FHWA Bridge Preservation Guide

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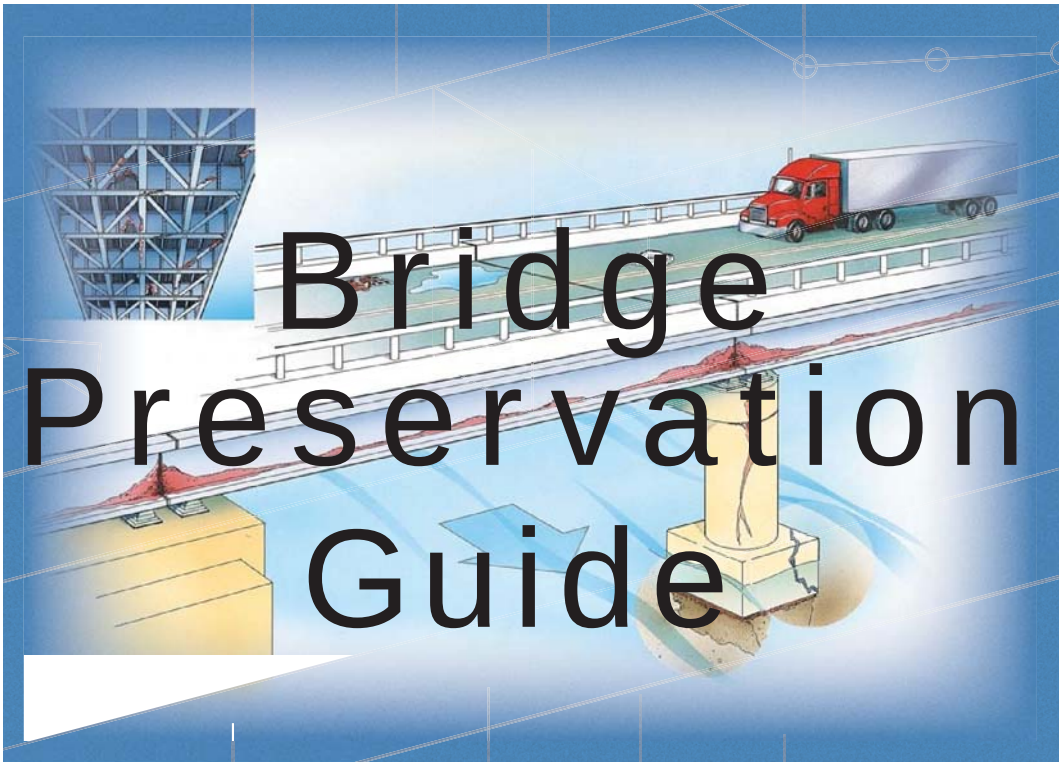

Bridge Preservation Guide

Maintaining a State of Good Repair Using Cost Effective Investment Strategies

U.S. Department of Transportation
Federal Highway Administration

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I. Introduction

State departments of transportation and other bridge owners are faced with significant challenges in addressing the Nation's highway bridge preservation and replacement needs.

More than 25 percent of the Nation's 600,000 bridges are rated as structurally deficient or functionally obsolete. More than 30 percent of existing bridges have exceeded their 50-year theoretical design life[1] and are in need of various levels of repairs, rehabilitation, or replacement. This issue is exacerbated by increasing travel demands, limited funding, and increasing costs of labor and materials. These circumstances have caused most bridge owners to become more reactive than proactive in their approach to managing and addressing their bridge program needs.

Bridge stewards and owners need to become, inevitably, more strategic by adopting and implementing systematic processes for bridge preservation as an integral component of their overall management of bridge assets.

A successful bridge program seeks a balanced approach to preservation and replacement. Focusing only on replacing deficient bridges while ignoring preservation needs will be inefficient and cost-prohibitive in the long term. Adopting a "worst first" approach to managing bridge assets may also yield ineffective results that allows bridges in good condition to deteriorate into the deficient category which generally is associated with higher costs and other challenges.

The objective of a good bridge preservation program is to employ cost effective strategies and actions to maximize the useful life of bridges. Applying the appropriate bridge preservation treatments and activities at the appropriate time can extend bridge useful life at lower lifetime cost.

Preservation activities often cost much less than major reconstruction or replacement activities. Delaying or forgoing warranted preservation treatments will result in worsening condition and can escalate the feasible treatment or activity from preservation to replacement. The latter will result in extensive work and higher cost. A viable alternative is timely and effective bridge preservation of sound bridges to assure their structural integrity and extend their useful life before they require replacement.

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[1] The theoretical design life of a bridge has been 50 years, but with the evolution of new design guidelines and construction materials the anticipated service life for newly constructed bridges is 75 years or greater.

II. Purpose

This guide provides bridge related definitions and corresponding commentaries, as well as the framework for a systematic approach to a preventive maintenance (PM) program. The goal is to provide guidance on bridge preservation. This guide does not create or confer any rights for or on any person or operate to bind the bridge owners or bridge operating agencies. Bridge owners or agencies may use an alternative approach if it satisfies the requirements of the applicable statutes and regulations.

III. Scope

This guide is intended for Federal, State, and local bridge engineers, area engineers, bridge owners, and bridge preservation practitioners. The success of a viable bridge preservation program will involve these individuals as well as others who support the Federal-aid highway program.

IV. Eligibility

Over the last 30 years, the Congress has provided approximately $77.6 billion to the States through the Federal-aid bridge program. In 2008, Congress renewed emphasis in preservation of our Nation's bridge infrastructure by changing the name from the Highway Bridge Replacement and Rehabilitation Program to the Highway Bridge Program (HBP) and adding systematic preventive maintenance (SPM)[2] as an eligible activity.

Title 23, United States Code (U.S.C.), Section 144 makes HBP funds available for highway bridge replacement and rehabilitation based on the development of the following: (1) a bridge inventory (National Bridge Inventory); (2) a classification system (Deficiency Status and Sufficiency Rating); (3) a priority system within the classification system (Sufficiency Rating and Selection List); and (4) a cost evaluation of the replacement and rehabilitation options. These funds may be expended for replacement, rehabilitation, painting, seismic retrofit, SPM, installation of scour countermeasures and application of anti-icing or de-icing compositions to eligible (i.e., on Selection List) highway bridge projects on and off the Federal-aid highways. Additionally, 23 U.S.C. 144(d) allows these funds to be expended for seismic retrofit, SPM, and

[2] The SAFETEA-LU Technical Corrections Bill was signed into law on June 5, 2008. What was formerly known as the Highway Bridge Replacement and Rehabilitation Program in 23 U.S.C. 144 is now legally known as the Highway Bridge Program (HBP). The Congress in making this change is placing greater emphasis on a program of SPM making HBP funds available for this type activity with less emphasis on replacement and rehabilitation. This flexibility allows State transportation departments to determine whether to spend HBP funds on replacement, rehabilitation, or SPM.

scour countermeasures without regard to whether the bridge is eligible for replacement or rehabilitation.

