Bridge Inspection Manual

Texas Department of Transportation

Revised March 2020

Manual Notice 2020-1

From: Graham A. Bettis, P.E., Director, Bridge Division

Manual: *Bridge Inspection Manual*

Effective Date: March 09, 2020

Purpose

This manual provides policy for bridge inspection personnel and helps ensure consistency in bridge inspection, rating, and evaluation.

Contents

Various chapters of this manual have been revised for consistency with the National Bridge Inspection Standards and to clarify TxDOT practices and policy related to the bridge inspection program. Historical information as well as other topics already covered in other TxDOT manuals have been removed from this manual.

Notable changes to this manual include revisions to clarify TxDOT policy related to:

- Follow-Up Actions / Recommendations made as part of an inspection.
- Securely storing and transferring bridge inspection information.
- Required documentation for scour critical bridges
- Required reporting to FHWA

Supersedes

This revision supersedes the February 2018 version of this manual.

Contact

For more information about any portion of this manual, please contact the Bridge Inspection Branch of the Bridge Division.

Archives

Past manual notices are available in a PDF archive.

Table of Contents

Chapter 1 — Introduction

Section 1 — About this Manual 1-2
Purpose 1-2
Contact 1-2

Chapter 2 — Bridge Inspection Program Overview

Section 1 — Texas Bridge Inspection Program 2-2
Section 2 — Primary References 2-3

Chapter 3 — Qualifications and Responsibilities of Bridge Inspection Personnel

Section 1 — Requirements 3-2
Federal Requirements 3-2
TxDOT Additional Requirements 3-3
Section 2 — TxDOT Bridge Inspection Personnel 3-4
Bridge Inspection Program Manager 3-4
Qualified Team Leaders - District Bridge Inspection Coordinators or Bridge Inspection Specialists in a District or Division 3-5
Other Bridge Inspection Specialists 3-6
Section 3 — Bridge Inspections by Consultants 3-7
General Requirements 3-7
Routine Bridge Inspections 3-7
Complex Bridge Inspections 3-8
Underwater Bridge Inspections 3-9
Non-Destructive Testing 3-9
Section 4 — Use of the Consultant Pool 3-10
Request for Consultant Inspection 3-10
Work Authorization Issuance 3-10
Managing Consultant Bridge Inspections 3-10
Evaluation of Bridge Inspection Consultant Firm and Project Manager 3-11

Chapter 4 — Field Inspection Requirements and Procedures

Section 1 — Types of Bridge Inspection 4-2
Section 2 — Consultant Inspection Requirements 4-3
General Requirements 4-3
Tools and Safety Equipment 4-3
Inspections Involving Railroads 4-3
Coordination with TxDOT District 4-3
Email and Correspondence 4-4

Quality Control Program 4-5
Section 3 — Initial Inspections 4-6
Overview 4-6
Section 4 — Routine Inspections 4-7
Overview 4-7
Inspection Equipment 4-7
Section 5 — Damage Inspections 4-9
Section 6 — In-Depth Inspections 4-10
Reasons for In-Depth Inspections 4-10
Section 7 — Fracture-Critical Inspections 4-11
Fracture-Critical Members 4-11
Redundancy 4-12
Inspection Procedures for Fracture Critical Members 4-13
Fatigue and Fatigue Fracture 4-14
Fatigue-Prone Details 4-14
Weld Details 4-16
Fatigue in Secondary Members 4-16
Proper Welding and Repair Techniques 4-17
FC Inspection Techniques 4-17
Section 8 — Underwater Inspections 4-18
Underwater Inspection Methods 4-18
Levels of Underwater Inspection 4-18
Underwater Structural Elements 4-19
Underwater Inspection Devices 4-19
Underwater Structural Materials 4-19
Section 9 — Special Inspections 4-20
Section 10 — Complex Bridge Inspections 4-21
Section 11 — Pedestrian Bridge Inspections 4-22
Section 12 — Element Level Data 4-23
Section 13 — Critical Inspection Findings (CIFs) 4-24
Overview 4-24
Section 14 — Bridge Emergency Response and Notification 4-25
Response and Notification Procedure 4-25
Definition and Background 4-26
Roles and Responsibilities 4-26
Immediate Response 4-26
Documentation and Record Keeping 4-27

Chapter 5 — Ratings and Load Posting

Section 1 — Condition Ratings 5-2
Definition of Condition Ratings 5-2
Recording Condition Ratings 5-2
Assigning Condition Ratings. 5-3
Section 2 — Appraisal Ratings 5-5
Definition of Appraisal Ratings. 5-5
Appraisal Ratings. 5-5
Section 3 — Load Ratings 5-9
Definition of Load Ratings 5-9
Determination of Load Ratings 5-9
Inventory Rating and Design Load Considerations. 5-9
Assigned Load Ratings. 5-10
Assumed Load Ratings. 5-10
Calculated Load Ratings 5-11
THD Design Supplement No. 1. 5-11
Customary Rating Procedures 5-13
Rating Concrete Bridges with No Plans 5-15
Ratings for Unusual Bridges 5-16
H- and HS-Load Ratings 5-17
Specialized Hauling Vehicle (SHV) Load Ratings. 5-17
Emergency Vehicle (EV) Load Ratings. 5-17
Substructure Load Ratings. 5-18
Section 4 — Legal Loads and Load Posting 5-19
Definition of State Legal Loads. 5-19
Load Posting 5-20
Procedures for Changing On-System Bridge Load Posting 5-23
Procedures for Emergency On-System Bridge Load Posting 5-25
Closure of Weak Bridges. 5-26
Procedures for Closing an Off-System Bridge 5-26
Procedures for Changing Off-System Bridge Load Posting 5-27

Chapter 6 — Routing and Permits

Section 1 — Role of District Permit Officers, District Bridge Inspection Coordinators, and the Texas Department of Motor Vehicles. 6-2
Section 2 — Permits 6-3
OverHeight and OverWidth Permits 6-3
Overweight Permit Loads 6-4
Superheavy Loads 6-4

Other Differences Between Overweight Permits and Operating Rating . . . 6-5
Overloads on Posted or Substandard Bridges . . . 6-5
Pre- and Post-Move Inspection . . . 6-6

Chapter 7 — Bridge Programming
Section 1 — Overview . . . 7-2

Chapter 8 — Bridge Records
Section 1 — Definition of Terms . . . 8-2
Bridge Record Terms . . . 8-2
Section 2 — Coding Guidelines . . . 8-6
Summary of Instructions . . . 8-6
Multiple-Pipe Culverts . . . 8-6
Data Quality and Timely Updating of Data . . . 8-6
Section 3 — Inspection Documentation . . . 8-8
Inspection File Contents - On System Bridges . . . 8-8
Inspection File Contents - Off System Bridges . . . 8-10
Section 4 — Calculations . . . 8-13
General Calculation Requirements . . . 8-13
Calculations for On-System Bridges . . . 8-13
Calculations for Off-System Bridges . . . 8-14
Section 5 — Data Submittal . . . 8-17
General Data Submittal Requirements . . . 8-17
Photographs . . . 8-17
Presentation of Documents . . . 8-18
On-System Data . . . 8-18
Off-System Data . . . 8-18
Summary Packages . . . 8-19
Scour Records and Reports . . . 8-19
Section 6 — The Bridge Record . . . 8-21
Section 7 — Open Records Requests . . . 8-22
Bridge Inspection Reports . . . 8-22
List of Inspection Consultants . . . 8-22
Section 8 — File Security . . . 8-23
Transferring Information to Local Bridge Owners . . . 8-23
Securing Hard Copy Bridge Inspection Files . . . 8-23
Disposing of Hard Copies . . . 8-23

Chapter 9 — Quality Control/Quality Assurance Program
Section 1 — Introduction of the Quality Control / Quality Assurance Program . . . 9-2

Quality Control/Quality Assurance Program. 9-2
Definitions 9-2
Goals 9-3
Section 2 — Bridge Inspection Program Organization 9-5
Bridge Inspection Program Organization 9-5
Bridge Division 9-5
District Bridge Section 9-5
Bridge Inspection Consulting Firm 9-6
Bridge Inspection Program Staff Requirements 9-7
TxDOT Bridge Inspection Program Staff 9-7
Bridge Division Staff. 9-7
District Bridge Section Staff 9-8
Bridge Inspection Consulting Firm Staff. 9-9
Section 3 — Quality Control 9-11
Quality Control Overview 9-11
QC Programmatic Elements 9-11
QC Programmatic Elements – Bridge Division. 9-11
QC Programmatic Elements – District Bridge Section 9-13
QC Programmatic Elements – Bridge Inspection Consulting Firm 9-14
Quality Control Review Elements. 9-14
QC Review Elements - Bridge Division Underwater (UW) and Fracture Critical (FC) Units . 9-14
QC Review Elements – District Bridge Section 9-16
QC Review Elements – Consulting Firm QC Program and Efforts 9-20
Section 4 — Quality Assurance 9-22
Quality Assurance Overview. 9-22
Quality Assurance Review 9-23
QA Review – Bridge Division Underwater and Fracture Critical Units. 9-23
QA Review – District Bridge Section 9-24
QA Review – Consulting Firm QC Program and Efforts 9-26

Appendix A — State and Federal Regulations
Bridge Inspection Guidelines A-1
Code of Federal Regulations Highlights A-1
U.S. Code for Bridge Inspection Highlights A-2
Texas Transportation Code Highlights A-2

Appendix B — Links to Coding Guidelines
Bridge Inspection Coding Guidelines. B-1

Appendix C — Quality Control (QC) Review Forms &

Contact Lists

QC Review Forms C-1
Contact Lists C-1

Chapter 1 — Introduction

Contents:

Section 1 — About this Manual

Section 1 — About this Manual

Purpose

This manual provides policy for bridge inspection personnel, provides a reference for consultants, and helps to ensure consistency in bridge inspection, rating, and evaluation.

This document outlines TxDOT’s policy and procedures related to the Statewide Bridge Inspection Program.

Contact

For more information about any portion of this manual, please contact the Bridge Inspection Branch of the Bridge Division.

Chapter 2 — Bridge Inspection Program Overview

Contents:

Section 1 — Texas Bridge Inspection Program

Section 2 — Primary References

Section 1 — Texas Bridge Inspection Program

The primary purpose of bridge inspections is to ensure public safety. The secondary purpose is to preserve the remaining life in our structures through the early detection and addressing of deficiencies.

Federal law governs the requirements of the TxDOT Bridge Inspection Program. The United States Code (23 U.S.C. 151) requires the Secretary of Transportation, in consultation with State transportation departments, to establish national bridge inspection standards for the proper safety inspection and evaluation of all highway bridges. These requirements are spelled out in the Code of Federal Regulations (Part 650, Subpart C) and govern the National Bridge Inspection Standards (NBIS) through purpose, applicability, definition of terms, qualification of personnel, inspection frequencies, inspection procedures, inventory procedures, and supporting references.

Federal Highway Administration (FHWA) has developed 23 Metrics for the Oversight of the National Bridge Inspection Program. These metrics are a risk-based assessment of the performance of state bridge inspection programs and compliance with the NBIS. Each year, TxDOT's Bridge Inspection Program is audited by the FHWA for compliance on these metrics.

TxDOT's Bridge Inspection Program has evolved since the first formal bridge inspection program in Texas began in 1975. Today, data recorded for Texas bridges exceeds that required by the FHWA. A detailed description of the data recorded is contained in the TxDOT Bridge Coding Guide.

Section 2 — Primary References

Many standards, manuals, and technical advisories have been developed over the years related to bridge inspection. Most of these are issued by the American Association of State Highway and Transportation Officials (AASHTO) or by the FHWA. The primary bridge inspection references are listed below:

- *AASHTO LRFD Bridge Design Specifications*
- *AASHTO Manual for Bridge Evaluation*
- *AASHTO Manual for Bridge Element Inspection*
- FHWA *Bridge Inspector's Reference Manual*
- FHWA Hydraulic Engineering Circular No. 18
- *Code of Federal Regulations*, 23 Highways Part 650, Subpart C - National Bridge Inspection Standards.
- FHWA Metrics for the Oversight of the National Bridge Inspection Program
- TxDOT Coding Guide

Chapter 3 — Qualifications and Responsibilities of Bridge Inspection Personnel

Contents:

Section 1 — Requirements

Section 2 — TxDOT Bridge Inspection Personnel

Section 3 — Bridge Inspections by Consultants

Section 4 — Use of the Consultant Pool

Section 1 — Requirements

Federal Requirements

The NBIS have specific qualification requirements for individuals working in the bridge inspection program of a state. These are summarized as:

- The individual in charge of each organizational unit (the Bridge Inspection Branch of the Bridge Division or the project manager for each firm under contract with TxDOT to perform bridge inspections) must:
  - be a Licensed Professional Engineer in Texas or have a minimum of ten years experience in NBIS bridge inspection experience; **and**
  - successfully completed an FHWA approved comprehensive bridge inspection training course.
- The individual in charge of any bridge inspection team (Team Leader), regardless of type, must:
  - have the same qualifications as above, **or**
  - be a Licensed Professional Engineer and have successfully completed an FHWA comprehensive bridge inspection training course, or
  - have a minimum of five years experience in NBIS bridge inspection and have successfully completed an FHWA approved comprehensive bridge inspection training course, **or**
  - have all of the following:

1. a bachelor's degree in engineering from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology; **and**
2. successfully passed the National Council of Examiners for Engineering and Surveying Fundamentals of Engineering examination;
3. two years of NBIS bridge inspection experience; **and**
4. successfully completed an FHWA approved comprehensive bridge inspection training course; **or**

  - have all of the following:

1. an associate's degree in engineering or engineering technology from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology; and
2. four years of NBIS bridge inspection experience; **and**
3. successfully completed an FHWA approved comprehensive bridge inspection training course.

- The individual charged with the overall responsibility for load rating bridges must be a registered professional engineer.
- An underwater bridge inspection diver must complete an FHWA approved underwater diver bridge inspection training course or an FHWA approved comprehensive bridge inspection training course.
- Any individual required to have successful completion of an FHWA approved comprehensive bridge inspection training course must also successfully complete an FHWA approved bridge inspection refresher course. This course shall be repeated every five years beginning on the first five-year anniversary of successful completion of the comprehensive training course.

TxDOT Additional Requirements

At a minimum, all bridge inspection activities performed by TxDOT and by TxDOT bridge inspection consultants must comply with Federal requirements. In addition to Federal requirements for bridge inspection personnel, some roles may require more specific job-related knowledge and skills such as:

- The use of breathing apparatus for underwater inspection.
- The various applicable requirements for inspection safety including applicable Occupational, Safety, and Health Administration (OSHA) requirements, such as requirements for working in confined spaces and at heights.
- Advanced computer skills related to bridge analysis.
- Geotechnical and hydrological knowledge.
- Familiarity with TxDOT bridge construction specifications and with current and historical TxDOT bridge designs.
- Expertise in the use of Non-Destructive Testing equipment.

TxDOT also has special requirements for consultants contracted to perform bridge inspection tasks. All firms and their staff acting as Project Managers and/or Team Leaders must be pre-certified. Further information on consultant requirements is presented later in this chapter in Section 3 titled “Bridge Inspection by Consultants.”

Section 2 — TxDOT Bridge Inspection Personnel

The following subsections briefly describe each TxDOT job position. Greater detail is given in the Human Resources Manual describing the various positions. TxDOT bridge inspection personnel must have the appropriate job classification, experience, and training.

Bridge Inspection Program Manager

This person heads the Bridge Inspection Branch of the Bridge Division. Under the general direction of the Director of the Bridge Division, the position has statewide responsibility for the Texas bridge inspection operations.

All the bridge inspection activities for Texas are under the general oversight of this position and includes major items such as:

- Oversee and maintain the Bridge Inspection Program in the Bridge Division and assist districts with bridge inspection-related matters.
- Coordinate fracture critical, underwater, and routine bridge inspection programs for on-system and off-system structures.
- Develop standards in conjunction with TxDOT divisions and districts and the Federal Highway Administration and ensure compliance with National Bridge Inspection Standards.
- Perform, review, and monitor detailed investigations, data collection, analyses and coordination of bridge related research, and recommend cost effective project level design for new, rehabilitated and reconstructed bridges.
- Prepare, evaluate, and perform final reviews of, contracts with consultants for routine, fracture critical and underwater inspections of bridges.
- Monitor consultants' progress and work quality; check invoices and associated documents; prepare supplemental agreements.
- Schedule, assign, and oversee bridge inspection activities.
- Oversee and perform bridge structural evaluations/analyses of structures; inspect bridges that have low appraisal and condition ratings or are recommended for closure.
- Determine and monitor the load carrying capacities of bridges.
- Maintain a list of bridges with critical inspection findings and coordinate with other Bridge Division staff, area engineers, and other district staff on such findings involving state-maintained bridges to have them posted for load, repaired, or closed.

- Recommend replacement, rehabilitation or repair of damaged bridges and coordinate with local officials on critical inspection findings involving structures not under state jurisdiction, to have them posted for load, repaired, or closed.
- Perform inspections on large, unusual, or complex structures as requested, including in response to emergencies.
- Recommend prioritization of bridge replacement, bridge rehabilitation, and repair of damaged bridges.
- Review contract development and related documents for execution.
- Oversee the processing and review of consultant selection documentation, contracts, and related documents.
- Interpret laws, rules, and regulations pertaining to professional services contracting to ensure compliance with department and governmental regulations.
- Chair or serve as a member of a contract selection team.
- Negotiate fees and budgets; develop and negotiate scopes of work; negotiate contract work schedules; and negotiate other contract agreements.
- Monitor contract performance; evaluate contract deliverables; review billing documentation; monitor consultants' compliance with contract terms; and prepare and deliver a written evaluation of consultants' performance.
- Serve as a project manager overseeing consultants performing advanced and complex engineering work.

Qualified Team Leaders - District Bridge Inspection Coordinators or Bridge Inspection Specialists in a District or Division

The TxDOT personnel assigned to these positions are directly responsible for bridge inspection operations within the division or district. Under general guidance from the Bridge Inspection Program Manager or from the District Engineer, they perform a variety of tasks. If the individual filling the District Bridge Inspection Coordinator position is not an engineer, then they must meet the minimum requirements of a Bridge Inspection Specialist.

Some of the major bridge inspection responsibilities and duties of this position may include:

- Implement and monitor the bridge inspection program in a district.
- Maintain and review files which indicate the condition of the bridge inventory and document compliance with bridge inspection policies.
- Inspect and appraise bridge structures according to the FHWA *Bridge Inspector's Reference Manual* and the TxDOT *Bridge Inspection Manual*.
- Coordinate the bridge load-posting program in the district

- Performs structural analysis and calculations on structures to certify load-carrying capacity.
- Conduct immediate inspection of damaged bridges, determine necessity of temporary or permanent repairs and notify maintenance personnel; make recommendations to close bridges.
- Implement and prepare Bridge Maintenance Program for a district.
- Prepare bridge inspection follow-up action worksheet for maintenance and give instructions for recommended actions.
- Monitor follow-up actions taken by maintenance.
- Work with county officials to load post, repair, or close bridges under the county's jurisdiction.
- Work with design and construction personnel on new construction projects to determine new structures to be added to the National Bridge Inventory.
- Determine extent of deterioration as the basis for planning bridge replacement and rehabilitation programs.
- Prepare and analyze summaries of bridge inspection data.
- Monitor inspection contract work authorization performance; evaluate deliverables; review billing documentation; monitor the consultant compliance with the terms of the contract; and evaluate the consultants’ performance.
- Perform fracture-critical bridge member inspections.
- Maintain bridge inspection and diving equipment.
- Research plan sets for use in underwater, fracture-critical, and routine bridge inspections.
- Perform underwater bridge inspection requiring diving.
- Ensure compliance with Occupational Safety and Health Administration (OSHA) standards.
- Perform Quality Control reviews on the work performed by consultants and other TxDOT staff.

Other Bridge Inspection Specialists

These TxDOT engineering technicians perform many of the bridge inspection tasks within the division or a district under direct supervision of the Bridge Inspection Program Manager, the District Bridge Inspection Coordinator, or the District Bridge Engineer. Duties are identical to those of the Qualified Team Leaders but are generally performed more in a support role. After sufficient experience is gained and these Specialist become Qualified Team Leaders they will then lead the work of other, less experienced staff.

Section 3 — Bridge Inspections by Consultants

General Requirements

All firms contracted by TxDOT to perform routine bridge inspections must be pre-certified in accordance with the requirements of the applicable portions of the Code of Federal Regulations given in Appendix A. In general, inspections performed under contract to TxDOT for inspection of both on- and off-system bridges will conform to the FHWA *Bridge Inspector's Reference Manual* [1], Services to Be Provided provisions in the TxDOT Bridge Inspection Contract, and this *manual*.

The qualifications listed below are the pre-certification requirements for Project Managers (PMs) and Team Leaders (TLs) engaged in the various types of bridge inspection contracts. Non-PM and non-TL requirements are also listed.

Routine Bridge Inspections

For routine bridge inspections, the firm must employ an individual to serve as Project Manager who meets the following qualifications:

- Is a Licensed Professional Engineer in the State of Texas; **and**
- Has a minimum of seven years of experience in performing NBIS bridge inspections or seven years experience managing NBIS bridge inspection contracts; **and**
- Has successfully completed the National Highway Institute (NHI) training course 130055 "Safety Inspection of In-Service Bridges." or training course 130056 "Safety Inspection of In-Service Bridges for Professional Engineers."

The bridge inspection Team Leaders employed by the firm must:

- be a Licensed Professional Engineer in the State of Texas, have successfully completed the National Highway Institute (NHI) training course 130055 "Safety Inspection of In-Service Bridges" or training course 130056 "Safety Inspection of In-Service Bridges for Professional Engineers", and have a minimum of one year NBIS bridge inspection experience; **or**
- have a minimum of five years experience in NBIS bridge inspection and have successfully completed the NHI training course 130055 "Safety Inspection of In-Service Bridges"; **or**

1. Bridge Inspector's Training Manual 90, FHWA, 1991.

- have all of the following:

1. a bachelor's degree in engineering from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology; **and**
2. successfully passed the National Council of Examiners for Engineering and Surveying Fundamentals of Engineering examination; **and**
3. two years of NBIS experience; **and**
4. successfully completed the NHI training course 130055 “Safety Inspection of In-Service Bridges”; **or**

- have all of the following:

1. an associate's degree in engineering or engineering technology from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology;
2. four years of NBIS bridge inspection experience; **and**
3. successfully completed the NHI training course 130055 “Safety Inspection of In-Service Bridges”.

Complex Bridge Inspections

For complex bridge inspections, such as those requiring fracture-critical inspections, the firm must employ an individual to serve as Project Manager who meets the following qualifications:

- have all of the following:

1. Is a Licensed Professional Engineer in the State of Texas; **and**
2. Has a minimum of seven years of experience in performing NBIS inspections, or a minimum of seven years of experience in the management of NBIS bridge inspection contracts, or a minimum of seven years of bridge design which includes a minimum of one year of experience in NBIS inspection of bridges considered complex; **and**
3. Has successfully completed the NHI training course 130055 “Safety Inspection of In-Service Bridges” or training course 130056 “Safety Inspection of In-Service Bridges for Professional Engineers”, and
4. Has Successfully completed the NHI training course 130078 “Fracture Critical Inspection Techniques for Steel Bridges”.

The bridge inspection Team Leaders employed by the firm must also be qualified and have:

- The same qualifications as required for the Project Manager, or

- The same qualifications as Team Leader for routine inspection and have all of the following:

1. Six years of NBIS bridge inspection or design experience, including one year of NBIS inspection or design of bridges considered as complex; **and**
2. Successfully completed the NHI training course 130055 “Safety Inspection of In-Service Bridges” or, if an engineer, training course 130056 “Safety Inspection of In-Service Bridges for Professional Engineers”; and
3. Has successfully completed the NHI training course 130078 “Fracture Critical Inspection Techniques for Steel Bridges”.

Underwater Bridge Inspections

For underwater bridge inspections, the firm must employ an individual to serve as Team Leader who meets the following qualifications:

- Meets the qualification requirements of a Team Leader for Routine Inspections, **and**
- A commercial diver certification, **and**
- A minimum of two years of underwater bridge inspection experience

NOTE: Underwater inspection team members not serving as the Team Leader must have successful completion of NHI training course 130055 or an engineer course 130056, or course 130091.

Non-Destructive Testing

For non-destructive testing on structural steel members of in-service structures, the firm must employ an individual who meets the following qualifications:

- A minimum of five years of experience in performing various types of non-destructive testing on structural steel members of in-service structures, **and**
- Certification by the American Society for Non-Destructive Testing (ASNT) as a Level 2 NDT Inspector.

Section 4 — Use of the Consultant Pool

Consultant firms who are under contract with the Bridge Division to perform bridge inspections in Texas are available for use by the districts. New inspection contracts are executed every two years by the Bridge Inspection Branch of the Bridge Division. The necessary procedures that must be followed by the districts to utilize these consultants is described below.

Request for Consultant Inspection

The district must initially provide the following three items to the Bridge Inspection Branch of the Bridge Division with a lead time of at least three months:

- A request in writing
- The total numbers of bridges to be inspected broken out by county
- An identification of the bridges as being on- and/or off-system

Work Authorization Issuance

The Bridge Inspection Branch of the Bridge Division will send to the district a blank Work Authorization along with a fee schedule for the recommended consulting firm who has been contacted. The district then proceeds with the following:

- Complete the Work Authorization and fee schedule.
- Include description of where the bridge inspections will take place (multiple counties may be included in the same Work Authorization).
- Complete the fee schedule with the number of bridges to be inspected by type.
- Include the total dollar amount on the Work Authorization.
- Contact the consultant firm and agrees to a termination date for the completion of the inspections, which is entered on the Work Authorization.

The Bridge Division will execute the Work Authorization and notify the district and the consulting firm once the Work Authorization has been executed. The consultant may begin bridge inspections upon execution of the Work Authorization.

Managing Consultant Bridge Inspections

To ensure that bridge inspections are performed in a competent and timely fashion, the district will perform oversight of the work by following these steps:

- Verify the bridge inspection firm's Project Manager and individual Team Leaders against the list provided by the Bridge Inspection Branch of the Bridge Division.
- Periodically visit the firm’s inspection teams in the field to verify team composition and to observe actual inspections during the field portion of the Work Authorization.
- Refer to Section 3 “Quality Control” of Chapter 9 of this manual for quality control requirements and procedures that must be followed by the District post-consultant inspection submittal.
- When invoices are submitted to the district by the consultant, they should be reviewed and submitted to the Finance Division as soon as possible (TxDOT has a maximum of 30 days to process an invoice from the date it is received to avoid payment of interest).
- The district should monitor the amount of completed consultant bridge inspections to ensure that additional structures that might be added as the work progresses will have sufficient funds in the Work Authorization.
- If additional funds or time is needed to complete the Work Authorization, a request for a Supplemental Agreement must be made to the Bridge Inspection Branch of the Bridge Division at least 2 weeks before the termination of the initial Work Authorization.

Evaluation of Bridge Inspection Consultant Firm and Project Manager

When the bridge inspections covered by the Work Authorization are finished, the district work authorization manager (typically the District Bridge Inspection Coordinator) completes an evaluation of the consultant as required by the Professional Engineering Procurement Services Division.

