CHAPTER 5 – REVIEW OF CFLHD SPECIFICATIONS

One of the objectives of this study was to review CFLHD specifications for prime and tack coat and compare them with best practices. To assist in determining best practice, the construction specifications from the 13 DOTs that make up the CFLHD region were reviewed and compared to CFLHD's *Standard Specifications* [53], *Construction Manual* [54] and *Field Materials Manual* [55]. In addition, each DOT in the CFLHD region was contacted by phone and surveyed for their typical materials, methods and procedures for using prime and tack coat.

PRIME COAT

Phone Survey

In order to determine typical agency practices regarding prime coat application, a representative from each state DOT was contacted by phone. The agency contact was either a member of the Construction Division or Materials Division. The results from the phone survey for prime coat are shown in Table 4. The responses are general in nature and would represent the normal agency procedures regarding prime coat usage. For the purpose of this study, agency responses of "rarely" or "occasionally" were interpreted as meaning the procedure/material was not used. The purpose of the survey was to determine when prime was used, what material was typically used, if cutbacks were allowed and if there were written guidelines for field personnel regarding deletion of prime coat. The CFLHD responses to the phone survey are included for comparison purposes only and are not included in the summary analysis.

Use of Prime Coat

Aggregate Base:

Two DOTs reported not using prime coats at all. The other 11 DOTs reported using prime coat over aggregate base. Of the 11 DOTs that reported using prime coat over aggregate base, two reported deleting the prime 95 percent of the time, two reported deleting prime coat 75 percent of the time, one reported deleting prime 50 percent of the time, one reported deleting prime 15-20 percent of the time and the remaining five agencies reported deleting prime less than 10 percent of the time. To summarize, 31 percent of the DOTs (4 of 13) reported deleting prime at least 95 percent of the time. Forty-six percent of the DOTs (6 of 13) reported deleting prime at least 75 percent of the time and 46 percent of the DOTs (6 of 13) reported deleting prime less than 25 percent of the time.

Stabilized Base:

Only one DOT reported using prime over asphalt stabilized base, such as a CIR or FDR base, and one DOT reported using prime over other stabilized bases.

Table 4. Results of prime coat practice phone survey.

Survey Questions	Arizona	California	Colorado	Kansas	Nebraska	Nevada	New Mexico
1. Is prime coat typically specified for use over:							
a. aggregate base?	Yes	No	Yes	No	Yes	Yes	Yes
b. cold recycled asphalt base?	No	No	No	No	No	No	No
c. other stabilized bases?	No	No	No	No	No	No	No
d. subgrade?	No	No	Varies	No	No	Yes	No
2. Is prime ever deleted by field personnel?	Yes	N/A	Yes	No	N/A	No	Yes
3. If deleted by field personnel, approximately what percentage of the time is it deleted?	>95%	N/A	50%	N/A	>95%	<1%	< 10%
4. Under what circumstances is prime deleted?	Note 1	N/A	Note 2	N/A	Note 3	Note 4	Note 4
5. Are there formal guidelines for deletion of prime?	Yes	N/A	No	N/A	N/A	No	No
6. Any pavement failures attributed to prime coat?	No	No	No	N/A	No	No	No
7. Material typically specified.	MC-70	N/A	MC-70 PEP AE-P	N/A	AE-P	MC & SC 70,250,800 CRS-1,2 SS-1h, CMS-2	AE-P PE-P
8. Other materials occasionally used.	None	N/A	None	N/A	PE-P	None	MC-70
9. Other comments		Cutbacks not used	Note 5		Cutbacks not used		Cutbacks rarely used

Note 1. If HMA thickness is 100 mm (4 in) or more, prime can be deleted without additional review.
If HMA thickness less 100 mm (4 in), additional review required.
Note 2. Deleted if full depth HMA or if base will be covered within a short period of time.
Note 3. Contractor has the option to delete prime if the base is maintained to the specified condition until placement of HMA.
Note 4. Deleted if base will be covered within a short period of time and contractor maintains specified condition of base.
Note 5. Cutbacks not used in ozone non-attainment areas.

Table 4 (Con't.). Results of prime coat practice phone survey.

