LONG TERM PAVEMENT PERFORMANCE PROGRAM DIRECTIVE

For the Technical Direction of the LTPP Program

Program Area: General Operations **Directive Number**: GO-09

Date: September 14, 1998 **Supersedes**: S-2

Subject: Policy for Monitoring Continuation on Rehabilitated Test Sections

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The Long-Term Pavement Performance (LTPP) program's policy on retention of rehabilitated and modified test sections are contained in the document **Long-Term Pavement Performance, *Guidelines for Monitoring Continuation on Rehabilitated Test Sections***, Federal Highway Administration, August 1998. These guidelines shall be followed beginning on the issuance date of this directive.

Approved by

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Long-Term Pavement Performance
Guidelines for Monitoring Continuation on Rehabilitated Test Sections

Final **August 1998**

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Federal Highway Administration

Long-Term Pavement Performance
Serving your need for durable pavements

Introduction

It is desired that Long-Term Pavement Performance (LTPP) pavement test sections remain in-service for as long as possible so that long-term performance trends can be established. However, since these pavement test sections are located on public roads, some form of modification to the pavement structure will ultimately occur to keep the road in a safe and serviceable condition. When a test section is modified by application of a rehabilitation treatment, some minimum requirements must be met in order for it to continue to be monitored as part of the LTPP program. This document presents LTPP program guidelines for monitoring continuation on rehabilitated LTPP test sections.

In order to improve the LTPP program's ability to provide performance information on rehabilitated pavement structures, more rehabilitation test sections are needed. Since LTPP test section recruitment has been completed, the existing LTPP test sections are the only source of additional rehabilitated pavements. Due to the accumulation of information previously collected on these test sections, continuation of monitoring after rehabilitation provides added benefit of observing and understanding pavement performance over the various phases in its life cycle. In order to provide the necessary data to explain performance, the minimums established in this document must be met.

Since the LTPP program's unique role within the national pavement research program in the United States are observations from in-service pavement across the North American continent, similarities between applied treatments are required so that factors affecting their performance can be evaluated from an experimental perspective. To promote uniformity and extend the existing LTPP rehabilitation studies, the preferred rehabilitation treatment guidelines presented in this document are consistent with those established by national panels of state highway agency pavement engineers for the Specific Pavement Studies. **Decisions on the timing and choice of applied rehabilitation treatments are the authority of the responsible highway agency.**

Definitions

The terms maintenance and rehabilitation are used within the LTPP program to classify how various treatments which alter a test section's structure are documented in the database. This is an important distinction since classification of some of these treatments may differ from highway agency terminology. For example, thin overlays, which some agencies may classify as maintenance, are classified within the LTPP program as rehabilitation since the data forms for overlays of any thickness are the same.

Maintenance	Maintenance activities include seal coats, crack sealing, patching, crack and joint sealing, grinding, milling less than 25-mm deep, and grooving.
Rehabilitation	Rehabilitation activities include overlays and associated pretreatments (patching, milling, joint repair, etc.), inlays (mill and fill), pressure relief joints in PCC pavements, subsealing or undersealing, retrofitted subdrainage, joint load transfer restoration, and shoulder restoration.

General Policy on Monitoring Continuation on Modified LTPP Test Sections

Application of maintenance treatments to LTPP test sections do not cause a change in experiment designation and, in general, these test sections will continued to be monitored provided:

1. LTPP data sheets documenting the treatment(s) are submitted.

2. Notification is provided to the LTPP program sufficiently in advance of the placement of seal coats, or other treatment which alter or hide the pavement surface, so that monitoring measurements can be performed prior to application.

It should be noted that this is not a change in LTPP policy.

Monitoring of a test section in the LTPP program after rehabilitation will be performed provided the following conditions are meet:

1. Participating highway agency performs the activities described under highway agency responsibilities in this document.

2. Applied rehabilitation activities fall within the range of acceptable treatments described in this document.

3. Pavement construction is completed and test section re-opened to traffic prior to January 1, 2002.

Reconstructed test sections will not be retained in the LTPP program. The LTPP program should be notified sufficiently in advance of reconstruction so that a final round of monitoring measurements can be performed.

