

JANUARY 2013 EDITION



Bridge Inspection Program Manual



Oregon
Department
of Transportation

FOREWORD

It is estimated that over 30% of the highway bridges, in the United States today are either structurally deficient or functionally obsolete. The bridges in the State of Oregon also follow this national trend. The urgency of this problem has been acknowledged at official levels, and more public funds are being set aside to address bridge inspection, rehabilitations and replacements needs. However, there remains a very definite need for bridge engineers that are well versed in the art of performing and reporting the condition assessment on the structures entrusted to our care. This ensures that the best bridge management decisions can be made with a very high degree of certainty. To some, performing a condition assessment on a bridge might be quite clear and straightforward. In fact, the condition assessment process can be a rather complex undertaking. This is because, over time, each bridge in the inventory has been required to support a very complicated history of load combinations and exposure to many different environments. Given the wide variety of bridge types, materials, workmanship, and traffic, each bridge is generally quite unique due to the multiple variables involved. Moreover, more than 25% of the bridge foundations details are unknown, as there are no plans that can be relied on for as-built structural details.

The Oregon Department of Transportation (ODOT) Bridge Inspection Manual is the result of collecting all of the bridge inspection practices and procedures that have been developed from the very start of the Bridge Inspection Program. Most of these practices and procedures were originally developed as training aids, for courses taught by and for the ODOT Region Bridge Inspectors. This manual represents over 30 years of effort to bring consistency to our bridge condition assessment techniques and reporting the results of the federally required inspections.

This manual will assist us in improving the management of our bridges by defining elements requiring maintenance, repair, rehabilitation, or replacement. This will help place our resources into programs that can extend the life of our bridges until replacement is economically feasible.

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Revisions

- Rev. 1 Added Late Inspection section in Chapter 7.3.2.
- Rev. 2 Updated Oregon's NBI Coding Guide definitions and element lists (6.1.1)
 - Spelling correction (6.1.3)
 - Updated Data Validation Check of Submitted Inspection Reports (7.3.2)
 - Updated Routine Bridge Inspection Introduction (10.1.1)
 - Updated NBI Routine Bridge Inspection Frequency (10.1.2)
 - Updated Other Bridge Inspection Frequency Parameters (10.1.3)
 - Removed > 2 year intervals from Extended Frequencies (10.1.4)
 - Added Gusset Plate Inspection file naming convention (10.2.1)
 - Changed to match formatting of Inspection of Concrete Decks (11.2)
 - Miscellaneous spelling and formatting changes (Ch. 12)
 - Updated Fatigue Prone Detail Inspection Frequency Criteria (14.5.4)
 - Added UT criteria for Pin & Hangers (14.7.5.1)
 - Updated Timber Member Inspection Frequency section (15.4)
 - Updated Timber Bridge Inspection Report section (15.5)
 - Miscellaneous formatting changes (16.1)
 - Updated Underwater Bridge Inspection Frequencies (16.3)

Updated Cable Suspended Bridge list (17.6)
Updated inspection frequency criteria for Moveable Bridges (18.6)
Added Cross Channel Profile Frequency guidelines (20.2.1)

- Rev. 3 Updated Bridge Inspection Program Manager certification requirements (5.1.1).
Updated Bridge Inspection Team Leader certification requirements (5.1.2).
Updated Bridge Inspection Proficiency Exam requirements (5.2.1)
Minor rewording (5.1.7)
- Rev. 4 Updated Chapter 8 to meet current AASHTO definitions and FHWA guidelines.
Added Suspension Bridge and Cable Stayed Bridge item inspection lists (17.6)
Removed Smith River (Gardiner) Bridge from list (18.6)
Added note to Coquille River (Bullards) Bridge (18.6)
Added inspection procedures item (18.6)

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CHAPTER 1: INTRODUCTION & PURPOSE OF THE MANUAL

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CHAPTER 1:

INTRODUCTION AND PURPOSE OF THIS MANUAL

1.1—INTRODUCTION

This Manual was developed to assist the Bridge Inspectors and Bridge Owners who work and/or reside in the State of Oregon. It contains ODOT Bridge Inspection Business Practices that meet the National Bridge Inspection Standards (NBIS). The manual is divided into a number of sections, each representing a distinct phase of the ODOT Administered Bridge Inspection Program. Successful management of any program must contain clearly defined guidance as to who must do what, where, when, and how the work must be completed. However, in this case these assigned tasks are exceedingly serious due to the potential outcomes.

Following the collapse of several structures that resulted in a significant number of deaths, the United States Congress added provisions to the Federal Aid Highway Act of 1968 which required the Secretary of Transportation to establish a National Bridge Inspection Standard (NBIS) and to develop and formalize a nationwide bridge inspection program. The NBIS was to be a compilation of Federal Regulations that established requirements for:

- Qualification of Bridge Inspection Personnel
- Bridge Inspection Procedures
- Frequency the Bridge Inspections are to be performed
- Content of the Inspection Reports
- Preparation and Maintenance of a State Bridge Inventory

Since then, the bridge inspection program has been continuously modified and improved. It is now a comprehensive set of procedures that requires training and management attention to help monitor and document the condition of the thousands of bridges that are located throughout the State of Oregon. Even though the NBIS requirements only pertain to those public bridges that are 20 feet and longer that carry vehicular traffic, ODOT elected to inspect all structures on the State Highway System that were 6 feet and longer, as well as, those structures that would have a significant impact on the traveling general public, if they were to fail.

CFR 650.307(a) states: "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.

1.2—GOALS/OBJECTIVES AND PURPOSE OF THIS MANUAL

The overriding goal of this document is to present a collection of instructions and explanations for the safety inspection of in-service bridge structures in the State of Oregon. To allow the user, to locate, and understand, the most pertinent items from a complex series of publications. Those ideas have been simplified, condensed, and organized in a manner that allows the user to locate them easily.

The specific objectives of this document are outlined in five simple statements in the following paragraph:

- To assemble in one document the primary instructions needed by bridge inspectors, performing safety inspections of in-service bridge structures, in the State of Oregon, that is supplementary to the various FHWA publications.
- To provide a document that may be used as a reference manual for a bridge inspection refresher training course that pertains to the safety inspections of in-service bridge structures, in the State of Oregon, that is supplementary to the 2 week comprehensive training sponsored by FHWA.
- To provide a document which is aimed towards improving the quality of inspections, introduce and document bridge inspection techniques or help to maintain the consistency of the bridge inspection program. It is anticipated that this manual will help promote uniformity and consistency in inspection from inspector to inspector, from jurisdiction to jurisdiction, and from year to year.
- To provide guidance and advice for the most difficult inspection items, condition ratings and appraisals of structural components, using examples and illustrations pertinent to Oregon's bridges.
- To increase the understanding by local and other governmental entities and their inspectors of the overall ODOT Bridge Inspection Program.

1.3—AUTHORITY FOR CREATING THIS MANUAL

The federal inspection reporting requirements for structures are contained in the National Bridge Inspection Standards.¹ The NBI Standards are applied to all bridges on public roads.

CFR 650.307(c) – Each State transportation department must include a bridge inspection organization that is responsible for the following:

- Statewide bridge inspection policies and procedures, quality assurance and quality control, and preparation and maintenance of a bridge inventory.

The above required information is contained within this manual.

¹ NBIS - Chapter 23 - Code of Federal Regulations, Part 650, Subpart C)

**CHAPTER 2: OVERVIEW OF THE BRIDGE INSPECTION
PROGRAM IN THE STATE OF OREGON**

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CHAPTER 2:

OVERVIEW OF THE BRIDGE INSPECTION PROGRAM IN THE STATE OF OREGON

2.1—FULFILLING OUR LEGAL RESPONSIBILITIES

2.1.1—Bridge Inspection Program Requirements as Specified in the NBIS

The National Bridge Inspection Standards (NBIS) are published in the Code of Federal Regulations, 23 CFR 650, subpart C. The NBIS sets the national standard for the proper safety inspection and evaluation of bridges and apply to all structures defined as highway bridges located on all public roads.

Title 23, Code of Federal Regulations (CFR) – Part 650 – Bridges, Structures, and Hydraulics – Subpart C – National Bridge Inspection Standards (NBIS)²

- The Intent of the NBIS is to locate, evaluate, and act on existing bridge deficiencies to ensure that safety of the traveling public.
- The Purpose of the NBIS is to set the national standards for the proper inspection and evaluation of all highway bridges in accordance with 23 U.S.C 151.
- The Applicability of the NBIS applies to all structures defined as a highway bridge, carries vehicular traffic, and is located on a public road as defined in 23 U.S.C. 101(a)(11).
- Benefits of an Inspection Program include:
 - Increased Public Safety
 - Ability to Effectively Manage Infrastructure Assets
 - Avoiding Non-Compliance, which could result in withholding of federal funds.

2.1.2—Fulfilling Our Legal Responsibilities

In laymen's terms, the Code of Federal Regulations³ directs each State to perform the following:

- Inspect all bridges that carry vehicular traffic and are located on a public road. In the State of Oregon, the bridge inventory includes:
 1. State Inventory
 - Structures that span 6 feet and longer
 - Other structures that could cause an immediate endangerment or impact to the highway user if they were to fail.
 2. Local or Other Public Agencies
 - Structures that span 20 feet or longer.
- Support a bridge inspection organization that is responsible for:
 - Establishing statewide bridge inspection policies and procedures;
 - Maintaining quality assurance and quality control of the bridge inspection program;
 - Preparing and maintaining the bridge inventory for the state.
 - Assuring that the required bridge inspections, reports, load ratings and other requirements are being performed.
- Designate a bridge inspection program manager who has been delegated the responsibilities for the State bridge inspection program.
- Inspect each bridge as thoroughly as necessary to clearly establish its condition and to insure its continued safe operation in accordance with the National Bridge Inspection Standards.
- Rate each bridge as to its safe load carrying capacity.
- When the maximum unrestricted legal loads or State routine permit loads exceed that allowed under the operating rating, the bridge will be posted or restricted in accordance with State law.
- Prepare and maintain bridge files that contain:
 - Reports on the results of bridge inspections;

² Accessed at: http://www.access.gpo.gov/nara/cfr/waisidx_03/23cfr650_03.html

³ CFR Part 650 – Bridges, Structures, and Hydraulics

- Notations of any action taken to address the findings of such inspections; and
- Relevant maintenance and inspection data allowing assessment of current bridge condition.
- Prepare and maintain a bridge inventory that contains certain Structure Inventory and Appraisal (SI&A) data that must be collected and retained by the State for submittal to FHWA.
- Enter the SI&A data for routine, in-depth, fracture critical member, underwater, damage, and special inspections into the State inventory within 90 days of inspection for State bridges and within 180 days of inspection for all other bridges.
- Identify specialized inspection procedures, and additional inspector training and experience required to inspect complex bridges according to those procedures.
- 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.

A bridge inspection report is considered to be a legal document. The bridge inspectors are directed to keep descriptions concise, specific, detailed, and quantitative (where possible) and complete. The completed report must be signed by the designated bridge inspection team leader, who has the responsibility of assuring that the inspection was performed in accordance with NBI Standards.

Original inspection notes should not be altered without consultation with the inspector who wrote the notes. A bridge inspection should be performed in accordance with NBIS, unless specifically stated otherwise in the report.

The risks of being sued continue to grow. What's more frightening is that in many cases, you could be personally held liable. Recently, courts are finding engineers and inspectors liable for failure to carry out both their discretionary duties as well as their mandatory ones. First there must be a legal duty before you can be liable. As professional staff, duties are defined by the laws of your state. Legally, the law holds you to the standard of care expected of professional engineers in your community.

The "Duty of a Professional", as described in the standard form of Jury Instruction BAJI 6.37:

Duty of a Professional

"In performing professional services, an [engineer] has the duty to have that degree of learning and skill ordinarily possessed by reputable [engineers], practicing in the same or similar locality under similar circumstances. It is their further duty to use the care and skill ordinarily used in like cases by reputable members of their profession practicing in the same or similar locality under similar circumstances, and to use reasonable diligence and their best judgment in the exercise of their professional skill and the applications of their learning, in an effort to accomplish the purpose for which they were employed. Failure to fulfill any such duty is negligence."

Note the following three important points in BAJI 6.37:

- "care and skill ordinarily used by reputable members"
- "possessed by reputable [engineers] practicing in the same or similar locality"
- "under similar circumstances"

2.1.3—Bottom Line: Why Do We Inspect Bridges?

There is one absolute fact of life: "All things deteriorate." Bridges represent the highest unit investment of all elements of the highway system. Additionally, bridge deficiencies can present the greatest danger of all potential highway failures for disruption of community welfare and loss of life. Therefore, our objectives are to:

- Maintain public safety and confidence by addressing structural safety concerns.
- Protect public investment by addressing bridge maintenance concerns.
- Maintain a desired level of service by addressing functionality issues.

- Provide bridge inspection program support by implementing the NBIS and certification of the bridge inspectors in the State of Oregon.
- Assure accurate bridge records by initiating a QA / QC program.
- Fulfill our legal responsibilities by staying in compliance with the NBIS / CFR.

