Chapter 28

NEVADA BRIDGE INSPECTION PROGRAM

NDOT STRUCTURES MANUAL

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Chapter 28
NEVADA BRIDGE INSPECTION PROGRAM

Chapter 28 discusses the National Bridge Inspection Standards (NBIS) and NDOT's implementation through its Bridge Inspection Program.

28.1 FEDERAL BRIDGE INSPECTION PROGRAM

28.1.1 Importance of Bridge Inspections

The State of Nevada contains approximately 1850 bridges on its public roads and streets; approximately 1050 of these are on the State highway system. In general, bridges are designed and constructed with the intent of providing a large margin of safety and a long service life (75 years) for the traveling public. This is accomplished through the application of stringent design criteria and construction specifications. Nevertheless, all structural elements deteriorate over time, sometimes prematurely, and, if left unchecked, will eventually present a hazard to bridge users. Therefore, a systematic program of periodic bridge inspections is necessary to evaluate condition and functionality, to detect structural problems and to extend the useful life of the bridge. Of course, the program must be developed recognizing economic constraints.

28.1.2 National Bridge Inspection Standards (NBIS)

The collapse of the Silver Bridge over the Ohio River in 1967 prompted the United States Congress to enact legislation requiring the establishment of the National Bridge Inspection Standards (NBIS), creating a nationwide bridge inspection and inventory program. The Federal Highway Administration has promulgated regulations to establish the specific criteria that each State transportation department must meet; i.e., the State DOTs are the administrators of the NBIS for all bridges located within the geographic boundaries of the State. For convenience, Appendix 28A duplicates the regulations from 23CFR Part 650, Subpart C "National Bridge Inspection Standards."

28.1.2.1 Primary Constituents

The following summarizes the primary constituents of the National Bridge Inspection Standards:

- NBIS requires the periodic inspection of all "bridges" (which are defined as having a roadway centerline length of greater than 20 ft) located on all highway facilities open to the public.
- NBIS does not mandate the inspection of pedestrian bridges, railroad bridges, privately owned bridges, or those bridges or culverts having a roadway centerline length of 20 ft or less. Further, the NBIS does not mandate the inspection of sign structures, traffic signals, luminaire supports, etc.
- NBIS establishes the basic requirements for each component of a State DOT Bridge Inspection Program:

+ Inspection Frequency/Procedures/Reports,
+ Qualifications of Personnel, and
+ Maintenance of the State's Bridge Inventory.

28.1.2.2 Operational Elements

The following presents a brief discussion on the operational elements of the NBIS:

1. Frequency of Inspections. The basic NBIS requirement is that each bridge be inspected at regular intervals not to exceed 24 months. Examples of structures requiring more frequent inspections may include:

   - unique structure types;
   - those with details that have no performance history;
   - those with potential foundation or scour problems;
   - non-redundant structures;
   - steel structures with fatigue-prone details;
   - steel structures with cracks or crack repairs;
   - structures experiencing heavy traffic loadings;
   - old structures; and
   - structures with known, significant structural problems.

2. Qualifications of Personnel. One of the most important elements of a State DOT bridge inspection program is the qualifications of its inspection personnel. This includes both the individual in charge of the overall organization and the field inspection personnel. §650.309 of the NBIS lists the minimum requirements for all bridge inspection personnel. In addition to education and experience requirements, the field inspectors must be physically fit and must have basic language, mathematical and mechanical skills.

3. Inspection Procedures and Reports. Each State must have a systematic strategy for conducting field inspections and reporting their findings. It must be clear to the inspection team which structural elements to check and what to look for. The bridge inspection report should accurately and clearly record all findings from the inspections and should include photographs of the overall structure and any significant defects.

4. Records. Each State must have a systematic means of entering, storing and retrieving bridge inspection data. The records should contain a full history of the structure including:

   - all inspections,
   - recommendations for maintenance or repair work,
   - any maintenance or repair work performed,
   - structure ratings,
   - calculations,
   - the Structure Inventory and Appraisal (SI&A) data, and
   - communications.

5. Load Ratings. All bridges must be load rated to determine their structural capacity. This includes the calculation of both the Operating and Inventory Ratings (see Section 28.3 for definitions). The ratings provide an indication of the bridge's safe load-carrying capacity. This information also assists in the determination of necessary load restriction

posting, the issuance of special overload permits, and the scheduling for rehabilitation or replacement.

28.1.3 National References

Several references have been developed at the national level for the implementation of the NBIS. The following briefly describes the most important references, and the discussion includes a brief statement on its status and application within NDOT.

28.1.3.1 *AASHTO Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges*

The AASHTO *Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges* serves as a standard and provides uniformity in the procedures and policies for determining the physical condition, maintenance needs and load capacity of highway bridges in the United States. This publication assists bridge owners by establishing inspection procedures and load rating practices that meet the National Bridge Inspection Standards (NBIS). The load rating procedures are based upon the LRFR methodology.

AASHTO has approved but not yet published the *Manual for Bridge Evaluation* (MBE). The MBE is an updated version of the *AASHTO Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges* incorporating the LRFR methodology plus the traditional ASR and LFR methodologies.

28.1.3.2 FHWA *Bridge Inspector's Reference Manual* (BIRM)

The FHWA *BIRM* provides guidelines for training bridge inspectors. The *BIRM* presents a fundamental discussion on the inspection and evaluation of specific bridge components, and it discusses field inspection procedures and reporting requirements. In addition, the *BIRM* discusses the basic qualifications of bridge inspectors and field safety procedures.

The *BIRM* is used as a primary reference in the comprehensive training program on bridge inspection presented by the National Highway Institute (NHI). NDOT uses the *BIRM* as a primary field and office reference for NDOT's bridge inspectors.

28.1.3.3 FHWA *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* (Coding Guide)

The FHWA *Coding Guide* has been prepared for use by the State DOTs to record and code the specific data items that are stored in the National Bridge Inventory (NBI) database. The NBI data is used to prepare legislatively required reports to Congress. The *Coding Guide* also provides the data necessary for FHWA and the Military Traffic Management Command to identify and classify the Strategic Highway Corridor Network and its connectors for national defense.

FHWA mandates that bridge inventory data be submitted to the Agency in a standardized format as required by NBIS. Therefore, NDOT has adopted the conventions, terminology, etc., within the FHWA *Coding Guide* for the collection, recording and reporting of bridge inspection data.

28.1.3.4 AASHTO *Guide for Commonly Recognized (CoRe) Structural Elements* (Guide)

The AASHTO *Guide* provides a description of structural elements that are commonly used in highway bridge construction and evaluated during bridge inspections. These elements are termed "Commonly Recognized" (CoRe) structural elements because of their nationwide recognition and use. Although the element descriptions were originally developed for PONTIS (AASHTOWare bridge management software used by NDOT), these descriptions are not considered unique to PONTIS; rather, they provide a uniform basis for data collection for any bridge management system and enable the sharing of data among States. NDOT uses the CoRe element descriptions in setting up data collection procedures for the NDOT Bridge Management System. See Chapter 29.

28.2 NEVADA BRIDGE INSPECTION PROGRAM

28.2.1 <u>General</u>

28.2.1.1 Compliance with NBIS

Section 28.2 describes the Nevada Bridge Inspection Program, which is NDOT's implementation of the National Bridge Inspection Standards (NBIS) for all public bridges in the State of Nevada not owned by Federal agencies. In general, the Nevada Bridge Inspection Program meets or exceeds the requirements of the NBIS. The following sections discuss specific procedures and criteria adopted by NDOT for its implementation of the Nevada Bridge Inspection Program.

28.2.1.2 Coding Bridge Inspection Data

FHWA and AASHTO have developed rating systems to aid in the inspection of bridges. The two primary rating systems currently in use are the National Bridge Inventory (NBI) rating system and the PONTIS (or element-level) rating system. Both rating systems are intended to create uniformity for rating the structural condition of a bridge. Each rating system relates the material distress found at the bridge to its effect on the structure's strength and safety. NDOT requires that the bridge inspector complete both an NBI and PONTIS inspection of each bridge inspected.

A PONTIS element-level inspection identifies each bridge component as a separate element, based not only upon function but also material type, and it evaluates each element by sub-dividing its total quantity into different "Condition States," or states of physical deterioration or damage. The AASHTO *Guide for Commonly Recognized (CoRe) Structural Elements* describes the PONTIS element-based rating system.

In a PONTIS inspection, each bridge element is assigned an element number and a standard description. The total quantity for an element is then sub-divided among up to 5 available Condition States, 1 to 5, where Condition State 1 indicates the best possible condition. Additional elements called "Smart Flags" are used to track event-driven damage, such as traffic impacts or fatigue cracks that are unique to a specific bridge.

In contrast, an NBI inspection evaluates each bridge component based only on function, and assigns a single "Condition Rating" representing the condition of the component type as a whole, regardless of quantity. Condition Rating codes range from 9 to 0, where 9 is the best rating possible ("excellent condition") and 0 is the worst rating possible ("failed condition"). A narrative description with quantities is used to describe the condition of the functional group.

The NBI inspection also includes the assignment of "Overall (condition) Ratings," representing the overall condition of the Deck, Superstructure, Substructure and Culvert. These specific condition ratings are incorporated into the Structure Inventory and Appraisal (SI&A) sheet, which serves as a comprehensive listing of all NBI data for any given bridge. The Overall Ratings are used, in part, to determine the Sufficiency Rating (SR) for the bridge, which is a numerical indicator of the bridge's sufficiency to remain in service.

The PONTIS rating system incorporates a database that, over time, can be used to estimate deterioration rates based on the material and the bridge environment. This allows bridge owners to schedule preventive and corrective actions more uniformly. In this way, NDOT can make informed decisions to optimize the expenditure of funds to prioritize funds, when to take action, and what type of action to take. See Chapter 29 for more discussion on bridge management.

28.2.2 Responsibilities/Qualifications

28.2.2.1 NDOT Structures Division

In compliance with §650.307 of the NBIS, the Inventory/Inspection Section is responsible for the Nevada Bridge Inspection Program. Section 1.3.2 briefly summarizes the functional responsibilities of each Unit within the Section. Section 28.2.2 elaborates on the responsibilities and qualifications of the NDOT staff within the Inventory/Inspection Section.

28.2.2.2 Assistant Chief Structures Engineer – Inventory/Inspection

The Assistant Chief Structures Engineer – Inventory/Inspection (ACSE – I/I) serves as the Program Manager (PM) for implementation of the National Bridge Inspection Standards. §650.305 defines the Program Manager as:

> *The individual in charge of the program that has been assigned or delegated the duties and responsibilities for bridge inspection, reporting and inventory. The program manager provides overall leadership and is available to inspection team leaders to provide guidance.*

In addition, the PM assists applicable NDOT staff in determining any maintenance or repair actions that are appropriate. Decisions on load posting and bridge closures require the approval of the PM.

§650.309(a) identifies the minimum qualifications of the PM. The PM must have a sound background in structure inspections, rehabilitation and maintenance to be an effective manager. On occasion, specialized knowledge and skills in fields such as structural design, construction, mechanical systems, electrical systems, soils, construction materials and emergency repair techniques will be required.

The PM is the primary liaison between FHWA and NDOT, and the PM is responsible for ensuring that NDOT complies with Federal directives for structure inspection and maintenance. This includes ensuring that all structures are inspected at the proper intervals and that NDOT files remain up-to-date and accurate. The Program Manager has overall responsibility for personnel supervision; scheduling structure inspections and maintenance; and scheduling the use of NDOT-owned specialized equipment. The responsibilities of the PM also include:

- Overseeing quality assurance reviews.
- Overseeing coordination with Federal, State and local governmental agencies.
- Monitoring an in-depth inspection program for structures with fracture critical members, underwater members, or unique or special features requiring additional attention during inspection to assure the safety of such structures.
- Oversight of coordination with the Railroad Companies operating in Nevada to inspect NDOT-owned bridges over railroads.

- Confirming that load-posted structures receive interim inspections as required by Federal and State laws, rules and policy.

- Developing, monitoring and updating training programs for State and private consultant inspectors in structure inspection, maintenance and repair techniques.

- Retaining the services of private consultants or contractors to supplement NDOT staff, as needed, to perform specialized inspection, testing or repair techniques.

- Analyzing Federal and State legislation, administrative rules, and national and industry standards for incorporation into NDOT programs and policies.

- As appropriate, recommending revisions to State of Nevada laws and participating in the development of new legislation.

- Being responsible for prompt, decisive and effective responses to emergencies (e.g., earthquakes, major bridge damage, bridge failures).

- Developing and administering the Nevada Bridge Inspection Program budget for the Inventory/Inspection Section.

28.2.2.3 Principal Structures Engineer – Inspection

The Principal Structures Engineer – Inspection (PSE) serves as the Bridge Inspection Squad's supervisor and Assistant Program Manager. The Principal Structures Engineer – Inspection assists the Assistant Chief Structures Engineer – Inventory/Inspection in fulfilling the responsibilities of the Program Manager including the following duties:

- Providing the day-to-day supervisory management for the Nevada Bridge Inspection Program.

- Managing the work of all consultants used to perform bridge inspections.

- Reviewing and approving all Bridge Inspection Reports.

- Coordinating with Federal, State and local governmental agencies.

- Directing an in-depth inspection program for structures with fracture critical members, underwater members, or unique or special features requiring additional attention during inspection to assure the safety of such structures.

- Coordinating with the Railroad Companies operating in Nevada to inspect NDOT-owned bridges over railroads.

- Directing the interim inspections of load-posted structures as required by Federal and State laws, rules and policies.

- Managing a technology transfer program for NDOT and consultant inspectors for the inspection of bridges.

- Providing training for personnel on proper access, equipment operation and safety procedures.

28.2.2.4 Professional Engineer

28.2.2.4.1 *Bridge Inspection Squad*

The Professional Engineer in the Bridge Inspection Squad serves as the Inspection Team Leader (TL) for the Nevada Bridge Inspection Program. §650.305 of the NBIS defines the Inspection Team Leader as the:

> *Individual in charge of an inspection team responsible for planning, preparing, and performing field inspection of the bridge.*

§650.309(b) of the NBIS identifies the qualifications of the Inspection Team Leader; see Appendix 28A. A TL has the authority to sign and process the Bridge Inspection Reports.