Highway Agency Responsibilities

In order for a test section to be considered for LTPP monitoring after rehabilitation, the participating highway agency must either have performed, or agree to perform, the following activities:

1. Traffic data collection on the test section prior to overlay must have met the minimum requirements relative to the LTPP experimental designation.

2. Agency agrees to perform at least the minimum level of traffic data collection on the test section after rehabilitation in accordance with current LTPP guidelines.

3. Agency notifies LTPP regional representatives sufficiently in advance of construction to permit scheduling and conduct of deflection, profile, and distress measurements prior to the start of construction.

4. Agency agrees to provide traffic control for all LTPP field monitoring activities.

5. Agency marks and signs the test section in accordance with LTPP program procedures.

6. Agency completes and submits all required LTPP data forms to document the rehabilitation construction activities.

7. Agency performs field materials sampling and testing in accordance with LTPP guidelines.

8. Agency performs, or have performed, all laboratory material tests which are not performed by the LTPP contract laboratories.

LTPP Program Responsibilities

LTPP program responsibilities for rehabilitated test sections include:

1. Conduct of pavement performance monitoring including deflection, profile, and distress measurements prior to and after rehabilitation.

2. Process and store in the LTPP database all data collected following LTPP protocols and submitted on LTPP data forms or LTPP electronic file formats.

3. Provide LTPP program information to participating highway agencies on test section monitoring and data collection requirements.

4. Timely communication of decisions concerning monitoring continuation after rehabilitation to the highway agency.

5. Provide to the highway agency a material sampling and testing plan tailored to the specific features of the test section.

6. Perform resilient modulus and associated tests on cores obtained by the agency from asphalt concrete overlay materials.

7. Perform thermal coefficient of expansion tests on cores obtained from new portland cement concrete layers.

8. Perform, sponsor, and/or promote the development of usable engineering products and information for rehabilitated pavements from analysis of the collected data.

Acceptable Rehabilitation Treatments

The general categories of rehabilitation treatments that are acceptable for continued monitoring by the LTPP program are shown in Table 1. Treatments applied to LTPP test sections which are not described in Table 1 or activities described under the unsuitable treatments portion of this document are unacceptable for continuation in the LTPP program.

The following definitions relate to the items shown in Table 1:

AC	Dense graded hot mix asphalt-aggregate concrete using either a conventional or modified asphalt cement. Mixtures designed in accordance with current Superpave guidelines are acceptable. Thickness restriction applies to the material in excess of that which is used to replaced portions of the milled pavement structure. The thickness restriction does not apply to thin seal coats or open graded friction courses that may be required by agency policy.
PCC	Portland cement concrete pavement layers. PCC pavement layers must be either Jointed Plain Concrete Pavement (JPCP), Jointed Reinforced Concrete Pavement (JRCP) or Continuously Reinforced Concrete Pavement (CRCP). JPCP layers must have either no load transfer devices or smooth dowel bars only. JRCP layers must contain smooth dowel bars for joint load transfer. Unbonded PCC overlay layers must be greater than 126-mm thick (GPS-9 requirement).
CPR	Concrete pavement restoration. Allowable CPR techniques include partial depth patching, full depth patching and joint replacement, load transfer restoration, full surface diamond grinding, undersealing or subsealing, and retro-fitted edge drains. Distinction between classification as CPR or maintenance activity depends on the extent and nature of the applied treatments.
Debond Interlayer	An interlayer of material placed between the original PCC surface and PCC overlay to prevent bonding. Examples include Stress Absorbing Membrane Interlayers (SAMI), asphalt-rubber seal coat, sand asphalt, aggregate interlayer, etc.
Milling	Cold milling of the AC structural layers. The milling depth must be less than half the total thickness of the existing AC structural layers.
Fracture	Fracture pretreatments to PCC pavements include crack and seat, break and seat, and rubblization.

Table 1. Acceptable rehabilitation treatments for monitoring continuation in LTPP program.

