

5. Surface Preparation (Prime and Tack Coats)



5.1. Preparing Existing Pavement (Tack Coat)

Pavements deteriorate with time. Air, water, traffic and temperature cycles all shorten pavement life. Existing pavements are overlaid to correct surface irregularities, to strengthen the pavement structure, and to seal out air and water.

Preparation for a pavement overlay includes *cleaning* dirt and debris off the old pavement and applying a *tack coat*. Tack is an asphalt product (usually an emulsion) that is sprayed on existing pavement in a thin film. It provides a bond between old and new pavement.

If the old pavement has severe dips or ruts, it may require leveling with asphalt concrete prior to the overlay. It may also be necessary to raise manhole covers, storm water inlets, and similar objects.

5.1.1 Leveling

If a need for filling dips and ruts is anticipated, it will generally be indicated on the typical section in the

plans for the project. Small holes and cracks are filled by hand with a shovel and a rake. Larger dips will require leveling with a motor grader (blade) or with a paving machine.

Normal procedure is for the inspector to stretch a string line across the dip to determine its depth and then mark the edges of dip with orange paint. Depth in the dip is marked in tenths of feet of asphalt fill required. The contractor then fills it to the depth and dimensions indicated. Deep dips must be filled in successive layers, starting at the deepest point and working radially outward. Each lift must be compacted separately with the rubber-tired roller.

All old pavement surfaces must be cleaned and tacked prior to leveling.

5.1.2 Surface Preparation for Tack Coat

The contractor must clean the old pavement if it is dirty or covered with debris (Highways 401-3.07, Airports 401-4.9). A power broom is normally used, but in extreme cases flushing with water may be necessary. The worst enemy of a tack coat is *dry dust*.



Figure 5-1
Power Brooming Before Tacking

A slightly damp (not wet) surface is preferable to a dry, dusty one. If all the dust cannot be removed, the old surface should be moistened slightly 0.05-0.10 gal/sq. yd. using a water truck with a high-pressure spray bar.

Curbs, manholes, inlets, and the like are usually dirty and require cleaning with a hand broom prior to the application of a tack coat.

5.1.3 Tack Coat

The standard specifications call for STE-1 Emulsified Asphalt to be used for tack coats (Highways 402-2.01, Airports 603). On some contracts the special provisions may call for a heavy grade of cutback asphalt instead.

A distributor truck applies the tack. Proper operation of the distributor truck is the key to a good tack job. See the description of the distributor truck in Section 5.3 for details.

Application rates vary and will be set forth in the contract (Highways 402-3.04 and Airports 603-2.1 specify 0.04-0.10 gals/sq.yd. The tack coat should give a uniform coat without excess. The inspector may adjust the application rate if the coverage is too heavy or too light. As a general rule, a small amount of the existing pavement should show through the tack coat. Too much tack can cause slippage between old and new pavements or bleeding.

A variation of up to 0.02 gallons per square yard is acceptable (Highways 402-3.02, Airports 602-3.2 allows a 10 percent variance). Most contractors control the spread closer than this. Even in small areas it is better to use the spray bar instead of the hand sprayer if it is possible to maneuver the truck.

Care must be taken to prevent spray overlap or missed areas at longitudinal joints between shots of tack. Missed spots can be tacked with the hand sprayer, but the result will be better if the application is done right in the first place.

At transverse joints, building paper should be placed over the end of the old shot of tack and the new shot should begin on the paper.

The tack should be applied the same day the surface is paved and must be in good condition when the paving machine reaches it. It is the contractor's responsibility to protect the tacked surface from damage until the pavement is placed (Airports 401-4.12).

Tack should be allowed to break before paving begins. When it breaks it will change from chocolate brown to black and from gooey (it will stick to your fingers) to tacky (it will feel sticky but will not stick to your fingers). Paving before the tack breaks results in the equipment picking the tack up off the road, which defeats the benefit of the tack.