Bridge inspections are conducted to determine the physical and functional condition of the bridge, to form the basis for the evaluation and load rating of the bridge, to analyze overload permit applications, to initiate maintenance actions, to provide a continuous record of bridge condition and rate of deterioration, and to establish priorities for repair and rehabilitation programs. Cooperation between individuals in those departments responsible for bridge inspection, load rating, permits, and maintenance is essential to the overall effectiveness of such a program.

2.2—HISTORY OF OREGON’S BRIDGE INSPECTION PROGRAM

The Oregon Transportation Commission and the Oregon State Highway Department was originally established by legislative order in 1913.

In 1919 the Oregon State Highway Department created Bridge Section with Conte B. McCullough as the first bridge engineer.

The first bridge condition assessments performed by the Oregon State Highway Department, were driven by maintenance needs and not necessarily load related. However, the Oregon State Highway Department did perform a load rating on the Willamette River Bridge for Benton County in 1925. Some of the earliest maintenance needs reports in the file date back to 1937.

Some of the first official bridge inspections were performed by an ODOT Underwater Dive Team following the 1964 floods.

During the construction boom of the 1950’s and early 1960’s, not much emphasis was placed on inspection and maintenance of bridges. That changed in 1967, when the Silver Bridge in West Virginia suddenly collapsed, resulting in the deaths of 46 people. This tragic loss of so many lives focused national attention on the condition of the nation’s bridges and aroused national interest in their inspection and maintenance. U.S. Congress was prompted to add a section to the “Federal Aid Highway Act of 1968” which required the Secretary of Transportation to establish a national bridge inspection standard. In response to that directive, the Federal Highway Administration (FHWA) issued the National Bridge Inspection Standards (NBIS).

The NBIS, published on April 27, 1971, established a program for the regular, comprehensive inspection of all bridges that were part of the federal highway system. The NBIS required a bridge inspection program to be established and maintained that was capable of accurately reviewing and assessing the condition of the bridges (A copy of the Code of Federal Regulations, Part 650, subpart C - National Bridge Inspection Standards, is located in the Appendix). In 1976, these requirements were extended to all public bridges, regardless of whether or not the bridge is located on a roadway which is part of the federal aid system.

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

- The Application of the Standards – bridges on federal aid routes.
- Inspection Procedures—bridge data annually submitted to FHWA.
- Inspection Frequencies—time between inspections at most every 24 months.
- Qualifications of Personnel – use only “certified” bridge inspectors.
- Inspection Reports – containing the required information and format.
- Bridge Inventory – applied to bridges longer than 20 feet.

Pursuant to the Federal Aid Highway Act of 1968, the State of Oregon officially initiated a complete Bridge Inspection Program in 1971. ODOT inventoried approximately 6500 public bridges that measured longer than 20 feet. Of that total approximately 2500 were State bridges and approximately 4500 were local agency City / County bridges. These structures became known as the “NBI Structures”. Due to a liability assessment, ODOT elected to

also inventory and inspect all structures down to 6 feet (based on the dimensional configuration of a truck tandem axle). These 4000+ structures became known as “Non-NBI Structures”. Since these structures were not specifically addressed in the CFR directives, the local agencies did not follow suit. However, ODOT has highly encouraged the local agencies to do so. ODOT inspects these Non-NBI structures on a 48 month inspection frequency, unless warranted otherwise by their condition. At that time, ODOT inspected the structures on the State Highway System and the Local Agencies inspected all of the structures under their jurisdiction. Each public agency was required to funnel their NBI Bridge data to ODOT, so that it could be compiled and submitted to FHWA in April and October of every year. Each public agency was required to pay its own bridge inspection costs.

In 1977, two primary concerns surfaced: (1) The bridge repair and replacement needs far exceeded available funding, and (2) the NBIS requirements were limited to only the Federal Aid Highway Bridges. This resulted in little incentive for the inspection and inventory of non-Federal Aid Highway bridges. These two concerns led to the passage of the “Surface Transportation Assistance Act of 1978”. This act established the funding mechanism for providing Federal funds for bridge replacements, which was badly needed. This act also specifically contained the following requirement: **All bridge structures, longer than 20 feet in length and located on a route that is open to the public, will be inspected and inventoried in accordance with the NBIS.** The act also specified penalties for **non-compliance which included withholding of federal bridge funds.** But, the lack of compliance still existed, because if that particular public agency had no plans to use federal bridge funds, there was no incentive to comply with the CFR.

During the 1988 FHWA Audit Review of the Bridge Inspection Program in the State of Oregon, several NBIS Compliance Issues were noted:

- Many bridge inspections were not being completed and reported on at the prescribed frequency.
- Many local agencies found it difficult to justify the retention of a Certified Bridge Inspector for such a small inventory which resulted in a bridge inspector qualification compliance issue.

Following the 1989 QA Review, ODOT decided to out-source the local agency bridge inspection work to consultants due to FTE restrictions. FHWA allowed the local agency bridge inspection program to be funded from the Local Agency portion of the HBRRP Program.

In 1992, ODOT formally adopted PONTIS as the bridge management system of choice. As such, the bridge inspection program started collecting Element Level condition assessment information in addition to the NBI Level condition ratings.

In a 1995 FHWA Quality Improvement Project, conducted in the State of Oregon, the program review concentrated on the **Overhead / Cantilevered Sign Structures, High Mast Light Towers and Large Traffic Signal Structures.** Though not mandated by the NBIS, the states are being encouraged to routinely inspect these features,

In 1998, FHWA allowed the state bridge inspection program to be funded from the state’s portion of the HBRRP Program. Therefore, ODOT federalized the State Bridge Inspection Program, using HBRR funds to pay for the inspections that were performed on the State NBI Structures. Inspections performed on the Non-NBI Structures continued to use state funds.

In 2004, FHWA re-drafted the NBIS Regulations. The new regulations were implemented in January 2005, after much input from the various States. These new CFR provisions, made the Department of Transportation in each State directly responsible for assuring that all NBI structures in the State are Inventoried, Inspected, and Load Rated in accordance with the NBIS. These same provisions also gave each State the option to officially delegate that task to other public agencies in the State through a formal Intergovernmental Agreement process that clearly spells out the roles and responsibilities of each agency.

2.3—TYPES OF BRIDGE INSPECTIONS

In essence, the CFR recitals state that each State Transportation Department is responsible for assuring that each bridge must be inspected as thoroughly as necessary to clearly establish its condition, inspected at the appropriate interval or frequency, and insure their continued safe operation. In accordance with the CFR recitals, the 7 required Bridge Condition Assessment Investigations performed by ODOT are:

2.3.1—Initial Inspection

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

2.3.2—Routine Inspection

Regularly scheduled inspection or condition assessment that consists 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. These inspection types are performed on every structure in the inventory.

2.3.3—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 requires diving or other appropriate techniques.

2.3.4—Fracture Critical Inspection

A hands-on inspection of a fracture critical member or member components that may include visual and other nondestructive evaluation. A fracture critical member is a steel member in tension, or with a tension element, whose failure would probably cause a portion of the entire bridge to collapse.

2.3.5—Special Inspections

An inspection scheduled at the discretion of the bridge owner, used to monitor a particular known or suspected deficiency. Examples of these inspections are:

- Deck Surveys for monitoring spalls and delaminations;
- Bridge Clearances for freight mobility routing;
- Concrete Corrosion / Cathodic Protection systems;
- Electro-slag Welded Bridges; and
- Bridge Health Monitoring / Load Testing.

2.3.6—In-Depth Inspections

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. Examples of these inspections are:

- Fatigue Prone Details, looking for signs of fatigue in steel members;
- Timber boring to monitor decay in the timber members;
- Ultra-sonic testing of Pin & Hanger Assemblies;
- Cross-Channel Profiles for monitoring scour;
- Cable Suspension Bridges.

2.3.7—Damage Inspections

This is an unscheduled inspection to assess structural damage resulting from environmental factors or human actions. Types of events that trigger a damage inspection are:

- High-Water Flood Drift Events;
- Post Earthquakes or Seismic Events;
- Fires; or
- Significant traffic collision damage.

2.3.8—Complex Bridge Inspections

(unique details or complex bridges that require a higher degree / level of expertise or inspection procedure to properly assess their condition) Bridge types that fit this category are:

- Movable drawbridges (Electrical / Mechanical Components);
- Cable stayed Bridges;
- Concrete Segmental Bridges; or
- Other bridges that contain unusual characteristics that require a higher level of expertise to assess the condition of the structure.

2.3.9—Major Bridge Inspections

A bridge that contains features that are difficult to access, or take an inordinate amount of time to properly evaluate the overall condition of the bridge. Bridges or tunnels that fit these categories are:

- Contain complex details such as: fracture critical and fatigue prone elements, pins and hangers, eye bars, mechanical and electrical elements (movable bridges), cathodic protection systems, suspender or suspension cables, segmental spans, electro slag welds, orthotropic decks, lattice girders, rock dowels, etc.
- Require special testing expertise and /or testing equipment such as: magnetic particle, ultra-sonic sounding, phased array, acoustic emissions, chloride sampling, scour monitoring devices, or electronic data collection gauges in order to fully evaluate the condition of the structure.
- Requires specialized skills to access all parts of the structure such as employing climbing techniques, large boom lifts, and / or Under Bridge Inspection Trucks (UBIT), or
- Take an inordinate amount of time or manpower to properly access and evaluate all components of the structure. These are bridges can have a deck area greater than 30,000 sq. ft. or spans longer than 500 feet.

2.3.10—Non-NBI Structure Inspections

Regularly scheduled condition assessments of structures shorter than 20 feet. Structures that fit this category are:

- Bridges that span from 6 to 20 feet;
- Culverts that span from 6 to 20 feet;
- Tunnels that carry highway traffic;
- Stand alone Pedestrian Structures;
- Sign Support Structures;
- Railroad and Private Structures located over a State Highway route.

2.3.11—Supplemental Ancillary Investigations

ODOT also performs a series of supplemental ancillary investigations to fulfill this requirement.

2.3.11.1—Critical Finding

ODOT has established a statewide procedure to assure critical findings are addressed in a timely manner while keeping FHWA apprised in accordance with the NBIS. A critical finding is a structural or safety related deficiency that requires immediate follow-up inspection or action. ODOT has interpreted this to mean that if the bridge deck, superstructure, substructure or channel is has a condition rating of 3 or less, triggers a critical finding follow-up.

2.3.11.2—Scour Monitoring

Scour is an erosion of the streambed or bank material due to flowing water; which is often considered as being localized around the bridge piers or abutments. A scour critical bridge is defined as a bridge with a foundation element that has been determined to be unstable for the observed or evaluated scour condition. ODOT scour monitoring program consists of the following:

- Every bridge over a waterway has been evaluated as to its vulnerability to scour in order to determine the prudent measures for its protection.
- A cross-channel profile has been collected on every bridge over a waterway which is measured longitudinally along the length of the bridge, generally on the upstream side. ODOT overlays multiples of channel profiles that were taken over a period of years with a profile view of the bridge. This process provides a clear picture of any vertical or horizontal movement of the channel, as well as, it's criticality by comparing the channel thalweg with the bridge footing information.
- ODOT performs an underwater dive inspection on any bridge that has substructure elements located in non-wadeable water. The dive team physically monitors any localized channel scour in relation to the bridge substructure information.
- ODOT has prepared a plan of action (POA) for the scour critical bridges in the inventory.
- Bridge Inspectors have received appropriate training and instruction in inspecting bridges for scour.

2.3.11.3—Quality Assurance / Quality Control Reviews

Each state must develop and provide a QA / QC program of the bridge inspections performed in the state. The QA review must provide procedures to verify or measure the quality level of the entire bridge inspection and load rating program. The QC procedures are to maintain the quality of the bridge inspection and load rating at or above a specified level.

2.3.11.4—Sign Support Structure Inspections

In a 1995, FHWA conducted a Quality Improvement Project in the State of Oregon. The program review concentrated on the Overhead, Cantilevered, or Butterfly Sign Support Structures, the High Mast Light Towers and Large Traffic Signal Structures. Following the review, ODOT was encouraged to incorporate these structures in the bridge inspection program. ODOT decided not to include the large traffic signals or the high mast light towers in the program.

2.3.11.5—Emergency Bridge Operations

The emergency event can be isolated to only one structure or widespread over a much larger geographical area. No one can predict the occurrence or nature of a major event. These events could include Earthquakes, Tsunamis, Forest or Transient Fires, Landslides and Mudflows, Winter Storms and Blizzards, Severe Thunderstorms, Floods and Flash Floods, Hurricanes, Tornadoes, and Volcanic Eruptions. It is important that personnel be familiar with the emergency procedures, so the plans can be quickly changed and implemented as the need arises. It is also imperative that the ODOT response procedures are designed so they can be easily modified to fit any major event.

