2.1 What is the purpose of this chapter? This chapter provides guidelines related to the design and maintenance of Service bridges.

2.2 What is the Service policy on bridge design and maintenance?

A. Except for routine bridge maintenance (cleaning and minor touch-up painting), all bridge rehabilitation or replacement projects are non-exempt construction projects. For non-exempt projects, the Regional Engineer or the Chief, Division of Engineering, must review, approve, and sign the final design documents before we procure construction materials or services (see 360 FW 1).

B. All bridge design projects must adhere to national design standards or guidelines such as those published by the American Association of State Highway and Transportation Officials and the Federal Highway Administration, or local standards such as those published by many State highway authorities.

C. We must design every bridge and its approaches so that the completed structure ensures the passage of fish and other aquatic organisms; is safe, economical, and aesthetically pleasing to the maximum extent possible; minimizes adverse ecological effects; and meets facility needs and traffic requirements.

D. Program representatives, the Project Leader, engineering staff, the Contracting Officer, and others must coordinate, cooperate, and communicate early in the design process to ensure the project is successful. We strongly recommend that all bridge design projects have a Project Management Plan (see 360 FW 2). If you do not develop a Project Management Plan, the designer must furnish conceptual designs to all stakeholders before proceeding with the final design. This gives everyone the opportunity to see how the proposed concept will work with available funding, schedules, environmental compatibility, aesthetics, and operations.

E. The designer must provide the Regional Engineering office with all decision records and design and construction documents that lead up to the final configuration of new bridges.

F. The Regional Engineering office must maintain a bridge history file for every bridge that includes:

1. The records noted in section 2.2E,
Bridge inspection reports and photographs,
Reports on accidents and bridge repairs, and
Information about other actions specific to the bridge.

2.3 What are the authorities for this chapter?

B. Federal Highway Administration Regulations; Standards for Bridges, Structures, and Hydraulics (23 CFR 650).

2.4 Who is responsible for bridge design and maintenance?

A. The Assistant Director – Business Management and Operations:
   (1) Is the senior advisor to the Service's Directorate for activities related to engineering, and
   (2) Ensures that the Division of Engineering develops bridge safety policy and guidance.
B. The Chief, Division of Engineering:
   (1) Develops bridge safety policy and guidelines,
   (2) May review and approve bridge concepts and designs,
   (3) Provides up-to-date, safe bridge carrying capacities for all of our bridges, and
   (4) Recommends bridge repair and rehabilitation projects and provides cost estimates for all of our bridges through the bridge inspection program (see 362 FW 3).
C. Regional Engineers:
   (1) Oversee all bridge-related design projects in their Regions,
   (2) Provide bridge design services or approve designs others develop, and
   (3) Maintain Regional bridge history files.
D. Regional Bridge Coordinators:
   (1) Must be familiar with our bridge design and bridge inspection guidelines,
   (2) Provide coordination and consultation for the bridge program in their Regions, and
   (3) Participate in the design or design review of new or rehabilitated bridges.
E. Regional Safety Managers:
   (1) Review the safety aspects of new and rehabilitated bridges, and
(2) Review contractor’s Health and Safety Plans on bridge construction projects.

F. The Project Leader or Facility Manager:

(1) Initiates new bridge design and existing bridge repair or replacement projects, and

(2) Identifies operational and maintenance requirements for bridge design projects on their facilities.

2.5 What terms do you need to know to understand this chapter?

A. Average Daily Traffic. The average number of daily vehicular trips across a bridge, usually reported as vehicles per day.

B. Bridge. A structure, including supports, erected over a depression or an obstruction, such as water, highway, or railway and having a track or passageway for carrying traffic or other moving loads. Bridges also include structures such as box or arch culverts and series of pipes where the clear distance between openings is less than half of the smaller contiguous opening.

C. Bridge Roadway Width. The shortest clear distance on a bridge between the faces of bridge railings or curbs.

D. Crash-Tested Railing and Crash-Tested Equivalent Railing.

(1) Crash-tested railing has been shown, through full-scale vehicle crash testing, to meet the requirements of the National Cooperative Highway Research Program (NCHRP) Report 350, Recommended Procedures for the Safety Performance Evaluation of Highway Features.