Strictly adhere to weather limitations given in the contract (Highways 402-3.01, Airports 603-3.1). Rain can wash unbroken emulsion off the grade, ruining the tack and creating a serious pollution problem. It can cause a serious public relations problem with the traveling public, if this oil is splashed on their cars. And it can cause extremely hazardous driving conditions. Tacking is never allowed in rainy weather.

Tack is normally paid for by weight. Asphalt emulsion (STE-1) is diluted with an equal amount of water prior to application. CSS-1 is paid for before it is diluted.

The distributor truck is weighed before and after the application and during the mixing process to determine the amount of tack that was placed.

Curbs, manholes, and other surfaces on which asphalt concrete will be placed or abutted must be tacked by hand prior to paving. Surfaces of curbs, etc. that will *not* have pavement placed on them must be protected from over spray from the distributor.

5.2. Preparing an Aggregate Surface (Prime Coat)

Liquid asphalt materials with high penetration qualities are used for prime coats. They are sprayed onto an aggregate surface, where they coat and bond the aggregate. Prime coats provide a temporary waterproofing of the base course surface and a permanent bond between the base course and asphalt concrete pavement. Prime coats may also preserve the finished base coarse for a few days if traffic must be allowed on it before paving begins, especially in wet weather. They also provide a zone of transition in

asphalt content between the pavement and the untreated material below.

Occasionally priming is deleted from a paving project. This may be considered late in the season when air temperatures are too cold for priming but still allows paving. Prime coats serve a real purpose in the pavement structure, however, so deletion is normally not allowed. Deletion of a prime coat must be approved at the regional level.

Sometimes an *asphalt treated base* is used instead of a primed base. This is briefly described in Section 5.2.5 of this chapter.

5.2.1 Alignment, Grade, and Compaction

Alignment is the horizontal positioning of the road or runway; grade is the vertical positioning. The plans describe the alignment and grade of a "profile line" for the road, runway, or taxiway. This is most often the centerline of the structure. The alignment and grade of other points relative to the profile line is shown in one or more "typical sections" in the plans.

The alignment and grade must be checked and approved by the grade inspector prior to priming. This ensures that the road or runway is in the correct location. This sounds simple, but stakes are lost during construction and mistakes do occur.

The surface width of the road or runway must also be checked; sometimes it is narrower than the planned paving width and must be corrected. The position and slope of the crown must be checked too (or just the slope in a superelevated section).

Compaction of the base course must be checked and approved prior to priming. The check is made by density tests performed by materials inspectors.

5.2.2 Surface Preparation for Prime Coat

A good prime coat requires a base course surface that is smooth, properly crowned, and free from washboarding, ruts, and standing water. This must be checked immediately before the prime coat is applied (Highways 403-3.03 and Airports 602-3.3).

On very tight, dense bases, sweeping with a power broom may be needed to remove a dust seal that has built up under traffic. More often the base is "tight bladed" with a motor grader. This slightly loosens the surface, which helps the prime penetrate. It also removes any loose rock.

As with tack coats, the worst enemy of a prime coat is *dry dust*. The surface of the base course should be slightly damp (*not wet*) for the prime to penetrate properly. Dry dust can be eliminated with a light fog of water sprayed under high pressure from a water truck. Whether to water, and how much to water, is a decision the inspector must make. This decision is based on how moist the grade is, how hot and sunny it is, and how soon it will be primed. Too little moisture and the prime will not penetrate; too much and it will puddle up or even run off the grade.

5.2.3 Prime Coat

Highways Standard Specification 403-2.01 allows MC-30 Liquid Asphalt or CSS-1 Emulsified Asphalt as prime coat material. Airport Standard Specification 602-2.1 allows MC-30 or CMS-2S Emulsified Asphalt. Contract special provisions may allow other materials. When emulsified asphalt is used, it is diluted with an equal amount of water prior to application.

The distributor truck sprays the prime material on. See the description of the distributor truck in Section 5.3 of this chapter for details.

