BRIDGE INSPECTION HANDBOOK

A guide to the proper safety inspection and evaluation of vehicular bridges on USFWS facilities

U.S. Fish and Wildlife Service
Division of Engineering

USFWS Bridge Inspection Handbook

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(2014 version amended by Decision Memorandum, “Approval of Revisions to ~350 Directives to Remove Gender-Specific Pronouns,” 6/22/2022)

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1 INTRODUCTION

1.1 BACKGROUND

On August 29th, 1990, then U.S. Fish and Wildlife Service (Service) Deputy Director Richard N. Smith initiated the Service "Bridge Safety Inspection Program." The stated intent of the initiative was "…to ensure the safety and structural integrity of the Service's bridges."

Since its inception, the Service Bridge Safety Program (Program) has been an integral part of Service asset management-related activities. The Program is governed by Service Manual Chapter 362 FW 3, which provides policy regarding structures we must inspect, inspection frequency, inspection program personnel, and other Bridge Safety Program requirements. Program management and technical oversight is the responsibility of the Division of Engineering - Headquarters office (DEN).

1.2 SCOPE OF HANDBOOK

This document, the *USFWS Bridge Inspection Handbook*, provides supplemental guidance about specific bridge inspection activities that have evolved over the duration of the Program. The purpose of this handbook is to:

- Ensure the proper safety inspection and evaluation of bridges on Service facilities,
- Standardize reporting procedures, and
- Provide guidance for complying with the requirements of 362 FW 3 and the National Bridge Inspection Standards (NBIS).

Both pedestrian and vehicular bridges are found on Service installations. This handbook addresses the requirements for the inventory, inspection, rating, and reporting for vehicular bridges only.

2 INSPECTION REQUIREMENTS

The Service conducts bridge inspections to determine the physical and functional condition of a bridge, to form a basis for evaluation and load rating, to provide a continuous record of the structure, and to establish priorities for repair or replacement. The success of the inspection is dependent on proper planning, having the right equipment, and the experience and qualifications of the inspection team.

All bridge inspections are to be conducted in accordance with NBIS and Service requirements. Service bridge inspection requirements are in 362 FW 3, Vehicular Bridge Inspection.

We must plan and conduct bridge inspections as necessary to properly evaluate the condition of the structure and to protect people traveling over or under the structure. The inspection plan should:

- Identify unique structural characteristics and special problems or hazards
- Apply current technology and practice
- Ensure the intensity and frequency of the inspection is consistent with the type of structure and details
- Assign inspection personnel in accordance with their qualifications

2.1 USFWS RESPONSIBILITIES

The Service must ensure the safety of vehicular bridges on Service-managed lands. In 1990, we initiated the Bridge Safety Inspection Program (as it was then known) to address this responsibility. Service Manual chapter 362 FW 3 provides policy, guidelines, and procedures for implementing the Bridge Safety Program, as it is now known. The responsibilities we describe in the 362 FW 3 ensure that we inventory, inspect, load rate, and report to the Federal Highway Administration (FHWA) National Bridge Inventory (NBI) for our bridges.

As the organizational unit responsible for Program Management, the Headquarters Division of Engineering (DEN) has responsibility for maintaining the Service bridge inventory, for bridge inspection, and for annual NBI reporting. The Service Bridge Safety Program Manager (PM) oversees the day-to-day activities of the Bridge Safety Program.

Regionally, the Regional Engineer appoints a Regional Bridge Coordinator who assists the Program Manager with coordination of inspections within the Region, reviews findings and recommendations included in bridge inspection reports, and distributes bridge inspection reports to field stations and others within the Region.

2.2 BRIDGE INSPECTION TEAM

Each bridge inspection team must be comprised of at least two bridge inspectors. The bridge inspection team must be under the full-time, on-site supervision of a team leader. Some inspections will require more than two team members for safety reasons or to include needed expertise.

A bridge inspection team leader must have, at a minimum, the following qualifications:

- Registration as a Professional Engineer;
- 5 years of bridge inspection experience;
- Certification of completion of an FHWA-approved comprehensive bridge inspection training course.

The Service Bridge Safety PM may waive the Professional Engineering registration requirement on a case-by-case basis if the following conditions are met:

- The proposed team leader meets the NBIS requirements of 23 CFR 650.309 (b). , and

- It is in the best interest of the Service to waive the requirement.

Team leaders must complete an FHWA-approved bridge inspection refresher course every 5 years.

If a team leader will be engaged in a fracture critical member inspection, the team leader must have successfully completed an FHWA-approved fracture critical member inspection course.

Underwater inspection personnel must:

- Have successfully completed an FHWA-approved underwater bridge inspection course, or
- Provide suitable documentation that they have received training throughout their career that covers the topics covered in an FHWA-approved underwater bridge inspection course.

Commercial diver certification is not in itself sufficient to meet underwater bridge inspection training requirements.

All inspectors conducting non-destructive tests must be trained in the specific technology employed and must have appropriate certification, as required, in accordance with the American Society for Nondestructive Testing (ASNT).

We strongly suggest that other members of the inspection team complete an FHWA-approved comprehensive bridge inspection training course.

2.3 TYPES OF INSPECTIONS

The type of inspection team personnel perform may vary over the useful life of a bridge to reflect the level of effort needed to document its condition. The following sections describe these types of inspections:

- Initial inspection
- Routine inspection
- In-depth inspection
- Damage inspection
- Fracture critical member inspection
- Underwater inspection
- Interim inspection
- Special inspection

2.3.1 Initial Inspection

An initial inspection is the first inspection of a bridge as it becomes part of the Service's bridge inventory. The initial inspection is a fully documented investigation performed by qualified personnel. It must also include an analytical determination of the load carrying capacity (load rating).

The purpose of an initial inspection is twofold. We use it to gather the FHWA NBI Structure Inventory and Appraisal (SI&A) data and any other data that the Service Bridge Safety PM requires. We also use it to determine the baseline structural conditions and identify any existing deficiencies or potential deficiencies. As part of the planning for an initial inspection, inspectors should review all available information about the bridge, including as-built plans. This review, in conjunction with the inspection, should identify any fracture critical elements that may warrant special attention. Refer to Section 2.3.5 for more information on fracture critical member inspection.

As a part of the initial inspection, inspectors must complete a structural analysis to determine the safe load carrying capacity (load rating). If there is not enough existing information available in the bridge history file to determine the load rating, the inspectors must collect more detailed information in the field. Refer to Section 2.3.3, In-Depth Inspection, for more information. During the initial inspection for bridges over a waterway, inspectors must take soundings of the channel bottom around each of the substructure units, across the channel along the upstream and downstream fascia, and along lines parallel to the upstream and downstream fascia at specified distances from the bridge.

2.3.2 Routine Inspection

The Service regularly schedules routine inspections consisting of observations and/or measurements needed to determine the physical and functional condition of the bridge and to identify changes from the previous inspection. The results of a routine inspection should fully document the condition of the bridge and must include text, images, and drawings.

Routine inspections consist of an arm's length visual inspection of all portions of the structure with the use of simple tools, measuring devices, and recording methods. Inspectors must use climbing techniques, ladders, and access equipment to reach all portions of the bridge structure. As part of a routine inspection, inspectors must estimate and document losses of bridge member cross sections due to deterioration and damage.

The routine inspection will include rating all components and component elements in accordance with the 1988 FHWA *Recording and Coding Guide for the Nations Bridges* (Coding Guide), and reporting the results of the inspection in accordance with the Service's reporting requirements, as described in Chapter 5.

During the routine inspection, the inspection team must verify all data, correct inconsistencies, and update the Structure Inventory and Appraisal (SI&A) data.

Routine inspections of bridges over water must include a visual inspection for indications of scour and an examination of the condition of the channel embankments. During the routine inspection for bridges over a waterway, inspectors should take soundings of the channel bottom around each of the substructure units and across the channel along the upstream and downstream fascias of the bridge.

2.3.3 In-Depth Inspection

An in-depth inspection is a close-up, hands-on inspection of one or more bridge members above or below water to identify and assess any deficiencies not readily detectable using routine inspection procedures. Inspectors may need special equipment, such as under-bridge inspection equipment, staging, and workboats to obtain access. Non-destructive field tests and/or material tests may be required to fully ascertain the existence or extent of deficiencies. We may need to conduct in-depth inspections to gather detailed information about the remaining cross section of structural members for load rating (see Chapter 4)

The level of effort necessary to collect the needed information is determined to some extent by the availability of design and as-built drawings. For well-documented structures, we may limit the field inspection to a routine inspection, plus verification of key dimensions, visual estimation of remaining thickness, and limited measurements. When there are limited or no construction drawings available, it will be necessary to get detailed measurements of structural members and the general configuration of the structure.

2.3.4 Damage Inspection

A damage inspection is an unanticipated inspection that is undertaken to assess the structural damage caused by environmental or human actions. Typically, Regional personnel initiate these inspections to determine if emergency load restrictions or closure of the bridge to traffic is necessary, and to determine what repairs are necessary. The effort needed for this type of inspection may vary significantly depending on the extent of damage. Inspectors must evaluate the affected members, determine the extent of section loss, measure misaligned members, and check for any loss of foundation support. The inspection team must be capable of making on-site assessments to determine if emergency load restrictions are necessary.

2.3.5 Fracture Critical Member Inspection

The Service regularly schedules fracture critical member (FCM) inspections to examine the fracture critical members or member components of a bridge. Bridges require a fracture critical member inspection if they have steel tension members or steel tension components along a non-redundant load path, whose failure would likely result in partial or full collapse of the bridge. Inspectors should have identified the FCMs during the initial inspection of the bridge. Below are some typical examples of FCMs:

- One or two girder systems, including single boxes with welds
- Suspension systems with two eyebar components
- Steel pier caps and cross girders
- Suspended spans with two girders
- Welded tied arches
- Pin and hanger connections on two or three girder systems
- Steel trusses or gusset-plate connection systems

2.3.6 Underwater Inspection

Underwater inspection is the examination and assessment of bridge elements located below the waterline.