(2) Crash-tested equivalent railing is railing that we can prove to be approximately equivalent to one of the six test levels listed in NCHRP Report 350 (see “Crash-Tested Railing”), or equivalent to crash-tested curb-type bridge railing (see section 2.5E below).

E. Curb-Type Bridge Railing. A relatively short, curb-like structural element that is acceptable for use as a bridge railing on one-lane bridges carrying low-volume, low-speed roadways (see Figure 2-1).

Figure 2-1: Curb-Type Bridge Railing. (Dimensions shown are millimeters.)
F. **Live Load.** The weight of the applied moving loads of vehicles and pedestrians.

G. **Low-Speed, Low Volume Roadway.** A road for vehicles, paved or unpaved, with an average daily traffic of fewer than 51 vehicles per day and a posted speed limit of 15 mph or less.

H. **The Manual on Uniform Traffic Control Devices** is a Federal Highway Administration manual that defines the standards road managers use to install and maintain traffic control devices on all streets and highways. The manual is available on their Web site.

I. **Multiple-Lane Bridge.** A structure wide enough for vehicles to travel in two directions at the same time. We consider bridges 16 feet or wider multiple-lane bridges.

J. **Nonpublic Use Bridge.** A bridge that is for the use of limited groups only, such as Service personnel, contractors, utility personnel, oil or logging companies, farmers or ranchers, people who own property surrounded by Federal property, and visitors to Service residences. The general public may not use the bridge.

K. **Object Markers.** Reflective signs used to indicate the outside edges of a bridge.

L. **Public Use Bridge.** A bridge that is open to the general public without restrictive gates, prohibitive signs, or regulation other than those based on size, weight, or class of registration. It carries a roadway that is always available except during scheduled periods, extreme weather, or emergency conditions and is passable by four-wheel standard passenger cars.

M. **Roadside Barrier.** A longitudinal barrier used to shield roadside obstacles or non-traversable terrain features. We also occasionally use roadside barriers to protect pedestrians from vehicle traffic.

### 2.6 What are bridge barrier systems and why are they important?

A. Bridge barrier systems are composed of four basic components:

1. Bridge railing.

2. Transition from the approach guardrail to the bridge railing. The transition is a section of barrier connected to a bridge railing or bridge pier. It produces a gradual stiffening of the approach rail to keep vehicles from hitting the approach guardrail. A guardrail is a flexible and semi-rigid roadside barrier.

3. Approach guardrail (the guardrail just before a bridge).

4. Approach guardrail end treatment (how the guardrail is tied into the ground or otherwise ends).

B. We typically move obstacles and other hazards out of a specific roadside area to make bridges and the areas before and after them safer in case a vehicle drives off the road. Whenever we can't remove an obstacle, such as at bridge crossings, we use bridge barrier systems to keep motorists away from the hazard.

C. Individual safety and keeping vehicles from running into obstacles are the primary considerations of bridge barrier system design. Barrier systems should be designed to:

1. Keep vehicles in a certain area and redirect them if they run off the road,

2. Prevent rollover,

3. Minimize snagging and the possibility of vehicle spinout, and
(4) Keep vehicles moving parallel with the barrier system.

2.7 What factors apply to the selection of bridge barriers?

A. There are five factors that engineers should consider when selecting a bridge barrier:

(1) Performance,

(2) Compatibility,

(3) Cost,

(4) Past experience using barriers with the same design, and

(5) Aesthetics.

B. When considering the five factors, never compromise performance—the capability of a barrier to prevent vehicles from running into an obstacle, ditch, or water.

2.8 What guidelines apply to new bridge barriers? Table 2-1 describes guidelines applicable to barrier systems at new bridges and to new barrier systems for existing bridges we are rehabilitating.