The TL must be at the structure site at all times during each field inspection. The TL shall be proficient with the NBIS, relevant FHWA and AASHTO publications, and this *Manual*. The TL should have a strong background in structural engineering, structure behavior trends, and bridge maintenance and rehabilitation techniques. The TL is also responsible for the general safety of the work site. Safety items include planning and monitoring any required traffic control and ensuring that each team member complies with all NDOT safety procedures, proper use of access equipment, etc.

28.2.2.4.2 *Load Rating/Over-Dimensional/Overweight Permitting Squad*

The Professional Engineer in the Load Rating/Over-Dimensional/Overweight Permitting Squad is responsible for calculating bridge Inventory and Operating Ratings, recommending load posting for existing bridges, and analyzing over-weight and/or over-dimensional vehicles for operating permit purposes. See Section 28.3.

28.2.2.5 Staff III Associate Engineer

28.2.2.5.1 *Bridge Inventory Management Squad*

The Staff III Associate Engineer in the Bridge Inventory Management Squad serves as the Squad's supervisor. The responsibilities of this position include:

- Act as the liaison with non-State bridge owners to receive bridge plans, ascertain new bridge locations, etc.
- Update Statewide bridge location maps.
- Conduct Inventory Inspections of new bridges, Statewide.
- Receive completed Bridge Inspection Reports from both in-house and consultant staff; disseminate reports to owners and file NDOT copies.
- Manage National Bridge Inventory (NBI) data, and disseminate to Structures Division personnel, consultant inspectors and the Federal Highway Administration.

The Staff III Associate Engineer in the Bridge Inventory Management Squad also serves as an Inspection Team Leader (TL) for the Nevada Bridge Inspection Program. See Section 28.2.2.4.1 for TL qualifications and responsibilities.

28.2.2.5.2 *Non Destructive Testing (NDT) Squad*

The Staff III Associate Engineer in the Non Destructive Testing Squad serves as the NDT Squad supervisor. The responsibilities of the NDT Squad with respect to the Nevada Bridge Inspection Program include providing NDT inspection of structural steel. See Chapter 26.

The Staff III Associate Engineer in the NDT Section also serves as an Assistant Inspector (AI) in the Nevada Bridge Inspection Program. When serving as the AI, the Staff III Assistant Engineer – NDT assists the TL in the field. It is expected that this individual, at a minimum, is familiar with this *Manual* and has a competency level sufficient to follow the directives of the TL.

28.2.2.6 Staff II Associate Engineer – Inventory Management

The Staff II Associate Engineer in the Bridge Inventory Management Squad assists the Staff III Associate Engineer – Inventory Management Squad in fulfilling the responsibilities of the Squad. See Section 28.2.2.5.1.

The Staff II Associate Engineer also services as an AI. See Section 28.2.2.5.2 for the AI responsibilities.

28.2.2.7 Staff I Associate Engineer – Non-Destructive Testing Squad

The Staff I Associate Engineer in the Non-Destructive Testing Squad (NDT) serves as an NDT specialist. NDT specialists perform non-destructive testing for NDOT within the context of the Nevada Bridge Inspection Program. See Chapter 26 for non-destructive testing in more detail and other responsibilities. The Staff I Associate Engineer in the NDT Squad also serves as the AI. See Section 28.2.2.5.2 for AI responsibilities.

28.2.2.8 Special Equipment Operator III – Bridge Inspection Squad

The Special Equipment Operator III in the Bridge Inspection Squad is in charge of the transport, operation and maintenance of the bridge inspection vehicles. The Special Equipment Operator III must possess a valid Class A or Class B Commercial Drivers License in the State of Nevada.

The Special Equipment Operator III has the following responsibilities:

- coordinates access-required inspections with in-house and consultant TLs,
- arranges for traffic control from District Offices,
- oversees the operation of the bridge inspection units,
- conducts minor bridge repairs as needed,
- coordinates and performs inspection vehicle maintenance,
- manages inventory of inspection hand tools and disposable equipment/supplies, and
- provides Under-Bridge Inspection Truck operator training.

28.2.2.9 Special Equipment Operator II – Bridge Inspection Squad

The Special Equipment Operator II in the Bridge Inspection Squad assists the Special Equipment Operator III in fulfilling the requirements of the Nevada Bridge Inspection Program. See Section 28.2.2.8 for requirements.

28.2.3 District Office

Nevada is divided into three districts that administer the transportation program at the local level. Each District Office has an Assistant District Engineer – Maintenance that oversees the maintenance operations in that District. The Assistant District Engineer – Maintenance is the primary contact for coordination between the District Office and the Structures Division for the Nevada Bridge Inspection Program. Most day-to-day coordination, however, occurs with the District Bridge Maintenance Crew. District involvement in the Nevada Bridge Inspection Program includes the following:

- The Bridge Inspection Squad submits the bridge inspection schedule for bridge inspections to the District (see Section 28.2.8).
- The District arranges traffic control for all bridge inspections as required (see Section 28.2.10.2).
- The District provides assistance during the bridge inspection as requested by the Bridge Inspection Squad.
- The Bridge Inventory Management Squad submits copies of all Bridge Inspection Reports for State-owned bridges to the appropriate District Office, and identifies which bridges require maintenance.
- The District may participate in Quality Assurance Field Inspections (see Section 28.2.13).
- The District responds to "critical maintenance" findings for State-owned bridges (see Section 28.2.6.8).
- The District collaborates with the ACSE – I/I to authorize bridge closures on State routes.
- The District performs routine bridge maintenance activities identified in the Bridge Inspection Reports.
- The PSE and District coordinate their activities to respond collaboratively to emergencies (see Section 28.2.6.10).

28.2.4 Consultant Program

28.2.4.1 General

NDOT does not have the staffing necessary to achieve all Program requirements and, therefore, uses the services of consultants to supplement in-house staff. When work cannot be performed consistent with the schedule for the Program, or when the work requires specialized professional or technical talents not readily available within NDOT, consultants may be employed. In addition, NDOT has a vested interest in retaining a contingent of qualified consultants that are available when needed.

Consultants are considered an extension of the NDOT staff for the implementation of the Nevada Bridge Inspection Program. During a field inspection, consultant employees are expected to represent NDOT in their interface with the public, and they must comply with all applicable NDOT requirements (e.g., wearing NDOT attire).

28.2.4.2 Special Uses

In addition to bridge inspections, NDOT uses consultants for the following specialized elements of its Bridge Inspection Program:

- load rating analyses of existing bridges;
- underwater inspections that require diving;
- overhead sign, signal and high-mast lighting inspection; and
- bridge scour evaluation and developing Plans of Action.

28.2.4.3 Operational Issues

In general, consultants are responsible for complying with all NDOT requirements in the implementation of the Nevada Bridge Inspection Program. The following discusses a few specific issues:

1. Registered Professional Engineer. A registered professional civil or structural engineer in the State of Nevada is required to be in overall management of the consultant's project. This is an NDOT requirement and not an NBIS requirement.

2. Team Leader (TL). NDOT does not mandate that the consultant TL be a Registered Professional Engineer. NDOT and the consultant must mutually agree on the acceptability of the proposed TL. The consultant must submit a resume for each proposed TL. The Principal Structures Engineer – Inspection will devote the time deemed necessary with each proposed TL to evaluate the TL's credentials, experience and performance.

3. Underwater Divers. The consultant is required to provide only certified Commercial Divers. Underwater TLs must meet the TL qualifications in Section 28.2.2.4.1. All diving operations must be conducted in compliance with OSHA 29 CFR 1910 Subpart T - Commercial Diving Operations (including OSHA Directive CPL 02-00-143) and Association of Diving Contractors International "CONSENSUS STANDARDS For Commercial Diving Operations."

4. Scheduling. NDOT provides a list of bridges for consultant inspection, and the consultant submits a schedule of inspections to NDOT for review and approval.

5. Coordination. Consultants are required to participate in the coordination with entities external to NDOT (e.g., Railroad Companies, State and local entities).

6. Field Inspections. The consultant Inspection Team and NDOT representatives (AIs, Special Equipment Operators, District maintenance personnel) work in tandem to perform the field inspection. NDOT operates in a support capacity (e.g., provide traffic control, provide special equipment).

7. Submission of Reports. Consultant Bridge Inspection Reports must be signed and sealed by a Registered Professional Engineer prior to submittal to NDOT.

8. NDOT QA Review. The Principal Structures Engineer – Inspection or his designated representative will review all Bridge Inspection Reports submitted by consultants for completeness and accuracy. The nature of the NDOT review is considered a Quality Assurance review, not an "approval"; i.e., the burden of responsibility for technical

content remains with the consultant. However, the consultant is required to respond to any written comments from NDOT.

28.2.5 NDOT References

NDOT has prepared the following references to assist in the implementation of its Bridge Inspection Program:

1. *NDOT Bridge Inspection Manual*. This reference provides instructions and guidance to all bridge inspection personnel on NDOT bridge inspection policies and procedures. Topics presented include:

   - Bridge Inspection Report format,
   - Condition Rating application,
   - rating of NBI data items, and
   - Maintenance Report coding instructions.

2. *NDOT PONTIS Coding Guide*. This reference provides instructions and guidance on NDOT procedures for conducting PONTIS element-level bridge inspections. Topics presented include:

   - unit of measurement conventions,
   - girder tabulation conventions,
   - condition state assignment conventions,
   - primer for PONTIS CoRe elements and Smart Flags, and
   - comprehensive listing of all PONTIS Elements used in Nevada.

28.2.6 Types of Inspections

28.2.6.1 General

The following identifies a few of the basic parameters for bridge inspections:

1. Inspection Team Composition. All Teams must have an Inspection Team Leader (TL). The minimum crew size is two, including the TL.

2. Inspection References. §650.313(a) of the NBIS requires that each State DOT:

   > *Inspect each bridge in accordance with the inspection procedures in the AASHTO Manual (i.e., the Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges).*

   In addition, NDOT uses the FHWA *Bridge Inspector's Reference Manual* (BIRM) and the FHWA *Coding Guide* as primary references for bridge inspections.

3. Units of Measurement. All PONTIS Element data and Structure Inventory and Appraisal (SI&A) data are reported in SI (metric) units of measurement (see Chapter 29). All other components of the NBIP are based on US Customary units of measurement.

28.2.6.2 Inventory Inspections

§650.305 of the NBIS defines the Inventory (or Initial) Inspection as:

> *The first inspection of a bridge as it becomes a part of the bridge file to provide all Structure Inventory and Appraisal (SI&A) data and other relevant data and to determine baseline structural conditions.*

An Inventory Inspection is the baseline inspection that must be completed for every new structure before it can be entered into the Nevada Bridge Inventory. An Inventory Inspection is a fully documented inspection, using the bridge plans, to determine basic data for a specific structure for entry into the file. The bridge inspector conducting the Inventory Inspection must complete a SI&A Sheet as part of the Inventory Inspection process. Data gathered for Inventory Inspections should include the following:

- an analytical determination of load capacity,
- all Structure Inventory and Appraisal (SI&A) data required by FHWA regulations,
- baseline structural conditions and quantities,
- any existing problems or locations in the structure that may have potential problems,
- the location and condition of any fracture critical members or details, and
- any recommendations for corrective action.

The Inventory Inspection must be complete and have Structure Inventory and Appraisal Data (SI&A) entered into the State Bridge Inventory within 90 days for State-owned bridges and within 180 days for all others. In addition, as part of the Inventory Inspection, bridge inspectors must evaluate the structure and identify other foreseeable types of inspections that the structure will require throughout its life. For example, a bridge spanning a waterway may in the future require an Underwater Inspection. The bridge should also be assessed for needing Fracture Critical or Complex Bridge Inspections, with Fracture Critical Members and special/complex inspection methodologies identified. Once the inspection types the structure will require have been identified, the bridge inspector should document the associated inspection frequencies as part of the Inventory Inspection. The inspector shall also document any special inspection equipment and access equipment that is needed to perform future inspections.

The Inventory Inspection shall be performed at arm's length. Because it is a baseline inspection, all deficiencies, cracks, construction errors, alignment problems, etc., should be quantified and documented.

Inventory Inspections are also used when a structure is discovered that has never been inventoried. For example, some short-span bridges and culverts that span more than 20 ft have never been inventoried or classified as bridges when they were built. Inventory Inspections are also performed when the configuration or geometry of a structure changes (e.g., widening, lengthening, change in vertical clearance) or when structural improvements are made (e.g., rehabilitation).

28.2.6.3 Routine Inspections

§650.305 defines a Routine Inspection as:

> *Regularly scheduled inspection consisting of observations and/or measurements needed to determine the physical and functional condition of the bridge to identify any changes from initial or previously recorded conditions, and to ensure that the structure continues to satisfy present service requirements.*

Routine Inspections are generally conducted from the deck, ground or water level or from permanent work platforms and walkways, if present. The bridge inspector shall closely inspect the critical load-carrying members (e.g., steel and concrete girders, decks, slabs, piers, bearings, abutments) and shall more closely examine any element that appears distressed. Fatigue prone and fracture critical details or elements shall be examined with a detailed, close-up (arm's length) inspection.

For some bridges, it may be necessary to schedule the use of special equipment (lift or under bridge inspection vehicle) to gain the needed access to perform a Routine Inspection. For example:

- bridges with one or more spans that are inaccessible due to stream characteristics; and
- bridges that are more than 30 ft above highways, railroads, etc.

For Routine Inspections, inspecting underwater portions of the substructure is limited to observations during low-flow periods and/or probing for signs of undermining. If substructure units are either immediately adjacent to or in the water, waterway soundings should be documented to detect changes in the channel. Substructure elements continuously submerged in greater than 3 ft of water shall be placed on the Underwater Inspection bridge list and applicable SI&A data coded. Document any structural changes or deterioration that could affect previously recorded bridge load ratings in the Report. See Section 28.2.6.6 for a discussion on mandatory requirements for Underwater Inspections.

