PDHonline Course C472 (1 PDH)

FHWA Bridge Inspector's Manual
Section 1 - Bridge Inspection Programs

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Bridge Inspection Programs

Abbreviations Used in this Section

AASHO	-	American Association of State Highway Officials (1921 to 1973)
AASHTO	-	American Association of State Highway and Transportation Officials (1973 to present)
AASHTO Manual	-	*Manual for Maintenance Inspection of Bridges*
BIRM	-	*Bridge Inspector's Reference Manual*
BMS	-	Bridge Management System
Coding Guide	-	FHWA *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*
DOT	-	Department of Transportation
FCM	-	fracture critical member
FHWA	-	Federal Highway Administration
HBRR	-	Highway Bridge Replacement & Rehabilitation
HEC	-	*Hydraulic Engineering Circular*
ISTEA	-	Intermodal Surface Transportation Efficiency Act
Manual 70	-	*Bridge Inspector's Training Manual 70*
Manual 90	-	Bridge Inspector's Training Manual 90
MR&R	-	maintenance, repair and rehabilitation
NBI	-	National Bridge Inventory
NBIS	-	National Bridge Inspection Standards
NCHRP	-	National Cooperative Highway Research Program
NDT	-	nondestructive testing
NHI	-	National Highway Institute
NHS	-	National Highway System
NICET	-	National Institute for Certification in Engineering Technologies
TEA-21	-	Transportation Equity Act of the 21st Century
TRB	-	Transportation Research Board
TWG	-	Technical Working Group

Section 1
Bridge Inspection Programs

Topic 1.1 History of the National Bridge Inspection Program

1.1.1 Introduction

In the years since the Federal Highway Administration's landmark publication, *Bridge Inspector's Training Manual 90* (*Manual 90*), bridge inspection and inventory programs of state and local governments have formed an important basis for formal bridge management programs. During the 1990's, the state DOT's implemented comprehensive bridge management systems, which rely heavily on accurate, consistent bridge inspection data.

This manual (*Bridge Inspector's Reference Manual*) updates *Manual 90* and reflects over ten years of change.

Advances in technology and construction have greatly enhanced current bridge design. However, the emergence of previously unknown problem areas and the escalating cost of replacing older bridges make it imperative that existing bridges be evaluated properly to be kept open and safe.

There are four letters that define the scope of bridge inspections in this country: NBIS, meaning National Bridge Inspection Standards. The **National Bridge Inspection Standards (NBIS)** are Federal regulations establishing requirements for:

- Inspection Procedures
- Frequency of Inspections
- Qualifications of Personnel
- Inspection Reports
- Maintenance of Bridge Inventory

The **National Bridge Inventory (NBI)** is the aggregation of structure inventory and appraisal data collected by each state to fulfill the requirements of NBIS.

To better understand the National Bridge Inventory Program, it is helpful to review the development of the program.

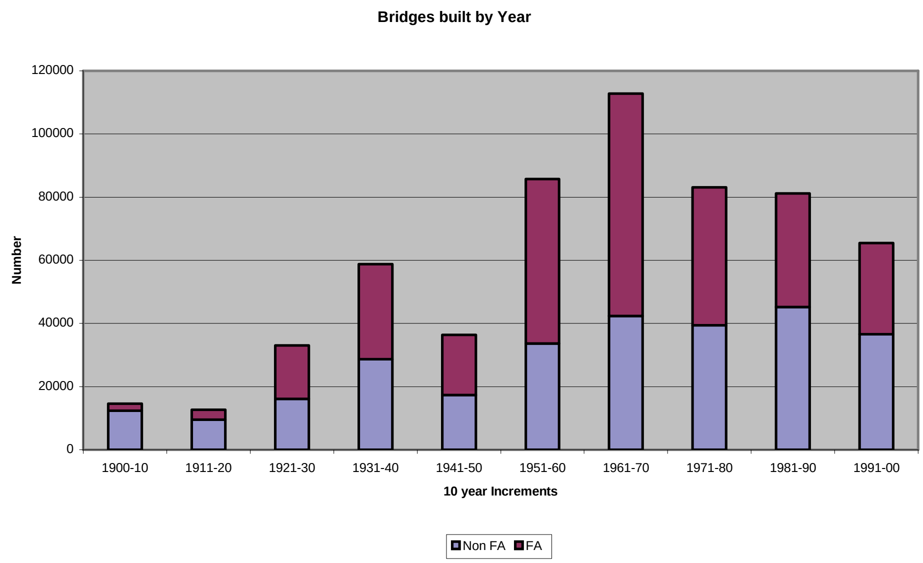

Table 1.1.1 Number of Bridges Built since 1900

1.1.2 History of the National Bridge Inspection Program

Background

During the bridge construction boom of the 1950's and 1960's, little emphasis was placed on safety inspection and maintenance of bridges. This changed when the 681 m (2,235-foot) Silver Bridge, at Point Pleasant, West Virginia, collapsed into the Ohio River on December 15, 1967, killing 46 people (see Figure 1.1.1).

