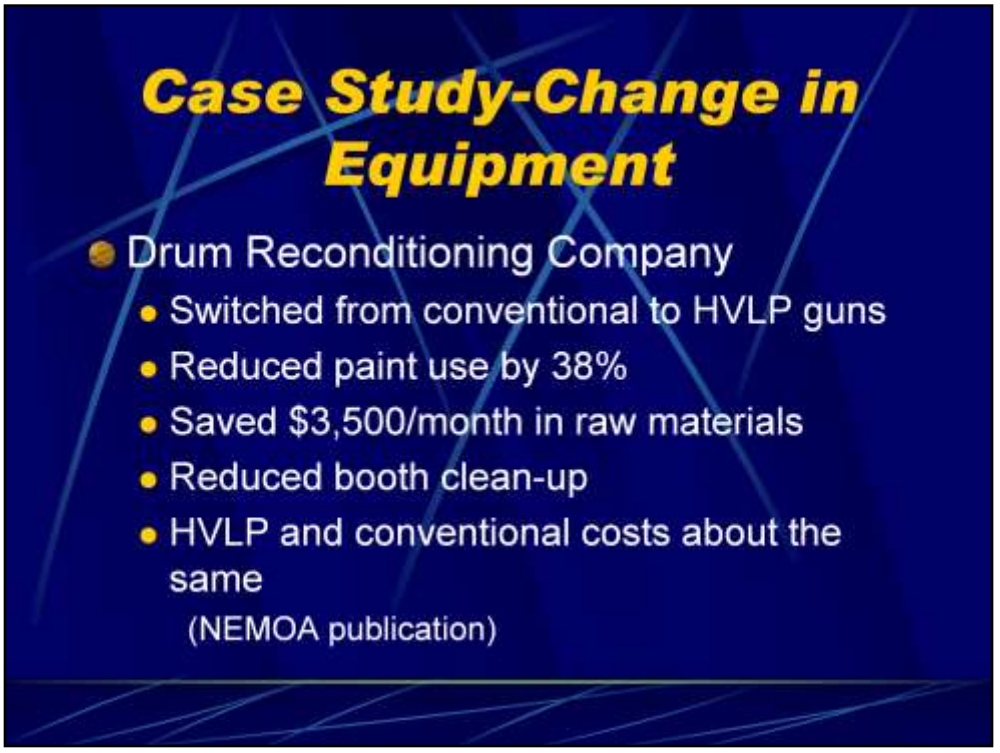
- Clean hangers
  - Thermally, chemically, media blast, mechanically
  - Clean conveyor chains/loadbars
- Tips
  - Do not coat empty racks or hooks
  - Clean hooks and racks on schedule
  - Check for proper grounding before adjusting gun settings
  - Turn down voltage to reduce the field size

When selecting your equipment you need to consider various factors.

Comparison of Spray Gun Types

Gun Type	TE Costs	Advantages	Disadvantages
Conventional	25% $500-$1,500	Higher production rates; High quality finish	Overspray (75%); high booth/filter costs; high VOC emissions
Airless Spray	40% $2,800-$4,300	Better TE; Improved Flow Can apply higher viscosity coatings	Poor atomization; tips plug; nozzle expense; skin injection; operator training; maintenance
Air-Assisted Airless	40% $3,100-$4,750	Good atomization; varied fluid delivery; low bounce back	Capital costs; skin injection; operator training; maintenance
High Volume Low Pressure (HVLP)	65% $1,300-$1,800	Sprays well in recesses; lower overspray (35%); reduced paint use; lower booth/filter costs; lower VOC emissions/wastes	Atomization poor for fine finishes; lower production rates; higher solids difficult to spray – may need heater

There are several types of spray booth filters.



Sometimes changing the type of equipment like a spray gun you use, can save you money.

HVLP Cost Calculator

- The Iowa Waste Reduction Center (IWRC) has developed a HVLP cost calculator. If you use a conventional spray gun, you can input the number of gallons of paint you use and the cost per gallon and the calculator will calculate the amount of money you will save by switching to an HVLP gun. The HVLP calculator is on-line at : http://www.iwrc.org/programs/hvlp.cfm

Case Study-Ethan Allen, NC

Cardboard filters replaced with metal, now cleaned in a solvent tank

- Metal filters with lacquer and sealer brushed off and dust sent for recycling, then cleaned in solvent tank
- Waste solvent /coating mix distilled
- Cost: $57,000
- Waste reduction: 10,000 lbs/year
- Savings: $48,125

(NEWMOA)

Case Study-Equipment selection-Crenlo, MN, coat aluminum and steel products

- Nozzle change in gun
  - Cleaned straining equipment with solvent with 0.172 inch diameter orifice (4.3 gpm flow, 30 psi. Produced 14,000 gallons of waste ($16,000 disposal cost)
  - Solvent is a recycled blend, distilled offsite.
  - Switched to 0.026 inch nozzle cleaned in 60-90 sec at 30 psi. Presoaked to loosen paint.
  - $120 capital investment (3 nozzles and in-line filter), 6 hours of labor. Total cost $270.
  - Reduced solvent waste by 11,000 gallons per year, saving $13,500 (reduced solvent use 80%)

(NEWMOA)

This photo shows you how nozzle size can vary.

Accessories - Hooks and Hangers

- Often “afterthought” when designing a line
- Requirements:
  - Ability to suspend part(s) to be painted
  - Allow easy loading/unloading
  - Minimal interference with coating application
  - Provide proper “ground” for electrostatic applications
  - Withstand cure-oven temperature

Benefits of a good hanger design

- Increase line density
- Better TE
- Improved ergonomics
- Reduced cleaning costs

- Design Options: wire/rod hooks-C,J and S, round, square, Certified load rates, chains, multi-racks, detachable adjustable systems, dedicated and masking fixtures, baskets

Applying booth coatings can make cleaning overspray much easier. These coatings allow you to “peel” off the overspray to clean the booth.

Covering the gun with disposable covers can also make clean-up much easier.

Liners for pots are available to make clean-up easier.

Cup liners are also available.

Paint Heating Advantages

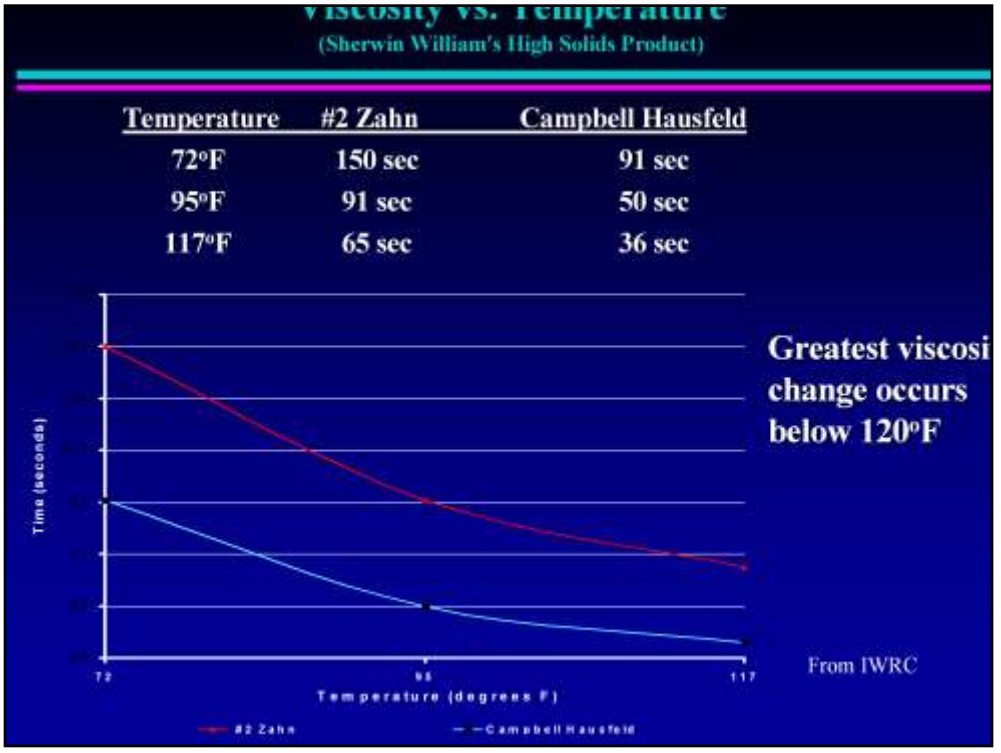
- Paint heaters may be used to reduce viscosity without adding solvent
- Maintain paint at constant temperature
- Allow spraying at lower fluid pressures
  - Lower pressure=better TE and reduced equipment wear
  - Improves atomization=better finish quality
  - Faster flash-off times between coats
  - A higher rate of film build is possible because material contains more solids and less solvent
    - Can achieve desired film build in fewer passes=increased productivity

