**2.1 What is the purpose of this chapter?** This chapter provides guidelines to assist Service personnel with decisions related to the design of Service bridges. The use of specific standards or guidelines such as those by the American Association of State Highway and Transportation Officials (AASHTO), Federal Highway Administration (FHWA), States, or others is optional as they fit the needs of the project.

**2.2 Who is responsible for bridge design?**

**A. Chief, Division of Engineering (DEN)** develops Service policy and guidelines.

**B. Regional Engineers:**

**(1)** Provide design and construction services and are responsible for the proper design of bridges within their Region.

**(2)** Provide approvals noted in this chapter.

**(3)** Maintain bridge folders as addressed in paragraphs 2.3C and 2.4D.

**C. Regional Bridge Coordinators:**

**(1)** Must be knowledgeable of the Service bridge design guidelines and provide coordination and consultant services for the bridge program within their Region.

**(2)** Participate in designs or design reviews as appropriate.

**D. Regional Safety Managers:**

**(1)** Review safety aspects of bridge design and construction.

**(2)** Provide approvals noted in this chapter.

**E. Project Leaders:**

**(1)** Initiate bridge repair or replacement projects and identify operational requirements for bridge repairs, replacements, and upgrades.

**(2)** Must be familiar with the guidelines in this chapter regarding the operation and maintenance of railings (paragraph 2.6), widths (paragraph 2.8), load capacities (paragraph 2.9), and signs (paragraph 2.10).

**2.3 What are some general considerations and procedures regarding the design of a bridge?**

**A.** When designing a bridge, each bridge structure should meet facility needs while considering safety, aesthetics, and the environment consistent with the volume, speed, types of vehicles, and drivers that may use the bridge during the life of the structure. Designs should anticipate future types of traffic use and proposed operational patterns. Parameters such as hydraulics, weather, potential for flooding, nighttime use, and pedestrian use should also be considered. See Exhibit 1 for additional factors. Exhibit 2 provides a list of bridge guidelines and references to assist with the design of bridge structures.

**B.** The designer should also consider types of materials depending on the environmental setting. For example, the use of creosote in wetland areas could cause environmental problems. See Exhibit 3 for guidance on environmental considerations.

**C.** The designer should furnish conceptual designs to the project leader and other Regional personnel as appropriate. This gives the project leader the opportunity to correlate the proposed concepts with available funding, time schedules, environmental compatibility, aesthetics, structure life, and operational considerations. It is vital that we develop an administrative record that documents the process by which a final design is reached. This record should document the guidelines or standards used in the design process, as well as operational considerations and other parameters that may have affected the design of a particular structure. For all new bridges, the Regional Engineering office will maintain this record in an individual bridge folder for the life of the structure. There is no specific format for the organization of the bridge folders; each Region will determine how they organize and store their bridge folders.

**2.4 What definitions are applicable to bridge design?**

**A. ADT (Average Daily Traffic).** The average number of vehicular crossings per day across a bridge.

**B. Approach Rail**. A rail in advance of the bridge to guide a vehicle onto the bridge or to protect against a hazard at the approach to the bridge such as the end of the bridge rail or an embankment drop-off at the bridge.

**C. Bridge.** A structure, including supports, erected over a depression or an obstruction, such as water, highway, or railroad, and having a track or passageway for carrying traffic or other moving loads. This includes structures such as box or arch culverts, and may also include multiple pipes where the clear distance between openings is less than half of the smaller contiguous opening. For bridge inspection program purposes, see the definition in 362 FW 3.

**D. Bridge Folder.** An individual folder to be maintained for the life of a bridge structure. Contents should include, but not necessarily be limited to, criteria used and decisions made during the design of the bridge and for major alterations during the life of the bridge.

**E. Bridge Guidelines and References.** Guidelines and references to assist with the design, maintenance, and inspection of bridge structures. Exhibit 2 contains a list of suggested references for Regional engineering offices.

**F. Bridge Rail.** A longitudinal barrier whose primary function is to prevent an errant vehicle from going over the side of a bridge structure. *(AASHTO Roadside Design Guide, 1996, Glossary).*

**G. Bridge Roadway Width.** The shortest clear distance on a bridge between the faces of a bridge rail or curb.

**H. Crash-Tested Rail.** A rail crash tested and approved for use as a bridge and/or approach rail. Can also include crash tested curb-type rails. The selection of a crash tested rail must match the bridge traffic requirements.

