EXECUTIVE SUMMARY

BACKGROUND

Prime and tack coats have a purpose in the pavement construction process, yet many times they are misused or eliminated during the project. While most of the time no harm appears to occur to the roadway and thus may be viewed as acceptable, technical guidance is warranted to assure appropriate usage. Unfortunately, the Central Federal Lands Highway Division (CFLHD) had no guideline document that described the conditions when prime and tack coats are necessary, and when they may be eliminated with confidence.

The objective of this study was to produce a prime and tack coat guide publication developed for project development and field personnel to provide decision-making guidance on how to use, when to keep, and when to eliminate prime and tack coats. In order to meet the objectives, this report was prepared to summarize the information collected from a literature review as well as information supplied through interviews and documents from knowledgeable experts, bituminous materials suppliers, industry organizations, state departments of transportation (DOT), and other agencies.

The literature search was conducted to determine the applicability and benefits of prime and tack coat, prime and tack coat effectiveness, materials used and when and where they are used. This activity included searching the databases of Transportation Research Information Services (TRIS), National Technical Information Services (NTIS), International Construction Database (ICONDA), Engineered Material Abstracts, EI Compendex, South African National Road Agency and the Association of Australian and New Zealand Road Transport and Traffic Authorities. Publications from AASHTO, TRB, ASTM and NCHRP were reviewed as well.

A review of CFLHD's current construction specifications was undertaken to compare CFLHD's current specifications with best practices and proposals for improving CFLHD's specifications were made. Due to the scarcity of research reports specifically devoted to prime and tack coat, a phone survey of current practice of state DOTs from the CFLHD region was undertaken to provide information on current practice. CFLHD's current prime and tack coat specifications were compared with best practices, as determined by the above tasks, and with standard specifications of the state DOTs within the CFLHD region.

A review of the potential harmful and positive environmental effects of the prime and tack coat process, including the various bituminous products used, was undertaken. General guidelines for the requirements for handling and storage of the bituminous materials as well as remedial action to take in the case of an accidental spill were reviewed.

Based on the information collected from the literature review as well as information supplied through interviews and documents from knowledgeable experts, bituminous materials suppliers, industry organizations, state DOTs, or other agencies, and summarized in the above tasks, a guideline for CFLHD project development and field personnel was developed. The guideline

provides decision-making guidance on how to use, when to keep, and when to eliminate prime and tack coats.

LITERATURE REVIEW

The literature search focused on handbooks and technical reports. There were few technical reports found on prime or tack coat. Only two technical reports were found that were specifically related to prime coats; a total of 37 references were cited in these two reports. However, only four of those references were research studies, two relating to prime coats and two relating to tack coats. There were 13 technical reports found which were directly related to tack coat application and performance. A total of 74 documents are cited in the report. Due to the scarcity of research reports specifically devoted to prime and tack coats, a survey of current practice of state DOTs from the CFLHD region was undertaken to provide information on current practice. The results from the literature review and survey were sufficient to allow determination of state-of-the-practice, material selection, application rates, when and where prime and tack coats are applied, and when and where they are deleted.

ENVIRONMENTAL ISSUES

Environmental issues related to the use of prime and tack coat are complex due to the overlapping jurisdiction of several federal agencies and the fact that the regulations are subject to interpretation by the courts. Local, state and federal regulations should be consulted for specific regulations regarding environmental issues with use of cutback and asphalt emulsions. Environmental issues related to the use of prime and tack coats can be grouped under the concerns of air and water quality, hazardous materials and worker safety.

Air Quality Issues

The primary pollutants of concern from asphalt paving operations are volatile organic compounds (VOC). Cutback asphalts are the major source of VOCs as only minor amounts of VOCs are emitted from emulsified asphalts and asphalt cements. VOC emissions from cutback asphalts result from the evaporation of the petroleum distillate used to liquefy the asphalt cement. VOC emissions can occur at both the job site and the mixing plant; however, the largest source of emissions was reported as from the road.

Asphalt emulsions are typically used in place of cutback asphalts to eliminate VOC emissions. The use of cutback asphalt is regulated in many jurisdictions to help reduce VOC emissions. Prohibitions on the use of cutback, either permanently or during certain times of the year, are common in jurisdictions that have either reached, or are nearing non attainment for ozone requirements of the Clean Air Act.