The layout of widths and lengths to be primed should be determined before application. A small amount of material 100 gallons or more should be left in the distributor at the end of each shot to prevent uneven application. The area, which can be covered by a load, must therefore be calculated ahead of time.

The rate of application is usually determined from the amount of material that will be absorbed in a 24-hour period. Ideally a trial section is laid out the first day. The application rate may require adjustment by the inspector if the coverage is too heavy or too light. It is sometimes necessary to split the application into two shots.

Care must be taken to prevent spray overlap or missed areas at longitudinal joints between shots of prime. Excess material can be mopped up from overlapped areas and missed spots can be primed with the hand sprayer, but the result will be better if the application is done right in the first place. If gaps are left in the prime coat where traffic will be allowed, the gaps will become potholes in the finished base course.

At transverse joints, building paper should be placed over the end of the old shot of prime and the new shot should begin on the paper (Highways 403-3.04).

Once the prime material has been absorbed enough that tires will not pick it up, traffic may be allowed on the surface. It is the contractor's responsibility to protect the surface from damage until the pavement is placed (Highways 403-3.04, Airports 602-3.3).

Strictly adhere to weather limitations in the contract (Highways 403-3.01, Airports 602-3.1). Rain can wash fresh prime material off the grade, ruining the application and creating a serious pollution problem. It can cause a serious public relations problem with the traveling public, if this oil is splashed on their cars. It can cause extremely hazardous driving conditions. Priming is never allowed in rainy weather.

Prime is normally paid for by weight. Emulsified asphalt is diluted with an equal amount of water prior to application. The state pays only for the undiluted emulsion, not for the dilution water. The distributor is weighed before and after the application and during the mixing process to determine the amount of prime that was placed.

If asphalt concrete will be placed against the surface of curbs, manholes, etc., these surfaces must be tacked (usually by hand). Surfaces of curbs, etc., that *won't* be paved must be protected from the distributor spray.

5.2.4 Blotter Material

The contractor is required to have clean sand available to use as blotter material. The contractor must also have an aggregate spreader to apply it, and a rotary broom to sweep surfaces on which blotter material has been placed (Highways 403-3.05, Airports 602-3.3).



**Figure 5-2
Distributor Truck**

Blotter sand is not normally used, but is sometimes spread on an uncured prime coat. The most common reasons for using it are (1) because traffic must be allowed on the prime before it has cured, and (2) because imminent rain threatens to wash uncured prime off the grade.

The use of blotter sand less than four hours after applying the prime is allowed only with written permission (Highways 403-3.05, Airports 602-3.3 after 48 hours). It is almost impossible to apply blotter without getting thick spots that eventually “reflect” through the surface. Because of this, the use of blotter sand should always be avoided if possible. If the base won’t absorb the prime material within four hours, the application rate probably needs to be reduced.

5.2.5 Emulsified Asphalt Treated Base

Asphalt treatment is used to strengthen the base course prior to paving. Asphalt treatment can be an alternative to placing thicker pavement layers or to replacing a degrading or damaged base course. Only a very brief description of asphalt treated bases is given here. A good source of additional information is Chapter 13 of the Asphalt Institute’s *Asphalt Handbook* (MS-4).

Emulsified asphalt treated base is produced by mixing base course material with emulsified asphalt and sometimes a few percent Portland cement. Portland cement is what the term “cement” usually means and is lime-based. The use of the term Portland cement differentiates it from asphalt cement, which is petroleum-based. Portland cement is added for the following reasons:

1. It may improve workability.
2. The hydration of the Portland cement dries the treated base. This helps the emulsified asphalt to break more rapidly.
3. It adds to the final strength of the base.

The proportions of the components will be listed in an emulsified asphalt mix design report similar to the ones for asphalt concrete.

An emulsified asphalt treated base can be produced using existing or new base course material. It can be mixed on grade by heavy equipment or by specially made traveling plants. It can be produced in a central mixing plant.