Please refer to the FHWA memorandum in Appendix C for additional information on the use of Federal-aid funds for preventive maintenance.

The commentary that follows goes into more detail regarding requirements and the kinds of activities included under each category. Recall that routine maintenance is ineligible for Federal-aid highway funding.

V. Definitions and Related Commentaries

A successful bridge program is based on a strategic, systematic, and balanced approach to managing bridge preservation and replacement needs.

Several definitions are presented within this section along with commentary. The definitions are offered as a means of establishing clear and consistent terminology for the bridge preservation practitioners.

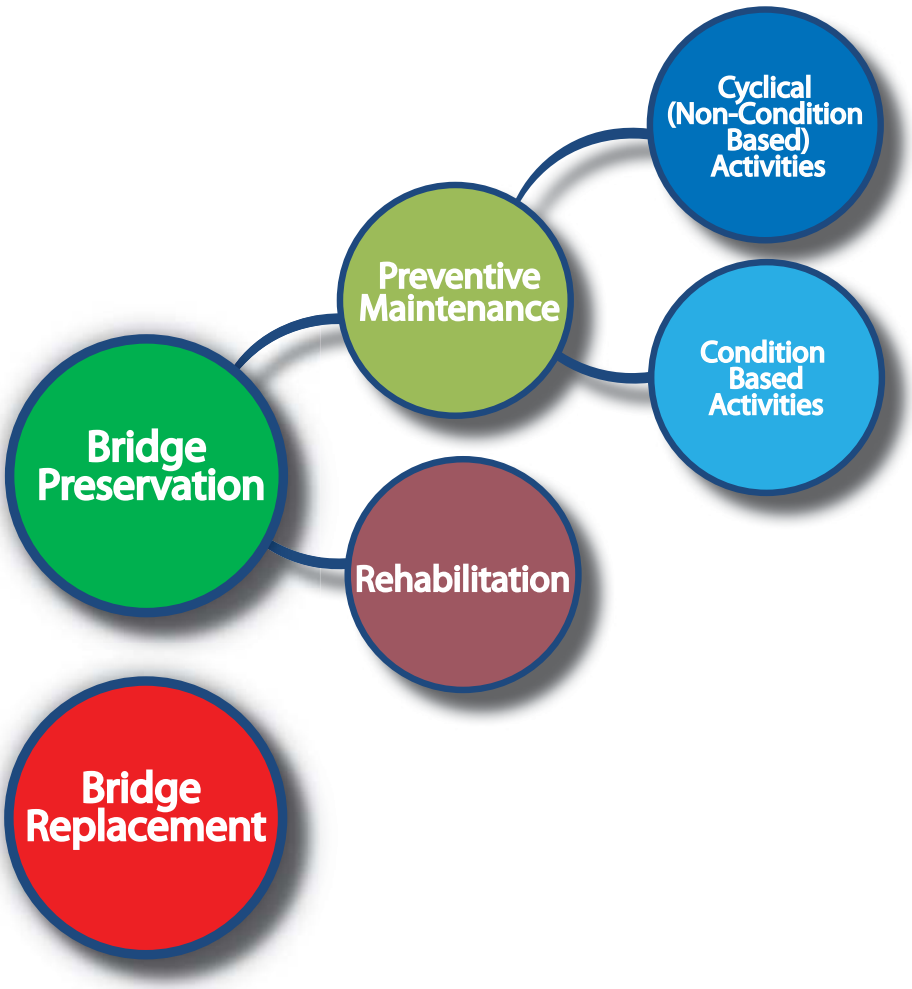

Figure 1 – Bridge Action Categories

Bridge Preservation –Definition

Bridge preservation is defined as actions or strategies that prevent, delay or reduce deterioration of bridges or bridge elements, restore the function of existing bridges, keep bridges in good condition and extend their life. Preservation actions may be preventive or condition-driven. *Source: FHWA Bridge Preservation Expert Task Group.*[3]

Bridge Preservation – Commentary

Effective bridge preservation actions are intended to delay the need for costly reconstruction or replacement actions by applying preservation strategies and actions on bridges while they are still in good or fair condition and before the onset of serious deterioration. Bridge preservation encompasses preventive maintenance and rehabilitation activities (refer to figure 1).

An effective bridge preservation program:

1) Employs long-term strategies and practices at the network level to preserve the condition of bridges and to extend their useful life;

2) Has sustained and adequate resources and funding sources; and

3) Has adequate tools and processes to ensure that the appropriate cost effective treatments are applied at the appropriate time.

Preventive Maintenance – Definition

Preventive maintenance is a planned strategy of cost-effective treatments to an existing roadway system and its appurtenances that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system (without substantially increasing structural capacity). *Source: AASHTO Subcommittee on Maintenance.*

[3] This is a definition developed through the Bridge Preservation Expert Task Group that will be vetted through the AASHTO Subcommittee on Bridges and Structures (SCOBS) and Subcommittee on Maintenance (SCOM) at their 2011 meetings for approval as an AASHTO definition.

Preventive Maintenance – Commentary

Bridge owners typically apply PM to elements or components of structures with significant remaining useful life. As a major part of bridge preservation, PM is a strategy of extending useful life by applying cost-effective treatments to sound bridges (good or fair condition). The concept of preventive bridge maintenance suggests that a planned strategy of cost-effective treatments should be performed to keep bridges in good condition, retard future deterioration, and avoid large expenses in bridge reconstruction or replacements.

Examples of PM activities may include but are not limited to the following:

- Bridge washing and or cleaning
- Sealing Deck Joints
- Facilitating Drainage
- Sealing Concrete
- Painting Steel
- Removing Channel Debris
- Protecting Against Scour
- Lubricating Bearings

Preventive maintenance includes cyclical (non-condition based) and condition-based activities as illustrated in figure 1.

Cyclical Preventive Maintenance Activities – Definition

Activities performed on a pre-determined interval and aimed to preserve existing bridge element or component conditions. Bridge element or component conditions are not always directly improved as a result of these activities, but deterioration is expected to be delayed.