Paint Heaters

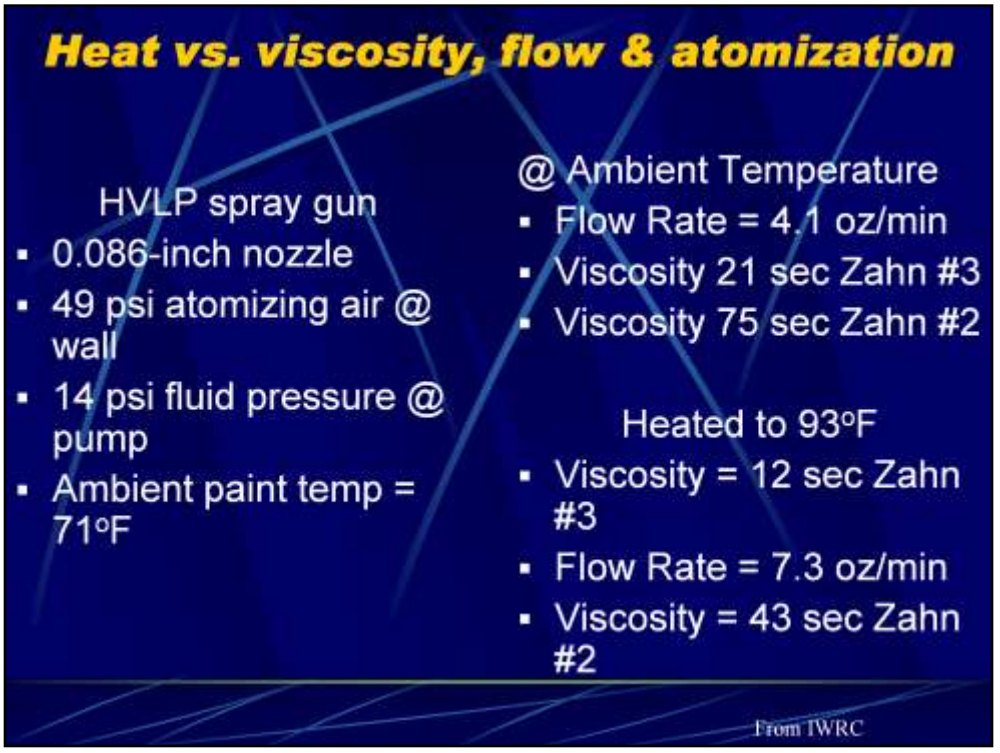
Decrease viscosity for steady flow rate, reduced operating pressures and less overspray reducing waste and booth maintenance. Fluid temp range of 85-220 F. The SS resists corrosion any coating, sealant, adhesive and lubricant

Graco website
http://www.graco.com/

Wall mount paint heater



This diagram shows the relationship of temperature and viscosity.



Here are some examples that illustrate how heating can decrease the viscosity and increase the flow rate without adding thinner.

A zahn cup like this can help you measure viscosity.

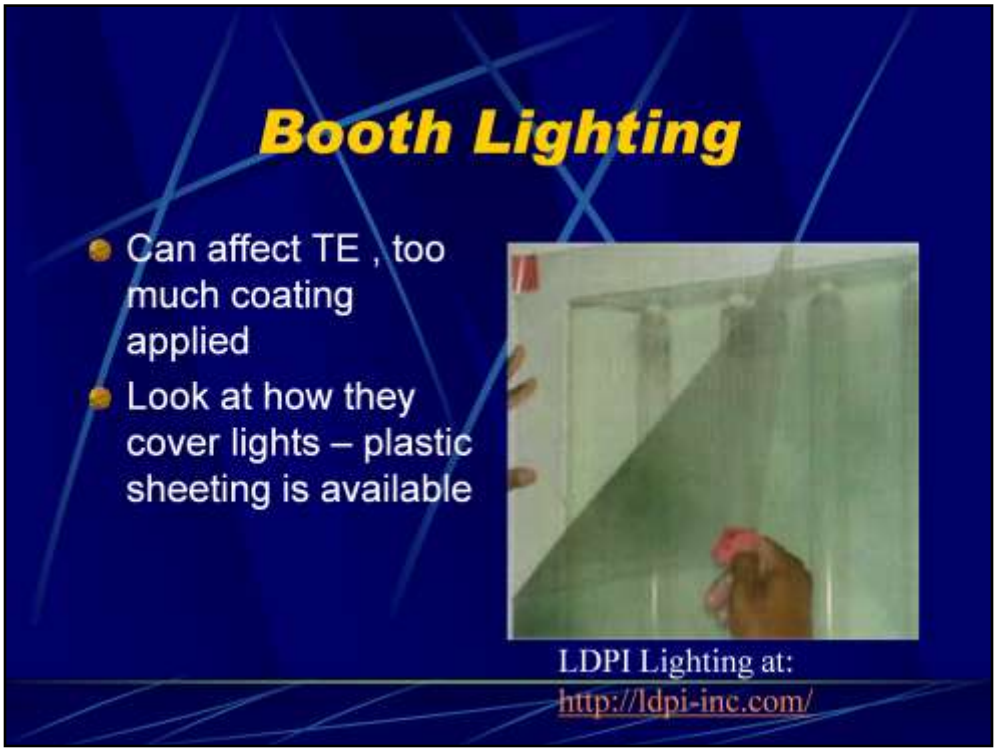
Here is a tool that can help operators achieve higher transfer efficiency. It is a laser that attaches to the gun and helps the operator stay the ideal distance from the target to maximize efficiency.

Laser Touch® Case Study

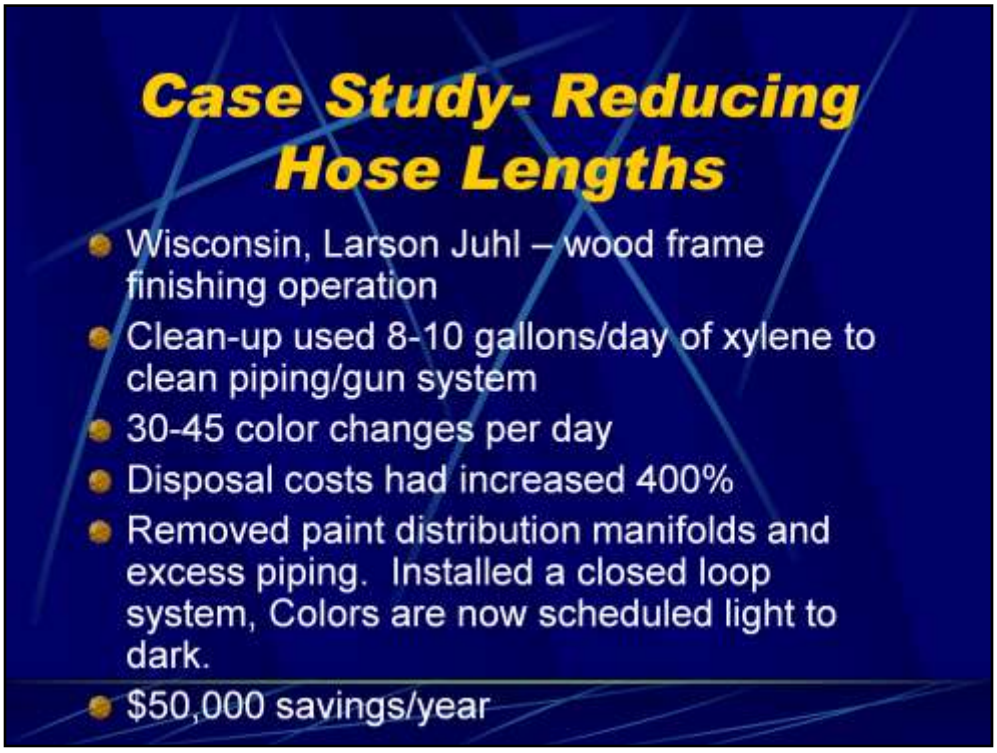
- Friesen, Iowa, paint silos
- Coat 10-15 silos per day on rotating axis, takes 2 painters 2 hours to coat one silo
  - Target mil thickness 3-4.5 mils
  - Prior to LT 3-8 mil range
  - After LT measured 3-4 mils
  - Now save 10-16 gallons paint per day
  - Better finish, with perfect overlap, more showroom appeal
    - (IWRC)

Can crushers can help you reduce the solid waste volume you generate.