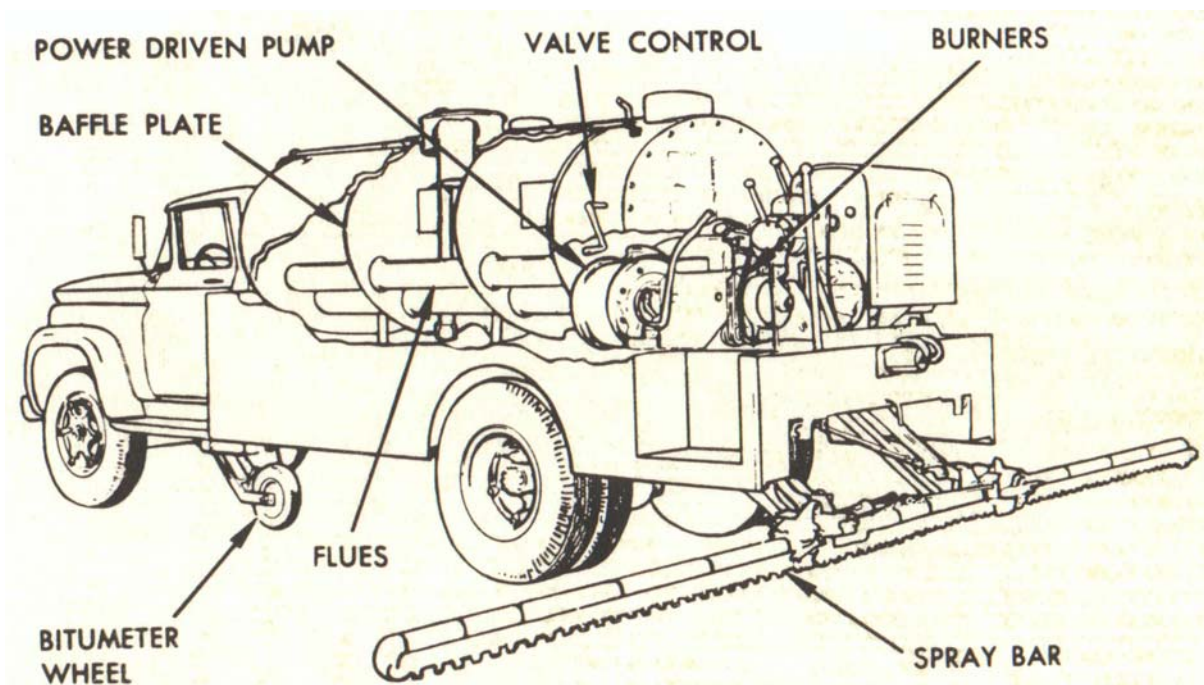


Figure 5-3
Typical Distributor Truck
 Courtesy of the Asphalt Institute

5.3. Distributor Truck

Trailer-mounted distributors are made, but nearly all distributors used in Alaska are truck-mounted units similar to the one shown in the diagram (Figure 5-3). The distributor tank is insulated and has a heating system (burner and flues) to maintain the asphalt material at the proper temperature. The pump circulates the material inside the tank and pumps it to the spray bar and hand sprayer. The bitumeter wheel drives a speedometer and odometer accurate at the low speeds used when priming or tacking (the speedometer usually reads in feet per minute).

Specifications require that the distributor have a pump tachometer, pressure gauges, and a tank thermometer. It must have a circulating spray bar (the material is pumped through the bar and back into the tank as well as out the nozzles). The distributor truck has a flow rate gauge; it measures gallons per minute.

The tank must be calibrated in 50-gallon increments or smaller, so volume measurements can be made.

The distributor truck is one of the most dangerous pieces of equipment on a paving spread. It has the potential for explosion from hot asphalt turning

trapped water (in the piping system) into steam, from fumes being ignited, and from pressure building up during heating operations. There is also the potential of being burned at almost any time during distributor operations, either by the oil itself or the piping or the heating system. It is possible to be overcome by the fumes if proper care is not taken.