Chapter 4 — Field Inspection Requirements and Procedures

Contents:

Section 1 — Types of Bridge Inspection

Section 2 — Consultant Inspection Requirements

Section 3 — Initial Inspections

Section 4 — Routine Inspections

Section 5 — Damage Inspections

Section 6 — In-Depth Inspections

Section 7 — Fracture-Critical Inspections

Section 8 — Underwater Inspections

Section 9 — Special Inspections

Section 10 — Complex Bridge Inspections

Section 11 — Pedestrian Bridge Inspections

Section 12 — Element Level Data

Section 13 — Critical Inspection Findings (CIFs)

Section 14 — Bridge Emergency Response and Notification

Section 1 — Types of Bridge Inspection

There are eight recognized types of bridge inspections in Texas:

- Initial (Inventory)
- Routine (Periodic)
- Damage
- In-Depth
- Fracture Critical
- Underwater
- Special (Interim)
- Complex

Section 2 — Consultant Inspection Requirements

General Requirements

Inspect each bridge in the inventory in accordance with this manual, and record the findings electronically in the Bridge Inspection Management System. Uphold a reasonable standard of care for all inspections. Reasonable standard of care for routine safety inspections is understood to imply an attentive visual and auditory inspection aided by routine inspection tools as afforded by routine means of access.

Tools and Safety Equipment

Inspection tools are listed in the *FHWA Bridge Inspector's Reference Manual*, 2015, in Section 2.4 - “Inspection Equipment.”[1] Use hard hats, safety vests, traffic cones, vehicle safety lights, and “BRIDGE INSPECTION AHEAD” or “SURVEY CREW AHEAD” signs for all bridges being inspected. Conduct inspections with minimal disruption to traffic flow. Inspections shall be done in a safe manner and in accordance to guidelines in *FHWA Bridge Inspector's Reference Manual*, 2015.

Inspections Involving Railroads

Notify the District at least ten (10) working days in advance of any work in which any person or equipment will be within twenty-five (25) feet of any railroad track. The District will coordinate with the appropriate Railroad Representative to determine if a flagman needs to be present and whether the Engineer needs to implement any special protective safety measures. Complete, and have certification of completion of the on-line Safety Awareness Course.

Coordination with TxDOT District

Inspect the bridges within the assigned inspection area only and verify the bridge locations. Notify the District Bridge Inspection Office a minimum of 48 hours in advance with the locations and dates when inspections will be performed. Verify the bridge location on the map(s) furnished by the State. If an error or omission is discovered, notify the District Bridge Inspection Office. Verify that the coordinates in the database are accurate, meaning located on the bridge. If the coordinates are missing, or not accurate, then collect new coordinates. Collect the coordinates by a hand-held GPS unit and provide the results in a decimal format. Sub-meter, differentially corrected data is not required. An Inspection Team Leader that has been approved by the Bridge Division must be present at each bridge site during the bridge inspection.

1. FHWA Bridge Inspector's Reference Manual, 2002.

New bridges located by the Engineer require approval from the District Bridge Inspection Office before an identification number is assigned, the bridge is inspected, or the bridge is added to the inventory. Create a new bridge record in the Bridge Inspection Management System, and input all data required by the NBI to insure a complete and accurate record. Inventory or inspect a bridge that is under construction only with the approval of the District Bridge Coordinator. Do not delete any bridge record from the inventory without prior approval of the District Bridge Inspection Office.

When the inspections are finished, complete reports within 60 days from the date of inspection. Enter condition ratings and other coding changes, along with reports and sheets as detailed below using the Bridge Inspection Management System. However, bring to the attention of the District Bridge Inspection Office immediately, both verbally and in writing, the bridges needing special consideration (which includes ANY bridge in which the engineer lowers the condition rating to a 4 or lower, or recommends closure). Notify the Bridge Division Inspection Branch in writing only. If the inspection indicates significant deterioration of any structural element, include documentation such as notes, measurements, sketches and photographs. Verify that coding for Item 113 - Scour matches the scour documentation on file for the bridge according to the current inspection conditions and TxDOT scour documentation requirements.

If a critical finding is discovered, send the notification, along with the supporting documentation, to TxDOT's “Dropbox Service” at https://ftp.dot.state.tx.us/dropbox/. When using the “Dropbox”, use BRG_Critical_Finding@txdot.gov as the notification email address. Notify the District Bridge Inspection Office by email that a critical finding has been sent to the Bridge Division.

If there is a recommendation to change the status of an on-system bridge structure (load restriction, revision of an existing load restriction or the removal of a load restriction), submit the recommendation to the Bridge Division as soon as the calculations are complete, but not more than 30 days after the date of the inspection. Include in the recommendation to change the load posting the recommended posting level, the most recent Bridge Inspection Record, load rating calculations, pictures and the as-built plans (if available) used in the calculation of the load posting recommendation. Send the recommendation, along with the supporting documentation, to TxDOT's “Dropbox Service” at https://ftp.dot.state.tx.us/dropbox/. When using the “Dropbox”, use BRG_Load_Posting@txdot.gov as the notification email address. Notify the District Bridge Inspection Office by email that a load posting recommendation has been sent to the Bridge Division.

Email and Correspondence

Maintain an Internet email address and notify the Inspection Branch of the Bridge Division of any address changes immediately. The Bridge Division will use email for notification of all bulletins, policy changes, and updates sent out to the members of the Statewide Consultant Pool for Bridge Inspections. The State routinely will send emails to the Engineer in an effort to keep the Bridge Inspection operations uniform throughout the state.

Quality Control Program

Have a Quality Control program in place to ensure the work of the Engineer and that of the sub-providers is of high quality. Submit a plan detailing the program to the Inspection Branch of the Bridge Division for review and approval prior to beginning of any contracted work. This program may be reviewed and audited by the Bridge Division on a random basis.

Section 3 — Initial Inspections

Overview

The *Code of Federal Regulations* contains the National Bridge Inspection Standards (NBIS). The NBIS require inventory information to be entered into the State's database within 90 days after the bridge is placed in service (begins carrying traffic).

District Bridge Inspection Coordinators are responsible for ensuring that initial inspections are performed on new bridges or when existing bridges are first entered into the database. This inspection provides a basis for all future inspections or modifications to a bridge. An initial inspection is also referred to as the inventory inspection since this is the inspection that facilitates adding the new bridge to the National Bridge Inventory. It can also be thought of as the first routine inspection.

Note initial deficiencies which might not have been present at the time of construction. Note changes in the condition of the site, such as:

- Erosion
- Scour
- Regrading of slopes

Area Engineers must notify the District Bridge Inspection Coordinator when the bridge is opened to traffic.

The opening of a new bridge, particularly an off-system bridge, is a good time to ensure that a copy of the bridge plans are included with the Bridge Records described in Chapter 8 of this manual. Texas law[1] requires a governmental entity that owns a bridge on a public road submit a copy of the final structural plans to TxDOT within 31 days after construction or rehabilitation is completed. In addition, it is important to ensure that all new bridges over waterways have a scour evaluation and load rating included with the bridge record submitted to TxDOT.

Prepare the electronic bridge record as a result of the Initial Inspection. A detailed description of the Bridge Record contents is given in Chapter 8 of this manual, Bridge Records. Be sure to include the required series of photos.

1. Submission of Bridge Design Plans to Department, Texas Transportation Code, Section 201.804.

Section 4 — Routine Inspections

Overview

Routine inspections are those regularly scheduled, performed, and recorded in accordance with all the procedures described in Chapter 8 of this manual, Bridge Records and the Coding Guide. Conduct these inspections every twenty-four months for most bridges, and every forty-eight months for some concrete culverts. Some bridges need more frequent inspections when conditions warrant. Criteria for the 48-month inspections of concrete box culverts is given in the Coding Guide[1].

Inspection Equipment

The equipment needed for routine bridge inspections usually includes the following:

- Cleaning tools including wire brushes, screwdrivers, brushes, scrapers.
- Inspection tools including pocket knife, ice pick, hand brace, bit, and increment borer for boring timber elements, and chipping hammer.
- Visual aid tools including binoculars, flashlight, magnifying glass, dye penetrant, and a mirror.
- Basic measuring equipment including thermometer, center punch, and simple surveying equipment.
- Recording materials such as appropriate forms, field books and cameras.
- Safety equipment including rigging, harnesses, scaffolds, ladders, Bosun’s chairs and a first-aid kit.
- Miscellaneous equipment should include C-clamps, penetrating oil, insect repellant, wasp and hornet killer, stakes, flagging, and markers.

A more complete description of the usual inspection equipment can be found in Chapter 2 Section 4 of the *Bridge Inspector's Reference Manual*.[2]

Some inspections may significantly interfere with normal traffic movement and could endanger the bridge inspectors and traveling public. Coordinate these inspections with District personnel to ensure that appropriate traffic control measures are taken.

The underside of some bridges cannot be reached for inspection by conventional ladders. Perform these inspections using a vehicle with under-bridge platforms. TxDOT owns and operates several of these vehicles. Small boats are also available.

1. Coding Guide, TxDOT, 2010. Bridge Inspector's Reference Manual, FHWA, 2015
2. *Bridge Inspector's Reference Manual*, FHWA, 2002 and 2006.

Coordinate in advance with the Inspection Branch of the Bridge Division to use any Division specialized access equipment.

Section 5 — Damage Inspections

Perform damage inspections as a result of collision, fire, flood, significant environmental changes, or loss of structural support. These are not recurring, planned inspections but are performed on an as-needed basis.

Prepare a report for each Damage Inspection. Include in the report, at a minimum, the following:

- photos and measurements documenting any damage
- load ratings verifying capacity after event (when applicable)
- channel profiles (when applicable)
- repair recommendations
- load restriction recommendations (when applicable).

Include all documentation from Damage Inspections in the permanent bridge inspection record in the Bridge Inspection Management System.

Section 6 — In-Depth Inspections

Reasons for In-Depth Inspections

In-Depth Inspections are supplementary and limited in nature. They are used to identify deficiencies not easily detected by routine means and methods. Specialized equipment might be required for access or material investigation. These inspections do not satisfy the NBIS requirements of routine, underwater, nor fracture critical inspections. These are usually planned, recurring inspections addressing specific features but can be performed as a follow-up to other types of inspection.

Examples of In-Depth Inspections are:

1. Ultrasonic Testing performed on hanger assemblies of a multi-girder bridge every 5 years.
2. Inspection of the grouting ducts in precast, post-tensioned segmental box beam bridge performed every 10 years.
3. Closing of the roadway on a bridge to allow for a chain-drag inspection of the deck performed every other year, off the routine cycle.

Section 7 — Fracture-Critical Inspections

Fracture-Critical (FC) Inspections limited to non-redundant load path steel tensile stress areas. These inspections are typically performed every 24 months but can be performed more frequently if conditions warrant. A Fracture Critical Inspection is a hands-on (within arm's length of the component) inspection of a fracture critical member or member components. It may include visual and other nondestructive evaluation. Methods of Non-Destructive Evaluation (NDE) of steel members may include dye penetrant, magnetic particle, or ultrasonic techniques.

Fracture-Critical Members

The most common types of FC members are tension flanges and parts of webs of flexural members such as beams and girders. Tension members of trusses, particularly eyebars, which commonly make up the lower chords of old trusses, can also be FC. Other tension members of trusses, such as diagonals, are also FC. Concrete members are not often used in tension. The design of flexural concrete members with multiple reinforcing bars precludes the possibility of abrupt failure due to their internal redundancy.

The following circumstances determine FC members:

- Steel girders in two-girder bridges not evaluated for system redundancy in accordance with the TxDOT Bridge Design Manual are FC. Fracture of lower flanges in positive moment areas (mid spans) and upper flanges in negative moment areas (over supports) can be expected to lead to collapse of the structure. However, cracks over interior supports may lead to subsequent higher positive stresses in the spans with no catastrophic collapse.
- The majority of steel caps are FC. The exceptions are those where support columns or multiple cap members provide load path redundancy.
- A floorbeam is FC if one or more of the following conditions exist: Flexible or hinged connection to support girders, or floorbeam spacing greater than 14 feet, or no stringers connected to the floorbeams supporting the deck, and stringers not continuous over floorbeams.
- Lower chords of trusses are FC. This determination is based on the fact that most truss bridges employ only two trusses and most are simple-span.
- Do not define secondary members such as diaphragms and stiffeners as FC. They are rarely used in a manner where failure would lead to a structure collapse. However, use caution in evaluating certain truss members that may appear to be secondary when, in fact, their attachment to main FC members can provide a starting place for the main member failure. The only exceptions to this are diaphragms used in horizontally curved fracture critical units. These elements are almost always classified as primary members due to the forces they are carrying and are also considered to be FC.

- The tied arch is a variation of the through arch with one significant difference. In a through arch, the horizontal thrust of the arch reactions is transferred to large rock, masonry, or concrete foundations. A tied arch transfers the horizontal reactions through a horizontal tie which connects the ends of the arch together, like the string on an archer's bow. As can be imagined, the tie is a tension member. If the string of a bow is cut, the bow will spring open. Similarly, if the arch tie fails, the arch will lose its compression and will collapse. The tie girder is FC.

Redundancy

In order for a bridge to be classified as fracture critical, it must have an element that if failed would cause total or partial collapse of the bridge. With this in mind, it is crucial to recognize and identify the type redundancy present in a bridge. Redundancy allows the load that was previously carried by the failed member to be redistributed to other members, thus avoiding failure or collapse.

There are three basic types of redundancy present in bridges:

- Load path redundancy
- Structural redundancy
- Internal Redundancy

Load Path Redundancy

Bridges with three or more main load-carrying members or load paths are considered load path redundant. If one member were to fail, load has a better chance of being safely redistributed to the other members, and bridge failure may not occur. An example of load path redundancy is a multi-girder bridge. Definitive determination of load path redundancy requires structural analysis with members eliminated in turn to determine resulting stresses in the remaining members. In extreme cases where girder spacing exceeds fifteen feet, a three girder bridge will also be classified as fracture critical.

Structural Redundancy

Bridges which provide continuity of load path from span to span are referred to as structurally redundant. Bridges where girders are continuous across internal span two-girder bridge designs are structurally redundant. In the event of a member failure, loading from that span can be redistributed to the adjacent spans, and bridge failure may not occur. The degree of structural redundancy can be determined through computer programs which model element failure. Some truss bridges have structural redundancy, but this can only be determined through analysis.

Internal Redundancy

Internal redundancy exists when a bridge member contains three or more elements that are mechanically fastened together so that multiple independent load paths are formed. Failure of one member element would not cause total failure of the member. Internal redundancy of a member can be decreased or eliminated by repairs that involve welding. The welds provide paths for cracks to travel from one element to another.

Presently TxDOT only considers load path redundancy for the classification of fracture critical members.

Inspection Procedures for Fracture Critical Members

Inspection procedures begin with proper advance planning. Important planning aspects, usually based on an office review of the structural plans, include:

- Identify possible FC members.
- 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 a snooper truck, ladders, bucket truck, air monitoring device, or climbing gear.
- Many structures designed for urban situations with necessary complex alignment geometries result in FC members. Proper inspection of these bridges may require closing a traffic lane and require a night time inspection due to high ADT, during normal business hours. Coordinate safe traffic control in advance with the local district and Area Engineer offices and their Safety Review Team.
- Use a railroad flagger coordinated with the proper railroad company if the structure crosses or is within 25 ft. of a railroad track centerline. Every individual entering a railroad right-of-way is required to complete, and have certification of completion of the on-line Safety Awareness Course. This course can be found at www.contractororientation.com.
- Working over railroad tracks requires significant coordination with rail companies. The issuance of inspection work containing FC members that cross railroad tracks will be done so as to allow for an eight (8) month lead time prior to the earliest inspection due date to accommodate this extra coordination. Beginning at the one-month anniversary of the execution of a Work Authorization for inspection of these bridges, and continuing every subsequent monthly anniversary until all bridges are inspected, an update from the consultant will be provided to the TxDOT Project Manager as to the status of obtaining the Right-of-Entry permits. TxDOT will in turn report monthly to the FHWA the status of obtaining such permits for in-house and consultant inspections. This reporting will continue until inspections are completed.
- Identify and make available any necessary special tools and equipment that may be required in addition to the normal inspection gear. A high-pressure washer is often useful in cleaning areas where a large accumulation of debris might obscure view of FC areas. Non-destructive test equipment such as ultra-sonic or ultra-sound devices may be advantageous in some areas, particularly inspection of box-type bent caps and pin-and-hanger connections.

The actual field inspection of all FC members consists of several steps. The most important step is a visual inspection. The inspector notes any:

- Visual cracks and their direction and location
- Evidence of rust, which may form at a working crack
- Weld terminations in a tension area
- Interrupted back-up bars used for built-up-member fabrication
- Arc strikes, scars from assembly cables or chains, or other physical damage
- Cross-section changes which may cause a sudden increase in the stress pattern

Fatigue and Fatigue Fracture

Members subjected to continued reversal of stress, or repeated loading such that a range of change in stress occurs, are subject to a behavior called fatigue. Members that have a relatively constant, steady stress are not subject to fatigue. The term has been in use for almost a century and is currently defined by the American Society of Testing Materials (ASTM 1823-96e1) as "the process of progressive localized permanent structural change occurring in a material subjected to conditions that produce fluctuating stresses and strains at some point or points and that may culminate in cracks or complete fracture after a sufficient number of fluctuations." Fatigue can result in:

- Loss of strength
- Loss of ductility
- Reduced service life

Fatigue fractures are the most difficult to predict since conditions producing them are often not clearly recognizable. Fatigue occurs at stress levels well within the elastic range, that is, less than the yield point of the steel, and is greatly influenced by minor imperfections in the structural material and by fabrication techniques.

Fatigue fracture occurs in three distinct stages:

- Local changes in atomic structure, accompanied by sub-microscopic cracking
- Crack growth
- Sudden fracture

Fatigue-Prone Details

Fatigue fracture almost always begins at a visible discontinuity, which acts as a stress-riser. Typical examples are:

- Design details such as holes, notches, or section changes

- Flaws in the material such as inclusions or fabrication cracks
- Poor welding procedures such as arc strikes, gouges and start-stops
- Weld terminations

Certain structural details have been long recognized as stress-risers and are classified as to their potential for damage. These details appear in the current *AASHTO Bridge Specifications*[1].

Proper consideration of member detail and sizing during design will help control stress level and, thus, control crack growth. The stress range, or algebraic difference in the maximum and minimum stress, also is important. The most effective way to control cracking and eventual fracture is sensible detailing. Details such as out-of-plane bending in girder webs and certain weld configurations can cause crack propagation and fracture.

Design for fatigue also includes observing a Fracture Control Plan. The Fracture Control Plan identifies the person responsible for assigning fracture-critical designations. It establishes minimum qualification standards for welding personnel and fabrication plants. It also sets forth material toughness and testing procedures. The specific members and affected sections are also identified in the plan. During fabrication, these members are subject to special requirements.

A fatigue failure is classified as a brittle fracture and is always an abrupt fracture. A brittle fracture is distinguished from a ductile fracture by absence of plastic deformation and by the direction of failure plane, which occurs normal to the direction of applied stress. Other failure surfaces due to high stress are usually at an angle to the direction of the stress and are often accompanied by a narrowing or necking of the material. Brittle fracture failures have no narrowing or necking present to indicate potential failure.

The three main contributing factors to brittle fracture are:

- Stress level
- Crack size
- Material toughness, sometimes called fracture toughness

Small, even microscopic cracks can form as a result of various manufacturing and fabrication processes. Rate of propagation, or growth, of cracks also depends on the stress level and the material toughness. Material toughness is the ability of a material to resist when stressed or the ability to absorb energy and plastically deform without fracturing. This resistance is primarily determined by chemical composition and to some extent by the manufacturing processes.

Usually, higher strength steels are more susceptible to brittle fracture and have lower toughness. Toughness can be improved by techniques such as heat treatment or by quenching and tempering or modifying the steel composition with varying amounts of alloys.

1. LRFD Bridge Design Specifications, AASHTO, 2017

Weld Details

Be familiar with the characteristics of good and poor structural details and identify those details in the field. Welding creates the details most susceptible to fatigue and fracture. Therefore, it is imperative to recognize features prone to FC failure.

Major FC problem areas are at weld discontinuities or changes in geometry such as:

- Toes of fillet welds
- Weld termination points
- Welds to girder tension flanges from other connections such as stiffeners or diaphragms
- Ends of welded cover plates

Welded cover plates on rolled beams were a very common detail until fatigue failures began to be recognized by bridge engineers. Whether the weld is terminated or continued around the end of the cover plate, the condition is at best Category E fatigue detail, which has a greater susceptibility to crack.

Weld attachments to a girder web or flange can reduce fatigue strength as the length of the attachment increases. Welds two inches or less fall in Category C and those greater than four inches in length reduce to Category E. Such details are commonly used to attach diaphragms for lateral stability and wind bracing to main structural members, either at the flange or web. Details such as run-off tabs and back-up bars may also provide possible stress riser discontinuities if not smoothed by grinding after removal.

Be familiar with acceptable and unacceptable fillet weld profiles in order to recognize potential problem areas in the field.

Fatigue in Secondary Members

Secondary members may also have fatigue problems. For instance, main girder stress reversal may induce vibrations in lateral bracing or diaphragms. In many cases the number of stress reversals in the secondary member is a magnification of those stresses in the main member. The attachment of plates to a girder web may cause out-of-plane bending in the web, a situation not usually considered by the designer.

In general, secondary members themselves are not subject to a FC inspection. However, some secondary members, even though designed only as secondary members, such as lateral wind bracing in the lower plane of a girder system, will act as primary members. These cases generally occur in curved or heavily skewed structures. A curved bridge will have twisting or torsional effects due to the live loads that are partially resisted by the diagonal lateral wind bracing. These braces, particularly those near supports, should be inspected for possible fatigue cracks.

Proper Welding and Repair Techniques

Proper welding of structural steel members is a tedious process under the very best of conditions, which are usually found in the fabrication shop. Closely examine any field welding, whether it is a welded girder splice, retrofit detail, or repair, for visible problems. Many shop splices are accomplished by automatic welding machines under controlled conditions and can be smoothly ground to eliminate surface discontinuities. Field splicing operations are subject to exposure to the elements and difficulties in stabilizing the pieces to be joined. In addition, the welding is usually done by hand and, therefore, subject to human error. Fortunately, welded field splices for bridges constructed with state supervision in Texas have always been subject to careful inspection and must be done by certified welders. The welded field splices for these bridges are usually of the same quality as shop splices and are often further inspected by radiographic (X-ray) techniques.

Be aware of problems that may arise from the use of improper field repair processes. Often a well-intentioned repair can actually make a member even more susceptible to a fatigue fracture.

FC Inspection Techniques

FC inspection techniques may include non-destructive testing to determine the condition of a structural member. There are several types available, including radiographic, ultrasonic, dye penetrant, and magnetic particle inspection. All are acceptable methods, but each has limitations and may not be suitable for a particular situation. One single technique may not be sufficient to assess damage and a combination of more than one may be advisable. Perform these types of inspection only if you have undergone the proper training.

The selection of the type of non-destructive testing method for a particular location is a function of the detail. For instance, potential cracks at the ends of welded cover plates are often inspected by the use of radiographic methods. Cracks in pins are best inspected by ultrasonic techniques. Subsurface defects such as inclusions may be found by magnetic field irregularities, and cracks adjacent to fillet welds at tee-joints are usually inspected by dye penetrant. These methods are all described in more detail in the *Bridge Inspector's Reference Manual*[1].

1. Bridge Inspector's Reference Manual, FHWA, 2002 and 2006.

Section 8 — Underwater Inspections

Underwater Inspections are performed every sixty months or more frequently if conditions warrant. Perform an Underwater Inspection on structures where the submerged portions of the structure have a history of water depths of at least four feet year round or where the submerged elements are in less than four feet of water, but wading would be unsafe due to channel bottom conditions, high current or localized scour.

Underwater Inspection Methods

There are currently three methods used to conduct Underwater Inspections. These are:

- Wading -- The most basic of the three methods, wading requires only a probing rod and wading boots to be effective. This is performed during Routine Inspections.
- Scuba diving -- A method that allows a more detailed examination of substructure conditions below the waterline. The diver has freedom of movement and may carry a variety of small tools with which to probe or measure.
- Surface Supplied Air Diving -- Involves the use of sophisticated diving equipment and a surface supplied air system. This inspection method is well suited when adverse conditions will be encountered, such as high water velocity, pollution, and unusual depth or duration requirements.

The choice of which method to employ depends largely on accessibility and the required inspection detail.

Levels of Underwater Inspection

Standard levels of inspection originated in the U.S. Navy. Three levels have been established as the result of the process through time.

- Level I -- A simple visual or tactile (by feel) inspection, without the aid of tools or measuring devices. It is usually employed to gain an overview of the structure and will precede or verify the need for a more detailed Level II or III inspection.
- Level II -- A detailed inspection which involves physically cleaning or removing growth from portions of the structure. In this way, hidden damage may be detected and assessed for severity. This level is usually performed on at least a portion of a structure, supplementing a Level I.
- Level III -- A highly detailed inspection of a structure which is warranted if extensive repair or replacement is being considered. This level requires extensive cleaning, detailed measurements, and testing techniques that may be destructive or non-destructive in nature.

Underwater Structural Elements

The elements of a bridge structure that may be located below the water line are abutments, bents, piers, and protection systems. Bents are distinguished from piers in that they carry the loads directly to the foundation rather than using a footing.

Abutments normally do not require an Underwater Inspection, but in rare instances may be continuously submerged. Although usually founded on piles or drilled shafts, abutments occasionally rest on spread footings. Scour is almost always the primary consideration when an underwater abutment inspection is being conducted. Local scour is often detectable during diving inspections, although sediment will eventually refill a scour hole between the events that cause the scour. More general scour, or channel degradation, will usually be undetectable to the diver and must be determined from known channel cross sections or historical data.

Underwater Inspection Devices

Divers may use several types of sounding or sensing devices in underwater investigations. The most common device is the black-and-white fathometer. It uses sound waves reflected from the channel bottom and records the depths continuously. It provides an inexpensive, effective means of recording channel depths, but does not detect a refilled scour hole. Another device is the color fathometer. It uses different colors to record different densities and in this way often detects scour refill. Other devices include ground penetrating radar, which works well for shallow water but has limited usefulness in murky water, and fixed instrumentation, which is reliable but requires periodic monitoring and resetting to be effective.

Underwater Structural Materials

Piers and bents, if located in a navigable waterway area, are often subject to material defects, collision damage and scour. Concrete is the most common type of material encountered in Underwater Inspections, followed by timber, steel, and masonry. Common defects in concrete substructures include cracking, spalling, laitance, and honeycombing. Minor or even moderate damage to concrete can be tolerated if it does not endanger the reinforcing. Corrosion of the reinforcing can lead to serious difficulties.

Timber has frequently been used for piles, especially in fenders or protection systems. The most common type of damage to timber members is from biological organisms, such as fungus, insects, and marine borers. In order to control infestations, timber is usually treated to poison the wood to block a food source for organisms. In time the treatment may leach out of the wood or the treatment layer may be penetrated. Pay particular attention to the area of the waterline and the vicinity of connectors where this type of damage may occur.

Section 9 — Special Inspections

Special Inspections are typically performed to monitor a known or suspected deficiency at a specific location. These inspections can be recurring or performed on an as-needed basis. These inspections are limited in nature and do not satisfy the NBIS requirements of routine, underwater, nor fracture critical inspections.

Example of Special Inspections are:

- Monitoring the settlement of a specific bent every 6 months.
- Monitoring the condition of a specific pin and hanger assembly every 3 months until the bridge is replaced.
- Performing a one-time up-close inspection of a bridge deck soffit on a flyover using the Snooper due to conditions discovered in a recent routine inspection.

Section 10 — Complex Bridge Inspections

A complex bridge inspection is one that involves inspection of a complex bridge. Texas Department of Transportation considers cable-stay, suspension, tied-arch, movable, pontoon bridges, as well as any bridge containing suspenders as complex bridges. These types of structures require specialized access equipment and inspection procedures as well as inspector qualifications. Chapter 3 of this manual details the requirements for training and experience of individuals performing complex bridge inspections.