Cyclical Preventive Maintenance Activities – Commentary

Different performance measures and frequencies could be established for cyclical activities based on the desired level of service and program goals. For example, a bridge owner may establish performance targets for bridges that are on the National Highway System that are different from those for bridges on other roadway systems with lower traffic volumes.

Examples of cyclical PM activities and commonly used frequencies that may be considered by bridge owners for implementation on sound bridges are shown in table 1 below:

Cyclical PM Activity Examples	Commonly Used Frequencies (Years)[4]
Wash/clean bridge decks or entire bridge	1 to 2
Install deck overlay on concrete decks such as:	
- Thin bonded polymer system overlays	10 to 15
- Asphalt overlays with waterproof membrane	10 to 15
- Rigid overlays such as silica fume and latex modified	20 to 25
Seal concrete decks with waterproofing penetrating sealant	3 to 5
Zone coat steel beam/girder ends	10 to 15
Lubricate bearing devices	2 to 4

[4] - *Frequencies are based on FHWA's knowledge of typical State DOT practices*

Table 1: Examples of Cyclical PM Activities

Condition Based Preventive Maintenance Activities – Definition

Activities that are performed on bridge elements as needed and identified through the bridge inspection process.

Condition Based Preventive Maintenance Activities – Commentary

These activities are typically performed on a bridge that is in overall good to fair condition to restore bridge elements to a state of good repair. Similar to cyclical preventive maintenance activities, the condition based preventive maintenance activities are designed to extend the useful life of bridges.

Examples of condition based preventive maintenance activities include but are not limited to: Sealing or replacement of leaking joints; Installation of deck overlays; Installation of cathodic protection (CP) systems; Complete, spot, or zone painting/coating of steel structural elements; Installation of scour countermeasures. These PM examples may also be implemented in advance of any condition-based observations. For example, installation of scour countermeasures at a substructure element that is deemed scour susceptible, but before observing any scour during the routine inspection.

Rehabilitation – Definition

Rehabilitation involves major work required to restore the structural integrity of a bridge as well as work necessary to correct major safety defects. *Source: 23 CFR 650.403(c).*

Rehabilitation – Commentary

Rehabilitation work can be done on one or multiple elements and/or components. Bridge rehabilitation projects are often intended to restore the structural integrity of a bridge and correct major safety defects.

As shown in figure 1, bridge rehabilitation activities are considered bridge preservation. However functional improvements such as adding a travel lane or raising vertical underclearance, while often is considered as rehabilitation are not considered preservation.

Bridge rehabilitation projects provide complete or nearly complete restoration of bridge elements or components. These projects typically require significant engineering resources for design, a lengthy completion schedule, and considerable costs. Most rehabilitation projects include repairs to several bridge components but can be limited to bridge deck replacement.

Examples of bridge rehabilitation include but are not limited to: Partial or complete deck replacement; Superstructure replacement; Strengthening. Incidental widening is often associated with some of these activities.

Replacement – Definition

Total replacement of a structurally deficient or functionally obsolete bridge with a new facility constructed in the same general traffic corridor. A nominal amount of approach work, sufficient to connect the new facility to the existing roadway or to return the gradeline to an attainable touchdown point in accordance with good design practice is also eligible. The replacement structure must meet the current geometric, construction and structural standards required for the types and volume of projected traffic on the facility over its design life. *Source: 23 CFR 650.405(b)(1).*

Replacement – Commentary

Similar to bridge rehabilitation, bridge replacement projects require engineering resources for design, a substantial and complex completion schedule, and considerable costs. Life cycle costs and other economic factors are usually considered when weighing rehabilitation versus replacement costs.

Bridge replacement is not considered a preservation activity.

Condition State

A condition state categorizes the nature and extent of damage or deterioration of a bridge element. The AASHTO Guide Manual for Bridge Element Inspection, first edition, 2011, provides detailed information on bridge elements and their corresponding condition states. According to the AASHTO guide manual, each bridge element can have four condition states. The higher the condition state, the higher the severity of the damage and/or deterioration. All elements defined in the AASHTO guide manual have the same general requirements:

1. Standard number of condition states

2. The condition states are generally comprised of good, fair, poor, and severe general descriptions

National Bridge Inventory (NBI) General Condition Ratings (GCRs)

General condition ratings are used to describe the existing, in-place bridge or culvert as compared to the as-built condition. The materials used in the bridge are considered as well as the physical condition of the deck, superstructure and substructure components. This information is used to determine GCRs on a numerical scale that ranges from 0 (failed condition) to 9 (excellent condition) as described in the FHWA Coding Guide[5]. Appendix A provides a description for each of these numeric values. The GCRs are used in evaluating bridge decks, bridge superstructures, bridge substructures, and culverts.

State of Good Repair (SGR)

A condition in which the existing physical assets, both individually and as a system (a) are functioning as designed within their useful service life, (b) are sustained through regular maintenance and replacement programs. SGR represents just one element of a comprehensive capital investment program that also addresses system capacity and performance. [6]

Considering the aforementioned characterization of SGR as it applies to physical assets, for bridge assets, SGR would mean: the existing physical conditions of bridge elements, components or entire bridges are such that the bridges (a) are functioning as designed and (b) are sustained through regular maintenance, preservation, and replacement programs.

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[5] FHWA Report number PD-96-001 "Recording and Coding Guide for Structure Inventory and Appraisal of the Nation's Bridges, December 1995".

[6] Secretary Mary Peters July 25, 2008 letter to Congress on this topic.

Structurally Deficient (SD)

Bridges are considered SD if significant load carrying elements are found to be in poor condition due to deterioration and/or damage, or the adequacy of the waterway opening provided by the bridge is determined to be extremely insufficient to the point of causing overtopping with intolerable traffic interruptions.

SD is numerically defined as follows:

- A bridge component (deck, superstructure, substructure or culvert) having an NBI general condition rating of a 4 or less (poor condition)

or

- Structural Evaluation or Waterway Adequacy rated a 2 or less (a bridge with a very low load rating capacity, or a bridge that is sub ject to overtopping with significant or severe traffic delays).