Proper operation of the distributor is the key to a good tack or prime coat. It should spray the right amount of tack or prime liquid on to the surface in a uniform film. This requires good equipment, trained operators, and proper adjustment of the following:

1. The height of the spray bar above the surface
2. The speed (pressure and capacity) of the pump
3. The speed of the truck
4. The size and angle of nozzles on the spray bar

The yield can be calculated with four factors in the equation: speed of the truck (feet per minute), length of the spray bar being used (feet), flow rate setting of the pump (gallons per minute), and the desired yield (gallons per square yard).

$$\text{Yield (gal / yd}^2\text{)} = \frac{\text{flow rate (gal/min)}}{\text{Speed (ft / min)} \times \frac{\text{width (ft)}}{9}}$$

The contractor will choose to hold the speed or the flow rate constant for a given width and yield, then calculate the remaining factors. Most distributors have a cardboard “slide rule” that makes this calculation even simpler.

Most distributors use a triple lap spray system (see Figure 5-4); a few use double lap. Closing off two out of every three nozzles can check spray bar height on the triple lap system (or every other one on a double lap). This change should result in a single, uniform coverage. If there is a gap between spray fans the bar is too low; if there are doubly covered streaks the bar is too high. The test may be made on the approved surface. After the bar is set, the test area can be retacked or reprimed to bring the total coverage (“yield”) up to the required amount.

The pump should be operated at the highest speed (pressure) that will not atomize the prime or tack spray. The asphalt coming out of each nozzle should look like a triangular black rubber sheet, not a fog or mist.

Contractors can usually make a good first guess of the pump and truck speeds necessary to achieve the required “yield” (measured in gallons per square yard). The quantity of tack or prime material sprayed on an initial, small area is carefully measured and the yield is calculated. Adjustments (usually to the truck speed) can then be made so that the yield matches plan amounts. Short shots should be repeated until the correct amount of tack or prime is being placed.

Nozzles (“snivvies”) must all be the same size and set at the angle specified by the distributor manufacturer. This is 30° to the spray bar for Etnyre machines, 60° for Grace, 15° for Littleford, and 25° for Roscoe. The fan of material sprayed from a nozzle should be uniform from edge to edge. If it isn’t, the nozzle is clogged, worn or damaged. The fan from all the nozzles should look the same. If they don’t, the pressure may be too low or the nozzles may be different sizes or clogged. If nozzles need to be replaced, the complete set should be changed at the same time to assure uniform operation. Distributors must be kept clean to operate properly, either with steam cleaning or scrubbing with solvent. This is particularly important if emulsions are used, since

residues can set or “break” inside the equipment, fouling or clogging it.

5.4. Responsibilities of the Inspector

Alignment and grade (or leveling) must be checked and approved by the grade inspector prior to priming or tacking. An approved grade may deteriorate under traffic or weather, however. You must therefore inspect and approve the grade immediately before priming or tacking. You must also decide if the surface needs to be moistened prior to priming or tacking. The finished asphalt surface will only be as good as the surface upon which it is laid.

Your measurements, comments, and other information are normally kept in a Prime (or Tack) Log, which is described in the next section. Any unacceptable or out-of-specification condition should be noted in the log. The contractor should be notified *immediately* of any such condition and corrective action taken prior to priming or tacking.

The prime or tack application should be watched constantly to see if the amount of material applied appears appropriate. If not, the yield may need to be adjusted. It takes good judgment and experience to make the proper adjustments to the yield.

You should keep the project engineer informed of the progress of work, especially if there are problems.

The following checklists should help you in your work.