During a Routine Inspection, the bridge inspector should evaluate traffic and pedestrian safety features in addition to structural items. Provide special attention to the condition of parapets, railings, pedestrian fencing, guardrail, sidewalks, etc. The following are examples of conditions that may warrant documentation in the Bridge Inspection Report:

- tripping hazards, severe approach roadway settlements or large spalls on sidewalks;
- rebar protruding from decks, walks or parapets;
- loose, missing or damaged railings or parapets;
- missing or damaged guardrail;
- loose concrete that could fall onto the traveled way, sidewalk, waterway or railroad; and
- any other condition that the inspector perceives as a threat to public safety.

28.2.6.4 In-Depth Inspections

28.2.6.4.1 *General*

§650.305 defines an In-Depth Inspection as:

> *A close-up inspection of one or more members above or below the water level to identify any deficiencies not readily detectible using routine Inspection procedures; hands-on inspection may be necessary at some locations.*

The PSE shall determine the need for In-Depth Inspections. Conditions that prompt an In-Depth Inspection are often identified during a Routine Inspection. These include:

- need for specialized access,
- need for special inspection/testing techniques and equipment, and
- need for increased inspection of an element.

28.2.6.4.2 *Description*

An In-Depth Inspection is a hands-on, close-up visual inspection that often requires special access equipment. Each element under investigation should be within arm's reach of the inspector. Non-destructive field tests and/or other material tests may be required. The inspection may include a recommendation for a load rating to assess the residual capacity of damaged or deteriorated members, depending on the extent of the damage or deterioration. Non-destructive load tests may be conducted to assist in determining a safe bridge load-carrying capacity.

The visual examination should reveal information including but not limited to:

- distortion, crippling and buckling of members;
- spalling and cracking of concrete;
- decaying, splitting and physical attack of timber;
- corrosion and cracking of steel;
- collision damage;
- paint or finish and bearing failures; and
- joint failures.

In-depth inspections may also consist of:

- sounding of concrete elements to determine the limits of delamination/deterioration;
- sounding and probing/drilling of timber elements to determine the limits of internal deterioration, rot and decay;
- connection inspections (bolts, rivets and welds) to identify failing welds/rivets and loose/failing bolts;
- section loss measurements (as practical) for steel elements; and
- inspection of bearings, paints or finishes and other miscellaneous structural elements.

Where loose bolts are found during connection inspections, these bolts shall be tightened in non-critical areas (e.g., cross-frames) and shall be marked for replacement in critical areas (e.g., girder splices).

Thoroughly document the activities, procedures and findings of In-Depth Inspections with the appropriate photographs, a location plan of deficiencies, test results, measurements and a written report. Any changes in the condition of the structure should be entered into the Bridge Inspection Report, and the Report shall also contain maintenance recommendations. If a bridge element condition is sufficiently severe, the In-Depth Inspection data can be used to develop rehabilitation plans for the bridge.

28.2.6.5 Special Inspections

A Special Inspection is performed when a bridge requires more frequent inspections than is provided by the Routine Inspection cycle. This is an inspection scheduled at the discretion of the PSE. A Special Inspection is typically used to monitor a specific known or suspected deficiency (e.g., foundation settlement, scour, member conditions and the public's use of a load-posted bridge) sufficiently severe to warrant heightened scrutiny. Other examples may include actively settling or rotating substructures, advanced section loss, and structures with any NBI Item 58 through 62 that has a rating of 4 or less.

The bridge inspector must make sufficient measurements and observations to evaluate the structure's physical and functional conditions, and denote changes in the known or suspected deficiency. The results of the Special Inspection should be documented in the Bridge Inspection Report. If the deficiency has become more severe, it may be necessary to reevaluate the structure's load rating.

The following provides guidance on the frequency of performing Special Inspections:

1. Load Posted Bridges. Any bridge not capable of carrying State legal loads requires inspection at least once every twelve months.

2. Bridges with an NBI Rating of 4 or Less. All bridges with an NBI rating of 4 or less for the deck, superstructure or substructure require inspection at least once every twelve months.

3. Special Cases. Bridges having advanced deterioration and/or unusual movement will be inspected at a frequency determined by the PSE.

28.2.6.6 Underwater Inspections

§650.305 defines an Underwater Inspection as:

> *Inspection of the underwater portion of a bridge substructure and the surrounding channel, which cannot be inspected visually at low water by wading or probing, generally requiring diving or other appropriate techniques.*

Inspectors can observe structural conditions above water well in advance of failure. However, significant underwater structural conditions cannot be readily observed above water until the defect has progressed to where distress is evident.

In general, an Underwater Inspection is required if, during a Routine Inspection, water conditions exist at the structure that prohibit access to all portions of an element by visual or tactile means that would ensure a level of certainty. See §650.313(e)(2) of the NBIS. However, many of Nevada's bridges spanning "waterways" are over dry land during some portion of each year. These structures are typically inspected during these "low-flow/no-flow" periods (i.e., where the water depth is 3 ft or less) and, therefore, do not require a true Underwater Inspection. Therefore, for those structures passing over waterways with substructure components continuously submerged in water equal to or greater than 3 ft, the following inspection procedures will apply:

1. Regulation and Certification. Underwater diving operations shall be conducted in compliance with OSHA 29 CFR 1910 Subpart T – Commercial Diving Operations (including OSHA Directive CPL-02-00-143) and Association of Diving Contractors International (ADCI) Consensus Standards for Commercial Diving Operations. All diving team personnel shall be commercial divers, and at least one team member shall be trained as an NBIS Inspection Team Leader (TL).

2. Extent of Inspections. Inspections shall consist of a visual/tactile examination of all structural elements and a scour evaluation using mechanical (probing rods, rules, etc.)

and/or electronic methods. As practical, the section loss of submerged steel elements shall also be ascertained.

3. Results of Inspections. A complete Bridge Inspection Report (including NBI and PONTIS) shall be completed for each Underwater Inspection. The Underwater Inspection Report shall include:

- a description and location of the elements inspected,
- the procedure employed for the inspection of these elements, and
- the frequency of the inspection.

28.2.6.7 Fracture Critical Member (FCM) Inspections

28.2.6.7.1 *General*

Fracture Critical Member (FCM) Inspections shall be conducted in conjunction with the Routine Inspections of the bridge. FCMs are steel tension members or portions of steel members in tension whose failure would likely result in a total or partial bridge collapse. FCMs require more thorough and detailed inspections than the members of non-fracture critical bridges.

A FCM Inspection is a “hands-on” inspection; i.e., a visual/manual inspection made at a distance no greater than arm’s length from the entire member/member component surface. Every square foot of the member/member component must be examined. The observations and/or measurements are used to determine the structural capacity of the member/member component, to identify any changes from previous FCM Inspections and to ensure that the structure continues to satisfy present safety and service requirements. Under-bridge access equipment is often required to move the inspector within arms length of the critical members. NDT examination is commonly used to examine potential deficiencies on fracture critical members.

Essentially, Fracture Critical Member (FCM) Inspections are a special type of In-Depth Inspection. The following will apply to the inspection of bridges with fracture critical members:

1. Fracture Critical Bridges. The ACSE – I/I maintains an inventory of bridges with fracture critical members. The PSE, with assistance from the Bridge Inventory/Inspection staff, is responsible for identifying structural members that are fracture critical.

2. Frequency. As required by §650.313(e)(1) of the NBIS, bridges containing fracture critical members shall be inspected in-depth at least every 24 months. A 24-month frequency will be employed until the inspection indicates a need to increase the frequency.

28.2.6.7.2 *Condition Rating of Cracked Steel Members*

The bridge inspector must devote special attention to the proper application of condition ratings to primary load-carrying steel bridge members that have experienced fatigue or weld cracking. Issues include both the consistency maintained in rating similar damage found at different bridges and the degree of conservatism used in the selection of condition ratings. The following provides guidance to aid the bridge inspector in rating fatigue damage.

To rate fatigue damage or weld cracking in primary steel superstructure elements, NDOT uses both “major” items (e.g., Items 59.2 “Stringer,” 59.3 “Girder or Beams,” 59.4 “Floor Beams”) and the "secondary" Item 59.8 "Welds-Cracks." Item 59.8 highlights or "weights" the magnitude and severity of cracking in steel superstructure elements or cracks in weldments. The numerical rating for this Item that best represents the extent and severity of cracking shall be selected in accordance with the Modified Condition Ratings found in Appendix A of the *NDOT Bridge Inspection Manual*. This rating may then be considered in establishing a Timing Code for repair of the cracking in the Bridge Inspection Report. In most cases, where noteworthy cracking is found, a Welds-Cracks condition rating of "5" or below is appropriate, with values of "4" or "3" being most often applied. These rating values can then be used to establish corresponding repair Timing Codes, varying from "within the next two years" to "as soon as possible." This is justified because it is best to stabilize or repair fatigue or impact-related cracks as soon as practical, whether or not the load-carrying capability of the member itself has been reduced.

The condition rating for the "major" item(s) shall be assigned based on the Condition Rating definitions in the FHWA *Coding Guide*. These ratings shall be downgraded to an appropriate level, based upon the existing or potential threat to the member(s) imposed by the fatigue damage. For example, when fatigue cracking exists that has propagated out of a weldment and into the base metal of a member, the major item rating shall be "4" or less (with Welds-Cracks rated "3" or less). However, when cracks are found that are confined to a weldment, and the degree of threat to the base metal of the member is low (such as in a compression zone), then the major rating for the member may be raised to a value as high as "6," and the Welds-Cracks rating used to signify the extent of cracking as discussed previously.

Inspection frequencies should be established based upon the degree of threat to the primary member. For those structures experiencing cracking that has propagated into base metal, the frequency of inspection should be set at a maximum of 6 months. For those structures where cracking is confined to a weldment, and propagation of the cracking into base metal is highly improbable, a 12-month inspection frequency should be established. Bi-ennial (24-month) inspection frequencies may be maintained only:

- where cracks exist that have previously been arrested/repaired;
- where cracks exist in secondary members (e.g., within the individual members of a cross-frame); or
- where cracks exist in non-structural welds (e.g., tack welds) where no potential for propagation outside of the weldment exists.

Communication and documentation of fatigue/weld crack findings is vitally important. Mandatory NDOT policy is that ANY cracking found in primary load-carrying steel members must be reported immediately to the ACSE – I/I. In this manner, findings can be discussed and "surprises" avoided. Further, findings should be documented in sufficient detail such that the precise location of the deficiency can be determined and the size of the deficiency "tracked" over time until a repair is completed. The use of framing sheets from the bridge plans to document fatigue damage is recommended.

28.2.6.8 Critical Maintenance Inspections

A critical maintenance inspection is a type of Special Inspection conducted to monitor significant structural damage or deterioration in a primary member. If a structure is determined to need "critical" maintenance, the structure is inspected at maximum intervals of six months for as long as the condition exists. A critical maintenance deficiency is defined as any deficiency in a primary load-carrying member requiring maintenance with a Maintenance Report Timing Code of "1" (as soon as possible) and a Criticality Code of "3" or "4" (i.e., having major structural significance).

When a critical maintenance condition is identified, the following actions occur:

1. The Inspection Team Leader (TL) notifies the Principal Structures Engineer (PSE) within 24 hours of the finding. This notification typically occurs by cell phone from the bridge site, immediately upon the finding.

2. The PSE will then immediately notify the Assistant Chief Structures Engineer – Inventory/Inspection (ACSE – I/I) of the finding. The PSE must also notify the District Office, if the bridge is State-owned, or the bridge owner, if the bridge is non-State owned.

3. The TL must prepare a Critical Maintenance Memorandum and submit it to the PSE within 24 hours of the finding. Copies of the Memorandum are sent to the:

    - Chief Structures Engineer;
    - Assistant Chief Structures Engineer – Inventory/Inspection;
    - Assistant Chief Structures Engineer – Design;
    - District, if a State owned bridge; and
    - bridge owner, if a non-State owned bridge.

4. For State owned bridges, the PSE will meet with the ACSE – I/I and Assistant Chief Structures Engineer – Design (ACSE – D) to determine the best course of action for the bridge repair. The determination of the repair strategy will depend upon the severity of the damage/deterioration, capability of NDT/District personnel and their workload, etc. Repairs can be accomplished using one of the following:

    - <u>NDT Squad</u>. The NDT Squad can perform certain repairs using bridge access equipment. These repairs can include drilling of fatigue cracks. See Section 26.3.2. The PSE is responsible for these repairs.

    - <u>District Personnel</u>. District maintenance personnel can perform certain repairs using their own or rented equipment. These repairs can include filling sinkholes in approach roadways and repairing undermined footings. The PSE is responsible for coordinating these repairs with the District.

    - <u>District Contract – Normal Procedures</u>. A conventional NDOT contract administered at the District level can be used to repair bridges in which the scope is not large but beyond the capabilities of the NDT Squad and District maintenance personnel. These repair contracts must also not be time sensitive or require special construction oversight necessitating the services of an NDOT construction crew. These repairs may include impact damage or fatigue damage of a less critical nature. The ACSE – D is responsible for coordinating these repairs with the District, which may include preparing contract drawings and specifications. The PSE remains in communication with the ACSE – D and District.

    - <u>District Contract – Emergency Procedures.</u> An emergency contract administered at the District level is used when the repairs are not large in scope, do not require special construction oversight necessitating the services of an NDOT construction crew, but are time sensitive. These repairs can include critical bridge impacts and fatigue damage. The ACSE – D is responsible for coordinating these repairs with the District, which may include preparing contract drawings and specifications. The ACSE – D also works with the District to declare the project an emergency. The PSE remains in communication with the ACSE – D and District.

- Headquarters Contract – Normal Procedures. A conventional NDOT contract administered through Headquarters can be used when the repairs are large in scope and require special construction oversight but are not time sensitive. These repairs could include less critical but pervasive fatigue damage or replacement of a non-critical bridge. The ACSE – D is responsible for programming the project, assigning a bridge design squad to prepare contract documents, and placing the project in the NDOT work program. The PSE remains in communication with the ACSE – D and District.

