MEMORANDUM

Texas Department of Transportation

TO: District Engineers

DATE: November 19, 2009

FROM: David B. Casteel, P.E.

SUBJECT: Policy for Alternate Pavement Design for New Construction and Total Reconstruction

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The "Policy for Alternate Pavement Design for New Construction and Total Reconstruction" (Attachment 1) has been issued to ensure that every effort is made to increase the competition for paving contracts.

The Texas Department of Transportation's (TxDOT) Llife Cycle Cost Analysis (LCCA) procedure, outlined in Attachment 1, has not been completed; however, we will begin the first phase of implementation. Effective immediately, the districts will submit both rigid and flexible pavement options in their plans, specifications, and estimates for projects that fall within the yellow portion (thickness design - without LCCA) of the alternate pavement design requirements chart in Attachment 1.

During this time, projects that fall within the orange portion of the chart should follow the guidelines in Mr. Barton's October 22, 2008 memorandum (Attachment 2), with two exceptions: 1.) the same type of pay schedule will be required for both pavement types; and 2.) referenced December 2, 2004 memorandum has been superseded by Mr. Bohuslav's April 1, 2009 memorandum (Attachment 3).

Upon completion of TxDOT's LCCA procedure, you will be notified to implement the remainder of the "Policy for Alternate Pavement Design for New Construction and Total Reconstruction."

If you have any questions concerning this memorandum or attached policy, please contact Magdy Mikhail at (512) 465-3686.

Attachments

cc: District Directors of Construction
District Directors of Maintenance
District Directors of Transportation Planning and Development
District Pavement Engineers
Mark A. Marek, P.E., Director, Design Division
Toribio Garza, Jr., P.E., Director, Maintenance Division
J. Jeffrey Seiders, Jr., P.E., Construction Division
Ken L. Barnett, P.E., Construction Division
Magdy Mikhail, P.E., Construction Division

Attachment 1

Policy for Alternate Pavement Design for New Construction and Total Reconstruction

This policy has been issued to ensure that every effort is being made to increase the competition for paving contracts and that the latest market rate is considered when determining pavement type when bids are received from the contractor.

When preparing plans, specifications, and estimates for projects with alternate pavement designs, the Texas Department of Transportation's (TxDOT) Life Cycle Cost Analysis (LCCA) will be utilized as outlined below for adjusting bid proposals. LCCA is an engineering economic analysis tool that compares the relative merit of competing project pavement alternatives. By considering the appropriate agency costs incurred during the service life of the pavement, TxDOT is able to analyze and prepare comparable flexible and rigid pavement designs that allow the contractor to consider market rates while preparing their bid and to select the pavement alternative that they can furnish for the lowest price.

Project Selection

Chart 1 provides the criteria of project selection for incorporation of alternate pavement designs into construction plans.

Projects with greater than 30 percent trucks or 100,000 average daily traffic (ADT), or any combination of percent trucks and ADT that falls above the curve in Chart 1, will require a LCCA and a design life of 30 years for both rigid and flexible pavements. These projects are represented by the orange region in Chart 1. The flexible pavement will require a perpetual design without staged construction. The LCCA will be used to determine the bid adjustment factors for these projects.

Projects with up to 30 percent trucks and ADT greater than 10,000 but less than 100,000, which are represented by the yellow region in Chart 1, will be referred to as "Thickness Design." Both the rigid and flexible alternates will have a 20-year design life. The rigid pavement is further defined by a minimum slab thickness of 6 inches. The flexible pavement design will be limited to one structural overlay with a maximum thickness of 2 inches. LCCA is not required, but it may be used for these projects at the discretion of the district. When LCCA is used for these projects, the cost of the structural overlay will be included to determine the bid adjustment factors.

For projects with less than 10,000 ADT, alternate pavement designs are not required. These projects are represented by the green region in Chart 1.

Exceptions

Several exceptions may justify utilization of district preference in lieu of incorporating an alternate pavement design in the construction plans. These exceptions are:

- projects with a total pavement cost less than $5 million;
- projects where it is necessary to match adjacent pavement types (i.e. intersections or projects of minimal length) requires specific documentation in the pavement design file; and,
- projects where constructability constraints such as limitations in width, traffic control, drainage, construction sequencing, etc., dictate a specific pavement type, requires specific documentation in the pavement design file.

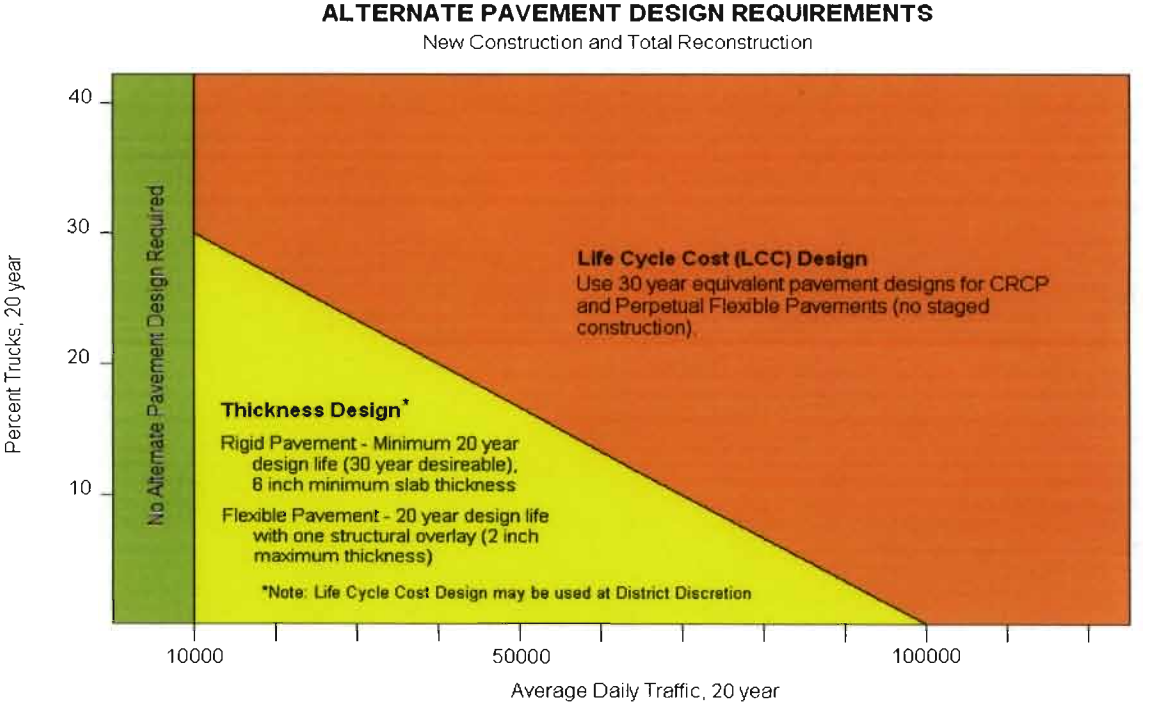

Chart 1. Criteria for Alternate Pavement Design

Exceptions

Several exceptions may justify utilization of district preference in lieu of incorporating an alternate pavement design in the construction plans. These exceptions are:

- Projects with a total pavement cost less than $5 million.
- Projects where it is necessary to match adjacent pavement types (i.e. intersections or projects of minimal length) requires specific documentation in the pavement design file.
- Projects where constructability constraints such as limitations in width, traffic control, drainage, construction sequencing, etc., dictate a specific pavement type, requires specific documentation in the pavement design file.

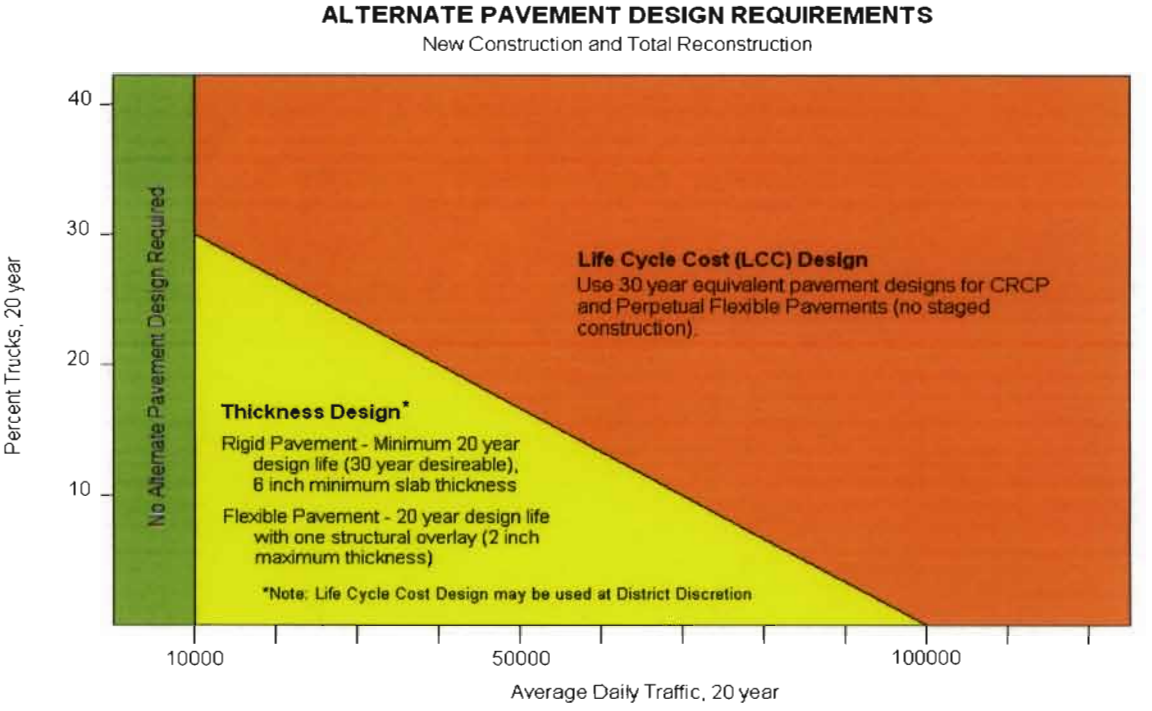

Chart 1. Criteria for Alternate Pavement Design

Attachment 2

MEMORANDUM

Texas Department of Transportation

TO: District Engineers **DATE:** October 22, 2008

FROM: John A. Barton, P.E. John A. Barton, P.E.

SUBJECT: Guidelines for Alternate Pavement Designs (Design-Bid-Build Process)

As we have discussed on numerous occasions over the past several months, it is appropriate for us to consider the use of alternates during the design of our projects to encourage competition and ensure we are receiving the best prices for the work being performed. This practice applies to the design of our pavements as well. The attached guidelines provide recommendations of pavement design parameters for flexible and rigid pavements when alternate pavement designs are included in the plans. These recommendations are intended to ensure that both pavement types are designed to the same standard.

In addition, the use of alternative pavement designs (concrete versus flexible) has been shown to be beneficial in reducing cost, even without discounting maintenance cycles. In accordance with Mr. Saenz' memorandum dated February 26, 2007, "Cost Control Summary Responses," districts are strongly encouraged to include alternative pavement designs in their PS&E whenever this is appropriate. These attached guidelines have been discussed with industry.

As a reminder, I have also attached Mr. Bohuslav's memorandum dated December 2, 2004, that provided suggested alternative design strategies for rehabilitating flexible pavements when non-competitive and proprietary processes and materials are desired.

If you have any questions, please contact Magdy Mikhail, P.E. at (512) 465-3686.

Attachments

cc: David Casteel, P.E., AED DO
Thomas R. Bohuslav, P.E., Director, Construction Division
Zane L. Webb, P.E., Director, Maintenance Division
Mark A. Marek, P.E., Director, Design Division

Guidance for Alternate Pavement Design Projects

This document provides guidance for projects when the PS&E allow an alternate pavement design. Alternate pavement designs should be used for new construction or full reconstruction projects.

These guidelines are provided to have both pavement types designed to the same standard. These recommendations will replace current requirements included in the Pavement Design Manual for when flexible and rigid pavements are used as alternates.