Figure 1.1.1 Collapse of the Silver Bridge

This tragic collapse aroused national interest in the safety inspection and maintenance of bridges. The U.S. Congress was prompted to add a section to the "Federal Highway Act of 1968" which required the Secretary of Transportation to establish a national bridge inspection standard. The Secretary was also required to develop a program to train bridge inspectors.

The 1970's

Thus, in 1971, the National Bridge Inspection Standards (NBIS) came into being. The NBIS established national policy regarding:

- Inspection procedures
- Frequency of inspections
- Qualifications of personnel
- Inspection reports
- Maintenance of state bridge inventory (NBI)

Three manuals were subsequently developed. These manuals were vital to the early success of the NBIS. The first manual was the Federal Highway Administration (FHWA) *Bridge Inspector's Training Manual 70* (*Manual 70)*. This manual set the standard for inspector training.

The second manual was the American Association of State Highway Officials (AASHO) *Manual for Maintenance Inspection of Bridges*, released in 1970. This manual served as a standard to provide uniformity in the procedures and policies for determining the physical condition, maintenance needs and load capacity of highway bridges.

The third manual was the FHWA *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* (*Coding Guide*), released in July 1972. It provided thorough and detailed guidance in evaluating and coding specific bridge data.

With the publication of *Manual 70*, the implementation of national standards and guidelines, the support of AASHO, and a newly available FHWA bridge inspector's training course for use in individual states, improved inventory and appraisal of the nation's bridges seemed inevitable. Several states began in-house training programs, and the 1970's looked promising. Maintenance and inspection problems associated with movable bridges were also addressed. In 1977, a supplement to *Manual 70*, the *Bridge Inspector's Manual for Movable Bridges*, was added.

However, the future was not to be trouble free. Two predominant concerns were identified during this period. One concern was that bridge repair and replacement needs far exceeded available funding. The other was that NBIS activity was limited to bridges on the Federal Aid highway systems. This resulted in little incentive for inspection and inventory of bridges not on Federal Aid highway systems.

These two concerns were addressed in the "Surface Transportation Assistance Act of 1978." This act provided badly needed funding for rehabilitation and new construction and required that all public bridges over 20 feet (6.1 m) in length be inspected and inventoried in accordance with the NBIS by December 31, 1980. Any bridge not inspected and inventoried in compliance with NBIS would be ineligible for funding from the special replacement program.

In 1978, the American Association of State Highway and Transportation Officials (AASHTO) revised their *Manual for Maintenance Inspection of Bridges* (*AASHTO Manual*). In 1979, the NBIS and the FHWA *Coding Guide* were also revised. These publications, along with *Manual 70*, provided state agencies with definite guidelines for compliance with the NBIS.

The 1980's

The National Bridge Inspection Program was now maturing and well positioned for the coming decade. Two additional supplements to *Manual 70* were published. First, culverts became an area of interest after several tragic failures. The 1979 NBIS revisions also prompted increased interest in culverts. The *Culvert Inspection Manual* was published July 1986. Then, an emerging national emphasis on fatigue and fracture critical bridges was sharply focused by the collapse of Connecticut's Mianus River Bridge in June 1983. *Inspection of Fracture Critical Bridge Members* was published in September 1986. These manuals were the products of ongoing research in these problem areas.

With the April 1987 collapse of New York's Schoharie Creek Bridge, national attention turned to underwater inspection. Of the over 593,000 bridges in the national inventory, approximately 86% are over waterways. The FHWA responded with *Scour at Bridges*, a technical advisory published in September 1988. This advisory provided guidance for developing and implementing a scour evaluation program for the:

- Design of new bridges to resist damage resulting from scour
- Evaluation of existing bridges for vulnerability to scour
- Use of scour countermeasures
- Improvement of the state-of-practice of estimating scour at bridges

Further documentation is available on this topic in the *Hydraulic Engineering Circular No. 18* (*HEC-18*).

In September 1988, the NBIS was modified, based on suggestions made in the "1987 Surface Transportation and Uniform Relocation Assistance Act," to require states to identify bridges with fracture critical details and establish special inspection procedures. The same requirements were made for bridges requiring underwater inspections. The NBIS revisions also allowed for adjustments in the frequency of inspections and the acceptance of National Institute for Certification in Engineering Technologies (NICET) Level III and IV certification for inspector qualifications.