Section 11 — Pedestrian Bridge Inspections

Pedestrian-only bridges over On-System routes are to be inventoried, added to the database, and receive a routine safety inspection every 48 months. If conditions warrant, the inspection frequency may be increased to 24 months or 12 months. These inspections are generally considered the same as any other grade-separation inspections and will be included with other routine bridge inspection work in the district.

Section 12 — Element Level Data

Texas Department of Transportation requires the collection of elemental data for all on-system structures and any off-system structures on the National Highway System as well as all off-system bridges owned by Harris County. The element level data should be collected in accordance with the latest edition of the AASHTO *Manual for Bridge Element Inspection*.

Section 13 — Critical Inspection Findings (CIFs)

Overview

Critical findings are defined in the NBIS as "a structural or safety related deficiency that requires immediate follow-up action or inspection." The following criteria are used to define a critical finding:

- Condition rating of 3 or less for any one of Items 598 (Deck), 59 (Superstructure), 60 (Substructure), 61 (Channel Protection), or 62 (Culvert)
- A coding of 2 or less for Item 113 (Scour Critical Bridges)
- New or updated (lower) load posting recommendations or other load posting needs, such as missing/incorrect signs. (Recommendations to remove a load posting or to increase the limits of a posting are not reason for CIFs. However, if there is a missing sign and a recommendation for a higher posting limit occurring simultaneously at a bridge, that would qualify as a CIF.)

TxDOT will act on a Critical Finding within 30 days of receiving notification via the Bridge Division e-mail address (BRG_Critical_Findings@txdot.gov). The actions in the 30 day timeframe are inclusive of immediate actions needed, as well as necessary follow-up items. This is not meant to imply that all actions will be completed within 30 days. Rather, the appropriate action will depend on the specific situation and conclusions will vary. The safety threat will be addressed within 30 days which might mean a full or partial closure instead of a timely repair.

Bridge Division will continue to track each individual Critical Finding until all follow-up actions are completed. The deadline for completing all follow-up items will be 24 months from the official notification date. Bridge Division submits a Critical Findings Tracking spreadsheet to FHWA quarterly.

Section 14 — Bridge Emergency Response and Notification

Response and Notification Procedure

Each district will communicate bridge related emergencies that result in traffic restrictions lasting four or more hours to Administration, FHWA, TxDMV and Bridge Division. Email groups have been established that include the appropriate Administration, Bridge Division, and FHWA personnel. Include the following information and contacts:

- Structure number
- Facility carried
- Feature crossed
- Date of damage
- Approximate time of incident
- Current status of bridge
- Damage summary
- Photos of damage (three maximum)
- Actual Clearance (Include for over-height vehicular impacts only)
- Signed Clearance (Include for over-height vehicular impacts only)
- Estimated Load Height (Include for over-height vehicular impacts only)

To:

- BRG_Notification
- District Engineer
- tx-fhwabridge@dot.gov
- MCD_SizeWeight@TxDMV.gov
- MCD_Permit-Restriction@TxDMV.gov
- DMV_ENF_MC@TxDMV.gov

The District Designee, along with maintenance personnel, will work together to fill out either the Bridge Incident Reporting Form or the Permit Restriction Application. Provide the District Permit Coordinator the form for review and submission to TxDMV and Bridge Division. Events warranting an emergency response should be reported within 8 hours of the incident.

Definition and Background

Bridge vehicular and non-vehicular emergencies create significant threats to public safety and highway infrastructure. Vehicular impact events include over-height impacts, column and rail impacts, and deck punch-through incidents. Non-vehicular emergencies include, but are not limited to, flooding, fires, and slope failures. These events result in serious damage to bridges and cause traffic congestion due to travel lane restrictions. Similarly, critical findings from bridge inspections can result in full or partial closures that significantly affect traffic. Any impact or other emergency to a bridge resulting in traffic restrictions expected to last longer than 4 hours is considered a reportable incident and must be reported. It is imperative that the proper response and notification procedure be implemented, in order to communicate bridge emergencies in a way that is both uniform and effective. An effective response procedure will quickly inform authorities of these events, help restore traffic restrictions to normal conditions, and expedite the rehabilitation of bridge structures.

Roles and Responsibilities

District Designee: The District Engineer will designate one primary and one backup person responsible for the overall response and notification of bridge emergencies that result in full or partial closures. This will typically be the District Bridge Engineer and District Bridge Inspection Coordinator but may vary from District to District. The District Designee will send an email with either vehicular or non-vehicular impact information to TxDOT Administration, FHWA, TxDMV and Bridge Division within 8 hours of occurrence. However, the first priority should be the onsite emergency response. Do not delay the field response for the sake of completing this notification process.

In the case of a vehicular impact, the Designee is responsible for completing the Bridge Incident Reporting Form and sending it to the District Permit Coordinator. A copy of the form should also be uploaded to the Bridge Inspection Management System as part of the official record. For non-vehicular impacts, the Designee will complete the Permit Restriction Application form and send it to the District Permit Coordinator. Designee should also follow the criteria for reporting closures as covered in the Highway Conditions Reporting System (HCRS) Manual at http://gsd-ultraseek/txdotmanuals/hcr/hcr.pdf.

Immediate Response

The District Designee, in conjunction with maintenance personnel, will conduct an initial assessment of the bridge site. For vehicular impacts, investigate the impact location and consider any reduction in structural capacity. Consider closing traffic lanes under the bridge due to the possibility of falling debris and/or risk of partial or total collapse. The Bridge Division is available to assist with all aspects of the post-impact assessment and repair procedures. For non-vehicular incidents, observe the extent of damage and the need for traffic restrictions. Bridge Division will assist Districts with the assessment of damage and determination of potential traffic restrictions and provide engineering support as necessary. District Permit Coordinator is responsible for reviewing both the

Bridge Incident Reporting Form and Permit Restriction Application, then sending it to the Texas Department of Motor Vehicles as soon as the bridge has been assessed and the lane/load limits determined (24 hours maximum).

Documentation and Record Keeping

TxDMV Bridge Incident Reporting Form: Use for vehicular incidents. This form contains vehicle identification information and details including the location and time of accident. The Texas Department of Motor Vehicles will use the information to issue potential fines and penalties for oversize/overweight, permit violations. More importantly, the TxDMV will alter or restrict the routing of permitted loads as appropriate. This form must be submitted to TxDMV by the District Permit Coordinator with a cc to the Bridge Division.

TxDMV Permit Restriction Application: Use for non-vehicular incidents. This form contains information about bridge location and dimensions, and allows for a description of the incident or situation that necessitates a load permit restriction. This form must be submitted to TxDMV by the District Permit Coordinator with a cc to the Bridge Division.

Bridge Impact Summary Spreadsheet: The Bridge Division maintains an impact summary spreadsheet documenting all vehicular impacts throughout the state. This information will be used to provide the Texas Legislature, Commission, and TxDOT Administration with detailed accounts for all bridge-related impact events.

Any repair plans submitted to remedy the damage should be uploaded to the Bridge Inspection Management System. If the condition rating needs to be lowered for Items 58-62 or 65, then a Damage Inspection Report should be completed and appropriate steps completed in the Bridge Inspection Management System to document the damage and substantiate the change in the rating.

Chapter 5 — Ratings and Load Posting

Contents:

Section 1 — Condition Ratings

Section 2 — Appraisal Ratings

Section 3 — Load Ratings

Section 4 — Legal Loads and Load Posting

Section 1 — Condition Ratings

Definition of Condition Ratings

Condition ratings based on field inspections are snapshots in time and cannot be used to predict future conditions or behavior of the structure. However, condition ratings based on inspections along with written comments by a field inspector act as the major source of information on the status of a bridge. Condition ratings also help planning for necessary repairs or modifications. In addition, the condition ratings are used as flags when performing over-weight permit evaluations.

Condition ratings are one-digit numbers given by the field inspector to the various components of a bridge. They are objective and not opinions.

Condition ratings reflect deterioration or damage and do not measure design deficiency. For instance, an old bridge designed to a low load capacity but with little or no deterioration may have excellent condition ratings while a newer bridge designed to modern loads but with deterioration will have lower condition ratings.

Channel, waterway, riprap, and other channel protection components under and directly upstream and downstream of the bridge are often related in assignment of a condition rating for the channel.

Recording Condition Ratings

Condition ratings are entered on the Bridge Inspection Record. Seven component items are covered on the form, and each lists four to 11 elements. The Item Numbers relate to the entry of the data in the electronic Bridge Inventory Files, the detailed instructions for which are contained in the Coding Instructions of the Coding Guide.

- Deck (Item 58)
- Superstructure (Item 59)
- Substructure (Item 60)
- Channel (Item 61)
- Culverts (Item 62)
- Approaches (Item 65)
- Miscellaneous (Used for informational purposes only. No condition ratings are reported to the National Bridge Inventory.)

The rating must equal or exceed the minimum values for each element of a component (shown to the left of the element description on the form). Each element is rated based on independent consideration. For instance, lower or deficient secondary members (bracing, diaphragms, etc.) in a superstructure may cause the Superstructure (Item 59) component to have a poor rating even though the main members show no significant deterioration. The summary Component Rating must be the least of the element ratings comprising that component.

However, Deck (Item 58) component is independent of its associated element ratings such as joints, railings, wearing surface, etc.

Do not base condition ratings on the known presence of chlorides in the deck, superstructure, or substructure concrete or low compressive strengths from core samples. Determine the condition rating solely on the observed, materials-related, physical condition of the component at the time of the inspection.

The Bridge Inspection Electronic Form has space for fully supportive written comments for each of the above features. These comments are required for any condition rating of 7 or lower. The form includes a brief summary of the description of each level of rating. More detail on the condition rating for each item number is given in the Coding Guide.

Assigning Condition Ratings

Evaluate each element separately based on general considerations for assignment of the ten levels of condition ratings. However, other deficiencies may affect the condition if they are directly related. For instance, instability of an approach embankment may reduce the abutment condition rating but not reduce the Superstructure condition rating.

Consider only permanently installed repairs when assigning condition ratings. Permanent implies that the repair has returned the damaged or deteriorated element to a condition as good as or better than the remainder of the bridge. For instance, a steel beam damaged by an over-height load that reduced the load capacity of the beam is considered permanently repaired when a section is replaced or a bent section is straightened by proper techniques and no residual cracks can be found. The strength of the repaired member is the primary concern. Modifications and repairs that simply improve the appearance of a damaged member are not considered to improve the condition rating.

Do not consider as temporary any repair which remains in place without further project activity for a period of 4 years. Consider the repair permanent and evaluate the structure accordingly. Four years from the repair date is a reasonable amount of time for a District to move a project forward. If the District requires more time, then submit a written justification for continuing to classify a repair as temporary.

Do not consider for condition rating any components with temporary repairs, even though functioning. For instance, a support or brace to a partially undermined column could be susceptible to damage from another flood; therefore, make the condition rating on the basis that the support is not present. Do not consider temporary repairs in determining condition ratings because they directly affect the calculations of the sufficiency ratings described in Chapter 7.

Condition ratings are still a matter of judgment, which should be made based on experience, knowledge, and consistency with other structures with the same deterioration.

Section 2 — Appraisal Ratings

Definition of Appraisal Ratings

In making appraisal ratings, consider the field condition, waterway adequacy, geometric and safety configurations, structural evaluation, and safe load capacity of the bridge. Appraisal ratings should be consistent among appraisers given the same field information, project plans, materials, and geometric and waterway data.

Evaluate seven features for their effect on the safety and serviceability of the bridge and its approaches. The intent is to compare the bridge to a new structure built to current standards. Different roadway standards - such as width, grade, and alignment - exist for the various roadway systems in Texas.

Appraisal Ratings

The detailed instructions for entering data are contained in the Coding Guide. The seven features are:

- Traffic Safety Features (Item 36)
- Structural Evaluation (Item 67)
- Deck Geometry (Item 68)
- Underclearances (Item 69)
- Bridge Posting (Item 70)
- Waterway Adequacy (Item 71)
- Approach Roadway Alignment (Item 72)

Four of the seven appraisal ratings are automatically generated from other inspection and inventory data, and include Structural Evaluation (Item 67), Deck Geometry (Item 68), Underclearances (Item 69), and Bridge Posting (Item 70). The remaining three items, Traffic Safety Features (Item 36), Waterway Adequacy (Item 71), and Approach Roadway Alignment (Item 72) are based upon observations and historical data collected during routine inspection events. The following paragraphs summarize instructions for coding the above seven features.

Traffic Safety Features (Item 36). This feature applies only to bridges carrying vehicular traffic. It is a measure of the adequacy of traffic safety features in meeting current acceptable standards, which reflect modern design criteria. Four digits are assigned that approximately measure the adequacy the traffic safety feature. The first digit is for the bridge railings, the second digit is for the guardrail to bridge railing transitions, the third digit is for approach guardrails, and the fourth digit is for guardrail terminals. Each of these four parts to Item 36 is assigned a value of 1 if it meets currently acceptable standards, a value of 0 if it does not, or a value of N if not applicable.

Collision damage or deterioration is not considered when assessing traffic safety acceptability. Assume that any damage to traffic safety features will be repaired in the near future. Note rail, transition, guardrail, or guardrail termination damage or deterioration on the Bridge Inspection Record.

Bridge class culverts do not require coding of traffic safety features if the headwall of the culvert is 30 ft or more from a traveled lane. With zero to three ft of fill over a culvert and acceptable guard fence installed over the culvert and along the approaches, bridge railings and transitions are not required. Culverts with less than three ft of fill may also have guard fence instead of bridge railing if steel posts are properly attached to the culvert.

Acceptable traffic safety standards have been developed using the current AASHTO Standard Specifications for Highway Bridges[1] and the AASHTO *Guide for Selecting, Locating, and Designing Traffic Barriers*.[2]

Current acceptable bridge railing details are shown in the Bridge Railing Manual.

Structural Evaluation (Item 67). This feature considers major structural deficiencies and is based on the condition ratings of the Superstructure (Item 59), the Substructure (Item 60), and the Inventory Rating (Item 66) as related to the Average Daily Traffic (Item 29). Items 66 and 29 are correlated in a table included with the detailed instructions for Item 67 in the instructions for the Coding Guide.

The Structural Evaluation Appraisal Rating should generally be no higher than the lowest of the Superstructure or Substructure condition ratings or the Inventory Rating - ADT correlation.

Deck Geometry (Item 68). This feature applies only to bridges that carry vehicle traffic. Roadway widths are measured perpendicular to traffic direction and between faces of railings, curbs, and median barriers. Mountable curbs are ignored if 4 in. or less high.

The Deck Geometry appraisal rating is determined from a four-part table included with the detailed instructions for Item 68 in the Coding Guide. This table relates the ADT (Item 29), Bridge Roadway Width (Item 51), and Number of Lanes (Item 28).

This appraisal rating is further controlled by another table in the instructions for Item 68 in the Coding Guide that relates the Minimum Vertical Clearance Over Bridge Roadway (Item 53) and the Functional Classification (Item 26) of the facility the bridge carries.

1. Standard Specifications for Highway Bridges, AASHTO, 1994.
2. Guide for Selecting, Locating, and Designing Traffic Barriers, AASHTO, 1977.

The Deck Geometry appraisal rating is the lowest number based on width, lanes, or vertical clearance and functional classification of the highway on which the bridge is located.

Underclearances (Item 69). This feature is a measure of both vertical and lateral clearances for any roadway or railroad passing under the bridge being rated. The vertical clearance is measured down from the lowest part of the bridge to the lower traveled roadway surface (excluding paved shoulders) or top of railroad rails.

The Underclearances appraisal rating is determined from two tables included with the detailed instructions for Item 69 in the Coding Guide. These tables relate the Vertical Underclearance (Item 54) and the Functional Classification (Item 26) of the lower roadway or railroad, and the Lateral Underclearances Right and Left (Items 55 and 56) of the lower roadway or railroad.

The Underclearances appraisal rating is the lowest number based on the vertical and lateral clearances and the functional classification of the lower roadway or railroad.

Bridge Posting (Item 70). This feature compares the load capacity of the bridge to the state legal load. At this time, the term state legal load is a load equivalent to the conventional HS-20 load pattern shown in Figure 5-1. Therefore, any inventory rating less than HS-20 requires further evaluation of the bridge. Bridges are normally not load restricted unless the capacity is less than an HS-20 Operating Rating. See the section of this chapter titled Legal Loads and Load Posting for more detail on the need for load restriction.

Specific criteria for coding this appraisal rating are included with the detailed instructions for Item 70 in the file titled Coding Guide, which has five posting levels. The Bridge Posting appraisal rating is 5 if the Operating Rating (Item 64) is more than HS-20. The Bridge Posting appraisal rating has a value of 0 to 4 depending on the percentage the Operating Rating is below the state legal load, which for this item is HS-20 loading.

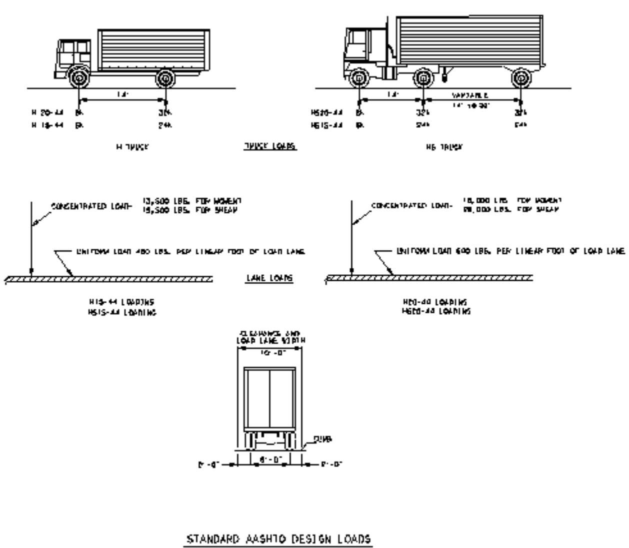


Figure 5-1. Standard AASHTO Design Loads

Waterway Adequacy (Item 71). This appraisal feature applies to all bridges carrying vehicle traffic over any type of waterway. It represents the capacity of the waterway opening to carry peak water flows and is based on the criteria included with the detailed instructions for Item 71 in the Coding Guide, which has eight values. The eight values range from 2, meaning the bridge is frequently overtopped by flood waters, to 9, meaning that chance of overtopping is remote.

The estimated potential for traffic delays from flood overtopping is also considered when assigning a value to Waterway Adequacy. The design flood is the maximum water flow that can pass under bridge for a given recurrence frequency, usually expressed in years.

When hydraulic information is unavailable, the design flood is assumed to be equal to the frequency of overtopping the bridge. Local officials and residents can often provide information on the frequency of overtopping.

Approach Roadway Alignment (Item 72). This feature applies to adequacy of the approach roadway to safely carry vehicle traffic considering both horizontal and vertical alignments.

Specific criteria are included with the detailed instructions for Item 72 in the instructions in the file titled Coding Guide. Approach curvature, lane and shoulder widths, surface roughness, and sight distances all enter into the evaluation of this appraisal rating. For bridges on crest or sag vertical curves, consider also headlight and stopping sight distances.

When approach alignment is questionable, drive the alignment on the approaches to the bridge in order to estimate an advisory safe speed with due consideration given to minimum sight distances. Advisory speed on approach curves is the speed above which more than usual concentration and effort on the part of a normal driver would be required to remain safely in the proper lane. Advisory speed limit should be the posted advisory speed if one exists.

Section 3 — Load Ratings

Definition of Load Ratings

The Load Rating is a measure of bridge live load capacity and has two commonly used categories:

- Inventory Rating, as defined by the current AASHTO *Manual for Bridge Evaluation*,[1] is that load, including loads in multiple lanes that can safely utilize the bridge for an indefinite period of time.
- Operating Rating, defined by the same manual, is the maximum permissible live load that can be placed on the bridge. This load rating also includes the same load in multiple lanes. Allowing unlimited usage at the Operating Rating level will reduce the life of the bridge.

Determination of Load Ratings

Currently, all Inventory and Operating Ratings are expressed in terms of an equivalent HS-truck as shown in `Figure 5-1`. Prior to about 1995, many ratings were for an equivalent H-truck, `also shown in Figure 5-1`. The H-truck directly corresponds to single-unit trucks, which used to be common on rural highways. Today, even rural Farm- or Ranch-to-Market highways and many off-system highways are exposed to much larger semi-trucks; therefore, the HS-truck is more realistic.

Inventory Rating and Design Load Considerations

The Inventory Rating (Item 66) can be initially estimated to be at least equal to the design loading if no damage or deterioration exists and the original design was made using an HS or HL-93 (LRFR) load pattern. Many old plans have a design loading shown as H-20 S-16, which some raters have misinterpreted as meaning H-20. AASHTO replaced the H-20 S-16 designation in 1965 with the HS-20 designation. Re-rating these bridges using LF procedures will usually increase the Inventory Rating above HS-20. Rating bridges designed between 1946 and about 1958 by current LF procedures may result in significantly different values than the original design loading. Although the plans may say designed to H-20 S-16 and THD Supplement No. 1, the bridge may rate significantly less than HS-20 loading. This difference is due to the more liberal effects of THD Design Supplement No. 1 described below.

There are three acceptable approaches to determining inventory and operating ratings: assigned, assumed, and calculated.

1. Manual for Bridge Evaluation, AASHTO, 2011.

Assigned Load Ratings

Per the September 29,2011 FHWA Assigned Load Rating Memo, FHWA has determined that the Inventory and Operating level ratings may be assigned based on the design load when:

1. The bridge was designed using either the AASHTO Load and Resistance Factor Design (LRFD) or Load Factor Design (LFD) methods to at least HL-93 or HS-20 live loads, respectively; and
2. The bridge was built in accordance with the design plans; and
3. No changes to the loading conditions or the structure condition have occurred that could reduce the inventory rating below the design load level; and
4. An evaluation has been completed and documented, determining that the force effects from State legal loads or permit loads do not exceed those from the design load; and
5. The checked design calculations, and relevant computer input and output information, must be accessible and referenced or included in the individual bridge records

TxDOT has updated its policy on the Load Rating Statement (form 2495) for assigned ratings to clarify that the following conditions must be met for assigned load ratings to be applicable:

1. The bridge must be designed using AASHTO Load and Resistance Factor Design (LRFD) or Load Factor Design (LFD) methods to at least HL-93 or HS-20 live loads, respectively.
2. The principal structural elements of Items 58, 59, 60, and 62 must have a condition rating greater than or equal to 5.
3. The bridge elements in their current state continue to maintain structural capacity equal to the original design.

For assigned load ratings, the coding for items 63 and 65.1 must be "C - Assigned rating based on LRFD reported in tons" or "A - Assigned rating based on LFD reported in tons" respectively.

Assumed Load Ratings

Assumed load ratings can be utilized for concrete structures that do not have plans. These types of ratings are based on field conditions of the structure and documented engineering judgement. The following conditions must apply in order for an assumed load rating to be applicable:

1. The bridge has been carrying unrestricted traffic for at least 4 years,
2. The bridge shows no signs of significant distress,
3. The simple span bridge's span-to-depth ratio of the main members does not exceed approximately 20,
4. Construction details conform to specifications at the time of the estimated construction, and
5. Appearance of the bridge indicates that construction was performed by a competent builder.

Refer to the “Rating Concrete Bridges with No Plans” subsection below for more detailed information.

Calculated Load Ratings

Traditionally Inventory or Operating Ratings were determined using either Load Factor (LF) or Allowable Stress (AS) methods. Load Factor is to be used for all on-system bridges, except for timber bridges. It is difficult to assign an ultimate strength to timber. Therefore, both on- and off-system timber bridges are rated using only AS methods. AASHTO has included Load and Resistance Factor Rating (LRFR) as an acceptable method for load rating bridges. Calculate load ratings using LRFR methods if the bridge was designed using the Load and Resistance Factor Design (LRFD) methodology.

Load Factor may be used for all off-system bridges, but AS should only be used for timber and masonry off-system bridges.

A Load Rating Summary Sheet should be completed for all calculated load ratings.

THD Design Supplement No. 1

In 1946, the Bridge Division of TxDOT (then called THD) issued what is commonly called THD Supplement No. 1.[1] Texas was influential in the development of the AASHTO Bridge Design Specifications. However, not all the Texas opinions were immediately accepted by the AASHTO Bridge Committee, which includes all states. As a result, TxDOT used the supplement for a number of years to amend portions of the 1944 and 1949 *AASHTO Standard Specifications for Highway Bridges*[2][3] for use in Texas.

The first version of Supplement No. 1 was dated June 1946.[4] The second version of Supplement No. 1 was dated September 1953[5] and included only those items of the 1946 version that had not been incorporated into the 1949 *AASHTO Standard Specifications for Highway Bridges*.[6] The primary subjects of the supplement that affected bridge design can be summarized as follows:

- **Crown Width Bridges.** The 1944 AASHTO Bridge Specifications[7] required curbs on all bridges. Texas initiated the concept of crown-width bridges with the following: “On non-

1. THD Supplement No. 1, TxDOT, September 1953.
2. Standard Specifications for Highway Bridges, AASHTO, 1944.
3. Standard Specifications for Highway Bridges, AASHTO, 1949.
4. THD Supplement No. 1, TxDOT, June 1946.
5. THD Supplement No. 1, TxDOT, September 1953.
6. Standard Specifications for Highway Bridges, AASHTO, 1949.
7. Standard Specifications for Highway Bridges, AASHTO, 1944.

restrictive bridges the curbs may be omitted provided the guard fence or an equivalent member is carried continuously through the structure." The 1949 AASHTO Bridge Specifications[1] allowed the condition of no curbs with certain additional width limitations. Texas continued the crown-width, no-curb concept with the retention of the provision in the second version of Supplement No. 1 dated September 1953.[2]

- **Design Overload.** The 1944 AASHTO Bridge Specifications[3] required an overload to be considered for all bridges designed for less than an H-20 (40,000 lbs) or H-20 S-16 (72,000 lbs) loading, now called HS-20 loading. The overload was to be the design truck (usually H-15) increased by 100 percent, but without concurrent loading of adjacent lanes, thus allowing single-lane load distribution. The allowable stress was to also be increased to 150 percent of the basic allowable. Texas modified this provision specifically to apply the same overload to truss counter members for all design loadings. Truss counters are those members that, for some positions of live load, will change from tension to compression. If a truss was designed H-15, H-20, or H-20 S-16, the overload was applied in determining the size of counter member.
- **Lane Load Negative Moments.** The 1944 AASHTO Bridge Specifications[4] required for H-10, H-15, or H-20 lane loads an additional concentrated load in one other span in a continuous unit positioned to produce maximum positive and negative moments. Texas limited the distance between the concentrated loads for the lane load to a maximum of 30 ft. This is probably based on the fact that the AASHTO 1944 bridge specifications[5] did not require an additional concentrated load for H-20 S-16 lane loadings. The H-20 S-16 truck loadings have a second axle spaced from 14 to 30 ft from the first heavy axle. This is probably the rationale for the limit of 30 feet in THD Supplement No. 1.[6] The 1949 AASHTO bridge specifications[7] made the lane loading negative moment requirement the same for HS-trucks. However, the 1953 THD Supplement No. 1[8] continued modifying the provision for continuous spans subjected to lane load by limiting the spacing between the additional concentrated load to 30 ft. This limit had the effect of reducing the lane load negative moment maximums for some continuous spans. The 30-ft limit may also have been in recognition that the second large axle for an HS-load pattern is spaced at a maximum of 30 feet from the first large axle, or it might have been because the lane load approximately represents a train of trucks with a headway distance of 30 feet between trucks. Placing the second concentrated load at least 30 ft from the first instead of a maximum of 30 ft would have been more logical. Current specifications do not limit the distance between the two loads for negative moment lane loadings.