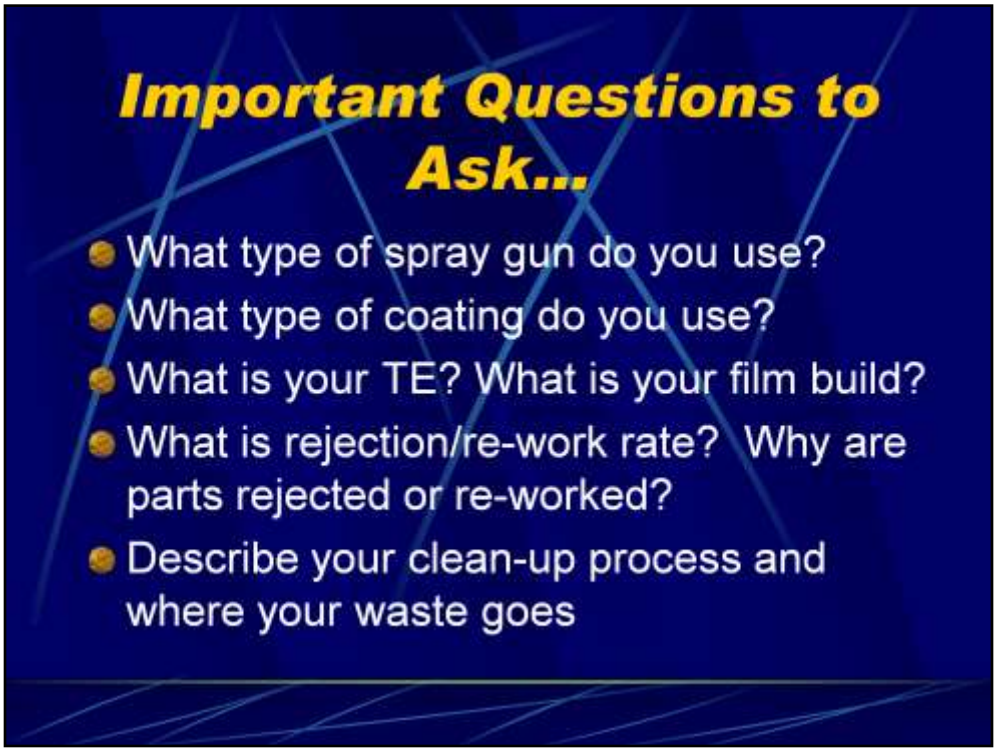
Mixing valves are another accessory that can help you minimize waste.



Covering the lighting in the paint booth with plastic sheeting can help make clean-up easier (it just peels off). It can help improve TE because the painter can see better and only apply the paint necessary.



Simple measures like reducing the hose lengths in a painting operation can save money.



When looking for P2 opportunities, here are some questions to ask and think about.

Important Questions/Observations

- Manual Spray Guns
  - Observe configuration of part, are they large, small, flat?
  - Observe how they are racked
  - Ask how many coats are applied
  - Ask what their production rate is in gallons/day or hour, square foot covered etc
  - What type of operator training program do you have?

Important Questions/Observations

- Robotic Guns
  - Observe gun triggering
  - Observe how closely spaced parts are
  - Observe racking of parts
  - Observe if they mask parts of guns/equipment
  - Ask how often clean booths
  - Ask how much overspray is generated
  - How are color changes handled?
  - Look to see if they mask any gun parts

Miscellaneous P2

- Evaluate reusable paint booth filters (plastic, metal)
- Schedule paint jobs from light to dark (less cleaning)
- Evaluate laundry service to clean and reuse wipers
- Size wiper for the job
- Develop inventory control system for purchasing coatings
- Filter spent solvent or settle out solids to reuse
- Evaluate alternative solvents
- Scrape paint cups or tanks before rinsing with solvent

Equipment cleaning is one area where solvent use can be reduced.

Cleaning Tips To Reduce Amount of Solvent Used

- Scrape paint cups or tanks before rinsing with solvent
- Schedule jobs from light to dark colors to minimize amount of solvent used
- Use 2 stage cleaning with solvent, using on fresh solvent for final rinse

Solvent Saver ™

Solvent Saver™

Saves solvent (up to 86%), and reduces VOCs. Operates with compressed air, is atomized blast of solvent traveling through spray guns, and hoses, can vary air/solvent mix.

http://www.devilbiss.com/

Clean-up Process P2
Purchase a Gun Washer

- Reduce VOC emissions 75-90%
- Reduce solvent consumption 50-75%
- Reduce labor from 5-20 minutes to 30-60 seconds (up to 60% labor reduction)
- Worker exposure reduced
- Less hazardous waste generated
- Cost - $800 and up

What is a gun washer?

- Similar to a dishwasher
- Can wash from one to four guns at a time, reusing the solvent over and over. Some units even have a built-in distillation unit that provides continuous clean solvent.

- The Iowa Waste Reduction Center (IWRC) has an on-line cost calculator that can assist businesses in determining the cost benefit of purchasing gun washing equipment at: http://www.iwrc.org/programs/gunwash.

Paint Gun Washers

Source: Technical Innovations

Source: Graco

Photo of inside of a gun washer.

Case Study

- Gun Washer Purchase, Electronic Manufacturer TX
- Used to soak guns to clean them
  - Purchased gun washer for $700
  - Cost recovered in 6-8 months due to reduced solvent costs and improved gun performance (not clogged)
    - (NEMOA)

Clean-up Process P2

Purchase a Solvent Distillation Unit

- Recovers 85-90% of solvent for reuse
- Remaining sludge (still bottoms) must be collected and disposed of properly
- Available in sizes from 5 to more than 500 gallons per hour
- May change composition slightly; may not be suitable for all reuse applications (thinning)
- Cost - $1,500 and up (average $3,000)

Solvent Distillation Units

Source: CBG

Source: SideWinder

Case Study

- Solvent Distillation Unit Purchased
  - Reclaim thinners from paint –related wastes
  - Reduced drums of thinner disposed of from 34 to 3 drums per year (disposal costs of $6,200 to $1,400/year)
  - Now purchase 2,000 gallons of thinner versus 4,000 gallons of thinner per year (purchase cost of $9,500 to $4,750/year)
  - 2.2 year payback with labor included (Annual savings $4,500, additional labor $5,000, distillation unit $10,000)
    - (NEWMOA)

Solvent Distillation Calculator

- The IWRC also has an on-line cost calculator to help businesses determine the cost benefit of purchasing a solvent distillation unit at: http://www.iwrc.org/programs/solvent.cfm

Consider using alternative solvents

- Dibasic esters (DBE), N-methyl-2-pyrrolidone (NMP), other alkaline-, citric-, and water-based solvents such as d-limonene, naptha, and terpenes, bio-solvents (soy based)
- These reduce VOCs due to lower evaporation rate

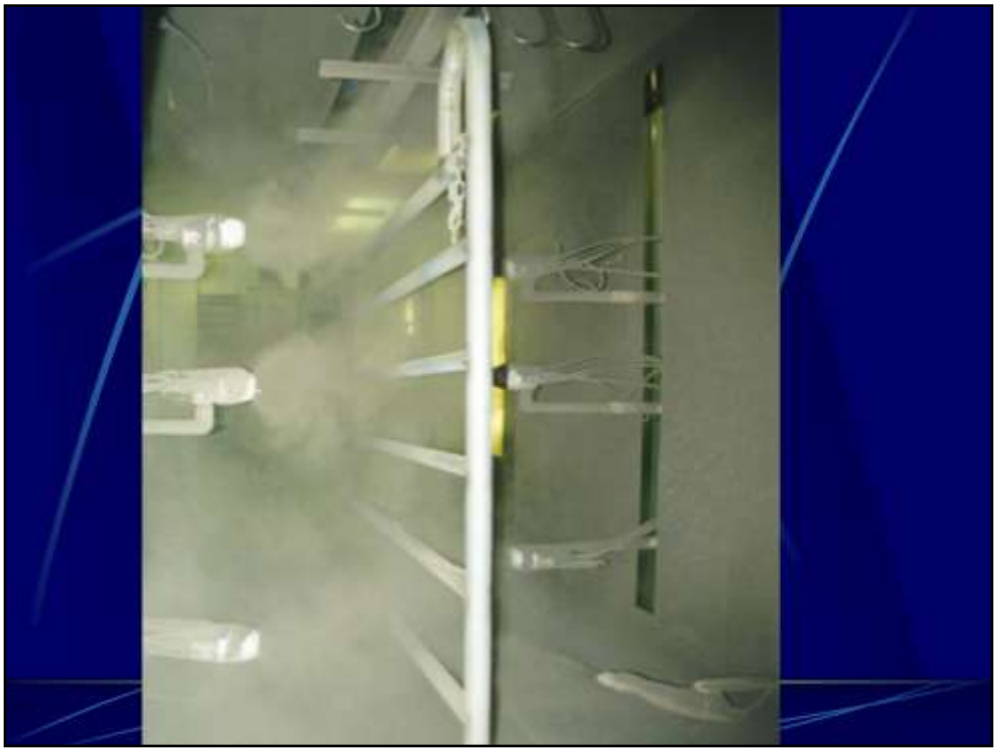
Case Study- Tiz's Door sales, Everett, WA, manufacture exterior doors and frames, window, base moldings and stained railings

- Purchased HVLP guns, installed automated flat line spray equipment, switched from toluene-based coatings to less hazardous coating, used heat instead of solvents for thinning, use dedicated pumps and lines for each type of coating, block gun nozzles and blow air back through guns and delivery system for clean-up
- Reduced coating use by 50%, saved $180,000 in material costs alone, not including labor costs, waste disposal costs

(Kansas, SBEAP)

Do you see any P2 opportunities here? The ergonomics of the painter are not ideal, adjusting the height of the line to make it easier on the painter could improve TE.

