ENNIS-FLINT
A Traffic Safety Solutions Company

Traffic Paint GuideBook

WATERBORNE

March 2014

EF series Training
An Investment in Know-how

Optimizing Product Performance and Applicator Knowledge for Striping and Pavement Marking Programs

Contents:

Ennis-Flint Waterborne Traffic Paints

Ennis-Flint's EF Series waterborne traffic paint is environmentally friendly, durable and formulated for use in a wide-range of applications. For streets and highways, rural roads, parking lots, and airfields, EF Series waterborne paint can be applied from temperatures as low as 35°F to as high as 120°F. The waterborne paint is suitable for applications on both bituminous and concrete roadways and can be sprayed with either airless or conventional spray equipment.

Standard Dry Waterborne Traffic Paint

- Low VOC formula with excellent atomization and application characteristics
- Dries to a durable, abrasion resistant finish within 30 minutes

Fast Dry Waterborne Traffic Paint

- Proven low VOC waterborne acrylic durability
- Minimizes traffic control when restriping, dries to no track in under 2 minutes @ 15 wet mils with glass beads applied 77° F and humidity below 75%

High Build Waterborne Traffic Paint

- Increased durability through greater (30 mil) film build
- Flexible paint film to withstand road expansion/contraction
- Greater retroreflectivity with the ability to use larger beads
- In the field, no track in under 3 minutes (77F / 25C and low humidity)

Durasheen Waterborne Traffic Paint

- Higher gloss than standard or fast dry waterborne
- Specifically for use where dirt buildup is an issue
- Excellent atomization and application characteristics - performs equally well on asphalt or concrete surfaces
- Commonly used for curbs and parking lots

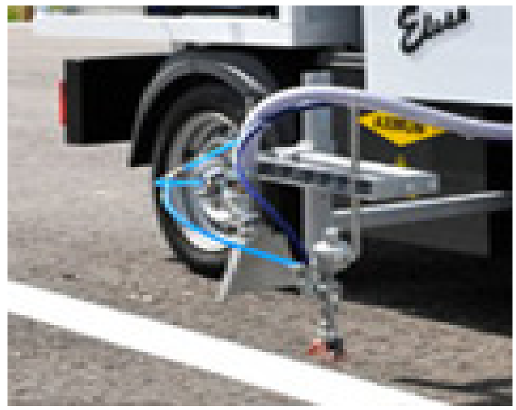
Extended Season Waterborne Traffic Paint (aka Wolverine)

- Developed for use from early Spring until late Fall, no switching to solvent systems in cold climates
- Designed to cure in temperatures as low as 35°F
- In the field, no track in less than 10 minutes at temperatures 37°F (3°C) and rising

Equipment

■ Airless:

The two most common types of equipment used to install traffic paint are Airless and Air Atomized. In airless paint equipment, the traffic paint is drawn from a pressurized paint tank, tote or bucket into a high pressure pump which delivers the paint through a filter to the paint gun. The paint is pushed through a small tip in the paint gun at high pressure usually ranging from 1500-3000 psi. The finished product is a crisp-edged, clean looking line. Always use extreme caution when working with airless paint systems, since the paint coming out of the gun is under high pressure and can cause serious injuries.



■ Air Atomized:

The air atomized paint system uses air pressure to push paint from a pressurized tank to the paint gun. Air is blown into the paint as it exits the tip causing it to atomize and fan out, giving the desired spray pattern. The edges of the paint appear less defined than the airless paint system. Care must be taken when loading paint into this system to prevent air from entering the system. After filling the tanks, fill the plumbing with paint to void air or rinse water. Always agitate the paint before loading or with the agitators in the paint tank. If loading less than a full tote or drum, always agitate or circulate prior to loading.

IMPORTANT NOTE: Galvanized, brass, copper, aluminum, and mild steel will react with waterborne traffic paints. Contact with these metals will cause the paint to react to a hardened state. All plumbing, valves, heat exchangers, and tanks should be stainless steel. PVC plastic may be used where the contents are not under pressure. Teflon-lined hoses work best. Be sure that fittings, reducers, and strainers are stainless if they come in contact with the paint. Use stainless steel fluid tips and fan caps.

Paint Tips

■ Airless:

The airless paint system uses a reversible paint tip that can be turned 180 degrees to extract an obstruction without disassembling the paint gun. Choosing the paint tip is critical in a good paint application. Consult with a paint distributor for information specific to their product selections. An example of a reversible paint tip is the Graco Switch Tip. The following information about paint tips can be found on Graco's website:

- The Graco road striping tips are yellow in color and have a three digit number stamped on it.

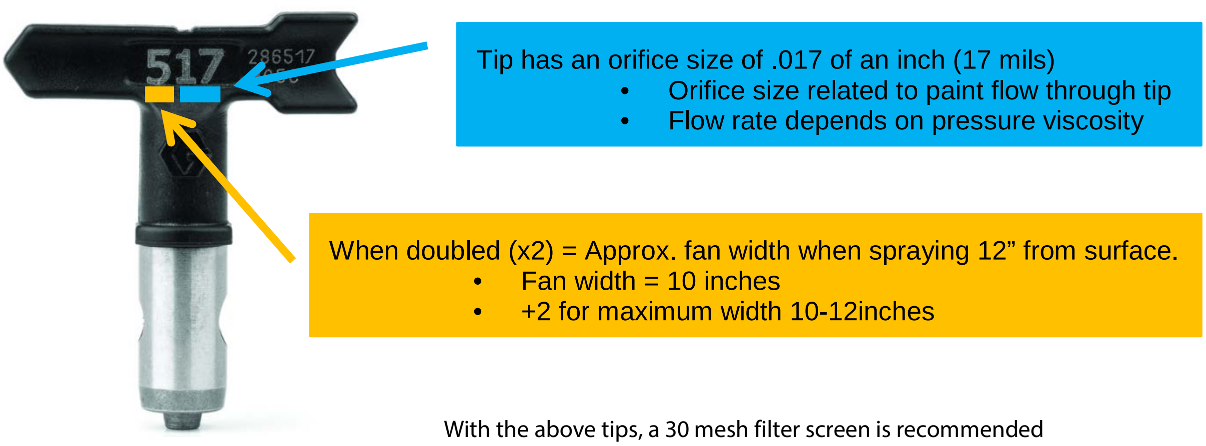
- The first three digits (LTX) are Graco's identification numbers which differentiate various tip styles. An LTX is a Graco RAC X SwitchTip. The second three digits (517) represent the actual tip size (fan and orifice).

- The number (5), when doubled, indicates approximate fan width when spraying 12 inches (305 mm) from the surface. The fan width on a 517 tip is approximately 10 to 12 inches (254 mm to 305 mm). All Graco tips are tested 12 inches (305 mm) from the surface with the same test material (water), at the same spraying pressure (LL5 at 6 inches). Different materials and spraying pressures may slightly change the width of your actual fan pattern.

- The last two digits (17) indicate the tip has an orifice size of .017 of an inch (0.43 mm). The orifice size is directly related to the amount of paint that will flow through the tip. Your actual flow rate will depend on your spraying pressure and the paint you are using (high pressure equals more flow; heavier paints equals less flow).

<u>Some Quick Rules on Selecting Tip Sizes</u>

- Use smaller orifice sizes when applying lower viscosity materials such as stains and lacquers
- Use larger orifice sizes for heavier viscosity coatings such as latexes or oil bases. The 517 indicates the tip size.
- The fan size is double the first digit (5), or 10 inches.
- The orifice size is (17) thousandths of an inch, or .017.



With the above tips, a 30 mesh filter screen is recommended

<u>Materials to be sprayed recommended tip sizes</u>

Latex Paint 0.015 - 0.019
Heavy Latex 0.021 - 0.025

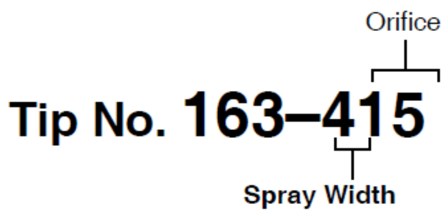
Paint Tips continued

■ Air Atomized:

The air atomized paint system uses a paint gun that has an enclosed tip that, when clogged, needs to be disassembled to remove the obstruction from the tip.