- Headquarters Contract – Emergency Procedures. An emergency NDOT contract administered through Headquarters can be used to perform repairs on large projects that require special construction oversight and the services of an NDOT construction crew, and the project is time sensitive. These repairs could include critical and pervasive fatigue damage, impact damage that requires closure of an important bridge, or replacement of an important bridge. The ACSE – D is responsible for programming the project, assigning a bridge design squad to prepare contract documents, and including the project in the NDOT work program. The ACSE – D also works with the District to declare the project an emergency. The PSE remains in communications with the ACSE – D and District.

After determining the best course of action, the PSE will contact the District for concurrence on the recommendation.

5. For non-State owned bridges, the PSE will request that the bridge owner submit a corrective action plan as soon as practical. The PSE will follow up with the bridge owner to determine the status of the repair, and continue to do so depending upon the severity of the damage/deterioration.

6. The status of critical-maintenance bridges is tracked using both the PONTIS database and a Critical Maintenance spreadsheet. The spreadsheet is shared between the ACSE – I/I, PSE and TL. The PSE is responsible for tracking the maintenance progress.

7. NDOT submits a Quarterly Report to FHWA detailing the status of all bridges requiring critical maintenance and those recently repaired.

8. A follow-up inspection shall be conducted after the critical maintenance repairs are complete. A Bridge Inspection Report shall be completed detailing the repair and shall include revised condition ratings justifying the removal of the bridge from Critical Maintenance status.

28.2.6.9 Complex Bridge Inspections

§650.305 of the NBIS defines a complex bridge as "movable, suspension, cable stayed, and other bridges with unusual characteristics." §650.313(f) discusses the NBIS requirements for their inspection.

NDOT assigns its senior staff to the inspection of complex bridges. In general, these inspections require more equipment and more time and often require assistance from the Non-Destructive Testing Squad. The Bridge Inspection Report for a complex bridge shall include:

- specialized inspection procedures employed, and
- the additional/specialized inspector training/experience required.

28.2.6.10 Damage Inspection

§650.305 defines a Damage Inspection as:

> *An unscheduled inspection to assess structural damage resulting from environmental factors or human actions.*

Common examples of events that may require a Damage Inspection include earthquakes, floods, vehicular impacts, fire damage and marine vessel impacts.

The scope of the 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 implement a repair. The level of effort for a Damage Inspection can vary significantly and depends on the severity of the damage.

The Damage Inspection is often succeeded by an In-Depth Inspection to better document the extent of damage and the urgency and scope of repairs. Follow-up activities include proper documentation, verification of field measurements and calculations and, perhaps, a more refined analysis to establish or adjust interim load restrictions.

The impetus for a Damage Inspection is often due to an “Emergency.” NDOT Policy TP 1-3-12 “Emergency Response” defines an emergency as “an unexpected or sudden event which causes serious damage which must be corrected immediately.” TP 1-3-12 also documents NDOT’s procedures for responding to an emergency. In addition, the NDOT publication “Role in Disasters” presents NDOT’s Emergency Operations Plan (EOP) pursuant to the “State of Nevada Comprehensive Emergency Management Plan” (SCEMP).

28.2.6.11 Overhead Sign/Signal/High-Mast Lighting, Bridge-Mounted Signs and Bridge-Mounted Utility Inspections

Although the NBIS does not require the inspection and inventory of these appurtenances, NDOT has developed an overhead sign, signal and high-mast lighting inventory that is separate from the Nevada Bridge Inventory. Bridge-mounted signs, luminaire supports and utilities are inspected as part of the overall bridge inspection. Inspections of these elements are visual and, where appropriate, NDT methods are used (e.g., ultrasonic). See Section 26.3.

NDOT has developed a separate data reporting form for the inspection of bridge-mounted signs, luminaire supports and utilities. The form is part of the Bridge Inspection Report. The bridge inspector should provide special attention to the attachments of these structures to the bridge.

28.2.6.12 Pedestrian Structures

NBIS does not require the periodic inspection of bridge structures that carry only pedestrian or bicycle traffic, and pedestrian structures are not included in the Nevada Bridge Inventory.

However, NDOT performs routine inspections on publicly owned pedestrian structures on a 24-month frequency, acknowledging concern for the roadway and motorists passing underneath.

28.2.6.13 Miscellaneous Structures

Although NBIS does not require the inspection of the following structures, the following presents NDOT practices for the inspection of these miscellaneous structures:

1. Culverts. Culverts less than or equal to 20 ft in length do not require scheduled inspections. These structures shall receive periodic inspections when warranted. A noticeable dip in the roadway, breakdown of the roadway shoulder, excessive pavement cracking, or restricted water flows are all signs of possible structural problems with the culvert. Culvert structures shall be assigned a Structure Identification Number beginning with the prefix "C" and shall be identified on structure location maps.

2. Retaining Walls. Retaining walls constructed to retain approach roadway fills adjacent to bridges are inspected as an integral part of the Routine Inspection process. Retaining walls shall also be inspected when they show visual signs of distress. Where the retaining wall retains the roadway, excessive roadway settlement and pavement cracking may indicate a problem with the wall. Retaining walls shall be checked for plumbness, excessive movement, spalling and heavy rust staining on the front face. Check for proper drainage behind the wall. Inadequate drainage can result in overstress of the wall.

3. Sound Barriers. Bridge-mounted sound barriers shall be inspected with the bridge. Sound barriers should be checked for collision damage, plumbness, corrosion and wall panel deterioration. The inspector shall also closely observe the connection details of the wall to the bridge.

4. Privately Owned Structures. Privately owned structures open to unrestricted public access are inspected and remain in the Nevada Bridge Inventory. Those structures restricted to open traffic are not inspected.

5. Tunnels. Tunnels carrying unrestricted highway traffic receive routine inspections every 24 months. An inspection report shall be produced for all tunnel inspections, which shall include condition ratings, written documentation of findings and maintenance recommendations.

28.2.6.14 Estimated Remaining Life

In general, NDOT determines the frequency of its bridge inspections based on the Estimated Remaining Life (ERL) of the structure. NDOT's criteria are:

1. ERL > 5 Years. All bridges with an ERL greater than 5 years are inspected at least once every 24 months.

2. ERL ≤ 5 Years. All bridges with an ERL of 5 years or less are inspected at least every 12 months.

Estimated Remaining Life determinations will be made according to the following criteria:

1. New and Reconstructed Structures. ERL of new and reconstructed structures shall be as follows:

   Bridges (including box culverts): 75 years
   Tunnels: 75 years

2. ERL Reduction. Reduction of ERL of bridges shall be on a year-for-year basis from the date of construction. If a bridge has been hit or otherwise damaged or if a bridge is found to have substandard materials or workmanship, the ERL may be reduced accordingly.

3. Limit of Reduction. Once the bridge ERL has been reduced to 15 years, it shall remain at 15 years until further deterioration of the structure indicates a need to continue reducing the ERL.

4. Rehabilitated Bridges. Rehabilitated bridges will be assigned an ERL value of 25 years with the year of rehabilitation as the base year. An exception to this is when the bridge rehabilitation occurred during the first 25 years of the bridge life. In this case, the ERL shall be based on the original 75-year life. The ERL of rehabilitated bridges shall be reduced as specified in Nos. 2 and 3. (Note: The distinction between reconstruction and rehabilitation will be made by the Structures Division on a case-by-case basis. A subjective evaluation will be made on how much the bridge improvement work adds to the Estimated Remaining Life of the structure).

5. Repaired Bridges. Any added bridge life resulting from bridge repairs will be determined on a case-by-case basis.

6. Tunnels. The ERL of tunnels shall be reduced on a year-for-year basis from the date of construction. If the tunnel has been damaged, the ERL may be reduced accordingly. Once the ERL of a tunnel has been reduced to 15 years, it shall remain at 15 years until further deterioration indicates a need to continue reducing the ERL.

7. Rehabilitated Tunnels. Rehabilitated tunnels will be assigned an ERL value of 50 years with the year of rehabilitation as the base year. The only exception to this rule is when the rehabilitation occurred during the first 25 years of the tunnel's life. In this case, the ERL shall be based on the original 75-year life. The ERL of rehabilitated tunnels shall be reduced as specified in No. 6.

28.2.7 Scour Critical Bridges

28.2.7.1 General

Scour is the movement of channel bed material by the action of the moving water. This movement may result in degradation, or erosion of material or aggradation, or accumulation of material. Degradation of the channel bed may lead to structure instability, posing an often unseen threat to safety. Scour is generally most severe during periods of high flow. When flows recede to normal levels, the presence of scour is often hidden by silt or debris, making detection difficult. Scour is the leading cause of bridge failures.

To address this concern, NDOT maintains bottom profile records of all Nevada bridges over waterways. The records include "local" channel bottom elevations along the upstream fascias of the bridge. Additionally, for bridges over large waterways, local channel bottom elevations are collected around the perimeter of all substructure elements in the water. These records are obtained in conjunction with both the Routine and Underwater Bridge Inspections.

Additionally, all Routine and Underwater Inspections include an evaluation of substructure foundation exposure, including the assessment of any foundation undermining found during the inspection. Often, foundation undermining can only be found or assessed using divers.

Finally, all Routine and Underwater Inspections include an evaluation of the waterway adjacent to the bridge. This evaluation includes an assessment of channel scour in the vertical orientation and channel embankment erosion/lateral channel migration in the horizontal orientation. Vegetation intrusion and channel bottom material aggradation adjacent to the bridge are also evaluated, as is the effectiveness of channel embankment protective measures (e.g., riprap, slope pavement).

28.2.7.2 Scour Evaluation and Plans of Action

§650.313(e)(3) of the NBIS requires that each State DOT must:

> *Prepare a plan of action to monitor known and potential deficiencies and to address critical findings. Monitor bridges that are scour critical in accordance with the plan.*

The following describes the NDOT Policy, which the Structures Division and Hydraulics Section developed and implemented jointly, to comply with NBIS Plan of Action (POA) requirements:

- For all bridges over waterways, a multi-disciplinary team of engineers (i.e., geotechnical, hydraulic, structural) shall perform a scour analysis. The multi-disciplinary team will develop a scour POA for use by the Bridge Inspection Squad.
- The ACSE – I/I maintains a list of those bridges in the State of Nevada that have been determined to be scour critical.
- Each scour critical bridge has a unique POA based on the specific hydraulic, geotechnical and structural characteristics for that bridge site.
- NDOT is responsible for ensuring that POAs are developed for all scour critical bridges.
- The POA includes:
  + the discharge of concern that will trigger an Underwater Inspection,
  + specific actions that must be performed during a bridge inspection to monitor the foundation,
  + scour mitigation measures that are deemed appropriate, and
  + threshold events that will justify closure of the bridge.

28.2.7.3 Scour Evaluation During Routine Inspections

A local channel bottom evaluation shall be conducted for all bridges over water. The minimum recommended channel bottom measurements to be obtained during a Routine Inspection should include:

- channel bottom elevations along upstream fascia of the bridge taken at each substructure unit or element and at mid-span points at a minimum, and

- additional channel bottom elevation measurements around substructure units as deemed necessary by the TL.

An evaluation of substructure foundation exposure/undermining shall also be conducted, using visual, wading and probing methods, as applicable. When exposures/undermining conditions cannot be adequately assessed using these methods, an underwater diving inspection shall be recommended.

The waterway adjacent to the bridge shall also be evaluated, largely using visual methods. This evaluation shall include the following assessments:

- channel scour in the vertical orientation;

- channel embankment erosion and lateral channel migration in the horizontal orientation;

- vegetative growth throughout the channel, including along the channel banks;

- material aggradation in the channel, both upstream and downstream of the bridge; and

- effectiveness of channel embankment protective measures (e.g., riprap, slope pavement). Where protection is warranted but lacking, it should be recommended.

28.2.7.4 Scour Evaluation During Underwater Inspections

In addition to evaluations required during the Routine Inspection, water depth measurements during an Underwater Inspection should also include the elevation measurements obtained in concentric rings at the ends and quarter points of the element at distances of 0 ft, 5 ft, 10 ft and 15 ft from the element face.

28.2.8 Scheduling Inspections

28.2.8.1 General

§650.311 presents the inspection frequencies based on the type of inspection (e.g., Routine Inspections) and/or special inspections (e.g., Fracture Critical Member Inspection). In general, NDOT schedules inspections during the year by District as follows:

- District I. October through February.
- District II. March through June.
- District III. July through September.

28.2.8.2 Routine Inspections

§650.311(a) requires that Routine Inspections for each bridge be scheduled at regular intervals not to exceed 24 months. NDOT shall use the following in scheduling Routine Inspections:

- scheduled based on the generated date of next inspection;
- completed no sooner than 30 days prior to, and no later than, the scheduled inspection date; and
- may be rescheduled in the event of an emergency, inclement weather, safety concerns or other unforeseen circumstance with the approval of the PSE. Inspection may be rescheduled no later than 30 days following the date of the next inspection.

28.2.8.3 Access-Required Routine Inspections

Figure 28.2-A will determine the frequency of inspections using access equipment. Due to resource limitations, not all bridges requiring access can be so accommodated in each inspection cycle. As a consequence, if time/resource constraints require the elimination of scheduled access-required inspections, those structures with 96-month frequencies shall be eliminated first and, if further eliminations are necessary, they shall be taken from the groups listed in Figure 28.2-A in the following sequence:

- concrete slab, box girder or filled-deck arch bridges (48 months);
- concrete girder or T-beam bridges;
- concrete open-spandrel or through-arch bridges; and
- steel bridges.

Candidate bridges so eliminated will be inspected without the use of access equipment.

28.2.8.4 In-Depth Inspections

In-Depth Inspections will be scheduled by the PSE on an as-needed basis with scheduling as close as practical following the Routine Inspection.

28.2.8.5 Complex Bridge Inspections

A Complex Bridge Inspection follows the requirements for Routine Inspections regarding the frequency date of the next inspection. Complex Bridge 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 should be clearly identified and recorded, and each should be assigned a frequency for re-inspection.