<table>
<thead>
<tr>
<th>Type of Bridge</th>
<th>Bridge Railing Design</th>
<th>Approach Rail Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Public Use, One-Lane Bridges on Low-Speed, Low-Volume Roadways</td>
<td>You should use full-height, crash-tested bridge railing that meets site-specific traffic requirements, whenever feasible. You may consider a curb-type bridge railing (crash-tested or equivalent) if: • The structure is less than 16 feet wide, • The average daily traffic involves fewer than 51 vehicles per day, and • Speeds approaching and crossing the bridge are 15 mph or less. Other factors may warrant a higher level of protection than curb-type bridge railing. See Exhibit 1 for additional criteria. The Regional Engineer and Regional Safety Manager must approve proposals to omit bridge railings.</td>
<td>Approach rails are optional, but the Regional Engineer and Regional Safety Manager must approve proposals to omit them. Regional Engineers must keep copies of documentation pertaining to approach rail exceptions in the bridge history file. You should use approach rail when full-height, crash-tested, bridge rails are used. Evaluate the need on a case-by-case basis using the criteria in Exhibit 1. Using approach rails with a curb-type bridge railing is rare. If you use an approach rail with curb-type bridge railing, you must use appropriate end sections at both transition and approach ends of the approach rail.</td>
</tr>
</tbody>
</table>
### Table 2-1: Guidelines for New Bridge Barriers

<table>
<thead>
<tr>
<th>Type of Bridge</th>
<th>Bridge Railing Design</th>
<th>Approach Rail Design</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B. All Other Public Use Bridges.</strong></td>
<td>In most circumstances, you should use full-height, crash-tested bridge railing that meets site-specific traffic requirements and the manufacturer’s or designer’s construction specifications. If there are operational or functional circumstances, such as the recurring use by agricultural equipment, that make full-height, crash-tested bridge railing undesirable for a bridge, you may consider using curb-type bridge railing. • The Regional Engineer and the Regional Safety Manager must review and approve this substitution. • Regional Engineers must keep copies of documentation pertaining to the substitution in the bridge history file.</td>
<td>We strongly recommend you use an approach rail because omitting it may pose a liability risk. • The approach rail should be compatible with the bridge rail. • The length, layout, and type of approach rail should be appropriate for the speed, volume, and vehicles and other applicable factors. • The minimum acceptable length of approach rail is 25 feet. The Regional Engineer and Regional Safety Manager must review and approve exceptions to the criteria above (i.e., no approach rail or length less than 25 feet). Regional Engineers must keep copies of documentation pertaining to approach rail exceptions in the bridge history file.</td>
</tr>
<tr>
<td><strong>C. Nonpublic Use Bridges</strong></td>
<td>In most circumstances, you should use full height, crash-tested bridge railing, regardless of location or use. See Exhibit 1 for criteria to use when evaluating other railing options. At a minimum, you should use crash-tested or crash-tested equivalent curb-type bridge railings on nonpublic use bridges to provide some level of safety. If there are operational or functional circumstances, such as the recurring use by agricultural equipment, that make bridge railing undesirable for a bridge, you may consider omitting the railing. • The Regional Engineer and the Regional Safety Manager must approve the omission. • Regional Engineers must keep copies of documentation pertaining to the omission in the bridge history file.</td>
<td>Evaluate the need for an approach rail on a case-by-case basis using the criteria in Exhibit 1.</td>
</tr>
</tbody>
</table>
2.9 What guidelines apply to barrier systems at existing bridges?

A. Barrier systems that are damaged, improperly maintained, or inadequate to keep vehicles from running into an obstacle, ditch, or water are a potential hazard to everyone who uses the bridge.

B. Engineers review the bridge’s barrier system routinely as a part of the regular bridge inspection (see 362 FW 3). The inspectors determine a condition rating and an appraisal rating for each component, which they will record in the inspection report. Inspectors determine the:

1. Condition rating by comparing the barrier’s condition to when it was built, and
2. Appraisal rating by comparing it with current level-of-service (i.e., safety) standards.