Preliminary Inspection Checklist

- Have the prime or tack log, a 50-foot tape, and an air temperature thermometer.
- Distributor has tachometer, pressure gauges, circulating spray bar, and bitumeter/odometer.
- Tank is calibrated and has a thermometer.
- All nozzles are the same size and set at same angle.
- Plan yield (gals/sq.yd.) has been converted to gals/station for proposed shot width.
- Maximum distance that can be shot with one load has been calculated.
- Spray bar is set at proper height using test strip.
- All nozzles spray a uniform fan of material without misting or fogging.
- Yield on first small area is carefully checked and pump/truck speed adjustments made
- Speed adjustments checked on additional

small areas until proper yield is obtained

Inspection Checklist for Each Shot

- Rain is not likely before tack or prime cures.
- (Tack coat): Old pavement is cleaned, leveled, and/or watered if needed.
- (Prime coat): Base course is tight-bladed and/or watered if needed.
- Surface is adequately warm.
- Building paper is used at beginning of shot.
- Number and effect of any equations are noted in log.
- Time and weather are noted in log.
- Tank and air temperatures are within specs and logged.
- Beginning and ending tank readings have been taken and logged.
- Yield calculated using temperature-corrected volumes or spread rate.
- Location of the area primed or tacked noted on truck weight ticket.
- An approved traffic control plan is in place and *Fresh Oil* signs are in place at all access points if traffic is allowed on the oil.

Routine Inspection Checklist

- (Prime coat): Base course has received grade approval and has passed density tests.
- Manholes, curbs, etc. are hand-primed or tacked.
- Bitumeter wheel is free of asphalt buildup.
- All nozzles spray a uniform fan of material without misting or fogging.
- Spray bar cutoff is positive and immediate.
- Distributor truck is weighed after each shot.
- Traffic is kept off uncured prime or tack.
- Blotter sand is spread on any uncured prime that is threatened by rain or early traffic.

DISTRIBUTOR

It is most important that the distributor be properly adjusted and operated to uniformly apply the proper amount of asphalt.

The bar and its snivies (nozzles) must be properly set to obtain a uniform shot (application). The snivy size, spacing, and angle in relation to the bar determine the height of the bar.

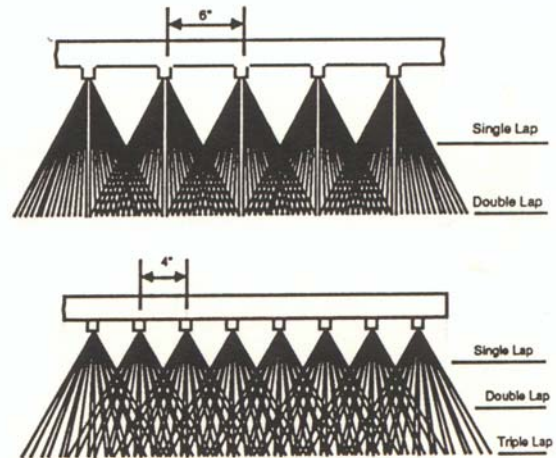


**Figure 5-4a
Distributor Adjustments**

Courtesy of Washington State Department of Transportation

Streaking will occur

- if the asphalt is too cold;
- when the viscosity of the asphalt is too high;
- if the snivies are not all at the same angle;

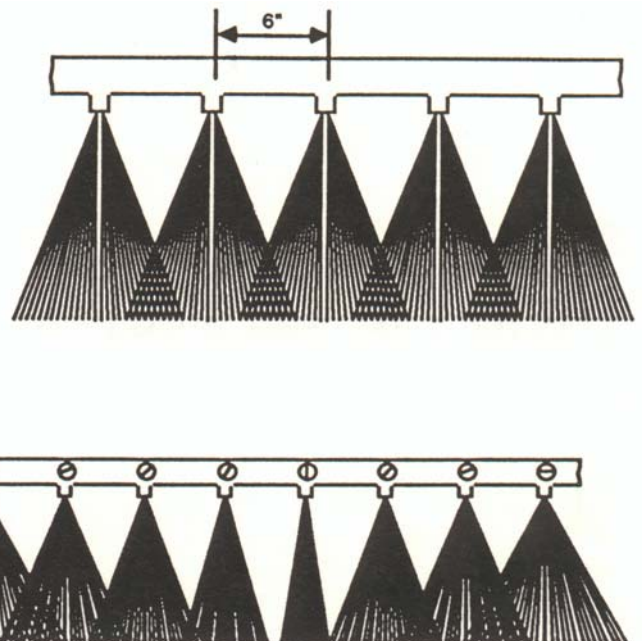
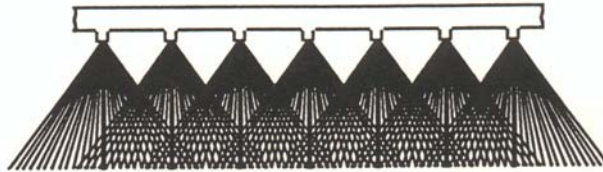