2.4—BRIDGE INSPECTION PROGRAM ORGANIZATION

Whatever organizational structure the agency chooses, the NBIS requires certain levels of experience and/or education of the individuals who make up the organization and the bridge inspection teams. These levels of experience and/or education vary according to the individual's level of responsibility. These minimum qualifications were established to insure that the individuals involved with the program received the training and experience necessary to perform the assigned duties. It is clearly understood that a successful bridge inspection is dependent on proper planning, utilizing proper techniques, having access to the right equipment, and the experience and reliability of the personnel performing the work. Inspections must not be confined to only searching for defects which may exist, but must also include anticipating incipient problems. Thus inspectors must be cognizant of both preventive, as well as, corrective maintenance programs. As a result, ODOT requires all Bridge Inspection Team Leaders to be certified specifically in the State of Oregon, so that their technical proficiency can be assessed.

2.4.1—Organizational Structure

To comply with these organizational mandates, individuals will generally be needed in each of the following areas:

2.4.1.1—Bridge Program Manager

An individual who heads the bridge inspection organization that is responsible for compliance with the NBIS, FHWA and ODOT bridge inspection program standards. In the State of Oregon, that person is the ODOT Bridge Operations Engineer. ODOT has further refined the organizational structure by establishing a Senior Bridge Inspector position to provide oversight on the state bridges and a Local Agency Bridge Inspection Coordinator position to administer the consultant contracts for the local agency bridges.

2.4.1.2—Bridge Inspection Team Leader

A lead bridge inspector(s) who will be responsible for leading the bridge inspection team(s) and conducting the bridge site inspections. The State of Oregon was subdivided into 5 geographical regions that basically follow the various county lines:

- The Portland Metro area and surrounding counties – Region 1;
- NW corner of state, excluding Portland – Region 2;
- SW corner of state (Eugene South) – Region 3;
- Central Oregon (California / Washington boundaries) – Region 4;
- E. Oregon (to Nevada, Idaho, Washington boundaries) – Region 5.

Each region has a Region Bridge Inspector that has the assigned responsibility for managing the structures within each assigned area. The 5 RBI's and 3 Assistant RBI's report to and are directly responsible to the ODOT, Bridge Operations Engineer.

2.4.1.3—ODOT Underwater Dive Team

ODOT also supports an Underwater Bridge Inspection Dive Team. The team consists primarily of a full time Dive Team Manager and a Sounding Coordinator. The Dive Team Manager schedules, initiates and reports on the condition of all bridge elements that are located in non-wadeable water. The Sounding Coordinator acts as an assistant dive team coordinator and performs cross channel sounding on all major structures during the high flow periods to monitor for scour. In addition to these two full time positions, the dive team also supports 5 part-time divers that are assigned to other positions within ODOT and only work on the dive team approximately 5 weeks a year.

2.4.1.4—Local Agency Bridge Inspections

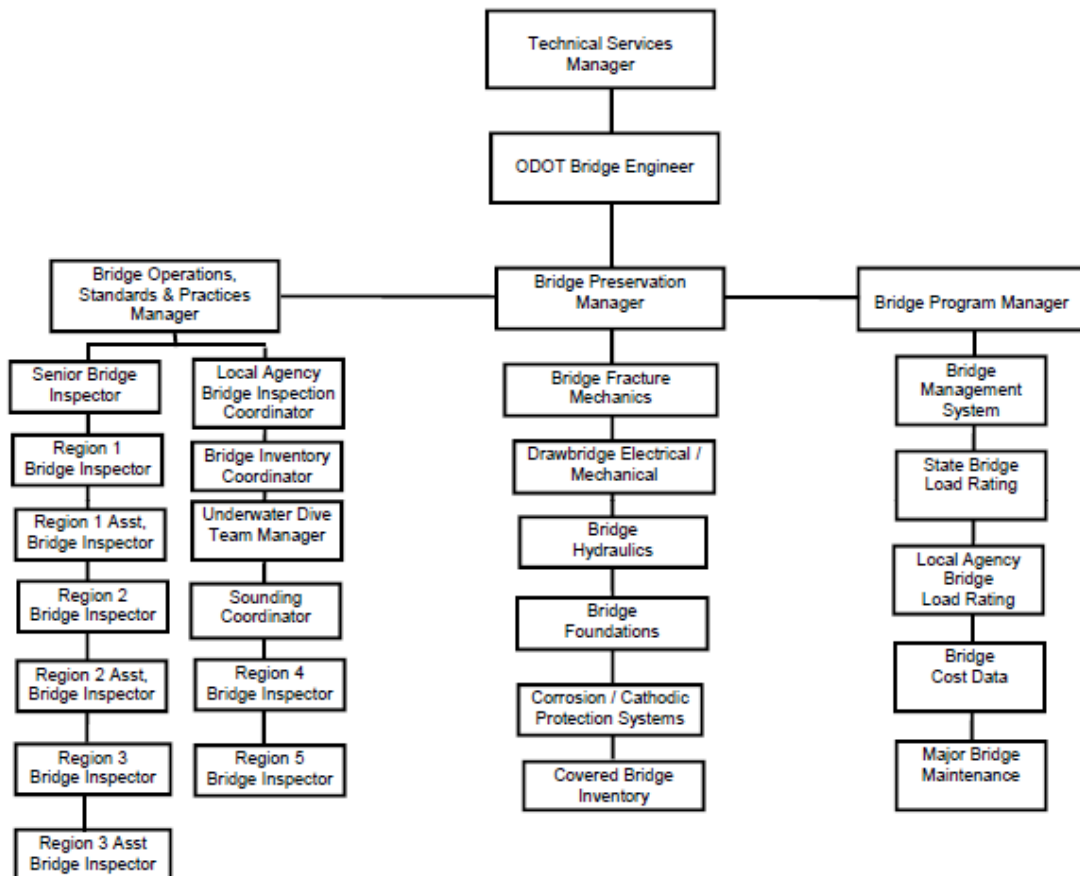
The local city/county bridges of NBI length that are located throughout the state are inspected by consulting engineering firms that are on contracts administered by the ODOT, Bridge Operations work unit. The seven consultant contracts are organized by geographical location, around the state.

2.4.1.5—Other Important Entities

It is clearly understood that a successful bridge inspection program requires others to work in concert with those listed above.

- **Region Tech Center Bridge Personnel** – These individual are primarily involved in bridge design and project delivery. However, they are also called up to investigate structural damage following traffic collision, or some other major event.
- **District Bridge Maintenance Crews** – In addition to performing the bridge maintenance and repairs, the bridge maintenance crews function as the first responders during all major events.
- **Bridge Owners (Local and Other Public Agency)** – Since ODOT Bridge Section only performs those activities that are required by the NBIS, all other Bridge Owners are required to manage their structure inventory accordingly.

2.4.2—Organization Structure Chart



2.5—BRIDGE INVENTORIES

2.5.1—NBI Inventory

The National Bridge Inventory database was intended for use by States, Federal agencies and other bridge owners for the recording and coding of pertinent bridge data elements that comprise the NBI. By having a complete and thorough inventory, an accurate report can be made to the Congress on the number and status of the Nation's bridges as well better manage the bridge infrastructure under our charge. The data also supports the Federal Highway Administration (FHWA) programs and efforts of the Military Surface Deployment and Distribution Command Transportation Agency. Submission of the information is used to meet several Federal reporting requirements (23CFR 650.315), as well as, support the structure program needs of each state.

The NBI data is collected using the Structure Inventory & Appraisal sheet (SI&A). It's important to note that the SI&A sheet is not an inspection report form but merely a summary of the bridge data required by FHWA to effectively monitor and manage the national bridge program.

2.5.2—Non-NBI Inventory

The only difference between the NBI and the Non-NBI Inventories is the recorded length of the structure. If a structure is longer than 20 feet, all pertinent information associated with that structure will be contained in the NBI

inventory. If a structure is longer than or equal to 6 feet, but shorter than or equal to 20 feet, then all pertinent information will be contained in the Non-NBI Inventory.

2.5.3—Sub-Inventories

In order to comply with the bridge inventory requirements and to help manage the Bridge program, ODOT established and maintains an inventory of the following structures:

- An inventory of all non-federal public agency structures inspected in the State of Oregon. State inventory contains all structures that are 6 feet or larger, other public agency inventory contains only structures of NBI length.
- Bridges that require Critical Follow-Up procedures.
- Bridges that require a Fracture Critical Inspection.
- Bridges that require Fatigue Prone Detail Inspection.
- Bridges that require Underwater Bridge Inspection.
- Bridges that have been determined to be Scour Critical.
- Bridges that require special access.
- Complex Bridges (Drawbridges and Suspension Bridges).
- Covered Bridges.
- Bridges that have been retrofitted with seismic restraints.
- Bridges that contain confined spaces.
- Bridges that have a fall restraint system installed.
- Bridges that have Load Restrictions.

CHAPTER 3: BRIDGE OWNER RESPONSIBILITIES

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CHAPTER 3:

BRIDGE OWNER RESPONSIBILITIES

3.1—SUMMARY OF THE BRIDGE OWNER'S RESPONSIBILITIES

3.1.1—Definition of a Bridge Owner

The Bridge Owner can be characterized or defined as an agency or organization responsible for the care, up-keep, maintenance, management, or having the decision on making authority about how services are provided or the establishment of operational controls, on a structure.

3.1.2—Bridge Owner's Responsibilities

Overall, the responsibilities of the Bridge Owners are either performed or cause others to perform the following:

- Maintain a bridge file that includes a full cradle-to-grave history of the bridge;
- Even though the Non-NBI structures are not required to be inspected in accordance with the National Bridge Inspection Standards, from an agency liability standard point, each bridge owner is strongly encouraged to do so.
- Maintain the structures in as good or better condition so that an appropriate level of service can be provided;
- Follow-up on Bridge Inspection Critical Findings in a timely manner;
- Post Load Restrictions;
- Issue overweight / oversize route permits;
- Provide Overweight / Oversize Enforcement;
- Monitor the Scour Critical Bridges for scour and drift;
- Perform the duties of the First Responder in the event of an Emergency; and
- Operate all drawbridge structures in accordance with U.S. Coast Guard Regulations.

Bridge Owners are responsible for maintaining a complete, accurate and current record of each bridge under their jurisdiction. Complete information, in good usable form, is vital to the effective management of the bridges. Such information also provides a record which may be important in legal action. The bridge record should contain all cumulative information about an individual bridge. It should provide a full history of the structure including damages and all strengthening and repairs made to the bridge. The bridge record should also provide data on the capacity of the structure, including the computations substantiating reduced load limits, if applicable.

3.2—BRIDGE FILE/INVENTORY REQUIREMENTS

3.2.1—Bridge File

CFR 650.313(d) requires each agency to “prepare bridge files as described in the AASHTO Manual. Maintain reports on the results of bridge inspection together with notations of any actions taken to address the findings of such inspections. Maintain relevant maintenance and inspection data to allow assessment of current bridge condition.”

In accordance with the AASHTO Manual for Bridge Evaluation (MBE) - “each bridge record should include a chronological record documenting the maintenance and repairs that have occurred since the initial construction of the bridge. Include details such as date, description of the project, who did the work, cost, contract number and related data...”

The significant elements of a bridge file should include:

- Inspection History
- Structure Inventory & Appraisal (SI & A) Sheets
- Bridge Load Rating & Posting Recommendations, including load rating calculations or load test data, dates and signing recommendations, traffic data.

- Photographs
- Maintenance & Repair History
- Inspection requirements and procedures – special equipment needed or features to be inspected.
- Flood data, waterway adequacy, channel cross sections, underwater inspection reports, scour data and assessments, POA's.

Bridge Maintenance Personnel often question the importance and urgency of reporting work accomplishments. After all, the work is done and that's what counts. Maintenance personnel must fully understand the importance of reporting as a means of building an information base in order to help do things better and more efficiently, in the future. The following list includes some of the benefits of reporting that might be of interest to maintenance personnel:

- Having a historical record of maintenance and repair on each bridge can be an excellent source of information as to who did what, how, when and where;
- Assess continual problems with a structure (lemon law);
- Assess the adequacy of the materials used to make the repair;
- Assess the adequacy of a bridge detail design or repair design;
- Assess the quality and adequacy of the work being performed;
- Assess the best time of year to plan future work on structure;
- Maintains a record of regular, periodic and special expenditures as a basis for developing and justifying future budgets;
- Maintains a current record to establish cost-to-performance relationships;
- Provides a source of information to enable maintenance managers to develop maintenance trends;
- Develop a source of information for public relations;
- Resource of generating accomplishment reports;
- Provides a record of cost to compare and update budget cost estimates;
- Resource that can be incorporated into the defense of a tort liability claim.

Each agency has their own specific reporting requirements. However, in general, the following five general classifications are used to describe the types of information any reporting system should include:

Who – Indicate who performed the work.

What – Report the specific type and amount of work performed. The report of “what” and “how much” is used to evaluate crew performance, the suitability of standards, and work progress and is also used for budget comparisons.

When – Given the date the work was performed is helpful in determining when work should be scheduled in future years. Certain times of the year have much more impact on work production than others.

Where – A given bridge maintenance / repair activity might not address all of the maintenance / repair needs to a given element. Therefore, are fully accounting must be kept on each structure.