This nozzle type is probably not ideal, a narrower slot oriented nozzle might work better.



The nozzle selection here is probably not ideal.

Wisconsin Case Study by IWRC

Issue:

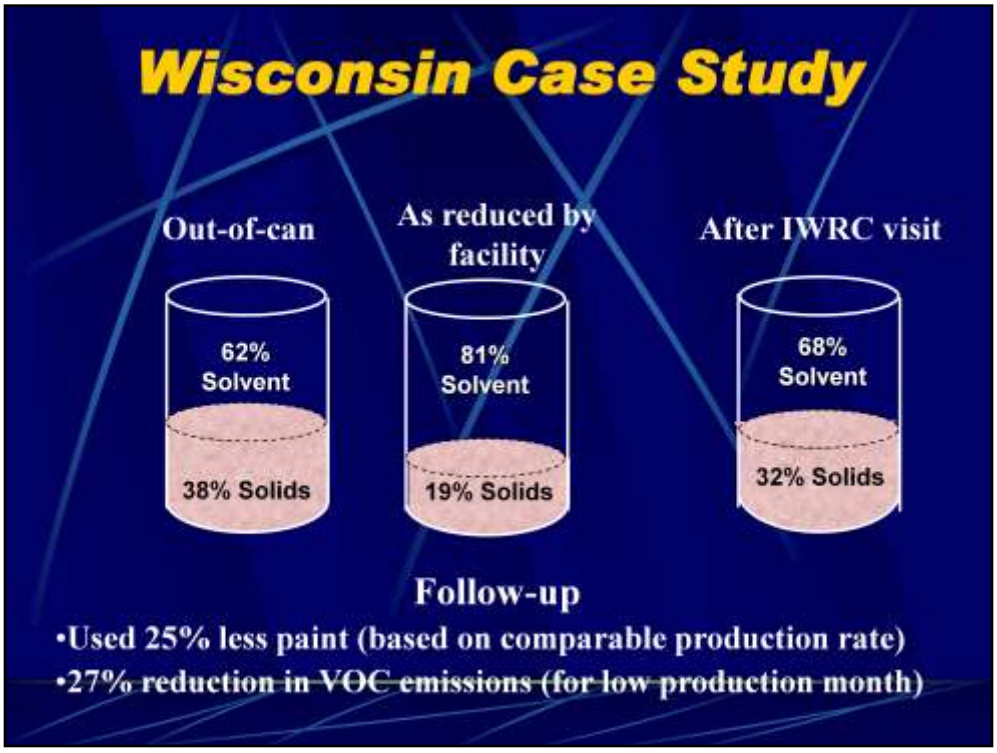
Company had switched from conventional to HVLP and were now using more material to coat the same amount of parts

IWRC Wisconsin Case Study

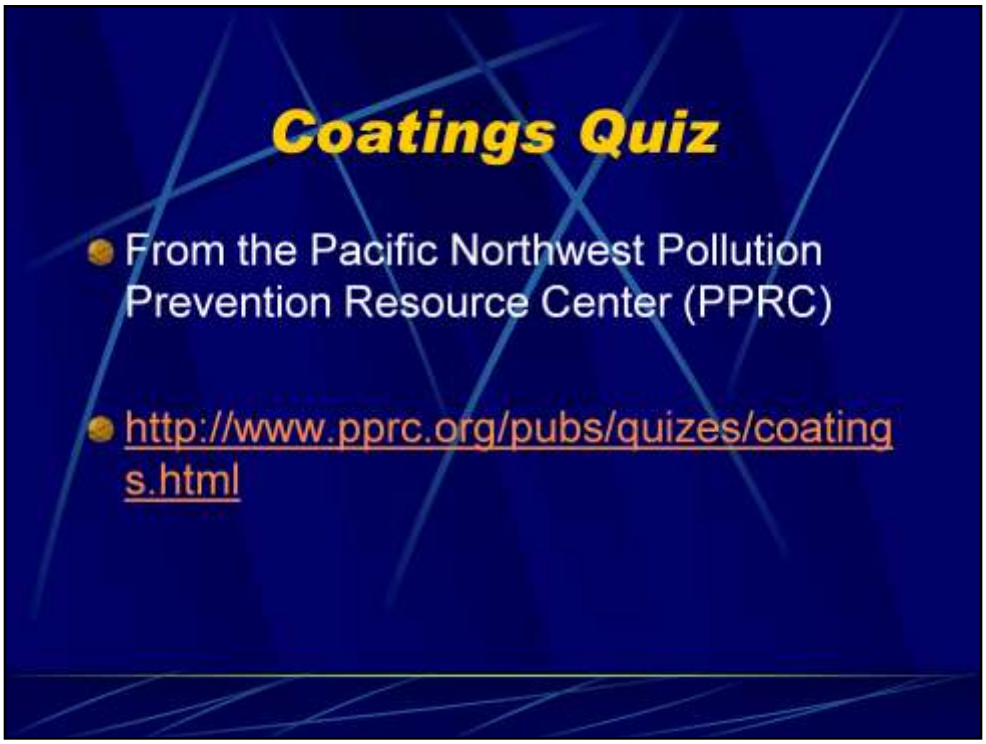
- Facility was reducing coating more than the manufacturer recommended

(1part solvent to 1 part paint, 38% to 19% solids, 23 sec viscosity)

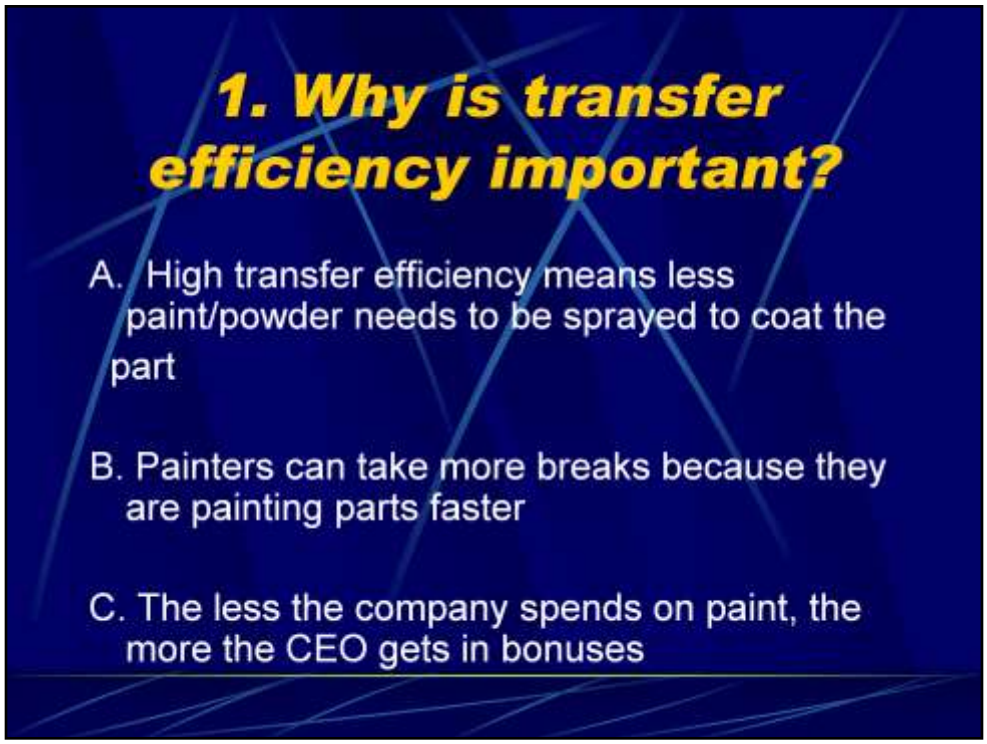
- IWRC recommended reducing coating to manufacturer specs (32% solids, 43 sec viscosity)
- IWRC recommended changing tips on gun (larger)
- Operator training for proper triggering and overlap



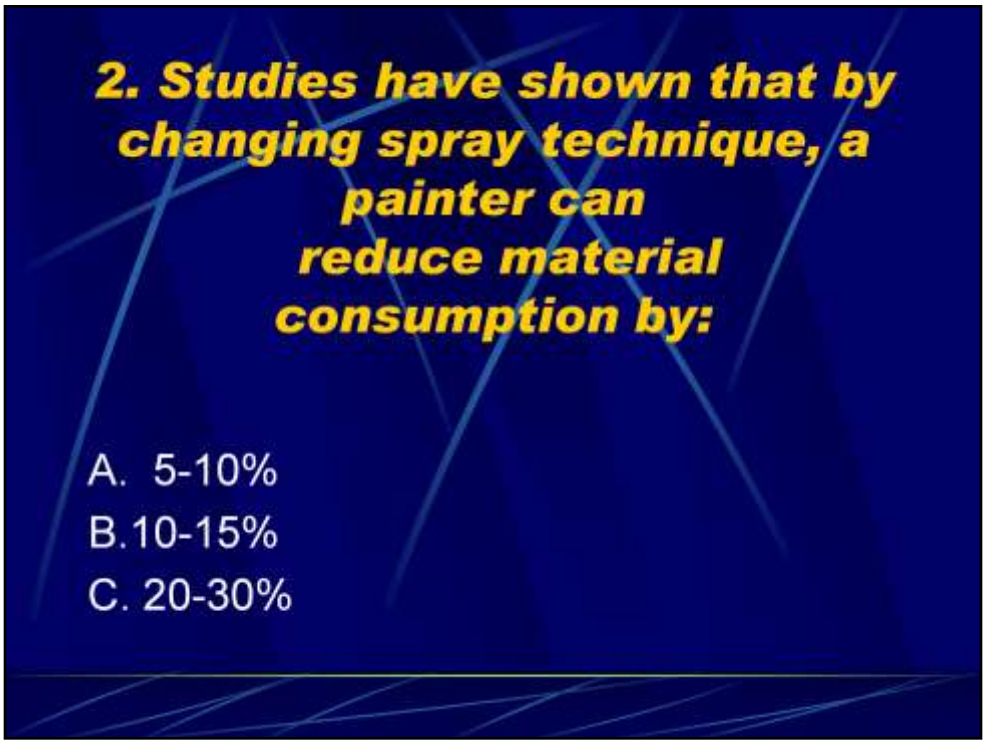
After IWRC evaluated the process and the company made the recommended changes, the company was able to reduce their paint used.