1. Standard Specifications for Highway Bridges, AASHTO, 1949.
2. THD Supplement No. 1, TxDOT, September 1953.
3. Standard Specifications for Highway Bridges, AASHTO, 1944.
4. Standard Specifications for Highway Bridges, AASHTO, 1944.
5. Standard Specifications for Highway Bridges, AASHTO, 1944.
6. THD Supplement No. 1, TxDOT, June 1946.
7. Standard Specifications for Highway Bridges, AASHTO, 1949.
8. THD Supplement No. 1, TxDOT, September 1953.

- **Impact Load Provision.** The 1944 AASHTO Bridge Specifications[1] required that the shortest length of adjacent spans in a continuous unit be used for the negative moment impact value. In 1949, AASHTO changed this to the current provision of using the average length of the adjacent spans. Both versions of THD Supplement No. 1[2,3] changed the impact provision for continuous units or other structures where discontinuous lane loadings are applied to be the loaded length as indicated by the influence line for the section of member considered. This change had the effect of slightly increasing the impact value.
- **Special Axle Loads.** The 1946 THD Supplement No. 1[4] added a provision that no axle load in excess of 24,000 lbs should be considered in the design of floor slabs. It further required that either a single 24,000-lb axle or two 16,000-lb axles spaced four ft apart must be used for the design of H-20 and H-20 S-16 bridge floors (slabs, grids, timber) instead of the 32,000 lb axle. The provision was dropped in the 1953 THD Supplement No. 1[5] because the 1949 AASHTO Bridge Specifications[6] included the provision specifically for concrete bridge slabs. The AASHTO Bridge Specifications further limited the 24,000-lb axle to slab spans under 18 ft and the two 16,000 lb axles for slab spans over 18 ft. This provision had the effect of reducing the design load for many slab spans designed during that time. It has been found that some beams have been designed in Texas using the single 24,000-lb axle. It is believed to be an error for beams to have been designed this way. For this reason, carefully evaluate any plans prepared during the period between approximately 1949 and 1961 with a design load of H20 or H20 S-16 that also had the THD Supplement No. 1[7] notation.

Customary Rating Procedures

When a bridge was originally designed, the designer often had to select the next size of reinforcing bar, size of steel beam, or thickness of cover plate to meet the design stress criteria. Sizes that were larger than the theoretically perfect size of member result in Inventory Ratings significantly higher than the design loading. However, the design loading and date of original construction are important parts of the bridge data since they often provide a basis for determining initial routing of overload permits.

If the original design was made using an H-load, such as H-15 or H-20, then the equivalent HS Inventory Rating will usually be significantly less numerically. For example, an H-15 design might rate at HS-12. However, this difference means that the total inventory HS-load capacity is 43,200 lb

1. Standard Specifications for Highway Bridges, AASHTO, 1944.
2. THD Supplement No. 1, TxDOT, June 1946.
3. THD Supplement No. 1, TxDOT, September 1953.
4. THD Supplement No. 1, TxDOT, June 1946.
5. THD Supplement No. 1, TxDOT, September 1953.
6. Standard Specifications for Highway Bridges, AASHTO, 1949.
7. THD Supplement No. 1, TxDOT, September 1953.

(two 19,200 pounds axles and one 4,800 lb axle totaling 21.6 tons) as compared to the H-15 design of 30,000 pounds (15 tons).

Determine the original design load from a review of the bridge plans if available. If the structure essentially matches an old TxDOT standard bridge, then the design load for that standard can be used for the Design Load (Item 31). Enter appropriate notation about this in the `Electronic` Bridge Record, and update the electronic Bridge Inventory File. However, use caution accepting the design load in plans that used the THD Design Supplement No. 1[1][2] due to circumstances described above.

When AASHTO first introduced the use of Grade 60 reinforcing steel in the 1970 Interim Bridge Design Specifications,[3] the allowable of 24 ksi for Grade 60 was assigned based approximately on the ratio of the Grade 60 ultimate strength to that of Grade 40. Thus, the AS procedures were still compatible in factor of safety for concrete members.

LF rating procedures usually assign a dead load factor of 1.3 and live load factors of 2.17 (when computing Inventory Ratings) and 1.3 (when computing Operating Ratings). The resulting stresses or bending moments are compared to the yield of steel members or the ultimate capacity of concrete members also considering appropriate phi strength reduction factors.

Note that the value of 2.17 is the dead load value of 1.3 times 1.67. The load factor of 1.3 accounts for a 30 percent increase in all loadings, either dead or live, so as to provide a uniform safety factor. The factor of 1.67 accounts for the variability of live load configurations other than a standard HS-load pattern and further provides for potential overloads or loads in excess of the State Legal Loads.

Specific analysis of structures for over-weight loads, particularly superheavy permits over 254,300 pounds, is usually done with a load multiplier consistent with the restricted speed of the vehicle. Commonly this factor is about 1.1, with total stresses compared to an allowable of 75 percent of the yield for steel bridges or 75 percent of the ultimate capacity for concrete bridges including prestressed beam bridges. This procedure is explained more fully in Chapter 6, Routing and Permits.

Do not consider temporary repairs for Inventory or Operating Ratings. However, take temporary repairs into account when assigning the operational status code of Item 41 to the structure. Temporary repairs are to be considered for the operational status code only until a more permanent repair is made. Do not use temporary repairs for more than four years. The Inventory Rating directly affects the Sufficiency Rating, so therefore do not assign any weight to temporary repairs in the Load Rating calculations.

1. THD Supplement No. 1, TxDOT, June 1946.
2. THD Supplement No. 1, TxDOT, September 1953.
3. Interim Specifications for Highway Bridges, AASHTO, 1970.

Use all field information and conventional analysis techniques when the design loading is unknown or deterioration exists. Even when the design loading is known, the only acceptable method for accurate load rating is to do calculations based on the plans and known field measurements.

Rating Concrete Bridges with No Plans

A concrete bridge with unknown reinforcing details (no plans) need not be posted for restricted loading, provided that the following two considerations are met:

- It has been carrying unrestricted traffic for many years.
- There are no signs of significant distress.

Ratings are assumed in the permanent Bridge Record, described in Chapter 8. This procedure is summarized in detail by Figure 5-2. If condition ratings meet the criteria in Figure 5-2, then assume an Inventory Rating of HS15 (27Tons) and an Operating Rating of HS20 (36Tons). If the condition rating criteria are not met, assume IR = HS15 and OR = HS20 or lower based on engineering judgement, and post the bridge at the Inventory level.

Three additional considerations for rating concrete bridges with unknown reinforcing are:

- Ensure bridge exhibits proper span-to-depth ratios of the main members, which indicates that the original design was by competent engineers. In general, this consideration means that for simple span structures the span-to-depth ratio of main members should not exceed approximately 20. Span-to-depth ratios exceeding this ratio may indicate that the designer did not properly consider reasonable design truck loadings.
- Construction details such as slab thickness and reinforcement cover over any exposed reinforcing to specifications current at the time of the estimated construction date.
- Appearance of the bridge shows that construction was done by a competent builder.
- Concrete decks that are a minimum of 6 inches thick and have an Item 58 condition rating greater than or equal to 5 shall not control the overall load rating of a bridge.
  - However, if Item 58<5, assume IR=HS15 and OR=HS20, or lower and post at Inventory level if the rating of the deck is controlling.

A comparative original design rating can be used to estimate the amount of reinforcing in the main members. Normally, if the design was done prior to about 1950 and the above five considerations are met exist, then the amount of reinforcing can be estimated based on a percentage of the gross concrete area of the main beams (if tee-beam construction), or depth of slab (if slab construction).

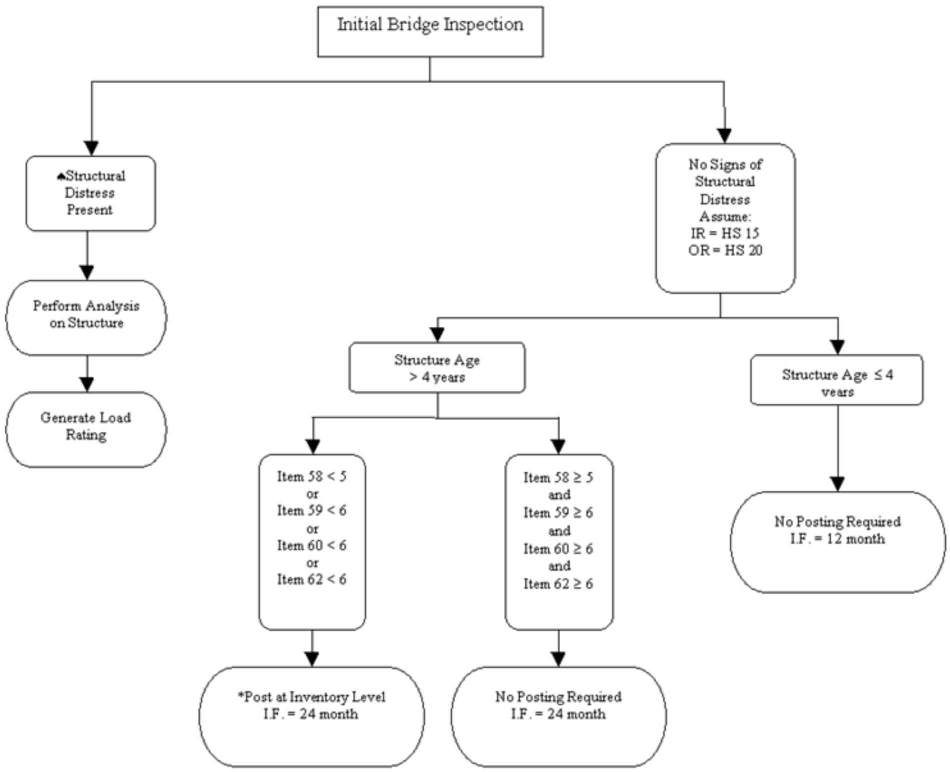


Figure 5-2. Load Ratings for Concrete Bridges without Plans

NOTE 1: *Permit Trucks with gross or axle weights that exceed the state legal load limits will not be allowed to use these bridges.

NOTE 2: I.F. - Inspection Frequency.

NOTE 3: Refer to AASHTO Manual for Bridge Evaluation, Chapter 6, Section B.

Ratings for Unusual Bridges

Unusual bridges, such as those composed of old railroad flat cars, can be rated, but ensure that the critical rating component is considered. For instance, flat cars were originally designed for a maximum point load combined with a uniform load over the whole car. When used for traffic loadings, even though the main two-girder members may give a good equivalent HS load rating, the transverse stiffening members and floor beams often control the live load capacity.

Another unusual type of bridge in Texas is the continuous cast-in-place (CIP) flat slab. Most of these bridges were designed in the 1940s and 1950s with an H-15 or H-20 load pattern. Unfortunately, the design negative moments were from the single truck load in one span. As a result, these bridges may be under-designed for HS-loadings and, as a consequence, may require a load restriction. Design procedures using an HS-20 design load; use a lane load with two concentrated loads in adjacent spans for the controlling negative moment case for longer continuous bridges. For shorter, continuous bridges, an HS-20 design uses two heavy axles of the HS-20 load pattern at variable spacing in adjacent spans. However, the current AASHTO Bridge Specifications do not differentiate between single-and multiple-lane distribution factors for slab bridges. As a result, this type of bridge has greater strength for multiple trucks positioned in the middle of the bridge span. Some structural evaluators make live load distribution adjustments based on the number of lanes loaded for flat slab bridges. Exercise care and properly correlate it to two- or three-dimensional methods of analysis to use this procedure.

H- and HS-Load Ratings

Previously, all ratings were done with the equivalent H-truck and HS-truck shown in Figure 5-1. Currently, all ratings are only with the HS-truck. A moment equivalency conversion from H- to HS-ratings is not recommended since this process would assume that the structure was exactly designed for the given H-loading. In addition, continuous spans cannot be converted by this process. Most structures have a degree of capacity past the design H-load, particularly since load distribution assumptions of the AASHTO Bridge Specifications[1] have been made more liberal since the time many structures were commonly designed using H-loads. However, as previously explained, some bridges were intentionally designed with AS methods to a 5 percent overstress for some components.

It is not acceptable to ratio the design live load moments for an H-truck to the same moment for an equivalent HS-truck. For instance, if a 48-ft simple-span bridge has a design load of H-15, the design load for moment equivalency would be HS-10.8. However, due to the above reasons, the actual rating based on LF methods might easily be HS-9 or HS-13. Generate an LF rating in this case.

Specialized Hauling Vehicle (SHV) Load Ratings

On November 15, 2013, FHWA delivered a memo to require that all bridges be load rated for Specialized Hauling Vehicles (SHVs) as defined in the current AASHTO *Manual for Bridge Evaluation (MBE)*, and load restricted if necessary. These single unit trucks have multiple axles that are closely spaced, and moveable axles that raise or lower if needed, resulting in higher concentrated loads within the shorter axle spacing. The MBE defines 4 SHV trucks: SU4, SU5, SU6, SU7. TxDOT has compiled a guide to the load rating of structures for SHVs, available on the Bridge Division webpage.

Emergency Vehicle (EV) Load Ratings

On November 3, 2016, FHWA delivered a memo to require load rating bridges that are on the Interstate System and within reasonable access to the Interstate System for Emergency Vehicles (EVs) as defined in Fixing America's Surface Transportation Act (FAST Act) (Pub. L.114-94). Since Texas allows EVs to operate legally on all bridges, all bridges in Texas must be evaluated for EVs.

1. Standard Specifications for Highway Bridges, AASHTO, 1994.

By definition, an emergency vehicle is used to transport personnel and equipment to respond to emergency situations such as fires and other hazardous conditions. The gross vehicle weight limit for emergency vehicles is 86,000 pounds. Two emergency vehicles were defined by FHWA, EV2 and EV3. TxDOT has compiled a guide to the load rating of structures for EVs, available on the Bridge Division webpage.

Substructure Load Ratings

Refer to AASHTO Manual for Bridge Evaluation for procedures regarding load rating of substructures. Substructures do not need to be routinely load rated unless the owner believes they have the potential to control the load rating for the bridge.

Section 4 — Legal Loads and Load Posting

Definition of State Legal Loads

State Legal Loads may safely use any of our highways and bridges. Some routes and many bridges must be load-posted to protect them from possible damage. At this time, a load capacity of HS-24.6 is considered to best represent the State Legal Load for evaluation of the need for load posting.

Truck loads in Texas are considered legal if the gross load, axle load, axle configuration, length, and width are within the current size and weight laws or rules. The applicable laws are contained in the current volume of the *Texas Transportation Code*.[1] See Section 623.0111 of the *Texas Transportation Code* for permit fees for selected numbers of counties, and see Section 201.8035 for requirements related to the notification of off-system municipalities and counties of deficient bridges.

The laws also provide for additional rules and regulations regarding truck weights and configurations as may be formulated by the Texas Transportation Commission.

In general, the laws require that the maximum gross load on any truck cannot exceed 80,000 lbs, the maximum load on any pair of tandem axles cannot exceed 34,000 lbs, and the maximum load on any single axle cannot exceed 20,000 lbs. Total length must not exceed 65 feet and total width must not exceed 96 inches. However, in 1989 the Texas Legislature enabled truck owners to pay an annual fee to allow their gross legal loads to be increased by 5 percent with any individual maximum axle load increased by 10 percent.[2] The bill was considered controversial because it allowed travel on any bridge, on- or off-system, even if it is load restricted. This portion of the Transportation Code was amended during the 77th Legislative Session to restrict vehicles possessing a permit of this type from crossing load restricted bridges unless the bridge is the only vehicular access.

There are other so-called legal loads, sometimes referred to as Bonded Trucks, such as ready-mix trucks, utility-pole trucks, garbage trucks, mobile cranes, oil well servicing equipment, etc., that have special rules passed by the legislature allowing special categories of loads and lengths exceeding the normal limits for trucks.

Most State Legal Loads do not have a greater effect on bridges than the current HS-20 design total gross load of 72,000 lbs even though they may have a total legal weight of 84,000 lbs.[3] This apparent contradiction is due to the different axle load configurations and numbers of axles.

1. Texas Transportation Code, Title 7, Chapter 621.
2. Texas Transportation Code, Section 623.011.
3. Texas Transportation Code, Section 623.011.

Load Posting

Load posting is often required for structures that, due to their original design or condition, do not have the structural capacity to safely carry the State Legal Loads. Posting is usually necessary for bridges designed at a time when the design truck for the particular stretch of roadway was only H-10 or H-15, meaning gross truck loads of 20,000 or 30,000 lbs. Structures may be posted at Operating Rating levels provided that the condition ratings exceed those defined in Figure 5-3 and Figure 5-4 and other requirements are met. Otherwise, if the Condition Ratings are less than those defined, the Posting must be at Inventory Rating level of the corresponding element (i.e. if the Condition Rating of the superstructure on a particular bridge is a 5, and the Condition Rating of the substructure is a 4, then the Posting is at the Inventory Rating level of the substructure, not the superstructure).

A load posting of a given truck size actually means that two trucks of the posted capacity to safely pass on the bridge. This concept is often misinterpreted by those doing load ratings and making load posting recommendations. It is recognized that a bridge posted for an HS-5 (18,000 lbs gross load) can safely carry a single truck of significantly more than 18,000 lbs. No method ensures that only a single truck is on the bridge. Therefore, assume that two trucks of the same size could be passing on the bridge simultaneously.

However, some bridges, particularly off-system, are load posted assuming only one rating truck even though they may be wider than 18 feet. This condition usually occurs due to the volume of truck traffic, structure width or approach roadway width, striping, runners, etc., making them functionally one-lane bridges for trucks.

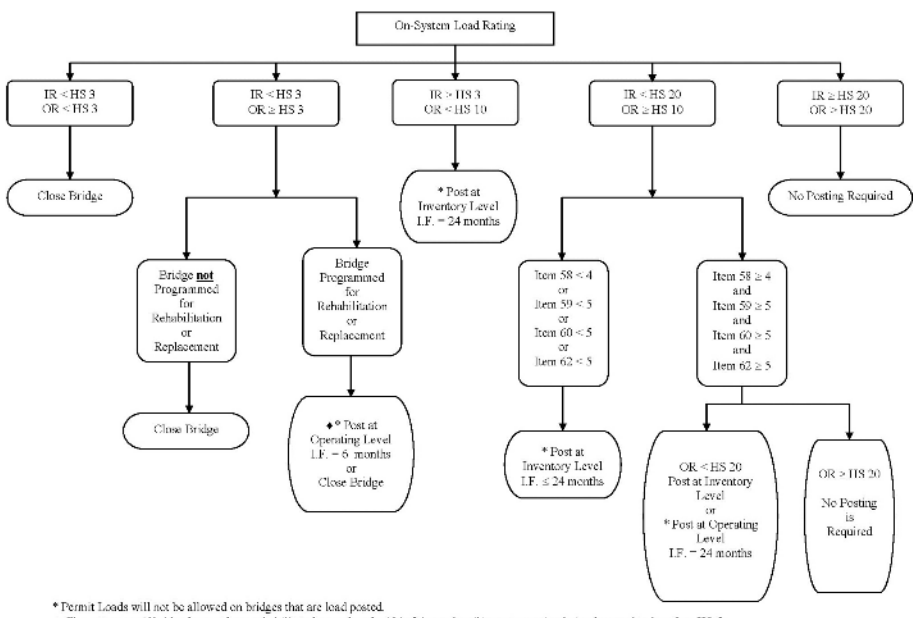
It is important to recognize that even though a bridge may have been designed to an H-15 loading, it may not need to be load posted due to considerations discussed previously, such as reinforcement or member size in excess of the theoretical amount, more liberal load distribution now used in analysis, and LF analysis methods which usually increase Inventory Ratings significantly more than the original design loading.

Transportation Code, Section 621.301 provides that a county may establish load limits for a county road or bridge only with the concurrence of the department. If a county determines that the load limit of a county bridge should be different than the load limit supported by a department inspection, the county must submit the proposed load limit to the district engineer. A request for a load limit must be accompanied by supporting documentation that is sealed by an engineer and that includes at a minimum: calculations supporting the proposed limit and a structural evaluation report documenting the condition of the bridge. The district engineer will give a concurrence to a county's proposal in writing. If the department does not indicate concurrence or non-concurrence in writing within 30 calendar days of receipt by the department of a request that included all required documentation, the proposed load limit must be deemed concurred with by the department. The department may review the load limit and withdraw this concurrence at any time by providing written notification to the county. A county may appeal the decision of the district engineer by submitting a written request along with the required documentation to the executive director. The executive director will review the request and determine if department concurrence will be granted. The executive director's decision is final.

Supply the recommended load posting of all off-system bridges to the affected municipalities and counties. TxDOT provides the necessary posting signs and placement hardware. If the local jurisdiction elects not to post the bridge, all federal funds could be jeopardized or delayed for all transportation-related projects, on- or off-system, in that county.

Send a list of off-system bridges that are recommended for load posting by certified mail to the owner of the bridges. A signed copy of the cover letter is returned to TxDOT from the local jurisdiction official. Subsequently, after the appropriate load zone signs have been prepared by TxDOT, a letter is sent notifying the local jurisdiction as to where the signs and hardware may be picked up along with installation instructions. After the signs are installed, the local jurisdiction returns a statement of compliance to TxDOT. Use photographs to document installation of load restriction signs, and then submit them to the inspection file for historical reference.

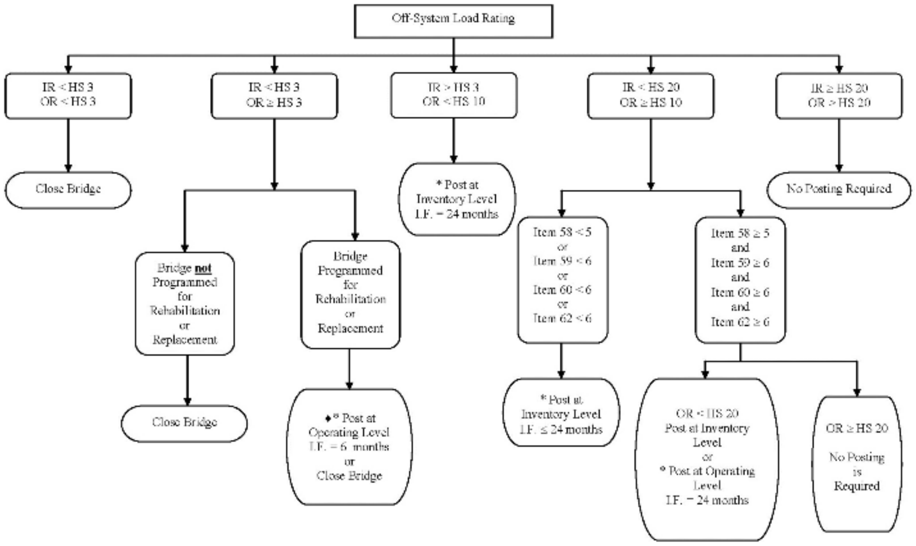
Typical load posting signs are shown in Figure 5-5.[1] Texas must comply with posting time limits, which are set by the *Code of Federal Regulations*. The time limit for initial or revised posting after bridge inspection is 90 days after the change in status for on-system bridges. This time limit is extended to 180 days for off-system bridges.[2]



* Permit Loads will not be allowed on bridges that are load posted.
♦ Close structure if bridge has not been rehabilitated or replaced within 24 months of inventory rating being lowered to less than HS-3.
I.F. – Inspection Frequency.
OR – Operating Rating (Item 64)
IR – Inventory Rating (Item 66)

Figure 5-3. On-System Load Posting Guidelines

1. Texas Manual on Uniform Traffic Control Devices, 1980
2. "Closing and Posting Recommendations for Off-System Structures," Memo from Robert L. Wilson, P.E., TxDOT, October 1997



* Permit Loads will not be allowed on bridges that are load posted.

◆ Close structure if bridge has not been rehabilitated or replaced within 24 months of inventory rating being lowered to less than HS-3.

I.F. – Inspection Frequency

OR – Operating Rating (Item 64)

IR – Inventory Rating (Item 66)

Figure 5-4. Off-System Load Posting Guidelines

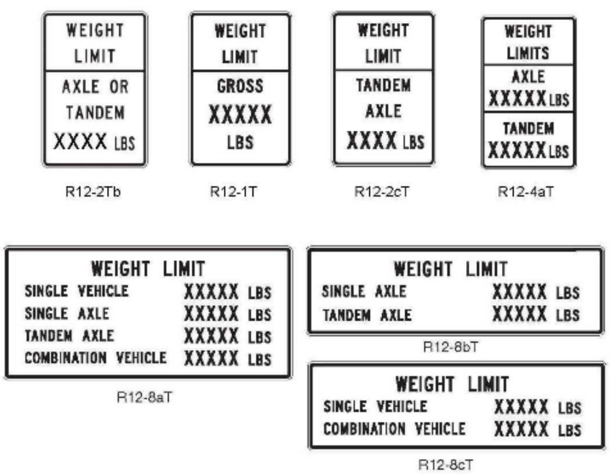


Figure 5-5. Typical Load Posting Signs

Procedures for Changing On-System Bridge Load Posting

The following table outlines the procedure for changing the load posting of an on-system bridge.

Table 5-1: Changing Load Posting of an On-System Bridge

Step	Responsible Party	Action
1	Consultant/District/BRG	Inspector determines a change in posting status based on condition ratings and load rating of the structure. A change in posting status may result from one of the following: ◆ a new load restriction ◆ a revision to an existing load restriction ◆ a removal of a load restriction
2	Consultant/District/BRG	◆ Submit Form 1083R, bridge inspection record, plans and supporting calculations to TxDOT Bridge Division within 30 days of inspection date.
3	Bridge Division Load Rating Engineer	◆ The date that the Bridge Division Load Rating Engineer receives 1083R starts the 90 day time period for posting On-System bridges. ◆ Record this date in the `Bridge Inspection Management System` and on Form 1083R. ◆ Review the recommendation and perform more detailed analysis, if necessary.
4a	Bridge Division Load Rating Engineer	Disapproval of recommendation: ◆ Notify the District that the recommendation was not approved. ◆ Update the `Bridge Inspection Management System` with this information and complete Form 1083R. ◆ Scan the form and upload it to the structure's file in `the Bridge Inspection Management System` with the file name format: DD-CCC-CCCC-SS-SSS_LPR_YYYY-MM-DD (Load Posting Request with date of disapproval). ◆ If the Load Rating Engineer performed a separate analysis, scan the load rating and uploads it to the structure's file in PonTex with the file name format: DD-CCC-CCCC-SS-SSS_LR_YYYY-MM-DD (Load Rating with date signed and sealed).
4b	Bridge Division Load Rating Engineer	Approval of recommendation or modifies recommendation: ◆ Calculate the appropriate posting level. ◆ Forward Form 1083R with the Load Rating Engineer's load posting recommendation to the Bridge Division Director for approval. ◆ Record the approval date in the `Bridge Inspection Management System` and on Form 1083R.
5a	Bridge Division Director	Approval of recommendation: ◆ Record the approval date on Form 1083R and sign form. ◆ Return Form 1083R to Bridge Division Load Rating Engineer.
5b	Bridge Division Director	Approval of recommendation: ◆ Record the disapproval date on Form 1083R and sign form. ◆ Return Form 1083R to Bridge Division Load Rating Engineer.