How – Report the resources that were used and the process used to get the job done. The hours of labor, types of equipment, and type and amount of materials used are included. This permits computing the cost of performing the work and provides resource utilization data. This information also permits managers to determine the monthly resource needs for use in future scheduling.

3.3—BRIDGE MAINTENANCE REQUIREMENTS

3.3.1—Introduction

The goal of any maintenance management program is to optimize the allocation of resources (i.e. personnel, equipment, and materials) for the total maintenance program, to provide the best service possible within the budgetary constraints in effect at the time. The objective of any Bridge Maintenance Program is to keep an existing facility in as good or better than its current condition.

Bridges may be identified as deficient for either one or both of the following reasons:

- Structural Deficient, or
- Functionally Deficient.

Bridges can become structurally deficient if:

- Their condition is allowed to deteriorate due to environmental impacts. Usually this degradation can be reduced through good maintenance practices.
- By allowing continuous vehicle loadings that exceed the bridge's design capacity to use the bridge. This can be reduced by properly posting of load restrictions on the structure.
- Just because a bridge is labeled "structurally deficient" does not necessarily mean that the structure is unsafe.

Bridges become functionally deficient when some aspect of the design or structure type is no longer appropriate to handle the traffic because of dimensional or geometric problems. These issues are generally beyond the scope of ordinary bridge maintenance activities.

3.3.2—Factors Associated with a Lack of Maintenance

If a given agency is contemplating whether to maintain a given structure under their jurisdiction, they should consider the following factors:

- The effect lack of maintenance would have on the calculated load capacity of the bridges under their jurisdiction. Each load rating has a factor that is used to assess how much risk should be imparted into the load rating calculations. If an agency has a robust maintenance practice, a lower risk is reflected in the load rating calculations. If an agency bridge maintenance practice is non-existent, a much higher degree of risk is reflected in the calculations. This load capacity reduction could result in more load restrictions on those structures under the jurisdiction of the public agency.
- It has been demonstrated that bridge maintenance is very cost-effective. In fact, it has been shown that the cost of bridge repair is exponentially related to condition. This is to say that maintenance can be deferred for a period of time, but the cost of restoring a structure to adequate or good condition is significantly greater than regularly maintaining the structure in a good condition.
- The bridge owner is responsible for monitoring the condition of the bridges under their charge and determining the appropriate course of action associated with the administration of their bridge program. If the agency chooses not to monitor the condition of their bridges, tort liability provisions could come into play.
- The bridge owner is responsible for reviewing the bridge maintenance recommendation reports located on State's Internet Bridge Inspection Web Site. The bridge owner is responsible for handling deficiencies that have been defined as a critical finding in a timely manner. If these critical findings are not being addressed in a timely manner, that agency could be found to be in non-compliance with the Code of Federal Regulations (CFR).

3.4—ADDRESS CRITICAL FINDINGS

3.4.1—Purpose

Of primary concern during every bridge inspection is to address the structural condition of the elements that are associated with the load path and their ability to transfer those loads, address items that have created a traffic hazard, or address items that have intensified a concern for scour around the bridge foundation. It is the responsibility of the bridge inspector to note, evaluate, and notify and it's the responsibility of the bridge owner to respond, protect the public and fix the deficiency.

The Federal Highway Administration (FHWA) Division Office will periodically review the critical follow-up reports and the tracking system to verify the needed repairs were promptly reported and the recommended repairs were completed within a reasonable period of time. If the agency fails to do so, they could be found to be in non-compliance with the Code of Federal Regulations (CFR). FHWA may also conduct field checks to verify that critical repair work was accomplished.

3.4.2—Deficiency Notification Process

As noted in the ODOT Bridge Inspection Coding Guide, each Bridge Inspector is instructed to provide a prioritized list of bridge maintenance recommendations that they feel would adequately address the deficiencies that is found on a given structure. If the deficiency can be classified as being “Urgent”, “Critical”, or “Significant”, the bridge inspector is instructed to immediately contact the appropriate bridge owner and take all necessary actions to preserve the safety of the public. In addition to information conveyed from the bridge inspector, the bridge owner can obtain additional information via the ODOT Bridge Inspection Web page. It’s expected that the bridge owner will periodically query the Bridge Inspection Database, when planning their work, and respond to each “Urgent” or “Critical” Deficiency, on an ASAP basis. For more details, refer to Chapter 8.

3.4.3—Bridge Owner’s Response Expectations

The bridge owner is responsible for managing the structures under their charge and determining the appropriate course of action associated with the administration of their bridge program. If the designated bridge owner chooses not to respond, tort liability provisions could come into play.

3.4.4—Post Repair Follow-Up Procedures

Within one month after completion of the recommended repairs, a post-repair condition assessment will be performed by the designated bridge inspection staff and for the record a follow-up document will be initiated and filed accordingly.

The Post Repairs Document will contain the following information:

- Describe Work Done (Describe what repair work was done to correct the problem; attach any appropriate photos.)
- Date of Completion (Date when the actual repairs were complete or restrictions were removed.)

The bridge manager who completes the document may be relying on reports and photos from those who have actually done the work. This is understandable and justified, recognizing that those who actually perform the work may not be the same person responsible for the bridge inspection and reporting. The purpose of the document is to provide accountability, as well as accurate, timely information, hence the requirement for submission of the document upon immediate completion of the work. However, it is still good practice to have trained bridge inspectors, to field verify that all the repairs are complete and satisfactory. If warranted, an inspection will be conducted within six months of completion of the required work.

ODOT will assure that the Bridge Inventory data is updated with the information received from the Bridge Owner, within the timeline as specified in the NBIS.

3.5—BRIDGE POSTING AND OVERLOAD ENFORCEMENT

3.5.1—Validation of Bridge Load Rating

Bridge load rating calculations provide a basis for determining the safe load capacity of a bridge. A load rating requires engineering judgment in determining a rating value that is applicable to maintaining the safe use of the bridge and arriving at posting and permit decisions. Bridge load rating calculations are based on information in the bridge file including the results of the most recent condition assessment performed by the bridge inspector. As part of every inspection cycle, each inspector is instructed to review each load rating and determine whether it needs to be updated to reflect any relevant changes in condition or dead load noted during the inspection. This process is accomplished by comparing the reported condition of the bridge at the time the load rating calculations were made with the current condition of the bridge. This information is contained in the load rating comparison table on the bridge inspection report.

Bridge posting should not be confused with bridge evaluation and rating. Evaluation and rating are engineering-related activities; whereas, bridge posting is a policy decision made by the bridge owner. Although the engineer may recommend posting a given bridge based on either the inventory or operating rating, it is the owner, not the

engineer, who ultimately must make the decision on whether a bridge will be posted. The owner does not have the option to post at a higher level and still comply with the Code of Federal Regulations.

3.5.2—Load Posting Requirements

The Code of Federal Regulations (CFR) 650.313(c) directs each agency to post or restrict the bridge in accordance with the AASHTO Manual for Bridge Evaluation (BME) or in accordance with State law.

The expectation is that ODOT will either be doing or causing the load rating calculations to be completed. Upon completion, at least two load rating reports will be generated. One report is kept in the ODOT Bridge Section file and the other is sent to the bridge owner agency. The bridge owner will find the load rating summary sheet that is contained in each load rating report to be of most use.

Posting is required when the maximum unrestricted legal loads exceed that allowed under the operating rating or equivalent rating factor. As a standard practice, ODOT does not post a bridge for permit loads, because each permit holder is issued maps, as part of the permitting process, which shows the location of each restricted bridge. As a condition of their permit each permit holder is required to honor those restrictions. The only exception to this rule is when a bridge, not shown on the map, is found to require a permit vehicle load restriction.

If a load restriction is found to be necessary, ODOT Bridge Section will send an official load posting recommendation letter to the bridge owner. It is expected that each bridge owner will post each structure accordingly, prior to the date specified on the notification letter. ODOT Bridge Section will follow-up to monitor whether the load posting recommendation was completed, recording the posting information as well as the posting date. In order to be enforceable, the configuration of the load posting sign must be in accordance with the Manual Uniform Traffic Control Devices (MUTCD), Section 2B-49. The accurate posting of bridges is a performance measure that is reviewed every six months by FHWA.

3.5.3—Posting Sign Confirmation

Regulatory signing must conform to the requirements of the “Manual of Uniform Traffic Control Devices” (MUTCD), and should be established in accordance with the requirements of the agency having authority over the highway. All load restrictions placed on a State Highway must be authorized by the Deputy Director of the Oregon Department of Transportation.

3.5.4—Posting of Vertical/Horizontal Clearance Restrictions

Warning signs call attention to unexpected conditions on or adjacent to a highway or street and to situations that might not be readily apparent to road users. Provisions contained in the Manual for Uniform Traffic Control Devices (MUTCD) can be viewed at: “mutcd.fhwa.dot.gov”.

3.5.4.1—Posting of Vertical Clearance Requirements (MUTCD Section 2C.20)

The low clearance sign shall be used to warn road users of clearances less than 12 inches above the statutory maximum vehicle height or minimum structure height. In the State of Oregon the statutory height of all vehicles is 14’ 0”.

- Where the clearance is less than the legal limit, in addition to posting the lowest clearance on the bridge, another sign to that effect should be placed at the nearest intersection road or wide point in the road at which a vehicle can detour or turn around. In the State of Oregon, this Vertical Clearance Dimension is 14’ or less.
- In the case of an arch or other structure under which the clearance varies greatly, two or more signs should be used as necessary on the structure itself to give information as to the clearance over the entire roadway.
- If Vertical Clearance Dimension is less than 15’ but greater than 14’ – The exact clearance dimension must be posted on the bridge.

- Clearances should be evaluated periodically, particularly when resurfacing operations have occurred.

3.5.4.2—Posting of Horizontal Clearance Restrictions (MUTCD Section 2C.14—15)

A “Narrow Bridge” Sign should be used in advance of any bridge or culvert having a two-way roadway clearance width of 16 feet, or any bridge or culvert having a roadway clearance less than the width of the approach travel lanes. Statutory legal vehicle width = 8’- 6”.

- Z- Boards – Additional emphasis should be provided by the use of object markers.
- One Way for Trucks and Buses – A “one Lane Bridge” sign should be used on two-way roadways in advance of any bridge or culvert:
 - Having a clear roadway width of less than 16 feet, or
 - Having a clear roadway width of less than 18 feet when commercial vehicles constitute a high proportion of the traffic, or
 - If the sight distance is limited on the approach to a structure having a clear roadway width of 18 feet or less.
 - Additional emphasis should be provided by the use of object markers, delineators, and/or pavement markings.

3.5.5—Over Size/Over Weight Permits

It is recommended that each Bridge Owner have established procedures which allow over-sized / weight vehicles to travel on the highway routes under their jurisdiction. These procedures involve the issuance of a permit which describes the features of the vehicle, its load, restrictions on how the load is to be carried across the bridge, and in most jurisdictions, will specify the allowable route or routes of travel. Generally speaking, permits should not be approved for divisible loads, (situations where the load or the hauling vehicle can be reduced to conform to the size and weight limitations). If the bridge owner has not established a procedure, the Operating Rating may be used for evaluating special permits for heavier than normal vehicles. Additional inspections may be necessary by the bridge owner when the structural members are frequently stressed near the Operating Level.

3.5.5.1—Over Load Enforcement

Each public agency is responsible for managing the infrastructure under their jurisdiction in accordance with laws in the State of Oregon and motor carrier regulations that govern the size and weight of the vehicles. Also, each bridge owner should strive to preserve the highway infrastructure under their jurisdiction by managing the movement of heavy loads on the routes under their jurisdiction, in order to minimize wear and tear and preserve the capacity of the route for sustained freight mobility. Refer 23 CFR 657, for additional guidance.

3.6—MONITORING BRIDGE AND APPROACH ROADWAY FOR SCOUR AND DRIFT

Nationwide, more bridges fail due to scour than any other cause. Even a small or intermittent stream can have a disastrous effect that can damage a bridge bent or undermine the bridge foundation. The most innocent looking stream can cut into the approach roadway embankment with unexpected fierceness at flood stage. It is a well known fact that the angle of the stream flow between low flow and high flow can differ significantly. Therefore, it’s extremely important to supplement the routine inspection of all scour critical bridges with more frequent site visits, in order to properly monitor for scour or drift build up in the channel. These more frequent site visits almost always falls on the bridge owner to perform.

3.6.1—Bridge Owner’s Responsibilities

It is anticipated that the bridge owner will perform the following:

- It is expected that each bridge owner will focus attention on proactive monitoring the condition of the scour critical bridges and closing if necessary during and after high-water events.
- Monitor the condition of the bridge foundation and stream movement, when conditions so dictate. This can be done by comparing current measurements with the cross channel profiles created by ODOT Bridge

Operations. The cross-channel profiles for each bridge can be downloaded via the ODOT Bridge Section Web Page.