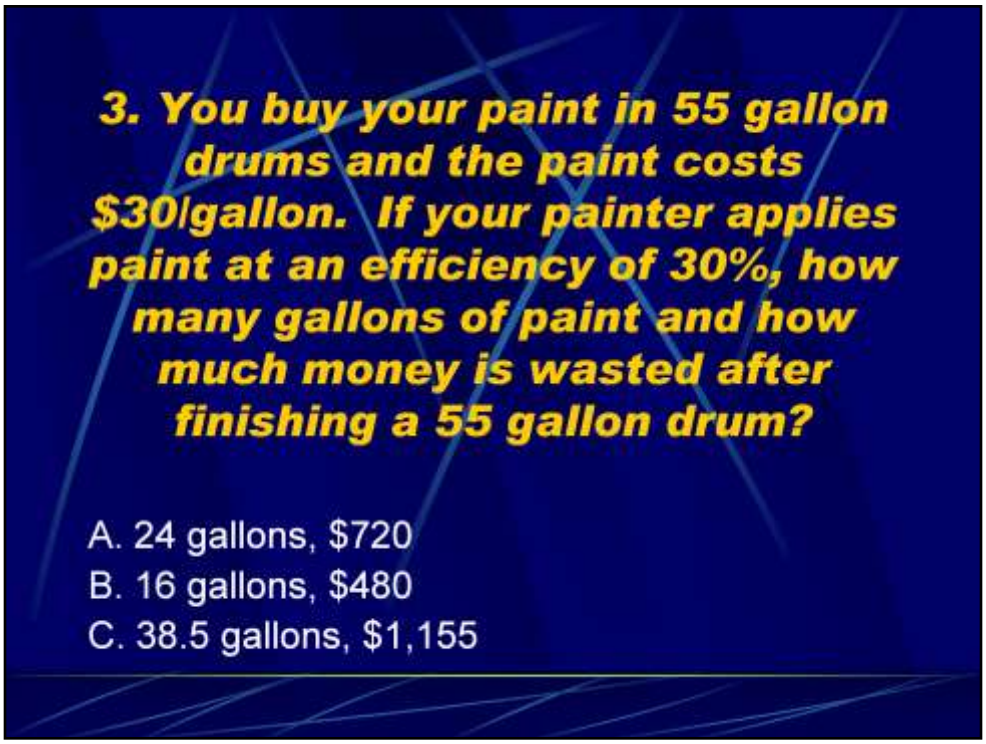
This quiz is quick review of many of the concepts that were covered in this training.



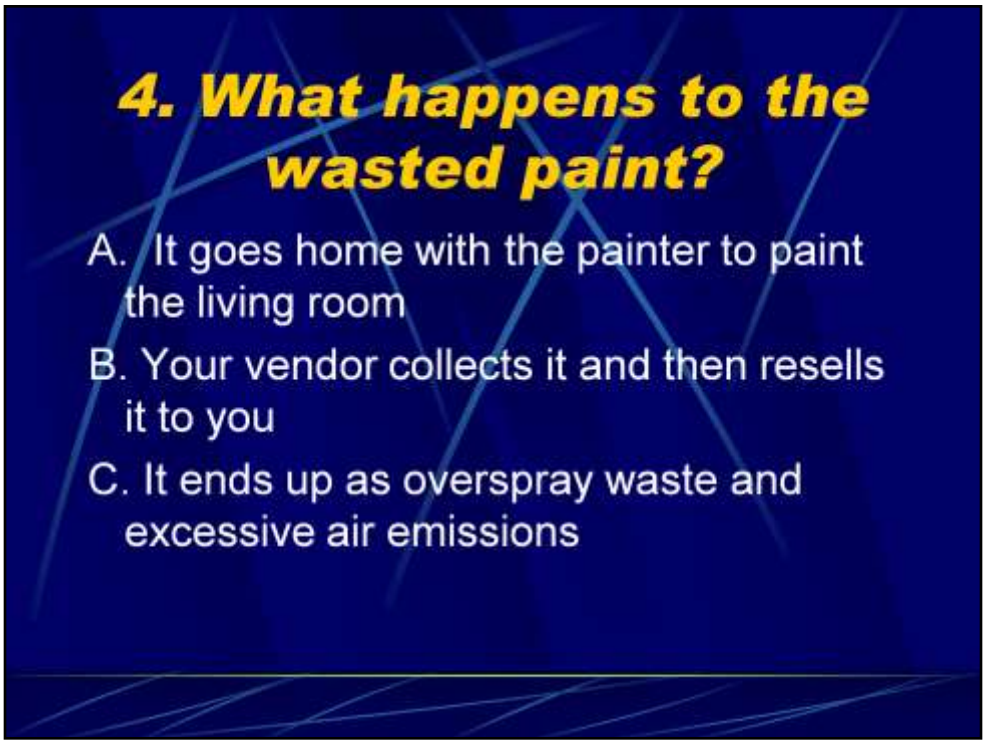
The correct answer is that high transfer efficiency means less paint/powder needs to be sprayed to coat the part. Higher transfer efficiency results in tremendous cost savings due to less inventory management, less material consumption, permit/compliance avoidance and actual reduction in production costs per part.



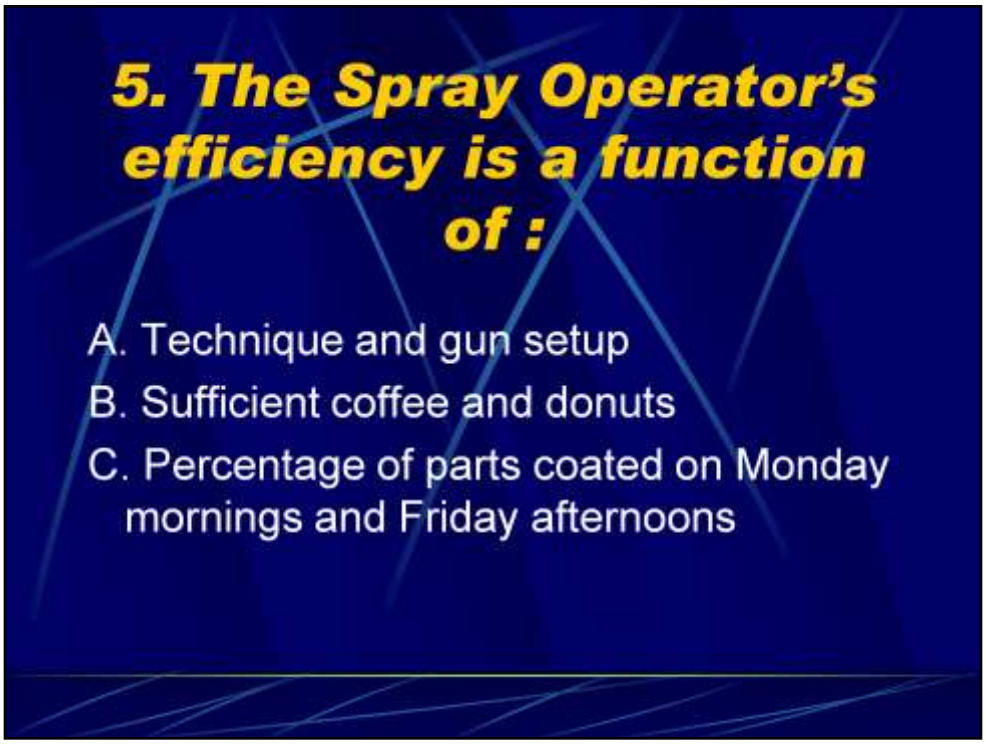
The answer is 20-30%. The Iowa Waste Reduction Center has been training spray operators through its Spray Technique Analysis and Research (STAR) training program. The average improvement of STAR trainees was approximately $4,196 in yearly material savings, 25% increase in transfer efficiency, 29% decrease in material cost, 31% decrease in pounds of VOCs/year.