Table 5-1: Changing Load Posting of an On-System Bridge

Step	Responsible Party	Action
6a	Bridge Division Load Rating Engineer	Upon Bridge Division Director Approval: ◆ If the Load Rating Engineer performed a separate analysis, scan the load rating and upload it to the structure's file in `the Bridge Inspection Management System` with the file name format: DD-CCC-CCCC-SS-SSS_LR_YYYY-MM-DD (Load Rating with date signed and sealed). ◆ Forward Form 1083R to Bridge Division QA/QC Engineer. ◆ Scan the load posting calculations and upload them to the structure's file in `the Bridge Inspection Management System` with the file name format: DD-CCC-CCCC-SS-SSS_LPSign_YYYY-MM-DD (Load Posting Sign with date of Administrative approval). ◆ Record the date of Bridge Division Director approval in the `Bridge Inspection Management System`.
6b	Bridge Division Load Rating Engineer	Upon Bridge Division Director Disapproval: ◆ If the Load Rating Engineer performed a separate analysis, scan the load rating and upload it to the structure's file in `the Bridge Inspection Management System` with the file name format: DD-CCC-CCCC-SS-SSS_LR_YYYY-MM-DD (Load Rating with date signed and sealed). ◆ Forward Form 1083R to Bridge Division QA/QC Engineer. ◆ Scan the load posting calculations and upload them to the structure's file in `the Bridge Inspection Management System` with the file name format: DD-CCC-CCCC-SS-SSS_LPSign_YYYY-MM-DD (Load Posting Sign with date of Administrative disapproval). ◆ Record the date of Bridge Division Director disapproval in the `Bridge Inspection Management System`.
7	Bridge Division QA/QC Engineer	Upon receipt of the approved load posting recommendation from the Load Rating Engineer: ◆ Provide approval notification to the District. ◆ Record this date in the `Bridge Inspection Management System` and on Form 1083R. ◆ Send follow-up emails to the District at 45 days, 60 days, and 75 days after the date that the Load Rating Engineer was notified of a recommended status change.
8	District	Upon receipt of recommendation approval notification, take one of the following actions: ◆ New Load Posting or Load Posting Revision- Immediately order load posting signs and erect the signs upon their receipt. ◆ Load Posting Removal - Immediately remove load posting signs.
9	District	After signs have been placed or removed: ◆ Notify the QA/QC Engineer that the signs have been erected/removed at the bridge, and include the completion date. ◆ Document the placement or removal of signs with photos.

Table 5-1: Changing Load Posting of an On-System Bridge

Step	Responsible Party	Action
10	Bridge Division QA/QC Engineer	Upon receiving district notification: ◆ Enter the erected/removed date on Form 1083R and record the date in the `Bridge Inspection Management System`. ◆ Notify the Texas Department of Motor Vehicles (DMV) and the Texas Department of Safety (DPS) of the status change for the structure. The notification includes: District name, county name, the facility carried, the feature crossed, latitude and longitude, the status prior to the change, and the changed status of the bridge. ◆ Record the DMV and DPS notification dates in the `Bridge Inspection Management System`. ◆ Scan the completed 1083R form and upload it to the structure's file in `the Bridge Inspection Management System` with the file name format: DD-CCC-CCCC-SS-SSS_LPR_YYYY-MM-DD (Load Posting Request with date of Administrative approval).

Under the following conditions, the District submits to the Bridge Division's Inspection Branch a completed Form 1083R showing reasons for a restriction removal:

- Repair or rehabilitation of a bridge that increases load capacity and eliminates a load restriction.
- Construction of a new bridge that replaces one with a load restriction.

Procedures for Emergency On-System Bridge Load Posting

The following table outlines the procedure for changing the load posting of an on-system bridge in an emergency.

Table 5-2: Changing Load Posting of an On-System Bridge in an Emergency

Step	Responsible Party	Action
1	District	Notify the Bridge Division’s Inspection Branch by telephone that an emergency load restriction is required. Identify deficiencies that justify the placement of an emergency load limit.
2	Bridge Division	Work with the District to determine the load limit, if required, and verbally authorize an emergency load restriction for a period not to exceed 60 days if necessary.
3	Bridge Division	Prepare a letter to the District for signature by the Director of the Bridge Division authorizing the temporary load limits and specifying the duration of the temporary limit.
4	Bridge Division	Verbally notify the District of official approval of the emergency load limit.

Table 5-2: Changing Load Posting of an On-System Bridge in an Emergency

Step	Responsible Party	Action
5	Bridge Division	Notify the Texas Department of Motor Vehicles and the Texas Department of Public Safety of any bridge load restriction.
6	District	On receipt of verbal approval by the Bridge Division, immediately erect signs indicating the emergency load limit.

If the emergency load limit is required for a period longer than 60 days, the District should submit a request to the Bridge Division for the emergency load restriction to remain in place for another 60 days. If the bridge is not replaced or repaired before the emergency load restriction extension expires, the District should submit a request to the Bridge Division for a permanent load restriction following the procedures for changing on-system bridge load postings.

Closure of Weak Bridges

Close bridges with less than an HS-3 Operating Rating capacity pursuant to the Texas Load Posting Guidelines presented in Figure 5-3 and Figure 5-4. Follow these policies for on-system bridges and they are strongly recommended for the municipalities and counties with jurisdiction over off-system bridges. Bridges with Inventory Ratings less than HS-3 but with Operating Ratings greater than HS-3 may remain open for 24 months. If it is desired to leave a bridge in this category open, then inspect it every six months and ensure the bridge is programmed for rehabilitation or replacement within two years. Close the bridge if after 24 months it has not been rehabilitated or replaced.

Procedures for Closing an Off-System Bridge

If inspection reveals deterioration that affects an off-system bridge's ability to safely carry vehicular traffic, the department may use the following procedure to recommend that it be closed for safety reasons:

Recommending Off-System Bridge Closures

Step	Responsible Party	Action
1	Consultant/District/BRG	Inspector immediately notifies the District and the Inspection Branch of the Bridge Division if a bridge should be closed based on the results of an inspection.
2	District	The district will verify as soon as possible the condition of a bridge recommended for closure by a consultant.

Recommending Off-System Bridge Closures

Step	Responsible Party	Action
3	District	The District will immediately notify the local entity of a valid closure recommendation, and offer to meet representatives of the local entity at the bridge location. The District will inform the local entity that its participation in the TxDOT Participation Waived and Equivalent Match Program depends on full compliance with departmental closure and posting recommendations and that failure to follow closure recommendations could result in the loss of federal funds. The District will promptly update the Bridge Inspection `Management System` to reflect the closure recommendation. (See Item 41 in the Coding Guide.)" NOTE: TxDOT will not conduct another formal inspection of the bridge until it is repaired or replaced.
4	Local Entity	Close the bridge and notify the District when the bridge is closed to traffic.
5	District	Verify closure of the bridge upon receipt of notification and include a photo or certified documentation verifying the closure in the bridge inspection file. Promptly update the Bridge Inspection Management System to reflect the closure status of the bridge. (See Item 41 in the Coding Guide.")
6	District	If the bridge will remain closed for an extended period of time, the district will verify and document with a photo, `uploaded into the Bridge Inspection Management System` that the bridge is still closed to traffic as part of the regular inspection cycle.

Procedures for Changing Off-System Bridge Load Posting

Use the following procedure to place, modify or remove load restrictions for off-system bridges where an inspection and subsequent load rating show that the bridge's ability to safely carry state legal loads is compromised:

Recommending Off-System Load Posting Changes

Step	Responsible Party	Action
1	Consultant/District/BRG	Inspector determines a change in posting status based on condition ratings and load rating of the structure. A change in posting status may result from one of the following: ◆ a new load restriction ◆ a revision to an existing load restriction ◆ a removal of a load restriction ◆ replacement of missing or damaged signs

Recommending Off-System Load Posting Changes

Step	Responsible Party	Action
2	District	Upon receipt of a recommendation for a change in load restriction, take the following actions: ◆ Notify the local entity that owns the bridge of the recommended change in load restriction. ◆ If the recommendation involves a new load posting, a load posting revision, or replacement of missing or damaged signs, immediately order the necessary signs. ◆ If the recommendation involves a removal of a load restriction, notify the local entity that the existing signage can be removed. ◆ The entire process for changing an off-system load restriction is not to exceed 180 days from the time the recommendation for change is made. Monitor the timeline to ensure that this requirement is met.
3	District	Take the following steps if signs are ordered for a load posting implementation: ◆ Monitor sign making request for delivery. If signs have not been received within 30 days contact GSD sign shop to follow-up. If sign orders continue to be delayed then the issue should be elevated to district administration or the Bridge Division. ◆ Once signs have been delivered, immediately notify the local entity that signs and hardware are ready for pick up. This process should be documented in writing or e-mail. ◆ Monitor sign pick up by local entity. If signs have not been picked up within 30 days then a reminder should be sent and documented. If signs have not been picked up within 15 days after reminder then the issue should be elevated to district administration or the Bridge Division. ◆ When the local entity picks up the signs and hardware have the local entity representative sign upon receipt. ◆ Monitor sign installation by the local entity. If signs have not been installed within 30 days of receipt then a reminder should be sent and documented. If signs have not been picked up within 15 days after reminder then the issue should be elevated to district administration or the Bridge Division.
4	District	After signs have been placed or removed: ◆ Document the placement or removal of signs with photos, and upload the documentation into the Bridge Inspection Management System.

Chapter 6 — Routing and Permits

Contents:

[Section 1 — Role of District Permit Officers, District Bridge Inspection Coordinators, and the Texas Department of Motor Vehicles]

[Section 2 — Permits]

Section 1 — Role of District Permit Officers, District Bridge Inspection Coordinators, and the Texas Department of Motor Vehicles

One of the responsibilities of the District Permit Officer is to assist the Texas Department of Motor Vehicles (TxDMV) in the evaluation of overheight and overwidth permit routes. Should there be any question regarding the accuracy of the current `Bridge Inspection Management System` Files, the actual plans should be reviewed and/or a field visit made prior to issuing a permit. The TxDMV issues the permit only after review by the District Permit Officer, who also coordinates closely with the District Bridge Inspection Coordinator.

A supplementary role of the District Bridge Inspection Coordinator is to notify the District Permit Officer of any changes to bridge load postings, particularly for bridges not previously posted. The TxDMV maintains a master set of maps showing the various width, height, and load restrictions on all highways. Each District Permit Officer coordinates with the TxDMV in maintaining the maps. Copies of the maps showing all restrictions for load, width, and heights on the various routes are distributed to each district.

All permits are issued by the TxDMV with the cooperation of the District Permit Officer. For overweight permits, the District Permit Officer also works closely with the District Bridge Inspection Coordinator. Any superheavy permits must also be coordinated the Bridge Division (BRG) for structural evaluation of the bridges on a proposed route. This process is fully explained below.

The TxDMV, in conjunction with the mover, selects a route based on known information in the Bridge Inventory Files, day-to-day construction status, road closures, and other known route restrictions.

Section 2 — Permits

OverHeight and OverWidth Permits

Many permits are for overheight or overwidth loads. The routing of these loads usually depends on data contained in the `Bridge Inspection Management System`. These types of loads do not normally require a structural evaluation of the affected bridges unless the weight and axle load distribution is such that an overweight permit may also be required.

The `Bridge Inspection Management System` gives the values for available clearances as Items 51 (Roadway Width), 52 (Deck Width), 53 (Vertical Clearance over Roadway), 54.2 (Vertical Clearance Under Bridge), 55 (Lateral Underclearance on Right), and 56 (Lateral Underclearance on Left). These items taken together usually give sufficient information to define the limits for the passage of overheight and overwidth vehicles.

The permit investigator, District Permit Officer, or District Bridge Inspection Coordinator can quickly access the `Bridge Inspection Management System` to determine if the proposed route is capable of handling the proposed overwidth or overheight load. Truss bridges are particularly of concern for both these types of loads since many are in the 18- to 22-foot width range, and vertical clearance to the portals is often less than normal current design clearances.

The `Bridge Inspection Management System` gives vertical clearances to the least inch of clearance over the roadway, including shoulders rounded down to the nearest inch. The posted clearance signs are normally 3 inches less than this value. The clearance symbols maintained on the TxDMV permit maps are rounded down to the next 6 inches below the posted clearance. For instance, if the actual recorded clearance is 14-ft 2-in., the clearance sign is 13-ft 11-in., and the permit maps show the maximum available clearance as 13-ft 6-in. Occasional overheight loads can therefore be permitted for heights slightly over the limits given in the TxDMV permit maps provided there is close coordination between the district and the owner and pre-move specific measurements taken.

Normally, overwidth permits are granted simply on the basis of available Roadway Width (the clear distance between curbs or railings). If the overwidth load is configured such that the load will adequately clear bridge railings, then moves may be granted for loads significantly wider than the Deck Width. This requires the careful cooperation of all concerned parties including escort vehicles and traffic control. Damage and or removal of signs and delineators may occur for some overwidth permits. TxDOT personnel should ensure that all such temporary changes are corrected immediately after the permit load has passed.

More information on overheight and overwidth permit requirements and procedures is given on the `Texas Department of Motor Vehicles – Motor Carriers website at` http://www.txdmv.gov/motor-carriers.

Overweight Permit Loads

Misconceptions often arise about the relationship between Operating Ratings and Overweight Permit Loads. The primary difference is that overweight Permit Load analysis usually assumes only one load on the bridge, which, therefore, allows the use of single-lane load distribution. The Operating Rating is based on the standard AASHTO load distribution given in the current *LRFD Bridge Design Specifications*[1] for multi-lane distribution for bridges over 18 feet in width. This distribution implies two or more of the Operating Rating trucks being on the bridge side-by-side at the same time.

The other major difference is that Operating Ratings and Overweight Permit Loads use different load multipliers, resulting in Overweight Permit Load analysis being significantly more liberal than Operating Rating analysis. Review the current Operating and Inventory Ratings, the age and type of structure, the span lengths, and the Condition Ratings for any structure proposed on a permit route. For any Condition Rating of 4 or less, request more detailed information on the structure, including the written inspection comments. Reduced strength in a portion of a bridge can often be avoided by controlling the load path of the Overweight Permit Load across the bridge.

Superheavy Loads

Overweight Permit Loads are classified as Routine or Superheavy. Routine Overweight Permit Loads may be allowed in the regular traffic stream. An escort is required if the load is also overlength or overwidth. Use the standard AASHTO load distributions since there may be a legal truck alongside the Routine Overweight Permit Load truck crossing a bridge at the same time.

The term Superheavy Permit Load designates total loads over 254,300 lbs gross. It consists of a 14,300 lb steering axle followed by four groups of three axles, each totaling 60,000 lbs. Any configuration with multiple axles with a gross load of over 254,300 lbs is considered a Superheavy load and requires structural evaluation of individual bridges. Loads with individual axles or axle group weights that exceed the maximum permit weights are also considered to be Superheavy. Any load exceeding 200,000 lbs with a total overall length of less than 95 feet is also considered Superheavy.

More information on superheavy permit requirements and procedures is given on the Texas Department of Motor Vehicles – Motor Carriers website at http://www.txdmv.gov/motor-carriers.

The Superheavy Permit often requires that the load cross all bridges straddling a lane line in the case of four or more lanes on a two-way bridge, or straddling the center line for a two-lane bridge. This procedure ensures that other legal trucks will not be alongside the Superheavy load and also gives better load distribution. The AASHTO load distributions used for Superheavy loads are, therefore, usually single-lane.

1. LRFD Bridge Design Specifications, AASHTO, 8th Ed., 2017.

A printout of the proposed list of bridges to be crossed is reviewed by the TxDMV and the Bridge Division. It may be necessary to structurally evaluate only a portion of the bridges on an extensive proposed Superheavy route. For any bridges on the route with a Deck, Superstructure or Substructure condition Rating of 4 or less, review the actual written Bridge Inspection Record. This bridge-by-bridge evaluation is one of the primary reasons that the data in the Bridge Inspection Management System must be accurate and up-to-date.

Superheavy Permit Loads are usually speed-controlled on bridges, sometimes as slow as a walk speed to minimize impact forces.

Many Superheavy Permit Loads also have greater than the usual 6-foot axle gage. The gages for Superheavy Permits can commonly be as much as 20 feet with 16 tires on each axle line. Methods of load distribution for these special carriers cannot directly use the customary AASHTO distributions, which are based on 6-foot axle gages with four tires on an axle line.

Other Differences Between Overweight Permits and Operating Rating

There are other major differences between Operating Ratings and Overweight Permit Loads.

The Operating Rating is usually based on Load Factor (LF) criteria, which use multipliers of 1.3 applied to both the dead and live loads. The live load has an additional allowance of up to 30 percent for impact. Note that Inventory Rating uses a significantly higher live load multiplier of 2.17. The result for either Operating Rating or Inventory Rating is compared to the yield or ultimate strength capacity of the members. A “phi” strength reduction factor (usually from 1.0 to 0.85) is also applied for concrete members.

Overweight Permit Load analysis usually assumes a factor of 1.0 applied to both the dead and live loads. Ten to 30 percent is added to the live load for impact, depending on the speed control and type of load suspension system. Stresses are compared to an allowable maximum of 75 percent of the yield capacity of steel members or 75 percent of the ultimate capacity for concrete members. The reciprocal of 75 percent is 1.33; thus it can be seen that Overweight Permit Load analysis with Allowable Stress (AS) methods has essentially the same factor of safety as an analysis using LF criteria. This result will be demonstrated below by a specific example comparison.

Overloads on Posted or Substandard Bridges

Occasionally a request is made for a Routine Overweight Permit or a Superheavy Overweight Permit to cross a load-posted bridge. TxDMV does not allow overweight permits for posted bridges.[1] However, Section 623.0113 of the *Texas Transportation Code* allows TxDOT to issue weight tolerance permits for overweight vehicles to cross load-posted bridges only when there is no other route.

1. Motor Carrier Division Handbook, TxDOT, Motor Carrier Division, August 2010.

Certain other bridges that are not load posted may not be capable of carrying Routine Overweight Permit Loads or Superheavy Permit Loads. Bridges that are in this category include but are not limited to continuous flat slabs with original H-15 designs. These bridges have short spans and were designed with the single H-load pattern truck placed along the span for maximum design conditions. Many of these bridges when rated with the now-required HS-load pattern, and even using LF analysis, will rate at significantly less capacity than other types of bridges designed with H-load patterns. These bridges, though not currently load posted, must be carefully evaluated when overload permits are considered. This is the primary reason that the original design loads as shown in the Coding Guide should be entered correctly. Often these bridges have been widened, and occasionally, the widening design load has been incorrectly entered as the original design load.

Pre- and Post-Move Inspection

Another occasional responsibility of the District Bridge Inspection Coordinator is to inspect bridges before and after the passage of a particular overweight permit load. A representative of the owner-mover should be present at these types of inspections. Cast-in-place short span slab bridges, particularly those which have been widened from an original H-10 design to an H-15 or H-20 design, are susceptible to cracking by overloads.

Unusual bridges, such as arch spans, segmentally constructed post-tensioned spans, or long-span plate girder bridges, may also need special attention before, during, and after the move of an overweight permit load. It has been found that simple attention to the sounds made by a bridge when the load passes will call attention to possible broken diaphragm connections or lateral wind bracing connections that actually act as torsional bracing for curved and/or heavily skewed structures.

Chapter 7 — Bridge Programming

Contents:

Section 1 — Overview

Section 1 — Overview

Districts and Bridge Division work together to prioritize bridges for replacement and preservation. Information captured from bridge inspections is included in the prioritization of candidate bridges. See the TxDOT *Bridge Project Development Manual* for bridge programming information.

Chapter 8 — Bridge Records

Contents:

Section 1 — Definition of Terms

Section 2 — Coding Guidelines

Section 3 — Inspection Documentation

Section 4 — Calculations

Section 5 — Data Submittal

Section 6 — The Bridge Record

Section 7 — Open Records Requests

Section 8 — File Security

Section 1 — Definition of Terms

Bridge Record Terms

A partial list of definitions related to bridge inspection is given in the *AASHTO Manual for Bridge Evaluation*.[1] The same AASHTO definitions and specific additional terms are also used in various other chapters of this manual. The following discussion of Bridge Records includes some of the additional specific terms.

Bridge—A structure, including supports, erected over a depression or an obstruction, such as water, a highway, or a railway; having a roadway or track for carrying traffic or other moving loads; and having an opening measured along the center of the roadway of more than 20 feet between inside faces of abutments, spring lines of arches, or extreme ends of the openings for multiple box culverts, or multiple pipes that are 60 inches or more in diameter and that have a clear distance between openings of less than half of the smallest pipe diameter.

Bridge Folder—Until recently the file for each bridge maintained by the District Bridge Inspection Office was a hard copy record of all inventory and inspection documentation for a bridge. With data now being submitted directly to the Bridge Inspection Management System, all data is recorded and held in electronic format and the bridge folder is now an archive of historical bridge information. Hard copy documents contained in the bridge folder are currently being scanned into the Bridge Inspection Management System.

National Bridge Inventory Number —The unique 15-digit number assigned to any structure meeting the definition of a bridge. The number includes the 2-digit District Number, 3-digit County Number, a 1 digit fixed zero, commonly referred to at the "Fed Zero", the 4-digit Control Number, the 2-digit Section Number, and the 3-digit Permanent Structure Number. The Transportation Planning and Programming Division (TPP) assigns the county road and city street index numbers, which typically begin with a letter instead of number. This off-system index number uses the same 6 digits assigned to Control and Section for on-system highways. The Permanent Structure Number for off-system bridges is assigned by the district. Bridge Identification Numbers are never to be reused, neither for on-system structures nor off-system structures. Similarly, Bridge Identification Numbers are never to change. If a bridge moves from the on-system to the off-system or vice-versa, it keeps the same ID. For most on-system bridges the first 12 digits of the ID will correspond with a physical stretch of roadway and are often directly related to the identification number of the construction plans from which the bridge was built. See **"Control-Section-Job (CSJ) Numbers"**.

Bridge File—The electronic data for each bridge in TxDOT's bridge inventory, including, but not limited to inspection reports, photographs, load rating calculations, and appraisal ratings. Data is entered through the online Bridge In-

1. *AASHTO Manual for Bridge Evaluation*, Second Edition, 2011.

spection Management System. The Coding Guide describes the step-by-step data entry requirements.

Bridge Record—The over-all collection of data including the documents that were contained in the hard copy Bridge Folder with completed forms, printout of coded electronic data, sketches, cross sections, photos, etc. It also includes the Bridge Inventory File stored on electronic media. The Bridge Record also includes the bridge plans, if available. Some of the bridge plans may also be available on electronic media in the form of computer-aided drafting (CAD) drawings. Historically this information was stored in hard copy format, but now the Bridge Record is being stored in the online Bridge Inspection Management System.

Control-Section-Job (CSJ) Numbers—These are the unique numbers assigned to all construction plan sets at TxDOT. The Control Number is assigned to a stretch of highway that often breaks at a county line or a major highway intersection, river or stream, but can also break at any convenient location. The Section Number is a number within a specific Control and is usually assigned sequentially from the beginning of the Control. An average length for most Sections is about 4 to 5 miles but can be less than a mile or 15 to 20 miles. The Job Number is the sequential number for any type of construction project (bridge, paving, etc) that may have ever occurred on that Section of highway. All off-system highways are assigned similar sequential numbers by the district within each county. Refer to Items 8.4 and 8.5 of the “Coding Guide” for more information.

Culverts—Multiple-barrel box culverts or multiple-pipe culverts are sometimes classed as bridges and a complete Bridge Record is made. The 2018 AASHTO Manual[1] defines a bridge as any structure carrying traffic (highway or railroad) having an opening measured along the centerline of the roadway of more than 20 feet between the limits of the extreme openings of abutments, arches, or multiple boxes. This definition has created the anomaly in some cases where, for instance, three cast-in-place 6-ft multiple box culverts installed at more than about a 15-degree skew to the roadway must have a Bridge Record. If the same three box culverts are installed perpendicular to the roadway, they have no Bridge Record. The AASHTO definition continues for multiple-pipe culverts by stating that they may be classed as bridges provided the distance between individual pipes (the fill) is less than half the adjacent pipe diameter. In addition to this provision, TxDOT also requires pipe culverts to be at least 60" in diameter to be considered as a multiple-pipe bridge-class culvert.

Elemental Data—Identifies the various parts of the bridge (Elements), the material type and measures or estimates the condition of that element through specific predefined condition states. Additional information is available in “Manual for Bridge Element Inspection” – AASHTO.

Collecting data in this manner helps to better quantify the condition of a bridge or a system of bridges. By characterizing part of a bridge by the type of member and its material the following types of analysis can more easily be performed: 1) prediction of deterioration, 2) prediction of costs for repair, rehabilitation or replacement, 3) identification of alternative programs based on level of service or other criteria, 4) optimization of expenditure based on user and agency costs, 5) budget forecasts, and 6) development of programs for improvements.

1. AASHTO Manual for Bridge Evaluation, Third Edition, 2018

Engineer—The qualified, Texas-licensed, Professional Engineer having responsibility for ensuring the accuracy of the information contained in the Bridge Record. A pre-qualified consulting firm engaged by TxDOT to perform routine bridge inspections is also considered in the following discussions to be covered by the term Engineer. Inspections done by TxDOT staff must also have a qualified, Texas-licensed, Professional Engineer responsible for the Bridge Records. The same basic procedures are used by TxDOT personnel as are required for consulting firms.

Forms—Specific forms within the Bridge Inspection Management System such as the Bridge Inspection Record, or the Bridge Inventory Record, or the Follow-up Action Worksheet forms may be developed as needed for specific types of data or classes of structures.

NBI Sheet—A printed copy with abbreviated names of the numerical data in the electronic Bridge Inspection File. NBI stands for National Bridge Inventory, which must include all the information required by the FHWA. Texas captures additional information exceeding that required by the NBI. However, in Texas the sheet is still commonly called the "NBI Sheet." The FHWA data requirements are described in a report titled Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges [1]."

Permanent Structure Number (PSN)—A unique three-digit number assigned to any structure meeting the definition of a bridge. It is part of the 15-digit National Bridge Inventory Number. PSNs are assigned by Control-Section Segments in ascending order as the bridges are built and are not necessarily in sequence along the Control-Section Segment. An on-system bridge replaced by a new bridge at the same location will have a new number assigned. A widened or reconstructed bridge will retain the same number. Districts assign similar unique numbers to off-system bridges. A bridge with a longitudinal open joint in the middle will have two PSNs, even if the superstructures share a common substructure element[2]. Districts should request the PSN before submitting the Preliminary Bridge Layout, so that the PSN can be included on the Preliminary Bridge Layout Review (PBLR).

Route Over or Under—A bridge at intersecting highways is defined as an underpass or overpass based on the inventory hierarchy of the two routes. This description is used where required on all forms, plans, etc. The hierarchy of Texas highways is: Interstate, US, SH, State Loops or Spurs, FM/RM, County Roads (CR), and Business Routes (BR). The lower route number takes precedence if the highways are of equal hierarchy. Examples are:

- IH 30 over IH 35 - IH 30 Overpass at IH 35
- IH 35 over IH 30 - IH 30 Underpass at IH 35
- FM 1234 over US 290 - US 290 Underpass at FM 1234
- CR 18 under US 183 - US 183 Overpass at County Road 18
- IH 20 Business under RM 456 - RM 456 Overpass at IH 20 Business

Signing and Sealing—The Engineer must sign, seal, and date the appropriate documents in bridge inspection reports. The Signing and Sealing requirements are in conformance with the Texas Engineering Practice Act and TxDOT policy.[34] Date the seal on the

1. Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges, FHWA, 1995.
2. "Permanent Structure Numbers," Administrative Circular 20-74, TxDOT, February 1974.

day it was affixed to the documents.

Work Authorization—Authorization issued by TxDOT to a consultant (Engineer) to perform inspections of bridge structures in various counties and districts in Texas. The Work Authorization is normally issued for a specific period of time with a commencement and ending date specified. Consultants under contract to TxDOT must pre-qualify by demonstrating that they are competent to inspect Texas bridges.