- Identify conditions that are indicative of potential problems with scour and stream stability by comparing the location and elevation of the channel cross-section to the elevation and location of the bridge footings. .
- It is expected that each bridge owner will have emergency contact information for the ODOT Bridge Inspection Staff, the ODOT Bridge Operations Engineer, the ODOT Hydraulics Engineer, and the ODOT Bridge Engineer so the findings of actual or potential scour problems can be promptly reported to others for further review and evaluation.

3.6.2—Scour Plan of Action

CFR 650.313(e) directs each agency to “Identify bridges that are scour critical”. CFR 650.313(e)(3) – For bridges that are scour critical, the agency is directed to “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.” In accordance with this provision, ODOT evaluated each bridge over a waterway as to its scour potential in accordance with the “FHWA Technical Advisory - 5140.23 **“Evaluating Scour at Bridges”** - dated October 28, 1991”. This evaluation included its vulnerability to scour in order to determine the prudent measures to be taken for its protection.

- In addition to the evaluation requirement, a plan of action was developed for each existing bridge that has been determined to be scour critical. (See HEC 18, Chapter 5).
- The plan of action includes instructions regarding the type and frequency of inspections to be made at the bridge, particularly in regard to monitoring the performance and closing of the bridge, if necessary, during and after flood events. (See HEC 18, Chapter 7).
- The plan of action includes a schedule for the timely design and construction of scour countermeasures determined to be needed for the protection of the bridge. (See HEC 18, Chapter 7).

3.7—EMERGENCY RESPONSE FIRST RESPONDER

3.7.1—Purpose

The purpose of this subsection is to provide a list of Bridge Owner expectations and actions that should be employed immediately following a major event that involves bridges in the State of Oregon. Depending on the size of the event, each public agency is charged with the responsibility of establishing order to the chaos that will occur.

The first order of business following a major event is to assure the bridges that are located on the life line routes are safe to use. Since most of the designated life line routes are under the jurisdiction of the local agencies, it is imperative that all public agencies partner in performing this task. In order for this to work:

- All personnel must be familiar with the role that each is expected to perform,
- Fully understand how to coordinate response actions with the other public agencies,
- Be able to react in accordance with the emergency response procedures with minimal communication (since it will be almost non-existent).

The Bridge Owner (ODOT District Office, the Local Agency Office, and Other Public Agency Offices) are considered to be the “Front Line of Defense”. The Bridge Owner will make the initial determination of whether they need additional inspection or engineering personnel.

If a Bridge Owner establishes an Incident Command Center, they will need to contact the other public agencies so that a coordinated effort can be deployed. If additional assistance is needed, District Bridge Maintenance, Construction, Region Tech Center, or Bridge Section Personnel will be immediately dispatched, to help coordinate bridge inspection, shoring, repair, or recovery activities. Bridge Operations can provide the bridge owner with a complete inventory check-off spreadsheet of all the structures within the apparent effected area. The local agency coordinator should maintain a multi-jurisdictional information file on all bridges inspected, recording information regarding their operational status, extent of the damage and a general description of any damage repair activity. All measures will be taken to assure the general public is being properly protected and as a way of establishing an acceptable level of confidence.

3.7.2—Responsibilities of the Bridge Owner

- First Look – Establish facility to Field emergency calls from the public, assess magnitude of the event, coordination with other public entities, interface with media.
- Level 1 Inspections – Perform these inspection with assigned staff
- Level 2 Inspections – Team bridge owner staff with bridge inspector and engineers.
- Level 3 Inspections – Coordinate traffic control, access equipment, shoring
- Event Recovery Phase – Traffic Routing / Control, Structural Shoring or Repairs, Contract vs Force Account decision, contract administration.

3.7.3—Bridge Inspection Seismic Expectations

If the magnitude of the event is from 4.0 to 5.0, with an epicenter within the State of Oregon, or within 50 miles of the Oregon Coast or State Border – The bridge owner will log observations and information from, the police, public, and media. Primary task – make sure the notification, communication, and response plans are working. Structure damage – unlikely.

If the magnitude of the event is from 5.0 to 6.0, with an epicenter within the State of Oregon, or within 50 miles of the Oregon Coast or State Border – The bridge owner will direct the Bridge Maintenance Crews to perform a condition assessment on all structures within 50 miles of the epicenter within the first 24 hours following the event.

If the magnitude of the event is from 6.0 to 8.0, with an epicenter within the State of Oregon, or within 100 miles of the Oregon Coast or State Border – The bridge owner will direct the Bridge Maintenance Crews to perform a condition assessment on all structures within 100 miles of the epicenter within the first 24 hours following the event. All damages structures will receive a follow-up condition assessment performed by engineering personnel within the first 72 hours.

If the magnitude of the event is greater than 8.0, with an epicenter within the State of Oregon, or within 300 miles of the Oregon Coast or State Border – The bridge owner will direct the Bridge Maintenance Crews to perform a condition assessment on all structures within 300 miles of the epicenter. A timeframe can not be estimated due to the magnitude of the damage and the uncertainty of being able to navigate the terrain.

For more details, refer to Chapter 23.

3.8—WHY OBTAIN BRIDGE INSPECTOR TRAINING

The bridge owner is strongly encouraged to retain at least one person on staff that has a good understanding of the National Bridge Inspection Standards. The following clearly defines the positive attributes that would result:

- The designated person would be familiar with the ODOT Bridge Program: who to contact, where to get information, and how the system works.
- The person would be familiar with the information contained on the Structure Inventory & Appraisal Sheet and what fields are used to calculate the sufficiency ratings.
- The person would be familiar with the ODOT Bridge Inspection Forms, the operation of the data entry computer application, and what all the numbers mean.
- Person would have the ability to perform any of the supplemental inspections that are required at frequencies other than the 2 year routine inspection frequency.
- The person would have the ability to perform the Non-NBI Structure Inspections for the agency, determine their inspection frequency that insures safe use of the structure, and identify the location of all bridge assets that are open to the public.
- The person would be trained to perform the Emergency Bridge Inspection Condition Assessments, when needed. Other types of inspections, though not specifically required by the NBIS, nor can they be anticipated, can be appropriate at certain times during the bridges' life. A damage to structure inspection is an unscheduled inspection to assess structural damage resulting from environmental factors or human factors. The scope of inspection should be sufficient to determine the need for emergency load restrictions, closure of the bridge to traffic, and/or to assess the level of effort necessary to effect a repair. The extent of

effort expended on this type of inspection may vary significantly depending on the extent of the damage. These inspection types are:

- Traffic Collision
- High Water Events
- Seismic Events
- When a structural member has been touched by a fire that is intense enough to blister the surface paint on a steel bridge, char the outside surface of a timber bridge, or pop off surface cover on a concrete bridge.
- They know how to obtain the Bridge Maintenance Recommendations and plan the bridge maintenance work for the agency.
- They are more familiar with the information contained in the Bridge Load Rating Reports and Summary Sheet.
- They are more familiar with the Load Posting, Permitting, Enforcement Requirements specified in the Code of Federal Regulations (CFR).

These individuals could also function as inspectors whenever they are in the field working. It is important to look for defects that might represent a potential safety hazard or a defect that will cause problems at some time in the future. It is much easier and more cost-effective to correct the problem while the crew is already at the site than to go back at some future date.

Maintenance crews may spend more time at the bridge site than the inspector does. When cleaning and preparing for a repair, they may discover or expose problems that the inspector did not see. The best results can be achieved when the bridge maintenance personnel and the inspectors work together as a team.

3.9—IMPORTANCE OF BRIDGE PROGRAM PARTNERSHIP

Establishing interagency partnerships is absolutely paramount. The traveling general public does not know which routes are under the direct jurisdiction of which agency: state, city, county, or other public agency. As a result, in order to provide an acceptable level of service we must work together in concert, for the following reasons:

Section 3.9.1 - Bottom line, as public officials we are all charged with the responsibility of Ensuring a Safe Facility is Available to the Public. Through the Bridge Inspection Program, ODOT Bridge Section can provide each bridge owner with a thorough and accurate bridge condition assessment with prioritized bridge maintenance recommendations and the calculated load capacity of each bridge in the inventory. But there is a limit to what ODOT Bridge Section can do. Taking the condition assessment information and doing something with it, in order to Ensure a Safe Facility, can only be done by the Bridge Owner. Therefore, it behooves us to work together as partners, in a coordinated fashion, so that we can assure that a structure does not fall through the cracks.

Section 3.9.1.1 - CFR 650.315(c) requires data contained in the NBI File accurately reflects the status of the bridge. Each State is required to cause the file to be updated as promptly as practical, but no later than 90 days after the change in status of a bridge under the State's jurisdiction or not later than 180 days for all other bridges on public roads within the state. Of particular concern are those NBI Items or Fields that are used to calculate the Sufficiency Rating for the bridge. This updating requirement applies to:

On all newly constructed structures. In this case, a change in status is deemed to occur when all construction activities have been substantially completed and the structure is physically opened for public travel. This is generally considered to be the 2nd Notice.

Any modification of an existing structure which would alter previously recorded data in the inventory. The purpose of this requirement is to provide added visibility and attention to major repair needs, as well as, the recording of work that was completed on a given structure.

Whenever there is a load restriction adjustment. This would occur any time a bridge sustains major structural damage, or an inspection uncovers deficiencies that would result in the placement of an emergency load restriction, a bridge closure, or the placement of temporary shoring to keep the structure open for legal loads. This item would require a bridge review before a load restriction can be removed from a given structure.

Bridge inspection staff can only accomplish this task, if they are aware of the modifications. Therefore, establishing lines of communication in a partnership fashion is a must.

Help identify completed major bridge repair, rehabilitation, and replacement projects and provide drawings. This is one of the most difficult issues when it comes to keeping the Bridge Inventory current and up-to-date. The only way it can be accomplished is through well-established lines of communication.

- Notify Bridge Operations when contact person has changed.
- Assist in updating the bridge inventory.
- Assist in data accuracy
- Provide traffic control for lane / shoulder closures
- Provide or Verify ADT counts, if available

CHAPTER 4: BRIDGE INVENTORY

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CHAPTER 4: BRIDGE INVENTORY

4.1—OVERVIEW OF THE BRIDGE INVENTORY

4.1.1—Definitions and Applicability

The language of 23 U.S.C. 151 is clear that the State Department of Transportation is the agency that is ultimately responsible for the inspection of all public highway bridges within the State, except for those that are federally or tribally owned. The State may delegate the bridge inspection work, policies and procedures, quality assurance and quality control, preparation and maintenance of a bridge inventory, inspection, load ratings and other requirements of these standards to other public agencies within the State like a city, county, port authority, or another public agency within the state. However, such delegation does not relieve the state transportation department of its responsibilities. This is to say that the bridge inspection work could be delegate to another public agency by initiating an Intergovernmental Agreement. However, if the other public agency does not complete the delegated work in accordance with the Code of Federal Regulations, the State Department of Transportation, would be required to complete the work, in order to stay in full compliance with the federal regulations. Because of the fundamental relationship established in Title 23 of the U.S. Code between the FHWA and a State, if the inspection work performed by the other public agency was not done in accordance with the NBIS, FHWA could withhold Federal-aid highway funds from the State. Therefore, ODOT made the decision to manage the NBI bridge inventory for the State of Oregon. However, from a liability stand point, the other public agencies within the State are strongly encouraged to inspect their non-NBI Structure Inventory in accordance with the National Bridge Inspection Standards.

The term “bridge” is defined in Section 650.305 Definitions as “A structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between under copings 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.”

In accordance with the CFR 650.303 “Applicability”, public authorities must follow the NBI for all highway bridges located on all public roads. The term “public road” is defined in 23 U.S.C. 101(a)(27) as “any road or street under the jurisdiction of and maintained by a public authority and open to public travel.” This is to infer that the NBIS applies to seasonally or periodically opened public roads and to limited access public access roads. A public authority is also inferred to include “local homeowner associations”. ORS 368.031 also addresses the Counties jurisdiction over local access roads.

The above is to say, that in order for a structure to be classified as a NBI Structure, it must meet the following test:

- The structure must be longer than 20 feet
- The structure must be on a public road
- The public road must be open to public travel
- The road or street must be under the jurisdiction of and maintained by a public authority

These structures are known as “NBI Structures”. Structures that do not carry highway vehicular traffic are not covered by the NBIS regulations and are know as “Non-NBI Structures”. Examples of these structure types are: railroad structures, pedestrian structures, sign support structures, high mast luminaries, retaining walls, noise barrier structures or overhead traffic directional signs and Tunnels. Since these structure types do not fit the definition of a bridge, are not covered by the NBIS. As a result, these structures are known as “Non-NBI Structures” and are not eligible for federal HBP Funding.

Even though the Code of Federal Regulations (23 U.S.C. 151) states that the NBIS is for all highway bridges, FHWA has no legal authority to require private bridge owners to inspect and maintain their bridges. However, the

private bridge owners are strongly encouraged to follow the NBIS as the standard for inspecting their highway bridges. When a privately owned bridge carries a designated public road, each State is required to either:

- Ensure that the private bridge owner inspects their bridge in accordance with the NBIS and a copy of the condition assessment is given to the State for reporting purposes
- The State will cause the bridge to be inspected in accordance with the NBIS
- Reroute the designated public road, so that traffic does not cross the structure.