In December 1988, the FHWA issued a revision to the *Coding Guide*. This time the revision would be one of major proportions, shaping the National Bridge Inspection Program for the next decade. The *Coding Guide* provided inspectors with additional direction in performing uniform and accurate bridge inspections.

The 1990's

The 1990's was the decade for bridge management systems (BMS). Several states, including New York, Pennsylvania, North Carolina, Alabama and Indiana, had their own comprehensive bridge management systems.

In 1991, the FHWA sponsored the development of a bridge management system called “Pontis” which is derived from the Latin word for bridge. The Pontis system has sufficient flexibility to allow customization to any agency or organization responsible for maintaining a network of bridges.

Simultaneously, the National Cooperative Highway Research Program (NCHRP) of the Transportation Research Board (TRB) developed a BMS software called “Bridgit.” Bridgit is primarily targeted to smaller bridge inventories or local highway systems.

As more and more bridge needs were identified, it became evident that needed funding for bridge maintenance, repair and rehabilitation (MR&R) far exceeded the available funding from federal and state sources. Even with the infusion of financial support provided by the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, funding for bridge MR&R projects was difficult to obtain. This was due in part to the enormous demand from across the nation. An October 1993 revision to NBIS permitted bridge owners to request approval from FHWA of extended inspection cycles of up to four years for bridges meeting certain requirements.

In 1994, the American Association of State Highway and Transportation Officials (AASHTO) revised their *Manual for Condition Evaluation of Bridges* (*AASHTO Manual*). In 1995, the FHWA *Coding Guide* was also revised. These publications, along with *Manual 90, Revised July 1995*, provided state agencies with continued definite guidelines for compliance with the NBIS and conducting bridge inspection.

Although later rescinded in the next transportation bill, the ISTEA legislation required that each state implement a comprehensive bridge management system by October 1995. This deadline represented a remarkable challenge since few states had previously implemented a BMS that could be considered to meet the definition of a comprehensive BMS. In fact, prior to the late 1980’s, there were no existing management systems adaptable to the management of bridge programs nor was there any clear, accepted definition of key bridge management principles or objectives.

This flexibility in the system was the result of developmental input by a Technical Working Group (TWG) comprised of representatives from the FHWA, the Transportation Research Board (TRB) and the following six states: California, Minnesota, North Carolina, Tennessee, Vermont and Washington. The TWG provided guidance drawing on considerable experience in bridge management and engineering.

The National Highway System (NHS) Act of 1995 rescinded the requirement for bridge management systems. However, many of the states continued to implement the Pontis BMS.

The Transportation Equity Act of the 21st Century (TEA-21) was signed into law in June 1998. TEA-21 built on and improved the initiatives established in ISTEA and, as mentioned earlier, rescinded the mandatory BMS requirement.

The 2000's

In 2002, *Manual 90* was revised and updated as a part of a complete overhaul of the FHWA Bridge Safety Inspection training program. The new manual was named the *Bridge Inspector's Reference Manual* (BIRM) and incorporated all of *Manual 90.* The BIRM also incorporates manual 70 Supplements for culvert inspection and Fracture Critical Members.

On December 14, 2004, the revised NBIS regulation was published in the *Federal Register*. The updated NBIS took affect January 13, 2005. Implementation plans were to be developed by April 13, 2005 to be fully implemented by January 13, 2006.

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) was signed into law in August 2005. SAFETEA-LU represents the largest surface transportation investment in our Nation's history. SAFETEA-LU builds on and improves the initiatives established in ISTEA and TEA-21.

Over the years, varying amounts of federal funds have been spent on bridge projects, depending on the demands of the transportation infrastructure. Table 1.1.2 illustrates the fluctuations in federal spending and shows current trends.

