DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, DC 20314-1000

ER 1110-2-111

CECW-EI
CECW-OD

Regulation
No. 1110-2-111

31 August 2002

Engineering and Design
PERIODIC SAFETY INSPECTION AND CONTINUING EVALUATION OF USACE BRIDGES

1. Purpose

This regulation defines the policy and prescribes procedures and responsibilities for the periodic inspection and evaluation of bridges owned or maintained by the U.S. Army Corps of Engineers (USACE) on civil works projects.

2. Applicability

This regulation applies to all USACE Commands having Civil Works responsibilities.

3. Distribution Statement.

Approved for public release; distribution is unlimited.

4. References

a. 23 F.R. 650, "National Bridge Inspection Standard," October 1988 (see Appendix A of this Engineer Regulation (ER)).

b. ER 1110-2-100, Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures.

c. ER 1110-2-101, Reporting of Evidence of Distress of Civil Works Structures.

d. EM 385-1-1, Safety and Health Requirements Manual.

e. "AASHTO LRFD Bridge Design Specifications" (latest edition).

f. "Bridge Inspector's Training Manual/90," July 1991 (Revised March 1995), Federal Highway Administration, 6300 Georgetown Pike, McLean, VA 22101.

g. "Bridge Inspector's Manual for Movable Bridges," Federal Highway Administration, FHWA-IP-77-10, 1977, supplement to reference 4*f*.

This regulation supersedes ER 1110-2-111, dated 30 April 1997.

h. "Construction and Maintenance Section," American Railway Engineering Association, Volumes I & II.

i. "Culvert Inspection Manual," Federal Highway Administration, FHWA-IP-86-2, July 01, 1986, supplement to reference 4*f*.

j. Evaluating Scour at Bridges," Hydraulic Engineering Circular (HEC) 18, Federal Highway Administration, FHWA-NHI-01-001, May 01, 2001.

k. "Evaluating Scour at Bridges," FHWA Technical Advisory T5140.23, October 28, 1991.

l. "Guide Specifications for Design of Pedestrian Bridges" (latest edition), American Association of State Highway and Transportation Officials.

m. "Guide Specifications for Fatigue Evaluation of Existing Steel Bridges," American Association of State Highway and Transportation Officials, 1990.

n. "Inspection of Fracture Critical Bridge Members," Federal Highway Administration, FHWA-IP-86-2, September 01, 1986, supplement to reference 4*f*.

o. "Manual for Maintenance Inspection of Bridges," American Association of State Highway and Transportation Officials, 444 N. Capitol Street NW, Washington, DC 20001 (latest edition).

p. "Manual for Condition Evaluation of Bridges," American Association of State Highway and Transportation Officials, 444 N. Capitol Street NW, Washington, DC 20001, 2nd ed.

q. "Manual for Railway Engineering," American Railway Engineering and Maintenance-of-Way Association, Volumes I & II (latest edition).

r. OSHA Standard 1926.106(a), Personal Protective and Life Saving Equipment, "Standards Interpretation, Fall Protection, Lifejacket, and Lifesaving Requirements When Working Over or Near Water."

s. "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nations Bridges," Design and Inspection Branch, Bridge Division, Federal Highway Administration, Washington, DC (latest edition).

t. "Revisions to the National Bridge Inspection Standards (NBIS)," FHWA Technical Advisory T5140.21, September 16, 1988.

u. "Seismic Retrofitting Manual for Highway Bridges," Federal Highway Administration, FHWA-RD-94-052, May 1995.

v. "Standard Specifications for Highway Bridges," American Association of State Highway and Transportation Officials, 16th ed.

w. "Stream Stability at Highway Structures," Hydraulic Engineering Circular (HEC) 20, Federal Highway Administration, FHWA-NHI-01-002, March 01, 2001.

x. "Underwater Inspection of Bridges," Federal Highway Administration, FHWA-DP-80-1, November 01, 1989.

y. "USACE Bridge Inventory System," September 1992.

5. Background

The Surface Transportation Assistance Act of 1978 (PL 100-17) requires that all structures defined as bridges (see reference 4*a*) on public roads be inventoried and inspected in accordance with the National Bridge Inspection Standards (NBIS). Under the standards, each state is required to record and maintain structure inventory and appraisal data on each bridge and submit the data to the Federal Highway Administration (FWHA) upon request.

6. Policy

All bridges identified within this regulation owned or maintained by the USACE on Civil Works projects shall be inspected and inventoried to ensure their safety and structural integrity.

a. Public highway/roadway bridges (see part 650.301 of reference 4*a* for definition) with spans greater than 6.1 m (20 feet) shall be inspected and evaluated in compliance with the NBIS.

b. Railway bridges shall be inspected and evaluated in accordance with references 4*f* through 4*i*, 4*n,* 4*o,* 4*q*, 4*x*, and 4*w*.

c. Access bridges to outlet works, dam service bridges which are closed to the public, public and non-public pedestrian bridges, and all bridges on public roads with spans of 6.1m (20 feet) or less shall be inspected and evaluated in accordance with a comprehensive, uniform plan approved by each Major Subordinate Command (MSC) in consultation with HQUSACE (CECW-EI).

d. An inventory of subject bridges (public highway/roadway, railroad, foot/pedestrian, access bridges to outlet works and dam service bridges) shall be prepared and maintained in accordance with the Corps of Engineers Bridge Inventory System (CEBIS), reference 4*y*. The CEBIS is composed of three database files: the Structure Inventory and Appraisal (SI&A), the Inspection Sheet, and the Maintenance Sheet.

e. All existing bridges over tidal and non-tidal waterways with public vehicular traffic should be evaluated for the risk of failure from scour during the occurrence of a flood on the order of magnitude of the 500-year return period. Bridge scour evaluations shall be conducted for each bridge to determine whether it is scour critical in accordance with references 4*j* and 4*w*. Scope of scour evaluations for all other bridges shall be determined by the structural engineer in charge of the bridge inspection and evaluation program (see paragraph 11*a* for definition) after consultation with Hydraulic and Geotechnical Engineering.

f. Fracture critical members (FCMs) of any bridge shall be identified and recorded in the bridge inspection report and CEBIS. An inspection plan for FCMs shall be developed and executed. See Appendix B for additional guidance.

g. Bridge seismic evaluations and retrofitting requirements shall be conducted in accordance with sections 1.4 and 1.5 of reference 4*u*.

h. Seismic performance category and soil type for each bridge shall be identified and recorded in the bridge inspection report and CEBIS.

i. HQUSACE (CECW-EI) shall send consolidated SI&A data of USACE Public Highway/Roadway bridges to the FHWA to comply with the NBIS.

7. Bridge Definitions

a. Public Highway/Roadway bridges are bridges defined in part 650.301 of reference 4*a*.

b. Short Span bridges are all bridges open to public vehicular traffic with spans less than or equal to 6.1 m (20 feet).

c. Non-Public Access bridges are access and service bridges used for operation and maintenance purposes only. Only traffic related to operation and maintenance of USACE projects is allowed.

d. Public Pedestrian bridges are bridges with bridge lengths not less than 6.1 m (20 feet) open to public use intended to carry primarily pedestrian and/or bicycle traffic. These bridges may be subjected to an occasional single maintenance vehicle or similar type loading.

e. Non-Public Pedestrian bridges are access bridges with bridge lengths not less than 6.1 m (20 feet) used for operation and maintenance purposes only. These bridges may be subjected to an occasional single maintenance vehicle or similar type loading. Only traffic related to operation and maintenance of USACE projects is allowed.

f. All Other Pedestrian bridges are public and non-public pedestrian bridges with lengths less than 6.1 m (20 feet). Inspection scope and frequency and inspector qualifications for All Other Pedestrian bridges shall be determined by the structural engineer in charge of the bridge inspection and evaluation program (see paragraph 11*a*).

8. Types of Safety Inspections

Inspection during the service life of the bridge includes an initial inventory inspection after construction is complete, periodic routine inspections, special inspection to evaluate damage or deterioration, or to monitor performance, and underwater inspections that require special equipment for access. Descriptions of the types of inspections are included in Appendix C (see paragraph 11*a*).

9. Frequency of Inspections

a. *Routine inspections*. Routine inspections for vehicle and pedestrian bridges shall be conducted every 2 years unless the condition of the bridge indicates that more frequent inspections are required. See Appendix D for guidelines on railway bridges.

b. *Other inspections.* Other types of inspections and their frequencies will depend upon the age, present load capacity, traffic, type of construction, state of maintenance, and any known deficiencies related to fatigue, scour, seismic influences, FCMs, and corrosion. Evaluation of bridge condition and scheduling of inspection intervals shall be the responsibility of the structural engineer in charge of the inspection program (see paragraph 11*a*).

c. *Maximum inspection intervals.* The maximum inspection interval may be increased for bridges if past inspection reports and favorable experience and analysis justify the increase. Maximum inspection intervals of 4 years and 5 years between inspections are permitted for bridges described in paragraphs 6*a* and 6*c*, respectively. Proposals to inspect bridges described in paragraph 6*a* at intervals greater than 2 years shall be submitted to the FHWA through the state agency responsible for bridge inspections in which the bridge is located. Proposals shall follow guidelines outlined in reference 4*t*. A copy of the request and FHWA approval, if received, shall be provided to the MSC and CECW-EI. Proposals to inspect bridges described in paragraph 6*c* at intervals greater than 2 years shall be submitted to the MSC. The plan for inspecting any bridge at intervals greater than 2 years should be based on the type (i.e., with tires, treads, or on a track) and frequency of vehicular traffic that may cause fatigue or deterioration of the structural members.

d. Underwater inspections. Underwater bridge members shall be inspected to the extent necessary to determine the condition and structural integrity of the bridge. Underwater inspections include wading, diving, and soundings as required. An underwater inspection of all substructures shall be performed at an interval not to exceed 5 years. Underwater inspections for bridges that cross dam structures shall be inspected under the dam safety program. See reference 4*b* for dam inspection requirements.

e. S*pecial inspections.* Special inspections are necessary after bridges experience significant events such as hurricanes, earthquakes, fires, floods, or collisions.