Bridge Type	Minimum Inspection Frequency
All steel bridges	48 months or 24 months
Concrete girder or T-beam bridges	48 months
Concrete slab, box girder or filled deck arch	96 months or 48 months
Concrete open-spandrel arch or through arch	48 months
Concrete frames, tunnels or other bridges	As needed

Notes:

1. *Steel bridges should be inspected using access equipment on a 48-month minimum frequency, if they are basically "totally accessible" (i.e., every span has a vertical clearance not exceeding 25 ft and is in the dry or otherwise able to be examined by walking under each span). If these structures are not "totally accessible," a 24-month minimum inspection frequency should be used.*
2. *Concrete refers to both prestressed and conventionally reinforced concrete.*
3. *Concrete slab, box beam or filled deck arch structures should be inspected using access equipment on a 96-month minimum frequency, if they are basically "totally accessible" (i.e., every span has a vertical clearance not exceeding 25 ft and is in the dry or otherwise able to be examined by walking under each span). If these structures are not "totally accessible," a 48-month minimum inspection frequency should be used.*

ACCESS-REQUIRED ROUTINE INSPECTIONS

Figure 28.2-A

28.2.8.6 Special Inspections

Special Inspections are used when a structure requires more frequent inspection than that of the Routine Inspection. Special Inspection frequency should reflect the severity of the deficiency. Special Inspections might be used to inspect load-posted bridges, monitor severely deteriorated conditions or when an In-Depth Inspection is warranted. Special Inspections will be scheduled by the PSE on a case-by-case basis.

28.2.8.7 Underwater Inspections

An inspection of permanently submerged structural elements shall be performed once every 48 months. *Note: FHWA requires an Underwater Inspection once every 60 months.* These inspections shall be scheduled to coincide with periods of low-flow to minimize the extent to which elements are submerged. The exceptions to the above shall be during flooding conditions. Submerged structural elements threatened by flood waters shall be inspected as soon as it is safe to enter the water following the flood.

28.2.8.8 Fracture Critical Member (FCM) Inspections

Fracture Critical Member Inspections (FCM) should be scheduled at regular intervals not to exceed 24 months, and are usually scheduled to coincide with the Routine Inspection of a bridge. These Inspections often require the scheduling of special access equipment, traffic control and NDT examination, and on normally conducted simultaneous Routine Inspections.

28.2.9 <u>Inspection Preparation Procedures</u>

The Inspection Team Leader (TL) should perform the following office procedures to prepare for the bridge inspection:

1. <u>Document Preparation</u>. Check the original bridge plans and rehabilitation plans, preferably "As-Built" plan (if available), which will determine the type of bridge, bridge components and foundation that will be inspected. Check the bridge files to review previous inspection reports and to determine the deficiencies that were noted. Prepare copies of relevant plan sheets and previous inspection report documentation, which will be used as reference materials during the inspection.

2. <u>Equipment</u>. Determine the access equipment and inspection equipment that will be needed for the group of bridges that will be inspected and where this equipment is located. Make the necessary arrangements to relocate the equipment to where it is needed. Make arrangements for NDT examination and traffic control if applicable.

3. <u>Coordination</u>. The following applies:

    a. Coordination Within NDOT. Notify all appropriate NDOT Divisions and Districts of the times that personnel from the Structures Division will be in the area to inspect bridges and to confirm staff and equipment availability, ability to provide traffic control, etc. Coordinate with the Public Information Officer for advance public notification as needed.

    b. Coordination Outside NDOT. Notify all outside agencies (e.g., local owners, NHP, media) of pertinent bridge inspections and arrange a mutually satisfactory time for their personnel to be present, if requested or necessary. Provide the traveling public with advance warning of lane or ramp closures, as deemed necessary by NDOT District and Public Information Officials. Make arrangements with private property owners when necessary to complete the inspection.

    c. Railroad Coordination. NDOT must coordinate with the Railroad Company when its Inspection Team will be working within 25 ft of the centerline of tracks. The Railroad Company will provide an employee to assist the Inspection Team with track control. NDOT provides the Railroad Company with ample advance notice (typically, 4 to 6 weeks) of the inspection schedules for bridges requiring Railroad track control. When on site, the TL will provide the Railroad employee with a two-way radio to notify the NDOT Team of an approaching train. NDOT inspectors must follow directives relating to railroad safety provided by the Railroad track control representative.

4. <u>Inspection Plan</u>. Develop an inspection plan for each bridge on the inspection schedule. Check the bridge folder to determine if an inspection plan has already been developed, and update the plan as needed.

28.2.10 <u>Field Inspection Procedures</u>

28.2.10.1 General

In general, NDOT requires that all bridge inspections in the field be consistent with the recommendations and guidance contained in the FHWA *BIRM* and AASHTO *Manual*. In addition, the *NDOT Bridge Inspection Manual* and FHWA *Coding Guide* present specific information for the bridge inspector's use in completing the field inspection and processing the resulting Bridge Inspection Reports. Both NBI and PONTIS element level inspections are required to be completed for each bridge. In addition, the following are recommended field procedures for all inspections:

1. <u>Safety Briefing</u>. When non-NDOT personnel are present, they shall be briefed on NDOT safety requirements before starting the inspection. Do not proceed with any inspection without the proper personnel being present and having received a safety briefing.

2. <u>Inspection Plan Review</u>. Examine the detailed inspection plan to determine where to position equipment. Modify the inspection plan by noting the location of piers, abutment slopes and any other obstructions under the bridge.

3. <u>Equipment Check</u>. Verify that the necessary equipment has been assembled and is on site.

28.2.10.2 Traffic Control

The District Offices are responsible for planning and implementing traffic control procedures for all Access-Required Bridge Inspections. Assessment of specific lane closures shall be determined by the TL in collaboration with the Special Equipment Operator and District Bridge Maintenance Crew leader.

Special considerations, such as restricting the time of inspections to low-volume periods, permit a more thorough inspection of the entire bridge. The District Bridge Maintenance Crew leader shall assess these options in conjunction with the PSA and the TL. These considerations shall be implemented where feasible.

28.2.10.3 Safety

In general, all bridge inspection activities shall conform to NDOT safety policies. NDOT must also follow regulations as promulgated by OSHA. OSHA regulations that have an especially significant impact on bridge inspections include those pertaining to:

- heights,
- use of respirators,
- confined spaces,
- lead exposure,
- water, and
- railroads.

Additionally, the safety regulations of the Railroad Company, other governmental agencies or bridge owner shall be followed. During Access-Required Bridge Inspections, it is sometimes necessary to leave the work platform to complete a thorough review of the structure. When the bridge inspector determines that this is necessary, the following guidelines will apply:

1. Notification. The bridge inspector will inform the inspection vehicle operator of his/her intention to leave the work platform.

2. Safety Line. When leaving the work platform, the bridge inspector will use a safety line. This line will be attached to the superstructure or appropriate portion of the bridge that will ensure the safety of the individual leaving the work platform. Climbing activities conducted over live traffic shall require the simultaneous use of two safety lines.

These guidelines apply to NDOT personnel involved in conducting bridge inspections. When individuals from other government agencies, consultants, contractors, etc., are participating in the inspection process, it will be the responsibility of the Special Equipment Operator to ensure that these individuals are not allowed to leave the work platform without conforming to these guidelines.

28.2.11 Inspection Reporting Procedures

§650.313 presents the NBIS bridge inspection reporting procedures. The following sections present specific NDOT reporting procedures for the Nevada Bridge Inspection Program.

28.2.11.1 Report Preparation

The Bridge Inspection Report incorporates the results of both the NBI and PONTIS element level inspections and serves as the permanent inspection record. These Reports portray the condition of the bridge as it relates to public safety. They are also used for future rehabilitation and replacement decisions. Therefore, it is imperative that the Reports present accurate and thorough information. Reports should include photos, sketches, addenda, etc., as necessary to adequately and thoroughly document the condition of the structure but also be as concise as possible. Do not include information that is not necessary to communicate the nature of the structure's condition. When conditions are very good or excellent, as noted by the appropriate condition rating number and PONTIS element data, it is not necessary to provide narrative comments.

28.2.11.2 Review and Processing

Use the following minimum procedure for processing Bridge Inspection Reports:

1. Field Notes. Field notes shall be reviewed at the inspection site for completeness and accuracy.

2. Data Entry. The bridge inspection data from each Report shall be entered into the appropriate computer files by the TL or AI.

3. Draft. Each Report shall be printed and reviewed both by the TL and AI for completeness and accuracy. Errors or omissions noted shall be rectified. Reports deemed accurate and complete will then be initialed by both the TL and AI.

4. QC Review. Initialed Reports shall be circulated for approval. Reports generated by NDOT staff shall be reviewed and signed by the PSE or designated representative, who shall be qualified as a TL. Consultant Reports shall be reviewed by the consultant Project Manager or NDOT-approved, designated alternate, who must be a Registered Professional Civil or Structural Engineer in Nevada.

5. Corrections. If originals are returned to the TL for corrections, they shall be revised to the satisfaction of the QC Reviewer.

6. Final Report. The revised Bridge Inspection Report shall then be submitted to the QC Reviewer for final approval. The consultant review process is finalized by the signing and sealing of the Report by the Project Manager or NDOT-approved, designated alternate. Completed reports shall be forwarded by the consultant to the PSE for final NDOT review and acceptance.

7. Submittal. The original copy of the accepted Bridge Inspection Report shall be forwarded by the PSE to the NDOT Bridge Inventory Management Squad for distribution and filing.

8. Distribution and Filing. Report originals shall be filed in the NDOT Bridge Inventory files with a copy distributed to the owner. For State-owned bridges, the copy is provided to the Assistant District Engineer or designated individual.

28.2.11.3 Submittal Time Requirements

The following identifies the time requirements for submitting the Bridge Inspection Report:

- Reports must be submitted to the PSE for acceptance review within 45 days of the date of inspection.

- Any Bridge Inspection Report returned by the PSE for correction must be returned to the PSE within 75 days of the date of inspection.

- §650.315(b) of the NBIS stipulates that States have 90 days following the date of inspection for State-owned bridges (180 days for non-State-owned bridges) to update the State Bridge Inventory. This is required following a field inspection, or at any other time there is any change in the reporting status of bridges. These time requirements shall have no influence over the 45- and 75-day requirements stipulated above.

28.2.12 Bridge Inventory Procedures

28.2.12.1 Definitions

The following definitions apply:

1. National Bridge Inventory (NBI). The aggregation of structure inventory and appraisal data collected to fulfill the requirements of the National Bridge Inspection Standards, which requires that each State prepare and maintain an inventory of all bridges subject to the NBIS.

2. National Bridge Inventory (NBI) Record. Data that has been coded according to the FHWA *Recording and Coding Guide* for each structure carrying highway traffic or each inventory route which goes under a structure.

3. Structure Inventory and Appraisal (SI&A) Sheet. The graphic representations of the data recorded and stored for each NBI record in accordance with the *Recording and Coding Guide*.

28.2.12.2 NBI Data Reporting

The Bridge Inventory Management Squad is responsible for maintaining the Nevada Bridge Inventory of all public bridges in Nevada not owned by any Federal agency. The Squad also prepares and processes the Structure Inventory and Appraisal (SI&A) data for all bridges in the Nevada Bridge Inventory. The implementation of these functions must comply with §650.315(a) of the NBIS.

The Nevada Bridge Inventory includes an element-level database, electronic directory of Supplemental information files (approved format such as .pdf, .doc, etc.), and the National Bridge Inventory (NBI) file. As mandated by FHWA, the NBI file has been programmed to submit the data in the format described in the FHWA *Recording and Coding Guide* for all bridges in the State. The submission to FHWA is typically due by March 31 of each year. These data are used by FHWA to assign a Sufficiency Rating to each bridge according to the Sufficiency Rating (SR) Formula in the FHWA *Coding Guide*. The ACSE – I/I is the primary point of contact regarding data submittal to FHWA.

28.2.12.3 Meaning of Sufficiency Rating

The "Sufficiency Rating" is used by FHWA as a numerical indicator of a bridge's sufficiency to remain in service. The Sufficiency Rating is based upon a 0 to 100 scale (100 being best), and is calculated using a formula which incorporates four factors:

- Structural Adequacy and Safety (55%),
- Serviceability (30%),
- Essentiality for Public Use (15%), and
- Special Reductions (up to 13%).

Bridges categorized as Structurally Deficient or Functionally Obsolete, with a Sufficiency Rating of less than 50.0, qualify for replacement using Federal Highway Bridge Program (HBP) funds; those bridges with a Sufficiency Rating of 80.0 or less are eligible for rehabilitation. See Section 22.1 for more discussion on the HBP.

A bridge is categorized as Structural Deficient if the bridge:

- is in relatively poor condition due to deterioration;
- has insufficient load-carrying capacity (whether due to the bridge being of older design or due to deterioration); or
- the structure frequently floods, causing significant traffic delays.

Deficient bridges require significant maintenance attention, rehabilitation or replacement. However, the classification of a bridge as Structurally Deficient does NOT typically mean that it is in danger of collapse.

A bridge is categorized as Functionally Obsolete if the bridge:

- is narrow,
- has inadequate underclearances,
- has insufficient load-carrying capacity,

- is poorly aligned with the adjacent roadway, and/or
- can no longer adequately service today's traffic.

Functionally obsolete bridges do not provide the lane widths, shoulder widths, vertical clearances, etc., adequate to serve traffic demand, or the bridge may not be able to handle occasional roadway flooding without causing traffic delays.

Bridges that qualify as both Structurally Deficient and Functionally Obsolete are categorized and reported solely as Structurally Deficient. Further, bridges built or reconstructed within the last 10 years do not qualify as Structurally Deficient or Functionally Obsolete, based on the FHWA "10-year rule."

28.2.12.4 Structure Number Assignment

The Bridge Inventory Management Squad is responsible for assigning Structure Numbers to all structures and for recording these numbers in NDOT's Structure Index. Therefore, the Structures Division has adopted a procedure to ensure that:

- Structure Numbers are properly recorded.
- Each structure location is assigned a unique number that is maintained for all subsequent replacement structures at that location.
- All appropriate files are created or modified for each structure in the contract documents.
- The files are updated in a timely manner consistent with NBIS requirements.