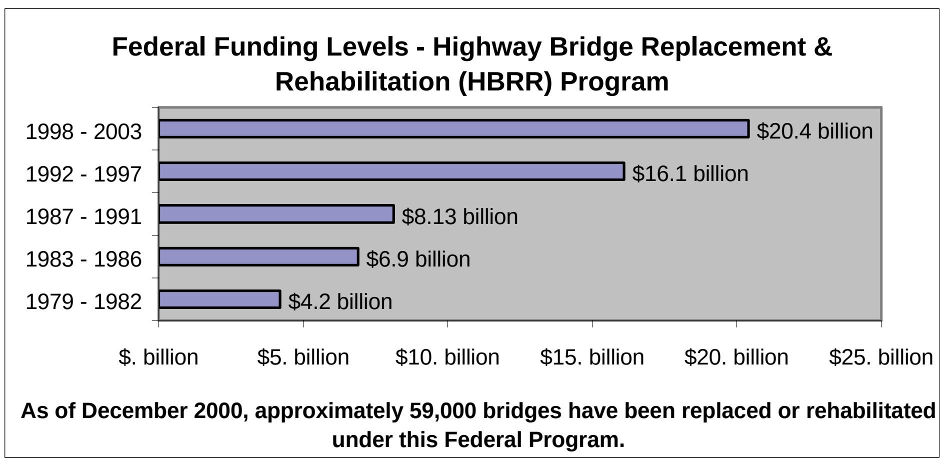

Table 1.1.2 Federal Funding Levels (1979 – 2003)

1.1.3 Today's National Bridge Inspection Program

Much has been learned in the field of bridge inspection, and a national Bridge Inspection Training Program is now fully implemented. State and federal inspection efforts are more organized, better managed and much broader in scope. The technology used to inspect and evaluate bridge members and bridge materials has significantly improved.

Areas of emphasis in bridge inspection programs are changing and expanding as new problems become apparent, as newer bridge types become more common, and as these newer bridges age enough to have areas of concern. Guidelines for inspection ratings have been refined to increase uniformity and consistency of inspections. Data from bridge inspections has become critical input into a variety of analyses and decisions by state agencies and the Federal Highway Administration.

The NBIS has kept current with the field of bridge inspection. The 2005 National Bridge Inspection Standards appear in Appendix A. The standards are divided into the following sections:

- Purpose
- Applicability
- Definitions
- Bridge inspection organization
- Qualifications of personnel
- Inspection frequency
- Inspection procedures
- Inventory
- Reference manuals

The FHWA has made a considerable effort to make available to the nation's bridge inspectors the information and knowledge necessary to accurately and thoroughly inspect and evaluate the nation's bridges.

FHWA Training

The FHWA has developed and now offers the following training courses relative to structure inspection through the National Highway Institute (NHI):

- "Bridge Inspection Refresher Training" (NHI Course Number FHWA-NHI-130053)

  This three-day course provides a review of the National Bridge Inspection Standards (NBIS) and includes discussions on structure inventory items, structure types, and the appropriate codes for the Federal Structure, Inventory and Appraisal reporting.

- "Bridge Inspector's Training Course, Part I - Engineering Concepts for Bridge Inspectors" (NHI Course Number FHWA-NHI-130054)

  This one-week course presents engineering concepts, as well as inspection procedures and information about bridge types, bridge components, and bridge materials. The one-week course is for new inspectors with little or no practical bridge inspection experience.

- "Bridge Inspector's Training Course, Part II - Safety Inspection of In-Service Bridges" (NHI Course Number FHWA-NHI-130055)

  This two-week course is for experienced inspectors or engineers who perform or manage bridge inspections. Emphasis is on inspection applications and procedures. The uniform coding and rating of bridge elements and components is also an objective of the two-week course. A unique feature of this course allows for customization of the course content by the host agency. Some states use component rating based on NBIS while some states use element condition level based on Pontis. Optional topics can be scheduled, and their level of coverage can be selected. These topics include identification and inspection of fracture critical members (FCM's), underwater inspection, culverts, field trips, case studies, and coatings. Several special bridge types may also be discussed at the host agency's request.

- "Fracture Critical Inspection Techniques for Steel Bridges" (NHI Course Number FHWA-NHI-130078)

  This three and one-half day course provides an understanding of fracture critical members (FCM's), FCM identification, failure mechanics and fatigue in metal. Emphasis is placed on inspection procedures and reporting of common FCM's and nondestructive testing (NDT) methods most often associated with steel highway bridges.

- "Stream Stability and Scour at Highway Bridges for Bridge Inspectors" (NHI Course Number FHWA-NHI-135047)

  This one-day course concentrates on visual keys to detecting scour and stream instability problems. The course emphasizes inspection guidelines to complete the hydraulic and scour-related coding requirements of the National Bridge Inspection Standards (NBIS).

- "Bridge Coatings Inspection" (NHI Course Number FHWA-NHI-130079)

  This four-day course provides information on the inspection of surface preparation and application of protective coating systems for bridge and highway structures. The course provides a basic overview of the theory of corrosion and its control and the characteristics of various bridge coating types.