Survey Questions	North Dakota	Oklahoma	South Dakota	Texas	Utah	Wyoming	CFLHD
1. Is prime coat typically specified for use over:							
a. aggregate base?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
b. cold recycled asphalt base?	N/A	No	Yes	N/A	No	No	No
c. other stabilized bases?	No	No	No	Yes	No	No	Varies
d. subgrade?	No	Yes	No	No	No	No	No
2. Is prime ever deleted by field personnel?	Yes	Yes	Yes	No	Yes	No	Yes
3. If deleted by field personnel, approximately what percentage of the time is it deleted?	Occasionally	>75%	15-20%	Rarely	>75%	0%	30%
4. Under what circumstances is prime deleted?	Note 4	Note 4	Notes 1 & 4	Note 4	Note 1	N/A	Notes 2 & 5
5. Are there formal guidelines for deletion of prime?	No	No	No	No	No	N/A	No
6. Any pavement failures attributed to prime coat?	No	No	No	No	No	No	No
7. Typical material specified.	MC-70 MC-250	MC-70	MC-70	MC-30	MC-70 MC-250	MC-70	MC-70
8. Other materials occasionally used.	None	SS-1	None	AE-P	SS-1	MC-30	CSS-1, SS-1, MC-30, MC-250
9. Other comments					Cutbacks not available		

Note 1. If HMA thickness is 100 mm (4 in) or more, prime can be deleted without additional review.
If HMA thickness less 100 mm (4 in), additional review required.
Note 2. Deleted if full depth HMA or if base will be covered within a short period of time.
Note 3. Contractor has the option to delete prime if the base is maintained to the specified condition until placement of HMA.
Note 4. Deleted if base will be covered within a short period of time and contractor maintains specified condition of base.
Note 5. Cutbacks not used in ozone non-attainment areas.

Subgrade:

Only three DOTs reported applying prime to subgrade, Colorado, Oklahoma and Nevada. Oklahoma reported that prime was used over subgrade less than 25 percent of the time and was used to ensure that the contractor maintained the specified moisture and density requirements of the subgrade. Colorado reported that the practice varied throughout the state.

Justification

Utah reported that prime coat could be deleted without additional agency review if the total thickness of HMA would exceed 100 mm (4 in). Colorado reported that prime was not used on full depth HMA pavements. Nebraska reported that the contractor is responsible for maintaining the base course within specification tolerances until the HMA is placed and that the use of prime coat is up to the contractor. Nebraska reported that contractors opt to use prime coat less than 5 percent of the time. Seven DOTs reported that prime can be deleted if the base will be covered with HMA within a short period of time and inclement weather is not expected.

Only one DOT, Arizona, has a written procedure for deletion of prime coat. The Arizona DOT Construction Manual states that [56]:

> Prime coats may be eliminated from the work in those cases where the aggregate base surface is tightly bound and will not displace under the laydown machine and hauling equipment. Except, never eliminate the prime coat on a secondary road project that has a chip seal, or an asphaltic concrete friction course applied directly on top of the prime coat.

Materials

Nine DOTs reported using cutbacks for prime coat with MC-70 being the most common followed by MC-250. Only three states, Nebraska, New Mexico and California, reported that cutback asphalts were no longer used by the agency. New Mexico reported using AE-P or PEP. Utah reported that many contractors have had difficulty obtaining either MC-70 or MC-250, and on projects that required prime, diluted SS-1 was reported as being substituted most frequently.

Pavement Failures

None of the DOTs could recall a pavement failure associated with prime coat. One or two DOTs reported hearing of slippage being reported on county roads where prime was deleted. It was generally thought that steep grades and thin pavement sections were involved but this information cannot be verified.

Agency Specifications

The standard construction specifications for the 13 state DOTs in the CFLHD region were reviewed for prime coat practices and specification requirements [57,58,59,60,61,62,63,64,65,66,67,68,69]. Because many CFLHD projects are for the U.S. Forest Service, their specifications were reviewed along with the Unified Facilities Criteria [4] of the military. The specifications were

reviewed to determine placement requirements, weather limitations, materials and application rates. There were several instances found where the specifications allowed materials, such as cutbacks, where the phone survey indicated they were not used by the agency. A summary of agency specifications for prime coat is shown in Table 5. The CFLHD specifications are included for comparison purposes only and are not included in the summary analysis.