FHWA recognizes that the NBIS does not apply to public agency owned bridges on roads that are used only by employees and not open to the general public. These bridges and administratively used roads support behind-the-scenes operations, are used by employees engaged in official business, and are not opened to the general public. While the NBIS does not apply to such bridges, these bridges still need to be periodically inspected to assure the safety of employees, contractors, official visitors and the motoring public which may inadvertently use these facilities. The public looks at the transportation infrastructure as seamless and may not know that they have driven on an administratively used road. Furthermore, public authorities could be liable for injuries or death resulting from the use of bridges that are not properly and systematically inspected and maintained. As a result, from a liability standpoint, the public agency is strongly encouraged to inspect the structures on these routes in accordance with the National Bridge Inspection Standards, as well. Again, these structures would be classified as “Non-NBI Structures” and would not qualify for HBP funding.

4.1.2—ODOT APPURTENANCES OR SPECIAL FEATURES

In addition to the NBI and Non-NBI Routine Inspection Inventory, to better manage the assigned infrastructure, ODOT also maintains a list of other important appurtenances and/or features that need to be tracked:

- Bridges that contain Fracture critical Members (650.313(e)(1))
- Bridges that contain Redundant Fatigue Prone / Sensitive Details
- Bridges that require an Underwater Inspection (650.313(e)(2))
- Bridges that require Load Restrictions
- Bridges that have Critical Findings (650.313(e)(3))
- Bridges that have Clearance issues
- Bridges that are Scour Critical (650.313(e)(3))
- Bridges that contain Confined Spaces and whether they are Permit Non-Permit Entry
- Bridge that have Fall Restraint Systems installed
- Bridges that have been Seismic Retrofitted
- Bridges that have Strengthening Details or Systems in-place
- Bridges that carry Dangerous Utilities
- Bridges that have a Cathodic Protection System In-place
- Bridge Rail Inventory
- Bridges that contain Hazardous Materials (Lead Base Paint, Asbestos, etc)
- Bridges that have been classified as Historical
- List of Certified Bridge Inspectors in the State of Oregon

4.1.3—Categorizing by Junction

In the State of Oregon, the bridge inventory is currently lumped into three separate pools:

- Bridges under the State jurisdiction that are 6 feet and longer,
- Bridge under the local agency (city / county) jurisdiction that are longer than 20 feet, and
- Bridges that are under the jurisdiction of other public agencies, such as the Oregon State Parks, Fish & Wildlife, University campuses, the State Military, and the various Port Facilities, that are longer than 20 feet.

4.1.4—ODOT Structure Inventory

Structure types contained in the ODOT Bridge Inventory include:

- All NBI structures that span more than 20 feet.
- All Non-NBI bridge type structures that span from 6 feet to 20 feet.

- Singular or multiple barreled NBI culvert type structures that span more than 20 feet.
- Singular or multiple barreled Non-NBI culvert type structures that span from 6 feet to 20 feet.
- Sign support structures not attached to a bridge that cantilever out over a travel lane.
- Pedestrian bridges, not attached to a bridge.
- Flumes crossing over a route
- Tunnels (including rigid frames).
- Structure connection ramps.
- Railroad structures crossing over a state route.

4.5.1—ODOT Bridge Ownership

A review of all available ODOT guidance and policy documents regarding ownership of over-crossing and under-crossing structure has not been created. However, there are a number of variations depending on the specific situation. Many times the ownership and maintenance question is resolved in a specific IGA based on negotiation between the Region and a local agency, railroad, or other entity, but not always. The Maintenance District would be involved making a recommendation on a case-by-case basis. Maintenance would need to issue an encroachment permit in each case, and an IGA would need to be prepared, which specifies both construction and maintenance responsibilities. We have not found any ODOT-wide policy document on this, but there is some general guidance. Responsibility for construction cost and maintenance is normally determined based on what is “driving the need” for the structure. The owner of the bridge is the owner that is identified in the agreement and this is often determined based on the original need for the bridge and which entity funded it. When ODOT built I-5 by adding lanes to US99 ODOT paid for and owns most of those bridges even though they do carry a designated local route. ODOT has agreements that specify the local agency does operational maintenance, such as winter snow removal and maintaining the roadway surface. Depending on the agreement, the local agency can fund a new overpass, and then it may be transferred to the state. Sunnybrook road over I-205 (Hwy 64) may be an example of this. ODOT also designed a Railroad structure over I-84 at MP 16.55. This is owned and maintained by the railroad. In cases where another agency owns a bridges over a State Highway, ODOT still does a cursory structural safety inspection of that bridge, and maintains an inventory record of the bridge, which documents our inspection. The Tech Services Right-of-Way Section informed us that ODOT needs to own the RW for bridges crossing over state highways, constructed by ODOT (whether or not funded by a local agency). Depending on the negotiated agreement, however, the right-of-way beyond that needed for maintaining the bridge can be given back to a local agency after construction is complete. The Planning Section informed us that they feel like more structured guidance is need in this area. They recommended Bridge Section write up a proposal to form a multi-disciplinary team to develop a policy document to define ownership and maintenance guidelines for structures over state highways. The Maintenance Section informed us that a policy would be complicated to prepare, since most of the situations are unique and currently are handled on a case-by-case basis, depending on what is driving the need for the overpass. They are not sure a Policy would be helpful. Bridge Section will prepare a proposal to create some kind of a consolidated guidelines and see if there is a consensus that it be pursued. Until that is done, we found there are not 100% rules to go by. Our preference for new over-crossings of State Highways is to require it be designed and built to ODOT standards, have the requesting agency pay for ODOT to review the design and supervise the construction, and then turn over the bridge to the requesting agency for maintenance with a provision that ODOT can do necessary emergency repairs or maintenance to ensure public safety and be reimbursed by the requesting agency. Our preference for new under-crossings of State Highway is to have the requesting agency pay for design and construction by ODOT and have ODOT then own and maintain the bridge.

4.2—WHAT IS USED FOR AND BY WHOM?

A bridge inventory is kept for the following reasons:

- Assure all public structures are accounted for.
- Assure their condition is periodically assessed and maintenance needs are reported.
- To help manage the structures through a systematic Asset Management Process.
- Report the information annually to FHWA in accordance with the NBIS

4.2.1—Bridge Inventory: What is it Used for and by Whom?

NBI Bridge Inventory - Originally FHWA required all bridges open to the public to be inventoried and periodically inspected in order to assure that a safe facility was available for public use. As a result, each state was required to report the condition of their bridge inventory to FHWA each year. Now FHWA also uses the reported condition of the state's inventory to apportion the federal Highway Bridge Program budget between the various states. As a result, FHWA performs an annual Audit Review to assure that the State is in full compliance with the NBIS regulations.

NBI and Non-NBI Inventory - The Oregon Bridge Inventory System was created so that ODOT could **track** and **report** the condition of the bridge assets located throughout the State of Oregon, in accordance with the NBIS requirements. The bridge inventory contains data that is associated with a variety of structure types that are located on, under, over, or immediately adjacent to a public route in the State of Oregon. **Report** - ODOT submits a copy of the NBI bridge inventory to FHWA so the information can be used in the appropriation of federal funds. In order for these tasks to occur, the condition of each bridge in the inventory must be determined, in accordance with the National Bridge Inspection Standards (NBIS). The NBIS provisions are contained in the Code of Federal Regulations (23 CFR 650, Part C). The data generated during the condition assessment process plays an integral part in determining whether a given structure falls within a predefined deficient bridge category: Structurally Deficient, Functionally Obsolete, or both, which is essential for the apportionment of HBP funds.

Manage - ODOT also uses the condition of the bridge inventory for the planning and development of the State Transportation Improvement Program (STIP) and the Major Bridge Maintenance Program (MBM).

4.2.2—Bridge Inventory Index

In order to help track each structure, ODOT Bridge Section created a "Bridge Log" which sorts the bridge inventory under ODOT jurisdiction by highway, milepost, and the first 6 digits of the bridge number. The Bridge Log is used throughout ODOT as an integral part of administering a wide variety of different programs, such as: Routing for Freight Mobility (Height and Weight); inventory of Sign Support structures; partial Culvert Inventory.

In order to minimize the size of the bridge log, Bridge Section integrated a number of abbreviations and acronyms into the publication:

4.3—ADMINISTRATION AND SECURITY MEASURES

4.3.1—Bridge Inventory Location

Pontis Bridge Inventory Database is located on server \\S-SALEMREV-63\PROD_M1.

4.3.2—Bridge Inventory Administration

ODOT Bridge Inspection Database Coordinator, and Database Administrator (DBA): Assigned ODOT Information Services Staff.

4.3.3—Bridge Inventory Access Security Measures

In order to maintain data integrity, access to the Bridge Inventory has been limited by the initiation of the following security measures:

- Internet Access: Limit Access by requiring the user to obtain a password from the ODOT Bridge Inventory Coordinator and approved by the ODOT Bridge Operations Engineer.
- Internet and Intranet Access: Limit Access by requiring NT Access Authentication by RACF ID
- Internet and Intranet Access: Limit Database Access by Permissions:
 - Administrator – Full Access
 - Inspector – See all records, can only edit certain fields
 - Load Rater – See all records, can only edit certain fields

- Read Only – See all records, can not edit anything
- Internet and Intranet Access: Limit Electronic Access:
 - Dedicated direct line with an ODBC Connection to the database (intranet)
 - User is issued a Virtual Private Network (SL VPN) token (internet)
 - User is issued a RAZ Card (internet)
- Limit Data Entry: In order to control the validity of the data that is entered into the bridge inspection data base, wherever possible, buttons have been used that will provide a selectable drop down pick list rather than an open text entry box.

4.4—Initial File Creation

4.4.1—Who's Responsible for Creating the Initial Bridge Inventory File?

The ODOT Bridge Inventory Coordinator creates the initial bridge inventory file in the ODOT Bridge Inspection Database. From there, the assigned bridge inspector populates the fields immediately following the completion of the Initial Bridge Inspection.

STRUCTURE INVENTORY AND APPRAISAL

IDENTIFY	CLASSIFY	NAVIGATE
(1)State Name	(112)NB/ Br. Length	(38)Navigation Control
(8)Structure No.	(104)Hwy System	(111)Pier Protection
(5)Inventory Rt.	(26)Functional Class	(39)Navigation Vert. Clearance
(2)State Hwy Dist.	(100)Defense Hwy	(116)Vert Lift Br. Min Clearance
(3)County	(101)Parallel Struct.	(40)Navigation Horiz. Clearance
(4)Place	(102)Direction of Traffic	
(6)Feature Intersected	(103)Temporary Struct.	GEOMETRY
(7)Facility Carried	(110)Designated Nat'l Network	(48)Length Max. Span
(9)Location	(20)Toll	(49)Structure Length
(11)Milepoint	(21)Maintain.	(50)Curb or Sidewalk, Left
(15)Latitude	(22)Owner	Curb or Sidewalk, Rt.
(17)Longitude	(37)Historical Significance	(51)Br Roadway Width, Curbs
(88)Border Br State		(52)Deck Width, Out to Out
% Share	STRTYPE	(32)Appr Roadway Width(w/shld)
(99)Border Br Str. No.	(43)Structure Type, Main	(33)Bridge Median
(121)Maintenance Notes	(45)No. of Main Spans	(34)Skew
(122)County Road No.	(44)Structure Type, Appr.	(35)Structure Flare
	(46)No. of Appr. Spans	(10)Inventory Rt. Min Vert. Clear.
AGE&SERV	(107)Deck Structure Type	(47)Inventory Rt. Min Horiz. Clear
(27)Year Built	(108A)Wearing Surface Type	(53)Min Vert Clear over Br Rdway
(106)Year Reconst.	(108B)Membrane Type	(54)Min Vert Underclear,
(42)Type of Serv. On	(108C)Deck Protection Type	(55)Min Lat Underclear Rt.
Type of Serv. Under		(56)Min Lat Underclear Lt.
(28)Lanes On	COND RATE	(118)Culvert Length
Lanes Under	(58)Deck	(119)Culvert Inside Height
(29)Ave. Daily Traffic	(59)Superstructure	
(30)Year of ADT	(60)Substructure	APPRAISE
(109)Truck ADT,%	(61)Channel&Channel Protect.	Sufficiency Rating
(19)Detour Length	(62)Culvert	Status (Structurally/Functionally)
	(72)Appr Roadway Alignment	(67)Structural Evaluation
		(68)Deck Geometry
IMPROVE	INSPECT	(69)Underclear, Vert. & Horiz.
(75)Type of Work	(90)Inspection Date	(71)Waterway Adequacy
(76)Length of Str Imp.	(91)Frequency	(36)Traffic Safety Features
(94)Br Improve. Cost	(92a)Fracture Crit. Detail	(113)Scour Critical Bridge
(95)Rdway Imp. Cost	Fracture Critical Insp. Freq.	(125)Roadway Embankment Erosion
(96)Total Proj. Cost	Fracture Crit. Insp. Date	
(97)Yr of Imp. Cost Est	(92b)Underwater Inspection	LOAD RATE
(114)Future ADT	Underwater Inspection Freq.	(31)Design Load
(115)Y of Future ADT	Underwater Inspection Date	(64)Operating Rating
(117)Est. Maint. Cost	(92c)Other Special Insp.	(63)Op Rating Calculation Method
	Other Special Insp. Freq.	(66)Inventory Rating
	Other Special Insp Date	(65)Inv Rating Calculation Method
	Inspector 1 No.	(70)Bridge Posting
	Inspector 2 No.	(41)Struct. Open, Posted, or Closed

4.4.2—Structure Number Protocol

Creation of a new record starts with the creation of the Structure Number

Each structure in the Bridge Inventory is issued a unique 15 digit Structure ID Number. The Structure ID Number is also referred to as the FHWA ID Number specified in the FHWA Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges (NBI Item 8). Once established the number preferably should never change for the life of the bridge.