For a structure to be considered SD, one of the following items must be true[7]:

	NBI GENERAL CONDITION RATINGS				APPRAISAL RATINGS	
NBI Item#	58	59	60	62	67	71
	Deck	Superstructure	Substructure	Culvert	Structural Evaluation	Waterway Adequacy
Code	<= 4	<= 4	<= 4	<= 4	<= 2	<= 2

Table 2- SD Criteria

Examples of Conditions Leading to an SD Classification

Deck

Superstructure

Substructure

[7] Each NBI item number shown in the table is further described in the Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges.

Functionally Obsolete (FO)

Bridges are considered FO when the deck geometry, load carrying capacity (comparison of the original design load to the current State legal load), clearance, or approach roadway alignment no longer meet the usual criteria for the system of which it is an integral part. In general, FO means that the bridge was built to standards that are not used today. Examples of characteristics leading to an FO classification:

- Low load carrying capacity
- Low waterway adequacy
- Deck geometry (insufficient deck roadway width)
- Insufficient horizontal and vertical clearances
- Poor approach roadway alignment.

For a structure to be considered FO, one of the following items must be true:

	APPRAISAL RATINGS				
NBI Item #	67	71	68	69	72
	Structural Evaluation	Waterway Adequacy	Deck Geometry	Underclearances	Approach Roadway Alignment
Code	= 3	= 3	<= 3	<= 3	<= 3

Table 3 – FO Criteria

Examples of Characteristics Resulting in FO Classifications

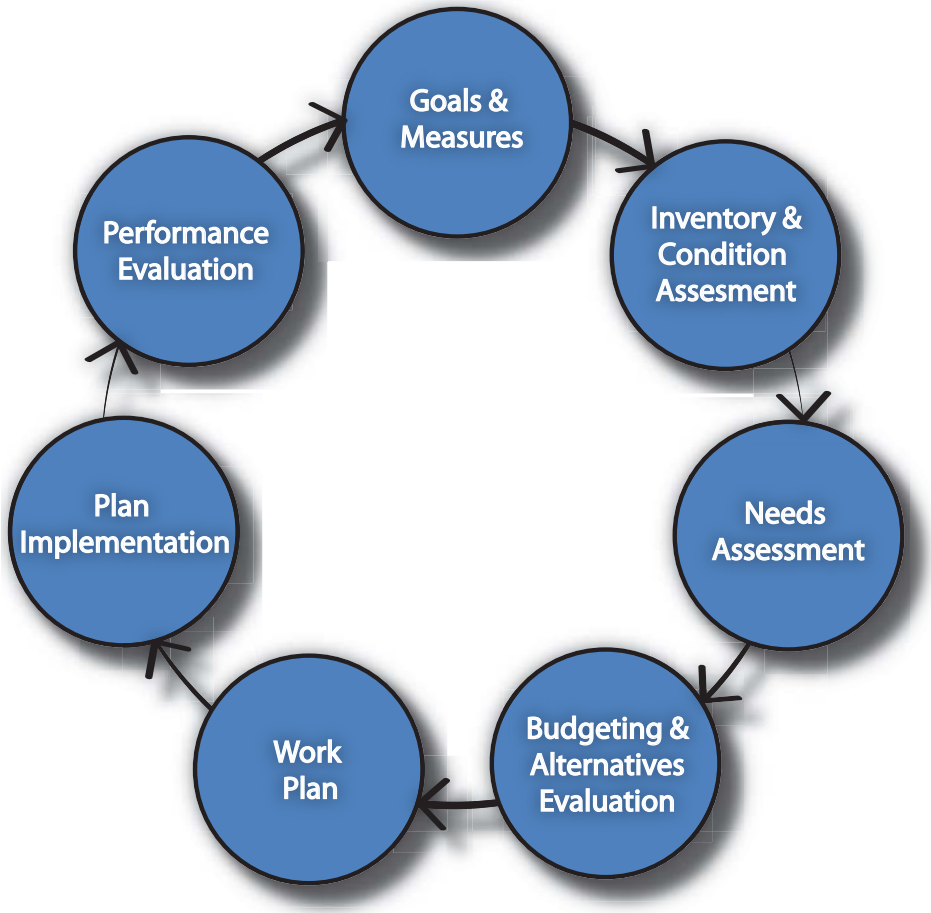
Shoulder widths less than current standards

Vertical Underclearance less than current standards

Sufficiency Rating (SR)

The sufficiency rating formula provides a method of evaluating highway bridge data by calculating four separate factors to obtain a numeric value which is indicative of bridge sufficiency to remain in service. The result of this method is a percentage in which 100 percent would represent an entirely sufficient bridge and zero percent would represent an entirely insufficient or deficient bridge. The formula considers the structural adequacy; functional obsolescence and level of service; and essentiality for public use. The SR formula is described in Appendix B of FHWA's *Recording and Coding Guide for the Structure, Inventory and Appraisal of the Nation's Bridges.*

VI. Systematic Preventive Maintenance (SPM) Program



What is Systematic Preventive Maintenance (SPM)?

The AASHTO Subcommittee on Maintenance's definition of "preventive maintenance" includes the phrase "a planned strategy of cost-effective treatments." An SPM program is based on a planned strategy that is equivalent to having a systematic process that defines the strategy, how it is planned, and how activities are determined to be cost effective.

An SPM program for bridges can be defined as a planned strategy of cost-effective treatments to existing bridges that are intended to maintain or preserve the structural integrity and functionality of elements and/or components, and retard future deterioration, thus maintaining or extending the useful life of the bridge.

An SPM program can also be defined as a documented methodology regularly applied to repeatedly achieve a desired outcome or goal. An SPM program may be applied to bridges at the network, highway system, area wide, or region wide basis.

A. Qualifying SPM Program Parameters for use of Federal-aid Funds

23 U.S.C. 144(d) allows HBP funds to be expended for SPM on highway bridges located on public roads regardless of whether a bridge is eligible for replacement or rehabilitation.

Additional information regarding the use of Federal-aid funds for PM is found in Appendix C (FHWA memorandum on Preventive Maintenance Eligibility, October 8, 2004).

The use of a Bridge Management System (BMS) is highly encouraged as it facilitates the implementation of an SPM program. However, a BMS is not a prerequisite for an SPM program. An acceptable SPM program at a minimum should have the following six attributes:

1. **Goals and Objectives** – Clearly defined goals and objectives for the SPM program.

2. **Inventory and Condition Assessment** – Availability of tools and resources to conduct bridge inspections and evaluation.

3. **Needs Assessment** - Documented needs assessment process that outlines how PM needs are identified, prioritized, and programmed.

4. **Cost Effective PM Activities** – Ability to demonstrate that the proposed PM activities are a cost-effective means of extending the life of a bridge.