2.3.6.1 Routine Wading Inspection

If the water is shallow enough (below approximately 3 feet), the inspector can cautiously wade through the water to do the inspection. While wading, the inspector should be able to touch or access all portions of the bridge elements below water.

2.3.6.2 In-Depth Diving Inspection

If the water is too deep, the current too swift, or other conditions are present such that the inspector cannot safely conduct the inspection or achieve certainty as to the underwater conditions, an underwater diving inspection is required.

Underwater diving inspections must be accomplished in accordance with the requirements for Level I, II, and III inspections, as described in the current editions of the AASHTO Manual for Bridge Evaluation and FHWA-NHI-10-027 Underwater Bridge Inspection manual. Generally, these are the underwater inspection levels:

- Level I inspection of 100% of underwater elements: This level is essentially a “swim-by” overview, which does not involve cleaning any structural elements. It should confirm as-built plans and detect obvious defects.
- Level II inspection of 10% of underwater elements: This level of effort is directed toward detecting and identifying damaged/deteriorated areas which may be hidden. It requires cleaning the structural elements in 1-foot-high bands at the mudline, waterline, and half way between.
- Level III inspection of 5% of underwater elements: This level of effort often requires the use of non-destructive testing techniques, but may also require use of partially destructive techniques, such as sample coring, material sampling, or in-situ surface hardness testing.

If the percentage of element inspection does not allow the inspector to be certain about the structural condition of the underwater elements, then the inspector should increase the level of inspection and use whatever techniques necessary to achieve certainty.

2.3.6.3 Soundings

At a minimum, the inspector should take soundings (elevation measurements) of the channel bottom around each of the substructure units, across the channel along the upstream and downstream fascias of the structure, and along additional lines parallel to the upstream and downstream fascias of the bridge as specified in the scope of work or as deemed necessary.

2.3.7 Interim Inspection

The Service uses interim inspections to monitor a particular known or suspected deficiency, such as foundation settlement, scour (undermining), or member conditions that may have an impact on the structural integrity of the bridge.

The team leader for an interim inspection, with input from the Regional Engineer, Regional Coordinator, and Service Bridge Safety PM, must:

- Have a clear understanding of the known or suspected deficiency
- Incorporate the appropriate guidelines and procedures from this handbook regarding what to observe or measure
- Develop an appropriate reporting method based on mitigation urgency

Interim inspections are usually not comprehensive enough to meet NBIS requirements for biennial inspections. Conditions and events warranting interim inspection include:

- Summary condition rating of 3.0 or less
- Load Rating of less than 3 tons
- Excessive deformation of any load bearing element
- Cracks in the tension zone of a Fracture Critical Member
- Scour that threatens the stability of a substructure unit
- Any other condition or event that the Service Bridge Safety PM deems sufficient, such as:
    - Natural disasters in the vicinity of the bridge including wildfire, flooding, or earthquake
    - Damage caused by humans, animals, or any other outside agency

2.3.8 Special Inspection

The Service Bridge Safety PM may schedule special inspections, which are typically used to verify and document the closure or removal of a bridge. The Service Bridge Safety PM will specify the condition to be documented and the appropriate reporting method in the bridge inspection task order Statement of Work (SOW).

2.4 FREQUENCY OF INSPECTION

In general, Service bridges are inspected at regular, 24-month intervals in accordance with the NBIS. Certain bridges may require inspection at less than 24-month intervals, while we can inspect others at greater than 24-month intervals. The Service Bridge Safety PM, based on the NBIS, Service policy, the recommendation of the inspection team leader, Regional input, and these guidelines, will determine the level and frequency of inspection for each bridge in the Service's inventory.

2.4.1 Initial Inspections

We conduct initial inspections once when we add a bridge to the Service inventory, typically during the next biennial inspection cycle encompassing the bridge's geographic area.

2.4.2 Routine Inspections

Routine inspections are required for all bridges on the Federal Highway Administration's National Bridge Inventory (NBI) at 24-month intervals. We inspect non-NBI bridges (typically bridges under 20 feet long or bridges not open to the public), at 24-month intervals unless they meet all of the following criteria:

- Structural condition ratings are seven or higher,
- Scour condition ratings are seven or higher,
- The bridge does not have fracture critical members, and
- The bridge's estimated remaining life is greater than 10 years.

If a non-NBI bridge meets these criteria, then we may inspect it at 48-month intervals.

2.4.3 Fracture Critical Member Inspections

All FCM elements of a bridge require fracture critical member inspection during initial and routine inspections.

2.4.4 Underwater Inspections

All submerged elements of a bridge require underwater inspection during initial and routine inspections. The team leader and Service Bridge Safety PM should assess the need for in-depth diving inspection for any portion of a bridge exposed to water deeper than 3 feet. The assessment should consider such factors as:

- Structure type
- Foundation type
- Footing location relative to channel bottom
- Known or suspected problems
- Waterway characteristics
- Superstructure and substructure redundancy

Any portion of a bridge submerged more than 6 feet during periods of normal low water must undergo an in-depth diving inspection at least every 5 years.

2.4.5 Interim Inspections

The Service Bridge Safety PM determines when to schedule interim inspections. Typically, we schedule interim inspections to take place midway between the regularly scheduled routine inspections and will continue until the deficiency requiring monitoring has been eliminated.

2.4.6 In-Depth, Damage, and Special Inspections

The Regional Engineer, Regional Coordinator, and Service Bridge Safety PM determine how often to conduct in-depth, damage, and special inspections.

3 INSPECTION PROCEDURES

3.1 PREPARATION FOR INSPECTION

Prior to beginning the inspection, the inspection team should obtain the original design drawings, as-built drawings, repair drawings, maintenance history, and previous inspection reports for the bridge. The Service Bridge Safety PM, Regional Engineering Office, or facility Point of Contact (POC) can assist in locating or supplying the original design drawings, records, previous inspection reports, etc.

The inspection team should review available records prior to going into the field. Inspection planning activities should include a determination of the necessary inspection equipment, required forms, and any special access requirements such as rigging, snooper or bucket trucks, underwater inspection equipment, and/or personnel. A copy of the previous inspection report, if available, should be used as a reference during the current inspection.

FCM inspection requires additional preparation. The most important activities are:

- Identify possible FCMs.
- Note the particular members in the structure that may require special field attention, such as built-up tension members composed of few individual pieces.
- Pre-plan necessary access to the members, including special equipment needs such as ladders, bucket truck, or climbing gear.
- Identify and make available any necessary special tools and equipment that may be required in addition to the normal inspection gear.

3.2 BRIDGE ACCESS

Many Service bridges are located in remote locations or in other areas that are not accessible to the general public. It is not unusual to encounter locked gates or other access controls due to wildlife migration and breeding, or because of natural hazards such as wildfire and flooding. Other bridge sites may be home to unexploded ordnance or wildlife that may not be amenable to human interaction. Some locations can only be accessed by boat, All Terrain Vehicle (ATV), or other means of conveyance. It's important to closely coordinate with the facility POC to make arrangements for special access, lodging, keys, escort (armed or otherwise), or site-specific training in the months, weeks, and days preceding field inspection.

3.3 FIELD DOCUMENTATION TECHNIQUES

Inspectors must document existing conditions found during the inspection with detailed field notes and digital color images. You must prepare inspection notes and sketches in enough detail to accurately locate deficiencies, describe the limits of the deficiencies in enough detail to estimate the quantities for proposed repairs and restoration work, and evaluate the effect of the deficiencies on the load carrying capacity of the structure. Images should support and supplement the field notes.

3.3.1 Field Notes

Thoroughly examine all physical features of a bridge that affect its structural integrity during the inspection. The inspection team must accurately determine and record the location, severity, and extent of all damaged and deteriorated sections. Direct measurements of the surface area, depth, and location of defects are preferred to visual estimates of percentage loss.

Inspectors make field measurements to provide baseline data on the existing structure components and to track changes, such as crack width and length. Deficiencies such as cracks, spalls, and delamination can change over time, so it's important to acquire the initial measurements in a manner that can be replicated during future inspections.

Measurements may be required on structures for which no plans are available or to verify data shown on plans. Your measurements should be precise enough to serve the purpose for which they are intended.

When plans are available for a structure that is to be load rated, you typically take dimensions, member types, and member sizes from the plans. However, many plans are not as-built plans and may not reflect all changes made to a bridge during construction or subsequent repairs. Check and compare the plans during the field inspection to ensure that they truly represent the structure before you use them in structural calculations. Give special attention to changes in dead load, such as alterations in deck geometry, additional overlays, and/or new utilities. Increased dead load may affect the load rating for the structure.

Make and record enough measurements to track changes in joint opening, crack size, or bearing position. You may also have to take measurements to monitor suspected or observed substructure tilting or movement. In these cases, it is necessary to permanently mark on the structure and record in the field notes the measurements to serve as a datum for future readings. Include a log of the readings in the inspection report and update it with the new readings after each inspection cycle.

3.3.2 Urgent Item Forms

Inspectors must bring critical findings to the attention of station personnel as soon as practicable using an Urgent Item form. A critical finding is an existing bridge or bridge-related condition that presents an imminent safety hazard to Service staff or to the general public. A completed Urgent Item form should contain the following:

- The location of the hazard
    - Region
    - Station
    - Bridge name and number
- A description of the hazard
- Feasible action or actions that will address the hazard
- The date that the hazard was *first* brought to the attention of station personnel (may be the current reporting date)
- The name and affiliation of the team leader reporting the hazard
- The name and title of the station representative to whom the critical finding is reported
- The date that the report is acknowledged by the station

Urgent Item forms must be prepared by the team leader and provided to a station representative within 24 hours of identification of the critical finding.

