U.S. Department of Transportation
Federal Highway Administration

Memorandum

Subject: **INFORMATION:** Risk-Based Interval Determination for Routine Bridge Inspections

Date: June 8, 2018

From: /Original signed by/
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In Reply Refer To: HIBS-30

To: Division Administrators
Federal Lands Highway Division Directors

The Moving Ahead for Progress in the 21st Century Act (MAP-21) (P.L. 112-141), was signed into law on July 6, 2012. As part of this enactment, Section 1111 amended Section 144 of Title 23 United States Code (U.S.C.) and directed the Federal Highway Administration to, "consider a risk-based approach to determining the frequency of bridge inspections."

Section 650.311(a)(3) of the National Bridge Inspection Standards (NBIS) (23 CFR 650 subpart C) states, "Certain bridges may be inspected at greater than twenty-four month intervals, not to exceed forty-eight months, with written FHWA approval." This extended routine inspection interval has historically been accomplished by following Technical Advisory 5140.21 dated September 16, 1988 (http://www.fhwa.dot.gov/bridge/nbis/t514021.cfm). To meet Section 1111 of MAP-21, the FHWA has developed risk-based, routine inspection interval guidance in the attachment that State transportation departments, Federal agencies, and tribal governments can use as an alternate approach to the current technical advisory.

Additionally, 23 CFR 650.311(a)(2) states, "Certain bridges require inspection at less than twenty-four intervals." The attached risk-based, routine inspection interval guidance may also be used to satisfy this provision.

When State transportation departments, Federal agencies, and tribal governments consider using this option, the Division offices should review the submission then coordinate with the Office of Bridges and Structures for final approval.

Please direct questions to John Thiel at (202) 366-8795 or e-mail at John.Thiel@dot.gov or to Shay Burrows at (202) 366-4675 or e-mail at Shay.Burrows@dot.gov .

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Risk-Based, Routine Inspection Interval Implementation Guidance
June 8, 2018

Bridges typically exhibit structural deterioration in a predictable manner over time; therefore, risk of structural safety or serviceability loss during the time between inspections is an effective measure upon which to base the interval of inspections. When risk is low, bridges may be inspected less frequently, and as risk grows, bridges should be inspected more often.

Bridges have attributes and a set of damage modes that may occur that will define the risk. The risk of each potential damage mode should be evaluated. The one that is the most critical is used to select the appropriate routine inspection interval. The process for identifying risk-based inspection intervals involves the identification and use of an interval that is commensurate with the risk of safety or service loss for each bridge. It provides additional flexibility to bridge inspection organizations by applying experience and engineering knowledge to optimize the use of limited resources across their bridge inventory.

This guidance establishes a general framework and process for assessment of risk, and provides bridge inspection organizations the latitude for exercising their knowledge in determination of probability, consequence, and risk for bridges in their inventory. The process requires bridges to be classified into one of three risk levels for consistency and uniformity. These risk levels have inspection intervals not to exceed 12, 24, or 48 months

This process allows for risk assessment by quantified statistical analysis, when possible, or by qualitative expert judgment. The risk assessment process, criteria, and resulting intervals should be documented and submitted by the State transportation department, Federal agency, or tribal government with a request for FHWA approval. For owners to implement inspections using the proposed risk-based intervals, it is envisioned that they will follow these general steps:

1. Assemble a Risk Assessment Panel (RAP), which includes the National Bridge Inspection Standards (NBIS) program manager and at least three experts with collective experience in bridge design, evaluation, inspection, maintenance, materials, and construction, to develop a formal policy.
2. Utilize the RAP to establish definitions for risk levels, categories, and the probability and consequence levels that will be used to define the risk for each bridge to be assessed.
3. Utilize the RAP to establish the damage modes and the attributes that will be considered in classifying probability and consequence levels, depending on their relevance to the bridge being considered. A system of screening, scoring, and thresholds will be defined by the RAP to assess the risks. Scoring is based on prioritizing attributes and their relative influence on damage modes.
4. Utilize the RAP to define a formal set of risk assessment criteria, written in standard logical format amenable for computer programming.
5. Develop and document supplemental inspection procedures and data collection that are aligned with the level of inspection required to obtain the data to apply the criteria.
6. Apply the criteria to bridges and classify each bridge into one of three risk levels with a corresponding interval not to exceed 12, 24, and 48 months.