10. Organizational Responsibilities

HQUSACE, MSC, and District responsibilities require teamwork among Engineering and Operations Divisions and Programs/Project Management organizations at all levels, and with the U.S. Army Engineer Research and Development Center (ERDC). The responsibilities are described below.

a. District. The District's engineering element shall be responsible for the following activities:

(1) Formulating the inspection plans, conducting the inspections, processing and analyzing the results of the instrument observations, evaluating the condition of the bridges, determining

scope and frequency of future inspections, preparing and submitting the inspection reports, and performing an independent technical review. All reports shall be submitted in an electronic format (see paragraph 16).

(2) Submitting all inspection reports by the District Commander to the MSC Commander (or to the delegated approval authority) for certification of quality assurance and approval (Part 1 of Appendix E) within 60 days after the inspection. Copies of approved reports shall be forwarded to the District Operations Division and the District Project Office.

(3) Preparing, maintaining, and updating the District CEBIS, maintaining permanent record copy of all inspection reports at the District, and developing a quality control plan (QCP) annually for MSC review and approval. The District CEBIS shall be submitted to the MSC no later than 01 January of each calendar year. The QCP may be included in the District's 5-year bridge inspection program budget and schedule (see paragraph 12). The QCP shall be furnished to the MSC by 15 January of each year.

(4) Inviting a representative from the Operations Division to participate in each inspection. For those bridges being inspected for the first time, a representative from the Construction Division and Operations Division shall be invited to participate.

(5) Coordinating with Operations Division and Programs and Project Management on the annual operations and maintenance (O&M) budget process for funding existing bridge inspections, evaluations, repairs, improvements, or rehabilitation related to bridge safety. The 5-year bridge inspection program budget, schedule, and justification shall be provided to the Operations Division and Programs and Project Management organizations for use in the O&M budgeting process.

(6) Notifying any city, county, state, or local government and operating railway company which has jurisdiction of the roadway or railway of the inspection.

(7) Providing status on the bridge inspection and evaluation program at least annually to the District's Dam Safety Committee.

b. *MSC*. The MSC's engineering element shall be responsible for the following activities:

(1) Reviewing and monitoring the data collection, processing, evaluation, and inspection activity; maintaining the schedule of inspections and status of reports; verifying qualifications of the Bridge Inspector's team; and establishing procedures to promptly inform CECW-EI and CECW-OD when the evaluation of a bridge or instrumentation data indicate that a bridge is unsafe.

(2) Coordinating with Operations Division and Programs and Project Management on the annual O&M budget process for funding existing bridge inspections, evaluations, repairs, improvements, or rehabilitation related to bridge safety.

(3) Approving inspection reports. MSC Commanders are authorized to approve inspection reports. If the MSC decides to delegate approval authority to the Districts, then it should retain

responsibility for program management and oversight. Review and approval of reports should be completed within 90 days after completion of the field inspection. This period should include satisfactory resolution of all review comments. Reports shall be sent to CECW-EI for review and approval, with the views and recommendations of the MSC Commander included in the transmittal correspondence only under the following circumstances:

(a) Views and recommendations are requested by a HQUSACE representative at the inspection.

(b) Bridge inspection indicates that the safety of a bridge is in jeopardy and requires posting as described in paragraph 14.

(4) Consolidating, by the MSC Commander, District CEBIS into MSC CEBIS and submit to ERDC before 1 February of each calendar year.

(5) Maintaining and updating the MSC CEBIS.

(6) Designating a qualified structural engineer, responsible for the bridge inspection safety program at the MSC/District, as the point of contact for CEBIS, inspection, report, maintenance, repair, and rehabilitation of bridges.

(7) Developing a quality assurance (QA) program and completion of Part 2 of Appendix E. The QA shall be furnished to CECW-EI by 15 February of each year.

(8) Submitting each approved District QCP to CECW-EI by 15 February of each year.

(9) Providing status on the bridge inspection and evaluation program at least annually to the Division's Dam Safety Committee.

c. *HQUSACE*. The CECW-EI shall be responsible for the following activities:

(1) Overseeing engineering management of all phases of the USACE Bridge Safety Program.

(2) Coordinating with CECW-OD on the annual O&M budget process for funding existing bridge inspections, evaluations, repairs, improvements, or rehabilitation related to bridge safety.

(3) Developing engineering guidance for implementing a Bridge Safety Program covering public access bridges and other USACE bridges.

(4) Providing policy advice to HQUSACE elements on any new legislation related to the safety of USACE bridges.

(5) Providing policy compliance review of all decision documents related to bridge safety deficiencies.

(6) Acting as proponent for training needs of USACE bridge engineers and coordinating the training effort with courses offered by FHWA and American Association of State Highway and Transportation Officials (AASHTO).

(7) Acting as liaison with state and other federal agencies to evaluate procedures and capabilities with respect to bridge safety.

d. ERDC. ERDC shall be responsible for the following activities:

(1) Consolidating and compiling the data from all District inspection reports and MSC CEBIS into the computer database, compiling SI&A data of USACE Public Highway/Roadway bridges, and submitting to CECW-EI for reporting to FHWA before 15 March of each calendar year.

(2) Providing CEBIS reports to HQUSACE, MSCs, Districts, and other USACE installations upon request.

11. Qualifications of Bridge Inspector's Team

a. Structural engineer. The structural engineer in charge of the bridge inspection and evaluation program shall be a registered professional engineer and have completed a comprehensive training course based on the "Bridge Inspector's Training Manual/90" (reference 4*f)*.

b. Field inspection team. All field inspections shall be performed by a team consisting of a team leader and at least one bridge technical specialist.

(1) The team leader shall be a structural engineer who meets the minimum qualifications stated in paragraph 650.307 of reference 4*a* and have completed a comprehensive training course based on the current version of reference 4*f*.

(2) Bridge technical specialists shall meet the following minimum qualifications:

(a) Have a Bachelor of Science Degree in Civil Engineering, or

(b) Have an Associate Degree in Civil Engineering Technology and have completed a comprehensive training course in Engineering Concepts for Bridge Inspectors based on the current version of reference 4*f*.

(3) The mechanical and electrical engineer involved with the inspection of movable bridges (swing, bascule, and vertical lift bridges) shall be qualified to be registered professional engineers who are proficient with the methods and procedures described in Chapter 20, reference 4*f*.

c. Underwater inspections and scour evaluation. Underwater inspectors must have knowledge and experience in bridge inspection. A diver not fully qualified as a bridge inspector or bridge inspection team leader must be used only under close supervision. Hydraulic and geotechnical engineers involved with the bridge scour evaluation should be registered

professional engineers or qualified to be registered who are proficient in the methods described in reference 4*j* and 4*w* and should have successfully completed the FHWA training course, Stream Stability and Scour at Highway Bridges. All underwater inspections and scour evaluations shall be conducted under the direct supervision of a qualified bridge inspection team leader.

d. Independent technical review. Reviewers should be senior engineers who have the proper knowledge, skills, training, and experience, and who were not directly involved in the inspection or report preparation. The reviewer's qualifications shall not be less than those stated in paragraph 11*a*, and must have current experience in inspecting and evaluating several bridges. Names and qualifications of the reviewers should be included in the District's QCPs, and be approved by the MSC as part of its QA program.

12. Inspection Procedures

A 5-year bridge inspection program budget and schedule shall be developed. Condition, age, size, and traffic are some of the parameters to consider in establishing priorities for the inspection plan. A copy of this plan is to be furnished through the MSC to CECW-EI by 15 February of each year. See Appendix D for guidelines specific to railroad bridges.

a. *Notification of inspections*. CECW-EI shall be notified, through the MSC, at least 30 days in advance of a scheduled inspection in order to determine whether a HQUSACE representative(s) will participate in the inspection.

b. Procedures for underwater members. See reference 4*x* and Chapter 17 of the reference 4*f* for details.

c. *Procedures for fracture critical members*. See Chapter 18 of the reference 4*f*, reference 4*n*, and Appendix B for details.

d. *Procedures for inspection and evaluation of bridge structures*. See Chapters 7-14 of reference 4*f* and reference 4*p* for details.

e. *Procedures for inspection of movable bridges*. See Chapter 20 of references 4*f* and 4*g* for details.

f. *Inspection of segmental concrete bridges, cable-stayed bridges, and suspension bridges*. See Chapter 21 of reference 4*f* for details.

g. *Procedures for evaluating scour at bridges*. See references 4*j* and 4*w* for details.

h. *Safety plan.* A safety plan, following guidelines in reference 4*d* of this regulation shall be prepared for all inspections in which the safety of the inspector is placed in jeopardy. Examples include falls and traffic. See reference 4*r* for guidance when working over water.