A 55 gallon drum of paint at $30/gallon costs $1,650. If a painter was applying paint at 30% efficiency then only 16.5 gallons (55 gallons x .30) are being used. So, 38.5 gallons are being wasted at a cost of $1,155 (38.5 gallons x $30/gallon).

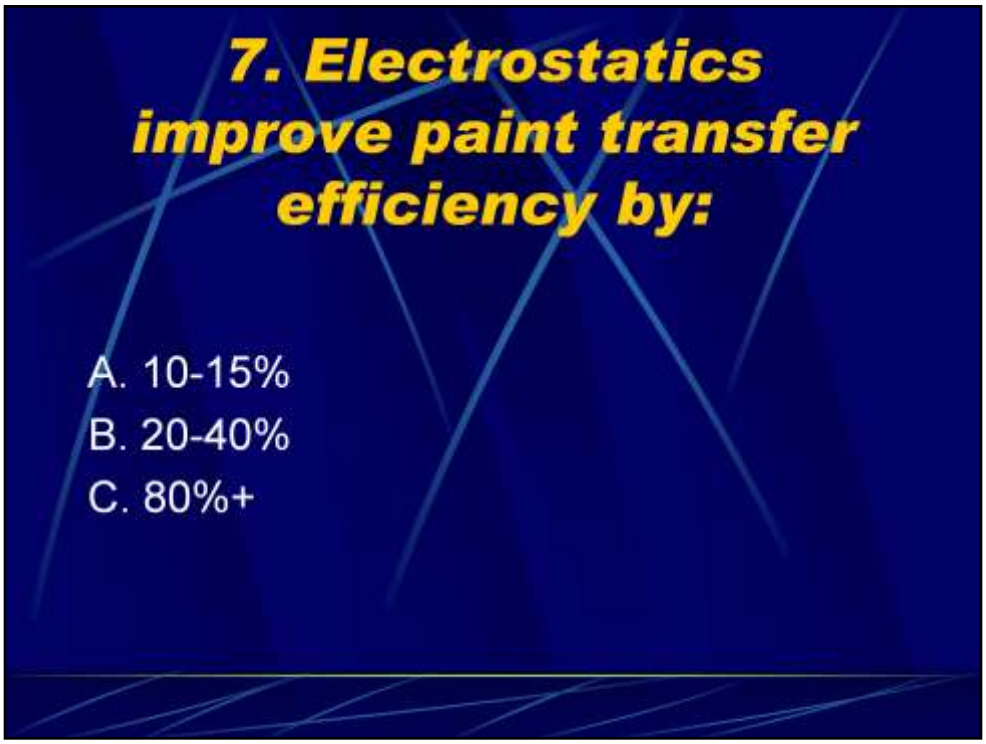


The wasted paint is in the form of overspray and air emissions. Overspray most often has to be collected and disposed of as a hazardous waste. Air emissions contribute to poor indoor air quality. Volatile emissions contribute to smog formation outdoors.

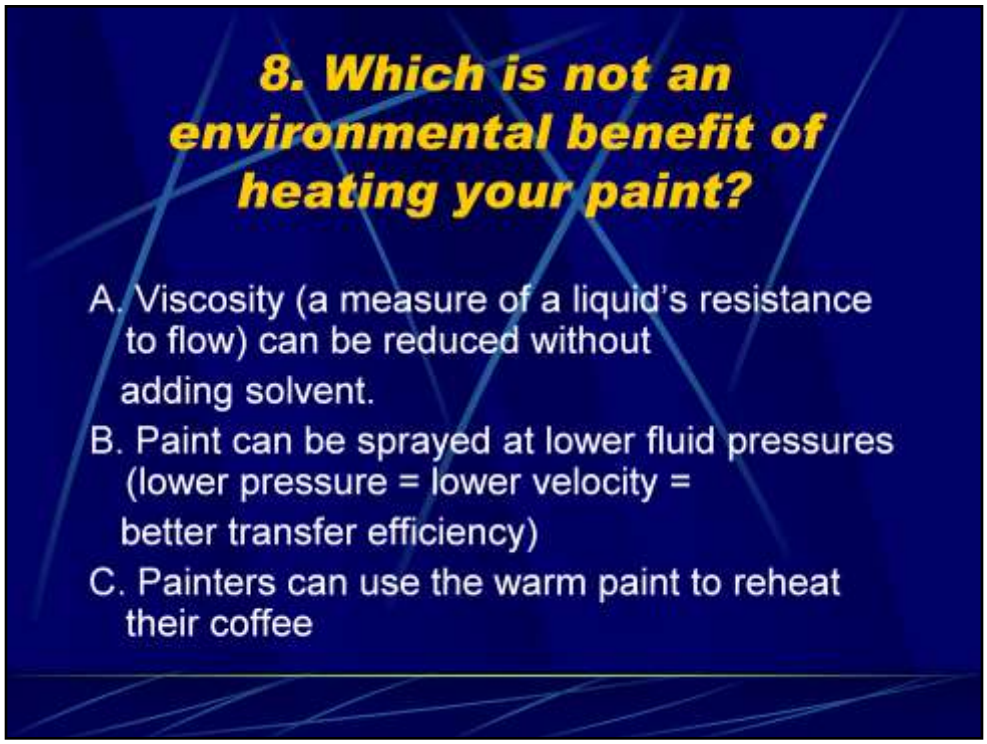


The spray operator is the most important variable in obtaining good transfer and build efficiencies. Operator efficiency is a function of technique and gun setup. To achieve the best technique and gun setup consider: Gun-to-target distance (this can be 4 - 14 inches depending on the type of spray equipment), gun position/orientation, gun speed, overlap, targeting; and plan of attack (know the geometry of the part and the most effective sequence for applying paint).

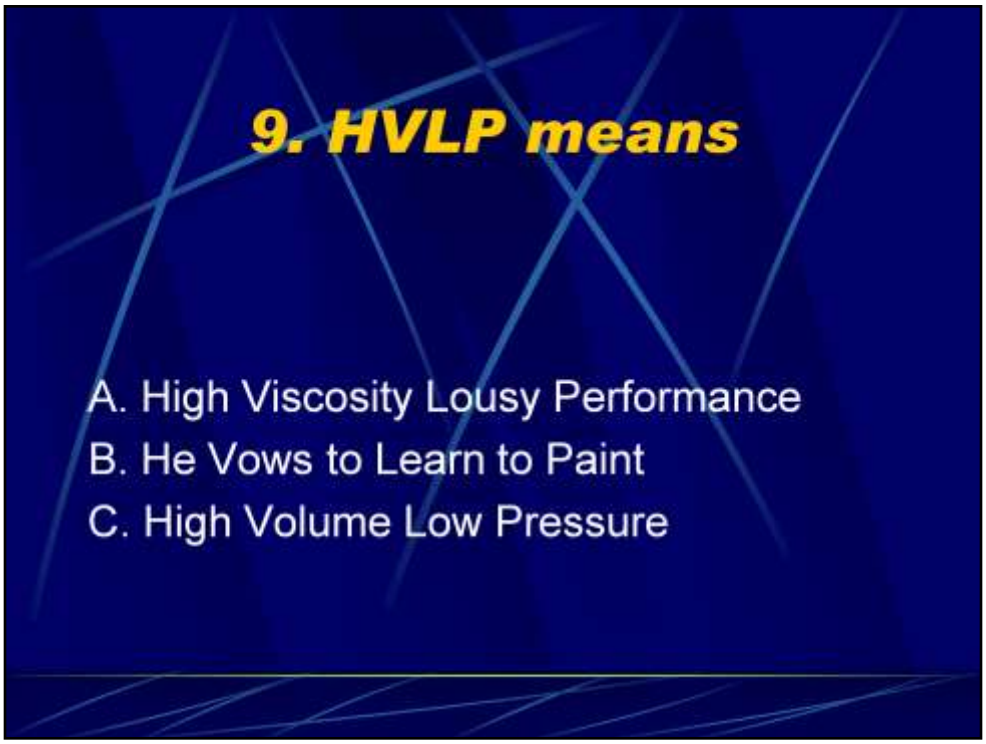
B is correct. Since the paint/powder particles are charged, an electrostatic attraction causes the paint/powder to wrap on the back side of the targeted part. This effect is called Electrostatic Wrap.