C. The inspectors may recommend repair or replacement of a bridge’s barrier system:

1. Due to a condition problem, or
2. If the barrier is a significant safety concern.

D. We should consider upgrading a bridge’s existing barrier system:

1. Any time that significant repair or rehabilitation is planned for an existing bridge,
2. When the latest inspection report recommends a repair or replacement of any component of the system, or
3. When there is any indication that the barrier is unable to stop a vehicle from going over the side.

E. All bridge barrier modifications should comply with the guidelines for new bridge barrier systems when feasible (see Table 2-1).

F. Regions should program the funds necessary through the asset maintenance management process for routine maintenance of existing bridge barrier systems, using the recommendations contained in the latest bridge inspection report as a guide.

2.10 How wide should a new bridge be? Table 2-2 provides the width guidelines for new bridges.

<table>
<thead>
<tr>
<th>Type of Bridge</th>
<th>Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. All Bridges</td>
<td>(1) Widths must be consistent with the design criteria; the standards adopted for the bridge design; and evaluation factors such as speed, average daily traffic, traffic makeup, and approach roadway width.</td>
</tr>
<tr>
<td></td>
<td>(2) A bridge roadway should not be narrower than the approach roadway, including shoulders.</td>
</tr>
<tr>
<td></td>
<td>(3) Where curbed roadway sections approach a structure, the same section should be carried across the structure.</td>
</tr>
<tr>
<td></td>
<td>(4) Some bridge roadways may be wider than the minimum values given here (e.g., those with average daily traffic greater than 100 vehicles per day, those on curves, and those carrying unusual vehicles). Sound engineering judgment may require more stringent specifications than what are in this chapter.</td>
</tr>
</tbody>
</table>
### Table 2-2: Widths for New Bridges

<table>
<thead>
<tr>
<th>Type of Bridge</th>
<th>Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B. One-Lane Bridges</strong></td>
<td>(5) Exhibit 2 includes more information to determine appropriate bridge widths.</td>
</tr>
<tr>
<td>(Generally, bridges less than 16 feet wide)</td>
<td>(1) Most one-lane bridge roadways should be at least 14 feet wide.</td>
</tr>
<tr>
<td></td>
<td>(2) One-lane bridge roadways may be as narrow as 12 feet, but no narrower, if the width is acceptable for the intended use.</td>
</tr>
<tr>
<td></td>
<td>(3) If a bridge 16 feet or wider is used as a one-lane bridge, we must post signs that identify it as a one-lane bridge.</td>
</tr>
<tr>
<td><strong>C. Multi-Lane Bridges</strong></td>
<td>A multi-lane bridge roadway must be at least 24 feet wide.</td>
</tr>
<tr>
<td>(Bridges 16 feet or more unless we use them as and post signs saying they are one-lane).</td>
<td></td>
</tr>
</tbody>
</table>

#### 2.11 What guidelines apply to existing bridge widths?

**A.** Project Leaders/Facility Managers and staff should:

1. Maintain existing bridge widths unless they need to restrict a section of a bridge from traffic because of safety concerns, and

2. Never widen a bridge without consulting with the Regional Engineer.

**B.** The Regional Engineer must approve any repairs, alterations, or modifications that affect an existing bridge roadway width before work begins.

#### 2.12 How much weight should new bridges be able to carry? Bridge designers should:

**A.** Design new bridges to carry an American Association of State Highway Transportation Officials standard design vehicle weighing 36 tons (commonly designated as an AASHTO HS20-44 standard truck). The Regional Engineer must approve any deviation from the HS20 standard before work may begin. (See section 2.5F for more information on live loads.)

**B.** Consider increasing the design live load to HS25 to accommodate today’s heavier vehicles or if they anticipate vehicles that are heavier than normal may need to use the bridge (e.g., logging trucks, combines, and gravel trucks).

**C.** Never design a bridge with a live load of less than HS15.

#### 2.13 What are the guidelines for live load capacity of existing bridges?

**A.** The Division of Engineering determines safe live load capacities during the initial (“Inventory”) inspection of our bridges and updates them whenever inspectors identify changes during the regular inspection process.

1. The live load capacities in inspection reports are the absolute maximum load levels to which a structure may be subjected for limited passages of loads.
(2) If there is a need to subject a bridge to sustained loading near this level, the Project Leader/Facility Manager must contact the Regional Engineer for guidance.