13. Load Capacity Rating

a. *Load capacity rating for Public Use bridges*. All Public Highway/Roadway bridges and Short Span bridges shall be rated for safe load-carrying capacity using the AASHTO vehicle loads described below. The capacity of all highway bridges shall be rated at two levels. The upper load level is referred to as the Operating Rating and the lower load level is referred to as the Inventory Rating. Load ratings for bridge members shall be made in accordance with references 4*o* and 4*p*.

(1) A load capacity rating shall be performed as part of:

(a) The initial inventory inspection.

(b) Periodic routine inspections if rating is not available in records or if the inspection reveals previously unknown conditions that affect the bridge load capacity.

(c) Special inspections after bridges experience significant events such as hurricanes, earthquakes, fires, floods, or collisions.

(2) A load rating shall be performed whenever the dead load from the bridge surface has increased due to a major rehabilitation or replacement of the decking.

(3) All load ratings shall be based on the AASHTO Standard MS (HS) Truck and Lane Load (references 4*e* and 4*v*) . Alternatively, the HL-93 vehicle load of reference 4*e* may be used to determine load ratings. The Strength-I load factors shall be used for determining the Inventory Rating, and the Strength-II load factors shall be used to determine the Operating Rating for this vehicle.

b. *Load capacity rating for Public Pedestrian bridges.* All Public Pedestrian bridges shall be rated for safe load-carrying capacity using the pedestrian load guidance in reference 4*l* as modified in paragraph 14*b.* These bridges shall also be rated for vehicle or other loadings, if applicable, following loading guidelines of reference 4*l*, including commentary. Vehicle ratings may be based on the Operating Rating defined by AASHTO.

c. *Load capacity rating for Non-Public and all other Pedestrian bridges.* All Non-Public and all other Pedestrian bridges shall be rated for safe load-carrying capacity using acceptable standards. Acceptable standards shall be determined by the structural engineer in charge of the bridge inspection and evaluation program. Material properties should be conservatively estimated if no material specifications or other records are available.

d. *Load capacity rating for Non-Public Access bridges*. These bridges shall be rated for safe load-carrying capacity using expected loads and load configurations. Rating procedures shall follow AASHTO bridge rating standards. Loads shall be limited to safe levels. Safe levels may be based on the AASHTO Operating Rating for bridges with low levels of traffic.

e. Load capacity rating for Railway bridges. Railway bridges shall be rated for safe load-carrying capacity in accordance with reference 4*q*. Load ratings shall be based on the Cooper E80 load and expected loads and configurations (reference 4*q*). See Appendix D for further rating guidelines.

f. Evaluation for fatigue and fracture. A fatigue evaluation following procedures of reference 4*m* shall be conducted on all public use bridges with FCMs and all public use bridges with a high number of load cycles or stress ranges. Fatigue evaluation for non-public use bridges shall be determined by the structural engineer in charge of the bridge inspection program and should be based on degree of redundancy, age and condition of bridge, and number and magnitude of stress cycles. A fracture analysis shall be conducted when cracks are detected. See Appendix B for more detail.

14. Load Limit Posting

a. Public Highway/Roadway bridges and Short Span bridges. These bridges shall be posted for load-carrying capacity when the maximum legal load exceeds the Operating Rating capacity. Districts may choose to post an Inventory Rating capacity. If the bridge condition requires reducing the posted limit to less than 2.7 tonnes (3 tons), the bridge or culvert shall be closed for vehicular traffic.

b. Load posting for pedestrian bridges. All pedestrian bridges shall be posted when the safe load capacity is below 3.1 kPa (60 psf) of uniform load. The posting shall limit the number of pedestrians on the bridge at one time. Bridges with a safe load capacity below 1.9 kPa (40 psf) of uniform load shall be closed. Higher posting and closing limits may be imposed by the structural engineer in charge of the bridge inspection and evaluation program if use and consequences of failure warrant increased limits. Bridges shall be closed if bridge railing does not meet the loading requirements of reference 4*d*.

c. Railway bridges. Refer to Appendix D for guidance on control of railway loads when the safe load capacity is below the Cooper E80 load or expected loads and configurations.

15. Seismic Evaluation of Bridges

All vehicle bridges, except those under Seismic Performance Category A described in reference 4*u*, shall be evaluated in accordance with Appendix F.

16. Inventories and Inspection Report

a. Report preparation. A formal technical report shall be a permanent record and will serve as a basis for determining the need for remedial work. The report will be based on a detailed inspection and evaluation of each bridge as to its safety and structural adequacy. As a minimum, the report shall contain the results of the inspection, recommendations for remedial work, and approximate total cost. In order to more accurately portray conditions and changes in conditions of surfaces and structural details, photographs are generally required. Photographs shall be provided of all areas requiring visual monitoring or critical regions of structural distress. The

CEBIS printout shall be part of the inspection report. All reports shall be submitted in electronic format. Report contents and format shall be as shown in Appendix G.

b. *Report review and certification*. All bridge inspection and evaluation reports shall receive an independent technical review. The district shall certify that the inspections and evaluations were performed in accordance with this regulation and the referenced criteria by qualified engineers. The District shall also certify that all remedial work necessary to ensure that the safety of the bridge is being developed on an appropriate schedule. See Appendix E for certification and approval.

c. *Report distribution*. One copy of each approved report shall be submitted by the originating office through the MSC to CECW-EI.

d. *Inventory preparation*. Each District shall prepare and maintain a District CEBIS of all their bridges. The District CEBIS includes the SI&A data shown in Appendix H. Newly completed structures, physical changes to existing structures which would alter previously recorded data, and placement of load and/or speed restriction signs shall be entered in the District CEBIS within 60 days after the change in condition. The MSC shall update and forward the MSC CEBIS data to CECW-EI and also furnish a copy to ERDC within 30 days after receiving District updates.

e. *CEBIS distribution*. The District Commander shall submit one copy of the District CEBIS to the MSC in an acceptable electronic format. The MSC shall consolidate all District CEBIS's into an MSC CEBIS and forward one copy to ERDC. ERDC shall consolidate all MSC CEBIS's into a Civil Works CEBIS and forward to CECW-EI.

17. Reporting Distress

If the bridge inspection and evaluation indicate evidence of distress or potential failure requiring immediate remedial action, the District shall inform CECW-EI and CECW-OD immediately through the MSC office. Emergency situations will be handled in accordance with the guidance set forth in reference 4*c*.

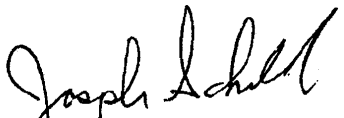
18. Interagency Coordination

In those cases where ownership of major elements is divided between the Corps and other agencies, information pertinent to the condition of project elements owned by others, as observed by the Corps inspection team, shall be furnished to the co-owner for information purposes only.

19. Funding

Requests for funding of bridge inspections, maintenance, and repair shall be prioritized and submitted to CECW-OD as part of the annual O&M budget process. CECW-OD, in consultation with CECW-EI, will allocate funds for inspections, evaluation, and repair of bridge structures not only in accordance with the needs and results reported in the Civil Works CEBIS database, but also subject to overall budget priorities.

FOR THE COMMANDER:



JOSEPH SCHROEDEL
Colonel, Corps of Engineers
Chief of Staff

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APPENDIX A
NATIONAL BRIDGE INSPECTION STANDARD

Excerpts from the Code of Federal Regulations
23 Highways - Part 650
Subpart C National Bridge Inspection Standards (NBIS)

§650.301 Application of Standards.

The National Bridge Inspection Standards (NBIS) in this part apply to all structures defined as bridges located on all public roads. In accordance with the AASHTO (American Association of State Highway and Transportation Officials) Transportation Glossary, a "bridge" is defined as a structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 6.1 m (20 feet) between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

§650.303 Inspection Procedures.

(a) Each highway department shall include a bridge inspection organization capable of performing inspections, preparing reports, and determining ratings in accordance with the provisions of the AASHTO Manual[1] and the Standards contained herein.

(b) Bridge inspectors shall meet the minimum qualifications stated in §650.307.

(c) Each structure required to be inspected under the Standards shall be rated as to its safe load-carrying capacity in accordance with Section 4 of the AASHTO Manual. If it is determined under this rating procedure that the maximum legal load under state law exceeds the load permitted under the Operating Rating, the bridge must be posted in conformity with the AASHTO Manual or in accordance with state law.

(d) Inspection records and bridge inventories shall be prepared and maintained in accordance with the Standards.

(e) The individual in charge of the organizational unit that has been delegated the responsibilities for bridge inspection, reporting, and inventory shall determine and designate on the individual inspection and inventory records and maintain a master list of the following:

[1] The AASHTO Manual referred to in this part is the "Manual for Maintenance Inspection of Bridges" (1983) together with subsequent interim changes or the most recent version of the AASHTO Manual published by the American Association of State Highway and Transportation Officials. A copy of the Manual may be examined during normal business hours at the office of each Division Administrator of the Federal Highway Administration, at the office of each Regional Federal Highway Administrator, and at the Washington Headquarters of the Federal Highway Administration. The addresses of those document inspection facilities are set forth in Appendix D to Part 7 of the regulations of the Office of the Secretary (40 CFR Part 7). In addition, a copy of the Manual may be secured upon payment in advance by writing to the American Association of State Highway and Transportation Officials, 444 N. Capitol Street NW, Suite 225, Washington, DC 20001.