Recommendations for Design Parameters for Alternate Pavement Design in the PS&E (Design-Bid-Build):

- **Design Life**: Both pavement types should be designed to the same period of 30 years.
- **Initial Serviceability Index**: The same serviceability index of 4.5 should be used for both pavement types.
- **Terminal serviceability Index**: The same terminal serviceability index of 2.5 should be used for pavement types.
- **Reliability**: The same reliability level of 95% should be used for both pavement types.
- **Time to first overlay for Flexible Pavement Design**: The time to first overlay to be used as a FPS 19W design input is 15 years (applies to flexible only).
- **Potential Vertical Rise (PVR)**: Design the overall subgrade and pavement structure to have a PVR no greater than 1.0 inch, as calculated by Tex-124-E from soil tests in a soil column 15 feet deep measured from the proposed finished pavement grade. The districts can alter the value based on local experience but must use the same value for both pavement types.
- **Recommendations for Ride Quality:** Use Pay Schedule 2 as the contract requirement for both pavement types.

The department has an ongoing research project that will address additional aspects of alternate pavement designs. The research project will provide guidelines on when to include alternative pavement designs in the plans and also protocols to evaluate competing bids of different pavement types.

MEMORANDUM

Texas Department of Transportation

TO: District Engineers
Phillip E. Russell, P.E

DATE: December 2, 2004

FROM: Thomas R. Bohuslav, P.E.

SUBJECT: Alternate Pavement Rehabilitation Options

Attached are guidance documents providing potential alternatives for Hot in Place Recycling (HIR), Ultrathin Bonded Hot Mix Wearing Course (UBHMWC), Reflective Crack Relief Interlayer (RCRI) and Thin Bonded Permeable Friction Course (TBPFC). This guidance is being provided for the districts optional use to promote competition.

The alternates proposed are considered comparable pavement rehabilitation techniques, when used with applicable time restrictions on pertinent PS&E requirements. No claims of equal performance are intended. Use these guidelines with engineering judgment when selecting rehabilitation options.

If you have any questions, please contact the Construction Division. Pavement related questions can be directed to Magdy Mikhail, P.E., (512) 506-5838 and time requirements related questions to Bob Hundley, P.E., (512) 416-2509.

Attachments

cc: Amadeo Saenz, Jr., P.E., Assistant Executive Director
Zane Webb, P.E., Director, Maintenance Division
Mark Marek, P.E., Director, Design Division

Table of Attachments

Guidelines for Alternate Rehabilitation Options for Hot In-Place Recycling

This guideline provides a brief description of the Hot In-Place Recycling (HIR) process and alternates for the repaving process to be considered to increase competition. Specifications and suggested general notes for each alternate are included. Special provisions for lane rental are also included.

Purpose of HIR and Alternates Herein - is correcting asphalt pavement surface distress such as surface cracking, roughness, or lack of skid resistance through recycling the existing pavement. HIR can be effective in correcting surface defects, as long as the defects are not caused by structural inadequacy of the pavement. The HIR process involves recycling the existing asphalt surface layer by heating, scarifying and adding a recycling agent. The recycled material is placed on the roadway surface and a thin overlay of new hot mix is placed over the recycled layer and the entire pavement layer is compacted using conventional compaction equipment.

Three options are:

- Option 1 (Repaving): This process involves recycling the existing asphalt surface layer by heating, scarifying and adding a recycling agent. The recycled material is placed on the roadway surface and a thin overlay of new hot mix is placed over the recycled layer. The entire operation is placed using a single piece of equipment. The entire pavement layer is compacted using conventional compaction equipment.

- Option 2 (Surface Recycling and Overlay): This process involves heating and scarifying the top layer of asphaltic pavement (typically top 1 inch), mixing a recycling agent and placing the recycled mix and compacting it. The new overlay is placed with a regular paving machine separate from the recycling equipment.

- Option 3 (Mill and Overlay): This process involves milling one inch of the existing top layer and placing back two inches. 30 % RAP should be allowed in the new two inch overlay.

Table 1 provides the required specification and special provisions for the three different options.

Table 1

Contract Alternates	Items Used			Special provision 001-xxx. (For Lane Rental)	Special provision 008-xxx. (For Lane Rental)	General Notes
	341	354	358			
Option 1	✓		✓	✓	✓	GN for Item 358
Option 2	✓		✓	✓	✓	GN for Item 358
Option 3	✓	✓		✓	✓	GN for item 341

Special General Notes for Options 1 and 2 for Item 358:

Guidelines for Alternate Rehabilitation Options for Hot In-Place Recycling

1. Do not mix the rehabilitated hot mix with the new hot mix.
2. Ensure the heated and scarified material has a temperature between 248 and 266 degrees Fahrenheit as measured immediately behind the scarifier.
3. Ensure the loose rehabilitated material is free of wheel ruts from recycling equipment before placing the new hot mix.
4. Place the new ACP overlay before the temperature of the in-place mix of the rehabilitated surface drops below 174 degrees Fahrenheit. Otherwise, place an extra 1/2-in. thickness of hot mix asphalt for the new layer to achieve the required in-place density and the proper ride quality. Place all additional temporary striping. Provide this additional work and materials at no expense to the Department. (This note allows Options 1 and 2).
5. General note for project specific lane rental schedule. (Example attached)

Special General Note for Option 3 for Item 341:

1. A maximum of 30% RAP from the milling will be allowed in the new surface mix.
2. General note for project specific lane rental schedule. (Example attached)

Key to Contract Specifications & Provisions

342 Dense-Graded Hot-Mix Asphalt (QC/QA)
354. Planning and Texturing Pavement
358 Asphalt Concrete Surface Rehabilitation

SP 001-xxx: Definition of Terms. (Draft example attached)
SP 008-xxx: Prosecution and Progress-Lane Rental. (Draft example attached)

To implement the lane rental specifications please refer to the example lane rental schedule shown at the end of this document. A project specific variation of this schedule would be included in the general notes.

Guidelines for Options for Ultra-thin Bonded Hot Mix Wearing Course

This guideline provides a brief description of the Ultrathin Bonded Hot Mix Wearing Course (UBHMWC) process and an alternate to be considered to increase competition. Specifications and suggested general notes for each alternate are included. Special provisions for lane rental are also included.

Purpose of UBHMWC – This surface is used as a preventive maintenance treatment to restore skid resistance, improve ride quality. The UBHMWC may also be used in cases of restrictions on overlay thickness due to clearance requirements.

- **Option 1:** Ultrathin Bonded Hot Mix Wearing Course is an open-graded mix placed on polymer modified rapid setting emulsion tack coat. The mix is placed before the emulsion breaks using a specialty paver. The paver must meet the requirements of the special specifications 3001.

- **Option 2**: An alternate would be to place an underseal (seal coat) plus a ¾" PFC, with two specific pieces of equipment.

Table 1 provides the required specification and special provisions for the two different options.

Table 1

Contract Alternates	Items Used			Special Provision 001-xxx. (For Lane Rental)	Special Provision 008-xxx. (For Lane Rental)
	3001	316 or 318	342		
Option 1	✓			✓	✓
Option 2		✓	✓	✓	✓

Special General Notes for Options 1 and 2

1. General note for project specific lane rental schedule. (Example attached)

Key to Contract Specifications & Provisions

316. Surface Treatment
318. Hot Asphalt-Rubber Surface Treatments
342. Permeable Friction Course (PFC)
3001. Ultra-Thin Bonded Hot Mix Wearing Course (UTBHMWC)

SP 001-xxx: Definition of Terms. (Draft example attached)
SP 008-xxx: Prosecution and Progress-Lane Rental. (Draft example attached)

To implement the lane rental specifications please refer to the example lane rental schedule shown at the end of this document. A project specific variation of this schedule would be included in the general notes.

December 2, 2004

Guidelines for Options for Reflective Crack Relief Interlayer

This guideline provides a brief description of the Reflective Crack Relief Interlayer (RCRI) process and an alternate to be considered to increase competition. Specifications and suggested general notes for each alternate are included.

Purpose of RCRI and alternate - The purpose of a RCRI is to retard reflection cracks on asphalt concrete overlays on top of jointed concrete pavements. The RCRI is not a rut resistant layer and may have low skid resistance. The RCRI should be covered with an adequate overlay thickness (minimum 3 inches) as soon as possible, usually within a few days.

- **Option1:** Reflective Crack Relief Interlayer (RCRI) is a fine mix that is designed for cracking resistance using the flexural beam fatigue. The mix is typically placed one inch thick and should be covered with an adequate overlay thickness to provide adequate resistance to rutting.

- **Option 2**: Rich Bottom Layer (RBL), the resistance to cracking of the RBL can be evaluated using the overlay tester. The RBL should be designed to 98% lab molded density using 50 gyrations. The mix is usually 1" thick.

Table 1 provides the required specification for the two different options.

Table 1

Contract Alternates	SS xxxx RCRI	344
Option 1	✓	
Option 2		✓

Key to Contract Specifications & Provisions

xxxx. Reflective Crack Relief Interlayer (RCRI) (Draft one time use specification attached)
344. Performance-Designed Mixes

Special General Notes for Options 1.

1. Where the (RCRI) is under traffic, place the overlay on top of the (RCRI) within 5 days.

Special General Notes for Option 2.

1. Design the RBL using 50 Gyrations.
2. Design the RBL to 98% Lab molded density.
3. Where the (RBL) is under traffic, place the overlay on top of the (RBL) within 5 days.

December 2, 2004

Guidelines for Alternate Options for Thin Bonded Permeable Friction Course

This guideline provides a brief description of the Thin Bonded Permeable Friction Course (TBPFC) process and also an alternate to be considered to increase competition. Specifications and general notes for each alternate are included. Special provisions for lane rental are also included.

Purpose of TBPFC and Alternate - This pavement surface is intended to provide a surface course placed on a sealed pavement surface on a high-speed roadway to increase safety and ride.

Option 1: TBPFC is the PFC mix placed on a polymer modified rapid setting emulsion tack coat before the emulsion breaks using a specialty paver that must meet the requirements for Item 3000.

Option 2: An alternate option to this process would be place an underseal (seal coat) plus a PFC, with two separate pieces of equipment.

Table 1 provides the required specification and special provisions for the two different options.

Table 1

Contract Alternates	Items Used			Special Provision 001-xxx. (For Lane Rental)	Special Provision 008-xxx. (For Lane Rental)
	3000	316 or 318	342		
Option 1	✓			✓	✓
Option 2		✓	✓	✓	✓

Special General Notes for Options 1 and 2

1. General note for project specific lane rental schedule. (Example attached)

Key to Contract Specifications & Provisions

316. Surface Treatment
318. Hot Asphalt-Rubber Surface Treatments
342. Permeable Friction Course (PFC)
3000. Thin Bonded Permeable Friction Course (TBPFC)

SP 001-xxx: Definition of Terms. (Draft example attached)
SP 008-xxx: Prosecution and Progress-Lane Rental. (Draft example attached)

To implement the lane rental specifications please refer to the example lane rental schedule shown at the end of this document. A project specific variation of this schedule would be included in the general notes.

SPECIAL PROVISION
TO
ITEM 1 DEFINITION OF TERMS

For this project, Item 1, "Definition of Terms", of the Standard Specifications, is hereby amended with respect to the clauses cited below and no other clauses or requirements of this changed hereby.

This Item is supplemented by the following:

1.85 Lane Rental Charge. The estimated hourly cost of interference and inconvenience to the road user for lane closures above and beyond those specified in the plan documents or for travel lane obstructions caused by the contractor. The lane rental period will begin when a traffic lane(s) is closed to traffic and will end when the closure is discontinued. The Engineer will determine the beginning and ending time of the lane closure for rental purposes. The lane rental provision will be applicable without regard to the length of the lane closed to traffic.

1.86 Obstruction. When the contractor's operations and/or equipment result in the usable lane width of the travelway to be less than that specified in the plan documents.

1.87 Hour. Any continuous 60-minute period or portion of a continuous 60-minute period beginning at that point when a lane(s) is closed or obstructed by the contractor's operations.