28.2.12.5 Contract Document Review

The following describes the procedures for reviewing the contract documents to identify Structure Numbers:

1. Structure Identification. Review the "Structure List" in each set of contract plans to determine if any "bridge" or "culvert" structures are within the limits of and are affected by the contract. "Bridge" structures shall be as defined in the most recent edition of the FHWA *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges.* "Culvert" structures shall include multi-pipe, RCB, etc., structures with total spans of 10 ft to 20 ft along the roadway centerline.
2. Absence of Structures. Return all copies of contract documents with no "bridge" and/or "culvert" structures to Central Records.
3. Structure Number Verification. Verify that all "bridge" and/or "culvert" structures have been assigned appropriate structure numbers.
4. Structure Number Assignment. If structures exist on the plans and no numbers have been assigned to them, it must be determined if these structures replace structures previously assigned numbers or are new structure locations. New structure locations should be assigned numbers in the current sequence, and replacement structures should be assigned the previous number with the appropriate prefix and/or suffix modifications.

5. Recording. Pen-in structure numbers on the “Structure List” and any other pertinent locations throughout the contract documents. File a copy of these plans in the Division’s Contract Plans file.

6. Nevada Map Atlas. Plot all “bridge” structures in the “Nevada Map Atlas” for “bridges” and all “culvert” structures in the “Nevada Map Atlas” for “culverts.” The Staff III Associate Engineer – Bridge Inventory Management Squad maintains these map atlases.

28.2.12.6 Bridge Inventory Updates

When the Bridge Inspection and PONTIS Inspection Reports are received, the Bridge Inventory Management Squad performs the following:

- The Squad checks the NBI data within the context of its responsibilities in managing the Nevada Bridge Inventory (e.g., error checks, reasonableness checks). For example, the Squad always checks the geometric range items.
- The Squad decides what NBI data, if any, that has been recommended for change should be updated in PONTIS by the NDOT or consultant TL.
- The Squad files the hard copy of the Bridge Inspection Reports in the appropriate Bridge Inspection folders segregated by Structure Number.
- The Squad prepares the SI&A data for submission to FHWA.

28.2.13 Quality Assurance Program (NDOT)

28.2.13.1 General

§650.305 of the NBIS defines Quality Assurance (QA) as:

> *The use of sampling and other measures to assure the adequacy of quality control procedures in order to verify or measure the quality level of the entire bridge inspection and load rating program.*

§650.313(g) requires that a State DOT have QA procedures that:

> *Include periodic field review of inspection teams, periodic bridge inspection refresher training for program managers and team leaders, and independent review of inspection reports and computations.*

Each year, NDOT conducts a QA review of approximately 5% of the bridges inspected in each District. The purpose of the review is to evaluate the field inspection and report processing performance of both NDOT and consultant inspection NBI staff. This is intended to be a constructive process with the objective of improving the quality, accuracy, utility, etc., of the inspections. The QA Review Team typically consists of:

- the Principal Structures Engineer (PSE) , and
- a representative of the District Bridge Maintenance Crew or an alternate from the District or Structures Division as determined by the PSE (field review only).

28.2.13.2 Field Review

The following summarizes the field review element of NDOT's QA Program:

1. Schedule. The QA field inspections are typically conducted in three, one-week trips; one in each of the three Districts.

2. Structure-Type Selection. The QA Review Team selects a random sample of those bridges in the District inspected during the preceding months. This sample will consist of between 15 and 25 structures with a distribution of structure types similar to that covered during the original inspections. However, in no case will more than two culvert-type structures be selected. The sample must also represent approximately equal numbers of structures inspected by each Inspection Team Leader. Furthermore, the sample must not include any structure previously included as part of a QA Review in the previous two years.

3. Review Procedure. For each structure, the QA Review Team will conduct a 100% independent inspection (i.e., without any knowledge of the original Bridge Inspection Report findings). The QA Review Team will assemble its own element-based condition and NBI ratings.

4. Results. The QA field inspection results will be compared to the results of the original inspections to identify any significant differences. Condition rating differences will be considered significant when they exceed a difference of ±1. PONTIS element changes will be considered significant when Condition State distributions or total quantity values vary by more than 15%.

28.2.13.3 Office Review

The PSE will review the original, approved Bridge Inspection Report. The individual sections of the Report will be reviewed in detail for consistency, accuracy and thoroughness.

28.2.13.4 Summary

The PSE will prepare a Summary Report of the QA Review. The Report will itemize the findings for each structure included in the QA Review, will provide a discussion on each significant finding and will document recommendations for improving inspection performance.

28.2.14 Quality Assurance (FHWA)

FHWA conducts an annual review of the Nevada Bridge Inspection Program as part of its nationwide Quality Assurance oversight of the NBIS. FHWA coordinates its QA review directly with the ACSE – I/I. The annual review is conducted by the Nevada Division Office Bridge Engineer and may include additional FHWA representatives. The following briefly describes the FHWA review:

1. Office Review. FHWA will conduct one or two on-site meetings with NDOT. Typical items that could be reviewed are:

- the integrity of the NBI data;
- the percent complete for load rating of existing bridges; and
- specialty items (e.g., Fracture Critical Member Inspections, Underwater Inspections).

2. Field Review. FHWA spends approximately one week in the field with the PSE. FHWA will review selected bridges concurrent with their scheduled Routine Inspections. Inspections completed by both NDOT and consultant forces are subject to FHWA review.

3. Summary Report. FHWA will prepare a Summary Report of its findings and recommendations and hold a close-out meeting with NDOT.

28.2.15 Administrative Procedures

28.2.15.1 Dangerous Duty Pay (DDP)

Nevada Administrative Code 284.208 provides for an additional 10% compensation for each hour that an employee performs duties at a height of more than 16 ft, or engages in underwater diving. DDP time shall be applicable to inspection work performed on eligible bridges. A list of eligible bridges is maintained by the PSE.

28.2.15.2 Bridge Owner Education Program

NDOT is implementing a Program to educate non-State bridge owners in Nevada on their bridges.

28.3 LOAD RATING AND RELATED OPERATIONAL ISSUES

28.3.1 Load Rating

28.3.1.1 Definitions

§650.305 of the NBIS defines load rating as:

> *The determination of the live load carrying capacity of a bridge using bridge plans and supplemented by information gathered from a field inspection.*

In addition, the following definitions apply:

1. Inventory Rating. The load level that can safely use an existing structure for an indefinite period of time.

2. Operating Rating. The maximum permissible load level to which the structure may be subjected for the load configuration used in the rating.

28.3.1.2 Responsibilities

The Load Rating/Over-Dimensional/Over-Weight Permitting Squad within the Inventory/ Inspection Section is responsible for determining the load-carrying capacities of all bridges in the State of Nevada open to the public. The NDOT procedures and methodology as presented in Section 28.3.1 meet all NBIS requirements.

Regarding weight-restriction (load) posting, the Load Rating/Over-Dimensional/Over-Weight Permitting Squad determines the need for load posting of all State-owned bridges. The Chief Structures Engineer has the authority to order that such a bridge be posted. For non-State bridges, the Squad recommends to the applicable owner the appropriate load posting for bridges under its jurisdiction.

28.3.1.3 Procedures

The bridge designer shall place all computer models, computations, assumptions and correspondence on a Compact Disc for storage in the Structural Design Notebook (see Chapter 7) and for storage on the NDOT server in the 011Bridge/011LoadRatings/BridgeLoadRatings folder for potential use in rating the bridge. Include a base computer model of the bridge in a separate location of the Compact Disc for future analysis needs. Computer models shall be developed on approved software programs.

When a bridge inspection reveals a quantifiable change in the bridge condition (e.g., increased metal section loss), the bridge must be re-rated to determine the new load-carrying capacities. These new load ratings are then entered into the NBI and PONTIS databases. If the load-carrying capacity falls below certain limits, the bridge must be posted.

28.3.1.4 General Rating Methodology

For all new or replacement bridges designed in-house or by NDOT consultants, the bridge designer shall calculate the Inventory and Operating Ratings during the design phase of a project. Load rating shall be based on the Load Factor Rating Method. All bridges shall be load rated for HS-20 loading (truck or lane, whichever produces the lowest rating). The number of wheel lines per girder (or other live load application), that is the live load distribution factor, shall be in accordance with the AASHTO *Standard Specifications for Highway Bridges* requirements for design.

All bridges shall be load rated for the Operating Rating for the California permit vehicles P13, P11, P9, P7 and P5. Axle loads of the P trucks shall be at 18 ft on center and the tandem axles shall be modeled as a single 48-kip load at the center of the tandem. Each vehicle shall be applied separately, and the number of wheel lines per girder (or other live load application) shall be the same as for HS-20 truck loading.

28.3.1.5 Rating by Structural Component

Girder bridges shall be rated by line girder analysis where applicable. Concrete box girders, except those of complex geometry, shall be rated on a whole-bridge basis with the total number of wheel lines equal to the sum of the wheel lines for the individual girders.

Concrete bridge decks supported by girders shall not be rated unless there is evidence of distress or deterioration to below a NBI 6 condition rating. Other types of bridge decks shall be rated. When concrete bridge decks are rated, bridge decks exposed to traffic shall be rated with the top ½ in of deck considered a sacrificial wearing surface and not included in the deck section properties.

Superstructure girders, floor beams, trusses and arches (including earth filled spandrel arches) shall be rated.

Concrete pier caps shall not be rated unless there is evidence of distress, deterioration to below a NBI 6 condition rating, or evidence that they would control the rating.

The substructure, including pier columns, abutments, footings and wing walls, shall not be rated unless a special rating is requested. Such special rating is justified only where there is evidence of distress, deterioration to below a NBI 6 condition rating, or scour or other undermining.

28.3.1.6 Material Properties

Material properties shall be as shown in the plans unless the latest Bridge Inspection Report states deterioration of a component and a NBI condition rating less than 6. With reported deterioration, material properties of the deteriorated component may be reduced based on engineering judgment derived from a visual inspection of the bridge or may be increased or decreased based on materials testing. Materials testing shall be performed only by written authorization of NDOT. Material testing shall not be done where the inventory rating factor for HS-20 loading is one (1.00) or more when based on materials properties without testing.

NDOT Standard Specifications after 1961 specify f'_c = 3000 psi for Class A, AA, B, BA, D and DA concrete and f'_c = 2500 psi for Class C and CA. Structures where the concrete strength f'_c is not specified in the plans shall be rated using the default concrete strengths in the AASHTO *Manual for Condition Evaluation of Bridges* for the date of construction, except that the above *NDOT Standard Specification* strengths shall be used where they apply. Concrete strengths for strength calculations may be reduced for deterioration per the above paragraph.

28.3.1.7 Dimensions

Dimensions shall be as shown in the plans unless the latest Bridge Inspection Report states deterioration of a component with a NBI condition rating less than 6 or if measured dimensions as part of a visual inspection deviate significantly from the plan dimensions. With reported deterioration, structural dimensions of a deteriorated component may be reduced based on engineering judgment derived from a visual inspection of the bridge to discount deteriorated material. A comprehensive field measurement of dimensions shall be performed only by written authorization from NDOT.

The section properties of composite girders shall be based on the full depth of the composite deck slab unless deterioration is noted and the NBI condition rating for the deck is less than 6.

28.3.1.8 Software

Software shall be used to perform the ratings as specified below where their use is possible. Data preparation, input files and output files shall be arranged such that the programs may be rerun by NDOT for truck-specific ratings and to update the ratings with a minimum of effort.

Culverts shall be rated using the computer program BRASS-CULVERT.

Girder bridges, other than those of post-tensioned concrete or curved steel girders, shall be rated by the computer program BRASS-GIRDER. If the P trucks are included in the BRASS-GIRDER truck library, the P5, P9 and P13 trucks shall be named exactly P5, P9 and P13 (capital P).

Girder bridges of combinations of pre-tensioned and post-tensioned concrete that do not have rigidly connected supports shall be rated by the computer program BRASS-GIRDER as possible and by other means if necessary. Such bridges with rigidly connected supports shall be rated by other means. Allowable concrete tension stress for inventory rating shall be $6\sqrt{f'_c}$ (psi units), except that the top of bridge decks located north of longitude 38°N, or in other areas where de-icing salts are used, shall be limited to $3\sqrt{f'_c}$ (psi units).

Girder bridges of post-tensioned concrete shall be rated by whole-bridge or line-girder analysis when applicable. Such bridges shall be rated by computing moments and shears by analysis using the computer program BD2 or WinBDS and computing strengths and rating factors with the Excel spreadsheet PTRater provided by NDOT. Bridges sharply curved, extremely flared, hourglass shaped or highly skewed with strong piers may require advanced analysis as a non-typical bridge. Allowable concrete tension stress for inventory rating shall be $6\sqrt{f'_c}$ (psi units), except that the top of bridge decks located north of longitude 38°N, or in other areas where de-icing salts are used, shall be limited to $3\sqrt{f'_c}$ (psi units).

Girder bridges of curved steel girders shall be rated by the computer program MDX.

Arch bridges, and other non-typical bridges, shall be analyzed by the computer program SAP2000 with manual calculations and spreadsheets for the rating as required. An alternative general frame analysis program (2D or 3D) or specialized software may be used only with approval from NDOT.

28.3.1.9 Skewed Bridges

The reactions and shears in an exterior girder of a skewed bridge are higher at the obtuse corners and lower at the acute corners compared to an interior girder. This becomes more pronounced as the skew increases. Section 13.2.2.3 discusses the analysis of skewed bridges.

28.3.1.10 Rating Methodology Details

Member properties for structural analysis shall be in accordance with the AASHTO *Manual for Condition Evaluation of Bridges.* Properties for concrete members shall be based on gross concrete section without adjustment for reinforcement or cracking, except that torsion properties of concrete members shall be adjusted when the torsion exceeds the cracking torsion of the member.