5. **Accomplishing the Work** – Availability of tools and resources to accomplish the PM work.

6. **Reporting and Evaluation** – Ability to track, evaluate, and report on the planned and accomplished PM work on an annual and/or as-needed basis.

SPM Program Parameters Commentary

1. **Goals & Objectives** – Clearly defined goals and objectives for the SPM program.
   As with any effective bridge management program, an SPM program should have objectives and measurable goals. An example of objective and overall goal that could be considered in adopting an SPM program is shown below.

   - **Objective:** Implement timely preservation treatments on structurally sound bridges, thereby extending their useful life. Structurally sound may be defined as having an overall NBI general condition rating of 5 or greater for the deck, superstructure, sub structure, or culvert components, or AASHTO Element Condition State of 1 or 2 for the elements associated with the deck, superstructure, substructure, and culvert units.

   - **Overall Program Goal:** Maintain X percent of bridges in a state of good repair.

     Measure: Percent of bridges with element condition state ≤ 2.

     Measure: Percent of bridges with NBI general condition rating ≥ 6.

     Measure: Percent of bridges with Health Index[8] ≥ "X" percent.

   Goals and measures can also be developed for specific PM strategies as shown in the following examples.

   Strategies for cyclical PM activities:

   1. **Goal:** Seal concrete decks with waterproof penetrating sealant every "X" years.

      Measure: Percent of bridge decks sealed annually.

   2. **Goal:** Paint steel beam/girder ends every "X" years.

      Measure: Percent of beam/girder ends painted annually.

   3. **Goal:** Bridges are clean and free of debris and contaminating chemicals.

      Measure: Percent of bridges washed/cleaned annually.

[8] Health Index or HI is used for the calculation of a single integral indicator of the structural health of the bridge. This indicator is expressed as a percentage value. This value may vary from 0%, which corresponds to the worst possible condition, to 100% in the best condition. Health index is calculated as a function of the fractional distribution of the bridge elements' quantities across the range of their applicable condition states (CS).

Strategies for condition-based PM activities:

1. **Goal:** - Maintain "X" percent of expansion joints in condition state 2 or better.

   Measure: Percent of expansion joints in condition state 2 or better.

2. **Goal:** Maintain "X" percent of coated steel surfaces in good condition.

   Measure: Percent of steel protective coating element in condition state 2 or better.

   Measure: Percent of steel bridges with NBI general condition rating of 6 or better for the superstructure.

3. **Goal:** Maintain "X" percent of bridge decks in good condition.

   Measure: Percent of deck and slab elements in condition state 2 or better.

   Measure: Percent of bridges with NBI general condition rating of 6 or better for the deck.

4. **Goal:** All bridges are clean and free of debris.

   Measure: Any reported debris cleared within "X" days of notification.

For additional examples of qualifying PM activities refer to section VI. B.

An agency may wish to consider establishing different goals for different highway systems, functional classifications, or Average Daily Traffic (ADT) ranges.

2. Inventory and Condition Assessment - Availability of tools and resources to conduct bridge inspections and evaluation.
The foundation of a good SPM program is based on the availability of quality inspection data and condition assessment outcomes from that data. Inventory and condition data are collected by bridge owners in accordance with the NBI and the National Bridge Inspection Standards. NBI general condition ratings are assigned by bridge inspectors during each inspection cycle for major components: deck, superstructure, substructure, and culvert (see appendix A). In addition to the NBI general condition rating for

bridge components, the majority of State DOTs have also been collecting bridge element inspection data[9]. Bridge element data can be very instrumental in the implementation of various aspects of bridge management strategies including bridge preservation.

3. Needs Assessment - Documented needs assessment process that outlines how PM needs are identified, prioritized and programmed.

An SPM program should include a needs assessment that describes the bridge owner's plan for identifying and prioritizing needs.

Examples of components of a needs assessment include the following:

- A schedule of predetermined intervals for conducting a needs assessment, such as annually or biennially.
- Storage of the data from the needs assessment that allows for querying and the identification, quantification, and ranking of PM work candidates.
- The means of estimating the cost of the work needed to achieve the established program goals.
- A repeatable, unbiased data collection process.

4. Cost Effective PM Activities – Ability to demonstrate that the proposed PM activities are a cost-effective means of extending the life of a bridge.

The examples of PM activities found in Section IV.B of this guide may be considered cost effective when applied to the appropriate bridges at the appropriate time using quality materials and workmanship. For example, painting a steel superstructure with severe deterioration and section loss resulting in significant reduction in the load carrying capacity of the bridge may not be considered cost effective, but painting a steel superstructure that is in fair condition where the structural load carrying capacity has not been adversely affected may be considered cost effective given that the entire bridge is expected to have a significant remaining life.

Multiple activities may be warranted on single or multiple bridge elements or components when planning and accomplishing bridge work. Addressing the root cause of bridge problems is a key strategy to a successful bridge program. For example, an ineffective strategy

[9] AASHTO Guide Manual for Bridge Element Inspection, first edition, 2011

would be repainting a partially failed paint zone along the beam ends and repairing deterioration on a pier cap located beneath a leaking deck joint without arresting the water leakage onto the superstructure and substructure elements. In addition to the beam zone painting and repairing the deterioration on the pier cap, sealing or replacing the leaking deck joint is an equally important preservation activity.

Further examples will be found in Section VI.B, but other qualifying activities may be presented to the FHWA Division Office for consideration and approval on a case-by-case basis. SPM program attributes 5 and 6 discussed below are essential in evaluating the effectiveness of employed PM activities and strategies and the impact of these activities and strategies on extending the life of the bridge assets.

5. **Accomplishing the Work –** Availability of tools and resources to accomplish the PM work.

   The SPM program should have the means to deliver the qualifying PM activities and comply with all applicable Federal, State, and Local requirements.

6. **Reporting and Evaluation –** Ability to track, evaluate, and report on the planned and accomplished PM work on an annual and/or as needed basis.

   The SPM program should have the means to report on all planned and accomplished PM work on a periodic basis, such as annually or biennially.

   The SPM program should track and report on costs, both by work type (e.g., $/sq ft for deck sealing), and in the aggregate (e.g., amount expended for deck sealing this year).

   The SPM program should track expenditures over time. In most cases this would be the dollars expended annually for the SPM program to allow the expenditures to be compared with the condition of the system to ensure that the investment is providing the return expected.