<u>Spray Tip Dimensions Determine Capability</u>
Selecting the proper spray tip is one of the most important parts of painting. The tip determines the application rate and spray fan width. The tip part number gives valuable information about its capability.

<u>Orifice Size</u> determines how many gallons per minute can be atomized through the spray tip. The last two digits of the part number tell the Orifice Size in thousandths of an inch. In this example, the orifice is .015" (0.381 mm)



<u>Spray Width</u> is based on spraying 12 in. (305 mm) from the surface. Double the fourth digit of the tip part number to determine the approximate minimum spray width in inches. Add two inches to that number for maximum width. In this example, this tip size produces an 8–10" (203 – 254 mm) spray pattern at 12" (305 mm) from the surface.

<u>General Tip Selection Information</u>
This is a general guideline to help you select a tip. Your equipment distributor should be your final source of information. They can recommend a tip based on their experience with an application like yours, or can help you conduct a test.

- Determine the maximum flow rate of your spray system. Your spray system (sprayer or pump and power source) must be sized adequately to support the flow rate of the tip you select.
- Determine the material(s) to be sprayed and the desired flow rate. If your pump is supporting more than one gun, add together the flow rate needed for each gun.
- Determine the required orifice size on the tip chart. If the total maximum flow rate(s) is compatible with your spray system, select the desired fan width and then order the tip number given in the adjacent column.

<u>General Tip Recommendations</u>
The following tips give good results with the most commonly used architectural and maintenance coatings. For the best results, spraying on flat surfaces, an 8–10" or 10–12" (203 – 254 or 254 – 305 mm) spray fan width is recommended.

Medium Heavy Viscosity Material	**Orifice Size** ***In Inch (mm)***	**Silver Tip Number**	**Contr. Tip Number**	**Fan Width 12" (305 mm) from Spray Tip** ***In inch (mm)***
Vinyls Acrylics Latex	.017" (.432)	163-317 163-417 163-517	269-317 269-417 269-517	6-8" (152-203) 8-10" (203-254) 10-12" (254-305)
Alkyds Oil Base Ext. Stain Etc.	.019" (.483)	163-319 163-419 163-519	269-319 269-419 269-519	6-8" (152-203) 8-10" (203-254) 10-12" (254-305)

With these tips use a 60 mesh filter screen

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Paint Flow Rate

In airless paint systems, the size of the pump and spray tip will determine the gallons of paint per minute (GPM) that can be applied by your paint system. The paint tip size works in conjunction with the paint pump pressure and speed of the painting machine to give you the desired line width and thickness. Consult your particular paint pump and tip manufacturer's literature to determine GPM and flow rate for your particular machine.

■ **Airless System:**

EXAMPLE: Line Laser Switchtip chart

ORIFICE SIZE - INCHES

Line Width	IN	(MM)	.013	.015	.017	.019	.021	.023	.025	.027	.029	.031	.033	.035	.039	.055
	2	(51)	213	215	217	219										
	4	(102)		315	317	319	321	323	325	327	329	331	333	335		355
	4-8	(102-204)			417	419	421	423	425	427	429	431		435		
	8-12	(204-305)					621	623	625	627	629	631		635	639	
	Flow Rate (gpm)		.18	.24	.31	.38	.47	.57	.67	.77	.90	1.03	1.17	1.31	1.63	3.25
	Flow Rate (lpm)		.69	.91	1.17	1.47	1.79	2.15	2.54	2.96	3.42	3.90	4.42	4.98	6.18	12.29

Water @ 2000 psi (138 bar, 13.8 MPa) - paints with a higher viscosity will decrease the flow rate

Example: for a tip with a .015 orifice and a 4 in (102 mm) pattern, order LL5215.
Fan width of a spray pattern is measured at 6 in (152 mm) from the surface

When working with an air atomized system, the paint tank pressure and paint tip size will determine GPM and flow rate. Again, consult your paint tip literature to determine GPM and flow rate.

■ **Atomized Air System:**

Contractor Flat Tip Chart

ORIFICE SIZE - INCHES

Fan Width	IN	(MM)	.011	.013	.015	.017	.019	.021	.023	.025	.027	.029	.031	.035
	4-6	(102-152)	211	213	215	217	219			225	227			
	6-8	(152-203)	311	313	315	317	319	321	323	325	327			
	8-10	(203-254)	411	413	415	417	419	421	423	425	427			435
	10-12	(254-305)	511	513	515	517	519	521	523	525	527		531	
	12-14	(305-356)		613	615	617	619	621	623	625	627		631	635
	14-16	(356-406)			715	717	719	721		725				
	16-18	(406-457)			815		819	821			827	829	831	
	18-20	(457-508)								925				
	Flow Rate (gpm)		.12	.18	.24	.31	.38	.47	.57	.67	.74	.90	1.03	1.31
	Flow Rate (lpm)		.49	.69	.91	1.17	1.47	1.79	2.15	2.54	2.96	3.42	3.90	4.98

Water @ 2000 psi (138 bar, 13.8 MPa) - paints with a higher viscosity will decrease the flow rate

Example: for a tip with a 0.011 in orifice and a 10 in (254 mm) pattern, order 269511

Selecting the proper tip size for your application:

The flow rates listed (see charts page 7) are established with water at 2000 psi, paint flow rates will vary with different pressures and viscosities.

$$\frac{\text{Gallons per Mile x Miles per Hour}}{60} = \text{Gallons per Minute}$$

Example: As a truck is traveling 10 miles per hour painting a four inch wide line, 15 mils thick, 16.5 gallons of paint is required for a 4 inch wide 15 mil line in one mile. (320' /Gallon)

$$\frac{16.5 \text{ X } 10}{60} = 2.75 \text{ Gallons/Mile}$$ (a 4 inch wide 15 mil thick line requires 2.75 gallons per minute)

When you look at the standard Graco tip chart you will see that a 51 thousandths tip is needed for this application. Your spray tip should be approximately six inches from the surface. A 451 tip would be selected.

Place the 163-451 paint tip into your spray gun and stripe a 4 inch line at 10 MPH

It is best to set your paint pressures in the middle of your operating range, and run the test as close to painting conditions as possible (temperature, mixed paint).

Take a millage test on the line (your actual millage should be less than 15 mils, paint is more viscous than water). Let's assume your millage is 11 mils.

Divide the actual millage by the theoretical millage, 11÷15 =.733. This would be the efficiency "number" of your paint and equipment at painting conditions.

Now divide the gallon-per-minute requirement by your efficiency number. This should give you the required gallons per minute. 2.75 ÷ .733 = 3.751 or a 59 thousandths tip.

$$\frac{16.5 \text{ X } 10}{60} = 2.75 \div .733 = 3.751 \text{ GPM}$$

When using the calculated efficiency flow rate of the paint and paint system, select the appropriate tip for use in the paint application. Then test the mil thickness to verify the proper application thickness is being applied to the surface.

Paint Filters: Once paint tips and pressures are established, it is important to choose a filter for the paint system to keep it clear of obstructions that can cause delays and lost production time. The filter will catch any solids that may have settled out of the paint or dried paint that may have been exposed to air, causing it to dry. The following chart can help you find the proper filter for your system.

Filter should be slightly smaller than the paint tip orifice.

Filter Calculator		
Mesh	Micron	Inches
4	5205	.2030
8	2487	0.0970
10	1923	0.0750
14	1307	0.0510
18	1000	0.0394
20	840	0.0331
25	710	0.0280
30	590	0.0232
35	500	0.0197
40	420	0.0165
45	350	0.0138
50	297	0.0117
60	250	0.0098
70	210	0.0083
80	177	0.0070

Formula for Determining Square Footage and Linear Footage per Gallon:

Square Footage:

One gallon of paint covers 1600 ft^2 when applied at a thickness of one mil (.001) or 25 microns.

Divide 1600 by the mil thickness to be applied to determine the square footage per gallon

Example: 1600 ft^2/ 15 mils= 106.667 ft^2

Linear Footage:

One square foot equals 12″ of linear line 12″ wide.