1.88 Quarter Hour. Any 15-minute period or portion of a 15-minute period. Fifteen minute periods will start either on the hour, or fifteen (15) minutes past the hour, or thirty (30) minutes past the hour, or forty-five (45) minutes past the hour.

SPECIAL PROVISION
TO
ITEM 8
PROSECUTION AND PROGRESS

For this project, Item 8, "Prosecution and Progress", of the Standard Specifications, is hereby amended with respect to the clauses cited below and no other clauses or requirements of this item are waived or changed hereby.

Article 8.5. Failure to Complete Work on Time is supplemented by the following:

The contractor will be assessed a lane rental charge for each lane or lanes closed or for each lane or lanes obstructed from the time the number of free lane closure hours has been exceeded until substantial completion of the project. The rental charge will be assessed for each lane or lanes closed or obstructed for each direction of traffic as shown in a lane rental table that is provided elsewhere in the contract. ***(ie: IN THE GENERAL NOTES)*** The hourly lane rental rates will be prorated to a quarter hour basis for lane closures that are less than one hour in duration.

The lane rental charge will be assessed not as a penalty, but for added expense incurred by the traveling public and by the department. These assessments will be deducted from any moneys due or to become due the Contractor.

EXAMPLE GENERAL NOTES FOR LANE RENTAL

General Notes Item 8

In reference to the Special Provision amending article 8.6, a lane rental charge will be assessed for each lane or lanes closed or obstructed for each direction of traffic as shown in the following table.

Highway Mainlane Closures	* Peak Hours (6-9 AM and 3-7 PM M-F)		Off-Peak Hours (9 AM to 3 PM M-F)		Nighttime Hours (7 PM to 6 AM M-F)		Weekend Hours (Fri 8 PM to Mon 6 AM)	
**No. of Lanes Closed	Hourly Lane Rental	Number of Free Lane Closure Hours	Hourly Lane Rental	Number of Free Lane Closure Hours	Hourly Lane Rental	Number of Free Lane Closure Hours	Hourly Lane Rental	Number of Free Lane Closure Hours
1	$10,000	0	$3,000	600	$1,000	1000	$1,000	1000
2	$20,000	0	$8,000	100	$3,000	250	$3,000	250
3	NA	NA	$10,000	100	$5,000	100	$5,000	250

Highway Frontage Road Closures	*** Peak Hours (6-9 AM and 3-7 PM M-F)		Off-Peak Hours (9 AM to 3 PM M-F)		Nighttime Hours (7 PM to 6 AM M-F)		Weekend Hours (Fri 8 PM to Mon 6 AM)	
****No. of Lanes Closed	Hourly Lane Rental	Number of Free Lane Closure Hours	Hourly Lane Rental	Number of Free Lane Closure Hours	Hourly Lane Rental	Number of Free Lane Closure Hours	Hourly Lane Rental	Number of Free Lane Closure Hours
1	$7,500	0	$3,000	1000	$1,000	1000	$1,000	1000
2	$10,000	NA	$5,000	NA	$3,000	200	$3,000	200

* No lane closures will be allowed during the peak-hours. If the lanes are not opened at the beginning of the period the contractor will be charged the lane rental fee shown.

** Closure of two lanes will only be allowed at night and on weekends.
Closure of three lanes will only be allowed for the hanging of the beams.

*** No lane closures will be allowed during the peak-hours. If the lanes are not opened at the beginning of the period the contractor will be charged the lane rental fee shown.

**** Closure of two lanes will only be allowed at night and on weekends as defined in the table.

SPECIAL SPECIFICATION

XXXX

Reflective Crack Relief Interlayer (RCRI)

1. **Description.** Produce and place a Reflective Crack Relief Bituminous Interlayer (RCRI) in one lift (1 in. thickness) in accordance with the plans, or as directed. Provide a RCRI meeting the requirements for asphaltic concrete defined in the Items "Dense-Graded Hot-Mix Asphalt (Method)" and "Dense-Graded Hot-Mix Asphalt (QC/QA)", except as modified by this specification.

2. **Materials.**

   A. **Asphalt Binder.** The Hveem Stability and Flexural Beam Fatigue requirements of Section 3.C.1. of this specification determine the final formulation for the asphalt binder used in the RCRI. Provide asphalt binder meeting the minimum requirements of Table 1 with a PG high temperature of 76°C and a PG low temperature of -22°C. Ensure the asphalt binder is smooth and homogeneous when tested in accordance with Test Method Tex-540-C. Separation, measured by the softening point, will be no more the 6°C.

   Separation testing is not required if:

   - Introducing a modifier separately at the mix plant either by injection in the asphalt line or mixer,
   - Blending the binder on site in continuously agitated tanks, or
   - Basing acceptance on field samples taken from an in-line sampling port at the hot mix plant after adding the modifiers.

Special Specification XXXX Reflective Crack Relief Interlayer (RCRI)

Table 1
Performance Graded Binders

Performance Grade	PG 58			PG 64				PG 70				PG 76				PG 82		
	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28
Average 7-day Max Pavement Design Temperature, ºC[1]	58			64				70				76				82		
Min Pavement Design Temperature, ºC[1]	>-22	>-28	>-34	>-16	>-22	>-28	>-34	>-16	>-22	>-28	>-34	>-16	>-22	>-28	>-34	>-16	>-22	>-28
ORIGINAL BINDER																		
Flash Point, AASHTO T 48: Min, ºC	230																	
Viscosity, AASHTO TP 48:[2,3] Max, 3.0 Pa□s, Test Temperature, ºC	135																	
Dynamic Shear, AASHTO TP 5:[4] G*/sin(□, Min, 1.00 kPa Test Temperature @ 10 rad/sec., ºC	58			64				70				76				82		
Elastic Recovery, ASTM D 6084, 50ºF, % Min	-	-	30	-	-	30	50	-	30	50	60	30	50	60	70	50	60	70
ROLLING THIN FILM OVEN (Tex-541-C)																		
Mass Loss, Max, %	1.0																	
Dynamic Shear, AASHTO TP 5: G*/sin(□, Min, 2.20 kPa Test Temperature @10 rad/sec., ºC	58			64				70				76				82		
PRESSURE AGING VESSEL (PAV) RESIDUE (AASHTO PP 1)																		
PAV Aging Temperature, ºC	100																	
Dynamic Shear, AASHTO TP 5: G*/sin(□, Max, 5000 kPa Test Temperature @10 rad/sec., ºC	25	22	19	28	25	22	19	28	25	22	19	28	25	22	19	28	25	22
Creep Stiffness, AASHTO TP 1:[5,6] *S*, Max, 300 MPa, *m* - value, Min, 0.300 Test Temperature @ 60 sec., ºC	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18
Direct Tension, AASHTO TP 3:[6] Failure Strain, Min, 1.0% Test Temperature @1.0 mm/min., ºC	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18

[1]Pavement temperatures are estimated from air temperatures using an algorithm contained in a TxDOT supplied computer program, may be provided by the Department or by following the procedures outlined in AASHTO MP 2 and PP 28.

[2]This requirement may be waived at the Department's discretion if the supplier warrants that the asphalt binder can be adequately pumped, mixed, and compacted at temperatures that meet all applicable safety, environmental, and constructability requirements. At test temperatures where the binder is a Newtonian fluid, any suitable standard means of viscosity measurement may be used, including capillary (AASHTO T 201 or T 202) or rotational viscometry (AASHTO TP 48).

[3]Viscosity at 135ºC is an indicator of mixing and compaction temperatures that can be expected in the lab and field. High values may indicate high mixing and compaction temperatures. Additionally, significant variation can occur from batch to batch. Variation could significantly impact mixing and compaction operations. Contractors are responsible for addressing any constructability issues that may arise.

[4]For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be substituted for dynamic shear measurements of G*/sin(□) at test temperatures where the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary (AASHTO T 201 or T 202) or rotational viscometry (AASHTO TP 48).

[5]Silicone beam molds, as described in AASHTO TP 1-93, are acceptable for use.

[6]If creep stiffness is below 300 MPa, direct tension test is not required. If creep stiffness is between 300 and 600 MPa, the direct tension failure strain requirement can be used instead of the creep stiffness requirement. The *m*-value requirement must be satisfied in both cases.

B. Blended Aggregate.

1. **Description.** The blended aggregate may consist of local materials; natural sands (50% maximum), crushed fines, and screenings (manufactured sands) meeting the criteria in Article 340.2 of the Standard Specification except as modified herein.
   a. Do not use RAP in the RCRI
   b. Submit samples of each aggregate for approval in accordance with Item 6, "Control of Materials" of the Standard Specification acceptance of the RCRI is based on mixture qualities (performance, volumetrics, and stability) shown in this specification.

2. **Gradation.** Produce blended aggregates meeting the requirements shown in Table 2.

Table 2
Gradation Requirements

Sieve Size	Percent by Weight (Tex-200-F, Part II)
3/8"	100
No. 4	80 – 100
No. 8	60 – 85
No. 16	40 – 70
No. 30	25 – 55
No. 50	15 – 35
No. 100	8 – 20
No. 200	6.0 –14.0

3. **Sand Equivalent.** The sand equivalent of the total blend is a minimum of 45% as determined by Tex-203-F.

4. **Material Acceptance.** Prior to using, the Engineer will sample, test, and approve the aggregates.

3. **Sampling and Design.** Provide the Job Mix Formula (JMF), Hveem Stability testing, and Flexural Beam Fatigue testing. Also, provide quality control in accordance with Item 340, "Dense-Graded Hot-Mix Asphalt (Method)" of the Standard Specifications and technical support for production and placement of the RCRI.

A. Job Mix Formula. Obtain, in the presence of the Engineer, representative samples of asphalt binder and mineral aggregates for testing. Provide samples of materials of the size specified and submit them to the designated laboratory for testing. Develop and submit the JMF, certified test results, and job control specimens for approval.

1. No mixture will be accepted for use until the JMF and job control specimens are approved.

2. Provide a JMF within the master range specified for the RCRI and include the type and sources of all materials, the gradations of the aggregates, the relative quantity of each material, and state a definite percentage for each sieve fraction of aggregate and asphalt binder.

3. The JMF approved for the RCRI will be in effect until modified in writing by the Engineer. Ensure the AASHTO T 321-03 test results are submitted to the Engineer. When unsatisfactory results or other conditions occur, or should a source of material be changed, a new JMF will be requested in accordance with the requirements of this Specification.

B. Mixture Testing Procedures. The RCRI will be tested in accordance with Section 340.4. (A), except as noted.

- Do not use RAP in the RCRI
- Use Test Method Tex-200-F, Part II "Washed Sieve Analysis" to develop the JMF
- Moisture susceptibility testing is not required
- Individual aggregate quality limitations shall conform to Sections 2.B.2. "Gradation" and 2.B.3., "Sand Equivalent".

C. Job Mix Formula Acceptance Criteria.

1. Fifty gyrations (N_{max} = 50) will be required for SuperPave gyratory compaction (150mm molds for volumetric properties). The JMF will meet the following volumetric and performance requirements. Prior to compacting the beams, age the RCRI for beam testing 4 hours at 135°C in accordance with AASHTO PP2-99 Section 7.2 "Mechanical Property Testing" prior to compacting the beams.

Table 3
Laboratory Mixture Design Properties

Mixture Property	Test Procedure	Criteria
Asphalt Content, %, min.	Tex-236-F	7.0
Air Voids (Va), %	Tex-207-F	0.5 - 2.5
Voids in the Mineral Aggregate (VMA), %, min.	Tex-207-F	16.0
Hveem Stability*, min.	Tex-208-F	18.0 min.
Flexural Beam Fatigue**, min., avg. of 2 samples	AASHTO T 321-03	100,000 cycles**

* Perform test at 140°F using 100mm molds, 50 gyrations, and the Superpave Gyratory Compactor
** Test parameters: 2000 Microstrain, 10 Hz, 3.0±1.0% air voids*, 20°C
Note: The void requirement for the Flexural Beam Fatigue test specimens differs from the gyratory samples. The 3.0 ± 1.0% air voids represents the in-place construction density.

2. **Job Control Specimens:** Produce job control specimens using the proposed JMF and compact to N_{max} (50 gyrations) using 150 mm SuperPave Gyratory Compactor Molds. Determine the Voids in the Mineral Aggregate (VMA) and Air Voids (Va).