   In addition to the above discussed program attributes, the process map shown in figure 3 can be used to assist in the evaluation process of an agency's systematic process to determine the eligibility of PM activities for Federal-aid funds.

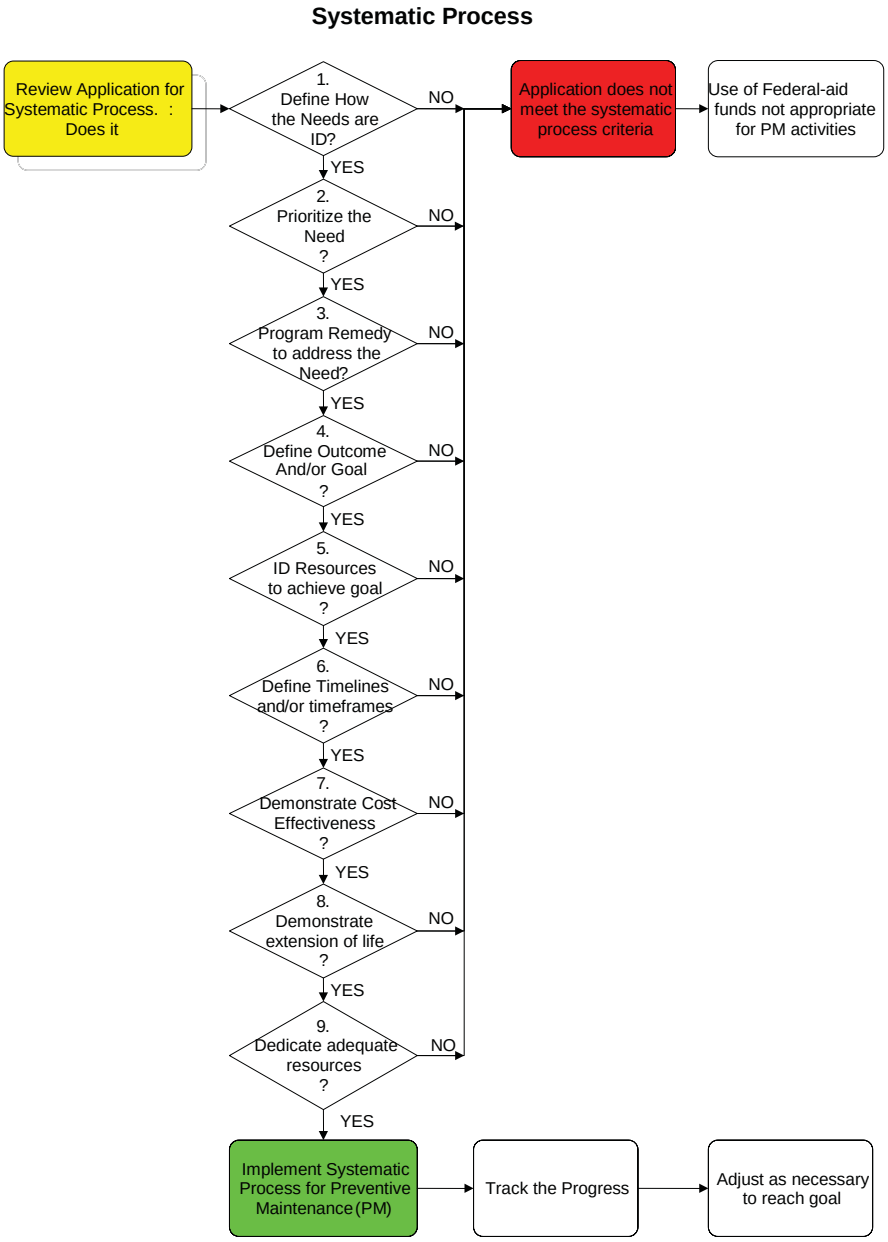


Figure 3 – Systematic Process

B. Examples of PM activities that may extend the life of bridges

This section presents several examples of PM activities and treatments that may be considered cost effective when applied to the appropriate bridges at the appropriate time using quality material and workmanship as discussed in section VI-A of this document. These examples are not intended to be all inclusive.

Decks:

1. **Seal or replace leaking joints or eliminate deck joints** - minimizes the deterioration of superstructure and substructure elements beneath the joints.



2. **Deck overlays** - significantly increase the life of the deck by sealing the deck surface from aggressive solutions and reducing the impact of aging and weathering. Overlay systems include waterproofing membrane with asphaltic concrete overlay, low permeability or high performance concrete overlays, and methyl methacrylate and polymer-system overlays.



3. **Cathodic Protection (CP) systems for bridge decks** - proven technology for stopping the corrosion of reinforcing steel.

4. **Electrochemical Chloride Extraction (ECE) treatment** - removes the chloride ions from the vicinity of the reinforcing steel and thus eliminates the source of corrosion.

5. **Concrete deck repairs in conjunction with installation of deck overlays, CP systems, or ECE treatment** - proven technology for stopping the corrosion of reinforcing steel.

Superstructure:

6. CP systems for superstructure elements other than decks - proven technology for stopping the corrosion of reinforcing steel.

7. Spot and zone painting/coating - protects against corrosion. Target areas where the paint deteriorates the fastest to slow the deterioration process and thus extend the life of the paint system and the painted element.

8. Painting/coating or overcoating of structural steel - protects against corrosion. Reduces the deterioration of the structural steel.

9. Retrofit of fracture critical members - methods to add redundancy to the structure such as installing a redundant catch system for pin and link assemblies.

10. Retrofit of fatigue prone details - methods to increase the life of fatigue prone details, such as using ultrasonic impact treatment on welds at ends of cover plates or connection plate welds not positively connected to flanges or other conventional fatigue retrofit methods.

Substructure:

11. CP systems for substructure elements - proven technology for stopping the corrosion of reinforcing steel.

12. ECE treatment for substructure elements - removes the chloride ions from the vicinity of the reinforcing steel and thus eliminates the source of corrosion. Can be very effective when the source of chlorides is eliminated.

13. Installation of scour countermeasures - protects the substructure elements from undermining and failure due to scour.

14. Removing large debris from channels - prevents channel bed material from scouring.

15. Substructure concrete repairs in conjunction with installation of CP systems or ECE treatment - proven technology for stopping the corrosion of reinforcing steel.