In order to make each bridge inventory number unique, the State of Oregon decided the structure ID number should consist of the following: The first six digits is the assigned structure number; the next four digits is the route the structure is located on; and the next five digits is the milepost marker for the structure.

Each structure in the inventory is assigned a single unique 6 digit number. The 6-place number recorded in the Oregon Bridge Inventory can include leading zeros and trailing blanks or alphas. These assigned numbers are permanently fixed "serial numbers" for the structures. Typical examples of the format are:

Position	1	2	3	4	5	6
	0	0	3	3	2	A
	0	7	9	4	9	
	1	6	8	8	3	

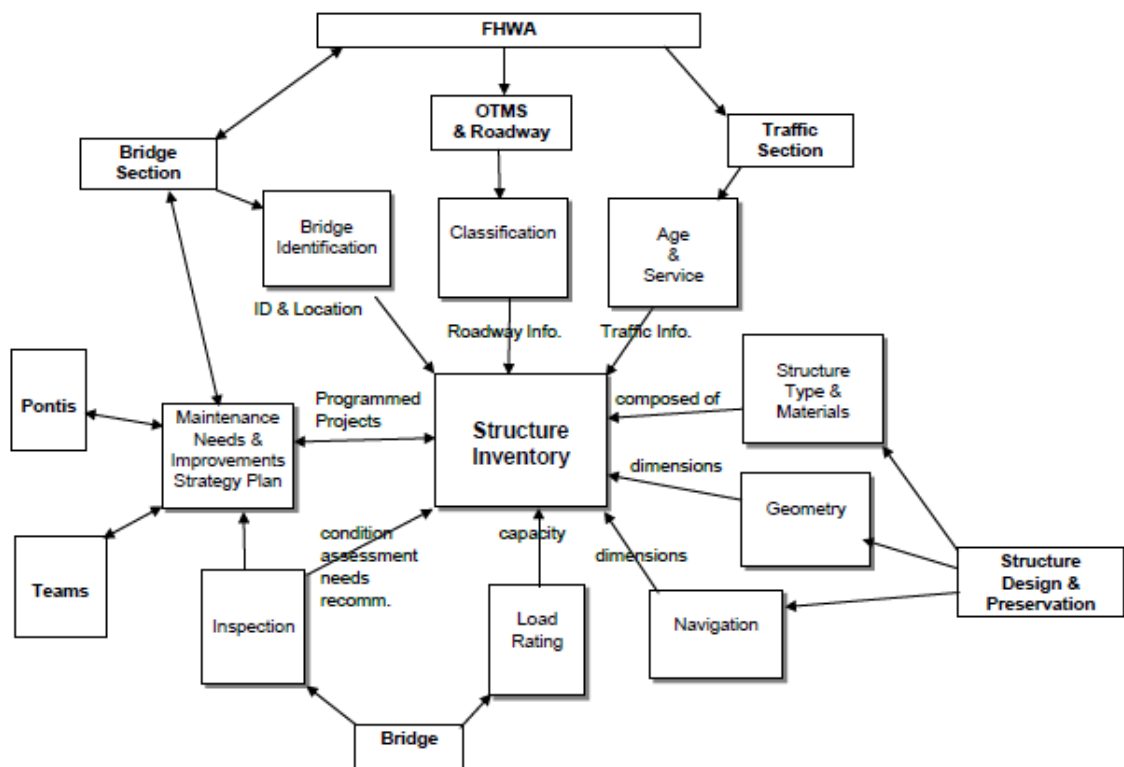
All new structure numbers will consist of numbers only, no alphas are permitted. The format will be consistent with the example shown above.

Structure numbers can be obtained through the Bridge Data System (BDS). Groups that do not have access to BDS will need to contact the Region Office where the work is to occur. The person trained in using BDS will determine whether or not a new structure number is required. The structural designer assigned to the project will provide information about what type of work is being performed for a given project.

To maintain structure numbering consistency, the following business rules were established. Resolution to situations not addressed will be reviewed for consistency with these guidelines, by ODOT Bridge HQ. Final resolution will be added to this document to provide future guidance.

- All structures that are determined to be one continuous structure and carry a designated route will be given one unique bridge ID number.
- When a structure number is assigned to a given structure it is considered to be all inclusive. A separate structure number will not be assigned to different components of an existing structure.
- When an existing structure is demolished and replaced, the new structure will be given a unique bridge number that is different than the retired structure number.
- When two structures are located immediately adjacent to each other but each separate superstructure is supported by a separate foundation, each will be given a unique bridge number, especially if they fall into differing age and condition groups.
- When an approach ramp is attached to a main thru structure, each approach ramp will be given a unique bridge number. The points of demarcation will generally be an identifiable deck joint.
- When four lines meet above grade at a self-supporting center structure (like Denny or Allen Blvd), the center structure will be considered a bent to the main thru structure and each side approach ramp will be given a separate unique bridge number.
- Every tunnel that carries traffic will be given a unique bridge number.
- If the spacing between each barrel of a multiple-barrel culvert is within $\frac{1}{2}$ the smallest diameter, a single unique bridge number will be assigned. If the distance between the barrels is greater than that dimension, each barrel will be given a separate unique bridge number.
- When an existing superstructure or any portion thereof, is moved to another location and set on a new foundation, that structure will be given a new bridge number.

- When a new structure is placed or constructed on the existing substructure, the structure will keep the old bridge number.
- When an existing superstructure or any portion thereof, is constructed on top of the existing substructure from the previous bridge, the structure will keep the previous bridge number.
- When an existing bridge is closed and remains in-place while a new detour structure is established to carry traffic until the existing structure is replaced, the original bridge number will remain in use. The temporary detour structure will not be given a unique bridge number.
- A single unique number will be given to each Viaduct structures and will be considered all inclusive. A separate number will not be given to retaining walls or other components if they are attached to the structure.
- A separate bridge number will be given to structures that are not attached to an existing structure, such as MSE Retaining Walls.
- If a structure is separated by sections of roadway fill or embankment, each separate section will be given a unique bridge number.
- A new structure number will be assigned to all new structures located on a new route.
- Features added to an existing structure, will have no affect on the assigned structure number.
- The existing bridge number will remain to be used when transferring ownership to another public agency.
- Changing the classification of the route will have no affect on the existing structure numbers.
- Work performed on a structure will have no affect on the existing structure number:
 - Structural Rehabilitation or Strengthening
 - Widening
 - Raising
 - Paving or Deck Overlays
 - Pedestrian Fencing
 - Painting
 - Maintenance Contracts
 - Special Studies
 - New railing
 - Changing electrical or mechanical systems
 - Seismic Retrofit
 - Scour protection
 - Installation of a Cathodic Protection System
 - Installation of a Pier Fender System
 - Modification of Sign Supports
 - Other minor remediations or repairs



4.4.3—Bridge Inventory: How is it Created/Updated/Maintained?

As directed by CFR 650.315(b) in order to assure that the NBI File accurately reflects the bridge's status, ODOT causes the file to be updated as promptly as practical, but no later than the specified 90 days after the change in status of a bridge under the State's jurisdiction or no longer than 180 days for all other bridges on public roads within the State. Preferably, this updating will occur as follows:

- Prior to the bid letting date of all newly constructed structures, Bridge Headquarters creates the initial bridge inventory file. The information contained in the file is based solely on information gleaned from the "Advanced Bridge Plans", and the appropriate assigned bridge inspector is notified of the upcoming addition to the inventory.
- When the construction of the new structure is substantially complete and the structure has been opened for public use, the assigned bridge inspector is directed to perform an initial condition assessment of the bridge, so that the bridge inventory can be updated. This update is based on information obtained in the field on the "As-Constructed" Bridge. In the State of Oregon, the term "substantially complete" is defined as the dissemination of the 2nd Notice. However, if the construction of a particular bridge is substantially complete prior to the completion of a project that contain a number of bundled bridges, the initial inspection could occur prior to the issuance of the 2nd Notice.
- Along with updating the Bridge Inventory, the assigned bridge inspector schedules the next routine inspection date and sets the bridge inspection frequencies. It is anticipated that these regularly scheduled inspections will occur throughout the remaining life of the bridge. The assigned bridge inspector is also required to complete and submit a signed copy of the routine bridge inspection report. This signed copy is filed as the official bridge inspection of record.
- Within the specified timeframes following completion of any modification of an existing structure which would alter the previously calculated sufficiency rating of the bridge, the assigned bridge inspector is required to perform a condition assessment of the modifications and assure that the bridge inventory data is correct, accurate, and up-to-date. This will require the assigned bridge inspector to complete and

submit a new amended Routine Bridge Inspection Report of Record. The purpose of this requirement is to provide added visibility and attention to major repair needs or to the completion of major repairs.

- As per CFR 650.313(d) in order to keep the load rating information contained in the bridge inventory current, the Bridge Section Program Unit, downloads the information into the bridge inventory at least on a bi-annual basis. This occurs just prior to the bi-annual FHWA submittal. The bridge load rating is revisited any time a bridge sustains major structural damage, or an inspector uncovers deficiencies that would result in the placement of an emergency load restriction, a bridge closure, or the placement of temporary shoring to keep the structure open for freight mobility. This item would also require a bridge review before a load restriction could be removed from a given structure. In any of the above occurs, the bridge inspector is directed to verbally notify the ODOT Bridge Load Raters and the jurisdictional owner of the structure immediately, followed by a "Damage to Structure" Report within 5 working days.
- To facilitate the collection and storage of such a volume of information that is continually changing, ODOT developed a web based system, using a SQL Server Database. Information can be entered into the database using the PONTIS Bridge Inspection Module. The information on all bridges that are NBI Structures is sent bi-annually to FHWA (April and October) and is stored in the national database called the Nation Bridge Inventory (NBI). This central database contains information on all NBI Bridges nationwide, and provides an information source for allocating federal dollars, establishing federal needs, and setting bridge priorities. Information on all structure that are Non-NBI Structures, is retained only in the state database and not reported to FHWA.
- The bridge record must reflect the information in the current bridge inspection report. That date upon which the field investigation was made must be noted. All work that has been done to the bridge since the last inspection should be listed. When maintenance or improvement work has altered the dimensions of the structure and/or channel, the new dimensions should be recorded.

4.5—ACCESS TO ELECTRONIC INSPECTION REPORTS

4.5.1—Primary Method: Internet/Intranet Access to the ODOT Bridge Inspection Web Page

This web page provides access to a set of standard reports that describe the condition and status of bridges and bridge structures in the State of Oregon. These reports provide users in the Bridge Community with a set of tools for evaluating alternative solutions, planning and coordinating work schedules, and analyzing cost estimates.

Intranet Access: [//highway.intranet.odot.state.or.us/cf/Pontis/](http://highway.intranet.odot.state.or.us/cf/Pontis/)

All intranet users have access permissions

Internet Access: [//egov.oregon.gov/ODOT/HWY/BRIDGE/](http://egov.oregon.gov/ODOT/HWY/BRIDGE/)

Click on Bridge Inspection Data link

Enter Login ID

Obtained from the ODOT Bridge Inventory Coordinator

The Web Page Contains 5 Standard Database Query Screens:

- Bridge Inspection Reports
- Inspection Schedule Report
- Bridge Maintenance Recommendations Report
- Load Rating Summary Report
- Sufficiency Rating Summary Report

4.5.1.1—Bridge Inspection Reports

This report identifies the condition of any bridge structure in the inventory, and provides basic information about a given structure, such as: who made the inspection, when was the inspection performed, what deficiencies were found, what actions were recommended by the bridge inspector, and how soon should the maintenance recommendation be implemented. Reports that can be downloaded via this query screen are:

- Routine Inspection Report
- Structure Inventory & Appraisal Sheet (SI&A)

- Underwater Inspection Report
- Fracture Critical Inspection Report
- Fatigue Prone Detail Inspection Reports
- Timber Boring Reports
- Bridge Clearance Diagrams
- Concrete Crack Diagrams
- Cross Channel Profiles
- Scour Plans of Action (POA's)
- Deck Surveys
- Sign Support Structure Inspection Reports
- Bridge Images

These reports can be queried by:

- Bridge Number
- Highway Route
- Milepoints
- County
- ODOT Highway District
- ODOT Region
- Bridge Inspection Area
- Custodian
- By Inspection Dates

4.5.1.2—Inspection Schedule

The depth, degree and frequency that each type of bridge inspection depends upon such factors as: the type of structure, its design features, age, condition, etc. Each bridge must be inspected as thoroughly and often as necessary to clearly establish its condition and to insure its continued safe operation. As a result, ODOT periodically performs a wide variety of different types of bridge inspections. The bridge inspection Schedule provides a scheduling and work planning tool for the bridge inspector. The report shows specifically when a given inspection was last performed on a specific structure, when the next inspection is due, and other supporting information. These inspection schedules can be downloaded into an Excel Spreadsheet for further data sorting or manipulation.