**Figure 5-4b
Distributor Adjustments (Cont.)**

- when the bar is too high;



- when the bar is too low;



Figure 5-4c
Distributor Adjustments (Cont.)

- when the bar pressure is too high. It cuts furrows because the snivies are too small and/or there is too much pump pressure.

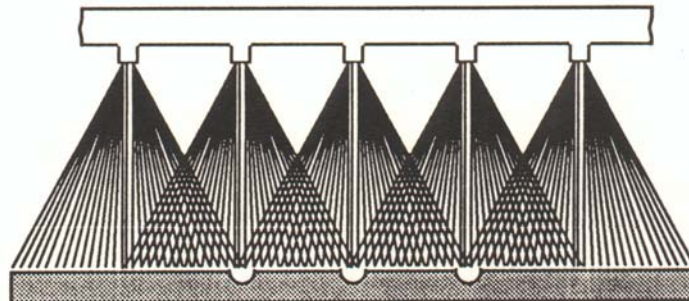


Figure 5-4d
Distributor Adjustments (Cont.)

- When the bar varies in height from a full to an empty distributor, blocking or locking against the overload springs will reduce or eliminate this variance in height.
- When the bar is too long and/or the snivy openings are too large for the pump capacity, this results in narrow and fluttering fans. Smaller snivies and/or higher pump capacity will correct this.
- If the pump pressure is too low it will create narrower spray fans and fluttering.
- If the distributor tank is allowed to run completely empty, an irregular pattern of misses and fluttering will occur across the bar. For this reason, the shot should be terminated while approximately 100 gallons are left in the distributor.



Figure 5-4e
Distributor Adjustments (Cont.)

5.5. Prime and Tack Logs

An example of a page from a tack and a prime log are included at the end of this section. The logbooks should be clearly marked with the name and number of the project as well as the pay item (prime or tack). Pages should be prepared with column headings, etc. ahead of time so you don't have to do this while you should be inspecting the work.

You must sign each page of the log. You can use initials only if there is an index to them in log with your signature (for example J.A.S. = John A. Smith).

Someone unfamiliar with the project should be able to look at your log and determine:

- The *location* of each prime or tack shot
- The *area* covered by the shot
- The *date* and *time* of the shot and the *weather* condition
- The *quantity* of material used on a shot and its *temperature*
- The *plan spread rate* ("yield") and the *actual spread rate*

The station and lane (or offset) information show the location. The width of the shot multiplied by its length gives the area. You must *note any equations* and their effect to determine the length correctly. Notice that in the example log pages, the plan spread rate ("Theo. Spread") has been converted from gals/sq.yd. to gals/station. The actual spread you get on the project can then be calculated in gals/station, too. This is

easier than calculating gals/sq.yd., so it saves time and reduces the chances for errors. The gallons per station method works well if most of the shots will be the same width, usually on a rural job. However, if the width of the road changes frequently, using gallons per square yard is less confusing (though more arithmetic).