Divide 12″ by the desired line width to find linear feet per square foot.

Multiply the linear feet per ft^2 by the ft^2 per gallon to get linear feet per gallon.

Example: 4″ wide line- 12/4 = 3 x 106.667 = 320 Linear feet per gallon @ 15 mils.

6″ wide line- 12/6 = 2 x 106.667 = 213.334 Linear feet per gallon @ 15 mils.

Paint Quantity Needed:

The amount of paint needed to stripe one mile of roadway is determined by dividing linear feet to be painted by linear feet per gallon.

Example: 5280/ 320 = 16.5 gallons per mile @ 4″ wide, 15 mils thick.

5280/ 213.334 = 24.75 gallons per mile @ 6″ wide, 15 mils thick.

General Paint Information:

All Ennis-Flint Waterborne Paint is shipped with water float on top of the paint to reduce skinning, or drying on top. This float is part of the paint mixture and needs to be mixed in before using the material. When looking into a new paint tote, drum, or bucket it will look as though the paint is an off color, especially yellow paint. This is, in fact, the float water on top of the paint to keep it from skinning.

Mixing:

As a rule you should always mix the paint before use to ensure that any solids that may have settled during shipping or storage are stirred into the material, as well as the float water. Mechanical mixers such as drum and tote mixers, bucket shakers, and helical mixers are the best to use to ensure a thorough mixture.

Tote Mixer

Bucket Shaker

Helical Mixer

Mixing can also be achieved by running the paint through your recirculation system. This will mix the paint well enough to get the float water mixed in, but will not mix in the solids that may have separated out during shipping or storage, unless your equipment has an agitation system in the paint tank.

Hazardous Waste:

Most waterborne paints do not contain lead, chrome, cadmium, or other dangerous metals and therefore may not be considered hazardous waste. Some waterborne paints do contain lead chromate (MCY). Check your labeling and MSDS to determine which type of paint that you are using.

Flammability:

Waterborne paints are not regulated by DOT and are not considered flammable. They do not require placards. Sprinklers are not required for inside storage in most areas. Check zoning and local codes for the regulations that apply to your facility.

Procedures for Extracting Field Samples for Laboratory Testing:

Ennis-Flint assures that your paint meets the required specification through extensive quality control testing of each batch of paint manufactured. On occasion, your paint may require additional testing by governmental agencies before use on the roadways. If your paint requires additional testing for the calculation of bonuses, deductions, or penalties, it is your responsibility to ensure a good sample is taken and that every batch of paint is approved before its application to the roadway. In most circumstances it would benefit you to obtain and save a "referee" sample for yourself while your sample is being taken for the state agency. Ennis-Flint cannot be responsible for any penalties or adjustments, resulting from sampling after the product has left our production facilities. However, we are 100% dedicated to assisting you in any way if problems arise from any sampling of this nature. Below is a recommended protocol to minimize problems you may encounter in field sampling.

Field sampling when not performed correctly will result in the paint not meeting specification when evaluated by a testing laboratory. When mixing waterborne paints, the "float" water must be mixed into the entire container and the sample must have no additional water added. Excess "float" water in the sample will always result in failure. Field Sampling of paint is highly discouraged when inspection at the time of manufacturing is an alternative.

Totes can be mixed before sampling, but must be done thoroughly. Ideally, a large blade high speed mixer should be used, but this is not always practical. (A small blade mixer will not produce enough mixing motion and will result in paint test failure.)

The best method to sample either a mixed or unmixed tote is to open the outlet valve at the bottom of the tote and allow 5 to 10 gallons to drain out into a clean bucket. Pull sample from the outlet valve after the above 5 to 10 gallons has drained. The drained paint can be poured back into the top of the tote for reuse. If the tote contains waterborne paint, add ½ gallon of water for a "float to prevent skinning on the surface of the sampled container. Mark the tote as having been "tested" to prevent re-testing of the same container with the additional water.

From Paint Trucks:

NOT RECOMMENDED! If a sample from the paint gun is mandatory, paint in the striping machine's tanks must be agitated for 15 minutes minimum, then a minimum of 1000 feet should be sprayed out prior to collection of the samples. Collect samples from the spray gun with the atomizing air OFF for air atomized systems, or the spray tip removed and pressure turned to a minimum for airless systems.

Paint Storage:

The shelf life of Latex paint is 9-12 months depending on how it is stored. Waterborne traffic paints consist of a pigmented latex emulsion in a water system. THEY WILL FREEZE! While all paints have a freeze/thaw protection in them, they must be stored above 33 degrees F. and preferably indoors. Allowing paint to freeze can cause the paint to become unstable and unusable. When storing outdoors during the warmer months, store out of direct sunlight when possible. Care must be taken when loading to prevent air from entering the system. After filling the tanks, fill the plumbing with paint to void air or rinse water. Always agitate the paint before loading or with the agitators in the paint tank. If loading less than a full tote or drum, always agitate or circulate prior to loading.

Application:

Weather:

Waterborne traffic paints are sensitive to wet pavements and rain. Best results are obtained when pavements are dry (24 hours since measurable rain) and no rain occurs for 4 hours after application. Since no one can control the weather, the following are some reasonable rules of thumb:

- Do not paint visually wet pavement even though it has not rained.
- Lines need at least 1 hour to dry before any rain. If rain is eminent, don't take the chance. You'll have to re-paint.
- If it does rain a significant amount, wait until the next day before beginning to paint.
- Latex paint will not dry below the dew point (relative humidity). Relative humidity of 100% indicates the dew point is equal to the current temperature and the air is maximally saturated with water.
- When the dew point remains constant and temperature increases, relative humidity will decrease.
- If painting at night or early in the morning, check your local weather report for the dew point temperatures.
- Wait until you have above dew point temperatures before starting, or stop when the dew point is reached at night. There is no process in which to change the dew point.
- If you have to paint below the dew point, it will be necessary to cone off the area to keep traffic off of the paint until it dries.
- If temperature is below freezing overnight the paint won't coalesce properly. Do not paint 18 hours before a freeze is expected.

How Paint Cures:

Waterborne paints dry or cure in a two stage process. In the first stage, the water evaporates and the paint dries to a no track condition. This evaporation is dependent on temperature and humidity. Low temperature and high humidity give longer drying times. In the second stage, the emulsion coalesces after the water is gone from the film. This process gives you the durable film. This process takes 2 hours at temperatures above 60° F. Paints that are rained on or the temperature drops before this coalescing is complete will have their durability severely reduced. 50° F is the recommended minimum application temperature for surface and air temperatures. The paint will form a film down to 38° F, but the durability will be severely reduced. If applied at temperatures below 50° F extended dry to no pick up times may be a problem. A good rule of thumb is that it is too cold to paint when lows at night reach 35° F. If you must paint on colder days, paint when temperatures are rising and stop when high for the day is reached. Two hours to form a film at or above 60° F may be 3 -5 hours at 40-50° F.

Paints may be heated to give optimum drying times and consistent flow viscosities. Set the glycol temperature on the furnace at 160° F maximum. Set the paint temperature between 100 and 130° F depending on the need for heat. Temperatures above 130° F on the paint do not give any benefit. Actually above 130° F is detrimental.

Surface to be painted:

Latex paint will adhere to both asphalt and concrete surfaces, provided that they are clean and dry. All surfaces must be dry, free of any loose debris and within the proper temperature range prior to striping. Ultimate adhesion of the product is more dependent on the cohesion of the concrete or asphalt to itself.

New or not previously striped concrete roadways - Concrete must be allowed to cure at least 30 days, and must be mechanically abraded to remove any curing compounds or surface film. Failure to properly prepare concrete surfaces will almost always result in poor adhesion and paint bonding failure.

Surface Preparation:

Cleaning the surface to be painted is critical for the paint to bond properly. Loose dirt and debris should be removed by means of a mechanical blower on the paint truck, a handheld blower or push broom. Fine dust particles can rest between the rocks on an asphalt surface and prevent the paint from properly bonding. Concrete surfaces after being abraded to remove curing compounds, may have a fine concrete dust that must be removed to ensure proper bonding.