- "Inspection and Maintenance of Ancillary Highway Structures" (NHI Course Number FHWA-NHI-130087)

  This two-day course provides training in the inspection and maintenance of ancillary structures, such as structural supports for highway signs, luminaries, and traffic signals. Its goal is to provide agencies with information to aid in establishing and conducting an inspection program in accordance with the FHWA "Guidelines for the Installation, Inspection, Maintenance, and Repair of Structural Supports for Highway Signs, Luminaries, and Traffic Signals".

- "Underwater Bridge Inspection" (NHI Course Number FHWA-NHI-130091)

  This three-day course provides an overview of diving operations that will be useful to agency personnel responsible for managing underwater bridge inspections. This course also fulfills the requirement due to the latest changes of the National Bridge Inspection Standards, which require bridge inspection training for all divers conducting underwater inspections.

- "Inspection of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes" (NHI Course Number FHWA-NHI-132080)

  This three-day course is part of a series to develop a training and qualification/certification program for field inspectors. A partial list of topics addressed in the course are MSE wall and RSS types and durability; construction methods and sequences; alignment control; methods of fill and compaction control; plans, specifications, and the geotechnical report; shop drawings; and safety.

Throughout all the expansions and improvements in bridge inspection programs and capabilities, one factor remains constant: the overriding importance of the inspector's ability to effectively inspect bridge components and materials and to make sound evaluations with accurate ratings. The validity of all analyses and decisions based on the inspection data is dependent on the quality and the reliability of the data collected in the field.

Across the nation, the duties, responsibilities, and qualifications of bridge inspectors vary widely. The two keys to a knowledgeable, effective inspection are training and experience in performing actual bridge inspections. Training of bridge inspectors has been, and will continue to be, an active process within state highway agencies for many years. This manual is designed to be an integral part of that training process.

Current FHWA Reference Material

- NBIS. *Code of Federal Regulations.* 23 Highways Part 650, Subpart C – National Bridge Inspection Standards.
- AASHTO. *LRFD Bridge Design Specifications*, *3rd Edition.* Washington, D.C.: American Association of State Highway and Transportation Officials, with 2005 and 2006 Interims.
- FHWA. *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges.* Washington, D.C.: United States Department of Transportation, 1995, Errata Sheet 03/ 2004.
    - http://www.fhwa.dot.gov/bridge/mtguide.pdf
- FHWA. *Bridge Inspector's Reference Manual.* Washington, D.C.: United States Department of Transportation, 2002, Revised 2006.
- AASHTO. *Manual for Condition Evaluation of Bridges, 2nd Edition.* Washington, D.C.: American Association of State Highway and Transportation Officials, with 2005 Interims.
- AASHTO. *Guide for Commonly Recognized* (*CoRe) Structural Elements.* Washington, D.C.: American Association of State Highway and Transportation Officials, 1998, with 2002 interims.

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Topic 1.2 Responsibilities of the Bridge Inspector

1.2.1 Introduction

Bridge inspection has played, and will continue to play, an increasingly important role in providing a safe infrastructure for our nation. As our nation's bridges continue to age and deteriorate, an accurate and thorough assessment of each bridge's condition is critical in maintaining a safe, functional and reliable highway system.

This section presents the responsibilities of the bridge inspector. It also describes how the inspector can prepare for the inspection and some of the major inspection procedures.

1.2.2 Responsibilities of the Bridge Inspector and Engineer

There are five basic responsibilities of the bridge inspector and engineer:

- Maintain public safety and confidence
- Protect public investment
- Provide bridge inspection program support
- Provide accurate bridge records
- Fulfill legal responsibilities

1. Maintain Public Safety and Confidence

The primary responsibility of the bridge inspector is to maintain public safety and confidence. This is also a prime concern to everyone in the highway agency. The general public travels our highways and bridges without hesitation. However, when a bridge fails, the public's confidence in our bridge system is violated (see Figure 1.2.1).

The engineer's role is:

- To incorporate safety factors.
- To provide cost-effective designs.

  Engineers provide a margin of safety to compensate for a lack of precise calculations, variations in the quality of material, erection loading conditions, and uncertain maintenance. This is particularly evident in older bridges, especially those designed prior to the use of computers. The bridge design engineer must be as confident as possible that the bridge will never fail under natural or man-made loads.

The inspector's role is:

- To provide thorough inspections identifying bridge conditions and defects.
- To prepare condition reports documenting these deficiencies and alerting supervisors or engineers of any findings which might impact the safety of the roadway user or the integrity of the structure.

Figure 1.2.1 Mianus Bridge Failure

2. Protect Public Investment

Another responsibility is to protect public investment in bridges. The inspector must be on guard for minor problems that can be corrected before they lead to costly major repairs. The inspector must also be able to recognize bridge elements that need repair in order to maintain bridge safety and avoid replacement costs.