(1) Those bridges that contain fracture critical members, the location and description of such members on the bridge, and the inspection frequency and procedures for inspection of such members. (Fracture critical members are tension members of a bridge whose failure will probably cause a portion of or the entire bridge to collapse.)

(2) Those bridges with underwater members which cannot be visually evaluated during periods of low flow or examined by feel for condition, integrity, and safe load capacity due to excessive water depth or turbidity. These members shall be described, the inspection frequency stated, not to exceed 5 years, and the inspection procedure specified.

(3) Those bridges which contain unique or special features requiring additional attention during inspection to ensure the safety of such bridges and the inspection frequency and procedure for inspection of each such feature.

(4) The date of last inspection of the features designated in paragraphs (e)(1) through (e)(3) of this section and a description of the findings and follow-up actions, if necessary, resulting from the most recent inspection of fracture critical details, underwater members, or special features of each so designated bridge.

ξ650.305 Frequency of Inspections.

(a) Each bridge is to be inspected at regular intervals not to exceed 2 years in accordance with Section 2.3 of the AASHTO Manual.

(b) Certain types or groups of bridges will require inspection at less than 2-year intervals. The depth and frequency to which bridges are to be inspected will depend on such factors as age, traffic characteristics, state of maintenance, and known deficiencies. The evaluation of these factors will be the responsibility of the individual in charge of the inspection program.

(c) The maximum inspection interval may be increased for certain types or groups of bridges where past inspection reports and favorable experience and analysis justify the increased interval of inspection. If a state proposes to inspect some bridges at greater than the specified 2-year interval, the state shall submit a detailed proposal and supporting data to the Federal Highway Administrator for approval.

ξ650.307 Qualifications of Personnel.

(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

(2) Be qualified for registration as a professional engineer under the laws of the state; or

(3) Have a minimum of 10 years of experience in bridge inspection assignments in a responsible capacity and have completed a comprehensive training course based on the “Bridge

Inspector's Training Manual,"[1] which has been developed by a joint Federal-state task force, and subsequent additions to the manual.[2]

(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 a minimum of 5 years experience in bridge inspection assignments in a responsible capacity and have completed a comprehensive training course based on the "Bridge Inspector's Training Manual," which has been developed by a joint Federal-state task force; or

(3) Current certification as a Level III or IV Bridge Safety Inspector under the National Society of Professional Engineer's program for National Institute for Certification in Engineering Technologies (NICET)[3] is an alternative acceptable means for establishing that a bridge inspection team leader is qualified.

ξ650.309 Inspection Report.

The findings and results of bridge inspection shall be recorded on standard forms. The data required to complete the forms and the functions which must be performed to compile the data are contained in Section 3 of the AASHTO Manual.

ξ650.311 Inventory.

(a) Each state shall prepare and maintain an inventory of all bridge structures subject to the Standards. Under these Standards, certain structure inventory and appraisal data must be collected and retained within the various departments of the state organization for collection by the Federal Highway Administration as needed. A tabulation of this data is contained in the structure inventory and appraisal sheet distributed by the Federal Highway Administration as part of the Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges (Coding Guide) in January of 1979. Reporting procedures have been developed by the Federal Highway Administration.

(b) Newly completed structures, modification of existing structures which would alter previously recorded data on the inventory forms, or placement of load restriction signs on the approaches to or at the structure itself shall be entered in the state's inspection reports and the computer inventory file as promptly as practical but no later than 90 days after the change in the status of the structure for bridges directly under the state's jurisdiction and no later than 180 days after the change in status of the structure for all other bridges on public roads within the state.

Effective date October 25, 1988.

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[1] The "Bridge Inspector's Training Manual" may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

[2] The following publications are supplements to the "Bridge Inspector's Training Manual": "Bridge Inspector's Manual for Movable Bridges," 1977, GPO Stock No. 050-002-00103-5; "Culvert Inspection Manual," July 1986, GPO Stock No. 050-001-0030-7; and "Inspection of Fracture Critical Bridge Members," 1986, GPO Stock No. 050-001-00302-3.

[3] For information on NICET program certification, contact: National Institute for Certification in Engineering Technologies, 1420 King Street, Alexandria, VA 22314. Phone (703) 684-2835.

APPENDIX B
FRACTURE CRITICAL MEMBERS

The U.S. Army Corps of Engineers (USACE) has adapted American Association of State Highway and Transportation Officials (AASHTO) guidelines for fracture critical members (FCMs) on all steel bridges stated in the "Manual for Condition Evaluation of Bridges" (reference 4*p*).

> *"Fracture critical members or member components are tension members or tension components of members whose failure would be expected to result in collapse of a bridge."*

Tension components of a bridge member consist of components of tension members and those portions of a flexural member that are subject to tension stress. Any attachment having a length in the direction of the tension stress greater than 100 mm (4 inches) that is welded to the tension area of a component of a "fracture critical" member shall be considered part of the tension component and, therefore, shall be considered "fracture critical."

Not all tension members are FCMs. Redundant tension members are not FCMs. Redundancy means that should a tension member or its component fail, the load carried by the failed member could be redistributed to other members that have reserve capacity to temporarily carry additional load, and avoid catastrophic collapse of the structure. See reference 4*n* for recommended procedures for identification of FCMs.

FCMs have all or part of their cross section in tension. Most cracks in steel members occur in the tension zones, generally at a flaw or defect in the base material. Frequently the crack is a result of fatigue, occurring near a weld, a material flaw, and/or changes in member cross section.

After the crack occurs, failure of the member could be sudden and would lead to the collapse of the bridge. For this reason, steel bridges with the following structural characteristics or components should receive special attention during inspection:

- One- or two-girder systems, including single boxes with welding.
- Suspension systems with two eyebar components.
- Steel pier caps and cross girders.
- Two-truss systems.
- Suspended spans with two girders.
- Welded tied arches.
- Pin and hanger connections on two or three girder systems.

Inspection of steel bridges should include the identification of FCMs and the development of a plan for inspecting such members. The FCM inspection plan should identify the inspection frequency and procedures to be used. A very detailed close visual "hands-on" inspection in the field is the primary method of detecting cracks. This inspection requires that critical areas be specially cleaned prior to the inspection and additional lighting and magnification be used. Other nondestructive testing procedures (see reference 4*n* and Chapter 18 of reference 4*f*) should be used for the members that are not accessible for close visual contact or for examination of suspected cracks or flaws on welded members. Photographs and sketches should be made of the conditions found, and onsite comparisons of photographs and sketches should be made at follow-up inspections.

The FCM inspection plan for each bridge shall be developed by a qualified bridge inspector who should decide the frequency, methods, and procedures of the inspection. Inspection procedures shall follow guidelines of reference 4*n*. The FCM shall receive an independent technical review and shall be subject to the approval process required for bridge inspections.

Initial inspection of FCMs should be conducted thoroughly for each welded, bolted, or riveted joint and connection. The condition of the inspected members should be recorded clearly in the report. The report should include assessment and recommendation for follow-up inspections of the members. The recommendation should include the frequency, methods, and procedures of the inspection. Maximum inspection intervals of 6 years for Public Highway/Roadway bridges are permitted if the inspected and assessed FCMs are in good condition and an evaluation of fatigue life shows that the member is not approaching its useful limit. See reference 4*f*, Chapter 18, and reference 4*n* for more detailed information on FCM inspection and evaluation. For routine biennial inspection, FCMs should be inspected and reported not less than other structural members.

Inspection intervals for FCM inspections on bridges other than Public Highway/Roadway bridges shall be determined based on number and magnitude of load cycles, condition of bridge, and internal redundancy. Inspection intervals generally should not exceed 6 years. Longer intervals may be proposed if, in the judgment of the engineer in charge of the bridge inspection program, longer intervals are justified. Justification for increased intervals should be based on condition of bridge, amount of internal redundancy, potential for fracture, and length of remaining life determined from a fatigue analysis. Proposals for longer intervals shall be submitted to the Major Subordinate Command for review and approval.

When cracks are detected in an FCM, or when bridge and traffic conditions warrant it, the inspection should be supplemented by a fatigue and/or fracture evaluation of the member. The evaluation should be used to determine the remaining useful life and the critical crack size. Procedures may follow those outlined in reference 4*n* and applicable USACE publications. The computer program, NASGRO, developed by the National Aeronautics and Space Administration, may be used for fracture analysis. The program is available at http://mmptdpublic.jsc.nasa.gov/nasgro/nasgromain.html. Whenever the fracture toughness of the steel is not documented, some testing will be necessary to determine the threat of brittle fracture at low temperatures.