**I. Crash-Tested or Equivalent Rail.** "Or equivalent" is intended to refer to a curb/deck combination where the curb is of equal dimension to a crash-tested curb, and the curb and installation are of equal strength. This applies to concrete curbs cast with the deck, and curbs fastened to the deck with anchors and attachments that equal or exceed the crash tested rail.

**J. Culvert Bridge.** A single or multiple box or arch culvert structure, or a series of pipe culverts, meeting the definition of a bridge.

**K. Curb-Type Rail.** A curb structure that has been crash tested and approved for use as a protective rail at certain vehicular speeds and traffic volumes on a bridge.

**L. Guardrail.** A longitudinal barrier used to shield roadside obstacles or nontraversable terrain features. It may occasionally be used to protect pedestrians or "bystanders" from vehicle traffic. *(AASHTO Roadside Design Guide, 1996, Glossary, taken from definition for Roadside Barrier).*

**M. MUTCD.** Manual on Uniform Traffic Control Devices.

**N. Nonpublic Use Bridge.** A bridge not meeting the definition of a public use bridge. Note: some Service bridges may have other uses, but are not to be considered general public use. Examples would be contractors, utility personnel, oil or logging companies, farmers or ranchers, in-holders, residences with visitors, or other nonpublic drivers.

**O. One-Lane Bridge.** A structure designed for travel in one direction at a given time. A one-lane bridge can be on a one-way road or a two-way road.

**P. Public Use Bridge.** The road/bridge is available, except during scheduled periods, extreme weather, or emergency conditions, passable by four-wheel standard passenger cars, and open to the general public for use without restrictive gates, prohibitive signs, or regulation other than restrictions based on size, weight, or class of registration (23 CFR 460).

**Q. Sign Manual, U.S. Fish and Wildlife Service.** The guideline for signs to be erected on a Service facility. Includes guidelines for traffic control signs and devices.

**R. State Standards.** Current published State standards that may be appropriate for use on a Service bridge. This could apply to a standard design used by a State. Designers should verify the status and applicability of a State standard or design before it is used on a Service project.

**S. Transition.** A section of barrier between two different barriers or, more commonly, where a roadside barrier is connected to a bridge rail or to a rigid object such as a bridge pier. The transition should produce a gradual stiffening of the approach rail so vehicular pocketing, snagging, or penetration at the connection can be avoided. *(AASHTO Roadside Design Guide, 1996, Glossary).*

**T. Two-Lane Bridge.** A structure designed for travel in two directions at the same time.

**2.5 What guidelines apply to new bridge rails?** These guidelines are applicable to rails for new bridges and for bridges being rehabilitated to the extent that rail replacement is appropriate. This section is not applicable for determining the need for upgrading or replacing existing rails. While most structures require some type of rail, on many small structures on low-speed, low-volume roadways, a rail designed to full AASHTO standards may be neither necessary nor desirable. *(AASHTO Roadside Design Guide, 1996, Chapter 7, Paragraph 7.2.).* There are alternatives to full AASHTO standards; information is available in various Bridge Guidelines and References (see Exhibit 2) and from other sources.

**A.** Public Use Bridges.

**(1)** Class I (Low-Speed, Low-Volume).

**(a)** Bridge Rail: A curb-type rail (crash-tested or equivalent) may be considered on a bridge if:

**(i)** The structure is a standard width one-lane bridge (i.e. less than 16 feet).

**(ii)** ADT is less than or equal to 50.

**(iii)** Speeds approaching and across the bridge are 15 mph or less.

**(b)** Other factors may warrant a higher level of protection than that afforded by a curb-type rail. Refer to Exhibit 1 for additional criteria to consider in the final design decision.

**(c)** If a situation exists where no curb or rail is proposed because of a special operational concern, the decision to install no rail or curb protection must be approved by the Regional Engineer and Regional Safety Manager.