Although paint exits the gun under pressure, and does push some of the dirt and debris out of the way, it does not replace the need for properly cleaning the surface with a broom and blower.

Application Rates:

Manufacturer or specification application rates should be adhered to. Too thick or too thin applications do not give the desired results. Normal thickness ranges are: 9 to 11 wet mils for parking lots, 14 to 16 wet mils for standard road marking, and 25 to 30 wet mils for durable high build applications.

When painting new asphalt or concrete parking lots, allow a minimum 30 days cure time, then apply a thin film 5-6 mils for the first coat and re-paint after 45 days. Initial heavy film thickness will result in edges curling on asphalt and possible delaminating on concrete.

To check the width and thickness of your application, get the striping machine up to the speed at which you will be painting, and spray a line on to a flat metal plate. Adjustments can be made, if necessary, by raising or lowering the paint gun, or changing paint tips to get the proper width. The thickness can be checked with a wet film thickness gauge, doing this will ensure that you are applying the correct amount of paint, and that it will dry properly.

Volume Solids, Dry Film:

Waterborne paints have volume solids of 60% +/- 2%. To determine the dry film thickness, multiply the applied wet film thickness by 60% to determine the dry film thickness of the applied line.

Example: 15wet mils of line will have a dry film thickness of 9 mils (.015 x .6 = .009).

Painting:

When painting with a walk behind machine it is important to keep a consistent speed to ensure that an even thickness of paint is applied to the surface. When moving too slowly the paint will be too thick and cause problems such as, asphalt curling and delaminating on concrete surfaces. If moving too quickly, the paint will be too thin, causing failure and re-painting will be necessary.

When applying paint with a long line truck it is possible to "outrun" the pump or paint tip, (painting too fast for the pump or tip to keep pace with the trucks speed). The pump and tip will only allow a predetermined amount of fluid to pass through it per minute. When painting too fast, the required paint thickness will be too thin, and will cause undesired results. The paint will not hold glass beads properly and cause premature bead loss. The truck's speed can also cause the beads to roll in the paint, instead of dropping onto it, covering them with paint and causing low retroreflectivity numbers.

Waterborne paints have not exhibited problems when applied over old markings that were in good condition, i.e. no chipping, delamination, or peeling. Always remember that the adhesion of your new stripe to the road surface is no better than the stripe that you are painting over. Painting over old fast dry alkyd/solvent base paints will sometimes make the old stripe come loose from the surface. Use good judgment before applying over old stripes that have been recoated many times.

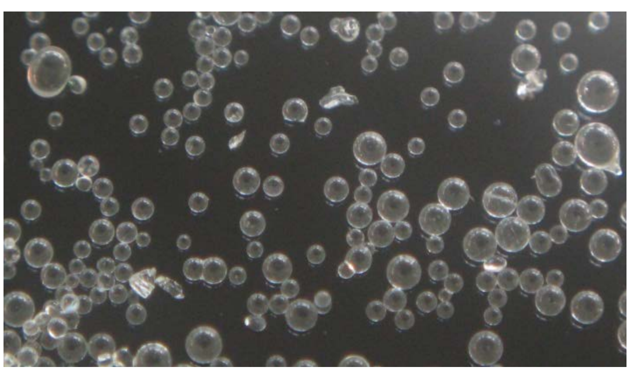
Waterborne paints perform equally well on both asphalt and concrete surfaces. Use discretion when painting over seal coat, slurry seal, and new chip seal.

Material Temperatures:

For best results, waterborne paints may be heated to 100 to 120° F. Viscosity and ease of spraying are dependent on material temperatures especially on cooler days when paint is cold from being stored outdoors. Increasing the heat above 120° F does no good. DO NOT EXCEED 120° F ANYWHERE IN THE PAINT SYSTEM. EXCESSIVE TEMPERATURES CAN CAUSE THE PAINT TO GEL WITH DISASTROUS RESULTS. YOU MIGHT HAVE TO REPLACE HEAT EXCHANGERS! All paints are totally stable below 120° F. Generally a temperature of 100° F is sufficient. Always cool down the heat exchangers before shutting down for the day or extended periods of time during the day.

Glass beads

Glass beads are small spherical pieces of glass of different shapes and sizes that have different coatings applied to them to help them bond with pavement markings. When glass beads are applied to traffic paint, the paint wicks up onto the beads to hold them in place. Glass beads are dropped on the paint directly behind the paint gun. The position of the bead gun is crucial for proper bead embedment and distribution. The closer the bead gun is to the paint gun, the farther in the beads will sink. If it is moved back away from the paint gun they will sit higher on the paint.



There are many glass bead manufacturers to choose from, and choosing the proper glass beads for your application is important for the traveling public's safety. A dual coated glass bead should be used for latex paint. The first coating is a moisture-proof coating, and the second coating is an adhesion coating to ensure that the beads bond with the paint. Generally parking lots do not require the use of glass beads, however if they are required, drop-on glass beads are applied at the rate of 3 to 4 pounds per gallon for parking lots and 6 to 8 pounds per gallon for standard road marking. Apply specialty paints designed for thicker application using specialty beads according to manufacturer's specifications.

Calibration:

Bead guns should be calibrated to ensure that the proper amount of glass beads is being applied to the paint for the desired retro reflectivity. Not enough glass beads or too many beads can result in low retro numbers. Applying too many beads can also prove to be expensive, as the beads that do not bond to the paint, will quickly wear off and end up on the shoulder of the road.

Proper bead calibration is done by holding a container under the bead gun and having a coworker turn on the gun for 10 seconds. Measure the amount of glass beads that come out of the gun in 10 seconds in a graduated cylinder marked in milliliters. Changing bead tank pressure or bead gun inserts may be necessary to achieve the desired rate needed. Continue this process until the proper bead application rate is achieved.

The following chart can help you calibrate your bead guns to gain the best retro reflective numbers.

Regular Bead Calibration Chart (AASHTO type 1 through AASHTO Type 4)

Lbs./100ft BEAD CALIBRATION CHART
BEAD VOLUME IN MILLILETERS PER 10 SECONDS FOR A 4” (10 CM) WIDE LINE
DROP RATE

Speed	6 Lbs/ 100ft²	8 Lbs/ 100ft²	10 Lbs/ 100ft²	12 Lbs/ 100ft²	14 Lbs/ 100ft²	16 Lbs/ 100ft²	18 Lbs/ 100ft²	20 Lbs/ 100ft²	22 Lbs/ 100 ft²	24 Lbs/ 100ft²
10 mph or 16 kph	800	1080	1340	1600	1880	2160	2400	2680	2930	3200
9 mph or 14.5 kph	720	960	1200	1440	1680	1920	2160	2400	2560	2880
8 mph or 12.9 kph	640	850	1070	1280	1500	1700	1920	2140	2350	2560
7 mph or 11.3 kph	560	750	940	1120	1300	1500	1680	1880	2040	2220
6 mph or 9.7 kph	480	640	800	960	1120	1280	1440	1600	1760	1920
5 mph or 8 kph	400	530	660	800	930	1060	1200	1320	1460	1600
4 mph or 6.4 kph	320	430	530	640	740	840	960	1060	1160	1280
3 mph or 4.8 kph	240	320	400	480	560	640	720	800	880	960
2 mph or 3.2 kph	160	210	260	320	370	420	480	520	580	640

6 lbs / 100ft² = 106 lbs / mile
8 lbs / 100ft² = 141 lbs / mile
10 lbs / 100ft² = 176 lbs / mile
12 lbs / 100ft² = 211 lbs / mile
14 lbs / 100 ft² = 246 lbs / mile
16 lbs / 100ft² = 282 lbs / mile
18 lbs / 100ft² = 317 lbs / mile
20 lbs/ 100 ft² = 352 lbs / mile
22 lbs / 100ft² = 387 lbs / mile
24 lbs / 100 ft² = 422 lbs / mile

Footage to Stripe (feet)	Desired Drop Rate (lbs)	
300	100 ft²	= LBS. of Beads required per Mile

Bead Quantity:

Glass beads are applied at pounds per gallon rate. To find the rate needed, multiply the pounds per gallon by 16.5 (gallons of paint per mile @ 4” wide, 15 mils thick) to determine the pounds per mile needed.