Existing Pavement Type - LTPP Experiment	Pretreatment	Overlay Material and Thickness Restrictions
AC *GPS-1* *GPS-2* *SPS-1* *SPS-3* *SPS-8 (AC)* *SPS-9 (New)*	None	AC < 127-mm
	Maintenance and Repair	AC < 127-mm
	Milling	AC < 127-mm
	None	PCC
	Maintenance and Repair	PCC
	Milling	PCC
PCC *GPS-3* *GPS-4* *GPS-5* *SPS-2* *SPS-4* *SPS-8 (PCC)*	CPR	None
	None	AC >102-mm, <203-mm
	CPR	AC >102-mm, <203-mm
	Fracture	AC >102-mm, <203-mm
	Debond Interlayer	PCC >126-mm
AC over AC *GPS-6* *SPS-5* *SPS-9 (Overlay)*	None	AC < 127-mm
	Maintenance and Repair	AC < 127-mm
	Milling	AC < 127-mm
AC over PCC *SPS-7* *SPS-6*	None	AC < 203-mm
	Milling	AC < 203-mm
	Milling + CPR	AC < 203-mm
	None	PCC > 126-mm
	Milling + Debond Interlayer	PCC > 126-mm

Unsuitable Treatments

If any of the following treatments or construction activities are applied to a test section, they will render the existing test section unsuitable for continued monitoring as part of the LTPP pavement rehabilitation studies:

- Widening of the LTPP test lane.
- Added lane next to the LTPP test lane.
- Intersections or ramps added inside maintenance control zone around test section.
- Tied concrete shoulders added to test lane.
- On pavements in the non-rehabilitated asphalt concrete pavement experiments, such as those in GPS 1, GPS 2, SPS 1, or SPS 8, removal of more than half the total thickness of the AC structural layer(s).
- Application of non-uniform treatments which result in differences in layer thicknesses of greater than 25-mm over more than one third of the test section length. This restriction is intended to apply primarily to milling depths and overlay thicknesses and not variations due to spot patching and repair of localized distresses.
- Use of non-standard paving materials that are considered "experimental." Determination of what is considered experimental will depend upon the extent of highway agency's routine use of the material.
- Performing construction activities which either hide surface distresses or alter the structural pavement response, prior to completion of LTPP monitoring measurements to document the condition of the existing pavement prior to rehabilitation.
- Use of bonded PCC overlays on existing PCC pavement sections. (The GPS-8 study on bonded PCC overlays was abandoned in 1988.)

When one or more of these conditions apply to a test section, or if the agency does not desire to participate in the continued monitoring of a test section after rehabilitation, the LTPP Regional Coordination Office should be contacted so that final monitoring measurements can be performed prior to the test section going out-of-study.

Preferred Rehabilitation Specifications

In order to provide greater consistency between the pavement structures studied in the LTPP program, use of any combination of the following treatments and specifications is desired. These specifications are based on the LTPP construction guidelines for the Specific Pavement Studies rehabilitation experiments. Although conformance with these preferred specifications is not required, their use can help to extend the results of the related LTPP experiments.

Preferred Specifications for Asphalt Concrete Pavements

When asphalt concrete pavement structures included in LTPP experiments GPS 1, 2, 6, or SPS 1, 5, 8, or 9 are rehabilitated, it is preferred that the materials and construction procedures conform to the SPS-5 Construction Guidelines (Ref. 1). Some of the details contained in the SPS-5 Construction Guidelines and other preferred practices include:

- It is preferred that all asphalt concrete mixes be design in accordance with FHWA Technical Advisory **T5040.27 Asphalt Concrete Mix Design and Field Control**, March 10, 1988. (Ref. 1) (*Note: Superpave mixes are allowable.)*

- It is preferred that milling be limited to less than one third the total combined thickness of the bound asphalt concrete structural surface layers.

- It is preferred that the asphalt concrete be composed of all new material conforming to the specifications in the SPS-5 Construction Guidelines.

- If the asphalt concrete mix contains recycled asphalt concrete materials, it is preferred that the recycle mixture conform to the specifications in the SPS-5 Construction Guidelines. (Excerpts from the SPS-5 Construction Guidelines concerning recycled asphalt concrete specifications are provided in Appendix A.)