**(d)** Approach Rail: For Class I bridges, approach rail to guide traffic onto the bridge is optional. Approach rail will be rare in conjunction with a curb-type bridge rail, but if approach rail is installed, an appropriate end section should be installed on the bridge end of the approach rail as well as the approach end.

**(2)** Class II (Greater than Class I).

**(a)** Bridge Rail: For situations where the bridge width, traffic volume, and/or speed are greater than Class I criteria, or where the designer feels a higher level of protection is warranted, properly designed and installed full-height AASHTO, State standard, or crash-tested

bridge rail suitable for the traffic situation should be present. There may be unusual circumstances where other types of rails (i.e. a curb-type rail) may be proposed (usually special operational or aesthetic concerns). If variance from a full-height AASHTO, State standard, or crash-tested rail is proposed, the Regional Engineer and Regional Safety Manager must approve such installation. In any case, document design decisions and criteria in the bridge folder.

**(b)** Approach Rail: In general, approach rail is recommended. The approach rail design level should be consistent with the bridge rail. The length and construction of the approach rail should be appropriate for the speed, type of traffic, and other applicable factors. On low-speed, low-volume Service bridges, a minimum approach rail length of 25 feet may be adequate, but in many cases the approach rail may need to be longer. The Regional Engineer and Regional Safety Manager must approve exceptions to the above criteria (i.e. no approach rail, or length less than 25 feet).

**B.** Nonpublic Use Bridges.

**(1)** Bridge Rail: It is recommended that all nonpublic use bridges have a crash tested or equivalent curb-type rail at a minimum. Consider o\Other types of rails (i.e. full rails) according to the Factors for Evaluating the Need for Bridge and Approach Rail (Exhibit 1) and appropriate design guidelines. The Regional Engineer and Regional Safety Manager must approve exceptions (i.e. no rail or curb).

**(2)** Approach Rail: Evaluate the need and design for approach rail in the same manner as the need for approach rail on public use bridges (i.e. the probability of an accident occurring, and the probable severity of an accident should one occur).

**(3)** For nonpublic use bridges, consider two additional factors when evaluating the need for bridge and/or approach rail. For bridges used only by station personnel, familiarity with the structure may reduce the risk or probability of an accident. However, this may not be the case where contractors, utility personnel, oil or logging companies, farmers or ranchers, in-holders, residences with visitors, or other nonpublic drivers also use the bridge.

### 2.6 What guidelines apply to existing bridge rails?

**A.** In general, because construction and maintenance costs of a do-nothing option are usually very low or zero, it will be rare that replacement or upgrading of an in-place rail that does not have a recognized poor performance record under its site specific conditions will be justified. *(AASHTO Guide Specifications for Bridge Railings, 1989, Page vi, Preface).*

**B.** You must maintain existing bridge and approach rails to their original designed condition.

**C.** During the inspection process, bridge rails will be evaluated against current Service guidelines for new bridges of that class and use. The rails will be identified as meeting or not meeting those guidelines. Recommendations in the bridge inspection reports will only address upgrading rails because of a condition problem or if the inspection team views the rail adequacy as a significant concern.

**D.** Regions will address maintenance or repair of bridge rails based upon deficiencies identified in the bridge inspection reports, consistent with existing maintenance management systems.

**E.** If a bridge is undergoing significant repair or rehabilitation, the existing rails, if they do not meet the current guidelines, should be evaluated for possible upgrading or replacement using the Factors for Evaluating the Need for Bridge and Approach Rail (Exhibit 1). If upgraded or replaced, the designs should comply with the guidelines for new bridge rails as much as possible.

### 2.7 What guidelines apply to new bridge widths?

**A.** The designer will use bridge widths that are consistent with design criteria, standards, and applicable evaluation factors. The designer should consider existing standards or guidelines (AASHTO, FHWA, State) and applicable evaluation factors (speed, volume, vehicle types, approach roadway width, etc.) in determining the appropriate width for new bridges. Bridge guidelines and references in Exhibit 2 include information that can be used to decide on a satisfactory width.

**B.** One-lane Bridges. Generally, the bridge roadway width of a one-lane bridge is less than 16 feet. If a bridge 16 feet or wider is used as a one-lane bridge, the bridge should be signed as a one-lane bridge.