3. Submit the Voids in the Mineral Aggregate (VMA) and Air Voids (Va) for the job control specimens to the Engineer. Do not place the mixture on the project until the job control specimens have been verified by the Engineer.

4. Construction Methods.

A. Surface and Base Preparation: Prior to placing the RCRI, thoroughly clean the surface of all vegetation, loose materials, dirt, mud, visible moisture, and other objectionable materials. Fill joints larger than 1/2 in. wide as directed. Use ASTM non-expansive crackfiller, silicone joint material or similar material, that will not be affected by the heat of the RCRI during placement.

Repair moderately or highly D-Cracked areas, high severity punch-outs, blow-ups, or severe distresses with a doweled, full-depth patch.

Prior to placing the RCRI, fill large surface deformities (greater than 3 in. deep and 4 ft. in diameter) with approved hot mix. Prior to placing the RCRI, fill smaller pavement deformities such as popouts, corner breaks, and spalls with the RCRI mixture.

B. Weather Limitations: Place the RCRI when the temperature of the surface on which the RCRI will be placed is 60°F or higher. Do not place the RCRI on a wet surface or within 24 hours of a rain unless approved actions are taken to dry the pavement.

C. Application of Tack: Apply only undiluted tack in accordance with Item 300, "Asphalts, Oils, and Emulsions". Apply at rates from 0.02 to 0.04 gal. per square yard (undiluted tack) as determined by the Engineer. Cutback asphalt tack is not permitted.

Place a tack coat between the hot mix overlay and the RCRI with undiluted tack.

D. Quality Control. Ensure the aggregate gradation and the asphalt binder content of the produced mixture does not vary from the JMF by more than the tolerances shown in Table 4, except as approved. Take control samples every 750 tons based on random numbers supplied by the Engineer. Sampling will take place at the hot mix plant in accordance with test method Tex-222-F, "Sampling Bituminous Mixtures". Each sample will be tested for the following qualities:

- Tex-200-F, "Washed Sieve Analysis"
- Tex-236-F**, "Determining Asphalt Content from Asphalt Paving Mixtures by the Ignition Method"
- Tex-227-F, "Determining Maximum Specific Gravity of Bituminous Mixtures"

- Tex-207-F, Part I, "Bulk Specific Gravity of Bituminous Material"
- Tex-203-F, "Sand Equivalent", 1 per 3 sublots

Note: Testing will be complete within one working day of the end of the sublot.

** Perform correction factors for asphalt content and gradation (#200 sieve) prior to the completion of the test strip or first sublot during production. Lab blend these samples using the JMF binder content and place in the ignition oven. Use the difference between the oven's display and the JMF binder content to correct the binder content during production.

Gradation Control: The maximum deviation from the approved JMF is shown in Table 4:

Table 4
Operational Tolerances

Description	Test Method	Allowable Difference (%) from Current JMF Target
% passing the No. 8 sieve	Tex-200-F	□4.0
% passing the No. 200	Tex-200-F	1.0
Air Voids (Va), %	Tex-207-F	□0.5
VMA, %	Tex-207-F	□1.0
Asphalt Content, %	Tex-236-F	□0.3

1. **Gradation Adjustment:** Adjustments to the Natural Sand portion of the gradation are limited to ±5% from the JMF and not to exceed the 50% natural sand limit as outlined in Section 2.B., "Blended Aggregate".

Mixture Control. Supply control specimens from the RCRI produced for the project in accordance with Section 340.3(2) Tex-207-F, Part I, "Bulk Specific Gravity of Bituminous Material". Ensure the specimens are within the following volumetric criteria when compacted to N_{max} of 50 gyrations using a Superpave gyratory Compactor. Ensure the mixture control is within the tolerances shown in Table 4 above.

1. **Asphalt Content Control:** Ensure the asphalt binder content is within the tolerances shown in Table 4 above.

Per Section 340.3(2), if 3 consecutive test results for the mix, or 2 consecutive test results for the binder content, fall outside the specified range, cease production until test results or other information indicate, to the satisfaction of the Engineer, that the next mixture produced will be within the specified range.

E. Placement. Apply RCRI at a thickness of 1 in. with a tolerance of ±1/4 in. and overlap the PCC longitudinal joints by at least 6 in.

1. **Temperatures.** Never mix the RCRI hotter than 350°F. The RCRI supplier will supply specific mixing, laydown, and compaction temperatures.

2. **Compaction and Density.** Begin compaction operations promptly after placing the RCRI. Use only steel wheel rollers in the static mode for compacting the mixture. Ensure density of the in-place place RCRI is 96% minimum of the maximum specific gravity as determined by test method Tex-207-F, Part III, "Determining Density of Compacted Bituminous Mixtures". Use the average of all maximum theoretical specific gravities for the day's placement to calculate in-place road densities.

   Place paper in front of the paver at the location where the core is taken.

3. **Release to Traffic and Overlay Placement.** Cover the RCRI with the binder course within five days after placement. Open the RCRI to traffic or cover with the hot mix overlay after cooling to less than 160°F or as directed.

4. **Appearance.** After final rolling, the RCRI should have a deep black color and the surface texture should be tight. Occasional small flushed areas approximately 1 ft. by 1 ft. are normal for the crack reducing purpose of the RCRI. More flushing than this may indicate that the mixture is out of specification. Verify the quality control criteria in areas of concern.

   Remove and replace unacceptable areas, in accordance with this specification, at no additional cost to the Department.

5. **Blisters.** If blisters occur in the mat after rolling, and do not disappear by the time of overlay, perforate, overlay or remove them with a roller as directed.

F. Test Strip.

1. This work consists of constructing the RCRI test strips for each mix design to determine the needed adjustments to meet specifications.

2. Construct Test strips after approval of a JMF and calibration of the bituminous hot mix plant. The test strip consists of approximately 250 tons or one hour's production, whichever is less, of approved mix in a single lane within the project limits. The paver and rollers to be used on the project will be used to place the test strip. Provide separate test strips for each mix design. Acceptable test strips meet the density and all other requirements for the mixture tested as outlined in Section 4.D.

3. Determine density in accordance with this specification. If necessary, construct additional test strips until a rolling pattern is established providing the specified density. Also a new test strip is required for each change in the JMF, the compaction method or the compaction equipment or if unacceptable results occur. Remove test strips that

do not have the specified density as directed. Do not place additional mix until an acceptable rolling pattern is established on a test strip.

G. **Damaged Areas.** Replace, at no charge to the Department, any traffic-damaged or marred areas.

5. **Transporting RCRI.** Haul the hot mix haul to the work site in tight vehicles previously cleaned of all foreign material. Use an approved truck bed release agent. Diesel will not be allowed as a truck bed release agent.

6. **Measurement**. This Item will be measured by the square yard of RCRI complete in place.

7. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Reflective Crack Relief Interlayer Test Strip" and "Reflective Crack Relief Interlayer". This price is full compensation for furnishing all materials, labor, tools, cleaning of existing base course or pavement, tack coat, placing, rolling and for all manipulations, equipment and incidentals.

   RCRI placed in test strips approved by the Engineer will be paid for at the unit price bid for RCRI Test Strips. All materials in unacceptable test strips shall be removed by the Contractor and shall become the property of the Contractor and will be disposed of by the Contractor at his expense.

From: Thomas Bohuslav
To: *DDO_DIST.HQ1.TxDOT@dot.state.tx.us; Phillip Russell
Date: 12/2/2004 10:28:25 AM
Subject: Alternate Pavement Rehabilitation Options

Attached is the subject memorandum and attachments.

Thomas R Bohuslav, P.E.
125 E. 11th St.
Austin, Tx 78701-2483
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Fx 512.416.2539

CC: Amadeo Saenz; Bob Hundley; Magdy Mikhail; Mark Marek; Zane Webb

Attachment 3

MEMORANDUM

Texas Department of Transportation

TO: District Engineers **DATE:** April 1, 2009

FROM: Thomas R. Bohuslav, P.E.

SUBJECT: Alternate Pavement Rehabilitation Options
Revised Attachments
March 16, 2009 Memorandum is Rescinded

Attached are guidance documents providing potential alternatives for Hot In-Place Recycling (HIR), Ultra-Thin Bonded Hot Mix Wearing Course (UTBHMWC), and Thin Bonded Permeable Friction Course (TBPFC). This guidance is provided to include updated specifications and HIR processes for the districts' optional use to promote competition.

The alternates proposed are considered comparable pavement rehabilitation techniques, when used with applicable time restrictions on pertinent PS&E requirements. No claims of equal performance are intended. Use these guidelines with engineering judgment when selecting rehabilitation options.

For pavement related questions, please contact Robert Lee of the Materials & Pavements Section, Construction Division at (512) 506-5938 and for time requirement related questions, please contact Juan Urrutia of the Construction Section, Construction Division at (512) 416-2455.

Attachments

cc: Mark A. Marek, P.E., Director, Design Division
Toribio Garza, Jr., P.E., Interim Director, Maintenance Division
District Directors of Construction
District Directors of Maintenance
District Directors of Transportation Planning
District Pavement Engineers
Dale Rand, P.E., Construction Division
Robert Lee, P.E., Construction Division
Juan Urrutia, P.E., Construction Division

Guidance for Alternative Flexible Pavement Systems

(Developed by the Construction Division, Materials and Pavements Section)

(1) Guidelines for Options for Thin Bonded Permeable Friction Course

(2) Guidelines for Options for Ultra-Thin Bonded Hot Mix Wearing Course

(3) Guidelines for Alternative Rehabilitation Options for Hot In-Place Recycling

(4) Special Provision 008---017 Prosecution and Progress

(5) Special Specification 3178 Hot In-Place Recycling of Asphalt Concrete Surfaces (HIR)

(6) Special Specification 3XXX Warranted Hot In-Place Recycling of Asphalt Concrete Surfaces (WHIR)

April 1, 2009

Guidelines for Options for Thin Bonded Permeable Friction Course

This guideline provides a brief description of the Thin Bonded Permeable Friction Course (TBPFC) process and also an alternate to be considered to increase competition. Specifications and general notes for each alternate are included. The special provision for lane rental is also included.

Purpose of TBPFC and Alternate. This pavement surface is intended to provide a permeable friction course placed in conjunction with a sealed surface membrane for use on high-speed roadways to improve safety and ride quality.

Option 1: TBPFC. TBPFC is a permeable friction course placed directly over a polymer modified rapid setting emulsion membrane in a single-pass system using a specialty paver that meets the requirements outlined in Special Specification 3127.

Option 2: PFC and Underseal. An alternate to option 1 would be to place an underseal (seal coat) followed by a PFC constructed in two separate operations.

Table 1 provides the required specification and special provisions for the two different options.

Table 1

Contract Alternates	Items Used			Special Provision 008-017 (For Lane Rental)
	SS 3127	Item 316 or 318	Item 342	
Option 1	✓			✓
Option 2		✓	✓	✓

Special General Notes for Table 1.

1. **Option 1.**
   a. General note for project specific lane rental schedule.
2. **Option 2.**
   a. General note for project specific lane rental schedule.

Key to Contract Specifications & Provisions.

Item 316, "Surface Treatment"
Item 318, "Hot Asphalt-Rubber Surface Treatments"
Item 342, "Permeable Friction Course (PFC)"
SS 3127, "Thin Bonded Permeable Friction Course (TBPFC)"
SP 008-017, "Prosecution and Progress-Lane Rental"

To implement the lane rental specifications please refer to the following link for example general notes: ftp://ftp.dot.state.tx.us/pub/txdot-info/des/specs/lanerent.pdf.

The link is found on TxDOT Web site on the *Specifications* page under *"2004 Specifications Book - Additional Information."* A project specific variation of this schedule would be included in the general notes.

April 1, 2009

Guidelines for Options for Ultra-Thin Bonded Hot Mix Wearing Course

This guideline provides a brief description of the Ultra-Thin Bonded Hot Mix Wearing Course (UTBHMWC) process and an alternate to be considered to increase competition. Specifications and suggested general notes for each alternate are included. Special provisions for lane rental are also included.