APPENDIX C
DESCRIPTION OF INSPECTION TYPES

Excerpts from the Code of Federal Regulations
23 Highways - Part 650
Subpart C National Bridge Inspection Standards (NBIS)

1. Inventory Inspections.

a. An Inventory Inspection is the first inspection of a bridge as it becomes part of the bridge inventory, but the elements of an Inventory Inspection may also apply when there has been a change in the configuration of the structure (e.g., widenings, lengthenings, supplemental bents). The Inventory Inspection is a fully documented investigation performed by engineers and technicians meeting the required qualifications for inspection personnel; it must be accompanied by an analytical determination of load capacity. The purpose of this inspection is twofold. First, it is used to determine all data for the "Structure Inventory and Appraisal Sheets" described in Appendix H to this Engineer Regulation plus other data required for U.S. Army Corps of Engineers records. Second, it is used for the determination of baseline conditions and the identification and listing of any existing problems or locations in the structure that may have potential problems. Aided by a prior detailed review of plans, it is during this inspection that any fracture critical members (or details) are noted for subsequent focus and that assessments are made of other conditions that may later warrant special attention.

b. If the bridge subjected to an Inventory Inspection is anything other than a newly constructed structure, it may be necessary to include some or all of the elements of an In-Depth Inspection.

2. Routine Inspections.

a. This is a regularly scheduled, intermediate-level inspection consisting of sufficient observations and/or measurements to determine the physical and functional condition of the bridge, to identify any developing problems and/or change from "Inventory" or previously recorded conditions, and to ensure that the structure continues to satisfy present service requirements.

b. The Routine Inspection must fully satisfy the requirements of this Engineer Regulation with respect to the maximum inspection frequency, updating of Structure Inventory and Appraisal data, and the qualifications of the inspection personnel. These inspections are generally conducted from deck, ground and/or water levels, and permanent work platforms and walkways, if such are present. Special equipment (e.g. underbridge inspection equipment, rigging, or staging) is necessary for a Routine Inspection in circumstances where its use provides the only practical means of access to areas of the structure that are being monitored.

c. The results of a Routine Inspection are to be fully documented with appropriate photographs and a written report that includes any recommendations for maintenance or repair and for scheduling of follow-up In-Depth Inspections, if necessary. Load capacity evaluations

will be provided to the extent that changes in structural conditions would affect any previously recorded ratings.

3. Damage Inspections.

This is an unscheduled inspection to assess structural damage resulting from environmental or man-inflicted causes. The scope of inspection must be sufficient to determine the need for emergency load restrictions or closure of the bridge to traffic and to assess the level of effort necessary to effect a repair. The amount of effort expended on this type of inspection will vary significantly depending upon the extent of the damage. If major damage has occurred, inspectors must evaluate fractured members and section loss, make measurements for misalignment of members, and check for any loss of foundation support. A capability to make onsite calculations to establish emergency load restrictions may be necessary. This inspection may be supplemented by a timely In-Depth Inspection as described in paragraph (4) to document more fully the extent of damage and the urgency and magnitude of repairs. Proper documentation, verification of field measurements and calculations, and perhaps a more refined analysis to establish or adjust interim load restrictions are required for follow-up procedures. A particular awareness of the potential for litigation must be exercised in the documentation of Damage Inspections.

4. In-Depth Inspections.

a. An In-Depth Inspection is a close-up, hands-on inspection of one or more members above or below the water level to detect any deficiencies not readily visible using Routine Inspection procedures. Traffic control and special equipment (e.g., underbridge inspection equipment, staging, and workboats) should be provided as necessary to obtain access. Personnel with special skills such as divers and riggers may be required.

b. When appropriate or necessary to fully ascertain the existence of or the extent of any deficiency(ies), nondestructive tests and/or other physical and chemical tests may need to be performed.

c. The inspection may include a load rating to assess the residual capacity of the member or members, depending upon the extent of the deterioration or damage.

d. This type of inspection can be scheduled as a supplement to a Routine Inspection, though generally at a longer interval, or it may be a follow-up for Damage or Inventory Inspections. It may include a diving inspection if needed.

e. On small bridges, the In-Depth Inspection, if warranted, should include all critical elements of the structure, but for large and complex structures, these inspections may be scheduled separately for defined segments of the bridge or for designated groups of elements, connections, or details that can be efficiently addressed by the same or similar inspection techniques. If the latter option is chosen, each defined bridge segment and/or each designated group of elements, connections, or details will be clearly identified as a matter of record, and each will be assigned a frequency for reinspection. To an even greater extent than is necessary for Inventory and Routine Inspections, the activities, procedures, and findings of In-Depth Inspections must be completely and carefully documented.

5. Interim Inspections.

a. Interim Inspections are scheduled at the discretion of the individual responsible for bridge inspection activities. An Interim Inspection is used to monitor a particular known or suspected deficiency (e.g., foundation settlement or scour, member condition, or the public's use of a load-posted bridge) and can be performed by any qualified person familiar with the bridge and available to accommodate the assigned frequency of investigation. Under the NBIS qualification requirements for inspection personnel, the individual performing an Interim Inspection must be carefully instructed regarding the nature of the known deficiency and its functional relationship to satisfactory bridge performance. In this circumstance, guidelines and procedures on what to observe and/or measure must be provided, and a timely process to interpret the field results must be in place.

b. The determination of an appropriate Interim Inspection frequency should consider the severity of the known deficiency.

6. Diving Inspection.

a. A bridge shall require a Diving Inspection if it meets one or more of the following diving criteria:

(1) A bridge with any portion of a substructure exposed to water deeper than 1.8 m (6 feet) during periods of normal low water shall be designated for diving inspection.

(2) A bridge with any portion of a substructure exposed to water deeper than 0.9 m (3 feet), but no deeper than 1.8 m (6 feet), during periods of normal low water may or may not be designated as a bridge requiring inspection by divers depending on the judgment of the professional engineer in charge of diving inspection activity. In making this determination, the professional engineer shall take into consideration, among other factors, structure type, materials of construction, foundation type, footing location relative to channel bottom, known or suspected problems, waterway characteristics, and superstructure and substructure redundancy. In making this evaluation and resulting determination, existing bridge records, including existing inspection information, shall be reviewed.

(3) A bridge with no portion of any substructure unit exposed to 0.9 m (3 feet) or more of water during periods of normal low water will normally not be designated for diving inspection.

b. Diving inspections may be performed as part of a Routine Inspection, In-Depth Inspection, Special Inspection, or as an independent inspection effort. When making determinations on the need for a Diving Inspection, it must be recognized that bridges are constructed of differing structural configurations and situated in widely varying environments. This results in varying degrees of inspection difficulty, complexity, structural redundancy, and structural sensitivity. Portions of the Diving Inspection criteria intentionally leave discretion to provide for proper bridge-by-bridge evaluation of the above and other factors in determining the need for a Diving Inspection. Diving Inspections shall be performed at maximum inspection intervals of 60 months. However, it shall be determined, on a bridge-by-bridge basis, if a "complete" or "partial" Diving Inspection is needed on a more frequent basis. If it is determined that more frequent Diving Inspections are needed, they shall be scheduled.

APPENDIX D
TRACK SAFETY STANDARDS

Excerpts from the Code of Federal Regulations
49 - Part 213
Appendix C to Part 213 – Statement of Agency Policy on the Safety of Railroad Bridges

Guidelines

1. Responsibility for Safety of Railroad Bridges

(a) Track owner. The owner of the track on a bridge, or another person assuming responsibility for the compliance of that track with this Part under provisions of Sec. 213.5, is responsible for ensuring that the bridge is capable of safely carrying all railroad traffic operated on that track, and for specifying the maximum loads that may be operated over the bridge.

(b) Divided ownership. Where the owner of the track on a bridge does not own the bridge, the track owner should ensure that the bridge owner is following a program that will maintain the integrity of the bridge. The track owner either should participate in the inspection of the bridge, or should obtain and review reports of inspections performed by the bridge owner. The track owner should maintain current information regarding loads that may be operated over the bridge, either from its own engineering evaluations or as provided by a competent engineer representing the bridge owner. Information on permissible loads may be communicated by the bridge owner either in terms of specific car and locomotive configurations and weights, or as values representing a standard railroad bridge rating reference system. The most common standard bridge rating reference system incorporated in the "Manual for Railway Engineering" of the American Railway Engineering and Maintenance-of-Way Association is the dimensional and proportional load configuration devised by Theodore Cooper. Other reference systems may be used where convenient provided their effects could be defined in terms of shear, bending, and pier reactions as necessary for a comprehensive evaluation and statement of the capacity of a bridge.

(c) Other railroads. The owner of the track on a bridge should advise other railroads operating on that track of the maximum loads permitted on the bridge stated in terms of car and locomotive configurations and weights. No railroad should operate a load that exceeds those limits without specific authority from, and in accordance with restrictions placed by, the track owner.

2. Capacity of Railroad Bridges

(a) Determination. The safe capacity of bridges should be determined by competent engineers using accepted principles of structural design and analysis.

(b) Analysis. Proper analysis of a bridge means knowledge of the actual dimensions, materials, and properties of the structural members of the bridge, their condition, and the stresses imposed in those members by the service loads.

(c) Rating. The factors that were used for the design of a bridge can generally be used to determine and rate the load capacity of a bridge provided:

(i) The condition of the bridge has not changed significantly, and

(ii) The stresses resulting from the service loads can be correlated to the stresses for which the bridge was designed or rated.

3. Railroad Bridge Loads

(a) Control of loads. The operating instructions for each railroad operating over bridges should include provisions to restrict the movement of cars and locomotives whose weight or configuration exceed the nominal capacity of the bridges.

(b) Authority for exceptions. Equipment exceeding the nominal weight restriction on a bridge should be operated only under conditions determined by a competent engineer who has properly analyzed the stresses resulting from the proposed loads.