Materials

Most agencies were not specific in their specifications with regard to prime coat materials and allow a wide range of materials. Of the 15 agency specifications reviewed, four agencies allowed cutbacks, asphalt emulsions and asphalt cement. Seven agencies allowed either cutback or asphalt emulsion. One agency apiece specified only cutback or asphalt emulsion. Three agencies had material specifications for AE-P or PEP. New Mexico requires the use of AE-P or PEP. California does not allow the use of cutbacks. All agencies indicated that the prime coat material would be indicated on the plans.

Weather Limitations and Curing

All agencies had a statement in their specifications concerning weather conditions. The majority stated that the surface should be dry, although nine agencies specifically mentioned that the surface could be moistened to enhance penetration. Temperature restrictions were found for all but three agencies. The temperature requirements ranged from a low of 4°C (40°F) to a high of 20°C (70°F). One agency required the temperature be above 4°C (40°F), eight required the ambient temperature be above 10°C (50°F), two required the temperature be above 15°C (60°F) and one required the temperature be above 20°C (70°F). Four agencies had requirements on both the ambient and surface temperature.

All agencies required the prime coat be fully cured before allowing traffic on the base or paving over the base with HMA. Cured appeared to be defined as being either not tacky to the touch or no pickup of the prime by traffic. Three agencies required a minimum 48-hour cure and one agency reported placement of HMA was "as directed by the engineer." One agency had separate cure requirements for cutback and asphalt emulsion prime, requiring a minimum five-day cure for cutback and 24 hours for asphalt emulsion. All agencies reported that any excess prime not absorbed into the base within 24 hours be removed with blotter material.

Application Rates

Five of the 15 agency specifications reviewed contained either maximum application rates or an application range. Eight agency specifications indicated that the application range would be found in the plans or special provisions and two agencies reported that the engineer or project monitor would provide the application rate. Application rates would vary depending on the material used and the permeability or openness of the base.

Table 5. Summary of agency prime coat specifications.

Agency	Material	Application Rates (L/m^2)	Temperature Limitations	Cure Requirements	Moisten Surface
Arizona (*57*)	CB & Emulsions	Shown in Special Provisions	Ambient > 20 C (70 F)	N/M	Yes
California (*58*)	No CB	1.15 (0.25 gal/yd^2)	N/M	N/M	N/M
Colorado (*59*)	AE-P PEP	Shown on Plans	N/M	N/M	N/M
Kansas (*60*)	CB & Emulsions	Shown on Plans	Ambient > 15 C (60 F)	48 hrs	Yes
Nebraska (*61*)	CB	1.35 (0.30 gal/yd^2)	Ambient >10 C (50 F)	N/M	N/M
Nevada (*62*)	CB & Emulsions	Shown on Plans	Ambient >10 C (50 F)	Cured	N/M
New Mexico (*63*)	AE-P PEP	By Project Manager	Ambient > 10 C (50 F)	N/M	Yes
North Dakota (*64*)	All	Shown on Plans	Ambient or Surface > 4 C (40 F)	48 hrs	N/M
Oklahoma (*65*)	CB & Emulsions	0.45 - 1.8 (0.1 - 0.4 gal/yd^2)	Ambient >10 C (50 F)	Cured	Yes
South Dakota (*66*)	CB & Emulsions	Shown on Plans	Ambient and Surface > 15 C (60 F)	As Directed by the Engineer	Yes
Texas (*67*)	All & AE-P PEP	By Engineer	Ambient >10 C (50 F)	N/M	Yes
Utah (*68*)	All	Shown on Plans	Ambient >10 C (50 F)	N/M	N/M
Wyoming (*69*)	All	Shown on Plans	Ambient or Surface > 10 C (50 F)	N/M	Yes
USFS (*70*)	CB & Emulsions	MC: 0.45 - 2.25 (0.10 - 0.50 gal/yd^2) EAC: 0.45 - 1.35 (0.10 - 0.30 gal/yd^2)	Ambient and Surface > 10 C (50 F)	Cutback 5 days EAC 24 hrs	Yes
UFC (*4*)	CB & Slow Set Emulsions	0.45 - 1.13 (0.10 - 0.25 gal/yd^2)	N/M	48 hours	Yes
CFLHD (*53*)	CB & Emulsions	MC: 0.45 - 2.25 (0.10 - 0.50 gal/yd^2) EAC: 0.45 - 1.35 (0.10 - 0.30 gal/yd^2)	Ambient and Surface > 10 C (50 F)	MC: 3 days EAC: 24 hrs	Yes

N/M = Not mentioned in specifications. CB = Cutback asphalt. EAC = Emulsified asphalt cement.