Purpose of UTBHMWC. This pavement surface is used as a preventive maintenance treatment to restore skid resistance, improve ride quality, and seal the existing pavement. The UTBHMWC may also be used in cases of restrictions on overlay thickness due to clearance requirements.

Option 1: UTBHMWC. Ultra-Thin Bonded Hot Mix Wearing Course is a gap-graded mixture placed directly over a polymer modified rapid setting emulsion membrane in a single-pass system using a specialty paver that meets the requirements outlined in Special Specification 3142.

Option 2: PFC and Underseal. An alternate to option 1 would be to place an underseal (seal coat) followed by a 3/4 in. PFC constructed in two separate operations.

Table 1 provides the required specification and special provisions for the two different options.

Table 1

Contract Alternates	Items Used			Special Provision 008-017 (For Lane Rental)
	SS 3142	Item 316 or 318	Item 342	
Option 1	✓			✓
Option 2		✓	✓	✓

Optional General Notes for Table 1.

1. **Option 1.**
   a. General note for project specific lane rental schedule.
2. **Option 2.**
   a. General note for project specific lane rental schedule.

Key to Contract Specifications & Provisions.

Item 316, "Surface Treatment"
Item 318, "Hot Asphalt-Rubber Surface Treatments"
Item 342, "Permeable Friction Course (PFC)"
SS 3142, "Ultra-Thin Bonded Hot Mix Wearing Course (UTBHMWC)"
SP 008-017, "Prosecution and Progress—Lane Rental" (A one-time use special provision has to be set up for each use—example attached.)

Use of lane rental is at the option of the designer, but is encouraged for high volume roadways. To implement the lane rental specifications please refer to the following link for example general notes: ftp://ftp.dot.state.tx.us/pub/txdot-info/des/specs/lanerent.pdf

The link is found on TxDOT Web site on the *Specifications* page under *2004 Specifications Book - Additional Information*. A project specific variation of this schedule would be included in the general notes.

April 1, 2009

Guidelines for Alternate Rehabilitation Options for Hot In-Place Recycling

This guideline provides a brief description of the Hot In-Place Recycling (HIR) process and alternates to be considered to increase competition. Specifications and suggested general notes for each alternate are included. Special Provisions for lane rental are also included.

Purpose of HIR and Alternates Herein. HIR is used to correct asphalt pavement surface distresses, such as surface cracking, roughness, or lack of skid resistance, through recycling the existing pavement. HIR can be effective in correcting surface defects, as long as the defects are not caused by structural inadequacy of the pavement. This process involves recycling the existing asphalt surface layer by heating, milling, or scarifying, and then adding a recycling agent.

The Engineer must determine which specification to use for a specific project based on initial construction costs, expected traffic levels, needed structural capacity, level of risk to the department, and future rehabilitation plans.

Item 358. Item 358 should be considered for low volume roadways or projects in need of a short-term solution, such as for pavements that will be rehabilitated or reconstructed in the next few years. This specification does impose a higher risk for the department but can potentially have a lower initial construction cost.

SS 3178 (HIR). Special Specification 3178 provides additional mix design and quality control requirements and should be considered for any range traffic volume roadways. The risk is lower for the department than Item 358, but it may have a higher initial construction cost.

SS 3XXX (WHIR). Special Specification 3XXX offers an additional level of assurance for the department by adding 3-year warranty to SS 3178. It provides the highest reduction in risk for the department, but it could have the highest initial construction cost as well.

Basic options for HIR are listed below:

Option 1: Surface Recycling. This process involves heating then milling the top layer of asphaltic pavement (typically the top 2 in.), mixing with a recycling agent, and then placing and compacting the recycled mix.

Option 2: Repaving. This process involves recycling approximately 1 in. of existing asphalt pavement by heating, milling, or scarifying, and then adding a recycling agent. The recycled material is placed on the roadway surface, and a thin overlay of new hot-mix asphalt is placed over the recycled layer. Both layers of mix are placed using a single piece of equipment. The combined pavement layer is compacted using conventional compaction equipment. Repaving will add approximately 1 in. to the pavement thickness, unless plans designate the surface to be pre-milled and require the original grade to be maintained.

Option 3: Remixing. This process involves recycling approximately 1 in. of existing asphalt pavement by heating, milling, or scarifying, and then adding a recycling agent. New hot-mix asphalt is added to the recycled material, and the resultant is thoroughly mixed. The homogeneous mixture is placed in one layer and compacted

using conventional compaction equipment. Remixing will add approximately 1 in. to the pavement thickness, unless plans designate the surface to be pre-milled and require the original grade to be maintained.

Option 4: Mill and Inlay. This process involves milling approximately 2 in. of the existing pavement layer and placing back new hot mix asphalt to the required depth shown in the plans. Twenty percent fractionated Recycled Asphalt Pavement (RAP) or ten percent unfractionated RAP is allowed in the new overlay, in accordance with current special provisions, unless otherwise shown in the plans.

Tables 1, 2, and 3 provide the required Specifications and Special Provisions for the four different options listed above. Choose the table that corresponds to the HIR specification required in the plans. Each table is divided into two sections: one restores the pavement to its original grade, and the other adds thickness to the overall pavement structure. If the plans call for additional thickness, Option 1 (Surface Recycling) must be overlaid after the existing pavement has been recycled. Option 2 (Repaving) and Option 3 (Remixing) do not need an overlay because they add new hot-mix asphalt during their recycle process. If the plans require the pavement to be restored to its original grade, Option 2 and Option 3 will require the pavement to be milled prior to recycling to compensate for the new hot-mix asphalt that is added during their recycle process. Option 1 does not require the pavement to be pre-milled. Use the section in the appropriate table that corresponds to the typical section and grade outlined in the plans. General notes are designated for each Option in the rightmost column of each table and are defined below Table 3.

Table 1
Contract Requirements for Alternates for Item 358

Contract Alternates	Required Specification Item 358			General Notes
	Additional Requirements		Optional Special Provision	
	Item 341	Item 354	SP 008-017 (For Lane Rental)	
Pavement Restored to Original Grade				
Option 1			O	4
Option 2	✓	✓	O	4
Option 3	✓	✓	O	4
Option 4	✓	✓	O	3a, 4
Additional Thickness Added to Pavement				
Option 1	✓		O	4
Option 2	✓		O	4
Option 3	✓		O	4
Option 4	✓	✓	O	3a or 3b, 4

Table 2
Contract Requirements for Alternates for SS 3178

Contract Alternates	Required Specification Special Specification 3178			General Notes
	Additional Requirements		Optional Special Provision	
	Item 341	Item 354	SP 008-017 (For Lane Rental)	
Pavement Restored to Original Grade				
Option 1			O	4
Option 2	✓	✓	O	1a, 1b, 4
Option 3	✓	✓	O	2a, 4
Option 4	✓	✓	O	3a, 4
Additional Thickness Added to Pavement				
Option 1	✓		O	4
Option 2	✓		O	1a, 1b, 1c, 4
Option 3	✓		O	2a, 2b, 4
Option 4	✓	✓	O	3a or 3b, 4

Table 3
Contract Requirements for Alternates for SS 3XXX Warranty

Contract Alternates	Required Specification Special Specification 3XXX Warranty				General Notes
	Additional Requirements			Optional Special Provision	
	Item 341	Item 354	SP 003-015 (For Warranty)	SP 008-017 (For Lane Rental)	
Pavement Restored to Original Grade					
Option 1			✓	O	4
Option 2	✓	✓	✓	O	1a, 1b, 4
Option 3	✓	✓	✓	O	2a, 4
Option 4	✓	✓		O	3a, 4
Additional Thickness Added to Pavement					
Option 1	✓		✓	O	4
Option 2	✓		✓	O	1a, 1b, 1c, 4
Option 3	✓		✓	O	2a, 2b, 4
Option 4	✓	✓		O	3a or 3b, 4

Optional General Notes for Tables 1, 2, and 3.

1. **SS 3178 or SS 3XXX, Option 2.**
   - **a.** Scarifying will be allowed as an alternate method for loosening the recycled material.
   - **b.** Place the new ACP overlay before the temperature of the in-place mix from the rehabilitated surface drops below 175°F; otherwise, place an additional 1/2-in. thickness of hot-mix asphalt for the new layer to achieve the required in-place density and the ride quality requirements. Provide the additional mix, work, and materials at no expense to the department.

c. Districts may consider use of Surface Test Type B, Pay Schedule (2 or 3) to evaluate ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces" (added thickness to pavement only).

2. **SS 3178 or SS 3XXX, Option 3.**
   a. Scarifying will be allowed as an alternate method for loosening the recycled material.
   b. Districts may consider use of Surface Test Type B, Pay Schedule (2 or 3) to evaluate ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces" (added thickness to pavement only).
3. **Item 341, Option 4.**
   a. Use Surface Test Type A to evaluate ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces."
   b. Districts may consider use of Surface Test Type B, Pay Schedule (2 or 3) to evaluate ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces" (added thickness to pavement only).
4. **Alternates in PS&E (High Traffic Justification)**
   a. General notes table for project specific lane rental schedule.

Key to Contract Specifications & Provisions.

Item 341, "Dense-Graded Hot-Mix Asphalt (QC/QA)"
Item 354, "Planing and Texturing Pavement"
Item 358, "Asphalt Concrete Surface Rehabilitation"
SS 3178, "Hot In-Place Recycling of Asphalt Concrete Surfaces"
SS 3XXX, "Warranted Hot In-Place Recycling of Asphalt Concrete Surfaces"
SP 003-015, "Warranty Bond"
SP 008-017, "Prosecution and Progress-Lane Rental"

Use of lane rental is at the option of the designer, but is encouraged for high volume roadways. To implement the lane rental specifications please refer to the following link for example general notes: ftp://ftp.dot.state.tx.us/pub/txdot-info/des/specs/lanerent.pdf

The link is found on TxDOT Web site on the *"Specifications"* page under *"2004 Specifications Book - Additional Information."* A project specific variation of this schedule would be included in the general notes.

SPECIAL PROVISION

008---017

Prosecution and Progress

For this project, Item 008, "Prosecution and Progress," of the Standard Specifications, is hereby amended with respect to the clauses cited below, and no other clauses or requirements of this Item are waived or changed hereby.

Article 8.5. Failure to Complete Work on Time is supplemented by the following:

The Contractor will be assessed a lane rental charge for each lane or lanes closed or for each lane or lanes obstructed from the time the number of free lane closure hours has been exceeded until substantial completion of the project. The rental charge will be assessed for each lane or lanes closed or obstructed for each direction of traffic as shown in a lane rental table that is provided elsewhere in the contract. The hourly lane rental rates will be prorated to a quarter hour basis for lane closures that are less than one hour in duration.

The lane rental charge will be assessed not as a penalty, but for added expense incurred by the traveling public and by the department. These assessments will be deducted from any moneys due or to become due the Contractor.

The following definitions shall apply:

Lane Rental Charge. The estimated hourly cost of interference and inconvenience to the road user for lane closures above and beyond those specified in the plan documents or for travel lane obstructions caused by the Contractor. The lane rental period will begin when a traffic lane(s) is closed to traffic and will end when the closure is discontinued. The Engineer will determine the beginning and ending time of the lane closure for rental purposes. The lane rental provision will be applicable without regard to the length of the lane closed to traffic.

Obstruction. When the Contractor's operations and/or equipment result in the usable lane width of the travelway to be less than that specified in the plan documents.

Hour. Any continuous 60-minute period or portion of a continuous 60-minute period beginning at that point when a lane(s) is closed or obstructed by the Contractor's operations.

Quarter Hour. Any 15-minute period or portion of a 15-minute period. Fifteen minute periods will start either on the hour, or 15 minutes past the hour, or 30 minutes past the hour, or 45 minutes past the hour.

SPECIAL SPECIFICATION

3178

Hot In-Place Recycling of Asphalt Concrete Surfaces (HIR)

1. **Description.** Use the hot in-place process to recycle the existing pavement in one of the following sub-categories described below.

   Recycling. Recycling is the process in which the existing asphalt pavement is heated, softened and then milled. A recycling agent is added and the material is thoroughly mixed and placed with a standard paving screed.