(c) Operating conditions. Operating conditions for exceptional loads may include speed restrictions, restriction of traffic from adjacent multiple tracks, and weight limitations on adjacent cars in the same train.

4. Railroad Bridge Records

(a) The organization responsible for the safety of a bridge should keep design, construction, maintenance, and repair records readily accessible to permit the determination of safe loads. Having design or rating drawings and calculations that conform to the actual structure greatly simplifies the process of making accurate determinations of safe bridge loads.

(b) Organizations acquiring railroad property should obtain original or usable copies of all bridge records and drawings, and protect or maintain knowledge of the location of the original records.

5. Specifications for Design and Rating of Railroad Bridges

(a) The recommended specifications for the design and rating of bridges are those found in the “Manual for Railway Engineering” published by the American Railway Engineering and Maintenance-of-Way Association. These specifications incorporate recognized principles of structural design and analysis to provide for the safe and economic utilization of railroad bridges during their expected useful lives. These specifications are continually reviewed and revised by committees of competent engineers. Other specifications for design and rating, however, have been successfully used by some railroads and may continue to be suitable.

(b) A bridge can be rated for capacity according to current specifications, regardless of the specification to which it was originally designed.

6. Periodic Inspections of Railroad Bridges

(a) Periodic bridge inspections by competent inspectors are necessary to determine whether a structure conforms to its design or rating condition and, if not, the degree of nonconformity.

(b) The prevailing practice throughout the railroad industry is to inspect railroad bridges at least annually. Inspections at more frequent intervals may be indicated by the nature or condition of a structure or intensive traffic levels.

7. Underwater Inspections of Railroad Bridges

(a) Inspections of bridges should include measuring and recording the condition of substructure support at locations subject to erosion from moving water.

(b) Stream beds often are not visible to the inspector. Indirect measurements by sounding, probing, or any other appropriate means are necessary in those cases. A series of records of those readings will provide the best information in the event unexpected changes suddenly occur. Where such indirect measurements do not provide the necessary assurance of foundation integrity, diving inspections should be performed as prescribed by a competent engineer.

8. Seismic Considerations

(a) Owners of bridges should be aware of the risks posed by earthquakes in the areas in which their bridges are located. Precautions should be taken to protect the safety of trains and the public following an earthquake.

(b) Contingency plans for seismic events should be prepared in advance, taking into account the potential for seismic activity in an area.

(c) The predicted attenuation of ground motion varies considerably within the United States. Local ground motion attenuation values and the magnitude of an earthquake both influence the extent of the area affected by an earthquake. Regions with low frequency of seismic events produce less data from which to predict attenuation factors. That uncertainty should be considered when designating the area in which precautions should be taken following the first notice of an earthquake. In fact, earthquakes in such regions might propagate their effects over much wider areas than earthquakes of the same magnitude occurring in regions with frequent seismic activity.

9. Special Inspections of Railroad Bridges

(a) A special bridge inspection should be performed after an occurrence that might have reduced the capacity of the bridge, such as a flood, an earthquake, a derailment, or an unusual impact.

(b) When a railroad’s managers learn that a bridge might have suffered damage through an unusual occurrence, they should restrict train operations over the bridge until the bridge is inspected and evaluated.

10. Railroad Bridge Inspection Records

(a) Bridge inspections should be recorded. Records should identify the structure inspected, the date of the inspection, the name of the inspector, the components inspected, and their condition.

(b) Information from bridge inspection reports should be incorporated into a bridge management program to ensure that exceptions on the reports are corrected or accounted for. A series of inspection reports prepared over time should be maintained so as to provide a valuable record of trends and rates of degradation of bridge components. The reports should be structured to promote comprehensive inspections and effective communication between an inspector and an engineer who performs an analysis of a bridge.

(c) An inspection report should be comprehensible to a competent person without interpretation by the reporting inspector.

11. Railroad Bridge Inspectors and Engineers

(a) Bridge inspections should be performed by technicians whose training and experience enable them to detect and record indications of distress on a bridge. Inspectors should provide accurate measurements and other information about the condition of the bridge in enough detail so that an engineer can make a proper evaluation of the safety of the bridge.

(b) Accurate information about the condition of a bridge should be evaluated by an engineer who is competent to determine the capacity of the bridge. The inspector and the evaluator often are not the same individual. The quality of the bridge evaluation depends on the quality of the communication between them.

12. Scheduling Inspections

(a) A bridge management program should include a means to ensure that each bridge under the program is inspected at the frequency prescribed for that bridge by a competent engineer.

(b) Bridge inspections should be scheduled from an accurate bridge inventory list that includes the due date of the next inspection.

13. Special Considerations for Railroad Bridges

Railroad bridges differ from other types of bridges in the types of loads they carry, in their modes of failure and indications of distress, and in their construction details and components. Proper inspection and analysis of railroad bridges require familiarity with the loads, details, and indications of distress that are unique to this class of structure. Particular care should be taken that modifications to railroad bridges, including retrofits for protection against the effects of earthquakes, are suitable for the structure to which they are to be applied. Modifications should not adversely affect the serviceability of the bridge or its accessibility for periodic or special inspection.

APPENDIX E
STATEMENT OF INSPECTION REVIEW AND APPROVAL

PART 1. COMPLETION OF INSPECTION AND EVALUATION

The inspection and evaluation of the *(name)* Bridge has been completed by a qualified inspection team according to the ER 1110-2-111. The inspection report received an independent technical review by a qualified bridge engineer and all substantive issues arising during the review have been resolved to meet the provisions of PL 100-17 and existing USACE policy.

(Signature) _____ (Date) _____
Bridge Inspection Team Leader

(Signature) _____ (Date) _____
Technical Review Team Leader

(Signature) _____ (Date) _____
Chief, Engineering Division

Notes:
1. After signed by Chief of Engineering, this report shall be forwarded to MSC for approval.
2. Only Public Highway/Roadway bridges are required to meet the provisions of PL 100-17.
3. Chief, Engineering Division, title can be changed to match District's or MSC's organizational title.

PART 2. CERTIFICATION OF QUALITY ASSURANCE AND APPROVAL

The inspection, evaluation, and review of the *(name)* Bridge has been completed in accordance with the approved Quality Control Plan, and this report is approved as sufficient in accordance with ER 1110-2-111 for updating the data in the CEBIS, and for proceeding to budget, schedule, and design all maintenance and rehabilitation work necessary to correct deficiencies which jeopardize the structural safety and integrity of the *(name)* Bridge.

(Signature) _____ (Date) _____
Director, Engineering and Technical Services
Directorate of MSC

Notes:
1. The MSC can modify this statement as appropriate if the MSC delegates approval authority to the District.
2. Director, Engineering and Technical Services, title can be changed to match District's or MSC's organizational title.

APPENDIX F
SEISMIC PERFORMANCE EVALUATION

1. All bridges in seismically susceptible regions must be evaluated for performance under seismic loading. The need for evaluation is a function of a bridge's seismic performance category (SPC) that is a function of seismic hazard and structure importance (Table F-1). Seismic hazard is a function of the acceleration coefficient. The importance of a bridge is a function of several factors including the need to serve as a lifeline for emergency vehicles, utilities, or civil defense immediately following an earthquake or a bridge whose loss would create a major economic impact. This category also includes those bridges that cross routes that are defined as critical in a local emergency response plan and those that are located on identified evacuation routes.

Table F-1
Seismic Performance Category (SPC)

	Importance Cassification[2]	
Acceleration Coefficient[1]	**Essential**	**Standard**
$A \leq 0.09$	B	A
$0.09 < A \leq 0.19$	C	B
$0.19 < A \leq 0.29$	C	C
$0.29 < A$	D	C

[1] Acceleration Coefficient (A) values that are assigned to all locations covered by the American Association of State Highway and Transportation Officials Specifications.

[2] "Essential" bridges are those which may continue to function after an earthquake or which cross routes that may continue to operate immediately following an earthquake. All other bridges are classified as "Standard."

2. The Federal Highway Administration has established a logical, systematic procedure for identifying seismically susceptible bridges and prioritizing retrofit needs. The U.S. Army Corps of Engineers has adopted and implemented these guidelines. The evaluation procedures should be conducted in three phases:

a. Phase I is an initial evaluation process that should prioritize seismic retrofitting needs for the bridge inventory.

(1) All bridges shall be classified according to their SPC. Bridges in SPC A do not have to be considered for seismic retrofitting. Bridges in SPC B need only be screened, evaluated, and strengthened based on the vulnerability of their bearings, joint restrainers, and support widths. However, a comprehensive program of retrofitting shall be established for all bridges classified in SPC C and D. Screening, evaluation, and retrofitting will include all major components subject to failure during a strong earthquake (bearings, substructures, and foundations). The effects of soil failure, such as liquefaction, are also considered for bridges in categories C and D, and for certain bridges in category B.

(2) A preliminary screening shall be conducted for all bridges classified as SPC B, C, and D in accordance with Chapter 2 of reference 4*u* of this regulation.

b. Phase II is a detailed evaluation conducted in accordance with Chapter 3 of reference 4*u*. All bridges identified in Phase I may not require further evaluation. The decision to evaluate will be based on location of bridge, type of use, bridge details, types of failures likely, and consequences of failure.

c. Phase III is design of retrofit measures. All bridges identified needing retrofit in Phase II evaluation shall be designed in accordance with Chapters 4 through 9 of reference 4*u*. In general, however, bridges in SPC B will only require retrofitting at the bearings and expansion joints. Bridges in SPC C should also be considered for retrofit of columns, piers, and footings. Bridges in SPC D should be considered for retrofit of all components.