**(1)** For Service bridges, a 14-foot width should usually be the minimum bridge roadway width for one-lane bridges. Also, the bridge roadway width should not be less than the approach roadway width including shoulders. Greater widths should be used to accommodate such factors as curve widening, off-highway vehicles, wide loads, station operations, and deviations resulting from using standard modular units.

**(2)** Structures on one-lane roads may have the width reduced to no less than 12 feet if the lesser width is acceptable for the intended use and traffic.

**C.** Two-lane Bridges. Generally, the minimum desired bridge roadway width of a two-lane bridge is 24 feet or greater. However, a bridge is considered a two-lane bridge if the width is 16 feet or greater, unless signed as a one-lane bridge.

**(1)** For Service bridges, 24 feet should usually be the minimum bridge roadway width for two-lane bridges with ADT less than or equal to 100. Also, the bridge roadway width should not be less than the approach roadway width including shoulders. Curve widening should be added as needed on bridges located on curves. A lesser width deviation of up to 2 feet may be considered if the lesser width is acceptable for the intended use and traffic.

**(2)** AASHTO and FHWA guidelines included in Exhibit 2 provide guidance on increased widths based on speeds, and ADT greater than 100.

**2.8 What guidelines apply to existing bridge widths?** Maintain existing bridges to their original designed width, or sign for restricted bridge width if needed. Exceptions are intentional changes in the use of the bridge, such as converting a two-lane bridge into a one-lane bridge. Prior to work being performed, the Regional Engineer must approve any repairs, alterations, or modifications that affect the original design width.

**2.9 What guidelines apply to load capacities?**

**A.** Unless as discussed below, all new bridges should be designed to AASHTO HS-20 standards.

**B.** There may be rare instances where a capacity lower than HS-20 is justified by station operations or other criteria. This should only be considered if there is no projected possibility that a vehicle exceeding the lower capacity might use the bridge. This includes special occasional uses, possible emergency equipment uses (such as fire fighting equipment), and the potential for future increase in the type vehicles using the bridge. The Regional Engineer must approve any exception to the HS-20 standard. The minimum design standard will not be less than H-15.

**C.** Maintain existing bridges to their original designed condition, or sign for restricted load capacity as appropriate. Bridge inspection reports will identify the current load capacity of a bridge, and recommend load posting signs when needed. Unless because of a condition problem, upgrading the load capacity will generally not be addressed in the inspection report. This is a station/Region decision based on operational needs. Prior to work being performed, the Regional Engineer must approve alterations to existing bridges that will or have the potential to affect the load capacity.

**2.10 What guidelines apply to bridge signs?**

**A.** Project leaders should install signs where conditions warrant. Base the need for signs on such factors as bridge location, average daily traffic, type of road, operating speed on the roadway, sight distance, and familiarity of users with the bridge. Other factors such as those listed in Exhibit 1 may also apply.

**B.** When bridge related signs are installed, they must comply with the Fish and Wildlife Service Sign Manual and the MUTCD. The MUTCD includes types of signs and, in most cases, installation guidance.

**C.** Object markers at each corner of a bridge are recommended for public use bridges, and should be considered for nonpublic use bridges. There are two types of object markers in the MUTCD to choose from to mark the corners of a bridge (Type 2 and Type 3).

**D.** The MUTCD contains one-lane bridge sign and narrow bridge sign guidance. In general, one-lane bridge signs apply to bridges on two-way roadways with a bridge roadway width of less than 16 feet. One-lane bridge signs would also apply to bridges 16 feet or wider if the bridge is used as a one-lane bridge. Narrow bridge signs apply to bridges on two-way roadways with a bridge roadway width of 16 to 18 feet, or for bridges having a bridge roadway width less than the approach roadway width.

**E.** Install load capacity signs on public use bridges when the bridge capacity is below AASHTO minimum truck-type standards (see bridge inspection reports for load ratings). On nonpublic use bridges, load capacity signs are recommended. In no instance will vehicles exceeding the load capacity of the bridge be allowed to use any Service structure, unless approved on a special need basis by the Regional Engineer.

**F.** The Regional Engineer and/or Regional Safety Manager may also require signs for situations where deemed necessary.

**G.** Once installed, you must maintain signs in an acceptable, effective condition.