Stations should resolve all items identified on the Urgent Item form as soon as possible, but in no case should a critical finding remain unresolved after 12 months.

A blank Urgent Item form is included in Appendix II.

3.3.3 Images

Take images with a minimum resolution of 240 dpi to document typical and significant structure conditions. Your images should be well composed, without extraneous vehicles, people, or debris. Images should be properly lighted using a flash if necessary. When composing images of details or localized deficiencies, place a scale or inspection tool (e.g., hammer, pencil, etc.) on the area you are recording in order to provide a frame of reference for the subject. Add digital annotations, such as arrows, when you prepare the report to draw attention to the deficiency or detail.

As a minimum, record the following images in the field:

- An elevation view of each side of the bridge
- A view of each approach roadway, looking toward the bridge
- A view of each approach roadway, looking away from the bridge
- A view looking upstream and a view looking downstream from the bridge
- Typical view of any deficiency rated "5" or less
- Typical view of superstructure
- Typical view of substructure units

3.4 Fracture Critical Members

3.4.1 General Requirements

Inspection of fracture critical members requires hands-on inspection, i.e. close up within arm's length to properly identify, measure, and determine the extent of deficiencies. When required by the condition of the member or where required by procedures established for the bridge, visual inspection must be supplemented by applicable non-destructive testing (NDT).

Inspections of fracture critical members are done at the same time as the routine inspection, and will be inspected on a frequency not to exceed 24 months. If a significant defect is found in a fracture critical member, inspection frequency will generally be 12 months or less until the defect can be repaired.

3.4.2 Pre-Inspection / Documentation

Bridges with fracture critical members are identified by the structure folder and any special inspection procedures must be in the folder. The outside of the folder must be labeled "Fracture Critical."

Fracture critical members are called out on the sketches with the symbol: (FCM) → Beneath the symbol is the member description (e.g. Bottom Chord, Floor Beams, etc.)

3.4.3 Inspection Documentation

Inspection types may be initial or routine. Formats for report types may be full or check.

NBI Item 92A will be coded as "Y _ _" where the second and third characters contain the inspection frequency in months (not to exceed 24).

NBI Item 93A must be coded with the last date a fracture critical inspection was done.

The "Additional Comments" field of the "Additional Information and Comments" section of the full report or the "Comments" section of the check report must contain a summary statement of the findings of the inspection of fracture critical members.

Recommendations for repair work or other action, such as load restriction or bridge closure due to significant inspection findings, must be included in the "Recommended Work" section of the report and marked as urgent.

3.4.4 Inspection Procedures:

FCM inspections are done no further than arm's length away. This may entail walking along the lower chord of trusses or conducting close inspections by other means. The inspection of FCMs may require an under bridge access vehicle, a ladder, a bucket truck, or a boat to get close enough to the members and connections to clean and measure corrosion and/or cracks. The inspector needs to follow safety protocol by using fall arrest or other applicable safety equipment. The inspector may need to remove dirt and debris to sufficiently observe and measure the remaining section on the lower chord, gusset plates, and ends of floor beams. Tension areas of FCMs will be the main focal points. The inspector needs to observe the coped sections of floor beams and their connections to the truss.

Inspectors must follow any special inspection procedures outlined in the bridge folders. For most bridges special inspection procedures are not needed, for example the detection of fatigue cracks in most steel girders is adequately addressed in the FHWA manual for the Safety Inspection of In-Service Bridges and the FHWA Bridge Inspector's Reference Manual.

If fatigue cracks are suspected, the bridge inspector must clean the area, remove any applied coating, if necessary, and perform grinding and/or dye penetrant testing as necessary to determine if there is cracking and the extent. If these methods are inadequate or impractical for the particular situation, the Service Bridge Safety PM must be consulted and additional personnel must be employed to complete the fracture critical inspection using ultrasonic or other applicable NDT methods. The locations, date, and type of test must be documented in the inspection report.

Significant defects, such as fatigue cracking, tearing, impact damage, significant corrosion, etc. will be brought to the attention of the station POC and Service Bridge Safety PM. The defects and repair or other action, such as load restriction or bridge closure, will be relayed to the station POC before leaving the station using the Urgent Bridge Work Recommendation Items form. The Service Bridge Safety PM or consultant's Senior Bridge Inspection Engineer must reduce the inspection frequency to 12 months or less until the defect can be repaired. The structure may be load restricted or closed until the deficiency is repaired. The Service Bridge Safety PM will determine the course of action.

3.5 In-Depth Dive Inspections

Each bridge with elements requiring in-depth dive inspection must have written bridge-specific inspection procedures which address items unique to the bridge. The written inspection procedures must address those items that the dive team leader should know to insure a successful inspection. In-depth dive inspections must be performed according to these written inspection procedures. Proper development of good inspection procedures and concerted attention to following those procedures will mitigate most risks. The prior inspection report is a valuable resource for reviewing previous inspection findings, but it does not serve the same purpose as the bridge-specific in-depth dive inspection procedures.

In addition to following the bridge-specific in-depth dive inspection procedures, planning and preparation for in-depth dive inspections must incorporate:

- Identified underwater elements
- Physical scour countermeasures
- Access
- Inspection equipment
- Structural details
- Hydraulic features and characteristics

- Risk factors (as detailed below)
- Inspection methods and frequencies
- Required qualifications of inspecting personnel
- Scheduling considerations (lake draw down, canal dry time, etc.)

Specific risk factors include waterway features that may promote scour and undermining of substructure elements, such as:

- Rapid stream flows
- Significant debris accumulation
- Constricted waterway openings
- Soft or unstable streambeds
- Meandering channels

Water conditions that may affect the inspection such as black water or rapid stream flows should also be identified and accounted for in the inspection methods. Water environment and structural systems or materials that may combine for accelerated deterioration of the bridge elements should be identified, such as highly corrosive water, unprotected steel members, timber piling in the presence of marine borers, etc. By identifying these conditions or risk factors, the underwater inspectors can appropriately prepare for and perform a thorough inspection.

3.6 STATION PRE-INSPECTION COORDINATION

Prior to arrival at a station, the inspection team must notify the station POC of the team's pending arrival. In the best circumstances, this should occur twice:

- Once prior to the start of the inspection trip to confirm the tentative inspection *date*, and
- Once anywhere from 3 to 24 hours before the anticipated arrival *time* at the station.

After arrival at the station but prior to starting the actual field work, the inspection team must conduct an in-brief meeting with station personnel. The purpose of this meeting is to:

- Review the scope of work
- Ensure all available information is collected
- Ensure facility personnel are aware of the scope and schedule
- Exchange emergency contact numbers
- Determine any special requirements, such as:
    - Work hour restrictions
    - Locked gates
    - Special access (boat, ATV, horse)
    - Special vehicles (required for load rating)

The agenda should include:

- Introductions
- Scope of work
- Maps of facilities
- Bridge plans
- Average Daily Traffic (ADT) counts
- Property record numbers

- Special bridge concerns/scheduling issues

During the meeting, the inspection team leader must ensure all interested parties understand the nature of the work and determine if they have any special requirements.

3.7 STATION POST-INSPECTION DEBRIEFING

At the end of the field inspection, the inspection team must hold a debriefing in conjunction with the on-site station representative. The purpose of the debriefing is to notify station personnel of conditions found during the inspection, any operational restrictions, and any possible repair recommendations. The inspection team leader must summarize the inspection findings for each bridge inspected.

Items to present include:

- General condition of each bridge
- Critical findings
- Other findings
- General recommendations for repairs or maintenance

Although the information presented is typically general in nature, it should be thorough and well-presented.

3.8 POST-TRIP DEBRIEFING

At the end of the field inspection trip, the inspection team must conduct a post-trip debriefing with the Service Bridge Safety PM and Regional Bridge Coordinator. This debriefing should include:

- Lead inspector(s) and stations visited
- Unscheduled inspections that were completed
  - Type of inspection completed
  - Reason for inspection
- Scheduled inspections that were not completed
- Critical findings
- Urgent Item forms
  - Acknowledged
  - Outstanding
    - Not yet provided
    - Not yet acknowledged
- Information still needed
  - Bridge numbers
  - Drawings
  - Other
- Follow-on inspection needs
  - Underwater dive inspections
  - Interim inspections
  - Other
- SOW changes and reason for change:
  - Check report to full report
  - Full report to check report
  - Other report- or inspection-type changes
- Station post-inspection debriefing status
- Public relations issues

- Station POC changes
- Brief review of *noteworthy* items at stations visited

4 LOAD RATING

Load rating provides a basis for determining the safe load capacity of a bridge based on a structural analysis and helps us to determine whether or not posting is required. The safe load carrying capacity of a bridge must be based on the existing conditions you observe during field inspection. A load rating is required:

- When a bridge is added to our inventory,
- When a bridge is modified, or
- When a bridge is damaged.

Bridge load rating calculations start with information available in the bridge file, including recent inspection findings and as-built or original design drawings. The bridge rating analysis must take into account any loss of cross-sectional area found during inspection.

Service load ratings must adhere to the American Association of State Highway and Transportation Officials (AASHTO) guidelines in effect at the time the rating calculations are prepared.

The Service records bridge load ratings in tons (U.S. Customary Units).

4.1 DATA COLLECTION

In order to complete the load rating of a bridge, inspectors must obtain several pieces of information. Following is a list of sources and types of information to collect:

- As-built or original design drawings
  - Bridge geometry
  - Roadway geometry
  - Dead loads
  - Superimposed dead loads
  - Primary load carrying member details
  - Material properties
  - Design live load
  - Design methodology
- Bridge inspection reports
  - Current condition of bridge elements
  - Size, location, and extent of defects
  - Images
  - SI&A data
- Structural calculations

In general, the information you obtain for rating analysis includes span lengths of major structural members; depths, widths, and thicknesses of main structural members and member components; locations and sizes of diaphragms, cross frames, and bracing members; identification of fatigue details; slab thicknesses; and wearing surface thicknesses. In some instances, additional measurements will be necessary to analyze the structure. Normally you don't need details of bearings and connections.