16. Installation of jackets with CP systems around concrete piles– protects against corrosion and deterioration.

Deck, Superstructure and Substructure:

17. Bridge cleaning and/or washing services – cleaning of decks, joints, drains, superstructure, and substructure horizontal elements. Slows the deterioration of concrete and steel elements since debris, bird droppings, and contaminants in conjunction with water will accelerate the deterioration of concrete and steel elements. Histoplasmosis from bird droppings is a known health hazard to inspectors and maintenance personnel.

18. **Application of concrete sealants, coatings, and membranes for surface protection of the concrete** - protect the rein forcing steel from corrosion by stopping or minimizing the intrusion of water and chloride through the concrete.

Appendix A – National Bridge Inventory General Condition Rating Guidance

Code	Description	Commonly Employed Feasible Actions
9	EXCELLENT CONDITION	Preventive Maintenance
8	VERY GOOD CONDITION No problems noted.	
7	GOOD CONDITION Some minor problems.	
6	SATISFACTORY CONDITION Structural elements show some minor deterioration.	Preventive Maintenance; and/or Repairs
5	FAIR CONDITION All primary structural elements are sound but may have some minor section loss, cracking, spalling or scour.	
4	POOR CONDITION Advanced section loss, deterioration, spalling or scour.	Rehabilitation or Replacement
3	SERIOUS CONDITION Loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.	
2	CRITICAL CONDITION Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored the bridge may have to be closed until corrective action is taken.	
1	IMMINENT FAILURE CONDITION Major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put back in light service.	
0	FAILED CONDITION Out of service - beyond corrective action.	

Appendix B- Bridge Element Condition State Guidance[10]

Condition State	Description	Commonly Employed Feasible Actions
1	Varies depending on element – Good	Preventive Maintenance
2	Varies depending on element – Fair	Preventive Maintenance or Repairs
3	Varies depending on element – Poor	Rehabilitation
4	Varies depending on element - Severe	Rehabilitation or Replacement

[10] AASHTO Guide Manual for Bridge Element Inspection, first edition, 2011

Appendix C - Resources

AASHTO's TSP2 – AASHTO has created the Transportation System Preservation Technical Services Program that provides services on pavement and bridge related preservation topics. Information on TSP2 can be found at the following Web site: http://www.tsp2.org

AASHTO Bridge Element Inspection Manual - Contains guidance on collecting element level inspection data. This manual is available for purchase at the following web site: https://bookstore.transportation.org/collection_detail.aspx?ID=97

FHWA Resource Center – The Structures Technical Services Team provides technical assistance, technology deployment and training. Information on the FHWA RC can be found at the following Web site: http://www.fhwa.dot.gov/resourcecenter/teams/structures/index.cfm

FHWA Turner–Fairbank Highway Research Center - The FHWA Infrastructure Research and Development (R&D) program provides technologies and solutions to advance practices in highway infrastructure engineering. Information on the FHWA TFHRC can be found at the following Web site: http://www.fhwa.dot.gov/research/tfhrc/programs/infrastructure/index.cfm

FHWA Office of Bridge Technology - Offers assistance in the areas of bridge design, construction, inspection and preservation. Information on the FHWA Office of Bridge technology can be found at the following Web site: http://www.fhwa.dot.gov/bridge/

FHWA Office of Asset Management - Offers assistance in the areas of system preservation techniques, pavement and bridge management systems, and materials usage and economic analysis tools. Information on the FHWA Office of Asset Management can be found at the following Web site : http://www.fhwa.dot.gov/infrastructure/asstmgmt/index.cfm

FHWA's Recording and Coding Guide for the Structure, Inventory and Appraisal of the Nation's Bridges is located at: http://www.fhwa.dot.gov/bridge/bripub.htm

Appendix D –Preventive Maintenance Eligibility Memorandum

U.S. Department of Transportation
Federal Highway Administration

MEMORANDUM

Subject: **ACTION**: Preventive Maintenance Eligibility
Date: October 8, 2004

From: /s/ Original signed by:
King W. Gee
Associate Administrator for Infrastructure
Refer To: HIAM-20

To: Directors of Field Services
Division Administrators
Federal Lands Highway Division Engineers

Timely preventive maintenance and preservation activities are necessary to ensure proper performance of the transportation infrastructure. Experience has shown that when properly applied, preventive maintenance is a cost-effective way of extending the service life of highway facilities and therefore is eligible for Federal-aid funding. By using lower-cost system preservation methods, States can improve system conditions, minimize road construction impacts on the traveling public, and better manage their resources needed for long-term improvements such as reconstruction or expansion. Preventive maintenance offers State DOT's a way of increasing the return on their infrastructure investment.

During the 1990's, Congress incrementally broadened, through legislation, the applicability of Federal-aid funding to preventive maintenance activities. Congress' acknowledgement of preventive maintenance activities as an eligible activity on Federal-aid highways is a logical step that reinforces the importance of implementing a continuing preventive maintenance program. Each of these actions was conveyed to the field through a series of memoranda. This policy memorandum supersedes the related memoranda listed in the attachment.

The FHWA division offices have an important role in promoting system preservation and are encouraged to work closely with their State DOT counterparts to establish a program that identifies eligible preventive maintenance measures for all roadway assets on Federal-aid highways. The AASHTO defined preventive maintenance "as the planned strategy of cost effective treatments to an existing roadway system and its appurtenances that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system without increasing structural capacity." Projects that address deficiencies in the pavement structure or increase the capacity of the facility are not considered preventive maintenance and should be designed using appropriate 3R standards. Functionally, Federal-aid eligible preventive maintenance activities are those that address aging, oxidation, surface deterioration, and normal wear and tear from day-to-day performance and environmental conditions. Preventive maintenance activities extend the service life of the roadway asset or facility in a cost-effective manner.

Division offices should proactively work with their State partners to establish a preservation component, which is composed of various preventive maintenance activities and treatments. These include roadway activities such as joint repair, seal coats, pavement patching, thin overlays, shoulder repair, restoration of drainage systems, and bridge activities such as crack sealing, joint repair, seismic retrofit, scour countermeasures, and painting. Many other activities that heretofore have been considered routine maintenance may be considered Federal-aid eligible on an area-wide or system-wide basis as preventive maintenance (i.e., extending the service life). This might include such work items as regionwide projects for periodic sign face cleaning, cleaning of drainage facilities, corrosion protection, spray-applied sealant for bridge parapets and piers, etc. These typical preventive maintenance work items are not intended to be all-inclusive but are rather a limited list of examples.

The final eligibility determination should be the result of collaboration between the division and the State DOT. This determination should be based on sound engineering judgment and economic evaluation, allowing flexibility in determining cost-effective strategies for extending the service life of existing pavements, bridges, and essential highway appurtenances on Federal-aid highways.