3. Occupations Code, Section 1001.401. Texas Administrative Code, Title 22, Section 131.166.
4. Procedures for Sealing Engineering Documents, Stand-alone Manual Notice 97-2, TxDOT, March 1997

Section 2 — Coding Guidelines

Summary of Instructions

Adhere to the step-by-step instructions for entering the data in the electronic Bridge Inspection Management System as presented in the Coding Guide. Follow coding and documentation requirements outlined in this chapter regardless of whether inspections are carried out in-house or by consultants. This requirement ensures statewide consistency in documenting and reporting inspection findings. The Coding Guide also includes interpretations, examples, and other data input guidance. The electronic Bridge Inspection Management System contains a record for each Bridge Class Structure on public roadways in Texas. The definition of a Bridge Class Structure is described in Item 112 in the "Coding Guide." The data are also used to update the National Bridge Inventory File for the FHWA. Once a year the complete bridge inspection database for off- and on-system bridges is converted to the Federal NBI format and submitted to the FHWA.

Multiple-Pipe Culverts

To achieve future consistency in recording information, the following clarifications are to be used for creating or maintaining Bridge Records for multiple-pipe culverts:

- Do not remove any existing multiple-pipe culverts from the Bridge Inventory File. The installation may already be in the prioritization process for repair or replacement, and the process should not be disrupted.
- Do not create Bridge Records for any new multiple-pipe culverts that are individually less than 60-inches in diameter even if the total installation, including fill between pipes, is more than 20 feet along the roadway. Inspections of smaller diameters would be difficult to make and the results would probably be of dubious quality. It is also very inconsistent engineering logic to require inspection of, for instance, an installation of five 48-inch pipe culverts and no inspection of an installation of four or fewer pipes of the same diameter.
- Make and maintain Bridge Records for multiple-pipe culverts that are individually 60-inches or greater in diameter, providing the total installation meets the 20-ft length criterion and the distance between individual pipes does not exceed one-half the diameter of the smallest pipe.

Data Quality and Timely Updating of Data

Data quality for the electronic Bridge Inspection Management System must be kept as up-to-date as possible. Texas must comply with data update time limits which are set by the Code of Federal Regulations and Metric 23 – Timely Updating of Data. Texas requires data updates reflecting changes to any existing structure to be made within 90 days of the evaluation or inspection that denotes the change in status. Report new, rebuilt, or rehabilitated structures within 90 days of job completion. All bridge inspection reports must be approved within 90 days of the date of inspection to have the data become part of the bridge inventory file.

Section 3 — Inspection Documentation

Inspection File Contents - On System Bridges

The following documentation is to be completed for each on-system bridge. All inspection documentation is to be entered and uploaded electronically within the Bridge Inspection Management System.

- **Bridge Inspection Record** – Delineates the basic components of the bridge to be inspected. Enter a rating for each element of each component following guidelines from the National Highway Institute (NHI) Safety Inspection of In-Service Bridges two-week training course and in accordance with the current TxDOT Bridge Inspection Manual Coding Guide. For any rating of seven (7) or below, include comments explaining the rating in the report. This form also includes the appraisal of the traffic safety features, waterway adequacy and approach alignment. Note the name of the Inspection Team Leader as well as other inspectors on site during the inspection. The Engineer must sign, seal, and date the report. Include on the report the Engineer's firm number.
- **Bridge Inspection Follow-Up Action Worksheet/Form** – lists items noted during the inspection that should be addressed via repairs or maintenance. The TxDOT maintenance section number must be clearly shown on this form. Bridge inspectors shall utilize the Follow-Up Action Worksheet/Form to transmit follow-up action recommendations to District Bridge Offices.
  - The Engineer must sign, seal, and date the form, and include the Engineer's firm number.
  - District Bridge Inspection Coordinators shall transmit Follow-Up Action recommendations to responsible area engineers through e-mail. Districts may distribute to maintenance sections or other individuals. Each district will have a document outlining persons responsible for addressing Follow-Up Action recommendations (area engineers). District Bridge Inspection Coordinators shall work with district bridge engineers, directors of maintenance, and responsible area engineers to obtain status updates for the follow-up action recommendations to help ensure items are addressed in the recommended time period.
  - District Bridge Inspection Coordinators shall document and track on-system corrective actions, communication, related progress using a workbook listing NBI numbers, responsible area engineers, and progress of work completed for all

bridges. Until the Maintenance Module is implemented, districts will store on-system corrective action workbooks locally on the intranet in folders that are accessible only to staff directly involved with follow-up actions.

- District Bridge Inspection Coordinators shall provide quarterly summaries to BRG of the tracking, communication, and progress of on-system corrective actions via the summary workbook.
- District Bridge Inspection Coordinators shall upload photos provided by responsible area engineers or maintenance sections to the Bridge Inspection Management System, along with the completed Follow-Up Action Worksheet, to document completion of corrective actions taken in response to follow-up recommendations. The file name format shall be DD-CCC-CCCC-SS-SSS_FUAW_X_Complete_YYYY-MM-DD. The X shall represent the number of the FUAW listed in the routine inspection documents.

NOTE: Until the Maintenance Module of the Bridge Inspection Management Software is used statewide, one extra copy of this form is required for each on-system bridge, grouped by Maintenance Section to include all bridges within that Maintenance Section. Submit these copies to the District Bridge Inspection Office with each submittal, and they will be transmitted to TxDOT maintenance personnel by the District Bridge Inspection Office.

- **Bridge Inspection Follow-Up Action Worksheet Summary** – Summarizes the information from the Bridge Inspection Follow-Up Action Worksheets of all the bridges assigned in the work authorization. Submit the electronic worksheet, in Microsoft Excel format, to the District Bridge Inspection Office at the end of the work authorization. (Do not sign and seal.)
- **Elemental Data Inspection Record** – Collect elemental data for use in the State's Bridge Inspection Management System for all on-system structures. Collect information per span, with the exception of culverts which are to be collected by the structure. The Engineer will determine the Elemental Data and quantities in each condition state for each on-system bridge. Do this in accordance with the current AASHTO Manual for Bridge Element Inspection. (Do not sign and seal.)
- **Bridge Inventory Record** – Provide a description of the bridge with a detailed sketch if plans are not available for the bridge. If there have been no changes to the structure and the existing description and sketches or plans properly represent the condition in the field, a new form is not necessary; maintain the existing form in the file with no modification by the Engineer. If there is no form in the file, a new form is to be completed by the Engineer. If plans are unavailable, complete both sides of the form. If plans are available, complete only the front side. Show the maintenance section number on the form. The Engineer

must sign, seal, and date the form. Scan a signed and sealed copy and import it into `the Bridge Inspection Management System`. If major (structural) changes have been made to the structure, complete a new "Bridge Inventory Record" form that is signed and sealed by the Engineer.

- **Bridge Inventory Record Revisions –** Use this form only for minor (non-structural) changes to the Bridge Inventory Record. (Do not sign and seal.) Scan and import the document into the Bridge Inspection Management System.
- **Channel Cross-Section Measurements Record –** Complete this form for each span bridge over a waterway (whether the waterway is wet or dry). This form is not required for culverts. The Engineer will take measurements on the upstream side of the bridge starting at the abutment. Take the measurements from a fixed bridge reference down to the channel bed. Take these measurements at each bent, at each significant change in the channel bed, and at the midpoint of the channel. Record the horizontal distance between each vertical measurement, as well as the cumulative horizontal distance from the beginning of the bridge abutment. Record several reference dimensions, including top of water level (see the form). The Engineer must add comments on the back of the form. (Do not sign and seal.)
- **Upstream Channel Cross-Section Sketch –** Required for span-type bridges only. (Culverts do not require an upstream channel sketch or any update to any such sketch that may be already in the file. Calculations of sediment material quantities are not required.) If there is an existing channel cross section plotted to scale in the inspection record, bring it forward into the current report and plot the new data on it in a different color ink. The Engineer is to initial and date the new plot. If the channel profile has not changed from the previous inspection, the Engineer is to initial and date a note stating that no significant change has occurred. For all bridges that have plans available, plot the channel section on a copy of the bridge layout sheet(s) from the plans. If plans are not available, draw a sketch using appropriate scale. It is acceptable for the horizontal and vertical scales to differ. (Do not sign and seal.)
- **Underclearance Record –** Record horizontal clearance information for on-system underpasses only. Draw a brief sketch indicating dimensions and reference points for collected horizontal clearance data. Provide all dimensions from a fixed reference point. Ultrasonic measuring is not acceptable. (Do not sign and seal.)

Inspection File Contents - Off System Bridges

The following documentation is to be completed for each off-system bridge. `All inspection documentation is to be entered and uploaded electronically within the Bridge Inspection Management System`.

- **Bridge Inspection Record –** Delineates the basic components of the bridge to be inspected. Enter a rating for each element of each component following guidelines from the National Highway Institute (NHI) Safety Inspection of In-Service Bridges two-week training course and in accordance with the current TxDOT Bridge Inspection Manual Coding Guide. For any rating of seven (7) or below, include comments explaining the rating in the report. This form also includes the appraisal of the traffic safety features, waterway adequacy and approach alignment. Note the name of the Inspection Team Leader as well as other inspectors on site during the inspection. The Engineer must sign, seal, and date the report. Include on the report the Engineer's firm number.

- **Elemental Data Inspection Record** – Collect elemental data for use in the State's Bridge Inspection Management System for all off-system structures on the National Highway System or owned by Harris County. The Engineer will determine the Elemental Data and quantities in each condition state for each off-system bridge. Do this in accordance with the current AASHTO Manual for Bridge Element Inspection. (Do not sign and seal.)
- **Bridge Inventory Record** – Provide a description of the bridge with a detailed sketch if plans are not available for the bridge. If there have been no changes to the structure and the existing description and sketches or plans properly represent the condition in the field, a new form is not necessary; maintain the existing form in the file with no modification by the Engineer. If there is no form in the file, a new form is to be completed by the Engineer. If plans are unavailable, complete both sides of the form. If plans are available, complete only the front side. The Engineer must sign, seal, and date the form. Scan a signed and sealed copy and import it into the Bridge Inspection Management System. If major (structural) changes have been made to the structure, complete a new "Bridge Inventory Record" form that is signed and sealed by the Engineer.

NOTE: For off-system bridges, these forms and sketches serve as as-built plans in many cases because original plans are not available. When plans are available and copies are included in the file, a detailed sketch is not required; however, the Engineer must complete the front side of the Bridge Inventory Record.

- **Bridge Inventory Record Revisions** – Use this form only for minor (non-structural) changes to the Bridge Inventory Record. (Do not sign and seal.) Scan and import the document into the Bridge Inspection Management System.
- **Channel Cross-Section Measurements Record** – Complete for each span bridge over a waterway (whether the waterway is wet or dry). This form is not required for culverts. The Engineer will take measurements on the upstream side of the bridge starting at the abutment. Take the measurements from a fixed bridge reference down to the channel bed. Take these measurements at each bent, at each significant change in the channel bed, and at the mid-point of the channel. Record the horizontal distance between each vertical measurement, as well as the cumulative horizontal distance from the beginning of the bridge abutment. Record several reference dimensions, including top of water level (see the form). The Engineer must add comments on the back of the form. (Do not sign and seal.)
- **Upstream Channel Cross-Section Sketch** – Required for span-type bridges only. (Culverts do not require an upstream channel sketch or any update to any such sketch that may be

already in the file. Calculations of sediment material quantities are not required.) If there is an existing channel cross section plotted to scale in the bridge inspection record, bring it forward into the current report and plot the new data on it in a different color ink. The Engineer is to initial and date the new plot. If the channel profile has not changed from the previous inspection, the Engineer is to initial and date a note stating that no significant change has occurred. For all bridges that have plans available, plot the channel section on a copy of the bridge layout sheet(s) from the plans. If plans are not available, draw a sketch using appropriate scale. It is acceptable for the horizontal and vertical scales to differ. (Do not sign and seal.)

- **Underclearance Record –** Complete this form for all grade separations, including pedestrian, utility, and railroad underpasses. Draw a brief sketch indicating dimensions and reference points for collected vertical and horizontal clearance data. Reference in Item 54.2 the exact minimum vertical clearance under the structure. The vertical clearance sign must read at least 3 in. lower than the minimum measured vertical clearance of the roadway. Ultrasonic measuring is not acceptable. (Do not sign and seal.)
- **Bridge Summary Sheet –** Complete this form for all off-system bridges. Summarize each component rating, areas of deterioration of the bridge, and recommend how to repair the bridge. Indicate previous, observed and recommended load posting, record current status of all signs, and denote materials needed to properly post the bridge. The Engineer must document the condition, location, and number of all signs in place on the date of inspection for all load posted bridges. Also record the load limit shown on existing load posting signs. Document these signs with legible photographs. The Engineer must sign, seal, and date the form.
- **Summary of Needed Load Posting Materials –** Use this summary to order signs/hardware needed for load posting on off-system bridges. Prepare a summary for each county, precinct and/or city, as agreed upon with the District Bridge Inspection Office, to insure each local jurisdiction has the materials necessary to properly post all of their bridges. Submit the summary to the District Bridge Inspection Office, never directly to a local jurisdiction. Complete the summary using the form supplied by TxDOT. (Do not sign and seal.)

Section 4 — Calculations

General Calculation Requirements

Provide bridge load rating calculations in accordance with currently accepted TxDOT bridge inspection procedures as described in this manual and in other associated documents such as the *Bridge Inspector's Reference Manual*, [1] the *Manual for Bridge Evaluation*,[2] and the *Standard Specifications for Highway Bridges*.[3] Note that the methods of calculation are different for on- and off-system bridges.

A qualified licensed Professional Engineer must sign, seal and date all calculations and/or documentation referring to load rating capacity. Date, sign and seal documents in accordance with the requirements given in this chapter and with the Texas Engineering Practice Act.[4] It is acceptable to only initial and date the calculations and seal only the Bridge Summary Sheet, which summarizes the results of the calculations, rather than sign, and seal each page of the calculations themselves. It is also acceptable, if you are in agreement with the previous calculations, to provide a statement concurring with the existing calculations. Import all calculations, along with pertinent plan sheets, into the Bridge Inspection Management System. If the engineer concurs with existing calculations, scan and import the original calculations and concurrence statement into the Bridge Inspection Management System. Sign, seal and date any concurrence statement.

Calculations for On-System Bridges

Perform bridge load rating analyses (calculations) and submit them in the findings. If no deficiencies are noted, limit the analysis to the superstructure of the bridge. According to the Manual for Bridge Evaluation[5], substructures should be rated if the engineer believes that the condition of a substructure element has the potential to control the load rating for the entire bridge. However, provide load rating analysis for any element that has any condition rating of 4 or less. All

1. Bridge Inspector's Training Manual 90, FHWA, 1991.
2. Manual for Condition Evaluation of Bridges, AASHTO, 1994.
3. Standard Specifications for Highway Bridges, AASHTO, 1994.
4. Occupations Code, Section 1001.401. Texas Administrative Code, Title 22, Section 131.166.
5. AASHTO Manual for Bridge Evaluation, 2018.

on-system bridge records must have documentation in the files to support any recommended changes in load ratings.

Perform all load rating calculations for on-system bridges not designed using Load and Resistance Factor Design (LRFD) using the "Load Factor" method as illustrated in AASHTO's *Manual for Bridge Evaluation* [1] with no exceptions. Load rate on-system bridges designed by LRFD using the Load and Resistance Factor Rating (LRFR) method as illustrated in *AASHTO's Manual for Bridge Evaluation*. When on-system ratings are calculated, present them to the State in HS loading for Inventory and Operating Ratings and in Rating Factor for SHV and EV Ratings. Some analyses may involve bridges that have section loss or damage to structural members. In these cases, verify and document the conditions of members and incorporate those findings into the analysis. The Inventory Rating (Item 66) can be assumed to be at least equal to the design loading if no damage or deterioration exists and the original design load was HS-20 or HL-93.If assumed load ratings of HS-20 or HL-93 based on the original design loads are to be used, then add plans sheets, preferably including the superstructure, with the design load called out to the Bridge Record by scanning the applicable plan sheets and importing them into the Bridge Inspection Management System.

Special attention is called to the coding of Items 41, 41.1, and 41.2 (operational status and posting limits). Verify these items and revise them, if needed, for all bridges to ensure that all posting, posting recommendations, closures and closure recommendations are properly reflected in the Bridge Record. Notify the District Bridge Inspection Office immediately of any bridges recommended for closure, and include details and calculations.

Calculations for Off-System Bridges

Provide bridge load rating calculations in accordance with the State's bridge inspection policy. Only Load Factor analysis is acceptable for most off-system structures; Allowable Stress methods should only be used for timber and masonry bridges. The Texas Bridge Load Rating Program (TBLR) which calculates load ratings using a Working-Stress analysis is acceptable. For all timber, steel, and truss bridge files, document calculations for load ratings of all structural elements that apply, including the deck, stringers or beams, truss members, bent caps, and piling or columns. The TBLR program will give an Inventory (INV) and Operating (OPR) rating both for H and HS truck loading. Use Figure 8-1, the Simplified Load Posting Procedure in the Bridge Inspection Manual, applying the H-loading to the table, to select the proper load posting sign type and weight limits. Load rating documentation, including assumptions, is required in the files for all bridge class structures (including culverts). Bring into conformance to current TxDOT policy concerning assumed ratings, etc. any assumed load ratings for concrete structures. For all off-system bridge files, for all bridge types, include documentation in the files to support changes in load ratings. When off-system ratings are

1. Manual for Bridge Evaluation, AASHTO, 2008, with current revisions.

calculated, present them to the State in HS loading for Inventory and Operating Ratings and in Rating Factor for SHV and EV Ratings.

Special attention is called to the coding of Items 41, 41.1, and 41.2 (operational status and posting limits). Verify these items and revise them, if needed, for all bridges to ensure that all posting, posting recommendations, closures and closure recommendations are properly reflected in the Bridge Record. Notify the District Bridge Inspection Office immediately of any bridges recommended for closure, and include details and calculations. The State will set a time to meet with the Engineer to review the findings, and the State will notify the bridge owner.

SIMPLIFIED LOAD POSTING PROCEDURE

This procedure is appropriate for computing posting loads equivalent to the inventory rating. Approximations are involved which make this procedure unacceptable at load levels higher than the Inventory Rating.

The posting load in pounds is the product of the RATING MULTIPLIER and the INVENTORY RATING in tons for the standard "H" truck. In selecting the RATING MULTIPLIER from the table use the longest simple span length or 80% of the longest continuous span length, whichever gives the longest span length for the bridge. If the resulting span length is 160' or greater, then the bridge should receive an analysis more exact than this procedure.

The recommended posting increments are listed below. Round off to the nearest increment listed.

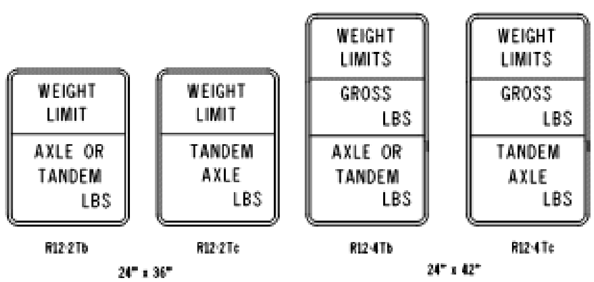
Post axle and gross load for span lengths 40' and greater. Post axle load only for span lengths 39' and less. Weight limit signs should conform to the Texas Manual on Uniform Traffic Control Devices. The recommended signs are R12-2Tb or R12-4Tb except if the axle load is noted "*" use signs R12-2Tc or R12-4Tc.

EXAMPLE 1
35' Simple Span Slab & Girder Bridge, H14 Rating
Axle = 14 x 1,450 = 20,300 lbs.
Post 21,000 tandem axle (Signs R12-2Tc)

EXAMPLE 2
120' Pony Truss, H7 Rating
Axle = 7 x 1,450 = 10,100 lbs.
Gross = 7 x 2,300 = 16,100 lbs.
Post 10,000 lbs. Axle or tandem and 16,000 lbs. Gross (sign R12-4Tb)

EXAMPLE 3
30'-40'-30' Continuous Slab Bridge with
25' slab approach spans, H10 Rating.
0.80 x 40' = 32'>25' = Use 32' span
Axle = 10 x 1,480 = 14,800 lbs.
Post 15,000 lbs. Axle or tandem (Sign R12-2Tb)

EXAMPLE 4
25' Simple Span Timber Bridge, H2 Rating
Axle = 1,550 x 2 = 3,100 lbs.
Recommendation: Close bridge until repair increases capacity.



SPAN	RATING MULTIPLIER	
	AXLE OR TANDEM	GROSS
FEET	LBS. H-TON	LBS. H-TON
≤ 20	1,600	
25	1,550	
30	1,500	
35	1,450	
40	1,450	3,100
45	1,450	2,950
50	1,450	2,800
60	1,450	2,600
70	1,450	2,500
80	1,450	2,450
90	1,450	2,400
100	1,450	2,350
120	1,450	2,300
140	1,450	2,250
160	1,450	2,200

LOAD INCREMENTS FOR AXLE OR TANDEM LBS.	LOAD INCREMENTS FOR GROSS LBS.
5,000	8,000
7,500	10,000
10,000	12,000
12,500	14,000
15,000	16,000
17,500	20,000
21,000*	24,000
24,000*	28,000
28,000*	32,000
32,000*	36,000
	40,000
	44,000
	48,000
	52,000
	60,000
	68,000
	76,000

*Axle load exceeds 20,000 lbs. Single axle limit, therefore post for tandem axle (Signs R12-2Tc or R12-4Tc).

Figure 8-1. Simplified Load Posting Procedure

Section 5 — Data Submittal

General Data Submittal Requirements

Consultants shall provide monthly submissions of files unless otherwise directed by the District Bridge Inspection Office. If necessary, bridge folders (hardcopy documentation) may be submitted to the District Bridge Inspection Office by mail or delivered in person.

All data included in the Bridge Record are prepared to meet the requirements given in the various controlling regulations given in Appendix A. Texas requires that updates to the electronic Bridge Inventory File be made within 90 days for all bridges. This includes updating inspection findings, adding new bridges to the inventory, documenting modifications to existing bridges, and making changes to the status of bridges (load posting changes and closures).

Photographs

Provide photo documentation using digital photographs having a minimum resolution of 300 dpi. Include a caption noting the direction, location, and description of each photo. Import the photo documentation into the Bridge Inspection Management System.

Include the following photographs in each bridge file (minimum):

- **Roadway View.** Photograph along the centerline of roadway showing a view of the bridge as seen from the roadway. If the bridge is load restricted, take a photograph from each approach. The photograph must be taken from a point of reference that includes the weight limit signs that are present, damaged, or missing. Weight limit signs must be legible in any photos that are taken.
- **Elevation View.** Photograph the bridge showing the overall length. (It may be impossible to show the entire structure length on long structures. In these cases, use an oblique angle at a further distance to attempt to capture an overall picture. Do not submit multiple pages of photographs attempting to show every part of a long structure.)
- **Underside View.** Photograph the bridge showing the type of superstructure and typical condition. (Bridges with several types of superstructures will require additional photographs.) The underside photo of the superstructure is not required for box culvert structures.
- **Stream or Roadway below the Bridge.** Photograph the bridge from below showing the stream or roadway as it passes under the bridge. The photos of the stream should show evidence of scour if applicable.
- **Upstream and Downstream Channel Views.** Photograph the condition of the channel upstream and downstream of the bridge. Take these photos from the bridge deck unless geometry and/or traffic conditions make that unsafe.

- Detail Photographs for Component Ratings of 4 or less. Photograph in detail all components rated 4 or less on the Bridge Inspection Record. Note details of the component rating on the photograph caption.
- **Photographs of Recommended Immediate Maintenance Needs.** Photograph previously unphotographed recommended maintenance needs that should be performed immediately.

Presentation of Documents

All inspection results submitted to the District Bridge Inspection Coordinator shall be submitted via the Bridge Inspection Management System. Provide TxDOT with the following information, in list format, at the end of the Work Authorization. Include in the list format the facility carried, as well as the NBI number.

- **A list of bridges recommended for fracture critical or underwater inspections.** Include only bridges to be added to the District's current fracture critical or underwater list. All current fracture critical and underwater (requiring scuba diver) bridges should be previously coded. Send a copy of this list to the Bridge Division Inspection Branch.
- **A list of all bridges that the condition rating has lowered to a 4 or less.** Include any bridge with a rating of 4 or less, which is not currently rated a 4 or less, or less on any component on the Bridge Inspection Record.
- **A list of all bridges requiring changes in operational status.** Include the bridges that do not meet State Load Posting Policy and require load restrictions. Sort and group these bridges by local jurisdiction if not on-system bridges.
- **A list of all recommended changes in vertical clearance signs.** (off-system only)
- **A list of bridges with missing or inaccurate coordinates.** Include new coordinates collected by a hand held GPS unit and provide them in a decimal format. Sub-meter, differentially corrected data is not required. Send a copy of this list to the Bridge Division Inspection Branch.

On-System Data

Submit the data and files for each on-system bridge, via the Bridge Inspection Management System. Make sure files are scanned into the Bridge Inspection Management System according to the list in Section 7 below.

Off-System Data

Submit one (1) set of original files and (1) set of summary packages for each off-system bridge. Relate the items to be included in the summary package to each local jurisdiction as detailed below.

Summarize the bridge conditions, load posting requirements, and needed maintenance repairs of all bridges within that jurisdiction.

Summary Packages

Prepare a standard Off-system Summary Package for each jurisdiction (e.g. each city, county, precinct, contact point, etc., as agreed upon with the District Bridge Inspection Office). The packages are intended to be summary reports for bridge inspection findings, maintenance items needed, and load posting requirements. The package of files should be transmitted on a password protected external storage drive or via DropBox password protected zip files, and transmitted to the District Bridge Inspection Office.

The format will be designated by the District Bridge Inspection Office and forwarded to the owning jurisdiction by the State. Include the following for each bridge in this summary package:

- Color copies of photos
- Bridge Inspection Record
- Bridge Summary Sheet
- Summary of Needed Load Posting Materials

Scour Records and Reports

Many bridges are susceptible to scour of the foundations and abutments from flowing water. These bridges are screened and classified for their potential for scour. Various scour reports, calculations, and photos are necessary to document the scour potential. Scour information should be included within the bridge record on the Bridge Inspection Management System. All bridges over waterways must have a scour evaluation and Scour Summary Sheet available within the Bridge Inspection Management System.

- Per the TxDOT Bridge Project Development Manual, a scour analysis is required for all new bridges over waterways.
- District Bridge Inspection Staff will work with Bridge Division to ensure new structures have accurate scour coding within 90 days of the date of the initial inspection. Scour documentation will be uploaded to the Bridge Inspection Management System.
- All existing structures over waterways require scour evaluations and a Scour Summary Sheet, and these items will be uploaded to the Bridge Inspection Management System.

- All structures coded as Scour Critical (Item 113 less than or equal to 3) require a Scour Plan of Action (POA) and the documentation will be uploaded to the Bridge Inspection Management System by District Bridge Inspection Staff.
- Any structure with a change in scour vulnerability shall have the coding of Item 113 updated within 90 days of the inspection or scour evaluation date.