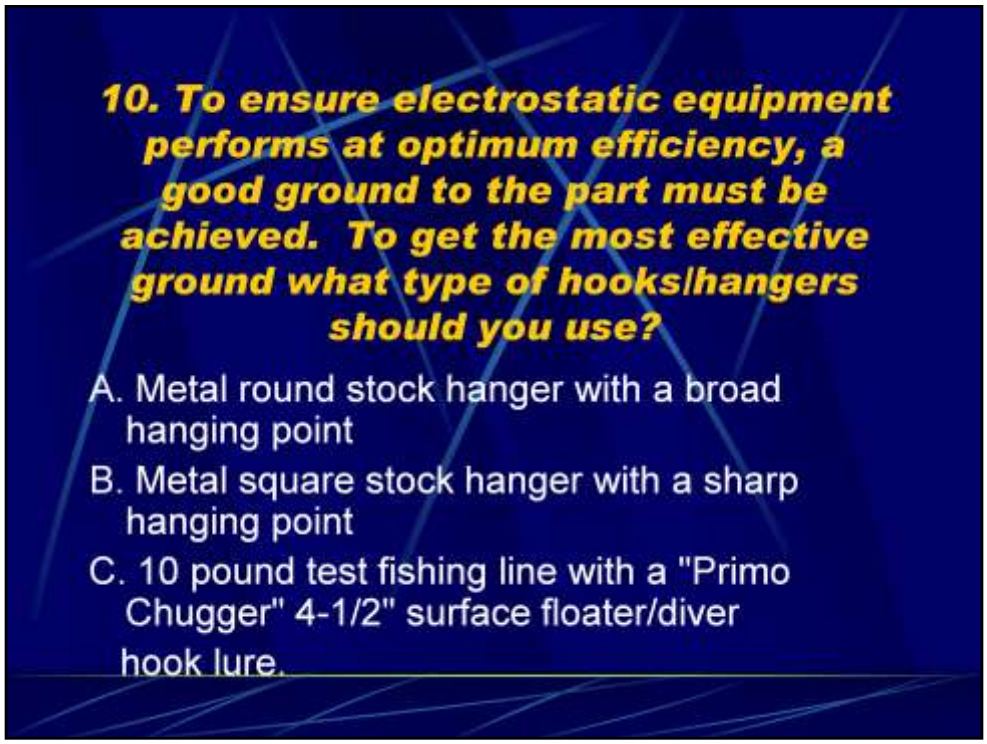
The Electrostatic Wrap effect, described in the answer to question #6, usually accounts for the 20-40% improvement in transfer efficiency.



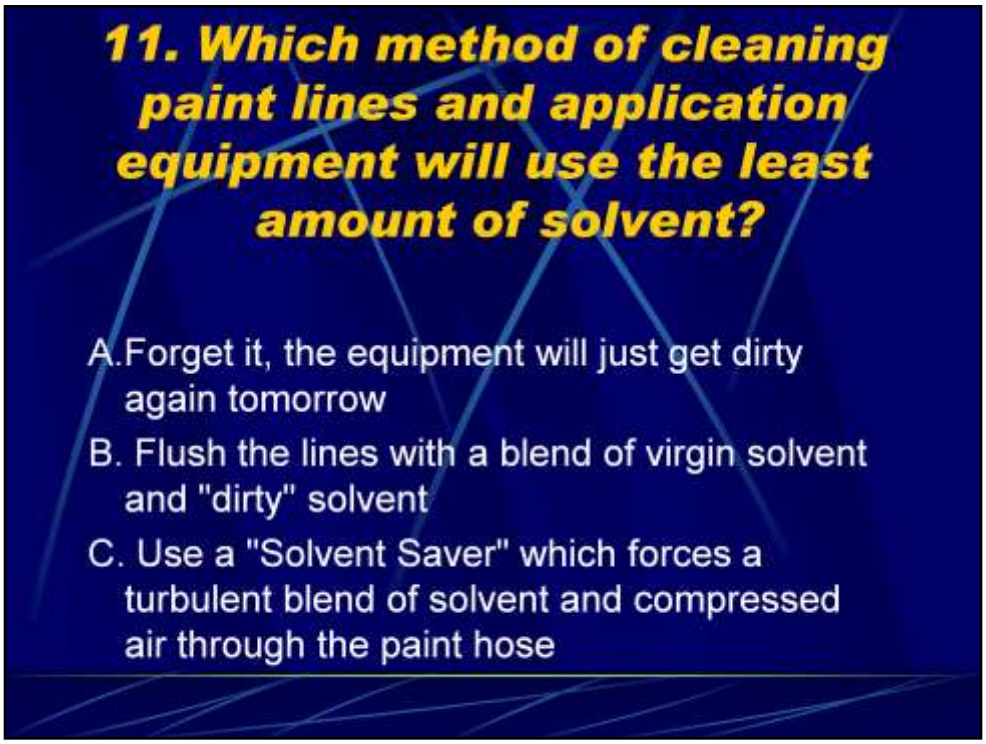
While some painters may be drinking questionable coffee, the advantages of heating your paint application system are: reduced viscosity, lower fluid pressure delivery, and more efficient film build.



The last answer is correct. HVLP guns use a high volume of compressed air at low pressure to atomize the paint. The advantages of HVLP spray application systems are: better transfer efficiency, less overspray/turbulence because of lower air pressure, increased productivity due to greater film build per pass, operator control of the equipment is easier, and reduced material consumption.

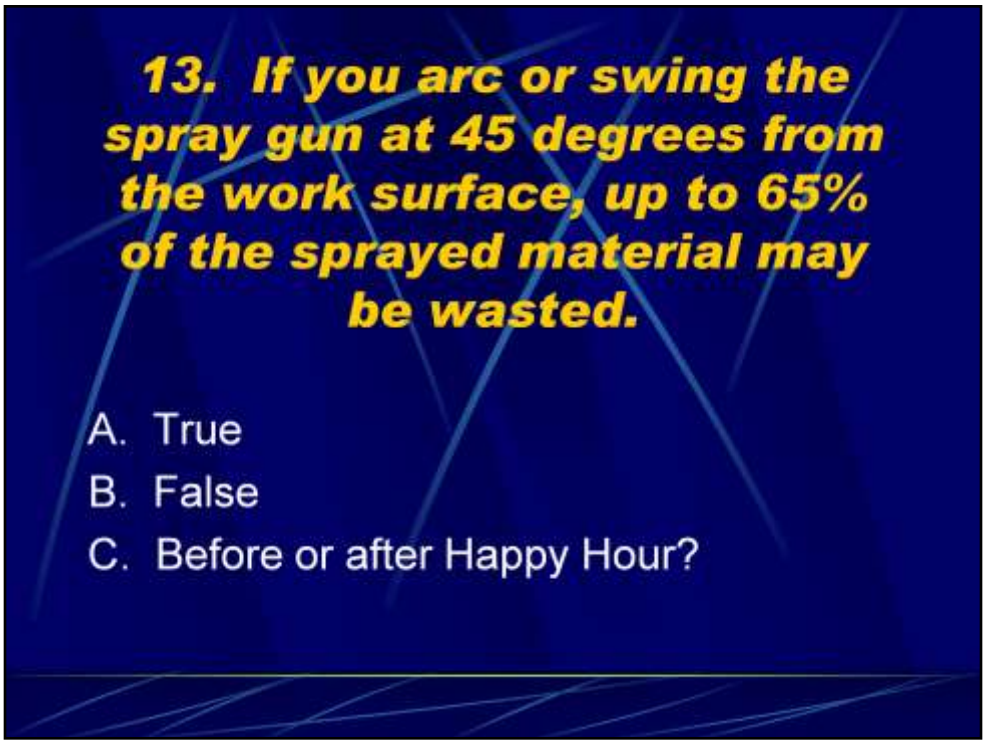


Using hooks constructed from metal square stock provides corners that bite into the part being hung, achieving good metal-to-metal contact. These hooks are less susceptible to grounding failure and require less frequent cleaning. Paint hooks constructed from metal rod don't provide much bite especially when parts are hung at points with rounded edges. So, it may take very little paint between the hook and the part to interrupt continuity to ground.

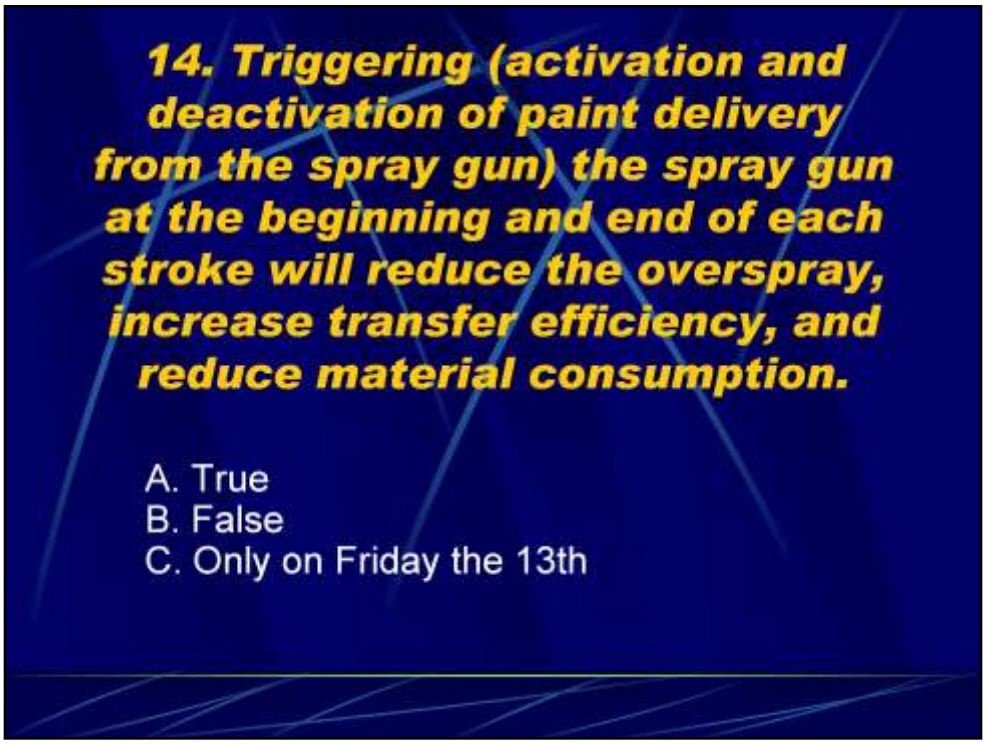


A Solvent Saver uses less solvent. The use of compressed air forces a turbulent blend of solvent and air through the hose which results in a mechanical/chemical cleaning. These Solvent Savers have been known to use approximately 50% less solvent to clean a fluid delivery line.