If the inspection report indicates damage, distress, or the presence of fatigue-prone details, it may be necessary to get measurements of those details. If the rating results indicate an unsafe condition, the unsafe condition is a critical finding subject to the requirements in Section 3.3.2 of this handbook.

4.2 TYPES OF LOAD RATING

Load ratings are calculated for two levels of performance using AASHTO standard design vehicles. The most common class of AASHTO design vehicle is prefixed "HS." Section 4.3 provides more information about AASHTO standard design vehicles.

4.2.1 Inventory Rating

Inventory rating is a measure of a bridge's serviceability. It represents the load that a bridge can safely carry on a day-to-day basis without adversely impacting the bridge's useful life. Simply defined, the inventory rating represents the largest sustained live load that a structure can safely carry for an indefinite period.

4.2.2 Operating Rating

Operating rating is a measure of a bridge's strength. It represents the absolute maximum permissible live load that a bridge can safely carry on a limited basis. Unlimited use of vehicles that subject the bridge to operating levels may shorten the useful life of the bridge.

4.3 STANDARD DESIGN VEHICLES

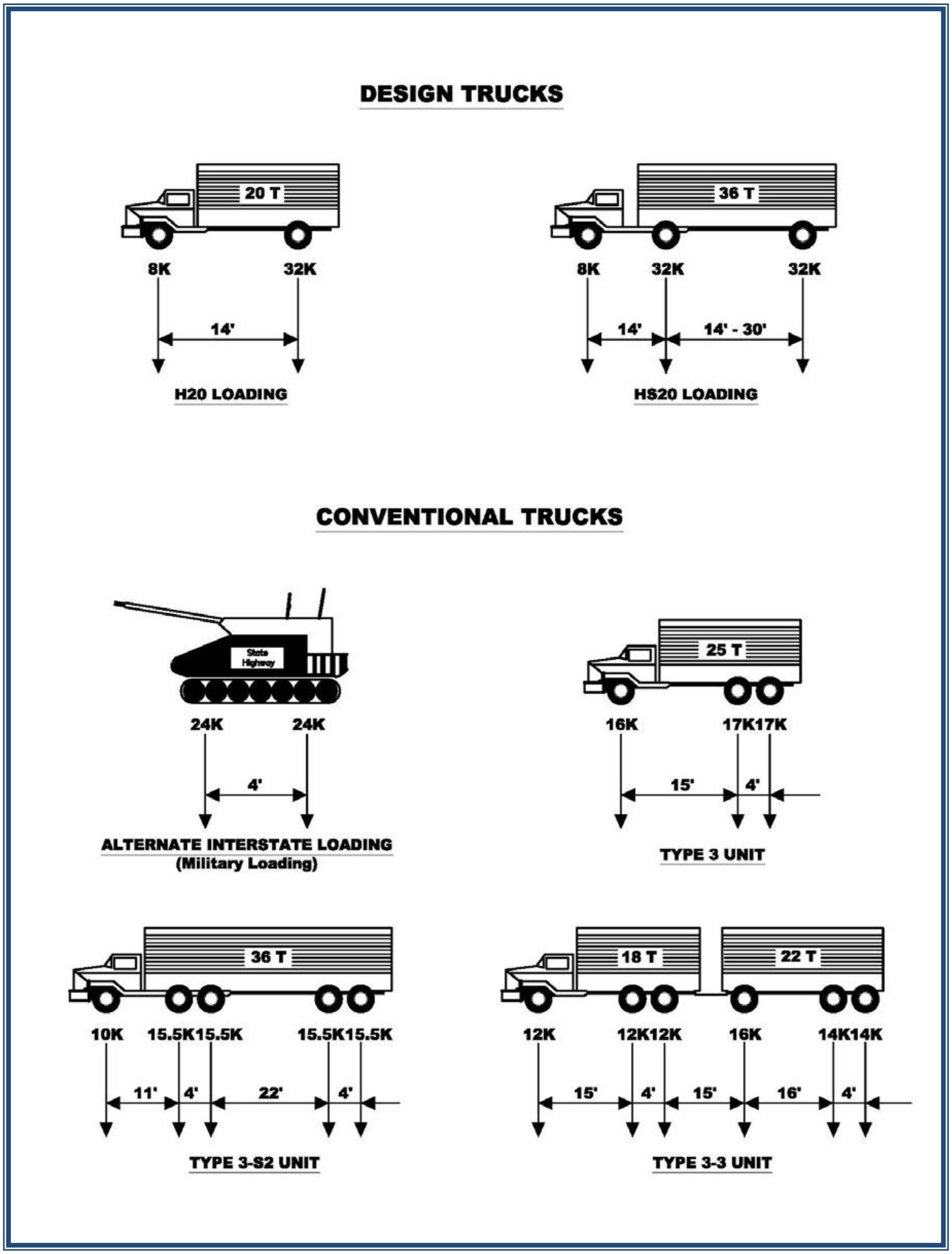
AASHTO has developed standard design vehicle live loads for use in bridge design and rating. These standard vehicles do not represent actual vehicles; rather, they were developed to allow a relatively simple method of analysis based on an approximation of actual highway live loads. We use the AASHTO HS truck as the standard design vehicle to load rate bridges. Other standard design vehicles are used to determine posting loads.

The Service's policy is that bridges be load rated for the following standard design vehicles:

- HS20
- Type 3 Unit
- Type 3-3 Unit
- Type 3-S2 Unit

The HS20 vehicle is a purely "design" vehicle comprised of a highway tractor and semi-trailer. Types 3, 3-S2, and 3-3 vehicles are based on actual vehicles that conform to the load regulations of most State agencies. Figure 4.3-1 shows these and other standard design vehicles

Figure 4.3-1 AASHTO Standard Design Vehicles



4.4 ANALYSIS METHOD

All bridge structures must be analyzed per current AASHTO and FHWA load rating guidelines.

If a structure was designed using the load factor method for HS20 or greater HS loading and other specific conditions are met (see FHWA *Assigned Load Ratings* memorandum dated September 29, 2006 in Appendix VI), inventory and operating ratings may be assigned based on the design loading unless changes to the structure occur that would reduce the inventory rating below the design load level. The HS design load rating factors for these bridges can be taken as:

- Inventory 1.00
- Operating 1.67

Appendix VI of this handbook includes additional FHWA load rating guidelines and policy memoranda that must be followed when analyzing Service bridges.

4.5 INITIAL LOAD RATING

You determine the initial load rating based on the actual condition of the bridge during the initial inspection. If the original design information is insufficient to determine the rating, you will have to calculate the load rating. Consider the extent of deterioration of the structural components of the bridge in the computation of dead loads and live load and their effect on the capacity of the members.

4.6 REVIEW AND UPDATE OF LOAD RATINGS

The team must review the load rating calculations of bridges inspected during regular inspection cycles. If the inspection results indicate a change that may affect the existing rating of the bridge, the team must notify the Service Bridge Safety PM and update the rating calculations within 90 days of discovering the change.

4.7 LOAD RATING CALCULATIONS AND RESULTS

You must present the load rating calculations in a clear and easily understood format. State clearly all of your assumptions, definitions, and nomenclature. Describe any formulas you use in the analysis and reference where you got them. All calculations must be checked and initialed by the engineer who developed them and the engineer who checked them. Computer output must include a cover page explaining the analysis performed, and must be initialed by the engineer who developed the input and the engineer who checked the input and results. The inspection team leader for the bridge being rated, as well as the person in charge of the bridge ratings, must also review the rating. This may be the same individual, except in special cases where the inspection team leader is not a registered engineer. All bridge ratings must be approved by a registered professional engineer qualified to perform bridge analysis.

Include a summary of the results of the calculations (inventory and operating ratings) listed by vehicle type in the calculations and in the inspection report.

When you have completed the load rating calculations, add a copy to the bridge history file.

4.8 BRIDGE POSTING

It is the Service's responsibility to enforce posting. The Service posts bridges to warn users of the load capacity of the bridge, to avoid safety hazards, and to adhere to Federal law. We typically post a bridge when the load rating indicates that the bridge cannot safely carry AASHTO standard design vehicles.

The inspection team leader must notify the Service within 24 hours of determining that a bridge requires posting. The inspection team leader must present the reasons for the posting recommendation, the suggested load limit, and the type and location of recommended signage.

Posting recommendations should be acted on by the station responsible for maintaining the bridge as soon as practical after receiving the posting recommendation. If a bridge cannot be posted in a timely manner, the station should take other action to insure that no oversized vehicles use the bridge, including erecting barricades or detouring traffic. A station should never allow a bridge to remain open to unrestricted traffic 90 days after posting has been recommended for the bridge.

Posting signage must conform to the latest edition of the FHWA's *Manual of Uniform Traffic Control Devices* (MUTCD). The MUTCD outlines the requirements for type and placement of signage for posting bridges. Figure 4.9-1 illustrates the types of signs found in the MUTCD that we commonly use for our bridges.

4.9 NBI CODING OF LOAD RATING RESULTS

The inspection team leader must ensure that new and updated load rating values are accurately and correctly recorded for NBI items 63, 64, 65, and 66. The inspection team leader should code these items using English units, following the guidelines provided in the current *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* and the FHWA policy and guidance memoranda included in Appendix VI.