Bridges with rigidly connected (integral) supports shall be analyzed as rigid frames. Diaphragm abutments free to translate and rotate at the bottom of the diaphragm shall be considered a simple support when $H < 0.1S$, where H = the extension of the diaphragm below the superstructure and S = the length of superstructure span that the diaphragm terminates. Skewed pier walls rigidly connected to the superstructure shall be modeled with appropriate section properties. The following is recommended but not required practice.

For 2D analysis by the whole-bridge or line-girder method, skewed pier walls rigidly connected to the superstructure may be modeled as a wall with:

- width = true wall length
- thickness = true thickness/cos(skew angle)
- skew angle = angle of support line from a perpendicular to the bridge centerline

The following applies:

1. Foundation Fixity. Columns or pier walls with structural hinges detailed at the bottom shall be considered pinned for rotation in the direction provided by the hinge at the hinge location. Columns or pier walls fixed to the foundation of a spread footing or pile cap shall be considered rigidly supported at a distance L below the top of the footing as appropriate for the analysis. The following is recommended but not required practice.

   Piers rigidly connected to the foundation may be considered fixed at a depth L below the top of the footing where:

$$L = \frac{L_f}{\left[4\left(L_f / L_c\right) + 6\left(I_f / I_c\right)\right]}$$

   where:

   L_c = column clear length
   L_f = footing length from CL column to edge of footing
   I_f = footing moment of inertia = $BH^3/12$
   (where B = footing width and H = footing depth)
   I_c = column moment of inertia

Column shafts shall be assumed fixed at L_s below the ground surface where:

$$L_s = 1.8\,(E_c / n_h)^{1/5}$$

L_s units are as obtained when consistent units are used and n_h is from the table below with medium soil as the default unless plans indicate another soil type.

	n_h (lb/in^3) (for static loading)		
	Loose	Medium	Dense
Above water table	30	80	200
Below water table	20	60	120

2. Sidewalk Loads. Bridges with sidewalks shall be rated based on the sidewalk carrying pedestrian live loads and stray wheel loads per AASHTO *Standard Specifications*. Sidewalk dead load is included and distributed across the entire bridge for box girders and slabs, to the nearest tub girder for tub girder bridges, and equally to the two nearest girders for I-girder and other open section bridges.

3. Barrier Rail, Curb and Median Loads. The loads from barrier rail and curb at the edge of the bridge shall be equally distributed across the bridge for box girders and slabs, to the exterior tub girder for tub girder bridges, and equally to the two outside girders for I-girder and other open section bridges. Median loads shall be distributed to the entire bridge for box girders and slabs, and equally to two girders on either side of the median for tub girder, I-girder and other open section bridges. When loads so distributed overlap, a uniform load across the bridge may be used.

4. Lost Forms and Stay-in-Place Metal Forms. Unless the plans indicate otherwise, box girders shall have a lost deck form weight of 12 psf. Decks with stay-in-place metal forms shall have a weight 12 psf greater than the nominal deck thickness as a load due to form weight and corrugation fill.

28.3.1.11 Deliverables

NDOT will provide the spreadsheet LoadRatingSummarySheets.xls to be completed and returned as a deliverable with the appropriate file name as specified below.

28.3.1.11.1 *Printed Deliverables (for Each Bridge Rated)*

1. One copy of the “Supplemental Maintenance Report” (part of the LoadRatingSummarySheets.xls) completed and with seal and signature of a Nevada licensed civil or structural engineer at the right of the Comments Block.

2. One copy of the “Load Rating Summary Sheet” for the girder or culvert as applicable (part of the LoadRatingSummarySheets.xls) completed. A similar sheet, derived from these, is required as a “Load Rating Summary Sheet” for each load rating when other methods are used for the rating.

3. One copy of manual calculations.

4. For Rating by BRASS-GIRDER: A print of the data echo and rating factor summary from the BRASS-GIRDER output file, to be compiled by cut and paste from the output file. Do not provide a print of the entire output file.

5. For Rating by PTRater: A print of the data and results of the worksheet “Main” in PTRater for each span rated and a sufficient excerpt of WinBDS output to document the input bridge properties and loads. Print WinBDS output in portrait mode using Courier 6 pt or Courier New 6 pt font with ¾-in margins.

6. For Rating by BRASS-CULVERT: A print of the summary of culvert geometry and loads (typically p. 13) and output rating factors (p. 19 for 1 cell; p. 22 for 2 cells, etc.) from the BRASS-CULVERT output to be compiled by cut and paste from the output file. Do not provide a print of the entire output file.

28.3.1.11.2 *Electronic Deliverables*

For the following specification of electronic deliverable, the bridgename is the bridge number without “ – ” (examples are B1558 for Bridge B-1558 or I1228N for I-1228N).

Provide a CD (standard density) for each group of bridges rated with bridge numbers in groups of 10 with the last digit 0 to 9 in sequence being a group (e.g., 500 to 509 is a group but 501 to 510 is not). For each structure rated, create on the appropriate CD a folder named bridgename, containing the following files and subfolders:

1. The spreadsheet LoadRatingSummarySheets.xls with sheets for the Supplemental Maintenance Report and Load Rating Summary Sheet completed and the file named bridgenameLRS.xls. Note that the condition rating is the NBI rating (0 to 9) from the last inspection; leave blank for initial rating of unconstructed bridges.

2. Custom spreadsheets as .xls Excel spreadsheet files; manual calculations scanned into electronic format and provided as .pdf or .jpg or .tif files; and text files as .txt files as used for the rating.

3. For Rating by BRASS-GIRDER: The BRASS-GIRDER input file named bridgename.dat and the BRASS-GIRDER output file named bridgename.out placed in a subfolder named BrassGirder.

4. For Rating by PTRater: The BD2 or WinBDS input file named bridgename.bds and the output file named bridgename.out in a subfolder named BD2. Additionally for each span rated, the PTRater file named PTRate“bridgename”sN.xls, where N is the span number (e.g., PTRateB1558Ns2.xls for span 2 of bridge B-1558N).

5. For rating of culverts by BRASS-CULVERT, the BRASS-CULVERT input file with file extension .cus with the name bridgename.cus and the BRASS-CULVERT output file with file extension .out named bridgename.out in a subfolder named BrassCulvert.

6. For rating of curved steel bridges, input and output files from the MDX program with the name bridgename.xxx for the input file and bridgename.out for the output file where .xxx is the native file extension of the rating program for input files. Place in a subfolder named MDX.

7. For arches and other non-standard bridges, input and output files for the computer programs used with files named in an organized manner to facilitate review of the input

data, review of the output results, and reanalysis of the bridge using the programs. Use a subfolder for each program used.

28.3.2 Bridge Posting

28.3.2.1 Weight Restriction

For bridges on the NHS, a bridge will be posted if its operating rating is below HS-20. For all other bridges, posting will be required if the operating rating is below H-15. In both cases, the posted load for signing shall be the inventory rating calculated for the bridge under evaluation. See Section 28.3.1.1 for the definitions of operating rating and inventory rating.

28.3.2.2 Size Restriction

It may be necessary to post a bridge because of vertical clearance restrictions or bridge width restrictions. The Traffic Engineering Section is responsible for selecting and installing any signs for bridge posting due to vehicular size restrictions, which will be based on the *Manual on Uniform Traffic Control Devices*. This includes any advance warning signs to notify approaching vehicles of the restrictions.

28.3.3 Over-Dimensional Permits (Superloads)

28.3.3.1 General

Very heavy and large transporter vehicles are allowed to travel over the State's highways by an over-dimensional permit. These permits are issued by the NDOT Load Rating/Over-Dimensional/Over-Weight Permitting Squad. Nevada allows double-wide vehicles to operate with these permits carrying double the load allowed for an 8-ft wide vehicle.

Nevada uses the same single-trip permit methodology as the States of California and Arizona. This methodology requires the integration of bridge design, bridge rating and truck weight regulation. Bridges are load rated for the Caltrans P5, P7, P9, P11 and P13 permit vehicles as permit loads, and a database of these ratings is maintained by Structures Division. A transporter truck is classified by its axle weights and axle spacing as a loading intensity and number of axles. The highest loading intensity allowed is called "Purple Loading." Bridges on a proposed route are checked for adequacy based on the load rating for a P truck with the same number of axles as the transporter. Additional load is allowed for vehicles with extra width and more than two wheel lines per axle. A single-wide transporter at Purple Loading produces stresses in a bridge up to those produced by a P-truck with the same number of axles. Similarly, a double-wide transporter with Purple Loading is equivalent to up to two P trucks side by side, each with the same number of axles as the transporter. Bridges listed as having P13 permit truck design are expected to carry a double-wide transporter equivalent to two P13 trucks side by side.

This methodology allows using load ratings on file for the P-trucks to quickly and accurately determine bridge adequacy for transporters. The Structures Division usually checks the adequacy of the bridges on the route of transporters over 250,000 lbs GVW in addition to the checks performed by the Load Rating/Over-Dimensional/Over-Weight Permitting Squad. Details of the single-trip permit methodology are provided in the following Sections.

28.3.3.2 Permit Limits

An over-dimensional permit is for a non-divisible load only, load intensity limit, GVW as the route will allow (bridges must be adequate), no length limit and width as the route will allow. The following applies:

1. NRS Tire Load Limits.

   Max tire load = 675 lbs/in x Tire Width for any steering axle
   = 550 lbs/in x Tire Width for any fixed axle

2. Truck Loading Classification and Maximum Load Intensity. Truck is classified as Purple, Green or Orange Loading as follows:

   a. Purple Loading.

      Single Axle: (axle-weight)/Bonus Factor ≤ 28,000 lbs

      Group of Axles: Sum of [(axle-weight)/Bonus Factor] ≤ 1.5 x 700(L + 40) lbs, where the group of axles considered are ≤ 18 ft center-to-center, first to last, and L = center-to-center distance of first to last axle in group considered, and tandem axles with spacing < 3.5 ft is considered a single axle, and Bonus Factors are tabulated for number of wheel lines and width.

   b. Green Loading.

      Max. Single-Axle Weight = 0.86 x Purple Load
      Max. Group-of-Axles Weight = 0.86 x Purple Load

   c. Orange Loading (seldom used).

      Max. Single-Axle Weight = 0.66 x Purple Load
      Max. Group-of-Axles Weight = 0.66 x Purple Load

   The maximum load intensity allowed is Purple Loading.

   Bonus Factors for axle width and number of wheel lines are as follows (all dimensions are in feet):

Out-to-Out Width of Truck at Tires (W, ft)	2 Tires/Axle	4 or 6 Tires/Axle	8 Tires/Axle	Dollys with 8 Tires in 2 to 4 Tires Dollys/Axle
W < 7	1.00	1.00	—	—
7 ≤ W < 10	1.00	1.00	1.15	—
10 ≤ W ≤ 14	1.00	1.10	1.25	—
W ≥ 13*	—	—	—	Lesser of (2) or (2 × intW/20) or (2 × X_{eff}/7)

* *For 13 ≤ W ≤ 15, minimum Dolly clearance = 2 ft. For W > 15, minimum Dolly clearance = 3 ft.*

X_{eff} = Minimum of (Dolly width) or (W – 2 × Dolly Width + 3)

Note: Dollys or special suspension required for axle width greater than 14 ft.

Special Bonus Factors for large axle spacing: Up to two tridem axles, with axle widths less than 10 ft, have a variable Bonus Factor = 60,000 lbs/(total axle weight of tridem in lbs), but not more than 1.15, provided that the following is met:

- Spacing from center axle of tridem to any axle not in tridem ≥ 18 ft.
- Spacing from any axle in tridem to any axle in another bonused tridem ≥ 24 ft.

Note: The Bonus Factor is reduced from 1.15 to limit the allowed axle weight of the tridem group to 60,000 lbs.

28.3.3.3 Bridge Adequacy

Bridges are rated for single-trip permit trucks based on the operating ratings for the Caltrans P5, P7, P9, P11 and P13 trucks as computed with the multi-lane live load distribution factor. The bridge rating is expressed as a five-letter color code. The letters from left to right are the rating for 5-axle, 7-axle, 9-axle, 11-axle and 13-axle permit trucks. The letters of the color code are:

Operating Rating	Code	Associated Loading Capacity
≥ 1.00	P	Purple
≥ 0.86	G	Green
≥ 0.66	O	Orange
< 0.66	R	Restricted

A typical color code would be PPGGO, meaning:

- P (Purple) capacity for 5-axle trucks
- P (Purple) capacity for 7-axle trucks
- G (Green) capacity for 9-axle trucks
- G (Green) capacity for 11-axle trucks
- O (Orange) capacity for 13-axle trucks

The bridge color code rating is for double-wide transporter trucks. Bridges designed for two P13 trucks side-by-side as a permit load (or overload in the AASHTO *Standard Specifications*) have a PPPPP rating by design. The P13 permit truck design using the multi-lane live load distribution factor is a slightly conservative, but standard method, used to produce the desired PPPPP rating.

The following applies:

- A bridge is adequate to carry a truck of Purple Loading with n axles without restrictions, if the permit rating for the bridge is "P" for a truck with n axles.

- A bridge is adequate to carry a truck of Green Loading with n axles without restrictions, if the permit rating for the bridge is "G" for a truck with n axles.

- A bridge is adequate to carry a truck of Orange Loading with n axles without restrictions, if the permit rating for the bridge is "O" for a truck with n axles.

- A bridge is not adequate to carry a truck of any Loading with n axles without special analysis, if the permit rating for the bridge is “R” for a truck with n axles.

28.3.3.4 Bridge Capacity Increases

Bridge capacities may be increased by restrictions on vehicular speed and location as follows:

1. The rating for a bridge is considered one classification higher than that from the load rating if the vehicle is restricted as follows: Either a 5-mph crossing speed, or the vehicle must cross in the center of a bridge with 10 ft clearance to the bridge railing on each side.

2. The rating for a bridge is considered two classifications higher than that from the load rating if the vehicle is restricted as follows: Both a 5-mph crossing speed, and the vehicle must cross in the center of a bridge with 10 ft clearance to the bridge railing on each side.