Application rates ranged from a low of 0.45 L/m^2 (0.10 gal/yd^2) to a maximum of 2.25 L/m^2 (0.50 gal/yd^2). All agencies indicated that the exact application rate would require approval by the engineer.

TACK COAT

Phone Survey

The results from the phone survey for tack coat practices are shown in Table 6. The responses are general in nature and would represent the normal agency procedure or procedures regarding tack coat usage. For the purpose of this study, an agency response of "rarely" was interpreted as meaning the procedure/material was not performed. The purpose of the survey was to determine when tack was used, what material was typically used, and if there were written guidelines for field personnel regarding deletion of tack coat. The CFLHD responses to the phone survey are included for comparison purposes only and are not included in the summary analysis.

Use of Tack Coat

All 13 DOTs reported using tack coat on a routine basis. All DOTs reported applying tack to existing HMA surfaces and between lifts of new HMA. Four DOTs indicated that they apply tack coat to an aggregate base or primed aggregate base. Six of the 10 DOTs that reported placing cold recycled asphalt pavements indicated they would use a tack coat on the recycled mix. Only one DOT reported not tacking a concrete surface prior to overlay with HMA prior to placing the HMA surface. All agencies reported that vertical surfaces, such as longitudinal joints, construction joints, curbs, gutters, etc. should be tacked.

Tack coat was rarely deleted by field personnel although nine of 13 DOTs reported that field personnel have deleted tack coat and only four agencies reported that tack was not deleted. Sixty-nine percent of the DOTs (9 of 13) reported that tack coats are not deleted or rarely deleted (< 5%) by field personnel. Three additional DOTs, or 92 percent of the DOTs (12 of 13), reported that tack is deleted less than ten percent of the time. One DOT reported that tack was deleted 25 percent of the time.

Justification

No DOT had written guidelines for deletion of tack coat. Seven of the respondents stated that tack is occasionally deleted if the existing surface is a new or recently placed HMA and the surface is clean, not tracked up and the surface is tacky. Three DOTs indicated the same conditions for deletion of tack as stated above and added that both lifts needed to be placed in the same day. One DOT added that the project must be small. Two DOTs, Texas and California, reported increased emphasis on using tack coat.

Table 6. Results of tack coat practice phone survey.

Survey Questions	Arizona	California	Colorado	Kansas	Nebraska	Nevada	New Mexico
1. Is tack coat typically specified over:							
a. new HMA surface?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
b. Old or existing HMA surface?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
c. aggregate base?	No	No	Yes	No	N/A	No	Yes
d. cold recycled asphalt base?	No	No	Yes	Yes	No	Yes	Yes
e. concrete surface?	Yes	Yes	Yes	Yes	Yes	No	Yes
2. Is tack ever deleted by field personnel?	Yes	No	No	Yes	No	Yes	Yes
3. If deleted by field personnel, approximately what percentage of the time is tack deleted?	Rarely	Rarely	Rarely	Rarely	<1%	25%	Rarely
4. Under what circumstances is tack deleted?	Note 1		Note 2	Note 1		Note 3	Note 3
5. Are there formal guidelines for deletion of tack?	No	Yes	No	No		No	No
6. Any pavement failures attributed to tack coat?	No	No	Yes	Yes	No	No	Yes
7. What was typical defect?	N/A	Debonding	Debonding / slippage	Debonding	N/A	N/A	Slippage
8. Material typically specified.	SS-1	AR-4000	CSS-1, 1h SS-1, 1h	SS-1h CSS-1h	SS-1h CSS-1h	SS-1h	CSS-1, 1h SS-1, 1h
9. Other material occasionally used?	PG-binder	CSS-1, SS-1	None	RC-70	None	SS-1, CSS-1, 1h	PG binder
10. Other comments		Note 3		Note 4			

Note 1. Deleted if existing surface is clean, tacky and will be covered in same day.
Note 2. Deleted if project is small and existing surface is clean and tacky.
Note 3. Deleted if existing surface is clean, tacky and will be covered within a short period of time.
Note 4. Full scale load testing showed debonding if tack inadequate. New guidelines published in March 2003.
Note 5. Failures attributed to too little tack coat.
Note 6. Do not allow dilution of tack. Ongoing research has shown dilution adversely affects bond strength.