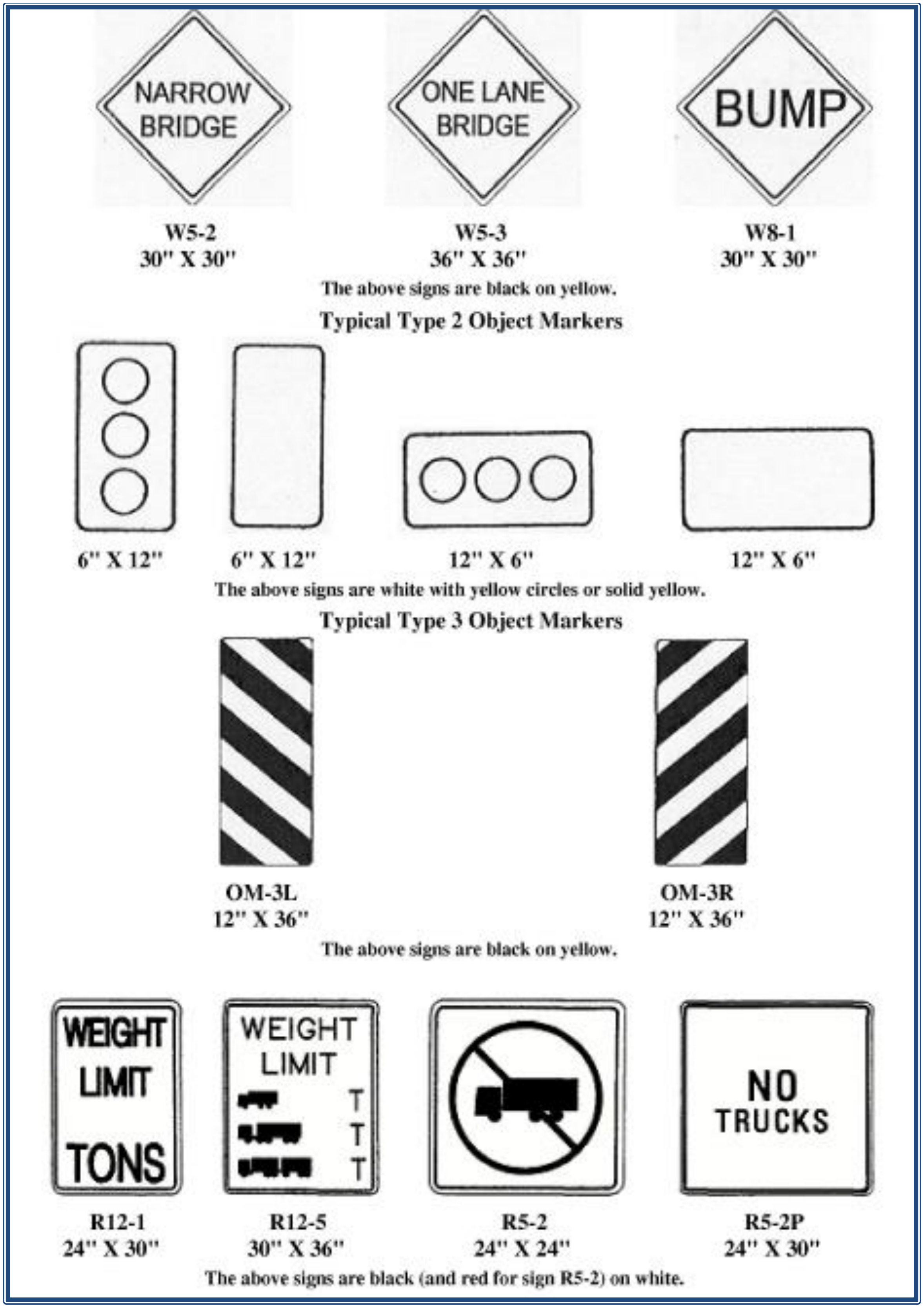


Figure 4.9-1 Typical Bridge Signs

5 INSPECTION REPORTS

5.1 INTRODUCTION

The primary objective of the inspection report is to provide Regional Service personnel an assessment of the existing condition of the bridge and all of its components. The report provides detailed information necessary to determine the maintenance and repair needs of the bridge, as well as that necessary to substantiate maintenance and repair funding requests. A separate report is required for each inspected structure.

In general, the report includes:

- Description of all major damage and deterioration.
- Description of the condition of non-structural components and component elements.
- Evaluation of existing physical condition of all structural and non-structural components and component elements.
- Recommendations for necessary repairs or maintenance measures.
- Load rating summary and posting recommendations.
- Signage recommendations.
- Budgetary estimates for the recommended maintenance or repair items.
- Recommendations for types and frequencies of future inspections.

5.2 TYPES

The following report types are typically prepared for Service bridges:

- Full
- Check
- Documentation
- Underwater
- Damage

INSPECTION	*REPORT TYPES*				
	FULL	*CHECK*	*DOCUMENTATION*	*UNDERWATER*	*DAMAGE*
INITIAL	✓				
ROUTINE	✓	✓			
IN-DEPTH	✓				
DAMAGE					✓
FRACTURE CRITICAL	✓	✓			
UNDERWATER	✓	✓		✓	
INTERIM	✓	✓			
SPECIAL			✓		

Table 5.2-1 Inspections and Report Types

The bridge inspection task order SOW will list the report type required for each bridge inspected. Table 5.2-1 lists the most common report types we use for each inspection type. Appendix I contains sample full and check reports.

5.2.1 Full Reports

A full report is a detailed, comprehensive record of inspection findings including all of the sections listed below:

- Cover Page
- Table of Contents
- Location Map
- Bridge Identification, Use, and Summary of Findings
- Recommended Work and Estimated Costs
- Replacement Cost
- Sign Recommendations and Load Ratings
- Additional Information and Comments
    - Description of Bridge
    - Comparison to Previous Inspection
    - Next Inspection Recommendations
    - Additional Comments
- Condition Ratings
- Sketches
- Photos
- Typical Signs *(final reports only)*
- Rating Vehicles *(final reports only)*
- Inventory and Appraisal Data Sheet *(draft reports only)*
- Additional National Bridge Inventory and FWS Items *(draft reports only)*

5.2.2 Check Report

A check report is a brief, one page narrative summary prepared for bridges that had no signs of progressive deterioration and were in satisfactory or better condition during the previous inspection. Check reports are only prepared when inspection findings verify that no significant adverse change has occurred in the condition of the bridge since the previous inspection. Check reports are never prepared for the same bridge during consecutive inspections. Check reports contain the following items:

- Bridge Identification
- Summary of Findings
- Comments
- Next Inspection Recommendations
- Recommended Work and Estimated Costs from Previous Inspection (with costs updated to the inspection year)
- Sign Recommendations and Load Ratings (from most recent full report)
- SI&A Datasheet (draft reports only)

5.2.3 Documentation Report

A documentation report is generally prepared as a result of a special inspection. We typically use documentation reports to verify the removal or proper closure of a bridge prior to removing it from the active Service bridge inventory or placing it in a non-inspection status. Documentation reports typically consist of the following report elements:

- Cover Page
- Additional Information and Comments
  - Description of Bridge
  - Comparison to Previous Inspection
  - Next Inspection
  - Additional Comments
- Photos of approach showing barricade or removal

5.2.4 Underwater and Damage Reports

Because we rarely develop underwater and damage reports, the requirements for these reports are specified on a case-by-case basis.

5.3 CONTENT

5.3.1 Summary of Findings

This section presents the overall findings of the inspection of the bridge and its components. The narrative should provide sufficient detail to ensure the reader understands the type of defect/deterioration, its typical or specific location, and the general condition of the component. The general condition assessment is based on the observed conditions and should indicate the condition of the entire component and its ability to perform its intended function. The 10 terms you must use to describe the general condition are:

- Excellent – Typically only used for very recent construction.
- Very Good – No problems noted.
- Good – Some minor problems noted.
- Satisfactory – Structural elements show some minor deterioration.
- Fair – All primary structural elements are sound but may have minor section loss, cracking, spalling, or scour.
- Poor - Advanced section loss, deterioration, spalling, or scour.
- Serious – Loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible.
- Critical – Advanced deterioration of primary structural elements. Unless closely monitored, it may be necessary to close the bridge until corrective action is taken.
- Imminent Failure – 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 allow light service.
- Failed – Out of service and beyond corrective action.

5.3.2 Fracture Critical Members (FCM) Findings

You must include a description of the FCM inspection findings in the body of the report. For full reports, list your findings under “Additional Comments” on the “Additional Information and Comments” section of the report. For check reports, list your findings under the “Comments” section of the report. For other report types, list the findings as required in the bridge inspection task order SOW.

5.3.3 Recommendations

Recommendations should address structural repairs as well as maintenance and safety items. They must be clearly presented and include:

- Recommendation for next inspection type and interval.
- Sign recommendations
- Specific actions to take to repair or maintain the bridge or any of its components.
- Bridge replacement recommendation, when applicable.

5.3.3.1 Cost Estimate

You must provide a construction cost estimate that details the quantities, materials, and labor costs for each repair, maintenance, and bridge replacement item that you recommend.

Construction cost estimates must be prepared for the specific location of the bridge in order to reflect the cost of labor and materials in the specific geographical area. This is especially important in remote areas, where the cost of mobilization and/or transportation of materials can be significantly higher. Construction cost estimates should be based on cost data such as R.S. Means, local State DOT costs, or similar data sources.

For repair and maintenance items with an estimated material plus labor cost up to $100,000, engineering (planning, design, construction management) costs, if needed, can be estimated as 0.18 (18%) times the material plus labor cost. A construction contingency, if needed, can be estimated as 0.15 (15%) times the material plus labor cost.

For repair and maintenance items greater than $100,000 and for bridge replacement, use the percentages shown in Table 5.3-1.

Item	$0-100,000	$101,000-500,000	$501,000-1,000,000	$1,001,000-5,000,000	$5,001,000-10,000,000+
Construction Contingency	15%	15%	10%	10%	9%
Planning/Design	21%	21%	18%	15%	14%
Construction Management	9%	9%	9%	9%	7%
Value Engineering	0%	0%	0%	2%	1%
G.A.S.	0%	5%	5%	5%	5%

Table 5.3-1 Indirect Costs and Construction Contingencies

As you prepare your estimate, keep the following in mind:

- Use the indicated markups only when applicable.
- The above percentages are guidelines based on average project complexity. You should adjust your estimate up or down as appropriate based on the anticipated complexity of the recommended item.
- G.A.S. is to be applied to any item over $100,000 in total project cost (materials + labor + engineering + construction contingency).