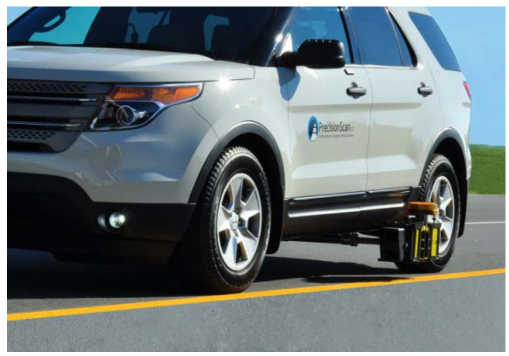
Retroreflectivity of Pavement Markings

Definition:

Retroreflectivity, as defined in the context of pavement marking materials, refers to the nighttime visibility of pavement markings. This visibility is provided by the presence of glass beads embedded in the surface of the pavement marking that focus light emanating from the headlights of vehicles and reflect back a portion of that light to the driver. You can use special equipment (LTL-X Retroreflectometer) to objectively measure the amount of this retro-reflected light to determine the effectiveness of the glass beads and the pavement marking material. In setting minimum performance standards for retroreflectivity of pavement marking materials you must understand all dynamics that are involved. The objective should be to maintain an adequate level of retroreflectivity throughout the service life of the marking. The following are two types of commonly used retroreflectometers or services.

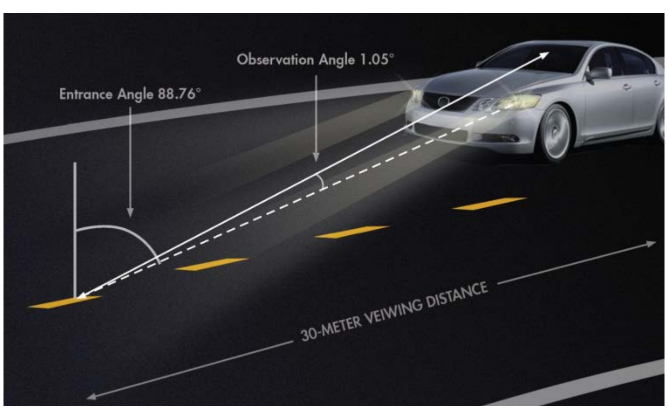
Hand-held DELTA LTL-X

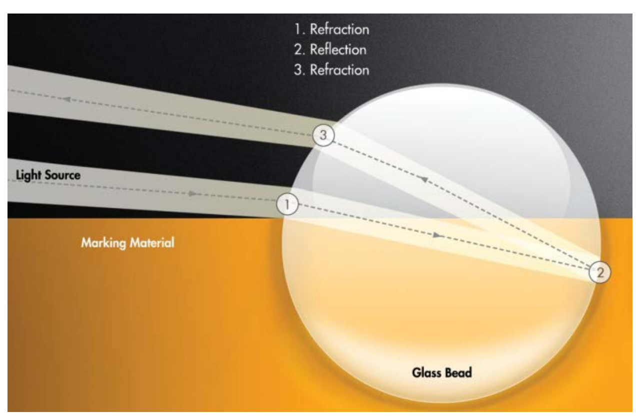
Mobile DELTA LTL-M



Factors Affecting Retroreflectivity:

Glass Beads:
The glass bead provides the mechanism by which the light from the vehicle's headlights are focused and retro-reflected back to the driver. The efficiency of this process is determined by the refractive index of the glass bead**.** This refractive index refers to the degree that light is bent as it passes through the glass bead. The higher the refractive index the "tighter" the focal point and therefore the higher the degree of retro-reflected light. The typical refractive index for glass beads used on applications for pavement markings is around 1.50.





The quality of the glass bead:

The roundness of the glass beads, the presence of air inclusions, and the clarity of the glass bead will play a role in the efficiency of the glass bead in returning light. The presence of irregular particles has the greatest effect on retroreflectivity as this type of shape will not bend the light into a focal point. Elliptical shapes and beads that are stuck together show some reduction in retroreflectivity but the results are much less than what would be observed by an irregular particle. Most specifications require a minimum of 70% to 80% round spheres with no more than 3% irregular particles present, no more than 10% air inclusions in the glass beads, and beads that are clear. The color of the glass bead has little effect on retroreflectivity but can affect the color and daytime appearance of the pavement marking on which it is applied.

The size of the glass bead:

The size of the glass beads is characterized by the gradation over a range of sizes set forth in the relevant specification. Glass beads that are closely sized provide higher and more uniform retroreflectivity compared to glass beads with a wide range of sizes. This is due to the phenomena of shadowing, which is caused by the presence of larger beads that cast a shadow over the smaller beads that are sitting behind the larger bead as it is exposed to the headlights. Larger beads provide higher retroreflectivity than do the smaller beads assuming that each are embedded into the pavement marking to the same degree.

The coating of the glass bead:

The surface tension between the glass bead and the pavement marking material determines how deeply the bead will embed in the pavement marking material. The surface tension of the glass beads can be altered by the application of various coatings applied to the bead thus affecting the degree of embedment of the glass bead into the pavement marking material. In addition the type of coating that is present on the glass bead will affect the adhesion of the glass bead to the marking material, which directly effects the long term retro reflective performance of the marking (retains the glass bead longer). Optimum retroreflectivity is achieved at 50 – 60% embedment. For maximum bead retention with minimal impact on retroreflectivity an embedment of 60- 70% is desirable.

Pavement Marking Material:

The primary factor affecting the retroreflectivity as it relates to the pavement marking material is the pigment content. This provides the opacity and the “background” from which the focused light from the glass bead is focused back to the driver. In most cases the type and quantity of the pigment to be used in the pavement marking is “fixed” by the agency specification. Only in some warranty type specifications the pigment type and loading is left to the discretion of the manufacturer of the pavement marking material.

Roadway Surface:

The roadway surface plays an integral role in the amount of reflectivity that can be expected. Smooth roadways like concrete offer the best suited means of applying a consistent system, while rough, or irregular roadways, like ones with large coarse aggregates can cause significant reductions in the amount of retro that can be achieved.

Application:

In order to achieve the desired results, the correct pavement marking with the proper glass bead must be applied in the right way. Application is the most important component to achieving the desired results. The pavement marking material must be applied under the right conditions, at the correct thickness, and the glass beads must be applied at the correct rates, with uniform coverage, and with the proper embedment achieved.

The chart is an indication of the retroreflectivity values of various components disregarding application.

Material Type	Retroreflectivity (mcd)
Concrete	10 - 25
Asphalt	1 - 16
Aluminum Film	4 - 8
White Paint	15 - 20
Yellow Paint	5 - 15
AASHTO Type 1 Beads on white paint (no embedment)	30 - 50
AASHTO Type 1 Beads on concrete	40 - 50

It is interesting to note that the retroreflectivity of white and yellow paint is no better than that of the pavement itself and that you get essentially the same retroreflectivity by dropping beads on concrete as you would by placing beads on the surface of a white marking. This is a very clear demonstration of the importance of application in achieving the desired results.