As stated before, the funding available to rehabilitate and replace deficient bridges is not adequate to meet all of the needs. It is important that preservation activities be a part of the bridge program to extend the performance life of as many bridges as possible and minimize the need for costly repairs or replacement.

The engineer's role is:

- To continually upgrade design standards to promote longevity of bridge performance.

The inspector's role is:

- To continually be on guard for minor problems that can become costly repairs.
- To recognize bridge components that need repair in order to maintain bridge safety and avoid the need for costly replacement.

3. Provide Bridge Inspection Program Support

Subpart C of the National Bridge Inspection Standards (NBIS) of the *Code of Federal Regulations*, 23 Highways Part 650, mandates:

- Purpose
- Applicability
- Definitions
- Bridge inspection organization
- Qualifications of personnel
- Inspection frequency

- Inspection procedures
- Inventory
- Reference manuals

Bridge Inspection Programs are funded by public tax dollars. Therefore, the bridge inspector is financially responsible to the public.

The "Surface Transportation Act of 1978" established the funding mechanism for providing federal funds for bridge replacement. The Act also established criteria for bridge inspections and requirements for compliance with the NBIS.

The "Intermodal Surface Transportation Efficiency Act" (ISTEA) of 1991 and the Transportation Equity Act for the 21st Century (TEA-21) of 1998 establish funding mechanisms for tolled and free bridges for bridge maintenance, rehabilitation and replacement to adequately preserve the bridges and their safety to all users.

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) was signed into law in August 2005. SAFETEA-LU represents the largest surface transportation investment in our Nation's history. SAFETEA-LU builds on and improves the initiatives established in ISTEA and TEA-21.

4. Provide Accurate Bridge Records

There are three major reasons why accurate bridge records are required:

a. To establish and maintain a structure history file.

For example, two bridge abutments are measured for tilt during several inspection cycles, and the results are as follows:

Year	Abutment A	Abutment B
2006	106 mm (4-3/16")	89 mm (3-1/2")
2004	106 mm (4-3/16")	57 mm (2-1/4")
2002	105 mm (4-1/8")	29 mm (1-1/8")
2000	102 mm (4")	25 mm (1")

Looking at year 2006 measurements only would indicate that Abutment A has a more severe problem. However, examining the changes each year, it is noted that the movement of Abutment A is slowing and may have stopped, while Abutment B is changing at a faster pace each inspection cycle. At the rate it is moving, Abutment B will probably surpass Abutment A by the next inspection.

b. To identify and assess bridge deficiencies and to identify and assess bridge repair requirements. An individual should be able to readily determine, from the records, what repairs are needed as well as a good estimate of quantities. Maintain reports on the results of the bridge inspection together with notations of any action taken to address the findings of such inspections.

c. To identify and assess minor bridge deficiencies and to identify and assess bridge maintenance needs in a similar manner to the repair requirements. Maintain relevant maintenance and inspection data to allow assessment of current bridge condition.

To ensure accurate bridge records, proper record keeping needs to be maintained. A system must be developed to review bridge data and evaluate quality of bridge inspections. Bridge files are to be prepared as described in the *AASHTO Manual for Condition Evaluation and Load and Resistance Factor Rating*. Record the findings and results of bridge inspections on standard State or Federal agency forms.

5. Fulfill Legal Responsibilities

A bridge inspection report is a legal document. Descriptions must be specific, detailed, quantitative (where possible), and complete. Vague adjectives such as good, fair, poor, and general deterioration, without concise descriptions to back them up, should not be used. To say "the bridge is OK" is just not good enough.

Example of inspection descriptions:

Bad description: "Fair beams"

Good description: "Reinforced concrete tee-beams are in fair condition with light scaling on bottom flanges of Beams B and D for their full length"

Bad description: "Deck in poor condition"

Good description: "Deck in poor condition with spalls covering 50% of the deck as indicated on field sketch, see Figure 42"

Any visual assessments should include phrases such as "no other apparent defects" or "no other defects observed."

Original inspection notes should not be altered without consultation with the inspector who wrote the notes.

A bridge inspection report implies that the inspection was performed in accordance with the National Bridge Inspection Standards, unless specifically stated otherwise in the report. Proper equipment, techniques, and personnel must be used. If the inspection is a special or interim inspection, this must be explained explicitly in the report.