   Remixing. Remixing is similar to recycling with the addition of virgin aggregate or new hot mix asphalt added to the recycled material. The materials are then thoroughly mixed and placed with a standard paving screed.

   Repaving. Repaving combines either recycling or remixing with an overlay of new hot-mix asphalt placed immediately after the recycled mixture. The new hot mix asphalt layer is placed directly on the recycled layer, and both are compacted simultaneously.

   The Department will provide in the plans all typical sections and any grade change requirements; the depth and width of recycling required; core information from the existing roadway to include pavement layers, lift thicknesses; the AC content and penetration value of the existing asphalt to be recycled plus any other data collected from the pavement evaluation.

2. **Materials.**

   A. **Recycling Agent.** Furnish a recycling agent in accordance with Section 4.A, "Mixture Design," and meeting the requirements of Section 300.2.F, "Recycling Agent."

   B. **Hot Mix Asphalt.** If the process requires additional hot-mix asphalt, furnish new hot-mix asphalt that meet the requirements of Section 4.A. Use materials meeting the requirements of Article 340.2, "Materials," to produce the new hot-mix asphalt.

   C. **Aggregate.** If the process requires additional aggregate, furnish aggregates to meet the requirements shown in Section 4.A, "Mixture Design." Use aggregates meeting the requirements of Article 340.2, "Materials."

3. **Equipment.**

   A. **Processing Equipment.** Provide equipment that is capable of a continuous single pass, multi-step operation, including heating; milling; introducing recycling agent, virgin materials, and/or hot mix asphalt (if determined necessary;) mixing the reclaimed material; redistributing the recycled material; placing the mix and leveling it with an asphalt paver or paving screed; and compacting the mixture, that meets the following requirements.

1. **Pavement Pre-Heaters.** Supply pavement pre-heaters capable of uniformly heating the existing pavement to a temperature high enough to remove excess moisture and allow dislodging of the material to the specified depth, while minimizing the fracturing of aggregate particles. Equip heaters with an enclosed or shielded hood to prevent damage to adjacent property or vegetation. Ensure that the heaters overlap the completed adjacent lane by a minimum of 6 in. to create a hot bond at the longitudinal joint.

2. **Pavement Milling Heads.** Provide milling heads for pavement recycling capable of uniformly loosening the entire pavement lane width to the depth specified in the plans. Accomplish the recycling by using milling heads that have a grade control system for each head. Ensure that the tooth spacing of the milling heads is sufficient to allow material to pass without excessive retention. Utilize equipment that is capable of raising and lowering the milling heads in order to recycle the material around manholes and other obstacles.

   Equip the milling heads such that they are capable of gathering the heated and loosened asphalt concrete pavement. Operate the milling heads in such a manner to minimize aggregate degradation. Utilize milling heads that are capable of creating a windrow of the milled material ahead of the mixing chamber or subsequent milling units.

3. **Recycling Agent Application System**. Provide a system for adding and uniformly applying a recycling agent at the specified rate with the hot, loosened material. Control the system to within 5.0% of the target application rate. Equip the recycling agent system with positive on/off capabilities to prevent any dripping. Add the recycling agent during or after milling has taken place to provide uniform application of the recycling agent and adequate mixing with the recycled material during the mixing cycle.

4. **Mixing Unit.** Provide equipment with an on-board mixing chamber that is capable of thoroughly mixing the heated, reworked material with new materials. Enclose and configure the mixing chamber such that no milled material escapes or bypasses the mixer chamber. Ensure that the rotation of the mixer apparatus does not cause segregation during the mixing process.

5. **Paving Unit.** Furnish a paver or paver screed meeting the requirements Section 320.2.C.1, "Equipment."

B. Rollers. Provide rollers meeting the requirements of Article 210.2, "Equipment."

C. Broom. Furnish rotary self-propelled power brooms. The broom should have positive control on the downward pressure applied to the surface.

D. Mobile Testing Laboratory. Unless otherwise shown on the plans, furnish a mobile testing laboratory meeting the requirements of Tex-237-F and a Level 1A certified laboratory technician qualified under the Department's approved program. If fresh hot mix asphalt is added, perform the tests necessary to control plant production.

4. **Construction.** Rehabilitate existing asphalt concrete pavement to meet the typical sections shown on the plans and the lines and grades established by the Engineer. The existing pavement should be heated and milled to the required depth of treatment as shown on the plans.

   A. **Mixture Design.** Provide a mix design and job mix formula that meets the criteria of Table 1. Specimens will be compacted using the Superpave Gyratory Compactor in accordance with Tex-241-F at 50 gyrations. The target number of gyrations may be adjusted if allowed by the Engineer. Submit the completed mix design to the Engineer for approval prior to the start of the project. Perform additional mix designs based on road variability, as directed by the Engineer.

      1. **Sampling.** Obtain cores at intervals throughout the project to determine the existing condition of the roadway and account for variability within the project limits. Obtain an adequate quantity of material to perform the mixture design. Evaluate cores and note any evidence of material (rubber seal, fabric underseal, etc.) that could be detrimental to the process. A minimum of 2 in. of the existing pavement structure must remain in place following milling. Note any base or uncoated material that falls within the layer to be recycled. Notify the Engineer of any of these conditions before proceeding with the mix design.

      2. **Job-Mix Formula Approval.** The job-mix formula (JMF) is the combined aggregate gradation and target asphalt recycling agent percentage established from the laboratory mixture design used for hot in-place production.

      3. **Hot Mix Asphalt.** If the process requires new hot-mix asphalt, use materials meeting the requirements of Section 340.4.A, "Mixture Design," to produce the new hot-mix asphalt. Document in the JMF the percentage of new hot-mix used in the laboratory mix design submitted to the Engineer.

      4. **Aggregates.** If necessary, use aggregates meeting the requirements in Table 1 of Article 340.2, "Materials."

      5. **Other Additives.** If necessary, use additives to meet the requirements in Table 1. In the case that an additive is used, describe the type and allowable usage percentage in the submitted design recommendation.

Table 1
Laboratory Mix Design Requirements

Mixture Property	Test Method	Min	Max
Target laboratory molded density, %	Tex-207-F	96.0	
Theoretical Maximum Spec. (Rice) Gravity[1]	Tex-227-F	NA	
Tensile strength, lbs./in.[2]	Tex-226-F	75	
Hamburg Wheel-tracking Test , 50°C, 10,000 cycles, mm	Tex-242-F		12.5
Overlay Test	Tex-248-F	Report Only	
Boil Test[2]	Tex-530-C	-	
Combined Asphalt Property	**Test Method**	**Min**	**Max**
Penetration, 77°F, 100 g, 5 sec.	T49	40	80

1. Used to determine lab molded density.

2. Used to establish baseline for comparison to production results.

B. Pavement Heating. Heat the existing pavement without charring the existing asphalt and without producing undesirable pollutants. The temperature of the material immediately behind the heater should maintain a minimum of 200°F. Uniformly heat the pavement surface across its full lane width such that cold milling of the pavement surface does not occur.

C. Pavement Milling. Mill the existing pavement to the required depth and width as indicated on the plans. Do not disturb the underlying material in the existing roadway when recycling. Remove grass and other vegetation from the edge of the existing pavement to prevent contamination of the recycled bituminous material during this operation.

Utilize the milling heads to remove a minimum of 3 in. laterally of the completed adjacent pass and make a square vertical cut in the heated material such that a hot bonded longitudinal joint is achieved. Ensure that all material across the full lane-width is processed between consecutive lane passes to assure that any wedges (slivers) of unprocessed materials are not left untouched by the milling heads and covered by the recycled material, unless otherwise approved by the Engineer.

Ensure that the temperature of the milled surface directly behind the milling heads is greater than 160°F so that cold milling does not occur. All loosened asphalt material must be cleaned away by the milling heads, and a milling tooth pattern must be clearly visible after milling.

Remove all material around manholes and utility structures prior to paving the recycled mixture to allow for the plan depth of the pavement around these structures.

Cold mill and sweep clean any areas that cannot be heated and milled by the recycling equipment. Properly tack and pave these areas of cold milling in advance of the recycling process.

D. Addition of Recycling Agent. Incorporate the asphalt recycling agent into the hot recycled bituminous material at the rate determined by the approved mix design(s).

Sampling and testing during mixture production may result in varying quantities of recycling agent at different portions of the project in order to meet the requirements in Table 1. Change the recycling agent content only with approval of the Engineer.

E. **Placement of Recycled Material.** Spread the material using a paver and screed attached to the mixing/milling unit or a traditional paver in a separate and continuous operation meeting the requirements of Section 320.2.C.1, "Equipment." Spread the recycled material to the lines and grades established by the Engineer. Ensure the temperature of the recycled material behind paver is greater than 200°F.

F. **Compaction.** Compact the recycled mix using rollers meeting the requirements of Section 3.B, "Rollers." Establish rolling patterns to achieve the target air voids in accordance with Tex-207-F. Only operate rollers in vibratory mode when doing so does not damage the pavement. Compact the recycled mix to in-place air voids between 4% and 9%, unless otherwise shown on the plans. Follow the selected rolling pattern unless changes occur in the recycled mix or placement conditions, at which time establish a new rolling pattern. Adjust or cease compaction when cracking or displacement occurs. Ensure that pavement is fully compacted before allowing rollers to park on the pavement.

G. **Traffic.** After the completion of compaction of the recycled material, permit no traffic, including that of the contractor, on the completed recycled material until the material has cooled to 160°F or less. After opening to traffic, maintain the surface of the recycled pavement in a condition suitable for the safe movement of traffic. Remove all loose particles that may develop on the pavement surface by power brooming.

H. **Irregularities.** Immediately take corrective action if surface irregularities, including but not limited to segregation, rutting, raveling, flushing, fat spots, mat slippage, color, texture, roller marks, tears, gouges, streaks, or uncoated aggregate particles, are detected. The Engineer may allow placement to continue for at most 1 day of production while taking appropriate action. If the problem still exists after that day, suspend paving until the problem is corrected to the satisfaction of the Engineer.

At the expense of the Contractor and to the satisfaction of the Engineer, repair any areas with surface irregularities as identified above prior to the placement of any hot mix asphalt surface course or other applicable surface treatment.

I. **Curing.** A surface treatment may be allowed as the final riding surface when shown on the plans. If hot-mix asphalt concrete or another applicable surface treatment is placed as a surface course, allow the hot in-place recycled bituminous material to cure for a minimum of 7 days, or as directed by the Engineer.

J. **Weather Limitations.** Unless otherwise approved, perform hot in-place recycling operations when the existing pavement surface temperature is 60°F or higher and when weather conditions and moisture conditions of the roadway surface are suitable, in the opinion of the Engineer.

5. **Quality Control.** Perform the quality control tests listed in Table 2. If operational tolerances in Table 2 are exceeded, adjust processes or cease production when directed by the Engineer. The Engineer may perform independent tests to confirm contractor compliance and may require testing differences or failing results to be resolved before resuming production. The Engineer will determine resolution for failures which may include requiring removal and replacement of failing material with new asphalt concrete pavement mixture.

Table 2
Operational Tolerance & Minimum Testing Frequency

Description	Test Method	Allowable Difference from JMF Target	Minimum Testing Frequency
Asphalt Content, %	Tex-236-F	± 0.5	1 per day
Theoretical Maximum Spec. (Rice) Gravity	Tex-227-F	N/A	1 per day
Laboratory-Molded Density, %	Tex-207-F	± 1.0	1 per day
Hamburg Wheel-tracking Test , 50°C, 10,000 cycles, mm	Tex-242-F	N/A[1]	1 per week
Boil Test	Tex-530-C	N/A[2]	1 per day
Air Voids (4% to 9%)	Tex-207-F	N/A[3]	1 per day

1. Hamburg values must not exceed 12.5 mm in 10,000 passes, unless otherwise directed.
2. Compare with sample from mix design to determine amount of stripping.
3. In-Place Air voids should be between 4% and 9%.

A. **Mixture Testing.** Sample the recycled mixture for testing in accordance with Tex-222-F. For Hamburg Wheel-tracking test, sample prior to compaction.