All preventive maintenance projects should consider appropriate ways to maintain or enhance the current level of safety and accessibility. Isolated or obvious deficiencies should always be addressed. Safety enhancements such as the installation or upgrading of guardrail and end treatments, installation or replacement of traffic signs and pavement markings, removal or shielding of roadside obstacles, mitigation of edge drop offs, the addition of paved or stabilization of unpaved shoulders, or installation of milled rumble strips should be encouraged and included in projects where they are determined to be a cost effective way to improve safety. To maintain preservation program flexibility, and in accordance with

23 U.S.C. 109(q), safety enhancements can be deferred and included within an operative safety management system or included in a future project in the STIP. In no way shall preventive maintenance type projects adversely impact the safety of the traveled way or its users.

As with any Federal-aid project, adequate warning devices for highway-rail grade crossings within the project limits or near the terminus shall be installed and functioning properly per 23 CFR 646 before opening the project to unrestricted use by traffic. For projects on the NHS, all traffic barriers shall comply with the FHWA September 29, 1994, memorandum entitled Traffic Barrier Safety Policy and Guidance, signed by E. Dean Carlson. This work can be accomplished by force account or through other existing contracts prior to final acceptance.

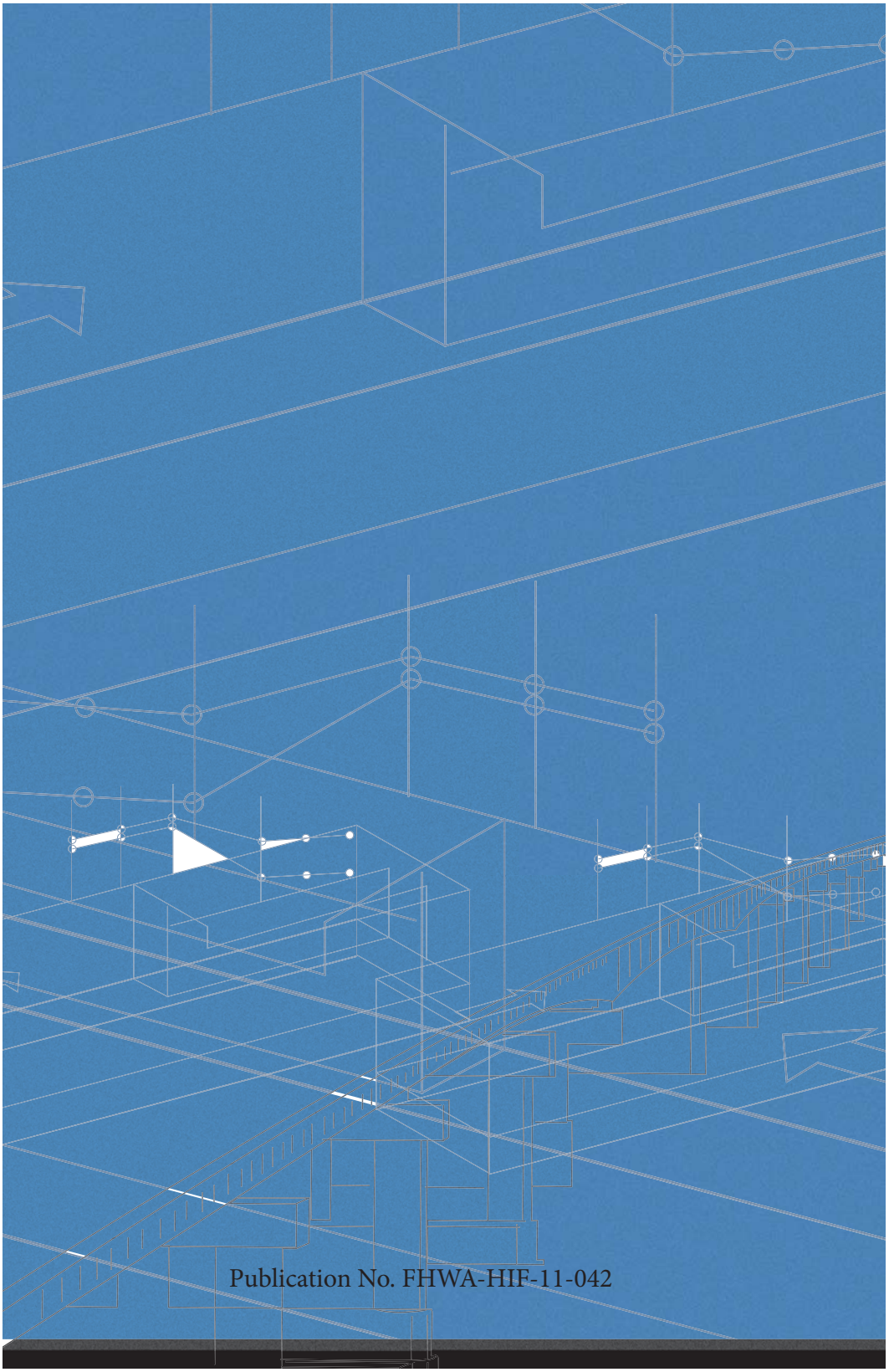
The FHWA supports the increased flexibility for using Federal-aid funding for cost-effective preventive maintenance. The Maintenance Quality Action Team (MQAT) is developing technical guidance on preventive maintenance activities and transportation system preservation as a whole; that technical guidance is under development and will be issued in the near future. For further information please contact Christopher Newman of the Office of Asset Management, at (202) 366-2023 or Christopher.newman@fhwa.dot.gov, or visit the Transportation System Preservation website at http://www.fhwa.dot.gov/preservation/.

Attachment

Attachment: Memoranda Superseded by Preventive Maintenance Memorandum

01/27/04 Stewardship of Preservation and Maintenance
01/11/02 HBRRP Funds For Preventive Maintenance (23 U.S.C. 116(d))
10/30/98 Implementation of TEA-21 Interstate Maintenance Guidelines
08/19/98 Phase Construction for Safety Considerations
06/18/97 Transportation System Preservation
03/21/96 Preventive Maintenance Revision to 23 U.S.C. 116
10/12/93 Safety and Geometric Considerations for Interstate Maintenance Program Projects
06/14/93 Interstate Maintenance Program
07/27/92 Preventive Maintenance

05/21/92 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) Implementation Interstate Maintenance Program



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