5.3.3.2 Priority Assessment Codes

The inspector must assign each recommended work item a Priority Assessment Code (PAC). The PAC represents a subjective, suggested priority associated with the recommended work item. It combines the elements of perceived hazard severity and potential negative outcome possibility. The inspector uses the PAC solely to help assign a relative priority for the recommended work item, and is not to be construed or interpreted as a prediction of future negative consequences.

Derive the PAC using the following:

1. Hazard Severity. The hazard severity is an assessment, based on the inspector's experience, of the worst potential consequence, as determined by degree of injury or damage, that is possible as a result of an identified deficiency. Assign hazard severity categories according to the following criteria:

    I. Catastrophic: May cause death or result in permanent loss-of-use of the structure; replacement of structure would be required.

    II. Critical: May cause severe bodily injury or temporary loss-of-use of all or a portion of the structure.

    III. Marginal: May cause vehicle damage, minor bodily injury, or result in damage that would reduce the capacity or useful life of the structure.

    IV. Negligible: Probably will not affect personnel safety or structural integrity; lack of corrective action could result in localized damage to bridge.

2. Likelihood of Outcome. The likelihood of outcome represents the inspector's subjective estimation of the possibility of a hazard resulting in a negative outcome—based on the inspector's judgment and a qualitative assessment of such factors as location, use, and traffic volume—assigned using the following criteria as a guide:

    A. Likely to occur either immediately, within a short period of time, or prior to the next regularly scheduled inspection.

    B. Likely to occur eventually.

    C. Possibly could occur eventually.

    D. Unlikely to occur in the foreseeable future.

The PAC is an expression of priority that combines the elements discussed above. Using the matrix shown in Figure 5.3-1, the PAC is expressed as an integer that can be used to help assign repair priorities, using 1 as the highest priority and 7 as the lowest priority.

HAZARD SEVERITY	OUTCOME LIKELIHOOD			
	A	B	C	D
I	1	2	3	4
II	2	3	4	5
III	3	4	5	6
IV	4	5	6	7

Figure 5.3-1 PAC Determination Matrix

5.3.4 Load Rating and Posting

The report must include a table showing the results of inventory and operating rating results, in tons, for each element analyzed. In addition, you should include a discussion of how the bridge was analyzed. This discussion should include the assumptions made as well as the material properties used for each element.

If, based on the results of the load rating, the bridge needs to be posted, the report must describe the recommended posting. Bridge posting recommendations should be based on the minimum operating rating capacity of the bridge.

5.3.5 Condition Ratings

We use condition ratings to describe the existing, in-place bridge as compared to the as-built condition. Inspectors must evaluate the material-related physical condition of the deck, superstructure, and substructure components, as well as the elements that make up these bridge components. Inspectors must also evaluate the condition of channels, channel protection, and culverts. Your evaluation should provide an overall characterization of the general condition of the entire component or element being rated. Conversely, they should not attempt to describe localized or nominally occurring instances of deterioration or disrepair. Correct assignment of a condition code must, therefore, consider both the severity of the deterioration or disrepair and the extent to which it exists throughout the component or element being rated.

We use the codes and instructions in the *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* (FHWA, December 1988) for evaluating and coding nearly all NBI-related bridge inventory and appraisal data. The inspection team must develop each element rating in accordance with the guidance provided in that document.

The condition rating section of the report also includes the inspector's remarks describing – at a minimum – the inspector's observations of the physical condition of each element rated less than 6 (Satisfactory). These remarks describe the defects that justify the less-than-satisfactory rating. The remarks also identify:

- Repair or rehabilitation work along with completion dates
- Fracture Critical Members (FCM)
- Any observation that the inspector deems noteworthy

5.3.6 Sketches

Sketches are very important in conveying the physical arrangement of the bridge. They should be detailed enough to give the reader a graphical representation of the major elements of the bridge structure and bridge-related items. If available, use original design drawings to develop the figures in the report. If these are not available, you'll need to gather enough information in the field to develop the figures to the level of detail needed. The sketch section of the report must contain the following:

- A plan view
- A cross section
- A profile view

Additional items that may be required, depending on the complexity of the bridge, include:

- Framing plan
- Details of superstructure elements

The sketches must be prepared using engineering industry standards and conventions.

5.3.6.1 Plan View

The plan view should illustrate the bridge in enough detail to allow the reader to understand the configuration of the bridge in relation to the roadway approaching and crossing the bridge, the feature or features crossed, and all appurtenant safety elements. The plan view should be oriented with South to North or West to East shown left to right and include the following elements:

- Title ("Plan")
- A North arrow
- Structure and approaches/sidewalks/etc. (as applicable)
- Wingwalls, headwalls
- Edges of channel
- Indication of water or traffic flow under bridge
- Dimensions
    - Out-to-out of the deck
    - Curb-to-curb clear distance
    - Overall NBIS bridge length
- Labels and call-outs
    - Roadway name
    - Edge of channel
    - Guardrails, bridge rails, and/or barriers
    - Wingwalls
- Appropriate notes, legend, and abbreviations

Refer to Figure 5.3-2 for a sample plan view sketch.

5.3.6.2 Section

The section illustrates the typical cross-sectional configuration of the superstructure. It usually includes:

- Title ("Section")
- Orientation
- Primary superstructure elements
- Barriers/guardrails

- Dimensions
  - Out-to-out of bridge deck
  - Clear distance curb-to-curb
  - Deck thickness
  - Pavement/topping thickness (if applicable)
  - Curb reveals
- Beam types, sizes, spacing, and materials
- Barriers and bridge rail

Refer to Figure 5.3-3 for a sample section sketch.

5.3.6.3 Profile

The profile should be oriented with South to North or West to East shown from left to right and include the following elements, appropriately labeled:

- Title ("Profile")
- Structure and approaches
- Wingwalls, headwalls
- Piles and footings
- Channel profile
- Barriers/guardrails
- Ground line with appropriate earth hatching below
- Waterline
- Spans
- Abutment and pier caps
- Columns/piles (diameter/width)

Refer to Figure 5.3-4 for a sample profile sketch.

5.3.6.4 Fracture Critical Members

The FCMs, if any, must be identified on the inspection report sketches. Figure 5.3-5 shows typical FCM call-outs on a sketch.