B. **Asphalt Recycling Agent.** Meet the requirements of Item 300, "Asphalt, Oils, and Emulsions," Table 12, "Recycling Agent and Emulsified Recycling Agent." Unless otherwise directed, obtain a sample from each transport in accordance with Tex-500-C prior to unloading into the contractor's storage units. Deliver the samples to the Engineer for testing. The Engineer will test at least one sample per project for specification compliance.

C. **Total Asphalt Binder Content.** Make asphalt recycling content changes based upon mix design recommendations for varying roadway conditions in order to meet the requirements in Table 2.

D. **New Hot Mix Asphalt.** Control the quantity of new hot-mix asphalt added to the recycled mix from haul tickets to within 5.0% of the target JMF.

E. **Depth of Recycled Material.** Maintain the required nominal depth on both outside vertical faces and in the center of the recycled area. Manually measure and report to the Engineer recorded depths each 1/4 mile, measured from the bottom of the mill pass to the top of the surface placed.

F. **In-Place Air Voids.** The Engineer will select and provide the Contractor random numbers for all placement tests. Unless otherwise shown on the plans, obtain two roadway specimens at each random location determined in accordance with Tex-225-F for in-place air void determination. The Engineer will measure air voids in accordance with Tex-207-F and Tex-227-F. Before drying to a constant weight, cores may be pre-dried using a Corelok or similar vacuum device to remove excess moisture. The Engineer will use the average air void content of the two cores to calculate the in-place air voids at the selected location.

G. **Ride Quality.** Use Surface Test Type A to evaluate ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces," unless otherwise shown on the plans.

6. **Measurement.** Hot in-place recycling of asphalt concrete surface will be measured by the square yard. The dimensions for determining the surface areas are established by the depths and widths shown on the plans and the lengths measured at placement.

   Recycling agent will be measured at the applied temperature by the gallon from strap depths measured from the calibrated strap stick for each load or other automated means approved by the Engineer.

   New hot-mix asphalt concrete will be measured by the ton of composite mix, which includes asphalt, aggregate, and additives. Measure the new hot-mix on scales in accordance with Item 520, "Weighing and Measuring Equipment."

7. **Payment.** Hot in-place recycling of asphalt concrete surfaces will be paid for at the unit price bid for "Hot In-Place Recycling of Asphalt Concrete (Surface)" of the depth specified.

   Asphalt recycling agent will be paid for separately at the unit price bid for "Hot In-Place Recycling of Asphalt Concrete (Recycling Agent)."

   New hot-mix asphalt concrete will be paid for at the unit price bid for "Hot In-Place Recycling of Asphalt Concrete (Mix)."

   This price is full compensation for the removal and processing of the existing pavement; for preparing, hauling, and placing materials; for all freight involved; for all manipulations, including rolling and brooming; and for all labor, tools, equipment, and incidentals necessary to complete the work. This price also includes any surface treatment that is allowed in the plans but not required to complete the above work.

SPECIAL SPECIFICATION

3XXX

Warranted Hot In-Place Recycling of Asphalt Concrete Surfaces (WHIR)

1. **Description.** Use the hot in-place process to recycle the existing pavement in one of the following sub-categories described below.

   Recycling. Recycling is the process in which the existing asphalt pavement is heated, softened and then milled. A recycling agent is added and the material is thoroughly mixed and placed with a standard paving screed.

   Remixing. Remixing is similar to recycling with the addition of virgin aggregate or new hot mix asphalt added to the recycled material. The materials are then thoroughly mixed and placed with a standard paving screed.

   Repaving. Repaving combines either recycling or remixing with an overlay of new hot-mix asphalt placed immediately after the recycled mixture. The new hot mix asphalt layer is placed directly on the recycled layer, and both are compacted simultaneously.

   The Department will provide in the plans all typical sections and any grade change requirements; the depth and width of recycling required; core information from the existing roadway to include pavement layers, lift thicknesses; the AC content and penetration value of the existing asphalt to be recycled plus any other data collected from the pavement evaluation.

2. **Materials.**

   A. **Recycling Agent.** Furnish a recycling agent in accordance with Section 4.A, "Mixture Design," and meeting the requirements of Section 300.2.F, "Recycling Agent."

   B. **Hot Mix Asphalt.** If the process requires additional hot-mix asphalt, furnish new hot-mix asphalt that meet the requirements of Section 4.A. Use materials meeting the requirements of Article 340.2, "Materials," to produce the new hot-mix asphalt.

   C. **Aggregate.** If the process requires additional aggregate, furnish aggregate that meets the requirements shown in Section 4.A, "Mixture Design." Use aggregate meeting the requirements of Article 340.2, "Materials."

3. **Equipment.**

   A. **Processing Equipment.** Provide equipment that is capable of a continuous single pass, multi-step operation, including heating; milling; introducing recycling agent, virgin materials, and/or hot mix asphalt (if determined necessary;) mixing the reclaimed material; redistributing the recycled material; placing the mix and leveling it with an asphalt paver or paving screed; and compacting the mixture, that meets the following requirements.

1. **Pavement Pre-Heaters.** Supply pavement pre-heaters capable of uniformly heating the existing pavement to a temperature high enough to remove excess moisture and allow dislodging of the material to the specified depth, while minimizing the fracturing of aggregate particles. Equip heaters with an enclosed or shielded hood to prevent damage to adjacent property or vegetation. Ensure that the heaters overlap the completed adjacent lane by a minimum of 6 in. (150 mm) to create a hot bond at the longitudinal joint.

2. **Pavement Milling Heads.** Provide milling heads for pavement recycling capable of uniformly loosening the entire pavement lane width to the depth specified in the plans. Accomplish the recycling by using milling heads that have a grade control system for each head. Ensure that the tooth spacing of the milling heads is sufficient to allow material to pass without excessive retention. Utilize equipment that is capable of raising and lowering the milling heads in order to recycle the material around manholes and other obstacles.

   Equip the milling heads such that they are capable of gathering the heated and loosened asphalt concrete pavement. Operate the milling heads in such a manner to minimize aggregate degradation. Utilize milling heads that are capable of creating a windrow of the milled material ahead of the mixing chamber or subsequent milling units.

3. **Recycling Agent Application System**. Provide a system for adding and uniformly applying a recycling agent at the specified rate with the hot, loosened material. Control the system to within 5% of the target application rate. Equip the recycling agent system with positive on/off capabilities to prevent any dripping. Add the recycling agent during or after milling has taken place to provide uniform application of the recycling agent and adequate mixing with the recycled material during the mixing cycle.

4. **Mixing Unit.** Provide equipment with an on-board mixing chamber that is capable of thoroughly mixing the heated, reworked material with new materials. Enclose and configure the mixing chamber such that no milled material escapes or bypasses the mixer chamber. Ensure that the rotation of the mixer apparatus does not cause segregation during the mixing process.

5. **Paving Unit.** Furnish a paver or paver screed meeting the requirements Section 320.2.C.1, "Equipment."

B. **Rollers.** Provide rollers meeting the requirements of Article 210.2, "Equipment."

C. **Broom.** Furnish rotary self-propelled power brooms. The broom should have positive control on the downward pressure applied to the surface.

D. **Mobile Testing Laboratory.** Unless otherwise shown on the plans, furnish a mobile testing laboratory meeting the requirements of Tex-237-F and a Level 1A certified laboratory technician qualified under the Department's approved program. If fresh hot mix asphalt is added, perform the tests necessary to control plant production.

4. **Construction.** Rehabilitate existing asphalt concrete pavement to meet the typical sections shown on the plans and the lines and grades established by the Engineer. The existing pavement should be heated and milled to the required depth of treatment as shown on the plans.

A. **Mixture Design.** Provide a mix design and job mix formula that meets the criteria of Table 1. Specimens will be compacted using the Superpave Gyratory Compactor in accordance with Tex-241-F at 50 gyrations. The target number of gyrations may be adjusted if allowed by the Engineer. Submit the completed mix design to the Engineer for acceptance prior to the start of the project. Perform additional mix designs based on road variability, as directed by the Engineer.

1. **Sampling.** Obtain cores at intervals throughout the project to determine the existing condition of the roadway and account for variability within the project limits. Obtain an adequate quantity of material to perform the mixture design. Evaluate cores and note any evidence of material (rubber seal, fabric underseal, etc.) that could be detrimental to the process. A minimum of 2 in. (52 mm) of the existing pavement structure must remain in place following milling. Note any base or uncoated material that falls within the layer to be recycled. Notify the Engineer of any of these conditions before proceeding with the mix design.

2. **Job-Mix Formula Acceptance.** The job-mix formula (JMF) is the combined aggregate gradation and target asphalt recycling agent percentage established from the laboratory mixture design used for hot in-place production.

3. **Hot Mix Asphalt.** If the process requires new hot-mix asphalt, use materials meeting the requirements of Section 340.4.A, "Mixture Design," to produce the new hot-mix asphalt. Document in the JMF the percentage of new hot-mix used in the laboratory mix design submitted to the Engineer.

4. **Aggregates.** If necessary, use aggregates meeting the requirements in Table 1 of Article 340.2, "Materials."

5. **Other Additives.** If necessary, use additives to meet the requirements in Table 1. In the case that an additive is used, describe the type and allowable usage percentage in the submitted design recommendation.

Table 1
Laboratory Mix Design Requirements

Mixture Property	Test Method	Min	Max
Target laboratory molded density, %	Tex-207-F	96.0	
Theoretical Maximum Spec. (Rice) Gravity[1]	Tex-227-F	NA	
Tensile strength, lbs./in.[2]	Tex-226-F	75	
Hamburg Wheel-tracking Test , 50°C, 10,000 cycles, mm	Tex-242-F		12.5
Overlay Test	Tex-248-F	Report Only	
Boil Test[2]	Tex-530-C	-	
Combined Asphalt Property	**Test Method**	**Min**	**Max**
Penetration, 77°F, 100 g, 5 sec.	T49	40	80

1. Used to determine lab molded density.

2. Used to establish baseline for comparison to production results.

B. **Pavement Heating.** Heat the existing pavement without charring the existing asphalt and without producing undesirable pollutants. The temperature of the material immediately behind the heater should maintain a minimum of 200°F. Uniformly heat

the pavement surface across its full lane width such that cold milling of the pavement surface does not occur.

C. **Pavement Milling.** Mill the existing pavement to the required depth and width as indicated on the plans. Do not disturb the underlying material in the existing roadway when recycling. Remove grass and other vegetation from the edge of the existing pavement to prevent contamination of the recycled bituminous material during this operation.

Utilize the milling heads to remove a minimum of 3 in. (75 mm) laterally of the completed adjacent pass and make a square vertical cut in the heated material such that a hot bonded longitudinal joint is achieved. Ensure that all material across the full lane-width is processed between consecutive lane passes to assure that any wedges (slivers) of unprocessed materials are not left untouched by the milling heads and covered by the recycled material, unless otherwise approved by the Engineer.

Ensure that the temperature of the milled surface directly behind the milling heads is greater than 160°F [70°C] so that cold milling does not occur. All loosened asphalt material must be cleaned away by the milling heads, and a milling tooth pattern must be clearly visible after milling.

Remove all material around manholes and utility structures prior to paving the recycled mixture to allow for the plan depth of the pavement around these structures.

Cold mill and sweep clean any areas that cannot be heated and milled by the recycling equipment. Properly tack and pave these areas of cold milling in advance of the recycling process.

D. **Addition of Recycling Agent.** Incorporate the asphalt recycling agent into the hot recycled bituminous material at the rate determined by the approved mix design(s). Sampling and testing during mixture production may result in varying quantities of recycling agent at different portions of the project in order to meet the requirements in Table 1. Inform the Engineer of any recycling agent content changes.

E. **Placement of Recycled Material.** Spread the material using a paver and screed attached to the mixing/milling unit or a traditional paver in a separate and continuous operation meeting the requirements of Section 320.2.C.1, "Equipment." Spread the recycled material to the lines and grades established by the Engineer. Ensure the temperature of the recycled material behind paver is greater than 200°F.