Section 6 — The Bridge Record

The following files should be saved within the Bridge Inspection Management System for each bridge asset:

1. Location map with bridge highlighted
2. All current inspection photos (including deterioration photos)
3. All other photos from previous inspections in chronological order
4. Bridge Summary Sheet (off-system)
5. Bridge Inspection Follow-Up Action Worksheet (on-system)
6. Bridge Inspection Record
7. Current Load Rating Calculations (or copies of design plans and/or indexing information)
8. Bridge Inventory Record (must include detailed sketch if plans are not in file), and Revision to Bridge Inventory Record form (if applicable)
9. Underclearance Sketch (if applicable)
10. Channel Cross-Section Measurements (if applicable)
11. Channel Cross-Section Sketch (if applicable)
12. Secondary Scour Screening Form (if applicable)
13. Form 113.1 (previously completed if applicable)
14. Any scour-related reports/documents (or indexing information, if applicable)
15. All scour photos
16. Elemental Data Report (field forms are not required)
17. Special Inspection Records and Reports (Underwater Inspection, Fracture Critical Inspection, etc.)
18. Bridge Structural Condition History Sheet
19. Previous inspections and all attachments in chronological order
20. Final Bridge Plans (as-builts)

Section 7 — Open Records Requests

TxDOT Open Records Coordinators, District Bridge Engineers, or other staff may contact the Bridge Division Open Records Coordinator for all Open Records Requests related to bridges.

Bridge Inspection Reports

Bridge inspection reports and other bridge inspection documentation are confidential under the Texas Homeland Security Act and 23 USC Section 409, Safety Sensitive Information. Bridge Inspection documentation includes items such as inspection reports, inspection photo reports, follow up actions, load rating, and scour evaluation.

In some cases, open records requests may require input from the General Counsel Division (GCD) and the Attorney General. When involving GCD to request an Attorney General review to withhold information, the request must be sent to GCD within 10 business days of when the request was received.

List of Inspection Consultants

The list of current inspection consultants is available for release. Contact the Bridge Division Open Records Coordinator to obtain the most current list.

Section 8 — File Security

Transferring Information to Local Bridge Owners

Bridge inspection files must be securely transferred to local government bridge owners. Acceptable methods to transfer bridge inspection files are to Drobox password protected zip files or password protected jump drives. District Bridge Inspection Coordinators shall retain records of transmittal and record of receipt of bridge inspection files. Drobox sends notification emails that files have been “picked up”. Saving this message will suffice for proof of transfer. Thumb drives can by physically signed for when handed over. If mailed, that should be done with certified mail as proof of delivery from the Post Office or other carriers with signature-required delivery.

Securing Hard Copy Bridge Inspection Files

All Bridge Inspection files are to be securely stored with limited access. Acceptable methods for securing files are to keep locked in cabinets or kept in rooms with limited access. Bridge inspection files at individuals' workstations shall be secured in locked drawers when not in use. Inspectors must take measures to ensure files remain secure while in the field and in transit.

Disposing of Hard Copies

Any destruction of hard copies should be done in a secure manner such as shredding. All destruction shall be in accordance with TxDOT Document Retention Policy. It is noted that the official copy of bridge inspection information resides electronically in the Bridge Inspection Management System. As historical hard copies are scanned and uploaded to the System the destruction of hard copies must only occur after the electronic copies are verified to be in place in the System. The document retention requirement for Bridge Inspection Information is the Life of the Asset plus 3 years. If hard copies are scanned, uploaded, and verified, the historical copies can be destroyed without waiting since the official copies are in the System. Refer any questions on this policy to the Bridge Inspection Program Manager.

Chapter 9 — Quality Control/Quality Assurance Program

Contents:

Section 1 — Introduction of the Quality Control / Quality Assurance Program

Section 2 — Bridge Inspection Program Organization

Section 3 — Quality Control

Section 4 — Quality Assurance

Section 1 — Introduction of the Quality Control / Quality Assurance Program

Quality Control/Quality Assurance Program

Title 23, Code of Federal Regulations (CFR), Part 650, Subpart C, Section 313, paragraph (g), Quality Control and Quality Assurance, requires each state to assure that systematic Quality Control (QC) and Quality Assurance (QA) procedures are being used to maintain a high degree of accuracy and consistency in their inspection program. The Texas Department of Transportation's (TxDOT's) Bridge Division is tasked with developing a QC/QA Program that fulfills this requirement. It is, however, the responsibility of all personnel involved with the Bridge Inspection Program (BIP) to implement the QC/QA Program.

Accuracy and consistency of the inspection data collected, the manner in which the bridge inspections are performed, and how the data is reported is critical to ensuring long-term reliability of the bridge inventory.

The QC/QA program influences all office and field BIP activities including:

- pre-inspection preparations,
- bridge inspections,
- load ratings,
- QC/QA procedures,
- data reporting, and
- all follow-up activities such as maintenance, repair and load posting.

Definitions

Quality

For purposes of the TxDOT bridge inspection QC/QA Program, the word quality is used and defined in terms of measurable variations from established procedures, practices, and requirements that are in accordance with National Bridge Inspection Standards (NBIS) as well as additional TxDOT requirements. The additional TxDOT requirements can be found in Chapter 3 of this manual, "Qualifications and Responsibilities of Bridge Inspection Personnel" and the current bridge contracts.

The Federal Highway Administration (FHWA) monitors 23 metrics for evaluating the performance of a State's BIP. These 23 metrics address components of and define different levels of compliance with the NBIS including:

- Section 650.307 Bridge inspection organization,

- Section 650.309 Qualifications of personnel,
- Section 650.311 Inspection frequency,
- Section 650.313 Inspection procedures, and
- Section 650.315 Inventory.

TxDOT is committed to attaining a quality assessment that measures no less than a level of compliance with all 23 NBIS metrics and TxDOT requirements, and to continuously pursue more effective measures leading to the compliance of such standards and requirements. Additionally, TxDOT will continuously strive toward implementing effective and comprehensive measures that enhance the overall quality and consistency of the BIP.

Quality Control

CFR Title 23, Part 650, Subpart C - NBIS, Section 650.305, defines Quality Control (QC) as "Procedures that are intended to maintain the quality of a bridge inspection and load rating at or above a specified level." These procedures will be implemented on an on-going basis for issues related to program organization and within specific time frames for review task related issues.

Quality Assurance

CFR Title 23, Part 650, Subpart C – NBIS, Section 650.305, defines Quality Assurance (QA) as, "The use of sampling and other measures to assure the adequacy of quality control procedures in order to verify or measure the quality level of the entire bridge inspection and load rating program." These procedures have the effect of identifying needed changes to policy, guidelines, etc. and permitting for continual improvements to QC protocol thus allowing for a more efficient and effective BIP.

Goals

TxDOT Bridge Division's QC/QA Program aims to:

- generate greater accuracy, consistency, and uniformity of the data collected and in the methodology employed for collecting and reporting this data,
- standardize the interpretation and prioritization of inspection findings,
- establish and monitor the qualifications of personnel involved in the program,
- identify and address unclear or misleading information in the bridge inspection guides and manuals, and
- increase communication between personnel involved in the BIP at all levels (Division, District, Consultants, Sub-Consultants, and FHWA).

These goals can be achieved through the establishment and application of procedures and protocols that are practical and pertinent to the BIP. The QC/QA Program allows for checks and balances over these procedures and protocols through periodic and independent inspections, reviews, and evaluations.

Section 2 — Bridge Inspection Program Organization

TxDOT's BIP organization is structured into workgroups that are distinguished according to employment role and location from which inspection tasks are administered. The different workgroups include the Bridge Division, District Bridge Sections, and Consulting Firms.

Bridge Inspection Program Organization

Bridge Division

At the top of TxDOT's bridge organization is the Bridge Division. The Bridge Division is responsible for overseeing and managing the TxDOT BIP. Priority responsibilities include:

- developing policies and procedures for the proper management of the bridge inspection process,
- providing support and guidance to the state District Bridge Sections including training, approval of consultant staff for routine inspections, and inspection equipment availability,
- managing the Consulting Firm's contracts for bridge inspection services,
- in-house performance of fracture critical and underwater inspections; other inspections may be performed at the Districts' request (initial, routine, damage, in-depth, and special),
- performing load ratings,
- overseeing the QC/QA program,
- managing the `Bridge Inspection Management System` (consisting of all bridge inventory and inspection data),
- reporting inspection data to FHWA and resolving any concerns arising from that data,
- developing and analyzing bridge data for statewide planning needs, and
- verification of compliance with the FHWA metrics.

District Bridge Section

District bridge personnel manage the day-to-day operation of the BIP for On- and Off-System structures located within their respective boundaries. There are 25 District Bridge Sections in TxDOT. These personnel serve as the implementation force for many of the tasks that relate to NBIS and FHWA metric requirements. It is essential that open and effective communication exists between the Bridge Division and District bridge inspection personnel to carry out these tasks efficiently. District responsibilities include but are not limited to:

- maintaining and being familiar with an accurate inventory of bridges,

- overseeing and managing the Consulting Firm's inspection services,
- assuring NBIS compliance of personnel and bridge inspections/report documentation,
- overseeing the load posting of bridges,
- implementing and documenting QC practices,
- inputting information directly into the State's `Bridge Inspection Management System`,
- coordinating the assignment of permanent structure numbers (PSNs),
- reviewing bridge conditions for recommendations regarding repair, rehabilitation or replacement for consideration by others,
- in-house performance of initial, routine, damage, in-depth, and special inspections,
- communicating with the local jurisdictions regarding management of Off-System bridges,
- supporting District maintenance in-house personnel with bridge maintenance inspections, training, management software support, bridge repair planning, etc., and
- performing Provider Evaluations for each work authorization.

Bridge Inspection Consulting Firm

The safety of highway bridges in Texas depends on the effective management of approximately 55,000 bridges the National Bridge Inventory (NBI). TxDOT does not employ the required personnel to perform the inspection of such a vast inventory. It therefore contracts with private engineering consulting firms for inspection services. Consulting Firm bridge inspectors are responsible for:

- performing bridge inspections (routine, fracture critical, or underwater),
- `performing load ratings`
- generating the documentation associated with the inspections performed through their services,
- `providing recommended follow up actions for bridge maintenance`
- inputting information directly into the `Bridge Inspection Management System`, and
- implementing the Consulting Firm's QC Program.

A Consulting Firm directly hired by TxDOT through a contract to perform bridge inspections is identified as the Prime Consultant.

A Sub-Consultant is an extension of the Prime Consultant's workforce. Staff from a Sub-Consulting Firm performs the same services for the State as staff from the Prime Consulting Firm. Staff from the Prime Consulting and Sub-Consulting Firms are held to the same ethical and quality standards as TxDOT personnel while performing inspection work.

Bridge Inspection Program Staff Requirements

The NBIS have specific qualification requirements for several of the principal players in a BIP. Chapter 3 of this manual, "Qualifications and Responsibilities of Bridge Inspection Personnel" discusses in detail the qualifications, required training, and responsibilities of each of the key BIP staff members.

TxDOT Bridge Inspection Program Staff

Bridge Division Staff

- **Program Manager**

  The TxDOT Bridge Inspection Program Manager is a member of the Bridge Division staff and provides guidance and support to all personnel involved in the BIP. The Program Manager has the responsibility of overseeing the operation of the entire program. Regardless of the personnel involved and delegated responsibilities, the Program Manager is ultimately responsible for assuring that the BIP remains in compliance with the NBIS and FHWA metrics.

- **Team Leader**

  A Team Leader (TL) is responsible for guiding an inspection team and oversees the planning, preparation, and performance of bridge inspections. Although a TL may not perform every aspect of the bridge inspection, a TL must be present from beginning through completion of an inspection, be an active participant of the inspection, and must sign the inspection reports. A TL can perform or oversee initial, routine, damage, in-depth, special, and QC Re-Inspections. Underwater and Fracture Critical inspections require specially trained TLs. (See Section 3, "Quality Control," of this chapter for discussions on Re-Inspections for the different staff members.)

  In addition, TxDOT personnel ultimately responsible for assigning and approving the work performed by a Consultant's or Sub-Consultant's staff must meet the qualifications of a TL.

- **Load Rating Engineer**

  TxDOT Bridge Division will employ a professional engineer knowledgeable and capable of performing load rating calculations that determine the capacity and stress limits of a bridge. The Load Rating Engineer will work directly under the direction of the Program Manager at the Bridge Division and will support TxDOT statewide needs for bridge load rating analysis.

- **QA Engineer**

  The QA Engineer will perform statewide QC/QA of the BIP with the goal of ensuring a high degree of accuracy and consistency in the operation and functions of the BIP. The QA Engineer will report directly to the Program Manager at the Bridge Division and will support and work in conjunction with other Division, District, and Bridge Inspection Consulting Firm personnel involved with the TxDOT BIP.

- **Underwater Unit**

  Members of the Underwater (UW) Unit performing underwater inspection activities will be knowledgeable in bridge inspection and skilled in diving techniques. At least one member of the UW Unit will be a qualified TL.

  The Program Manager and UW Unit will ensure that an underwater-qualified TL is present during the performance of all UW Inspections. All underwater inspection personnel will work under the direction of the Program Manager and will support needs for TxDOT UW Inspections statewide. All UW Unit members must have successfully completed the required training.

- **Fracture Critical Unit**

  The Fracture Critical (FC) Unit consists of FC Inspectors and specialized equipment operators, some of whom are TLs.

  The Program Manager and FC Unit will ensure that a fracture critical-qualified TL is present during the performance of all FC Inspections. Personnel performing FC Inspections will be knowledgeable in FC Inspection techniques and will have successfully completed the required training to perform such inspections.

  The FC Unit works under the direction of the Program Manager and supports needs for TxDOT FC Inspections statewide.

District Bridge Section Staff

- **Bridge Engineer**

  The District Bridge Engineer (BE) is directly responsible for bridge inspection operations within the District. A BE implements and monitors the BIP in a District under the general guidance of the Bridge Division Program Manager. A BE also manages tasks centered around the planning, design, and maintenance of bridges. The BE may function as the District's inspecting TL and oversees the work of a District Bridge Inspection Coordinator.

- **Bridge Inspection Coordinators and Bridge Section Staff**

  Bridge Inspection Coordinators (BIC) and Bridge Section Staff are personnel located in the District. These personnel manage the day-to-day operation of District inspection activities and perform the same general tasks as TLs. If a BIC is not a qualified TL, these personnel should refrain from performing NBIS bridge inspections on their own and should have a qualified TL oversee the inspection work they perform.

- **District Team Leader**

Same qualifications and responsibilities as those for a TL in the Bridge Division – See section Bridge Division Staff, Team Leader.

Bridge Inspection Consulting Firm Staff

- **Consulting Firm Project Manager**

  Consulting Firms that are contracted by TxDOT to perform bridge inspection services must have a Project Manager (PM) on board that is responsible for coordinating with State personnel and for managing the work assigned to the firm.

  A firm that is directly contracted by TxDOT to perform bridge inspection services is known as a Prime Consultant. A firm that is employed by the Prime Consultant to assist in performing bridge inspection services for TxDOT (under the Prime Consultant's contract) is known as a Sub-Consultant. All communication between TxDOT and a contracted firm will take place via the Prime Consultant.

  The Prime Consultant PM ensures that the inspection work is performed according to the Scope of Services provided in the contract, that this work is performed in a timely manner according to schedules as described in the Work Authorizations, and that the work is of high quality. These performance standards apply regardless of whether the PM is managing personnel directly employed by the Prime Consultant or by the Sub-Consultant.

- **Consulting/Sub-Consulting Firm Team Leader**

  A Consultant TL performs the same tasks for bridge inspection as that described for a TxDOT TL (see section Bridge Division Staff, Team Leader). The inspections performed by a Consultant TL are to be performed consistent with the requirements noted under Attachment C - "Services to be Provided by the Engineer" of the current bridge inspection contract. These requirements are applicable to Consultant and Sub-Consultant TLs.

- **Consulting/Sub-Consulting Firm Load Rating Engineer**

  Consulting Firms providing bridge inspection services for TxDOT will employ a professional engineer knowledgeable and capable of performing load rating calculations that determine the load carrying capacity and stress limits of a bridge.

  Structural evaluation and load rating of a bridge structure will be necessary in instances where a structure has been designed for less than the current design standard or current conditions/deterioration warrants an evaluation and no appropriate analysis exists.

- **Consulting/Sub-Consulting Firm Underwater Bridge Inspection Team**

  Consulting Firms providing UW Inspection services for TxDOT will ensure that an underwater qualified TL is present during the performance of all UW Inspections and that the personnel performing UW Inspections are knowledgeable in diving techniques and have received training to perform such inspections.

The inspection work will be performed as stipulated in the Scope of Services of the current UW Inspection contract.

- **Consulting Firm Quality Control Program Personnel**

  Although there are currently no existing written guidelines that discuss requirements of a Consulting Firm's QC Program or the personnel in charge of managing it, a Prime Consulting firm under contract with TxDOT to perform bridge inspections will have a QC Program in place. The purpose of the Consulting Firm's QC Program is to ensure that the contract deliverables to TxDOT, submitted by Prime Consultant and Sub-Consultant personnel, are of high quality.

Section 3 — Quality Control

Quality Control Overview

NBIS defines Quality Control (QC) as "procedures that are intended to maintain the quality of a bridge inspection and load rating at or above a specified level."[1]

QC procedures are designed to assure a minimum level of compliance with standards while simultaneously aiming to improve the quality of the overall BIP. QC procedures are divided into two categories: Programmatic and Review Elements.

This section provides QC procedures as they apply to the different BIP workgroups (Bridge Division, District Bridge Sections, and Consulting Firms).

QC Programmatic Elements

Programmatic elements are those procedures that are tied to the operation of a structured on-going practice that is carried out throughout the year and requires the maintenance of documentation. Programmatic elements applicable to the BIP address the following areas:

- Bridge Inspection Program Organization,
- Bridge Inspection Personnel Qualifications,
- Inspection Planning Practices, and
- Bridge File Maintenance.

QC Programmatic Elements – Bridge Division

Bridge Inspection Program Organization

The Bridge Division Program Manager will keep a list of both District and Division personnel that administer the BIP and will update the list quarterly. The BIP personnel list will list names, role titles, and contact information.

The names, role titles, and contact information of all Consulting Firm personnel performing bridge inspection services for TxDOT under Prime Consultant and Sub-Consultant capacities, will be documented in a separate personnel list. Contact information for the assigned Consulting Firm will be provided to District personnel along with each routine inspection contract work assignment. This list will be updated on an as needed basis.

1. CFR Title 23, Part 650, Subpart C – National Bridge Inspection Standards, § 650.305

The TxDOT BIP personnel list will be made available electronically via the TxDOT Intranet, under the Bridge Division, Field Operations, Inspection directory as a link titled, “Bridge Inspection Contact List.” Refer to Appendix C for links to this information.

Bridge Inspection Personnel Qualifications

The Bridge Division Program Manager will maintain records documenting the qualifications, completion of required training (copies of class certificates) certifications, and bridge inspection experience of both District and Division TxDOT personnel that administer and manage the BIP. These records will be updated upon notification of individual's status changes and will be reviewed for accuracy on a yearly basis.

The Program Manager will maintain similar records for consultant PMs, TLs, and sub-consultant TLs. It is the responsibility of the PM of each Prime Consulting Firm to review and update personnel records if changes occur, and notify TxDOT with any changes. A list of consultant Approved Inspection Team Leaders is available through the TxDOT Intranet and Internet sites. The Approved Team Leader lists will be updated on a quarterly basis by the Inspection Branch of Bridge Division. Refer to Appendix C for links to this list.

Inspection Planning Practices

For any inspection (routine, FC, UW, etc.) performed by a TL, if possible, that person should refrain from participating in the inspection of the same structure during the next inspection cycle. This is intended to enhance the quality of the inspection program by providing for a different set of eyes on the same structure, thus enabling inspection results from different inspectors to be compared. It is important that organized, well documented records of the inspection findings and personnel involved with the inspections be kept. If there are major inconsistencies between the inspection findings reported by the two TLs, this can allow for analysis and discussion of the cause of the inconsistency so that overall quality can be improved. Inspection documents should clarify the roles of each individual participating in inspections.

Bridge File Maintenance

The Bridge Division UW and FC units maintain the inspection files for UW and FC inspections. The routine bridge inspection files for bridges with these types of inspections are maintained by the District Bridge Section. The District Bridge Section is able to access the completed UW and FC inspection files via the Bridge Inspection Management System; filters can be saved to view recently completed inspections.

QC Programmatic Elements – District Bridge Section

Bridge Inspection Personnel Organization and Qualifications

It is the responsibility of the District Bridge Engineer or District BIC to notify the Program Manager of any changes to personnel in the District Bridge Section or any changes discovered with the Consulting Firm staff, as well as any changes affecting personnel qualifications, as soon as this information is known.

It is the responsibility of the Consulting Firm PM to inform the Districts and the Program Manager of any change in inspection personnel or change in qualifications of personnel.

Inspection Planning Practices

It is important to keep organized records of inspection findings and personnel involved in the inspection of bridges. This is done to avoid having personnel perform an inspection on the same bridge(s) during consecutive inspection cycles, running the risk of becoming complacent with findings. In addition to keeping well organized records, open dialogue between personnel from the different BIP workgroups is essential to preventing this type of deficiency.

Inspection results from two different inspection TLs concerning the same bridge can be compared. Different perspectives and inconsistencies regarding the inspection procedures and/or results can be identified, discussed, and addressed thus increasing the quality of future inspections.

Bridge File Maintenance

The maintenance of the official electronic bridge file is an on-going task. Although the Bridge Division and Consulting Firm staff update and upload information to the Bridge Inspection Management System, as the asset owner, the ultimate responsibility for carrying out this task falls to the District Bridge Section personnel. Bridge files need to be updated within 90 days of changes to the bridge data as a result of inspection (routine, FC, UW, etc.). For example, rail upgrades, structure widenings, overlays, repairs, results from an inspection after a significant occurrence, etc., all require that documentation be uploaded into the Bridge Inspection Management System.

Completed documentation for an inspection performed by personnel from a Consulting Firm is uploaded into the Bridge Inspection Management System. It is the responsibility of the District Bridge Section personnel to ensure that these tasks are performed thoroughly and according to existing guidelines.

Refer to Chapter 8 of this manual, "Bridge Records," for detailed information regarding bridge documentation electronic filing, documentation requirements, etc. Requirements for secure storage of remaining hard copy files are given in this chapter as well.

QC Programmatic Elements – Bridge Inspection Consulting Firm

These practices are internal to each Consulting Firm and will not be discussed in this manual.

Quality Control Review Elements

Review elements are those procedures and protocols that are tied to specific tasks related to the bridge inspection process that occur during a specific time frame. The purpose of these procedures is to ensure that the *quality* of the bridge inspection process (office and field efforts) is maintained. The Reviewer is evaluating the *quality* of the bridge inspection process by confirming that there is a relationship between the inspection documentation and the reported findings (i.e. written comments and photographs are in line with conditions ratings). It is important to note that the Reviewer is not "critiquing" the inspector's ratings and/or comments. The Reviewer is implicitly evaluating the inspector's adherence to inspection practice regarding procedures, guidelines, and training. Indirectly, the inspector's proficiency to convey inspection findings through the required documentation is assessed. Three effective QC review elements used to evaluate the bridge inspection process include:

- QC Bridge Inspection Electronic Documentation Review (10% of bridges, per batch submittal),
- QC Bridge Re-Inspection (5% of bridges, per batch submittal), and
- QC Inspection Team Field Review (2% of scheduled inspections per consultant field trip).

QC review elements procedures are performed for each work authorization and typically involve the use of checklists to ensure that the reviews are carried out thoroughly and in a consistent manner. In addition, an initial submittal of documentation from 10 completed bridge inspections from the consultant to the District is highly recommended. This 10 bridge submittal should receive a thorough QC review with feedback to the consultant so that comments or any needed revisions to the content of the deliverables is incorporated into future work. Turnaround for this review should take no more than 2 weeks.

QC Review Elements - Bridge Division Underwater (UW) and Fracture Critical (FC) Units

QC Bridge Inspection Documentation Review

For bridges with no significant findings, UW and FC inspections are typically scheduled for 60 and 24 month intervals, respectively. QC bridge inspection documentation review efforts for UW and FC inspections performed by Bridge Division personnel will be exercised for every inspection. Since the personnel involved with this type of inspection are limited, the first stage of the QC bridge inspection documentation review process will be handled by the team members of the UW and FC Units through the Bridge Inspection Management System report approval process.

Stage 1 of the QC bridge inspection documentation review process:

- The UW or FC Unit Inspector prepares the documentation and performs a review of his or her own work. The Inspector sends the report for Preliminary Approval to a team leader member of the UW or FC Unit (this person cannot be the Engineer of Record).
- The TL performs an independent review on the report documentation. If corrections are needed, the report is returned to the report creator. If the report is satisfactory, the TL will send the report to the Engineer of Record for Final Approval Review.
- The Engineer of Record will perform an independent review of the report documentation. If corrections are needed, the report is returned to the report creator. If the report is satisfactory, the Engineer of Record will sign and seal the report, and perform the Final Approval.

Stage 2 of the QC bridge inspection documentation review will consist of the Program Manager performing a review on a combined 10% of the UW and FC inspections for each Inspector on a yearly basis.

QC Bridge Re-Inspection

Performing UW and FC bridge inspections requires specially trained personnel and equipment. Additionally, these types of inspections will typically require timely and detailed communication with District personnel, bridge owners, and possibly external entities (FAA, Coast Guard, law enforcement, etc.) due to factors such as bridge location, use, geometric constraints, traffic volumes, and traffic control needs. For this reason, QC bridge re-inspection for UW and FC inspections performed by Bridge Division personnel will not be performed unless specifically requested by the Program Manager. If requested, the Program Manager will advise of the participants performing this QC bridge re-inspection review.

QC Inspection Team Field Review

Performing UW and FC bridge inspection requires specialized trained personnel and equipment. Therefore, the Program Manager, or their designee, will perform an annual review of inspection qualifications for in-house TxDOT personnel assigned to perform these types of inspections. The qualification of TLs for these inspections is verified prior to each team's departure to the field.

QC Review Elements – District Bridge Section

In the following discussions, it is assumed that Consulting Firms (Prime Consultants and Sub-Consultants) under contract with TxDOT are performing routine inspection services for the District Bridge Sections.

QC Bridge Inspection Electronic Documentation Review

The inspection contract deliverables are submitted to the District by the Prime Consultant in batches according to bridge inspection due date, submittal deadlines, and District instructions. As these are submitted, a minimum of 10% of the bridges from every batch will be reviewed to verify that:

- the required documentation is included in the submittal,
- the inspection TL meets NBIS requirements,
- the documentation is complete and accurate,
- load rating analysis is correct,
- the data recorded is consistent with TxDOT and NBIS requirements, and
- the documentation is uploaded into the Bridge Inspection Management System completely and consistent with TxDOT requirements.

The review of the load rating will include a Level I and Level II review.

- A Level I review process includes ensuring that the correct load limits and proper load limit signs are in place for instances where previously recommended load postings are retained. Recommended changes to load postings will be verified at a later time not to exceed either 90 days for On-System or 180 days for Off-System. Load rating items will be checked and updated in the Bridge Inspection Management System as necessary to reflect recommended and existing field conditions. For proposed load posting changes, photos depicting the final signs will be as uploaded into the Bridge Inspection Management System as soon as possible after installation.
- A Level II review process involves all of the Level I process plus checking:
  - documentation for completeness,
  - signatures and seals,
  - that assumptions made with respect to the condition of the bridge are reflective of current field conditions,
  - that the assumptions are accounted for in the values used in the load rating calculations, and
  - that the calculated results are those which are reported in the Bridge Inspection Management System.

The review of recorded data is limited to verification of the bridge major component ratings (e.g. Items 58, 59, 60 and 62) using comments and photographs included with the current inspection report and comparison of ratings from previous inspection results (with consideration of expected bridge deterioration).

It is important to follow through with the required scheme of reviewing 10% of bridges for **every batch** of submitted bridges as they are returned to the District. Bridge inspection documentation review procedures will be an ongoing task for the duration of the inspection cycle work authorization(s). The importance of this lies in assuring that the work submitted by different TLs used throughout the duration of the inspection cycle work authorization(s) is reviewed and feedback provided to them for purposes of continued improvement.