7. Submit the formal criteria and a summary report to the FHWA for approval. Once approval is granted, the owner may implement risk-based, routine inspection intervals for the bridges.
8. Any time in the future that the criteria are revised, the criteria and summary report must be resubmitted to the FHWA for approval.

It is recognized that there may be few quantified measures to develop mathematical risk calculations; therefore, the knowledge and experience of qualified experts may be used to determine the expected performance and outcomes. The RAP should define a set of detailed criteria to classify bridges into one of the three risk levels. The criteria should be based on the fundamental proposed definitions of risk and address all required considerations. It is expected that this will follow the NCHRP 12-82 process of using a matrix with risk partitions and probability and consequence categories on the two axes.

The risk assessment criteria and resulting intervals must be documented and submitted by the State transportation department, Federal agency, or tribal government with a request for FHWA approval. At a minimum, the request must include the elements listed below. Changes to the risk assessment criteria must be resubmitted for FHWA approval.

1. Endorsement from the RAP members, including the NBIS program manager and at least three experts with collective experience in bridge design, evaluation, inspection, maintenance, materials, and construction.
2. Documentation clearly defining screening criteria, bridges being analyzed, attributes, damage modes, risk assessments and results.
    a. The screening criteria is used to determine if a bridge should be considered in the assessment or to establish maximum inspection intervals. At a minimum, the screening criteria should include:
        i. Requirements for significant flexure and shear cracking in concrete primary load members.
        ii. Requirements for fatigue cracking and corrosion in steel primary load members.
        iii. Requirements for other details, loadings, conditions, and inspection findings that are known to affect the performance of the bridge or its elements.

        **Bridges classified as in poor condition cannot have an inspection interval greater than 24 months.
    b. The attributes in each assessment should include material properties, loads and safe load capacity, and condition.
    c. The damage modes in each assessment should include:
        i. For steel elements: section loss, fatigue, and fracture.
        ii. For concrete elements: flexural cracking, shear cracking, and reinforcing steel corrosion.
        iii. For superstructure elements: seismic, overload, and vehicle/vessel impact
        iv. For substructure elements: seismic, scour, and settlement.

    d. A set of criteria to assess risk for each bridge element in terms of probability and consequence of structural safety or serviceability loss in the time between inspections.
3. Classification of the analyzed bridges into one of three risk levels with an interval not to exceed 12, 24, and 48 months.
4. Supplemental inspection procedures and/or data collection that are required to apply the criteria, as appropriate.

Additional information can be found in NCHRP Report 782, Proposed Guideline for Reliability-Based Inspection Practices. This report is a result research performed under NCHRP Project 12-82, Developing Reliability-Based Bridge Inspection Practices.

The owner should review the criteria after each inspection to ensure the proper interval is assigned. Then the owner must establish the next inspection due date based on the established interval and the last inspection date. Information on the criteria used to establish the inspection interval should be kept in the bridge file.

Lastly, any new, rehabilitated, or structurally modified bridge should receive an initial inspection, be in service for at least 24 months, and receive its next routine inspection before establishing a risk-based, routine inspection interval. The assessment must be reviewed after each routine inspection to set the next inspection interval.

Risk-Based Inspection Interval Implementation Definitions
June 8, 2018

Attribute - Characteristic of the design, loading, conditions, and environment that affect the expected performance of a bridge or bridge element.

Consequence - A measure of impacts to structural safety and serviceability in a hypothetical scenario where a damage mode progresses to the point of requiring immediate action. This may include costs to restore the bridge to safe operating condition or other costs.

Damage mode – Typical damage affecting the condition of a bridge element that may affect the structural safety or serviceability of the bridge.

Probability - Extent to which an event is likely to occur during a given interval. This may be based on the frequency of events, such as in the quantitative probability of failure, or on degree of belief or expectation. Degrees of belief about probability can be chosen using qualitative scales, ranks, or categories such as, remote, low, moderate, or high.

Risk - The exposure to the possibility of structural safety or serviceability loss during the interval between inspections. It is the combination of the probability of an event and its consequence.