Water Quality Issues

Water quality issues are much more complex than air quality issues because of the overlapping jurisdiction of several federal agencies, the complexity of many of the regulations, and the variability of regulations and jurisdictions on the state and local levels.

The Environmental Protection Agency (EPA) has interpreted asphalt emulsions and cutback as oil as defined in the Clean Water Act; therefore, there is no differentiation between spills of cutback or asphalt emulsion. The Clean Water Act, in part, requires that any spill of oil that could enter a waterway and violates applicable water quality standards or causes a film or sheen on the water, would require reporting to the National Response Center and local authorities. A direct spill into a waterway is not the only way prime and tack coat materials can enter a waterway. Entry is available through a spill that enters storm water and waste water sewers, drainage ditches or runoff from a rain shower. It is generally recommended that prime coat be omitted if there is a strong possibility of runoff.

The reporting requirements for a spill of oil on the ground that does not enter a waterway, for oil as defined by the clean water act, is more complicated due to the various agencies that could have jurisdiction. Under Spill Prevention, Control and Countermeasure (SPCC) regulations, a spill of oil must be reported to the National Response Center and local authorities if, in part, the spill is greater than 3,785 L (1,000 gal) or a spill of over 160 L (42 gal) of oil in each of two spills occur within a 12 month period. Local requirements could be more stringent.

Under the Resource Conservation and Recovery Act (RCRA), hazardous chemicals have an associated reportable quantity (RQ). If a spill or release of more than a RQ of a material occurs at a site, the spill must be reported to the National Response Center and local authorities. There can be RCRA regulated materials in cutback and occasionally in some asphalt emulsions. However, these RCRA hazardous materials are usually present in such low concentrations that those RQs would rarely be reached in normal paving operations. State and local jurisdictions can have lower RQ requirements and suppliers and local agencies should be contacted if there is a question concerning a reportable spill.

Worker Safety and Hazardous Materials Issues

According to RCRA, asphalt cement is not considered a hazardous material. However, occasionally RCRA defined hazardous materials are contained in diluents used to make cutback asphalts or in additives added to emulsifying agents or performance enhancing agents in asphalt emulsions. The concentrations of these RCRA defined hazardous materials in MC cutbacks and asphalt emulsions are usually in such small quantities that a major release, much larger than would be likely to occur on a typical CFLHD paving project, would be required to meet or exceed RCRA reportable quantity (RQ) limits.

Other worker safety issues concern health risks to workers from exposure to the product, fire danger and stability or reactivity of the product. The majority of the materials typically used for prime or tack is reactive or pose more than a slight health risk. There is a health risk associated with worker exposure to fumes from heated asphalt products, mainly in confined spaces. This is not usually an issue when applying prime or tack coat if workers stay a reasonable distance away from the spray bar during application. Fire can be a concern when using MC for prime coat or rapid cure cutbacks (RC) for tack coat as application often involves heating the material above its flash point. This should not be a serious issue for CFLHD as they do not specify RC cutback for prime or tack.

Contractor Liability Issues

There is the possibility of civil liability and public relations/public perception issues associated with accidental spills or releases of oils. Many local jurisdictions, including cities and counties, are routinely deleting prime coat, often at the request of the contractor. The rational for deleting prime coat appears to be that the benefits of prime do not outweigh the increased liability associated with handling liquid asphalts.

CONCLUSIONS

Based on the literature review and information supplied through the phone survey, interviews with knowledgeable experts, bituminous materials suppliers, industry organizations, state DOTs, and other agencies, the following conclusions for prime and tack coat usage are warranted.