1.2.3 Qualifications of Bridge Inspectors

The NBIS are very specific with regard to the qualifications of bridge inspectors. The *Code of Federal Regulations*, Title 23, Part 650, Subpart C, Section 650.309, (23 CFR 650.309), lists the qualifications of personnel for the National Bridge Inspection Standards (Appendix B of this Manual). These are minimum standards; therefore, state or local highway agencies can implement higher requirements.

Inspection Program Manager

(a) The individual in charge of the organizational unit that has been delegated the responsibilities for bridge inspection, reporting, and inventory shall possess the following minimum qualifications:

   1) Be a registered professional engineer, or have ten years bridge inspection experience; and

   2) Successfully complete a Federal Highway Administration (FHWA) approved comprehensive bridge inspection training course.

Inspection Team Leader

(b) An individual in charge of a bridge inspection team shall possess the following minimum qualifications:

1) Have the qualifications specified in paragraph (a) of this section; or
2) Have five years bridge inspection experience and have successfully completed an FHWA approved comprehensive bridge inspection training course; or
3) Be certified as a Level III or IV Bridge Safety Inspector under the National Society of Professional Engineer's program for National Certification in Engineering Technologies (NICET) and have successfully completed an FHWA approved comprehensive bridge inspection training course, or
4) Have all of the following:
    i) 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;
    ii) Successfully passed the National Council of Examiners for Engineering and Surveying Fundamentals of Engineering examination;
    iii) Two years of bridge inspection experience; and
    iv) Successfully completed an FHWA approved comprehensive bridge inspection training course, or
5) Have all of the following:
    i) 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;
    ii) Four years of bridge inspection experience; and
    iii) Successfully completed an FHWA approved comprehensive bridge inspection training course.

1.2.4 Consequence of Irresponsibility

The dictionary defines tort as “a wrongful act for which a civil action will lie except one involving a breach of contract.”

In the event of negligence in carrying out the basic responsibilities described above, an individual, including department heads, engineers, and inspectors, is subject to personal liability. An inspector should strive to be as objective and complete as possible. Accidents that result in litigation are generally related, but not necessarily limited, to the following:

- Deficient safety features
- Failed members
- Failed substructure elements
- Failed joints or decks

- Potholes or other hazards to the traveling public
- Improper or deficient load posting

Anything said or written in the bridge file could be used in litigation cases held against you. In litigation involving a bridge, the inspection notes and reports may be used as evidence. A subjective report may have negative consequences for the highway agency involved in lawsuits involving bridges. The report will be scrutinized to determine if conditions are documented thoroughly and for the "proper" reasons. An inspector should, therefore, strive to be as objective and complete as possible. State if something could not be inspected.

Example of liabilities:

In a recent case, a consulting firm was found liable for negligent inspection practices. A tractor-trailer hit a large hole in a bridge deck, swerved, went through the bridge railing, and fell 9.1 m (30 feet) to the ground. Ten years prior to the accident, the consulting firm had noted severe deterioration of the deck and had recommended tests to determine the need for replacement. Two years prior to the accident, their annual inspection report did not show the deterioration or recommend repairs. One year before the accident, inspectors from the consultant checked 345 bridges in five days, including the bridge on which the accident occurred. The court found that the consulting firm had been negligent in its inspection, and assessed the firm 75% of the ensuing settlement.

In another case, four cars drove into a hole 3.7 m (12 feet) deep and 9.1 m (30 feet) across during the night. Five people were killed and four were injured. The hole was the result of a collapse of a multi-plate arch. Six lawsuits were filed and, defendants included the county, the county engineer, the manufacturer, the supplier, and the consulting engineers who inspected the arch each year. The arch was built and backfilled, with mostly clay, by a county maintenance crew 16 years prior to the accident. Three years later, the county engineer found movement of 75 to 100 mm (3 to 4 inches) at one headwall. The manufacturer sent an inspector, who determined that the problem was backfill-related and recommended periodic measurements. These measurements were done once, but the arch was described as "in good condition" or "in good condition with housekeeping necessary" on subsequent inspections. Inspection reports documented a 150 mm (6 inch) gap between the steel plate and the headwall. A contractor examined the arch at the county engineer's request to provide a proposal for shoring. The county engineer discussed the proposal with the consulting engineers a month before the accident. Thirteen inspections in all were conducted on the structure. An engineering report accuses the county engineer of poor engineering practice.

1.2.5 Quality Control and Quality Assurance

The NBIS requires Quality Control (QC) and Quality Assurance (QA) procedures to maintain a high degree of accuracy and consistency in the highway bridge inspection program. Accuracy and consistency are important since the bridge inspection process is the foundation to the bridge management systems. FHWA has developed a recommended framework for a bridge inspection QC/QA program (see Topic 1.3).