The conversion is simply the plan spread (gals/sq.yd.) multiplied by the number of square yards shot per station. The width of the shot in feet times the length (100 feet) will give the number of square feet; dividing this answer by 9 will convert the area to square yards (9 sq.ft. = 1 sq.yd.):

Width (in feet) x 100/9 = Width x 11.11 = Area in square yards, so:

Spread (gals/sq.yd) x width (in feet) x 11.11 = Spread (gals/sta.)

Example

In the sample prime log, the plan spread rate ("Theo. Spread") is 0.30 gals/sq.yd. and the width of the shot is 13 feet, so

$$0.30 \times 13 \times 11.11 = 43.33 \text{ gals/station}$$

The actual spread rate is simply the number of gallons of material used on a shot ("before" gallons minus "after" gallons) divided by the number of stations covered by the shot. The standard temperature at

which the volume of asphalt materials is measured is 60°F. Since asphalt materials expand when heated, volume measurements won't be in "standard gallons" if they aren't made at 60°.

"Hot gallons" must therefore be adjusted to "standard gallons" by multiplying them by a correction factor. Appendix B has tables listing these correction factors for different temperatures. Note that there are tables for three categories of materials. You have to use the correction factor from the right table (the Group I table for cutbacks, the emulsified asphalt table for emulsions).

Example

The first correction factor listed in the sample prime log is 0.9662. This is the factor listed in the Group I table for 146°F, the tank temperature shown in the log. (Since the Group I table has been used, the sample log must be for a cutback asphalt.) The "standard" or "Net Gal" is therefore

$$1150(\text{"Hot Gal"}) \times 0.9662 = 1111 \text{ "Net Gal"}$$

If the material is nearly the same temperature on every shot, the plan spread rate can be converted from "standard" gallons/sta. to an equivalent number of "hot" gallons/sta. The actual spread in "hot" gallons can then be compared directly with the plan "hot" spread rate; you don't have to convert your tank measurements. This saves time and cuts down on chances for errors.

The log should also note any unusual events that occur during the prime or tack operation. If any material is wasted, you should note how much and why. You should also note if the operation stops due to equipment problems or weather. If blotter sand is used, note where and the reason for it.

(Showing how to record waste)

Phil Morris 7/5/72)

Figure 5-5 Sample Tack Log

SAMPLE PRIME LOG

Date: 7/21/72		Lane: Left		Width: 13'		Thea Spread = 0.30 Gal./sq.yd = 43.33 Gal./sta.				
Number of Equations this Section: 0-0						Lab No. 664-1642 Seals: 8421-8418				
Sta.	Temp °F	Tank Reading or Wit. Before	After	Net Gal. or #	Temp. Corr. or Unit Wit.	Net Gal.	Distance in Sta.	Spread Gal./sta	Time of Day	Weather
355+00										
	146°	1250	100	1150	0.9662	1111	25.00	44.44	5:30A	67° Clear
380+00										
	148°	1260	220	1040	0.9655	1004	23.50	42.72		
403+50										
	150°	1275	75	1200	0.9647	1158	27.00	42.89	8:35A	71° Clear
430+50										
	146°	1270	90	1180	0.9662	1140	25.50	44.71		
456+00										
	147°	1245	120	1125	0.9659	1088	25.00	43.53	9:50A	73° Clear
481+00										
E Lane 13 ft. Wide										
355+00										
	147°	1275	105	1170	0.9659	1130	26.00	43.46	10:15A	76° Clear
381+00										
	146°	1165	125	1040	0.9662	1005	23.00	43.70		
404+00										
	145°	1235	70	1165	0.9666	1126	26.00	43.31	11:00A	76° O'cast
430+00										
	144°	1275	95	1180	0.9670	1141	26.50	43.06	12:00 Noon	
456+50										
	144°	1270	160	1110	0.9670	1073	24.50	43.80	1:30P	78° O'cast
481+00					Total = 10976 ÷ 252 = 43.56 Ave. Spread					
checked By: Ted King 7/22/72							Paul Morris 7/21/72			

Figure 5-6
Sample Prime Log