Prime Coat

1. The major purpose of prime coat is to protect the underlying layers from wet weather by providing a temporary waterproofing layer.
2. Additional benefits of prime coat are stabilizing or binding the surface fines together and promoting bond to the HMA layer.
3. Prime must adequately penetrate the base to function properly.
4. Medium cure cutbacks are normally used for prime. Medium cure cutback asphalts penetrate deeper than conventional emulsified asphalts. Dilution of emulsified asphalts with water helps penetration but emulsified asphalts generally require mixing into the base to function properly.
5. Prime coats need to be allowed to cure completely before covering with HMA. Cutbacks generally take longer to cure than asphalt emulsions.
6. Excess prime not absorbed into the base after 24 hours should be absorbed with blotter sand and removed from the surface.
7. Prime is often deleted in cold weather because it is riskier to pave over uncured prime than over unprimed base.
8. Prime coats are often deleted if no wet weather is anticipated and the base can be covered within seven days. Prime may not be necessary if the HMA is greater than 100 mm (4 in) thick.
9. Prime coat increased the bond strength at the interface between a compacted base and asphalt layer over that of no prime coat. The reported differences were not always statistically significant.
10. At higher static normal stresses, shear strength at the interface is not appreciably affected by the type or even the presence of a prime coat. This supports the practice of deleting prime at a minimum HMA thickness, typically 100 mm (4 in).
11. Use of prime coat is not a substitute for maintaining the specified condition of the base or subgrade.
12. Prime should not be applied to stabilized bases or subgrade.
13. The main environmental concern with prime coat applications is air pollution associated with the release of VOCs into the air.

14. The EPA treats spills of cutbacks and emulsified asphalts the same; therefore, priming with emulsified asphalts or specially formulated penetrating asphalt emulsions does not result in reduced oil spill reporting regulations or requirements.
15. Deleting prime would lessen the amount of liquid asphalt contractors must handle, lessening the associated liability with handling these products.
16. Prime may be omitted if there is a strong possibility of runoff entering a waterway.

Tack Coat

1. The purpose of tack coat is to ensure bond between the existing pavement surface and a new pavement surface.
2. A loss of bond between HMA layers can cause crescent-shaped slippage cracks or debonding to occur, leading to reduced pavement life.
3. Prior to tack application the surface should be clean, dry and free from loose material.
4. Applying tack is not a substitute for properly cleaning the existing HMA surface.
5. Tack coat should be applied in a thin coat and uniformly cover the entire surface, including all vertical surfaces of joints and structures. Too little tack coat can cause debonding and too much tack coat can cause slippage.
6. If possible, all traffic should be kept off tacked surfaces.
7. Tack should be applied to old existing HMA surfaces and PCC surfaces.
8. Tack has been successfully deleted between new lifts of HMA when the existing surface is still clean and tacky.
9. There is not complete agreement regarding the requirement that tack coat be allowed to break and set before placing the HMA layer.
10. Many factors were shown to affect laboratory interface shear strength, including rate of shear, magnitude of normal force, temperature and joint construction.
11. In a few studies, tacked surfaces were shown to have slightly lower interface shear strengths than untacked surfaces. However, in these studies the statistical significance of the difference in interface shear strength was not reported. In reports where the statistical significance of the differences in interface shear strength was evaluated, tacked interfaces were either stronger or not significantly different from untacked interfaces.
12. The higher the viscosity of the bituminous binder in the tack, the higher the reported interface shear strength.
13. At typically specified application rates, application rate had little effect on interface shear strength. Higher than recommended application rates resulted in slightly lower interface shear strengths.
14. Diluted slow set emulsions are typically used for tack coat.

RECOMMENDATIONS

CFLHD Specifications

Based on the literature review and information supplied through the phone survey, interviews with knowledgeable experts, bituminous materials suppliers, industry organizations, state DOTs, and other agencies, the following changes to CFLHD's *Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, FP-03,* are proposed.

1. Specifications for AE-P and PEP should be added to *Section 702. – ASPHALT MATERIAL* under subsection *702.03 Emulsified Asphalt*.
2. In *Section 412. – ASPHALT TACK COAT*, asphalt binder, meeting the requirements of subsection *702.01 Asphalt Cement*, could be added to subsection *412.02*. This would allow contractors the option of tacking with the paving grade asphalt cement.
3. A reference to the requirements for tacking longitudinal and transverse joints, placed in the *Construction Manual* or *Field Materials Manual*, would remove questions regarding the necessity of tacking joints. This could be most helpful with longitudinal joints.
4. A table placed in either the *Construction Manual* or *Field Materials Manual* with recommended application rates for different surface conditions, similar to those shown in Tables 2 and 8, could assist CFLHD field personnel with initial tack coat application rates.

Guidelines for Prime and Tack Coat Usage

A decision tree and flow chart included in Chapter 7, were developed to provide CFLHD project development and field personnel decision-making guidance on how to use, when to keep, and when to eliminate prime and tack coat.