F. **Compaction.** Compact the recycled mix using rollers meeting the requirements of Section 3.B, "Rollers." Establish rolling patterns to achieve the target air voids in accordance with Tex-207-F. Only operate rollers in vibratory mode when doing so does not damage the pavement. Compact the recycled mix to in-place air voids between 4% and 9%, unless otherwise shown on the plans. Follow the selected rolling pattern unless changes occur in the recycled mix or placement conditions, at which time establish a new rolling pattern. Adjust or cease compaction when cracking or displacement occurs. Ensure that pavement is fully compacted before allowing rollers to park on the pavement.

G. **Traffic.** After the completion of compaction of the recycled material, permit no traffic, including that of the contractor, on the completed recycled material until the material has cooled to 160°F or less. After opening to traffic, maintain the surface of the

recycled pavement in a condition suitable for the safe movement of traffic. Remove all loose particles that may develop on the pavement surface by power brooming.

H. **Irregularities.** Immediately take corrective action if surface irregularities, including but not limited to segregation, rutting, raveling, flushing, fat spots, mat slippage, color, texture, roller marks, tears, gouges, streaks, or uncoated aggregate particles, are detected. The Engineer may allow placement to continue for at most 1 day of production while taking appropriate action. If the problem still exists after that day, suspend paving until the problem is corrected to the satisfaction of the Engineer.

At the expense of the Contractor and to the satisfaction of the Engineer, repair any areas with surface irregularities as identified above prior to the placement of any hot mix asphalt surface course or other applicable surface treatment.

I. **Curing.** A surface treatment may be allowed as the final riding surface when shown on the plans. If hot-mix asphalt concrete or another applicable surface treatment is placed as a surface course, allow the hot in-place recycled bituminous material to cure for a minimum of 7 days, or as directed by the Engineer.

J. **Weather Limitations.** Unless otherwise approved, perform hot in-place recycling operations when the existing pavement surface temperature is 60°F or higher and when weather conditions and moisture conditions of the roadway surface are suitable, in the opinion of the Engineer.

5. **Quality Control.** Perform the quality control tests listed in Table 2. If operational tolerances in Table 2 are exceeded, adjust processes or cease production when directed by the Engineer. The Engineer may perform independent tests to confirm contractor compliance and may require testing differences or failing results to be resolved before resuming production. The Engineer will determine resolution for failures which may include requiring removal and replacement of failing material with new asphalt concrete pavement mixture.

Table 2
Operational Tolerance & Minimum Testing Frequency

Description	Test Method	Allowable Difference from JMF Target	Minimum Testing Frequency
Asphalt Content, %	Tex-236-F	± 0.5	1 per day
Theoretical Maximum Spec. (Rice) Gravity	Tex-227-F	N/A	1 per day
Laboratory-Molded Density, %	Tex-207-F	± 1.0	1 per day
Hamburg Wheel-tracking Test , 50°C, 10,000 cycles, mm	Tex-242-F	N/A[1]	1 per week
Boil Test	Tex-530-C	N/A[2]	1 per day
Air Voids (4% to 9%)	Tex-207-F	N/A[3]	1 per day

1. Hamburg values must not exceed 12.5 mm in 10,000 passes, unless otherwise directed.
2. Compare with sample from mix design to determine amount of stripping.
3. In-Place Air voids should be between 4% and 9%.

A. **Mixture Testing.** Sample the recycled mixture for testing in accordance with Tex-222-F. For Hamburg Wheel-tracking test, sample prior to compaction.

B. **Asphalt Recycling Agent.** Unless otherwise directed, obtain a sample from each transport in accordance with Tex-500-C prior to unloading into the contractor's storage units. Deliver the samples to the Engineer for testing. The Engineer will test at least one sample per project for specification compliance.

Measure recycling agent at the applied temperature by the gallon from strap depths measured from the calibrated strap stick for each load or other automated means approved by the Engineer.

C. **Total Asphalt Binder Content.** Make asphalt recycling content changes based upon mix design recommendations for varying roadway conditions in order to meet the requirements in Table 2.

D. **New Hot Mix Asphalt.** New hot-mix asphalt concrete will be measured by weight of composite mix, which includes asphalt, aggregate, and additives. Measure the new hot-mix on scales in accordance with Item 520, "Weighing and Measuring Equipment." Control the quantity of new hot-mix asphalt added to the recycled mix from haul tickets to within 5.0% of the target JMF.

E. **Depth of Recycled Material.** Maintain the required nominal depth on both outside vertical faces and in the center of the recycled area. Manually measure and report to the Engineer recorded depths each 1/4 mile, measured from the bottom of the mill pass to the top of the surface placed.

F. **In-Place Air Voids.** The Engineer will select and provide the Contractor random numbers for all placement tests. Unless otherwise shown on the plans, obtain two roadway specimens at each random location determined in accordance with Tex-225-F for in-place air void determination. The Engineer will measure air voids in accordance with Tex-207-F and Tex-227-F. Before drying to a constant weight, cores may be pre-dried using a Corelok or similar vacuum device to remove excess moisture. The Engineer will use the average air void content of the two cores to calculate the in-place air voids at the selected location.

G. **Ride Quality.** Use Surface Test Type A to evaluate ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces," unless otherwise shown on the plans.

6. **Performance Requirements.**

A. **Performance Characteristic Requirements.** Meet the WHIR performance requirements in Table 3 for each lane-width, 0.1-mi. segment of WHIR applied in the Contract.

Table 3

Performance Characteristic	Requirement
Flushing, %, max	0.5
Cracking (longitudinal), linear ft, max[1]	50
Cracking (alligator), %, max	1.0
Delamination / Slippage, %, max	0.5
Raveling, %, max	0.5
Rutting, in., max	3/8

1. The longitudinal construction joint at the lane line is not considered as cracking during survey.

B. **Performance Evaluation Procedures.** The Department will conduct performance evaluations for each lane-width, 0.1-mi. segment of the completed WHIR. The Contractor may be present during these evaluations.

1. **Flushing.** The Engineer will visually evaluate segments for excess asphalt binder on the WHIR surface that creates a shiny, reflective condition that becomes tacky to the touch at higher temperatures. The Engineer will determine the percentage of flushed surface area based on the area of the segment.

2. **Cracking.** The Engineer will measure all cracks over 1/8 inches in width for each 0.1-mi.segment of each lane-width of WHIR surface. The Engineer will determine the total linear feet or percentage of cracking for each segment.

3. **Delamination / Slippage.** Delamination / slippage describe areas where the hot in-place recycling has debonded from the underlying pavement surface. The Engineer will visually evaluate segments for delamination / slippage and will determine the percentage of delaminated surface area based on the area of the segment.

4. **Raveling.** Weathering and raveling describes the wearing away of the pavement from the underlying pavement surface course, caused by the dislodging of aggregate particles from the recycled mix. The Engineer will visually evaluate each segment and determine the percentage of raveled surface area based on the area of the segment.

5. **Rutting.** The Engineer will place a 10 ft. straightedge across the lane width and perpendicular to the flow of traffic and measure rutting as the greatest perpendicular distance measured from the pavement surface to the bottom of the straightedge.

C. **Warranty Disclaimer.** The specifications and plan requirements do not relieve the contractor from warranty performance requirements, with the exception of the second to last paragraph under Article 7 of this specification.

7. **Contractor's Warranty Period.** The Contractor must provide a warranty bond using the Department-approved form, titled 'Contractor's Warranty Bond.' for the full bid price of WHIR and traffic control, markings, and markers required for the WHIR.

The Contractor's warranty period is for 3 yr. and starts the day after written acceptance of each separate project location. The Contractor is responsible for meeting Article 6, "Performance Requirements," for the duration of the warranty period.

During the warranty period, the Engineer will conduct periodic visual performance evaluations of WHIR. The Contractor may be present during these evaluations. For areas, which, in the opinion of the Engineer, have a questionable visual evaluation, the Contractor may replace the WHIR or the Department will conduct a formal performance evaluation for the performance requirement in question in accordance with Section 6.B, "Performance Evaluation Procedures."

Replace WHIR that fails to meet the performance requirements during the warranty period and within 30 days after notification following the procedures in Article 4, "Construction." All replacement WHIR must meet the performance requirements in Article 6, "Performance Requirements." The end of the warranty period does not relieve the Contractor from the performance deficiencies requiring corrective action identified during the warranty period.

The Engineer may exclude WHIR from the replacement provisions of the warranty period, provided the Engineer determines that the failure is from a source other than those normally associated with type of process. Examples of other sources of distress are damage by snow or ice removal, spills due to accidents and underlying pavement failures.

Provide a contact name, address, and phone number for notification of needed WHIR corrective action. Perform corrective action in accordance with the original Contract, including traffic control, markings, and markers unless otherwise directed.

8. **Measurement.** Warranted hot in-place recycling of asphalt concrete surface will be measured by the square yard. The dimensions for determining the surface areas are established by the depths and widths shown on the plans and the lengths measured at placement.

9. **Payment.** Warranted hot in-place recycling of asphalt concrete surfaces will be paid for at the unit price bid for "Warranted Hot In-Place Recycling of Asphalt Concrete (Surface)" of the depth specified.

   This price is full compensation for the removal and processing of the existing pavement; for all materials including new hot mix asphalt, aggregate, recycling agent and additives; for preparing, hauling, and placing materials; for all freight involved; for all manipulations, including rolling and brooming; and for all labor, tools, equipment, and incidentals necessary to complete the work. This price also includes any surface treatment that is allowed in the plans but not required to complete the above work.

WHIR INSTALLATION RECORD FOR WRITTEN ACCEPTANCE

** Warranty period begins the day after written acceptance, for each separate project location.

COUNTY HIGHWAY	CONTROL PROJECT	LIMITS FROM LIMITS TO	LENGTH	INITIAL PERFORMANCE VERIFICATION AND DATE	ACCEPTANCE DATE

Contractor signature_____

Department signature_____

CONTRACTOR'S WARRANTY BOND		CONTRACT NO.	
		COUNTY	
		BOND NO	

KNOW ALL PERSONS BY THESE PRESENTS: That we, _____, an installing contractor of warranted hot in-place recycling of asphalt concrete surfaces, as Principal, and _____, as Surety, are held and firmly bound unto the State of Texas, as Obligee, in the penal sum of _____Dollars $_____, lawful money of the United States, well and truly to be paid to the State of Texas, and we bind ourselves, our heirs, successors, executors, and administrators jointly and severally, firmly by these presents.

Whereas, the above bounden Principal has provided warranted hot in-place recycling of asphalt concrete surfaces to _____for the foregoing contract entered into between _____ and the Obligee, attached hereto; and

Whereas, the Principal is required to protect the Obligee against any defects resulting from faulty warranted hot in-place recycling of asphalt concrete surfaces installed under said contract for a period of 3 years beginning the day after written acceptance.

Now, therefore, the condition of this obligation is such that if the above bounden principal, its heirs, successors, executors, and administrators shall promptly and faithfully carry out and perform the warranty as provided in said contract, and shall, within thirty days of due notice, replace any installed warranted hot in-place recycling of asphalt concrete surfaces that may fail to meet Obligee's performance evaluation as provided for in the Contract during the period specified above or shall pay over, make good, and reimburse to the said Obligee all loss and damage that said Obligee may sustain by reason of failure or default of said Principal so to do, then this obligation shall be null and void, otherwise it shall remain in full force and effect.

Provided further that the end of a warranty period shall not relieve Principal from its obligation to correct deficiencies requiring corrective action, so long as those deficiencies are identified during the warranty period.

WITNESS our hand this _____ day of _____ 20 _____.

_____
(Company Name)

_____
****SURETY** (Print Firm Name and Seal)

By: _____
(Title)

* By: _____
(Company Officer)

* By: _____
(Company Officer)

_____
****SURETY** (Print Firm Name and Seal)

By: _____
(Title)

_____
****SURETY** (Print Firm Name and Seal)

By: _____
(Title)

Note:

* Attach a Power of Attorney showing that the officer of the installing contractor has authority to sign this obligation.

** Attach a Power of Attorney showing that the surety officer or Attorney-In-Fact has authority to sign this obligation; the Power of Attorney and bond must be impressed with the corporate seal. The surety must be a US Treasury listed company and provide notification information.