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Topic 1.3 Quality Control and Quality Assurance

1.3.1 Introduction

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 FHWA has developed a recommended framework for a bridge inspection QC/QA program to assist bridge owners in developing their QC / QA programs.

Accuracy and consistency of the data is important since the bridge inspection process is the foundation of the entire bridge management operation and bridge management systems. Information obtained during the inspection is used for determining needed maintenance and repairs, for prioritizing rehabilitations and replacements, for allocating resources, and for evaluating and improving design for new bridges. The accuracy and consistency of the inspection and documentation is vital because it not only impacts programming and funding appropriations, it also affects public safety.

1.3.2 Quality Control

Quality Control (QC) is the establishment and enforcement of procedures that are intended to maintain the quality of the inspection at or above a specific level. If an inspection program is decentralized, the state program manager is still responsible for QC.

1.3.3 Quality Assurance

Quality Assurance (QA) is 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. This is accomplished by the re-inspection of a sample of bridges by an independent inspection team. For decentralized state inspections or delegated inspection programs, the QA program can be performed by the central staff or their agent (e.g., consultants). If the inspections are centralized within the state, then the QA program should be performed by consultants or a division separate and independent of the inspection state organization.

The quality of the inspection and reports rests primarily with the inspection team leaders and team members and their knowledge and professionalism in developing a quality product. A QC/QA program is a means by which periodic and independent inspections, reviews, and evaluations are performed in order to provide feedback concerning the quality and uniformity of the state's or agency's inspection program. The feedback is then used to enhance the inspection program through improved inspection processes and procedures, training, and quality of the inspection report.

1.3.4 Quality Control and Quality Assurance Framework

The FHWA has developed the following recommended framework for a bridge inspection QC/QA program.

A. **Documentation of QC/QA Program**:

1. Develop, document, and maintain a bridge inspection manual that contains Quality Control/Quality Assurance (QC/QA) procedures in accordance with this recommended framework.
2. Elaborate on the purpose and benefits of the QC/QA program.
3. Provide appropriate definitions.

B. **Quality Control (QC) Procedures**

1. Define and document QC roles and responsibilities.
2. Document qualifications required for Program Manager, Team Leader, Inspection Team Member and Load Rater.
3. Document process for tracking how qualifications are met, including:
    a. Years and type of experience.
    b. Training completed.
    c. Certifications/registrations.
4. Document required refresher training, including:
    a. NHI training courses, other specialized training courses, and/or periodic meetings.
    b. Define refresher training content, frequency, and method of delivery.
5. Document special skills, training, and equipment needs for specific types of inspections.
6. Document procedures for review and validation of inspection reports and data.
7. Document procedures for identification and resolution of data errors, omissions and/or changes.

C. **Quality Assurance (QA) Procedures**

1. Define and document QA roles and responsibilities.
2. Document procedures for conducting office and field QA reviews, including:
    a. Procedures for maintaining, documenting, and

sharing review results; including an annual report.

b. Establish review frequency parameters. Parameters should include:

    i. Recommended review frequency for districts/units to be reviewed (e.g. review each district once every 4 years). Or establish number of districts/units to be reviewed annually.

    ii. Recommended number of bridges to review.

c. Procedures and sampling parameters for selecting bridges to review. Procedure should consider:

    i. Whether the bridge is or is not posted.

    ii. Bridge's deficiency status.

    iii. Whether the bridge is programmed for rehab or replacement.

    iv. Whether the bridge has had critical findings and the status of any follow-up action.

    v. Bridges with unusual changes in condition ratings (e.g. more than 1 appraisal rating change from previous inspection).

    vi. Bridges that require special inspections (underwater, fracture critical, other special).

    vii. Location of bridge.

d. Procedures for reviewing current inspection report, bridge file, and load rating.

e. Procedures to validate qualifications of inspector and load rater.

f. Define "out-of-tolerance" for condition rating and load rating. (e.g. rating of +/- 1 or load ratings that differ by more than 15%)

g. Checklists covering typical items to review as part of QA procedures.

    i. Bridge file.

    ii. Field inspection.

    iii. Load rating analysis.

h. Others.

3. Document disqualification procedures for team leaders and

consultant inspection firms that have continued record of poor performance.

4. Document re-qualification procedures for previously disqualified team leaders and consultant inspection firms that demonstrate they have acceptable performance.

5. Document procedures for conducting inspections on a “control” bridge.

6. Document procedures to validate the QC procedures.

Examples of Commendable State practices and additional resources regarding QC/QA programs are available at the following link: http://www.fhwa.dot.gov/bridge/nbis/nbisframework.cfm