Table 6 (Con't.). Results of tack coat practice phone survey.

Survey Questions	North Dakota	Oklahoma	South Dakota	Texas	Utah	Wyoming	CFLHD
1. Is tack coat typically specified over:							
d. new HMA surface?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
c. Old or existing HMA surface?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
a. aggregate base?	Yes	No	Yes	No	No	No	No
b. cold recycled asphalt base?	N/A	N/A	Yes	Yes	No	N/A	Yes
e. concrete surface?	Yes	Yes	Yes	Yes	Yes	N/A	Yes
2. Is tack ever deleted by field personnel?	Yes	Yes	No	Yes	Yes	Yes	Yes
3. If deleted by field personnel, approximately what percentage of the time is tack deleted?	10%	<5%	<1%	<10%	<10%	<5%	Rarely
4. Under what circumstances is tack deleted?	Note 3	Note 3	Note 3	Note 3	Note 3	Note 1	Notes 1 & 3
5. Are there formal guidelines for deletion of tack?	No	No	No	Yes	No	No	No
6. Any pavement failures attributed to tack coat?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7. What was typical defect?	Slippage	Slippage	Debonding	Debonding	Debonding	Slippage	Slippage
8. Typical material specified.	SS-1h CSS-1h	SS-1	SS-1h CSS-1h	SS-1h CSS-1h	SS-1h	SS-1, 1h	CSS-1, 1h SS-1, 1h
9. Other material occasionally used?	MS-1	None	None	PG binder	None	None	None
10. Other comments				Note 6	Note 5		

Note 1. Deleted if existing surface is clean, tacky and will be covered in same day.
Note 2. Deleted if project is small and existing surface is clean and tacky.
Note 3. Deleted if existing surface is clean, tacky and will be covered within a short period of time.
Note 4. Full scale load testing showed debonding if tack inadequate. New guidelines published in March 2003.
Note 5. Failures attributed to too little tack coat.
Note 6. Do not allow dilution of tack. Ongoing research has shown dilution adversely affects bond strength.

Materials

Kansas DOT was the only agency that reported occasionally using cutback asphalts as tack coat. Kansas reported that cutback was occasionally used in cool weather and over concrete pavements to improve bond. Twelve of the 13 DOTs reported using slow set emulsified asphalts as the primary material for tack coat, either an SS-1 or SS-1h or a CSS-1 or CSS-1h. California reported that a paving grade asphalt, AR-4000, was the most common tack coat material followed by either SS-1 or CSS-1 emulsified asphalt. New Mexico and Texas reported that PG binders were occasionally used as tack.

Pavement Failures

None of the DOTs could recall a specific pavement failure associated with tack coat; however, none of the 13 DOTs could recall a pavement failure, either slippage or debonding, that was possibly caused by tack coat. Insufficient tack was mentioned as a cause of debonding, but in no instance was too much tack listed as the cause of slippage. California and Texas recently released new guidelines for tack coat application. California's tack coat application rates were increased [71] to prevent debonding that was reported in pavements tested at an accelerated loading facility [72] and Texas revised their application rates to address debonding as well [22]. The Texas DOT reported no longer allowing dilution of emulsions for tack coat to improve bond strength.

Agency Specifications

The standard construction specifications for the 13 state DOTs in the CFLHD region, the US Forest Service [70] and the UFC [4] specifications were reviewed to determine placement requirements, weather limitations, materials and application rates for tack coat. There were several instances found where the specifications allowed materials, such as cutbacks, where the phone survey indicated they were not used by the agency. A summary of agency specifications for tack coat is shown in Table 7. The CFLHD specifications are included for comparison purposes only and are not included in the summary analysis.