Bridge capacities may be increased for single-wide vehicles as follows: The rating for a bridge is one classification higher than that from the load rating for single-wide trucks with bonus factors no more than less than 1.10. *Note: This is approximately the no-bonus exception of the Caltrans procedures.*

Appendix 28A

NATIONAL BRIDGE INSPECTION STANDARDS

For convenience, Appendix 28A reproduces 23 CFR Part 650 Subpart C.

NATIONAL BRIDGE INSPECTION STANDARDS (23CFR, Part 650, Subpart C)

Title 23: Highways
PART 650 —BRIDGES, STRUCTURES, AND HYDRAULICS

Subpart C – National Bridge Inspection Standards

Source: 69 FR 74436, Dec. 14, 2004, unless otherwise noted.

§ 650.301 Purpose.

This subpart sets the national standards for the proper safety inspection and evaluation of all highway bridges in accordance with 23 U.S.C. 151.

§ 650.303 Applicability.

The National Bridge Inspection Standards (NBIS) in this subpart apply to all structures defined as highway bridges located on all public roads.

§650.305 Definitions.

Terms used in this subpart are defined as follows:

American Association of State Highway and Transportation Officials (AASHTO) Manual. "Manual for Condition Evaluation of Bridges," second edition, published by the American Association of State Highway and Transportation Officials (incorporated by reference, see §650.317).

Bridge. 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 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.

Bridge inspection experience. Active participation in bridge inspections in accordance with the NBIS, in either a field inspection, supervisory, or management role. A combination of bridge design, bridge maintenance, bridge construction and bridge inspection experience, with the predominant amount in bridge inspection, is acceptable.

Bridge inspection refresher training. The National Highway Institute "Bridge Inspection Refresher Training Course"[1] or other State, local, or federally developed instruction aimed to improve quality of inspections, introduce new techniques, and maintain the consistency of the inspection program.

Bridge Inspector's Reference Manual (BIRM). A comprehensive FHWA manual on programs, procedures and techniques for inspecting and evaluating a variety of in-service highway bridges. This manual may be purchased from the U.S. Government Printing Office, Washington, DC 20402 and from National Technical Information Service, Springfield, Virginia 22161, and is available at the following URL: *http://www.fhwa.dot.gov/bridge/bripub.htm.*

Complex bridge. Movable, suspension, cable stayed, and other bridges with unusual characteristics.

Comprehensive bridge inspection training. Training that covers all aspects of bridge inspection and enables inspectors to relate conditions observed on a bridge to established criteria (see the Bridge Inspector's Reference Manual for the recommended material to be covered in a comprehensive training course).

Critical finding. A structural or safety related deficiency that requires immediate follow-up inspection or action.

Damage inspection. This is an unscheduled inspection to assess structural damage resulting from environmental factors or human actions.

Fracture critical member (FCM). A steel member in tension, or with a tension element, whose failure would probably cause a portion of or the entire bridge to collapse.

Fracture critical member inspection. A hands-on inspection of a fracture critical member or member components that may include visual and other nondestructive evaluation.

[1] The National Highway Institute training may be found at the following URL: *http://www.nhi.fhwa.dot.gov./*

Hands-on. Inspection within arms length of the component. Inspection uses visual techniques that may be supplemented by nondestructive testing.

Highway. The term "highway" is defined in 23 U.S.C. 101(a)(11).

In-depth inspection. A close-up, inspection of one or more members above or below the water level to identify any deficiencies not readily detectable using routine inspection procedures; hands-on inspection may be necessary at some locations.

Initial inspection. The first inspection of a bridge as it becomes a part of the bridge file to provide all Structure Inventory and Appraisal (SI&A) data and other relevant data and to determine baseline structural conditions.

Legal load. The maximum legal load for each vehicle configuration permitted by law for the State in which the bridge is located.

Load rating. The determination of the live load carrying capacity of a bridge using bridge plans and supplemented by information gathered from a field inspection.

National Institute for Certification in Engineering Technologies (NICET). The NICET provides nationally applicable voluntary certification programs covering several broad engineering technology fields and a number of specialized subfields. For information on the NICET program certification contact: National Institute for Certification in Engineering Technologies, 1420 King Street, Alexandria, VA 22314-2794.

Operating rating. The maximum permissible live load to which the structure may be subjected for the load configuration used in the rating.

Professional engineer (PE). An individual, who has fulfilled education and experience requirements and passed rigorous exams that, under State licensure laws, permits them to offer engineering services directly to the public. Engineering licensure laws vary from State to State, but, in general, to become a PE an individual must be a graduate of an engineering program accredited by the Accreditation Board for Engineering and Technology, pass the Fundamentals of Engineering exam, gain four years of experience working under a PE, and pass the Principles of Practice of Engineering exam.

Program manager. The individual in charge of the program, that has been assigned or delegated the duties and responsibilities for bridge inspection, reporting, and inventory. The program manager provides overall leadership and is available to inspection team leaders to provide guidance.

Public road. The term "public road" is defined in 23 U.S.C. 101(a)(27).

Quality assurance (QA). 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.

Quality control (QC). Procedures that are intended to maintain the quality of a bridge inspections and load rating at or above a specified level.

Routine inspection. Regularly scheduled inspection consisting of observation and/or measurements needed to determine the physical and functional condition of the bridge, to identify any changes from initial or previously recorded conditions, and to ensure that the structure continues to satisfy present service requirements.

Routine permit load. A live load, which has a gross weight, axle weight or distance between axles not conforming with State statutes for legally configured vehicles, authorized for unlimited trips over an extended period of time to move alongside other heavy vehicles on a regular basis.

Scour. Erosion of streambed or bank material due to flowing water; often considered as being localized around piers and abutments of bridges.

Scour critical bridge. A bridge with a foundation element that has been determined to be unstable for the observed or evaluated scour condition.

Special inspection. An inspection scheduled at the discretion of the bridge owner, used to monitor a particular known or suspected deficiency.

Team leader. Individual in charge of an inspection team responsible for planning, preparing, and performing field inspection of the bridge.

Underwater diver bridge inspection training. Training that covers all aspects of underwater bridge inspection and enables inspectors to relate the conditions of underwater bridge elements to established criteria (see the Bridge Inspector's Reference Manual section on underwater inspection for the recommended material to be covered in an underwater diver bridge inspection training course).

Underwater inspection. Inspection of the underwater portion of a bridge substructure and the surrounding channel, which cannot be inspected visually at low water by wading or probing, generally requiring diving or other appropriate techniques.

§ 650.307 Bridge inspection organization.

(a) Each State transportation department must inspect, or cause to be inspected, all highway bridges located on public roads that are fully or partially located within the State's boundaries, except for bridges that are owned by Federal agencies.

(b) Federal agencies must inspect, or cause to be inspected, all highway bridges located on public roads that are fully or partially located within the respective agency responsibility or jurisdiction.

(c) Each State transportation department or Federal agency must include a bridge inspection organization that is responsible for the following:

(1) Statewide or Federal agency wide bridge inspection policies and procedures, quality assurance and quality control, and preparation and maintenance of a bridge inventory.

(2) Bridge inspections, reports, load ratings and other requirements of these standards.

(d) Functions identified in paragraphs (c)(1) and (2) of this section may be delegated, but such delegation does not relieve the State transportation department or Federal agency of any of its responsibilities under this subpart.

(e) The State transportation department or Federal agency bridge inspection organization must have a program manager with the qualifications defined in §650.309(a), who has been delegated responsibility for paragraphs (c)(1) and (2) of this section.

§ 650.309 Qualifications of personnel.

(a) A program manager must, at a minimum:

(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.

(b) There are five ways to qualify as a team leader. A team leader must, at a minimum:

(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.

(c) The individual charged with the overall responsibility for load rating bridges must be a registered professional engineer.

(d) An underwater bridge inspection diver must complete an FHWA approved comprehensive bridge inspection training course or other FHWA approved underwater diver bridge inspection training course.

§ 650.311 Inspection frequency.

(a) *Routine inspections.* (1) Inspect each bridge at regular intervals not to exceed twenty-four months.

(2) Certain bridges require inspection at less than twenty-four-month intervals. Establish criteria to determine the level and frequency to which these bridges are inspected considering such factors as age, traffic characteristics, and known deficiencies.

(3) Certain bridges may be inspected at greater than twenty-four month intervals, not to exceed forty-eight-months, with written FHWA approval. This may be appropriate when past inspection findings and analysis justifies the increased inspection interval.

(b) *Underwater inspections.* (1) Inspect underwater structural elements at regular intervals not to exceed sixty months.

(2) Certain underwater structural elements require inspection at less than sixty-month intervals. Establish criteria to determine the level and frequency to which these members are inspected considering such factors as construction material, environment, age, scour characteristics, condition rating from past inspections and known deficiencies.

(3) Certain underwater structural elements may be inspected at greater than sixty-month intervals, not to exceed seventy-two months, with written FHWA approval. This may be appropriate when past inspection findings and analysis justifies the increased inspection interval.

(c) *Fracture critical member (FCM) inspections.* (1) Inspect FCMs at intervals not to exceed twenty-four months.

(2) Certain FCMs require inspection at less than twenty-four-month intervals. Establish criteria to determine the level and frequency to which these members are inspected considering such factors as age, traffic characteristics, and known deficiencies.

(d) Damage, in-depth, and special inspections. Establish criteria to determine the level and frequency of these inspections.

§ 650.313 Inspection procedures.

(a) Inspect each bridge in accordance with the inspection procedures in the AASHTO Manual (incorporated by reference, *see* §650.317).

(b) Provide at least one team leader, who meets the minimum qualifications stated in §650.309, at the bridge at all times during each initial, routine, in-depth, fracture critical member and underwater inspection.

(c) Rate each bridge as to its safe load-carrying capacity in accordance with the AASHTO Manual (incorporated by reference, *see* §650.317). Post or restrict the bridge in accordance with the AASHTO Manual or in accordance with State law, when the maximum unrestricted legal loads or State routine permit loads exceed that allowed under the operating rating or equivalent rating factor.

(d) Prepare bridge files as described in the AASHTO Manual (incorporated by reference, *see* §650.317). Maintain reports on the results of bridge inspections together with notations of any action taken to address the findings of such inspections. Maintain relevant maintenance and inspection data to allow assessment of current bridge condition. Record the findings and results of bridge inspections on standard State or Federal agency forms.

(e) Identify bridges with FCMs, bridges requiring underwater inspection, and bridges that are scour critical.

(1) Bridges with fracture critical members. In the inspection records, identify the location of FCMs and describe the FCM inspection frequency and procedures. Inspect FCMs according to these procedures.

(2) Bridges requiring underwater inspections. Identify the location of underwater elements and include a description of the underwater elements, the inspection frequency and the procedures in the inspection records for each bridge requiring underwater inspection. Inspect those elements requiring underwater inspections according to these procedures.

(3) Bridges that are scour critical. Prepare a plan of action to monitor known and potential deficiencies and to address critical findings. Monitor bridges that are scour critical in accordance with the plan.

(f) *Complex bridges.* Identify specialized inspection procedures, and additional inspector training and experience required to inspect complex bridges. Inspect complex bridges according to those procedures.

(g) *Quality control and quality assurance.* Assure systematic quality control (QC) and quality assurance (QA) procedures are used to maintain a high degree of accuracy and consistency in the inspection program. Include periodic field review of inspection teams, periodic bridge inspection refresher training for program managers and team leaders, and independent review of inspection reports and computations.

(h) *Follow-up on critical findings.* Establish a statewide or Federal agency wide procedure to assure that critical findings are addressed in a timely manner. Periodically notify the FHWA of the actions taken to resolve or monitor critical findings.

§ 650.315 Inventory.

(a) Each State or Federal agency must prepare and maintain an inventory of all bridges subject to the NBIS. Certain Structure Inventory and Appraisal (SI&A) data must be collected and retained by the State or Federal agency for collection by the FHWA as requested. A tabulation of this data is contained in the SI&A sheet distributed by the FHWA as part of the "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges," (December 1995) together with subsequent interim changes or the most recent version. Report the data using FHWA established procedures as outlined in the "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges."

(b) For routine, in-depth, fracture critical member, underwater, damage and special inspections enter the SI&A data into the State or Federal agency inventory within 90 days of the date of inspection for State or Federal agency bridges and within 180 days of the date of inspection for all other bridges.

(c) For existing bridge modifications that alter previously recorded data and for new bridges, enter the SI&A data into the State or Federal agency inventory within 90 days after the completion of the work for State or Federal agency bridges and within 180 days after the completion of the work for all other bridges.

(d) For changes in load restriction or closure status, enter the SI&A data into the State or Federal agency inventory within 90 days after the change in status of the structure for State or Federal agency bridges and within 180 days after the change in status of the structure for all other bridges.

§ 650.317 Reference manuals.

(a) The materials listed in this subpart are incorporated by reference in the corresponding sections noted. These incorporations by reference were approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. These materials are incorporated as they exist on the date of the approval, and notice of any change in these documents will be published in the Federal Register. The materials are available for purchase at the address listed below, and are available for inspection at the National Archives and Records Administration (NARA). These materials may also be reviewed at the Department of Transportation Library, 400 Seventh Street, SW., Washington, DC, in Room 2200. For information on the availability of these materials at NARA call (202) 741–6030, or go to the following URL:*http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.* In the event there is a conflict between the standards in this subpart and any of these materials, the standards in this subpart will apply.

(b) The following materials are available for purchase from the American Association of State Highway and Transportation Officials, Suite 249, 444 N. Capitol Street, NW., Washington, DC 20001. The materials may also be ordered via the AASHTO bookstore located at the following URL: *http://www.aashto.org/aashto/home.nsf/FrontPage.*

(1) The Manual for Condition Evaluation of Bridges, 1994, second edition, as amended by the 1995, 1996, 1998, and 2000 interim revisions, AASHTO, incorporation by reference approved for §§650.305 and 650.313.

(2) 2001 Interim Revision to the Manual for Condition Evaluation of Bridges, AASHTO, incorporation by reference approved for §§650.305 and 650.313.

(3) 2003 Interim Revision to the Manual for Condition Evaluation of Bridges, AASHTO, incorporation by reference approved for §§650.305 and 650.313.