B. The Project Leader/Facility Manager:

(1) Must maintain existing bridges in their current condition.

(2) Should review all repair and maintenance recommendations in the latest bridge inspection report and complete "Urgent" repairs immediately upon availability of funds and materials. If the Project Leader/Facility Manager cannot obtain funding or materials within an appropriate time from the discovery of an urgently needed repair, staff should barricade the bridge or otherwise limit access until we complete repairs or other recommended actions.

(3) Should use the asset maintenance management process to program all non-urgent, recommended repair and maintenance items that are in the latest bridge inspection report.

C. Station personnel should notify the Regional Engineer and Regional Safety Manager of any previously unreported condition that they observe if they believe it reduces the live load capacity of the bridge.

D. If the Project Leader/Facility Manager determines that the current live load capacity of a structure is insufficient for current or future needs, he or she must get approval from the Regional Engineer and Regional Safety Manager before beginning alterations that would increase the bridge’s live load capacity.

2.14 What are the guidelines for signs the Service uses at bridges?

A. Project Leaders/Facility Managers are responsible for installing and maintaining the signs listed in the “Sign Recommendations” section of the latest inspection report.

B. Bridge signage must comply with the Service Sign Handbook and the Department of Transportation’s Manual on Uniform Traffic Control Devices. You can get the Service Sign Handbook from the Regional sign coordinator.

C. We must use:

(1) Object markers at all corners of all bridges. If the object marker has diagonal stripes, the stripes must slope downward toward the bridge roadway.

(2) “One-Lane Bridge” signs on approaches to bridges that are:

(a) Less than 16 feet wide but carry two-way traffic, and

(b) 16 feet or wider if the bridge is used as a one-lane bridge.

(3) “Narrow Bridge” signs on:

(a) All approaches to bridges carrying multi-lane roadways when the bridge roadway is between 16 and 18 feet wide, and

(b) Bridges with a roadway width less than the approach roadway width.
D. When the latest inspection report recommends installing signs indicating a reduced live load capacity, the Project Leader/Facility Manager must post signs displaying the maximum safe live load capacity at both ends of the bridge.

E. The Regional Engineer or Regional Safety Manager may require other signs.

2.15 Does the Service allow the use of treated wood in sensitive environments?

A. Yes. All structures, including treated and untreated-wood structures, may impact the aquatic environment. Because there is not conclusive data on the long-term impacts of treated wood on the aquatic environment, we require a cautious approach to using treated wood. Potential impacts may preclude the use of treated wood.

B. If the bridge design calls for treated wood, the Project Leader/Facility Manager must make product choices that reduce the chance of environmental impact. They do this by:

1. Ensuring wood is factory-treated to meet current industry standards,
2. Imposing site-specific conditions, such as restricting the timing of installation, and
3. Complying with U.S Environmental Protection Agency and U.S. Department of Agriculture recommendations or restrictions.

C. There are a variety of treated wood products available. Making decisions about what product to choose depends on several factors, including:

1. Intended use (in, above, or adjacent to the sensitive environment),
2. Timber species,
3. Required performance, and
4. Environmental conditions (see Exhibit 3 for more information).

D. Common products used in treated wood include:

1. ACQ (Alkaline Copper Quaternary)
2. ACZA (Ammoniacal Copper Zinc Arsenate)
3. CA-B (Copper Azole)
4. CCA (Chromated Copper Arsenate)
5. Creosote
6. Copper Napthenate
7. Pentachlorophenol (Penta)

E. The best way to minimize risk to aquatic environments is to:

1. Use the selected product in accordance with American Wood Protection Association standards,
(2) Follow the guidance in the Material Safety Data Sheets (MSDS) for the chosen product,

(3) Specify best management practices for the production of the treated wood, and

(4) Recognize that even wood treated according to best management practices can impact aquatic life under certain conditions.

F. You can find more information about treated wood in Exhibit 3.

/sgd/ Paul Henne
ACTING DIRECTOR

Date: September 28, 2010