Materials

Most agencies allow a wide range of materials for use as tack coat in their specifications. All agency specifications allowed emulsified asphalts and a few agencies indicated that asphalt cements could be used. The Kansas DOT was the only agency that specified cutbacks. Ten agencies reported diluting asphalt emulsions with water to achieve more uniform coverage. Five agencies required a 1 to 1 dilution with water, one agency used 40% water, two agencies indicated the dilution rate would be stated in the plans or determined by the engineer, and two agencies did not specify a dilution rate.

Table 7. Summary of agency tack coat specifications.

Agency	Application Rates (L/m^2)	Temperature Limitations	Require Dry Surface	Tack Vertical Surfaces	Require Dilution	Limits on Application
Arizona (*57*)	Target rate of 0.3 - 0.5 (0.06 - 0.12 gal/yd^2)	NF	Yes	NF	NS	Same Day Coverage
California (*58*)	See table 8	A & B mix >10 C (50 F) Base mix > 5 C (40 F)	Yes	Yes	NS	Same Day Coverage
Colorado (*59*)	Shown in Plans and Specifications	Surface or Ambient > 5 C (40 F)	Yes	Yes	NS	NF
Kansas (*60*)	Shown in Plans and Specifications	Air > 4C (40 F) Surface > 7 C (45	Yes	Yes	50%	NF
Nebraska (*61*)	0.2 - 0.45 (0.05 - 0.10 gal/yd^2)	Surface > 3 C (37 F)	Yes	NF	50%	NF
Nevada (*62*)	Shown in Plans and Specifications	Ambient & Aggregate > 4 C (40 F)	Yes	Yes	40% Water	Same Shift Coverage
New Mexico (*63*)	Provided by Project Manager	Ambient > 7 C (40 F)	Yes	Yes	NS	NF
North Dakota (*64*)	Shown in Plans and Specifications	Surface or Ambient > 5 C (40 F)	Yes	NF	50%	NF
Oklahoma (*65*)	< 0.45 (0.10 gal/yd^2)	NF	Yes	Yes	Yes	Same Day Coverage
South Dakota (*66*)	Shown in Plans and Specifications	Surface or Ambient > 2 C (35 F)	Yes	Yes	As Per Engineer	Same Day Coverage
Texas (*67*)	0.2 - 0.45 (0.04 - 0.10 gal/yd^2)	Surface > 15 C (60 F)	Yes	Yes	Not Allowed	NF
Utah (*68*)	Shown in Plans and Specifications	Surface > 10 C (50 F)	Yes	Yes	In Plans	Same Day Coverage
Wyoming (*69*)	Shown in Plans and Specifications	Surface & Air > 5 C (40 F)	NF	Yes	50%	Same Day Coverage
USFS (*70*)	0.15 - 0.70 (0.03 - 0.15 gal/yd^2)	Surface > 5 C (40 F)	Yes	NF	50%	Cover Within 4 hrs
UFC (*4*)	0.23 - 0.68 (0.05 - 0.15 gal/yd^2)	NF	Yes	NF	Yes	Same Day Coverage
CFLHD (*53*)	0.15 - 0.70 (0.03 - 0.15 gal/yd^2)	Surface > 2 C (35 F)	Yes	NF	Yes	Cover Within 4 hrs

NF = Not found in specifications. NS = Not specified.

Weather Limitations and Curing

Weather limitations for tack coat application were generally the same as for HMA paving and were often found under paving specifications rather than tack coat specifications. Twelve agencies required a minimum ambient and/or surface temperature before placing tack. Minimum temperatures for tack application ranged from a low of 2°C (35°F) to a high of 15°C (60°F).

All agencies required the surface to be clean and dry during tack application. Six agencies specifically required the tack be cured (allowed to break) before paving. No mention of breaking or curing prior to overlay was found in the remaining agency specifications. Seven agencies required tack to be covered the same day it was placed, one agency required coverage in the same shift and one agency required coverage within 4 hours. All agencies indicated that no more tack should be placed than could be covered in the same day and tack that was not covered would require re-tacking prior to paving. The Texas DOT has a test to evaluate tackiness of the tack coat [(73)]. The current test method, TEX 243-F, is subjective; however, an objective test method is under development [(73)].