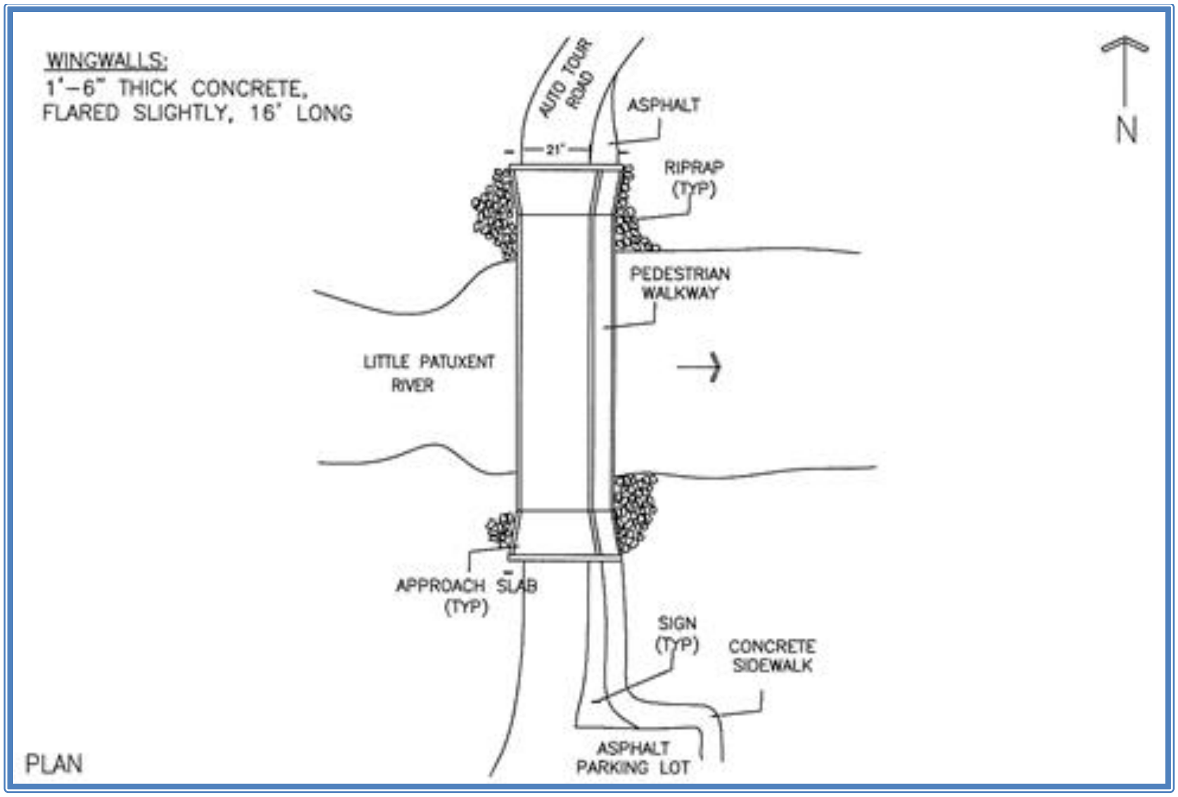


Figure 5.3-2 Sample Plan Sketch

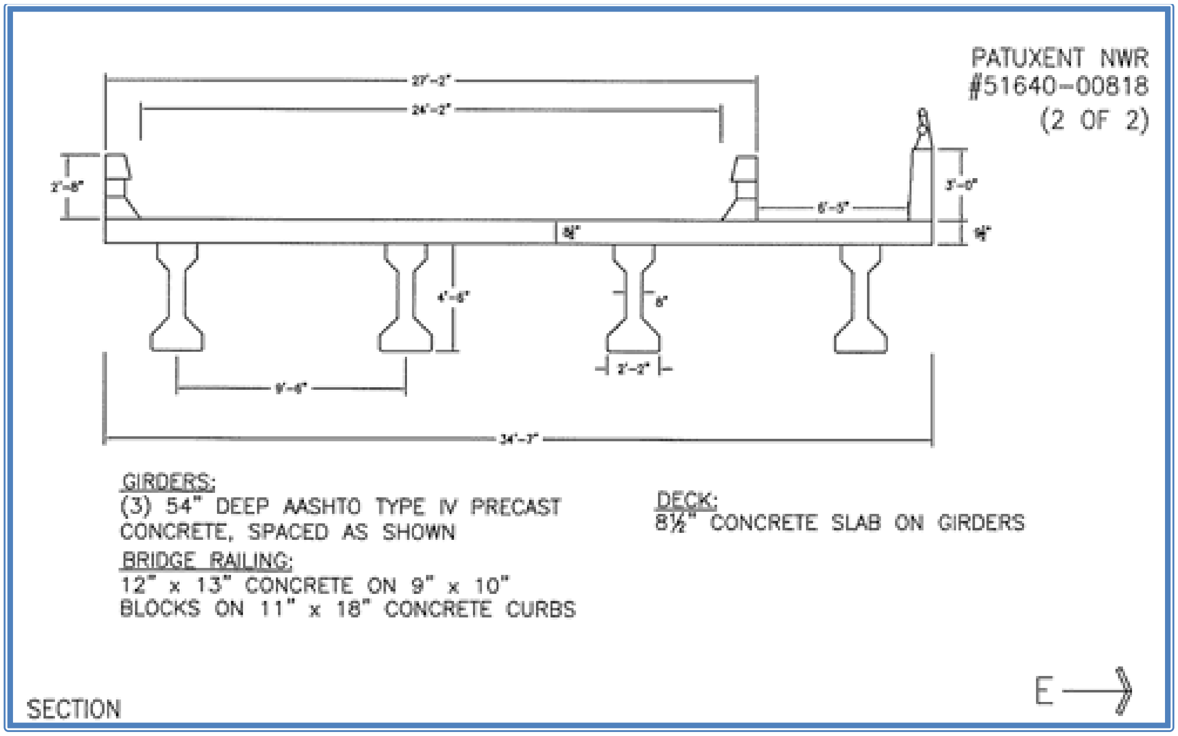


Figure 5.3-3 Sample Section Sketch

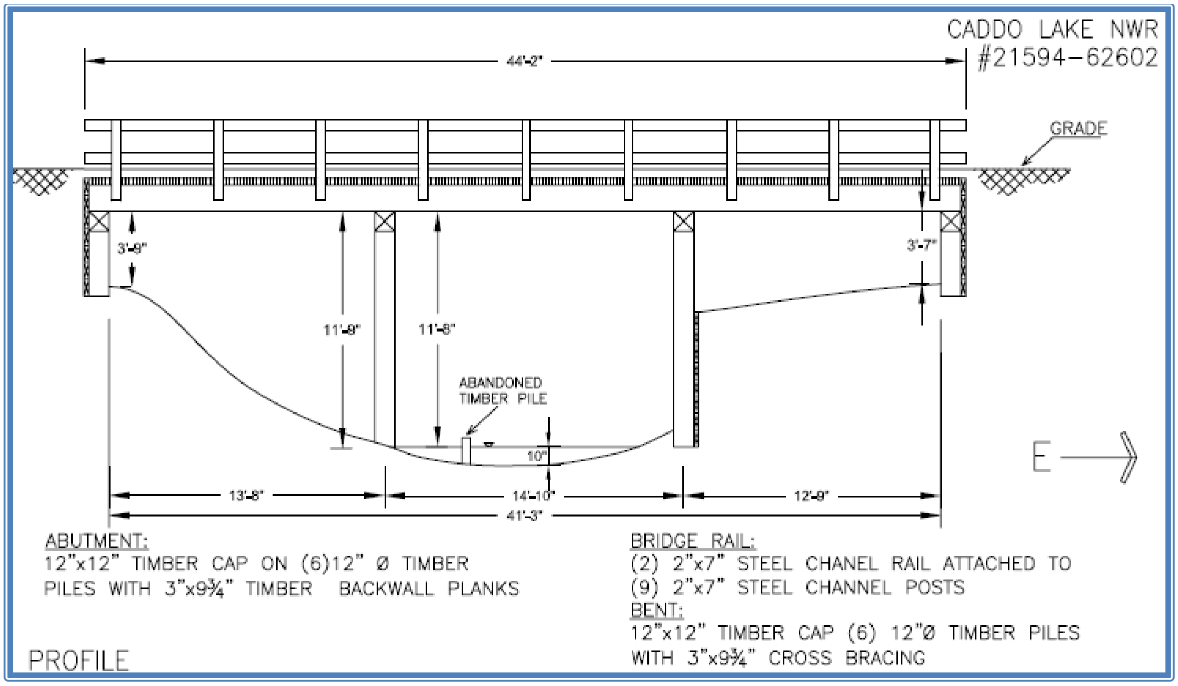


Figure 5.3-4 Sample Profile Sketch

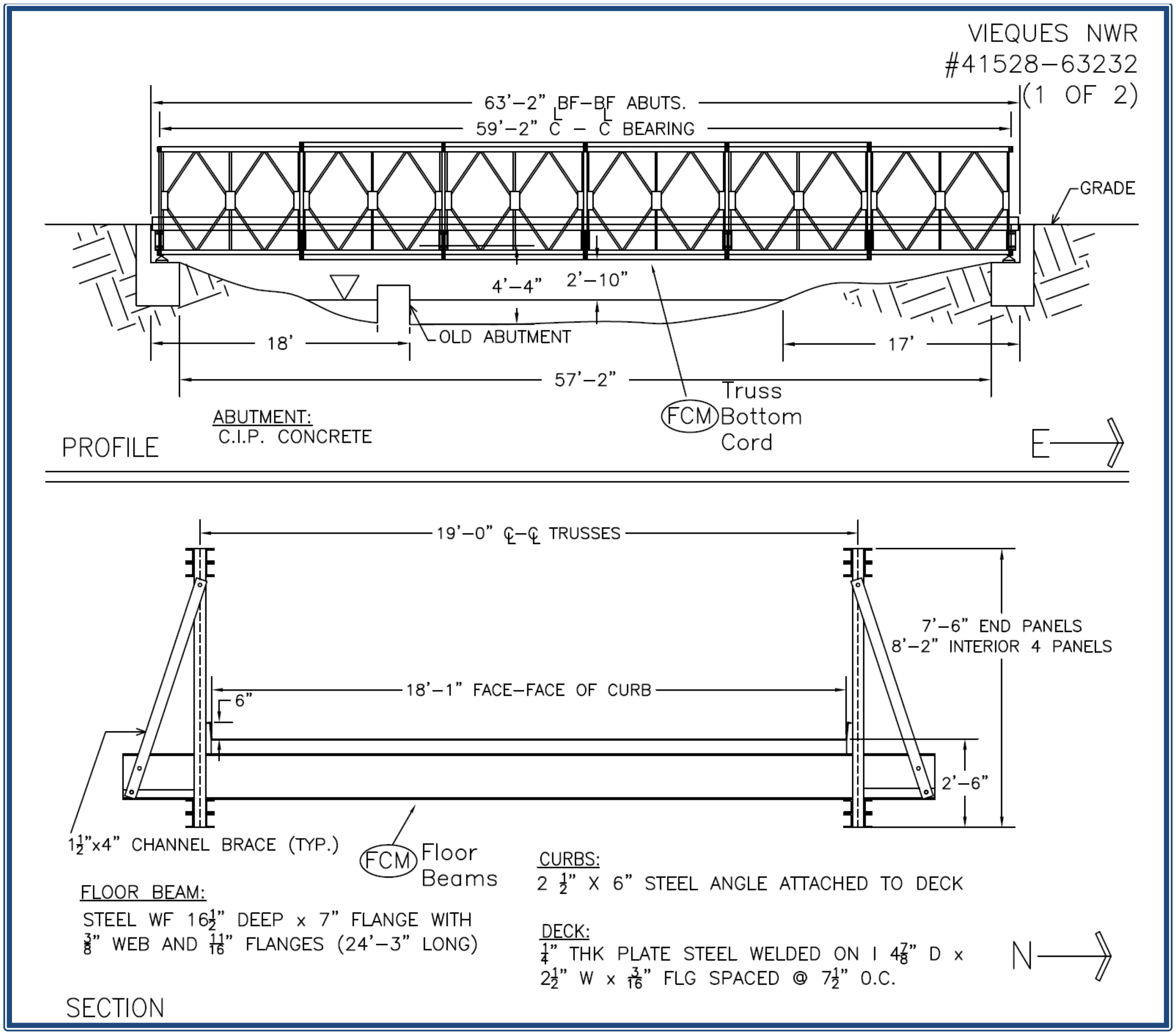


Figure 5.3-5 Typical FCM Call-outs

5.3.7 Images

Good images are an excellent way to document the condition of a bridge. They help to verify the identity of the bridge, provide clear evidence of the defects and deterioration that were found during the inspection, and can support funding requests.

Images must be of high quality, in focus, and of sufficient contrast. Each image must have a caption that reinforces the findings described in the narrative. The captions should describe where the image was taken and what it depicts.

Images should be simple and uncluttered. Include a measuring scale or some other reference object when digital imaging damage and defects to provide a frame of reference for the size and extent of deterioration. Superimpose arrows or reference lines to emphasize specific characteristics that may not be readily apparent.