3. Reference 4*u* is intended for use on highway bridges of conventional steel and concrete girder and box girder construction with spans not exceeding 150 m (500 feet). Suspension bridges, cable-stayed bridges, arches, long-span trusses, and movable bridges are not covered. However, many of the concepts presented in reference 4*u* are applicable to these types of structures if appropriate judgment is used.

4. All retrofit schemes should be carefully evaluated to avoid forcing objectionable damage into critical bridge components or areas that are difficult to inspect after an earthquake.

APPENDIX G
INSPECTION REPORT FORMAT AND CONTENT

The report format for all U.S. Army Corps of Engineers (USACE) bridge inspections is described in this appendix. Reports shall be prepared as follows:

1. Inspection Report Format for Initial Inventory, In-Depth, and Other Special Inspections

a. Front cover page. The words "U.S. ARMY CORPS OF ENGINEERS" with the castle logo on top shall be placed at the left-hand upper corner of the page. The bridge's name and number, report number, and its location shall be centered on the front page. The report date and the Division and District names shall be placed at the left and right lower corners, respectively, on the front page.

b. First page. The first page after the cover page shall be the "Statement of Inspection Review and Approval." See Appendix E for more information.

c. Second page. The second page shall contain an executive summary of the report.

d. Third page. The third page shall be the Table of Contents. See page A-9, "Sample Bridge Inspection Report" of reference 4*f*, for more information.

e. Main body. The main body of inspection reports shall follow the "Sample Bridge Inspection Report" from pages A-11 through A-26 of reference 4*f*. Estimated costs for remedial work and a USACE Bridge Inventory System printout shall also be included in the report.

f. Other. Load rating and scour analyses and underwater inspections shall be included in the inspection report when conducted in conjunction with that inspection.

2. Inspection Report Format for Routine Inspections

a. Application. This paragraph applies to all bridges, except Public Highway/Roadway bridges with single spans greater than 50 m in length and total lengths greater than 200 m for which the reporting format of Paragraph 1 applies.

b. Contents. Each report shall consist of at a minimum:

(1) An executive summary of the report.

(2) The "Statement of Inspection Review and Approval."

(3) One Corps of Engineers Bridge Inventory System Structure Inventory and Appraisal (CEBIS SI&A) sheet for the entire bridge.

(4) A CEBIS Inspection Record Sheet for each span of the entire bridge or one sheet for the entire bridge for bridges less than 100 m in length.

(5) Photos of any damaged or excessively deteriorated areas.

The executive summary shall include recommendations resulting from the current inspection, status of recommendations from previous inspections, and a summary of maintenance performed since the last inspection. Example SI&A sheets are shown in Appendix H.

c. Maintenance record sheet. A maintenance record sheet may be provided with each report to aid Operations Divisions in the development of operations budgets but need not be forwarded to USACE.

d. Other. Load rating and scour analyses and underwater inspections may be included in the routine inspection report when conducted in conjunction with that inspection or may be provided separately.

3. Submission of Inspection Report

All inspection reports shall be submitted in Adobe Acrobat portable document format or other formats approved by the Major Subordinate Command.

4. Field Books

A field book shall be prepared and maintained at the District for each bridge inspected. The field book shall follow the format presented in reference 4*f* and shall include all field notes, sketches, and photographs used to document the inspection. Field books shall be maintained at each District by the structural engineer in charge of the bridge inspection program.

APPENDIX H
STRUCTURE INVENTORY AND APPRAISAL (SI&A) SHEETS

PUBLIC HIGHWAY/ROADWAY BRIDGES

202	COE Number	XXXXXXXX-XXXXXX	
8	NBI Structure Number:	15 digits	

Geographical and Route Data		
1	State	3 digits
2	District	2 digits
3	County	3 digits
4	Place	5 digits
6	Feature Under	25 digits
7	Facility On	18 digits
9	Location	25 digits
16	Latitude	8 digits XXdegXXminXX.XXsec
17	Longitude	9 digits XXXdegXXminXX.XXsec
98	Border Bridge	5 digits
99	Border Bridge Str No	15 digits
103	Temporary Str	1 digit

On and Under Record Data		
5	Inventory Route	9 digits
10	Min Vert Clr	4 digits XX.XX m
11	Kilometer Point	7 digits XXXX.XXX
19	Detour Length	3 digits XXX
20	Toll	1 digit
26	Func Class	2 digits
28	Lanes on/under	4 digits
29	ADT	6 digits
30	Year ADT	4 digits
47	Total Horz Clearance	3 digits XX.X
100	Defense Hwy	1 digit
101	Parallel Str	1 digit
102	Direction of Traffic	1 digit
104	Hwy System	1 digit
109	Truck Traffic	2 digits XX%
110	Natl Truck Network	1 digit

General Data		
12	Base Hwy Network	1 digit
13	LRS Inventory Rt, Subrt.	12 digits
21	Maintenance Responsibility	2 digits
22	Owner	2 digits
31	Design Load	1 digit
33	Bridge Median	1 digit
34	Skew	2 digits XX deg.
35	Str Flared	1 digit
37	Hist Significance	1 digit
38	Navigation Control	1 digit
42	Type of Service	2 digits
43	Structure Type Main	3 digits
44	Structure Type Approach	3 digits
45	No of Span Main	3 digits
46	No of Approach Spans	4 digits
27	Year Built	4 digits
105	Federal Land Highways	1 digit
106	Year Reconstructed	0000
107	Deck Str Type	1 digit
108	Wear Surf/Protv Sys	3 digits
111	Nav Pier/ Abut Protection	1 digit

Inspection data		
90	Inspection Date (MoYr)	4 digits
91	Inspection Frequency	2 digits
92	Critical Inspection Feature	9 digits
	Frac Crit Insp:	Y/N mo
	Underwater Insp:	Y/N mo
	Other Spec Insp:	Y/N mo
93	Critical Inspection Feature	12 digits
	Frac Crit Insp:	moyr of last insp
	Underwater Insp:	moyr of last insp
	Other Spec Insp:	moyr of last insp

Dimensional Data		
32	Approach Rdwy Width	4 digits XXX.X m
39	Navigation Vert Clearance	4 digits XXX.X m
40	Navigation Horiz Clearance	5 digits XXXX.X m
48	Max Span Length	5 digits XXXX.X m
49	Str Length	6 digits XXXXX.X m
50	Curb/Sidewalk Width, Left	6 digits XX.X m, XX.X m
51	Brg Roadway Width, curb-curb	4 digits XXX.X m
52	Deck width out-out	4 digits XXX.X m
53	Min Vert Clr Over	4 digits XX.XX m
54	Min Vert Clr under	5 digits X code, XX.XX m
55	Min Lat Underclr R	4 digits X code, XX.X m
56	Min Lat Underclr L	3 digits XX.X m
112	NBIS Bridge Length	1 digit
116	Navigation Min Vert Clr	4 digits XXX.X m

Proposed Improvements		
75	Type of Work	3 digits
76	Improvement Length	6 digits XXXXX.X m
94	Bridge Improv Cost	6 digits
95	Rdwy Improv Cost	6 digits
96	Total Proj Cost	6 digits
97	Year of Cost Est	4 digits
114	Future ADT	6 digits
115	Year of Future ADT	4 digits

Condition Rating		
58	Deck	1 digit
59	Superstructure	1 digit
60	Substructure	1 digit
61	Channel & Channel Protect	1 digit
62	Culverts	1 digit

Apparaisal Rating		
67	Structure Evaluation	1 digit
68	Deck Geometry	1 digit
69	Underclrn Vert & Horz	1 digit
71	Waterway Adequacy	1 digit
72	Approach Rdwy Alignment	1 digit
36	Traffic Safety Features	4 digits
113	Scour Critical Bridges	1 digit

Load Rate and Post		
41	Str Open/Post/Close	1 digit
63	Method to Detrmn Op. Rtg	1 digit
64	Operating Rating	3 digits XX.X metric tons
65	Method to Detrmn Inv. Rtg	1 digit
66	Inventory Rating	3 digits XX.X metric tons
70	Bridge Posting	1 digit

Over 200 Items		
200	COE MSC	
201	COE District	
202	Structure Number	
203	Inspection Officer	
204	Inspector	
205	Inspection Cost	
209	Recommended Speed Limit	
210	Posted Speed Limit	
216	Seismic Category	
217	Acceleration Coefficient	
218	Soil Site Coefficient	

RAILROAD BRIDGES

202	COE Number	XXXXXX-XXXXXX	8	NBI Structure Number:	15 digits

Geographical and Route Data		
1	State	3 digits
2	District	2 digits
3	County	3 digits
6	Feature Under	25 digits
7	Facility On	18 digits
9	Location	25 digits
16	Latitude	8 digits XXdegXXminXX.XXsec
17	Longitude	9 digits XXXdegXXminXX.XXsec
98	Border Bridge	5 digits
99	Border Bridge Str No	15 digits

On and Under Record Data		
5	Inventory Route	9 digits
10	Min Vert Clr	4 digits XX.XX m
11	Kilometer Point	7 digits XXXX.XXX
28	Lanes on/under	4 digits
29	ADT	6 digits
30	Year ADT	4 digits
47	Total Horz Clearance	3 digits XX.X