Ten agency specifications made reference to applying tack coat to all vertical surfaces, including longitudinal and transverse joints, curbs and gutters, and other structures. It appeared from the review of the specifications that if tack were deleted, longitudinal and transverse joints would not be tacked either.

Application Rates

Seven of the 15 agency specifications reviewed contained either a maximum recommended application rate or an application rate range for tack coat. Seven agency specifications indicated that the application range would be found in the plans and one agency reported that the engineer would provide the application rate. Application rates vary depending on the material used, the condition of the existing surface and how application rates are reported. Application rates can be reported as residual asphalt content, undiluted liquid asphalt content or as a diluted quantity for diluted asphalt emulsions. Application rates ranged from a low of 0.15 L/m^2 (0.03 gal/yd^2) to a maximum of 0.70 L/m^2 (0.15 gal/yd^2). All agencies indicated that the exact application rate would require approval by the engineer. Recommended application rates recently released by the California DOT [(71)], based on results from full scale load tests [(72)], are shown in Table 8. Recommended tack coat application rates from the Texas DOT [(22)], based on OCAPE recommendations [(21)], were shown in Table 2.

CFLHD SPECIFICATIONS

The CFLHD *Standard Specifications* [(53)], *Construction Manual* [(54)], and *Field Materials Manual* [(55)] were reviewed to obtain information on prime and tack coat requirements for comparison to local agency practice. The information from CFLHD *Standard Specifications* [(53)], *Construction Manual* [(54)] and *Field Materials Manual* [(55)] are shown in Tables 5 and 7 to aid in comparison of CFLHD's practice to local agency practices.

Table 8. Recommended tack coat application rates [71].

Asphalt Concrete overlay (except Open Graded) Liters per square meter			
Type of Surface to be Tack Coated	Slow-Setting Asphaltic Emulsion	Rapid-Setting Asphaltic Emulsion	Paving Asphalt
Dense, Tight Surface (e.g., between lifts)	0.20 – 0.35 [A]	0.10 – 0.20[B]	0.05 – 0.10
Open Textured or Dry, Aged Surface (e.g., milled surface)	0.35 – 0.90 [A]	0.20 – 0.40 [B]	0.10 – 0.25
Open-Graded Asphalt Concrete overlay Liters per square meter			
Type of Surface to be Tack Coated	Slow-Setting Asphaltic Emulsion	Rapid-Setting Asphaltic Emulsion	Paving Asphalt
Dense, Tight Surface (e.g., between lifts)	0.25 – 0.50[A]	0.10 – 0.25 [B]	0.05 – 0.15
Open Textured or Dry, Aged Surface (e.g., milled surface)	0.50 – 1.10 [A]	0.25 – 0.55 [B]	0.15 – 0.30

[A]Asphaltic emulsion diluted with additional water. The water shall be added and mixed with the asphaltic emulsion (which contains up to 43 percent water) so that the resulting mixture will contain one part asphaltic emulsion and not more than one part added water. The water shall be added by the emulsion producer or at a facility that has the capability to mix or agitate the combined blend.
[B]Undiluted Asphaltic Emulsion.

Prime Coat

As shown in Table 5, the CFLHD specifications and practices for prime coat compare well with agency specifications within the CFLHD jurisdiction. The CFLHD specifications were one of several specifications that required scarification of the base to improve penetration when priming with emulsified asphalts. CFLHD did not have a materials specification for AE-P and PEP. With air pollution requirements limiting the usage of cutback asphalts in some locations, a materials specification for AE-P and PEP would be a beneficial addition.

Tack Coat

As shown in Table 7, the CFLHD specifications and practices for tack coat compare well with agency specifications within the CFLHD jurisdiction. The CFLHD specifications are more restrictive in materials allowed and curing conditions than most agencies reviewed. CFLHD could consider including paving grade asphalt cements for use as tack coat. A specific reference to tacking vertical surfaces of longitudinal and transverse joints, and the surface of angled longitudinal joints could remove some confusion among CFLHD field personnel and contractors, and result in standard practice for tacking joints. Finally, inclusion of application rates similar to those recommended by OCAPE [21] and published by Texas DOT [22], as shown in Table 2, or those published by the California DOT [71], as shown in Table 8, could provide additional guidance in selecting initial tack coat application rates.