- It is preferred that overlay thicknesses of 51 or 127-mm be placed. This thickness is in addition to any material that was used to replaced portions of the pavement structure that were milled. (These are the same thicknesses used in the SPS-5 experiment.)

Preferred Specifications for Portland Cement Concrete Pavements

When PCC pavements included in the LTPP GPS 3, 4, or 5, or SPS 2 or 8 experiments are rehabilitated, it is preferred that the materials and construction procedures conform to the SPS-6 Construction Guidelines (Ref. 1). Some of the construction specifications contained in the SPS-6 Construction Guidelines and other preferred practices include:

- Partial depth patching of areas with spalling or scaling that are confined to the upper half of the concrete layer.

- Full depth patching of deteriorated joints or working cracks.
- Load transfer restoration at joints or working cracks.
- Full surface diamond grinding.
- Undersealing or subsealing.
- Retrofitted subsurface drainage systems (particularly on crack/break and seat sections).
- Crack and seat for jointed concrete pavements and break and seat for jointed reinforced concrete pavements.
- Joint and/or crack sealing prior to placement of an asphalt concrete overlay is not desired.
- Asphalt concrete overlays are the preferred rehabilitation treatment for LTPP PCC test sections only because the majority of rehabilitated PCC pavements in the LTPP program have this type of overlay.
- It is preferred that asphalt concrete overlay mixes be design in accordance with FHWA Technical Advisory T5040.27 (Ref. 2). (*Note: Superpave mixes are allowable.)*
- It is preferred that the asphalt concrete be composed of all new material.
- It is preferred that the thicknesses of the asphalt concrete overlay be either 102-mm or 203-mm. (These are the same thicknesses used in SPS-6 experiment).
- If saw and sealing of the asphalt concrete overlay at joint and working crack locations in the PCC pavement are performed, it is preferred that the procedures and specifications contained in the SPS-6 Construction Guidelines (Ref 3) be followed.

Preferred Specifications for SPS-6 Test Sections

To extend the results of the SPS-6 experiment, a prescribed set of treatments for each test section was established by the LTPP program in 1992. It is preferred that these treatments be followed in order to extend the results of this experiment. All construction activities and materials used to rehabilitate existing SPS-6 test sections should conform to the specifications contained in the SPS-6 Construction Guidelines (Ref. 3).

- Routine Maintenance Section. This test section should be rehabilitated using the applicable SPS-6 intensive restoration techniques and overlaid with a 102-mm thick asphalt concrete overlay. It is desired that the materials used in the asphalt concrete

mixture be reasonably similar to those used in the original overlay mixtures for the other SPS-6 test sections at the site.

- Minimum Restoration Sections. SPS-6 test sections 2, 3, and 4 should be rehabilitated using the applicable SPS-6 intensive restoration techniques for the PCC layer and overlaid with a 102-mm thick asphalt concrete overlay. It is desired that the materials used in the asphalt concrete mixture be reasonably similar to those used in the original overlay mixtures for the other SPS-6 test sections at the site. On Section 2 (the minimum restoration section without overlay), the entire 305-m length of the test section should be overlaid and established as the new test section. On Sections 3 and 4, the existing asphalt concrete overlay layer should be completely removed prior to application of restoration treatments and placement of the new overlay.

- Intensive Restoration Test Sections. SPS-6 test sections 5 and 6 should be rehabilitated by using applicable SPS-6 intensive restoration techniques on the PCC layer and overlaid with a 102-mm thick asphalt concrete overlay. It is desired that the materials used in the asphalt concrete mixture be reasonably similar to those used in the original overlay mixtures for the other SPS-6 test sections at the site. On Section 5 (maximum restoration section without overlay), the entire 305-m length of the test section should be overlaid and established as the new test section. On Section 6, the existing asphalt concrete overlay layer should be completely removed prior to application of restoration treatments and placement of the new overlay.

- Crack/Break and Seat Sections. SPS-6 test sections 7 and 8 should be rehabilitated by using applicable SPS-5 (Ref. 2) intensive surface preparation techniques and a 51-mm thick asphalt concrete overlay. The 51-mm overlay thickness is in addition to the amount material used to replace any portion of the existing AC overlay layer that was milled.