Recommended Performance Levels for Retroreflectivity:

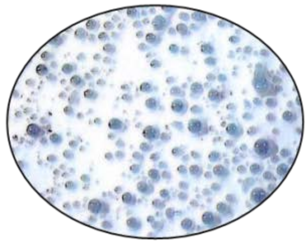
In setting up minimum retroreflectivity performance levels in agency specifications there are a number of things to consider. One should be cautioned against specifying too high of an initial retroreflectivity at the expense of long term retroreflectivity performance. Durability is a function of bead rate, coverage, and embedment. For example with traffic paint, using a standard AASHTO Type 1 drop on bead, one can obtain higher retroreflectivity values with a drop on rate of 5 lbs. per 100 ft^2 than at higher rates. A rate of around 8 - 9 lbs. per 100ft^2 would be at the saturation rate, which although would give quite a bit lower retroreflectivity results but would provide maximum durability, as the glass beads provide a wearing surface, protecting the marking from abrasion loss. In addition, a bead embedment of only 40 – 50% would provide maximum retroreflectivity but a bead embedment of 60 – 80% would provide much improved long term durability and retention of retroreflectivity. Based on these considerations we recommend the following as the best compromise for durability and retroreflectivity for a standard performance oriented specification when using a high quality glass bead on smooth roadways:

Pavement Marking Material Color	Bead Gradation	Bead Coating	Drop on Rate (lbs/ 100 ft2)	Minimum Initial (3-60 day) Retro	Minimum Service Life Retro (After 60 + Days)
STANDARD TRAFFIC PAINTS- 15 MIL APPLICATION					
White	AASHTO Type 1	Dual Adhesion/ Moisture proof	6-8 lbs/100ft2	300	125
Yellow	AASHTO Type 1	Dual Adhesion/ Moisture proof	6-8 lbs/100ft2	200	125
HI-BUILD TRAFFIC PAINTS- 25 MIL APPLICATION (LARGE BEADS)					
White	AASHTO Type 3	Adhesion	10-12 lbs/100ft2	400	125
Yellow	AASHTO Type 3	Adhesion	10-12 lbs/100ft2	275	125

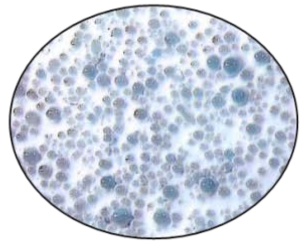
*Note: The reduction of the level of retroreflectivity over time is affected by many condition such as snow plowing and the use of studded tires.

Examples of Bead Rates

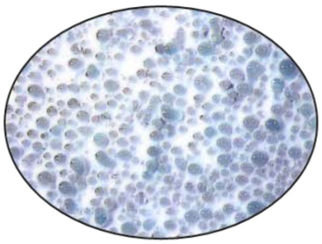
3LB/100Ft^2



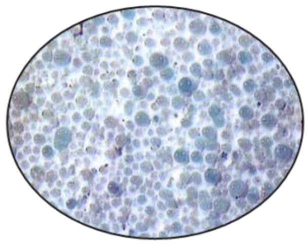
5.2LB/100Ft^2



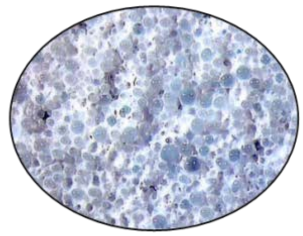
7.2LB/100Ft^2



8.2LB/100Ft^2



9.3LB/100Ft^2



15.4LB/100Ft^2

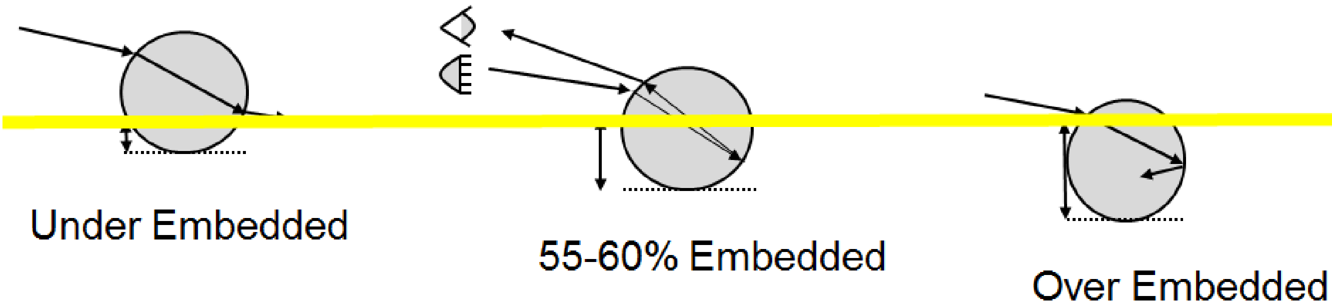
Bead Embedment

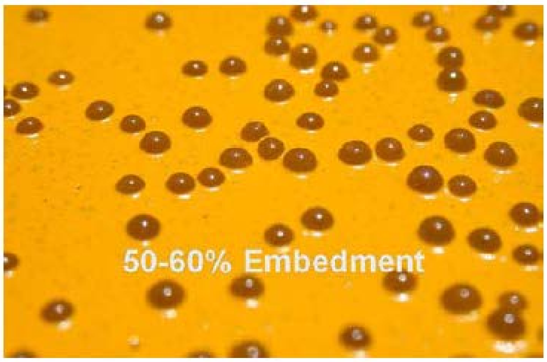
For a daytime check on the bead placement, position yourself where the shadow of your head is over the stripe. This means that the sun is directly behind you and it is being reflected by the beads. (Caution: sometimes a line looks bright with sun but at night it is dead. This is because headlights enter the beads at a much lower angle and if they are sunken into the paint they do not reflect.)

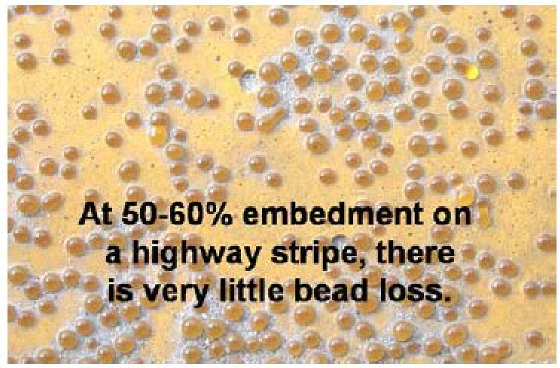
One of the most important things to look at is to get a close look at the actual bead embedment. If the beads are not deep enough into the stripe, there is not enough binder to hold them and they will be lost when traffic impacts them. If the beads are sunk too deep, then the light from the headlights cannot enter the bead and reflect back to the driver. Beads should be embedded between 50 to 60% into the material for optimum compromise between retroreflectivity and durability. At less than 50% you can still see the downward curvature of the bottom half of the bead. At more than 60% the top of the bead is sticking up like the yolk of a fried egg. The best way to check glass bead embedment and distribution is with a magnifying glass.

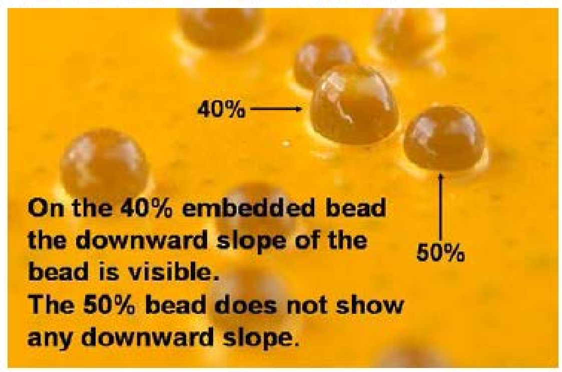
Bead distribution can be affected by several variables such as bead tank pressure, moisture in the bead tank, and crosswinds. Always be sure that the entire line is coated with beads so the pavement markings will be visible at night. The beads should be distributed uniformly and at the same embedment across the whole stripe. The “sun over the shoulder” method can show uniformity but close inspection is needed for the embedment. If the stripe is thicker in the middle than at the edges and if the beads are properly embedded on the edges, the ones in the middle will probably be sunk too deep. If the ones on the middle are embedded correctly, then the ones on the edges will not be deep enough and will be lost causing the stripe to look narrow at night. If there are too many beads on the stripe, they can shadow each other and decrease the reflectivity. (Most of these photos are lab samples and the bead load is a little lower than normal on the road.)

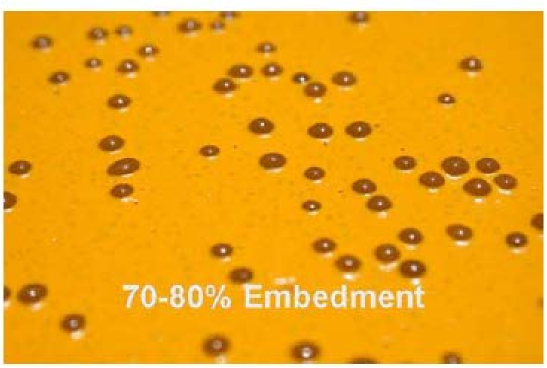
Beads provide best durability and retroreflectivity at 55-60% embedment.