General Data		
21	Maintenance Responsibility	2 digits
22	Owner	2 digits
34	Skew	2 digits XX deg.
35	Str Flared	1 digit
37	Hist Significance	1 digit
38	Navigation Control	1 digit
42	Type of Service	2 digits
43	Structure Type Main	3 digits
44	Structure Type Approach	3 digits
45	No of Span Main	3 digits
46	No of Approach Spans	4 digits
27	Year Built	4 digits
106	Year Reconstructed	4 digits
111	Nav Pier/ Abut Protection	1 digit

Inspection data		
90	Inspection Date (MoYr)	4 digits
91	Inspection Frequency	2 digits
92	Critical Inspection Feature	9 digits
	Frac Crit Insp:	Y/N mo
	Underwater Insp:	Y/N mo
	Other Spec Insp:	Y/N mo
93	Critical Inspection Feature	12 digits
	Frac Crit Insp:	moyr of last insp
	Underwater Insp:	moyr of last insp
	Other Spec Insp:	moyr of last insp

Load Rate and Post		
41	Str Open/Post/Close	1 digit

Dimensional Data		
39	Navigation Vert Clearance	4 digits XXX.X m
40	Navigation Horiz Clearance	5 digits XXXX.X m
48	Max Span Length	5 digits XXXX.X m
49	Str Length	6 digits XXXXX.X m
50	Curb/Sidewalk Width, Left	6 digits XX.X m, XX.X m
51	Brg Roadway Width, curb-curb	4 digits XXX.X m
52	Deck width out-out	4 digits XXX.X m
53	Min Vert Clr Over	4 digits XX.XX m
54	Min Vert Clr under	5 digits X code, XX.XX m
55	Min Lat Underclr R	4 digits X code, XX.X m
116	Navigation Min Vert Clr	4 digits XXX.X m

Proposed Improvements		
75	Type of Work	3 digits
76	Improvement Length	6 digits XXXXX.X m
94	Bridge Improv Cost	6 digits
95	Rdwy Improv Cost	6 digits
96	Total Proj Cost	6 digits
97	Year of Cost Est	4 digits
114	Future ADT	6 digits
115	Year of Future ADT	4 digits

Condition Rating		
58	Deck	1 digit
59	Superstructure	1 digit
60	Substructure	1 digit
61	Channel & Channel Protect	1 digit
62	Culverts	1 digit

Apparaisal Rating		
71	Waterway Adequacy	1 digit
72	Approach Rdwy Alignment	1 digit
36	Traffic Safety Features	4 digits
113	Scour Critical Bridges	1 digit

Over 200 Items		
200	COE Division	
201	COE District	
202	COE Number	
206	Cooper's loading	
207	Railroad Stru Number	
208	Name of Railroad	
209	Recommended Speed Limit	
210	Posted Speed Limit	
216	Seismic Category	
217	Acceleration Coefficient	
218	Soil Site Coefficient	

NON-PUBLIC ACCESS/SERVICE BRIDGES

202	COE Number	XXXXXX-XXXXXX	
8	NBI Structure Number:	15 digits	

Geographical and Route Data		
1	State	3 digits
2	District	2 digits
3	County	3 digits
4	Place	5 digits
6	Feature Under	25 digits
7	Facility On	18 digits
9	Location	25 digits
16	Latitude	8 digits XXdegXXminXX.XXsec
17	Longitude	9 digits XXXdegXXminXX.XXsec
103	Temporary Str	1 digit

On and Under Record Data		
5	Inventory Route	9 digits
10	Min Vert Clr	4 digits XX.XX m
29	ADT	6 digits
30	Year ADT	4 digits
47	Total Horz Clearance	3 digits XX.X

General Data		
21	Maintenance Responsibility	2 digits
22	Owner	2 digits
34	Skew	2 digits XX deg.
37	Hist Significance	1 digit
38	Navigation Control	1 digit
42	Type of Service	2 digits
43	Structure Type Main	3 digits
44	Structure Type Approach	3 digits
45	No of Span Main	3 digits
46	No of Approach Spans	4 digits
27	Year Built	4 digits
106	Year Reconstructed	4 digits
107	Deck Str Type	1 digit
108	Wear Surf/Protv Sys	3 digits
111	Nav Pier/ Abut Protection	1 digit

Condition Rating		
58	Deck	1 digit
59	Superstructure	1 digit
60	Substructure	1 digit
61	Channel & Channel Protect	1 digit
62	Culverts	1 digit

Inspection data		
90	Inspection Date (MoYr)	4 digits
91	Inspection Frequency	2 digits
92	Critical Inspection Feature	9 digits
	Frac Crit Insp:	Y/N mo
	Underwater Insp:	Y/N mo
	Other Spec Insp:	Y/N mo
93	Critical Inspection Feature	12 digits
	Frac Crit Insp:	moyr of last insp
	Underwater Insp:	moyr of last insp
	Other Spec Insp:	moyr of last insp

Dimensional Data		
32	Approach Rdwy Width	4 digits XXX.X m
48	Max Span Length	5 digits XXXX.X m
49	Str Length	6 digits XXXXX.X m
53	Min Vert Clr Over	4 digits XX.XX m
54	Min Vert Clr under	5 digits X code, XX.XX m
55	Min Lat Underclr R	4 digits X code, XX.X m
56	Min Lat Underclr L	3 digits XX.X m

Proposed Improvements		
75	Type of Work	3 digits
76	Improvement Length	6 digits XXXXX.X m
94	Bridge Improv Cost	6 digits
95	Rdwy Improv Cost	6 digits
96	Total Proj Cost	6 digits
97	Year of Cost Est	4 digits
114	Future ADT	6 digits
115	Year of Future ADT	4 digits

Apparaisal Rating		
67	Structure Evaluation	1 digit
68	Deck Geometry	1 digit
69	Underclrn Vert & Horz	1 digit
71	Waterway Adequacy	1 digit
72	Approach Rdwy Alignment	1 digit
36	Traffic Safety Features	4 digits
113	Scour Critical Bridges	1 digit

Load Rate and Post		
41	Str Open/Post/Close	1 digit
63	Method to Detrmn Op. Rtg	1 digit
64	Operating Rating	3 digits XX.X metric tons
65	Method to Detrmn Inv. Rtg	1 digit
66	Inventory Rating	3 digits XX.X metric tons
70	Bridge Posting	1 digit

Over 200 Items		
200	COE MSC	
201	COE District	
202	Structure Number	
203	Inspection Officer	
204	Inspector	
205	Inspection Cost	
209	Recommended Speed Limit	
210	Posted Speed Limit	
216	Seismic Category	
217	Acceleration Coefficient	
218	Soil Site Coefficient	

PEDESTRIAN BRIDGES

202	COE Number	XXXXXXXX-XXXXXX	
8	NBI Structure Number:	15 digits	

Geographical and Route Data		
1	State	3 digits
2	District	2 digits
3	County	3 digits
4	Place	5 digits
6	Feature Under	25 digits
7	Facility On	18 digits
9	Location	25 digits
16	Latitude	8 digits XXdegXXminXX.XXsec
17	Longitude	9 digits XXXdegXXminXX.XXsec

General Data		
21	Maintenance Responsibility	2 digits
22	Owner	2 digits
34	Skew	2 digits XX deg.
35	Str Flared	1 digit
42	Type of Service	2 digits
43	Structure Type Main	3 digits
44	Structure Type Approach	3 digits
45	No of Span Main	3 digits
46	No of Approach Spans	4 digits
27	Year Built	4 digits
106	Year Reconstructed	4 digits
107	Deck Str Type	1 digit
108	Wear Surf/Protv Sys	3 digits

Inspection data		
90	Inspection Date (MoYr)	4 digits
91	Inspection Frequency	2 digits
92	Critical Inspection Feature	9 digits
	Frac Crit Insp:	Y/N mo
	Underwater Insp:	Y/N mo
	Other Spec Insp:	Y/N mo
93	Critical Inspection Feature	12 digits
	Frac Crit Insp:	moyr of last insp
	Underwater Insp:	moyr of last insp
	Other Spec Insp:	moyr of last insp

Dimensional Data		
48	Max Span Length	5 digits XXXX.X m
49	Str Length	6 digits XXXXX.X m
51	Brg Roadway Width, curb-curb	4 digits XXX.X m
52	Deck width out-out	4 digits XXX.X m

Proposed Improvements		
75	Type of Work	3 digits
94	Bridge Improv Cost	6 digits
95	Rdwy Improv Cost	6 digits
96	Total Proj Cost	6 digits
97	Year of Cost Est	4 digits

Condition Rating		
58	Deck	1 digit
59	Superstructure	1 digit
60	Substructure	1 digit
61	Channel & Channel Protect	1 digit

Apparaisal Rating		
71	Waterway Adequacy	1 digit
72	Approach Rdwy Alignment	1 digit
36	Traffic Safety Features	4 digits
113	Scour Critical Bridges	1 digit

Load Rate and Post		
41	Str Open/Post/Close	1 digit
220	Pedestrian (kilopascal)	
221	Vehicle (Metric Tons)	

Over 200 Items		
202	Structure Number	
203	Inspection Officer	
204	Inspector	
205	Inspection Cost	
216	Seismic Category	
217	Acceleration Coefficient	
218	Soil Site Coefficient	