To completely document the inspection findings, the images should include, at a minimum, the following bridge elements:

- View of the bridge as seen from the approaching roadway
- Upstream and downstream elevations
- Typical views of the approach roadways
- Typical views of the feature crossed
- Bridge signage and object markers
- Typical view of the underside of the superstructure

In addition to the above elements, include any examples of notable defects described in the "Bridge Summary" and "Condition Rating" remarks.

5.3.8 Structure Inventory and Appraisal Data

The inspection team must update the Service's bridge inventory data after every bridge inspection. Code SI&A data in accordance with the 1988 edition of the FHWA *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*. Our SI&A data is included in the FHWA National Bridge Inventory (NBI), which is used to track and report on the health of the Nation's public bridges.

Too often there are errors or information that is omitted when coding the SI&A data. The inspection team must exercise extreme care when inputting or updating the data to ensure that it conforms *exactly* to the noted guidelines. This will ensure a smooth transmission of Service data to FHWA.

5.3.9 Additional NBI and FWS Items

NBI and FWS items are either defined in the 1988 *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* or described below. Items not described are self-explanatory.

5.3.9.1 NBI Items 63 and 65 Method Used to Determine Operating and Inventory Rating

These NBI items should be coded using the current edition of the *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* and any subsequent FHWA guidance included in Appendix VI.

5.3.9.2 NBI Item 106 Year Reconstructed

Reconstruction is defined as a significant amount of work done to increase the load carrying capacity of a component or an element of a bridge that is not capable of carrying current design loads. Reconstruction also includes work that substantially changes the physical geometry of a bridge to correct a previous functional deficiency, such as widening the roadway or raising the superstructure in order to significantly increase the waterway opening below.

Reconstruction varies with the size and type of bridge under consideration. A complete deck replacement for a concrete bridge may constitute reconstruction, while a complete deck replacement for a timber bridge normally would not, unless the new deck increased the load carrying capacity or eliminated a structural deficiency of the bridge.

5.3.9.3 FWS Item 204 Bridge Number

The FWS Bridge Number is a unique 10-digit number assigned by the Service Bridge Safety PM. The first 5 digits are typically an organizational code, and the second 5 digits are typically derived from Real Property Inventory (RPI) records. (Note: the second 5 digits reflect RPI coding in use at the time the value is/was assigned).

5.3.9.4 FWS Item 205 FWS Bridge Class

Refer to Table 5.3-2.

Class	Description
A	Bridges that have minimum openings of more than 20 feet and are open to public travel as defined under Title 23 United States Code.
B	Bridges that have minimum openings of 20 feet or more and are not open to public travel, and bridges with openings between 10 feet and 20 feet that require frequent inspections because of condition or hazard (that is, not meeting the requirements for Class C bridges). Multiple pipes with openings less than 20 feet between extreme ends are excluded from this and the following classifications.
C	Bridges with openings between 10 feet and 20 feet where an increased interval of inspection is justified on the basis of the following criteria determined in accordance with the NBIS: • Structural condition ratings are seven or higher (good condition with only minor problems). • Scour condition ratings are seven or higher (any previous scour problems have been corrected; bridge is no longer scour critical). • The bridge does not have fracture critical members requiring special attention. The estimated remaining life is more than 10 years; that is, the structure shows no appreciable signs of deterioration.
D	Bridges out of service because of condition, road closure, etc.
E	Bridges that are maintained and inspected under another jurisdiction: i.e., State, county, or other agency.
N	Bridge-like structures that have been brought to the Service Bridge Safety PM's attention by station or Regional personnel that were subsequently determined to be non-inventory structures.
X	Bridges that were included on the inventory at one time, but have been removed due to physical removal or replacement. Bridges in this category should have the prefix "(OLD)" added to their name and the bridge records should be "Archived."

Table 5.3-2 FWS Bridge Class

5.3.9.5 FWS Item 206 FWS Functional Level

Refer to Table 5.3-3

Level	Description
1	Serves the main circulatory tour or thoroughfare for visitors or critical administrative functions.
2	Provides optional side trips to areas of scenic beauty, picnic areas, etc. for visitors or serves secondary administrative functions.
3	Provides convenience for visitors or service personnel, but is not critical to the function of the Service. Reasonable alternate access exists.
4	Provides only truck or 4-wheel drive access and no public use. Serves lower priority administrative or management functions.

Table 5.3-3 FWS Functional Level

5.3.9.6 FWS Item 219 Estimated Remaining Life

You should code this item under the assumption that no reconstruction work is planned for the bridge. Table 5.3-4 provides additional guidance.

Remaining Life (years)	Description
> 10	Structure shows no appreciable signs of deterioration.
5-10	Structure is beginning to deteriorate. This structure is not in particular risk at the present, but inspectors anticipate that unless corrective action is taken, it will need to be reconstructed within the foreseeable future.
2-5	Structure has deteriorated to the point where we should begin to program funds for a replacement.
0-2	Structure has deteriorated to the point that it could be closed at any time, but is still able to function at the time of the inspection. This is generally considered to be a "critical" structure.
0	Structure should be closed immediately.

Table 5.3-4 Estimating Remaining Useful Life

5.3.9.7 FWS Item 220 FWS Structural Capacity Code

Refer to Table 5.3-5

Code	Description
A	Closed or in danger of collapse.
B	Deficient, may require repair or major rehabilitation, but can remain in service at reduced loads.
C	Sound, may require preventive maintenance or minor rehabilitation.
D	Good or better, only minor problems noted or no problems.

Table 5.3-5 FWS Structural Capacity Code

5.3.9.8 FWS Item 221 FWS Safety Features Code

Refer to Table 5.3-6

Code	Description
A	Functionally obsolete or dangerous.
B	Deficient, but can remain in use with vehicle and/or speed restrictions.
C	Safe with existing traffic.

Table 5.3-6 FWS Safety Features Code

5.3.9.9 FWS Item 227 Bridge Summary Condition

The Summary Condition is a weighted average consisting of:

- The bridge condition,
- An adjustment for the bridge width,
- An adjustment for meeting the needs of the station (station input),
- An adjustment for safety concerns, and
- A bottom line inspector's subjective correction, which is usually a neutral entry of 0.5 to get the weighted average centered on the following scale:
    - Excellent = 9.9 to 9.0
    - Very Good = 8.9 to 8.0
    - Good = 7.9 to 7.0
    - Satisfactory = 6.9 to 6.0
    - Fair = 5.9 to 5.0
    - Poor = 4.9 to 4.0
    - Critical = below 3.0

Calculate the Summary Condition using the applicable formula below:

- Culverts: (Item 218 + 5 x Item 62 + Item 61 + 2 x Item 67 + Item 236) / 10 + Item 237 + Item 238 + Item 239
- All Other: (Item 218 + Item 58 + 2 x Item 59 + 2 x Item 60 + Item 61 + 2 x Item 67 + Item 236) / 10 + Item 237 + Item 238 + Item 239

Where:

Item 58	=	Deck Condition Rating
Item 59	=	Superstructure Condition Rating
Item 60	=	Substructure Condition Rating
Item 61	=	Channel Condition Rating
Item 62	=	Culvert Condition Rating
Item 67	=	Structural Evaluation
Item 218	=	Approach Evaluation
Item 236	=	Deck Width Rating
Item 237	=	Meets Needs Adjustment
Item 238	=	Safety Concerns Adjustment
Item 239	=	Summary Condition Adjustment (usually 0.5)

5.4 WRITING GUIDELINES

The Service selects and retains architectural and engineering firms (A/Es) based on their expertise and their professionalism. A completed inspection report should convey this image and instill in the reader confidence in the A/E's work. Clear and concise language, full sentences, and correct grammar go a long way toward projecting a favorable image.

5.4.1 Be Clear

Use consistent terms throughout the report, in both text and figures.

While the use of engineering vernacular is necessary, keep in mind that non-technical people who probably do not have an engineering dictionary handy may read the inspection report. As a general rule regarding technical terminology: If you cannot find it in the *Glossary of Common Engineering and Construction Terms* in this handbook, do not use it.

Provide context when necessary to avoid ambiguity:

- The rocker bearings on the east abutment are rotated toward the backwall.
- The wingwall is tilted toward the north.

When listing a number of items in a sentence, use commas to separate the items, including before the word 'and:'

- The timber was secured by a bolt, nail, and lag bolt.
- The timber was secured by a bolt, hook and eye, and lag bolt.

5.4.2 Be Concise

Avoid long complicated sentences.

Use relatively short paragraphs to divide various thoughts and subjects.

Do not use qualifying clauses that overwhelm and confuse the subject of the sentence:

For example, instead of saying:

- It was observed that the timber is rotten, or
- It appears that the timber is rotten

state facts directly:

- The timber is rotten.

5.4.3 Be Correct

Be consistent and correct with subject-verb tense.

Do not misuse or misspell words. Have a dictionary handy and refer to it often.

Do use abbreviations for units of measure; however, do not use abbreviations when referring to a unit within the text:

- The pier is 100 ft long.
- The length of the pier was measured in feet.

(Note that there is a space between the number and the abbreviation.)

Do not use a period when abbreviating units of measure, except when abbreviating inches (in.) where it might be confused with the preposition 'in.'

Spell out integers of less than ten, unless units of measure or units of time are given. Always write integers of ten or greater in numeral form:

- A support beam is needed every 8 ft
- A total of eight beams will be needed
- A total of 10 beams are affected
- The reconstruction was completed 4 years ago

Avoid starting a sentence with an integer in numeral form.

Hyphenate numbers that you use as compound adjectives before a noun:

- The 15-year-old structure
- The 300-ft pier

Do not hyphenate numbers used elsewhere in a sentence:

- This structure is 15 years old
- The pile is 30 ft long

When referring to a group of numbered items, such as column lines, bents, or figures, avoid using the abbreviation 'no.' whenever practical:

- Bent 12 is preferable to Bent no. 12