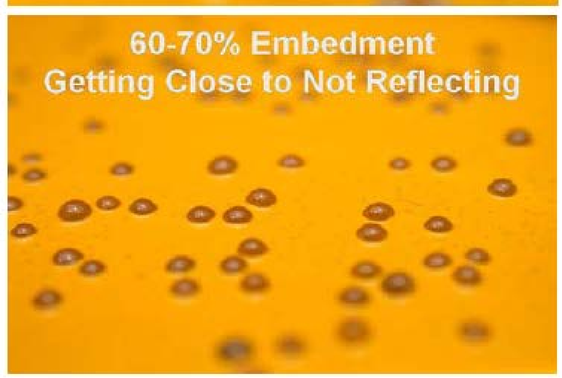












Improving Retroreflectivity

Line quality is basic to achieving good retroreflectivity. Before applying glass beads, ensure a uniform paint line of specified wet film thickness is applied. Check with a wet film thickness gauge in the center and both edges to establish a flat uniform line. If you are applying 15 wet mils, adjust to a range of 14-16 wet mils across the width of the line. When applying paint with large 1 mm -1.5 mm glass beads, the wet film should be in the range of 25-30 wet mils.

After wet paint thickness is obtained, apply the specified amount of glass beads to the line and allow time to dry. Using a magnifying glass, determine the level of glass bead embedment (beads should be embedded at least 60%). Adjust the bead gun to achieve desired level of bead embedment and distribution, and then check retro reflectance. The bead gun height should be only high enough to uniformly cover the line with glass beads, reducing waste. Move the bead gun closer to the paint gun, or farther back to achieve the desired embedment, and change the angle of the gun if possible. If using a Binks type gun, rotating up or above horizontal embeds the beads deeper into the paint, and rotating down or below horizontal the beads will sit higher in the paint.

Set up your equipment at the same speed as you plan to paint. The same rate of paint and beads are delivered through the system regardless of speed. Painting faster than what you have set up for reduces the amount of paint and glass beads per foot, giving a thinner wet film and fewer pounds per foot of glass beads. Slower speeds give more uniform results as wind effect is reduced and beads do not roll in the paint film as severely. When speed is changed over 2-4 MPH you need to recheck your film thickness and bead calibration. Make the necessary adjustments to meet the new application speed.

Coarse aggregate pavements present a unique problem as paint and glass beads accumulate heavier in the direction in which they were painted, and lead to lower retroreflectivity readings when reading from the opposite direction. This is especially noticeable on two lane roadways in the centerline. To compensate for this discrepancy, rotate the bead gun toward the rear of the paint truck by approximately 15 degrees. This delivers paint to the back side of the stone during application. You may also wish to increase the wet film thickness by 2-3 wet mils, as much of the paint fills in the voids of the asphalt. A duel bead gun arrangement improves the bead distribution on the line. If two guns are used, the front gun should be mounted horizontally, and the back gun should be mounted vertically as its purpose is to deliver beads to the back side of the stone. "Potter's" type bead guns are limited to vertical mounts, but can be adjusted to give similar results when used in tandem. Since coarse aggregate pavements are irregular in texture, retroreflectometer readings may vary or be distorted.

Paint Drying

There is much confusion on determining "dry time" due to the broad ranges of application methods, locations, and techniques used, especially when attempting to correlate laboratory methods against various field methods. The outline below will attempt to bring some of these all into light and stress the most reliable and significant methods for comparison.

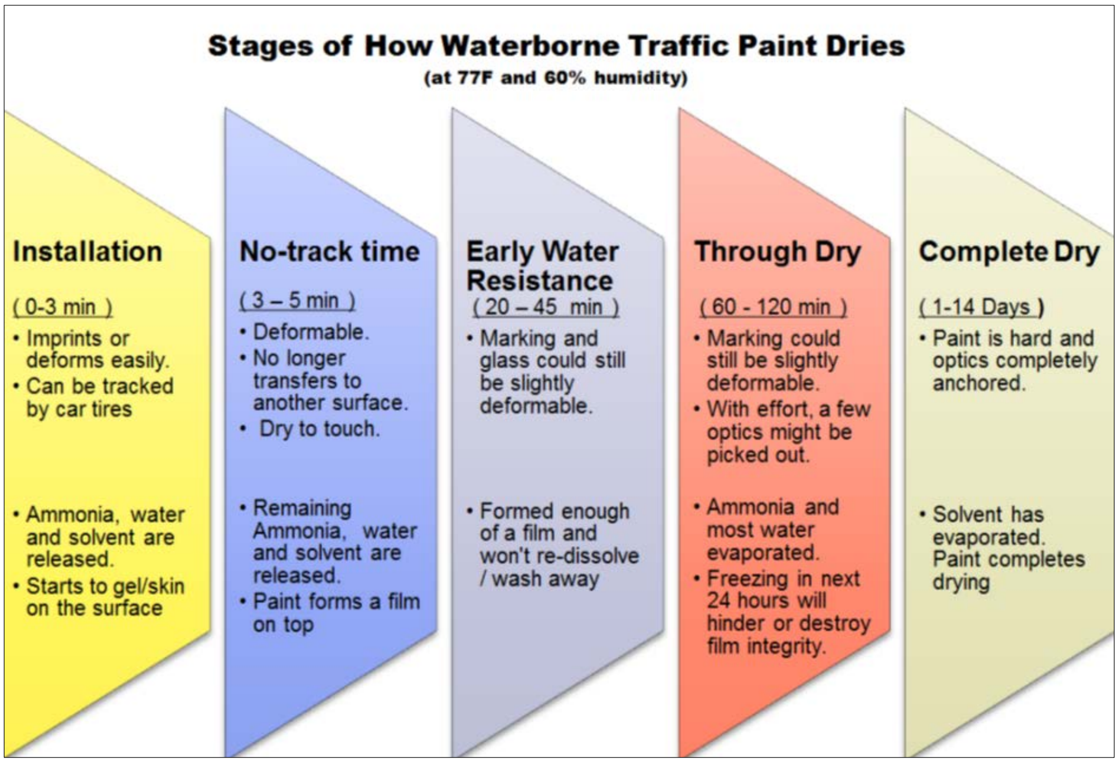
Realistically this is the best method to evaluate dry time in the field, as it directly measures the amount of time after line application that vehicles can be allowed back on the road. The test simulates a common passing maneuver of a vehicle driving at 20-30 mph. Passing or failing the tests is based on whether an observer is able to see paint from the line tracked onto the roadway from 50 feet away.

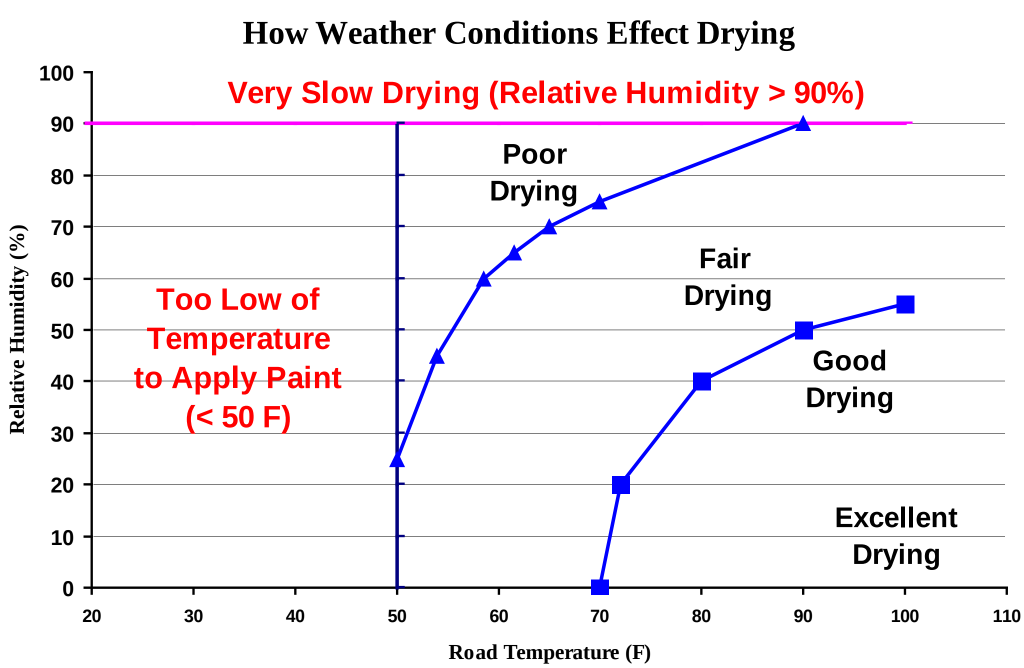
Note that to ensure repeatability; the test method requires that the vehicle must pass at an angle over the line at a single point. A standard vehicle type is also specified. Driving down the line several feet, making turning, twisting or braking maneuvers, or using heavy large trucks or a vehicle with non-standard tires affects the repeatability and are not allowed.