Typically, when a submittal is made to the District this is accompanied by a list that identifies all the bridges being submitted by permanent structure numbers (PSNs) and bridge types. The following best practice criteria shall be used to select bridges for the 10% electronic documentation review:

- Variety of superstructure types; avoid selecting the same type of bridge for the entire review sample (keep eye out for superstructures that have known problems, for example cracking in the ends of pre-stressed girders, punch-through failures in pan girders, etc.),
- Mixture of span bridges and culverts, (dependent upon submittal content),
- New structures,
- Structures recently rehabilitated or widened,
- Variety of TLs (strive to review work from as many TLs as possible, prime and sub)
- Structures with load postings,
- Structures located in different counties,
- Bridges with critical findings (to verify that appropriate supporting documentation/photographs are included), and
- Bridges that cross different features (for example: stream, railroad, roadway - these will require different types of documentation).

Appendix C in this manual addresses the logs and forms to be completed with each QC bridge inspection review.

QC Bridge Re-Inspection

A QC bridge Re-Inspection consists of a qualified TL from each District performing independent inspections of bridges inspected by consultants under contract with TxDOT. These bridge Re-Inspections are conducted for the following purposes:

- assess the consistency and accuracy of component ratings and comments noted on the inspection report,
- validate critical findings and load posting needs,
- confirm a thorough account of findings,
- confirm measurements,
- confirm inspection photo adequacy,
- confirm adequacy of recommended maintenance follow-up actions, and
- confirm accurate account of the bridge geometry (number of spans, configuration, etc.).

A minimum of 5% of the total number of bridges inspected under the current work authorization(s) will be re-inspected under this QC bridge Re-Inspection procedure. These Re-Inspections **must** be performed by a qualified District Bridge Section TL.

When practical, schedule the Re-Inspections so that they are done within 90 days after the consultant's performance of the routine inspection so that field conditions would not have changed significantly between the two inspections.

The following best practice criteria shall be used to select bridges for the 5% re-inspection review:

- Structures in the routine inspection work authorization,
- Structures with critical findings and load postings,
- Structures with condition ratings of a 5 or below for items 58, 59, 60 and 62,
- Structures with condition ratings of 3 or lower for 58, 59, 60 or 62 or item 113 of a 2 or lower,
- Structures with problematic superstructure types, such as prestressed girders with end cracking or pan girders with punch-through failures,
- Structures with increased inspection frequency,
- New structures,
- Structures recently rehabilitated or widened,
- Variety of TLs (strive to review work from as many TLs as possible, prime and sub) Mixture of span bridges and culverts (dependent upon submittal content),

- Structures with different county and roadway classifications, IH, US, FM/RM, etc,
- Structures that did not receive any QC review in the last two cycles,
- Mixture of bridges and culverts (grade separation/stream crossing) and bridge superstructure types (steel/timber/concrete),
- Structures with Follow-Up Actions reported during previous inspection cycles that have not been addressed.

Appendix C in this manual addresses the logs and forms to be completed with each bridge Re-Inspection field review.

QC Inspection Team Field Review

Another field QC review by the District Bridge Section consists of performing bridge Inspection Team Field Reviews that evaluate the performance of a Consulting Firm’s staff (Prime and Sub-Consultants) as the inspections are being performed. A minimum of 2% of the total number of bridges inspected during a routine inspection cycle will have an Inspection Team Field Review performed. The purpose of the Inspection Team Field Review is to evaluate the inspecting team on inspection procedures, NOT the accuracy of the inspection ratings. An Inspection Team Field Review will typically involve, but not be limited to, reviewing for compliance with safety guidelines, use of adequate equipment for the type of structure and field conditions, and implementation of established inspection procedures as per NBIS and TxDOT requirements.

As with the Re-Inspection Field Review, the Inspection Team Field Review should also consist of a selection of bridges that may contribute to constructive feedback that will add quality to the inspection process. The Inspection Team Field Review should also be performed throughout the duration of the routine inspection cycle so that it includes an assortment of different bridges and different TLs.

The following best practice criteria shall be used to select bridges for the 2% inspection team field review:

- Variety of TLs (strive to review work from as many TLs as possible, prime and sub),
- Mixture of on and off system structures,
- Mixture of bridges, culverts, and bridge superstructure types
- Mixture of structures with different county and roadway classifications
- Structures that cross different features, such as railroad, stream crossing, grade separation.

Although scheduling of the bridge Inspection Team Field Review may be dependent on the consultant's schedule, the Reviewer can anticipate an approximate range of dates of when these inspections may take place based on inspection due dates, allowing for scheduling of unannounced visits by District and Division personnel.

Open, effective communication with the consulting bridge inspector is important for successful Inspection Team Field Reviews. A good practice as part of this communication is to set up a protocol in which the consulting inspector submits a weekly schedule identifying proposed bridge inspection locations and inspection dates. Ask the Consultant to submit this schedule at least a week in advance of beginning the inspections and to narrow down the location of these bridge inspections to roadway control-section identifications, if possible. A bridge inspector may have this information available ahead of time and although this schedule may change slightly due to unforeseen circumstances, the schedule will typically not change significantly. Some situations will require advance notice to the consultant inspector but as much of the review as possible should be unannounced.

Personnel conducting these reviews should not sacrifice the quality of the results that a bridge Inspection Team Field Review may yield in order to meet the 2% Team Field Review requirement. Proper planning should be exercised. This may include requesting bi-weekly inspection schedules from the PM for the purpose of unannounced field reviews.

NOTE: For example, if the consultant has plans to inspect six culverts and one span bridge, and the span bridge will allow for a quality Inspection Team Field Review, consider reviewing one culvert inspection and the inspection of the span bridge. Other District field activities can be performed (e.g. scour or follow-up inspections) throughout the day to fill gaps in the schedule. Per the selection criteria given above, one should not follow the consultant through six culvert bridge Inspection Team Field Reviews that will probably yield very similar results.

When coordinating with the consultants, a balance must be struck between having a minimal impact on the consultants' scheduling and obtaining quality field reviews of varying inspectors and structure types. It is important to remember that every effort should be made to impact the consultants' inspection efforts as little as possible.

Appendix C in this manual addresses the logs and forms to be completed with each bridge Inspection Team Field Review.

QC Review Elements – Consulting Firm QC Program and Efforts

There is currently no defined format for a Consulting Firm's QC Program. The bridge inspection contract Scope of Services for Routine FC and UW inspections requires that all Consulting Firms contracted to perform bridge inspections for TxDOT have a QC Program defining internal procedures to ensure that the deliverables submitted to TxDOT by the Prime and Sub-Consultants are of high quality. These internal procedures are to be written into a plan which is to be submitted to the Bridge Division Program Manager prior to initiating work. The Consulting Firm's QC Program may be reviewed by TxDOT Bridge Division personnel on a random basis.

Section 4 — Quality Assurance

Quality Assurance Overview

NBIS defines Quality Assurance (QA) as, "The use of sampling and other measures to assure the adequacy of quality control procedures in order to verify or measure the quality level of the entire bridge inspection and load rating program."[1]

The Bridge Division's Bridge Inspection QA Program is carried out by the Bridge Division's QA Engineers in conjunction with the Quality Control efforts from the following workgroups:

- Bridge Division UW and FC Units,
- District Bridge Sections, and
- Consulting Firms.

The purpose of QA is to confirm that the QC procedures within all facets of TxDOT's BIP are efficient, that the procedures are suitable to achieve quality, and that the overall QC program is successful in maintaining and improving quality.

The QA reviews are intended to confirm that the QC efforts are equally effective across TxDOT's BIP, resulting in overall quality and confidence in the BIP. The purpose of QA activities are not to remove, for example, the errors of a specific inspection report or load rating, but to observe and modify the program requirements and procedures, as needed, to ensure that the desired quality levels are maintained and improved.

Important aspects of a QA program include:

- Reviews being conducted in a uniform manner with documented procedures and practices. These procedures and practices are intended to be constructive with the end goal of improving the BIP.
- Consistent areas of discussion, such as frequency of QA reviews, means of assessing quality, reporting requirements, and procedures for implementing corrective actions, should they be warranted.
- Fair and objective reviews so that all workgroups are evaluated with the same level of review effort.
- The different workgroups understanding the review process, acknowledging the objectives of the QA review, and viewing the process as a positive and collective effort to improve the quality of the BIP.

Elements of TxDOT's QA reviews will include:

1. CFR Title 23, Part 650, Subpart C - National Bridge Inspection Standards, § 650.305

- the different workgroup organizations and their QC efforts,
- a sample of inspection reports and bridge file elements, and
- a field review of a sample of bridges.

These elements will be reviewed based on variances such as inspection types, workgroup organization, QC responsibilities, duties, etc.

The presentation of QA review results is important in establishing a method for effectively documenting and evaluating improvements to the BIP over time. Thus, effective QA activities rely on quantitative data as well as qualitative data.

Quantitative data is represented numerically and provides objective assessments of quality, reducing bias and subjectivity of data results. It can be summarized and used for independent analysis and comparison (e.g. the specific number of errors found in the assessment of condition ratings and inventory items from a bridge inspection report or the number of errors found in the `Bridge Inspection Management System`). It is the quantitative data that makes feasible the unbiased results of QA across the different workgroups in TxDOT's BIP, provides a measure of each workgroup relative to the overall system, and can be used as a measurement for progress.

Qualitative data is anything not represented numerically and can include general observations or descriptions of performance qualities (above average, inadequate, inconsistent, etc.). Qualitative results help identify areas where actions are warranted.

Quality Assurance Review

QA Review – Bridge Division Underwater and Fracture Critical Units

The QA reviews on the UW and FC inspection units in Bridge Division will be performed by the Bridge Division's QA Engineers `every` two years between reviews. They will consist of two general parts – an office review and a field review. The UW and FC inspection units will be evaluated separately.

Office Review

The office part of the review will be made up of a discussion of the UW or FC Unit concerning the organization of the unit and inspection team members' qualifications, how the unit conducts its operations, and a QA `inspection documentation` review. The QA review of the unit's QC efforts will use the Division's QC documentation, `existing` bridge folders, and the `Bridge Inspection Management System`. The results of the discussion will yield qualitative data that will include general observations and descriptions of performance qualities. This data can be used to document the results of the QA review and to describe actions to be taken in response to the findings. The QA office review will look at whether the QC bridge inspection documentation review was performed and documented. Additionally, a sampling of bridges will be selected and reviewed for completeness, accuracy, etc. Any data errors resulting from this review will be noted and reported as quantitative discrepancies in the QA report for that unit.

Field Review

The field review will involve an evaluation of the inspection procedures, equipment used, and reported QC field findings. The results of the field review will be qualitative in nature and will help the reviewer identify areas where actions are warranted.

The results of the QA review will be presented in a report sent to the Program Manager detailing the quantitative and qualitative findings. Corrective actions can be taken or best-practice techniques implemented to improve the quality of the UW and FC inspection units, if warranted. Corrective actions could include changes to manuals, reporting methods, policies or procedures, or training curriculum as well as collaborative meetings, or other appropriate recommendations.

QA Review – District Bridge Section

The QA reviews on the District Bridge Sections will be performed by the Bridge Division's QA Engineer responsible for that District, on a regular schedule, not to exceed two years between reviews. They will consist of two general parts – an office review and a field review. The QA review of the District's QC efforts will focus on the deliverables from the completed work authorizations since the last QA review. The QA Engineer will randomly preselect bridges from the District's QC documentation for the subject work authorization(s).

Office Review

The office review will be made up of a discussion of the District Bridge Section concerning the organization of the section, as well as how the section conducts its operations. This will be followed by a QA review of the District's QC efforts using the District's QC documentation, existing bridge folders, and the documentation in the Bridge Inspection Management System. The general discussion will include topics such as the District's Bridge Section personnel, the required qualifications, the organization, record keeping, inspection management, routine inspection work authorizations, quality control approach, and any other TxDOT BIP topics the District bridge personnel would like to discuss. The results of these discussions will yield qualitative data that will include general observations and descriptions of performance measures. This qualitative data can be used to help document the results of the QA review, be used to describe corrective actions, if warranted, to be taken in response to the findings, and identify best practices to share with other Districts.

The QA office review will also look at whether the required percentages of QC review were performed and documented for Electronic Documentation Review, Inspection Team Field

Review, and Re-Inspections. The date(s) of the District's QC review will be compared to the submission dates to verify if the QC review was done in a timely manner.

For the `Electronic Documentation` Review, the QA Engineer will use a QA checklist that is similar to the "TxDOT QC Review - Bridge Folder Review" form to check for items that should be included in the bridge `file`. The documents will be reviewed to ensure that the forms are current, have been updated with inspection findings, and that recommended actions are implemented or followed-up upon and documented, if applicable. For examples of additional documentation that may be in the `bridge file`, see Chapter 8, Section 7, "The Bridge `Record`" of this manual.

If any of the selected bridges have been load rated, the QA Engineer will conduct a review of the District's QC efforts by verifying that the Level I and Level II load rating reviews (described in Section 3, in the "QC Bridge `Electronic Documentation` Review" paragraph of this chapter) were performed. If the District's review resulted in anything that looked incorrect or suspect, a Level III review should have been initiated, by contacting the Bridge Division's Load Rating Engineer, to verify the load rating documentation. If a Level III review was warranted, the Bridge Division's Load Rating Engineer bears the responsibility for verifying or recalculating the load rating. This however does not relieve the District's responsibility of making sure that the process is carried through its entirety, assuring the correct load posting signs, per recommendations or approved calculations, are erected by established deadlines. Photographs of the final signs are to be uploaded into the bridge management software as soon as possible after installation.

The `Bridge Inspection Management System` will be spot checked to confirm the coding of various inventory items and that required items have been uploaded into the `Bridge Inspection Management System`. Any coding errors or missing documentation will be recorded and noted as a deficiency. Another piece of quantitative data that will be determined is the percent of critical findings that have been addressed or followed up on since the last QA review.

Field Review

The field review will involve a QA Re-Inspection of bridges for which District personnel have performed a QC Re-Inspection. These are listed on the "TxDOT Bridge Inspection QC Review, Bridge Re-Inspection Log." The results of the routine, district QC, and QA inspection results will be compared. The QA Re-Inspection will be a collaboration between the QA Engineer and District bridge personnel, with on-site discussion of bridge components, condition states, condition ratings, and any follow-up action recommendations. Any condition rating that differs by more than plus or minus one condition rating will be considered out-of-tolerance. If the difference in condition rating is determined to have occurred from damage since the last inspection, this will be noted and no error will be reported.

If applicable, the Elements and their condition states will be reviewed for concurrence.

Any follow-up action recommendations will be discussed to see if the District has acted or plans to act on the recommendations. If any of these actions were reported with critical inspection or scour critical findings and they have yet to be acted upon, this will be quantified, included in the report findings, and will be considered an important corrective action.

The information obtained from the QA office and field reviews will be objective, quantitative data that can be summarized and used for comparison. Information from discussions can lead to qualitative as well as quantitative findings.

The results of the QA review will be presented in a report sent to the Program Manager detailing the quantitative and qualitative findings so that corrective actions, should they be warranted, can be taken or best-practice techniques implemented to improve the quality of the overall BIP.

QA Review – Consulting Firm QC Program and Efforts

At a minimum of once for the duration of the contract, the QA Engineer assigned to a current Consulting Firm will review the Firm's QC Program on file. The QA Engineer will schedule a visit to the Consulting Firm's office, visit with the PM, review their QC documentation, and discuss any concerns, comments, or suggestions they have with TxDOT's BIP. Since QC programs vary significantly from firm to firm, a standard rating form would not be appropriate. Therefore, the QA Engineer will advise TxDOT's BIP Program Manager as to whether or not the Consulting Firm is following its own QC Program. These office visits can be performed with little advanced notice to the Consulting Firm.

The results of the QA review will be presented in a report sent to the Consulting Firm. A copy of the same report will be provided to the TxDOT BIP Program Manager. The report will detail the quantitative and qualitative findings, so that corrective actions, should they be warranted, can be taken or best-practice techniques suggested for implementation, thus improving the overall BIP. The corrective actions could include changes to policies, procedures, or training curriculum as well as collaborative meetings or other appropriate recommendations.

Appendix A — State and Federal Regulations

Bridge Inspection Guidelines

Three regulations and codes have particular bearing on bridge inspection.

Regulations Affecting Bridge Inspection

Regulation	WWW Link
Code of Federal Regulations	http://www.fhwa.dot.gov/legsregs/ directives/fapg/ cfr0650c.htm
U.S. Code for Bridge Inspection	http://www.fhwa.dot.gov/legsregs/ title23.pdf
Texas Transportation Code	http://www.statutes.legis.state.tx.us/Docs/TN/htm/ TN.545.htm

Code of Federal Regulations Highlights

Section 650.301, Application of standards. This section states that all sections in this part (Subpart C) apply to all structures defined as bridges. It also restates the current AASHTO definition of a bridge. This section was first added to the Federal Register in 1979, and it was amended in 1986.

Section 650.303, Inspection procedures. This section requires each state transportation department to have an organization that is capable of performing bridge inspections and preparing reports and ratings in accordance with the AASHTO Manual for Maintenance Inspection of Bridges. It further requires that each structure be rated to determine safe load capacity, and it gives the criteria at which the structure must be load-restricted. This section makes TxDOT responsible for determining the safe load capacity of each bridge in the inventory. This section was first added to the Federal Register in 1971 and amended in 1979 and 1988.

Section 650.305, Frequency of inspections. This section defines the maximum interval between bridge inspections. This section was first added to the Federal Register in 1971 and amended in 1974, 1988, and 1992.

Section 650.307, Qualifications of personnel. This section gives the minimum qualifications for individuals conducting bridge inspections and administering a bridge inspection program. This section was first added to the Federal Register in 1971 and amended in 1979 and 1988.

Section 650.309, Inspection report. This section requires standard forms to be used for reporting bridge inspections. This section was first added to the Federal Register in 1974.

Section 650.311, Inventory. This section requires each state to maintain an inventory of all the bridges in the state. It also stipulates that the maximum allowable time states have to update the inventory is 90 days after any change in the status of a structure. This section was first added to the Federal Register in 1979 and amended in 1988.

U.S. Code for Bridge Inspection Highlights

Section 116, Maintenance. This section states that if any project, including bridges, constructed under the provisions of this chapter is found not being properly maintained, including inspections and load posting of bridges, then the state has 90 days after the problem is called to its attention to correct the problem. If nothing is done, then approval of further projects can be withheld. This section is used to justify withholding federal funds to local entities that do not comply with the National Bridge Inspection Standards.

Section 144, Highway Bridge Replacement and Rehabilitation Program. This section states that it is of vital interest to the nation to establish a bridge rehabilitation and replacement program to address those structures that are unsafe due to structural deficiencies, physical deterioration, or functional obsolescence. As part of this program, the state must inventory all on- and off-system bridges and classify them for serviceability, safety, and essentiality for public use. This section was used to require each state to establish a bridge inspection program. It requires that the rehabilitation and replacement program be based on the number of unsafe bridges in each state. It also requires the inventory, retention, rehabilitation, adaptive reuse, and future study of historic bridges. A historic bridge is any bridge that is listed on or eligible for listing on the National Register of Historic Places.

Section 151, National Bridge Inspection Program. This section requires the state transportation departments to establish standards for the procedures used to make bridge inspections. These standards must establish methods, frequencies, qualifications for inspectors, reporting procedures, and a procedure for national certification and training of bridge inspectors.

Texas Transportation Code Highlights

Section 201.803, Information for Road Construction and Maintenance. Subsection (e) allows TxDOT to request from county and municipal officials any information necessary for performance of the department’s duties under this section. Therefore, if the department first requests the information, it should have no problem obtaining as-built plans. However, in almost all cases, the department does not have prior knowledge of the construction of an off-system bridge. Often, by the time the structure is first located by the department, the plans have disappeared.

Section 201.8035, Inspection of County and Municipal Bridges. This section deals with the inspection of off-system bridges. Subsection (a) requires TxDOT to notify local jurisdictions when a bridge qualifies for a lower load rating. Subsection (b) requires that local entities post notices on the roadway approaching the bridge. This section gives TxDOT the authority and responsibility to require posting of off-system bridges by counties and municipalities. This section holds TxDOT accountable for ensuring that off-system bridges are capable of safely carrying loads. Local entities should provide the information necessary for TxDOT to carry out this duty.

Section 621.301, County's Authority to Set Maximum Weights. This section allows a county to establish load limits for a county road or bridge only with the concurrence of the department. If a county determines that the load limit of a county bridge should be different from the load limit supported by a department inspection, the county must submit the proposed load limit to the district engineer. A request for a load limit must be accompanied by supporting documentation that is sealed by an engineer and that includes at a minimum calculations supporting the proposed limit and a structural evaluation report documenting the condition of the bridge. The district engineer concurs with a county's proposal in writing. If the department does not indicate concurrence or non-concurrence in writing within 30 calendar days of receipt by the department of a request that includes all required documentation, the proposed load limit is deemed concurred with by the department. The department may review the load limit and withdraw this concurrence at any time by providing written notification to the county. A county may appeal the decision of the district engineer by submitting a written request, along with the required documentation, to the executive director. The executive director will review the request and determine if department concurrence will be granted. The executive director's decision is final.

Appendix B — Links to Coding Guidelines

Bridge Inspection Coding Guidelines

Refer to the Coding Guide for maintaining data in the Bridge Inspection Management System.
http://onlinemanuals.txdot.gov/txdotmanuals/ins/coding_guide.pdf

Appendix C — Quality Control (QC) Review Forms & Contact Lists

QC Review Forms

QC Review element procedures are performed for each work authorization and are carried on throughout the duration of the work authorization.

The QC Review forms and logs were created using Excel spreadsheets. There are four (4) QC Review forms (spreadsheets) depending on the type of review being done.

- TxDOT Bridge Inspection QC Review Re-Inspection Log, Form 2620
- TxDOT Bridge Inspection QC Review Inspection Team Field Review Log, Form 2621
- TxDOT Bridge Inspection QC Review Folder Review Log, On-System, Form 2622

The forms use pull-down menus and auto-populate macros that make them convenient for Users who want to complete them electronically. They may however be completed manually.

The Bridge Division QC Review forms can be accessed internally via the Bridge Division, Field Operations website, under `QC Quarterly Forms and Information`.

Alternatively, they can be accessed through e-Forms.

Contact Lists

Bridge Inspection Contact List

Approved Inspection Team Leaders List

Index

A

AASHTO manual
- 1970 2-4
- 1974 2-4
- 1978 2-5
- 1983 2-6
- interim specifications 2-6

appraisal ratings
- definition 5-5
- recording 5-5

Approach Roadway Alignment (Item 72) 5-8

B

basis for bridge rehabilitation 7-2
basis for bridge replacement 7-2
bridge folder 8-24
bridge inspection history 2-13
bridge inspection program 2-2
Bridge Management System (BMS) 7-10
Bridge Posting (Item 70) 5-7
bridge rehabilitation
- basis 7-2

bridge replacement
- basis 7-2

C

calculations
- general requirements 8-16
- off-system bridges 8-17
- on-system bridges 8-16

closure
- off-system bridge 5-26

coding
- element data 8-10
- guidelines C-1
- multiple-pipe culverts 8-9
- summary 8-9

complex bridge inspections 3-9
condition ratings
- assigning 5-4
- definition 5-3

consultants
- coordination with TxDOT 8-7
- email 8-7
- inspection equipment 8-7
- pre-certification 3-9
- request for 3-11
- requirements 8-7
- work authorization management 3-12

D

data submittal
- duplicate records 8-22
- original records 8-22
- presentation of documents 8-21
- requirements 8-19
- scour records 8-23
- summary reports 8-22

data submittals
- photographs 8-19

Deck Geometry (Item 68) 5-6
details
- fatigue-prone 4-14
- weld 4-15

district bridge inspection coordinator 3-5
duplicate records, submittal 8-22

E

equipment
- consultants 8-7
- routine bridge inspections 4-4

examples
- rating concrete bridges with no plans 5-16
- typical continuous I-beam bridge 6-8

F

fatigue
- secondary members 4-15

fatigue failure 4-10
fatigue-prone details 4-14
FHWA manual 2-13
form 8-14
forms
- Bridge Appraisal Worksheet 8-11
- Bridge Inspection Follow-Up Action Worksheet 8-12

Bridge Inventory Record 8-12
Bridge Inventory Record Revision 8-13
Bridge Structural Condition History 8-12
Bridge Summary Sheet 8-14
Channel Cross-Section Measurements Record 8-13
Recommended Change in Bridge Load Zoning 8-15
Underclearance Sketch 8-14
fracture-critical inspections
fatigue failure 4-10
history 4-10

H

history, bridge inspection program 2-2
HS-truck ratings 5-18
H-truck ratings 5-18

I

initial inspections 4-3
inspection
post-move 6-7
pre-move 6-7
inspection program history 2-2
inspections
complex bridge 3-9
initial 4-3
interim 4-5
routine 3-8, 4-4
types 4-2
interim inspections 4-5
Inventory Rating (Item 66) 5-10
Item
36 (Traffic Safety Features) 5-5
66 (Inventory Rating) 5-10
67 (Structural Evaluation) 5-6
68 (Deck Geometry) 5-6
69 (Underclearances) 5-7
70 (Bridge Posting) 5-7
71 (Waterway Adequacy) 5-8
72 (Approach Roadway Alignment) 5-8

L

load
over-height 6-4
over-weight 6-5
state legal 5-19
superheavy 6-5
load posting 5-20
changing on-system bridge 5-24
emergency on-system bridge 5-25
load ratings
definition 5-10
determination 5-10

M

manual
feedback 1-2
purpose 1-2
revision history 1-2

O

off-system bridges
calculations 8-17
closure 5-26
summary reports 8-22
on-system bridges
calculations 8-16
changing load posting 5-24
emergency load posting 5-25
original records, submittal 8-22
over-height permits 6-4
overloads on substandard bridges 6-7
over-width permits 6-4

P

permits
over-height 6-4
overloads on substandard bridges 6-7
over-width 6-4
personnel requirements
AASHTO 3-3
district bridge inspection coordinator 3-5
division bridge inspection branch manager 3-5
division bridge inspection engineers 3-6
division bridge inspection specialists 3-6, 3-7
division bridge inspection supervisor 3-5
division bridge inspection technicians 3-7
FHWA 3-2

general 3-2
positions 3-4
TxDOT 3-3
photos, data submittal 8-19
posted bridges
overloads 6-7
post-move inspections 6-7
pre-certification of consultants 3-9
pre-move inspections 6-7
procedures, bridge inspection 2-13

R

rating
concrete bridge with no plans 5-15
procedures 5-13
ratings, see type of rating
references 2-3
regulations
federal A-1
state A-1
rehabilitation
basis 7-2
replacement
basis 7-2
request for consultant 3-11
requirements for personnel
AASHTO 3-3
FHWA 3-2
general 3-2
positions 3-4
TxDOT 3-3
routine bridge inspections 3-8
routine inspections 4-4

S

scour records, submittal 8-23
secondary members, fatigue 4-15
state legal loads 5-19
structural deficiency 7-4
Structural Evaluation (Item 67) 5-6
Sufficiency Rating 7-6
summary reports, submittal 8-22
superheavy loads 6-5

T

THD Design Supplement No. 1 5-11
Traffic Safety Features (Item 36) 5-5

U

Underclearances (Item 69) 5-7
underwater inspections
levels 4-8
methods 4-7
structural elements 4-8
update transactions B-2

W

Waterway Adequacy (Item 71) 5-8
weld details 4-15
work authorization
management 3-12