Appendix A

Excerpt from SPS-5 Construction Guidelines (Ref. 1)

Pages 12 - 14

ASPHALT CONCRETE MIX DESIGN

The generic type of hot mixed asphalt concrete material used in the overlays is a main factor in this experiment. Mixtures composed of "virgin" (all new) materials and those containing a portion of recycled asphalt concrete materials are the two chosen levels for this factor.

It is not practical or feasible to specify either the same mix, mix design, or even mix design method for all test locations. To promote uniformity across test sites, design of the asphalt mixes shall be performed in compliance with the guidelines contained in the FHWA Technical Advisory T5040.27, "Asphalt Concrete Mix Design and Field Control", March 10, 1988 with the mix design criteria revision to conform to the Asphalt Institute Manual MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types", 1988. A copy of these guidelines are reproduced in Appendix B of this report.

In accordance with the FHWA Technical Advisory and The Asphalt Institute Manual, both the virgin and recycled asphalt concrete mixtures should be designed to the following specifications:

Marshall -	Compaction blows	75	
	Stability (minimum)	1,800	
	Flow	8 - 14	
Hveem -	Stability (Minimum)	37	
	Swell (Maximum)	0.30	in.
Air Voids -		3 - 5%	

Agencies using non-standard Hveem or Marshall mix design procedures, should design the mixes to achieve design indices equivalent to those obtained using these standard procedures.

Virgin Materials

The asphalt concrete designated as "virgin" shall employ new materials which have not been used in previous construction.

Aggregates. Aggregates used in the virgin mixes shall be new aggregates of the highest quality available to the agency. These aggregates shall conform to the following guidelines:

- A minimum of 60% of the crushed coarse aggregate (retained on the #4 sieve) with two fractured faces.

- A minimum sand equivalent test of 45 as obtained following AASHTO T 176.

- A dense aggregate gradation.

Asphalt Cement. The asphalt grade and characteristics should be selected by the agency based on normal practice. Asphalt cements with low temperature susceptibility (PVN$ -0.5) are recommended.

Additives. Additives, such as lime, which are routinely used by an agency are permitted in the mix design. Experimental additives or modifiers should not be used in the test sections, but may be used in supplemental test sections.

Recycled Materials

The asphaltic concrete mix containing recycled asphalt concrete materials shall conform to the following guidelines:

- A fixed 30% of recycled asphalt pavement (RAP) shall be used in the mixture.

- All RAP shall be free of organic or deleterious material.

- RAP containing poor quality aggregates with a history of stripping or high abrasion should not be used.

- All reclaimed coarse aggregate material shall have 100% passing the 1½ inch sieve and a maximum of 25% passing the ⅜ inch sieve.

- Reclaimed crushed fines shall have 100% passing the ¾ inch sieve and no more than 25% passing retained on the ⅜ inch sieve.

- Measurement of the composition of the RAP including aggregate gradation, asphalt content, asphalt viscosity (@ 140E and 275EF), and penetration at 77EF should be performed for proper design of the recycled mix.

- New aggregates shall conform to the same specifications as the virgin mix.

- Only asphalt cement shall be added as a binder in the recycled mix.

- Asphalt cement obtained from the same source or supplier as that used in the virgin mix is recommended.

- The use of asphalts with low temperature susceptibility (PVN $ -0.5) are recommended.

- Rejuvenating agents are not permitted in the recycled asphalt concrete mix.

References

1. **Specific Pavement Studies, Construction Guidelines for Experiment SPS-5, Rehabilitation of Asphalt Concrete Pavements**, Operational Memorandum SHRP-LTPP-OM-12, Strategic Highway Research Program, June 1990

1. FHWA Technical Advisory **T5040.27 Asphalt Concrete Mix Design and Field Control**, Federal Highway Administration, March 10, 1988.

1. **Specific Pavement Studies, Construction Guidelines for Experiment SPS-6, Rehabilitation of Jointed Portland Cement Concrete Pavements**, Operational Memorandum No. SHRP-LTPP-OM-013, Strategic Highway Research Program, July 1990.