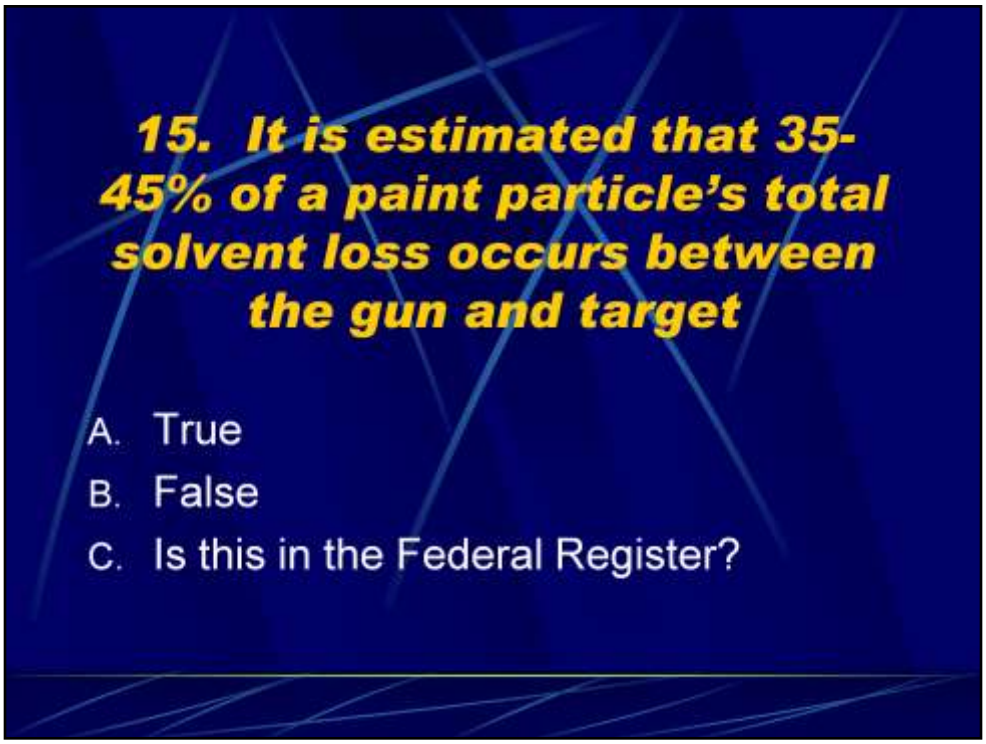
Spray technicians are often expected to coat parts that are difficult to see because of inadequate lighting and poor booth maintenance. The most common result is the technician applies more coating than necessary to cover the part, or parts have to be reworked because there is inadequate coverage. Enhancing the lighting by replacing fluorescent bulbs (recommended two times per year), installing spray booth lighting inserts, spraying a clear liquid masking over the lights, and painting inside of the booth with a white strippable booth coating (improves brightness of work area) will improve visibility.



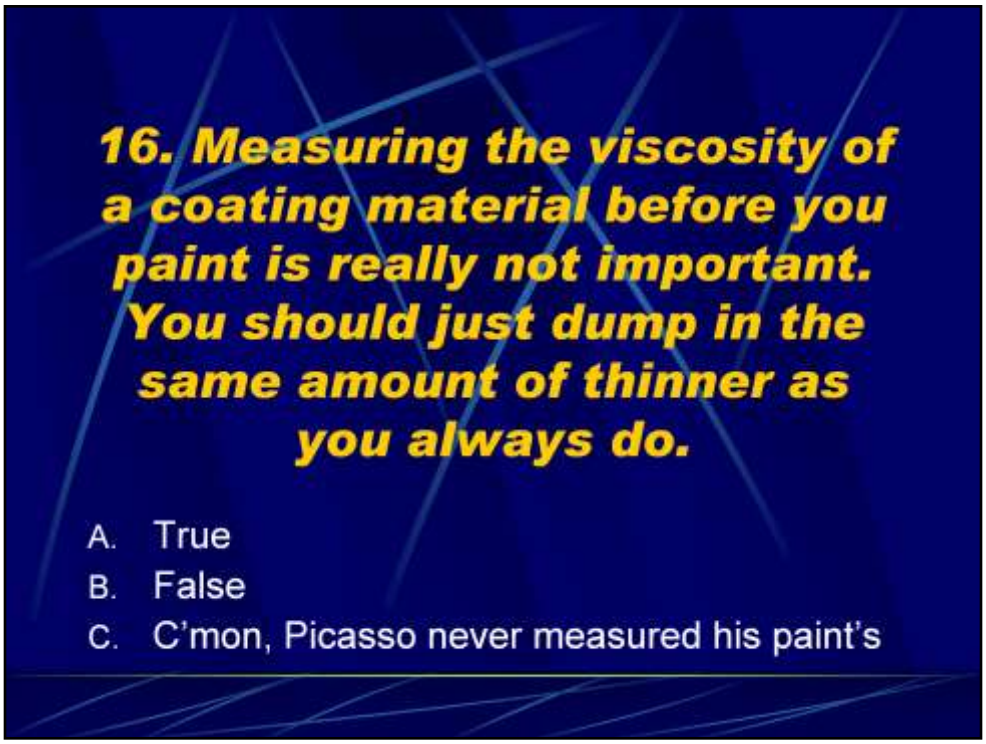
The answer is TRUE.



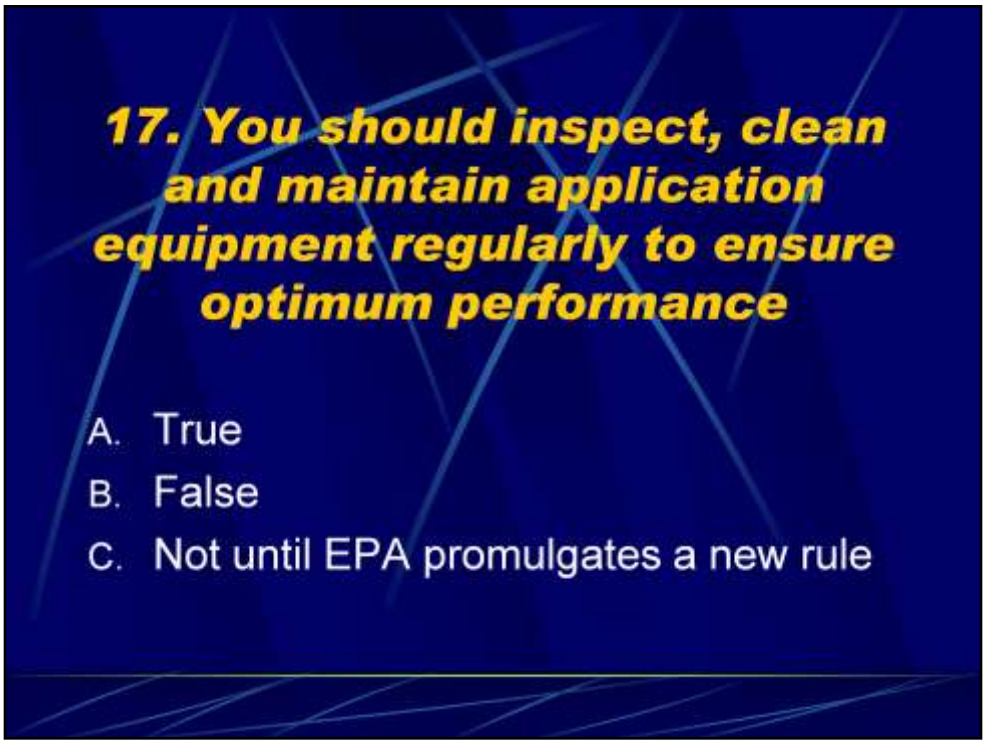
The answer is TRUE.



The answer is TRUE.



The answer is FALSE.



The answer is TRUE.