There are several other improper non-standardized methods, which include, scraping with fingernail, touching with finger, even kicking which are all extremely variable due to pressure and surface area . These methods are often frowned upon to determine a means to determine whether the marking has dried to the point where it is acceptable for release to the driving public. These methods have no real correlation to the intended purpose.

It's important to note that all paints, regardless of type, take many hours, sometimes even days to fully cure 100%. This typically has little bearing on the readiness or suitability of a pavement marking to moving traffic.

When non-typical or undesirable results are observed, the temperature, relative humidity, and dew point at a minimum should always be noted. Additionally, differences in film thickness, the amount and type of drop on glass beads, all play a major role in the measured and perceived dry time results. Dry times are not linear but algebraic or exponential. If a 15 mil film dries in 10 minutes, a 30 mil film does not dry in 20 minutes. It may be 3 times or even longer.





Clean Up

<u>Daily Maintenance</u>:

Do not run tanks dry! An empty tank allows air into the system causing a “tree ring effect” inside the plumbing. After this happens several times, the system will need to be torn down and completely cleaned. To prevent this if you run out of paint, reload the tanks and pump paint through the entire system until all plumbing is full. At the end of each daily use, remove the gun shrouds and fan atomizing caps and clean with soap and water. Clean the fluid tips with a wet rag or brush. If paint is dried so that soap and water will not clean, use a mixture of 25% Methanol and 75% water to clean dried paint. A good soap is a household cleaner like “Fantastic”. For overnight storage, completely fill the paint tanks with paint. To prevent skins (paint drying on the surface) pour some water (1/2 gal to 1 gal) on top of the paint after the truck has been parked. Check for skins on paint in the tanks each day before starting. If any skins are present, remove them before turning on the agitators. It is important not to inject water into the heat exchangers except during cleaning. Leave exchangers full of paint. It is necessary to turn off the heated glycol to the heat exchangers prior to daily shutdown to allow the paint to cool in the exchanger. Fifteen (15) minutes prior to shutdown will sufficiently cool the system down.

<u>Weekly Maintenance</u>:

For weekend storage, flush water through the heated hoses and out the paint guns. Clean the strainer at discharge end of the heat exchanger. It is much easier and cleaner after they have been flushed out.

<u>Regular and Periodic Cleaning</u>:

Remove strainer at the discharge of paint tank, clean and replace. Flush the entire system with water. Clean and check the heat exchanger at this time. After flushing and cleaning, fill the entire system with paint to remove trapped air and water. This should be done every two weeks of operation, or more often if needed.

<u>End of Season Cleaning</u>:

Flush complete paint system with water. If needed to remove any dried residue, use a mixture of 75% water and 25% Methanol. After flushing, remove all drain plugs to prevent any settling into low spots. Remove ends of heat exchangers and inspect to determine if additional cleaning is necessary. Over a period of several months of operation, paint will gradually collect in the heat exchangers. It may harden or remain in a putty-like condition, which will plug the tubes and interfere with normal paint flow. The heat exchanger cover can be removed and the end unbolted. Be sure to remove the exchanger ends by pulling them directly away from the main body. **DO NOT SLIDE THEM!** Some heat exchangers have small reinforcing pins and tube sheet dividers which are designed to hold the gaskets in place and can be bent or broken unless care is taken when removing the ends. The tubes should be individually routed clean. If using a drill bit be careful!!! <u>DO NOT</u> damage the tube. After cleaning, the exchanger should be pressure tested (100 PSI) for damaged tubes. Any tubes that leak air should be soldered shut on both ends. The exchanger is then blown out, washed with water and reassembled using new gaskets. It might be necessary to scrape off the paint buildup on the tank walls and agitators. Tanks should be left empty with no winter carryover of paint. The entire system should be flushed, cleaned, drained, and put back together prior to storage for winter.

Procedure for Removing Paint from Vehicles

In the unfortunate event that waterborne traffic paint comes in contact with the traveling public's vehicles, it is important to get to a pressure car wash as soon as possible. This will loosen and remove most of the paint unless it has dried for more than a day. If the car wash does not remove the paint, allow the water to dry off of the vehicle, and then spray the paint residue with WD-40, and allow it to remain for 1-2 hours and rewash the vehicle. The WD-40 will soften the traffic paint without harming the vehicles finish. If there is a heavy concentration of paint, repeat the WD-40 procedure.

For heavy accumulations or paint that has dried for several days, apply a liberal coating of Vaseline to the dried traffic paint and allow it to remain overnight. The next day, take the vehicle to a pressure car wash to remove the paint. If this does not remove all of the paint, repeat this procedure.

<u>DO NOT</u> scrub the finish with a solvent or scouring cleanser! This <u>WILL</u> damage the finish.

After cleaning the traffic paint off of the vehicle, apply a quality car wax to the finish. Wax should remove any lasting signs of the paint from the finish.

Wheel wells are very difficult to remove traffic paint from, since they are not normally a smooth surface. Apply a liberal coating of Vaseline to the area and leave on for several days. Pressure washing should remove the paint from the area. Applying an alcohol such as Solox or rubbing alcohol to the area in the wheel well will help to soften any residue left from the Vaseline. Once again, <u>DO NOT</u> scrub the surface, apply with a wetted rag or sponge.

Troubleshooting Guide

Paint Bonding Failure:
Surface not properly cleaned prior to installation.
Not properly cleaned between multiple passes.

Paint Discoloration/ Tire Tracks on Paint:
Highway traffic paint used on parking lot.
This type of paint is to be installed using glass beads.

Paint Bonding Failure on Concrete:
Concrete curing compounds not removed from bridge deck prior to application.

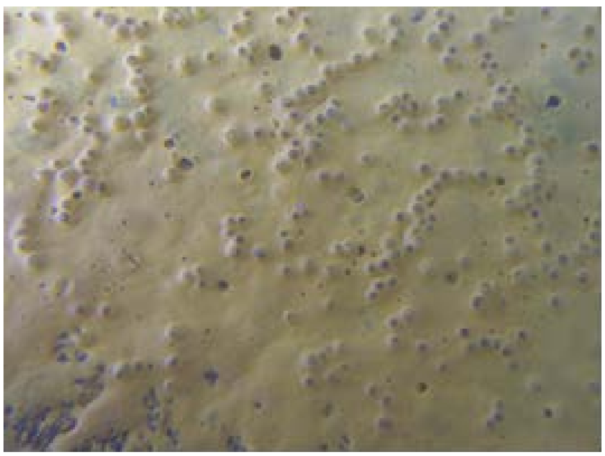
Paint Bonding Failure on Asphalt:
Surface not properly cleaned prior to application.

Premature Bead Loss:
Incorrect or no bead coating on glass beads.

Low Reflectivity Numbers:
Overlapping layers of paint are built up beyond acceptable limits. Should be removed prior to new paint application.

Asphalt Curling:
Paint installed too thick in first application on new asphalt.

Overspray on Glass Beads:
Glass beads too close to paint application. Reflectivity numbers will be low; however, overspray will wear off over time.



Bead Roll:
Paint application speed too fast. Glass beads roll in paint rather than drop onto it.

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