Inspection Schedules that can be downloaded via this query screen are:

- Routine Inspection
- Underwater Inspection
- Fracture Critical Inspection
- Fatigue Prone Detail Inspection
- Timber Boring
- Cross Channel Profiles
- Deck Surveys
- Pin and Hanger Inspection
- Scour Inspection

The schedule for the inspection of these structures can be queried by:

- Bridge Number
- Highway Route
- Milepoints
- County
- ODOT Highway District
- ODOT Region
- Bridge Inspection Area
- Custodian
- By Inspection Dates

4.5.1.3—Maintenance Recommendations

Each Bridge Maintenance Manager is responsible for developing a bridge maintenance program for each bridge/structure in their inventory. This maintenance program addresses who, what, when, where, why and how this maintenance program is to be accomplished. The Maintenance Recommendation report provides the Bridge Manager with a concise, prioritized list of bridge maintenance needs in order to ensure that a safe facility is available for the public. It is the Bridge Maintenance Managers responsibility to develop a work plan that will assure that the most important problems, on the most critical bridges, are getting the highest priority and are being addressed in the most cost effective manner. These reports can be downloaded into an Excel Spreadsheet for further data sorting or manipulation.

Bridge Maintenance Recommendations can be queried by:

- Bridge Number
- Highway Route
- Milepoints
- County
- ODOT Highway District
- ODOT Region
- Bridge Inspection Area
- Custodian
- Bridge Element
- Assigned Work Crew
- Priority
- Recommended Action
- Status of the Action
- Estimated Cost of the recommended Action

4.5.1.4—Load Rating Summary

The NBIS stipulates that each state will determine the safe load carrying capacity of each structure in their inventory in accordance with AASHTO guidelines. If it is determined under this rating procedure that the maximum legal load under State Law exceeds the load permitted under the Operating Rating, the bridge must be posted in conformity with the State Law. The Load Rating Summary report provides information relating to the results of the load rating analysis and follow-up inspections and/or evaluations.

Load Rating Summaries can be queried by:

- Bridge Number
- Highway Route
- Milepoints
- County
- ODOT Highway District
- ODOT Region
- Bridge Inspection Area
- Custodian
- Whether Load Posting is Required (Y/N)

4.5.1.5—Sufficiency Rating

This report provides the last three NBI sufficiency ratings that were calculated for any bridge in the inventory. The intent of this report is to review structure digression and improvement trends. These reports can be downloaded into an Excel Spreadsheet for further data sorting or manipulation.

The Sufficiency Rating Summary Report can be queried by:

- Bridge Number

- Highway Route
- Milepoints
- County
- ODOT Highway District
- ODOT Region
- Bridge Inspection Area
- Custodian
- Whether Temporary Repairs have been installed (Y/N)

4.5.2—Secondary Method: Intranet Access to the Supplemental Bridge Inspection Data Files

These files are located on Bridge Server S7000b and can only be accessed via the Intranet if the user has approved access permissions. The ODOT Bridge Operations Engineer has to approve access to these files. The supplemental reports are:

- Underwater Inspection Report
- Fracture Critical Inspection Report
- Fatigue Prone Detail Inspection Reports
- Timber Boring Reports
- Bridge Clearance Diagrams
- Cross Channel Profiles
- Bridge Images
- Scour Plans of Action (POA's)

4.5.3—Alternative Method: Generation of an Adhoc Report

If the above, does not provide the desired information, the User can request an “Adhoc Report”. However, in order to assure the data contained in a requested report is accurate, ODOT has limited the staff that can generate these adhoc reports, to the ODOT Bridge Management System Coordinators.

CHAPTER 5: CERTIFICATION OF BRIDGE INSPECTION PERSONNEL

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CHAPTER 5:

CERTIFICATION OF BRIDGE INSPECTION PERSONNEL

5.1—REQUIRED BRIDGE INSPECTOR QUALIFICATIONS

Code of Federal Regulation Requirements - Whatever the organizational structure the agency chooses, the NBIS requires certain levels of experience and/or education of the individuals who make up the organization and the bridge inspection team. These levels of experience and/or education vary according to the individual's level of responsibility. These minimum qualifications were established to insure that the individuals involved with the program received the training and experience necessary to perform the assigned tasks. It is clearly understood that a successful bridge inspection is dependent on proper planning, utilizing proper techniques, having access to the right equipment, and the experience and reliability of the personnel performing the work. Inspections must not be confined to only searching for defects which may exist, but must also include anticipating incipient problems. Thus, inspectors must be cognizant of both preventive, as well as, corrective maintenance programs.

State of Oregon Qualification Requirements – It's understood that each State Department of Transportation may require the individuals to meet certain additional qualifications that are over and above the minimum FHWA requirements specified in the CFR. In the State of Oregon, these additional qualification requirements are as follows:

- Successful completion of the ODOT Bridge Inspection Proficiency Test, as administered by ODOT Bridge Operations, and
- Meet the specified Training Requirements (chapter 5.3)

The minimum qualifications are as follows:

5.1.1—Bridge Inspection Program Manager

CFR 650.307(e) requires each State transportation department to have a Bridge Inspection Organization Program Manager, that meets the qualifications defined in 650.309(a). ODOT requires the following:

- Be a registered professional engineer, or
- Have 10 years bridge inspection experience;

and

- Successfully completed a FHWA approved comprehensive bridge inspection training course based on element level inspections, and
- Successfully completed an FHWA approved Fracture Critical bridge inspection training course, and
- Pass the ODOT Bridge Inspection Proficiency Exam

The Program Manager is the person that has been delegated the responsibility for:

- 650.307(c)(1): Statewide bridge inspection policies and procedures, quality assurance and quality control, and preparation and maintenance of a bridge inventory, and
- 650.307(c)(2): Bridge inspections, reports, load ratings and other requirements contained in the NBIS.

In the State of Oregon, the individual who heads the ODOT Bridge Inspection organization and is responsible for compliance with the NBIS, FHWA and ODOT bridge inspection program standards is the ODOT Bridge Operations Engineer.

5.1.2—Bridge Inspection Team Leader

CFR 650.313(a) requires each State to inspect each bridge in their inventory in accordance with the inspection procedures in the AASHTO Manual. CFR 650.313(b) requires at least one team leader, who meets the minimum qualifications provided in 650.309(b), to be at the bridge site at all times during each initial, routine, in-depth, fracture critical member and underwater inspections. As provided in the CFR, there are five ways to qualify as a bridge inspection team leader. ODOT added the "pass the proficiency exam requirement" due to the following: Bridge Inspection work is serious business; ODOT often has very little information regarding the bridge inspectors background, skill level, or training; the bridge inspection team leader has minimal programmatic direction or over-

sight; data consistency and uniformity is absolutely paramount. As a result, the minimum qualifications for a bridge inspection team leader are:

- Meet the same qualifications as the Program Manager, **or**
- Have five years bridge inspection experience, successfully completed an FHWA approved comprehensive bridge inspection training course based on element level inspections, successfully completed an FHWA approved Fracture Critical bridge inspection training course, and pass the ODOT Bridge Inspection Proficiency Exam; **or**
- 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, successfully completed an FHWA approved Fracture Critical bridge inspection training course, and pass the ODOT Bridge Inspection Proficiency Exam; **or**
- Have all of the following:
 - A bachelor's degree in engineering from a college or university accredited by or determined as substantially equivalent by the Accreditation Board of Engineering and Technology;
 - Successfully passed the National Council of Examiners for Engineering and Surveying Fundamentals of Engineering Examination;
 - Two years of bridge inspection experience; **and**
 - Successfully completed an FHWA approved comprehensive bridge inspection training course, **and**
 - Successfully completed an FHWA approved Fracture Critical bridge inspection training course, **and**
 - Pass the ODOT Bridge Inspection Proficiency Exam; **or**
- Have all of the following:
 - 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;
 - Four years of bridge inspection experience; **and**
 - Successfully completed an FHWA approved comprehensive bridge inspection training course, **and**
 - Successfully completed an FHWA approved Fracture Critical bridge inspection training course, **and**
 - Pass the ODOT Bridge Inspection Proficiency Exam.

The Registered Professional Engineer specified above, is primarily referring to the civil or structural discipline and registered in the State of Oregon. Otherwise their activities and involvement in the Bridge Inspection Program are controlled by the Canons of Ethical Professional Practice.

5.1.3—Bridge Inspector Trainee

Quite often, other bridge inspection members are assigned to the team as a trainee, in order to accrue experience as a bridge inspector or to fulfill assigned tasks that support the work of the bridge inspection team leader.. These team members can be assigned the following duties:

- To assist the lead inspector gather bridge inspection information,
- Traffic control, traffic spotter
- Deal with safety issues,
- Take measurements,
- Preparing notes and sketches,
- Take photographs,
- Enter data into the computer,
- Perform inspections on Non-NBI Structures, or
- Perform a task where the team member has a demonstrated specialized area of expertise.

If the bridge inspection team leader is an observer, taking notes, while the inspection work is being performed by another team member, who might not be qualified as a team leader, the other team member must at least be qualified

as a bridge inspector trainee and required to review the notes, immediately, upon returning to the location of the team leader, verify their content, and attest to their completeness by initialing or signing the notes.

5.1.4—Load Rating Engineer

CFR 650.309(c) requires that the individual that has been charged with the overall responsibility for load rating bridges must be a Registered Professional Engineer in the State of Oregon.

5.1.5—Underwater Bridge Inspection Dive Team Leader

CFR 650.309(d) requires all dive team members to have completed an FHWA approved comprehensive bridge inspection training course, or the FHWA approved NHI Underwater Diver Bridge Inspection Training course. However, since during the course of a typical underwater inspection, the divers are not necessarily under direct visual observation by the team leader, each diver must be capable of conducting a thorough inspection, recognizing defects and deterioration, and documenting and describing their observations using common terminology and techniques. For that reason, the State of Oregon requires, the Underwater Bridge Inspector-of-Record must be certified as a Bridge Inspection Team Leader and must be on-site during every underwater inspection. By signing and posting the Inspection Report, the UW Bridge Inspector-of-Record is certifying the work was completed in accordance with the NBIS and ODOT Bridge Inspection Guidelines.

5.1.5.1—Underwater Dive Team Member

CFR 650.309(d) requires all dive team members to have completed an FHWA approved comprehensive bridge inspection training course, or other FHWA approved Underwater Diver Bridge Inspection Training course (similar to the NHI Course). Even though not required, the other part-time divers are strongly encouraged to obtain their certification as a Bridge Inspection Team Leader.

5.1.6—Inspection of Complex Bridge Details

CFR 650.313(f) – Inspection Procedures Complex Bridges: Identify specialized inspection procedures and additional inspector training and experience required to inspect complex bridges. Inspect complex bridges according to those procedures.

Bridge Inspection tasks that can be classified as requiring specialized skills, knowledge and/or expertise, to complete, does not necessarily have to be accompanied by a bridge inspection team leader, i.e., material testing, timber boring, inspecting cathodic protection systems, inspection of drawbridge electrical / mechanical system, bridge health monitoring, etc.. However the tasks must be performed by a person that has demonstrated the desired specialized skills, knowledge and/or expertise, to the satisfaction of the ODOT Bridge Operations Engineer.

5.1.7—Allowance for Past Experience

Qualifying bridge inspection experience is assumed to be while performing safety inspection of in-service bridges in accordance with the NBIS and under the direct supervision of a Certified Bridge Inspection Team Leader. One year worth of experience has been determined to be the active participation in at least 25 bridge inspections in a given year.

Allowances may be made for experience other than NBIS inspections under a Certified Team Leader. This may include, but is not necessarily limited to:

- Bridge design,
- Bridge construction inspection,
- Bridge maintenance, or
- Other structural related experience.

Normal practice is to allow a maximum of the equivalent of one year credit for other 4 years of other experience. The Bridge Operations Engineer will determine, on an individual basis, the appropriate level of credit to be allowed upon review of the individual's application, resume', and proficiency inspections performed.

5.1.8—Training Requirements

In order for the comprehensive Bridge Inspection Training Course to be accepted the individual must show that the training course either meets or is equivalent to the following:

The individual has a certificate of successful completion of the training course;

- Based on the FHWA Bridge Inspection Reference Manual (BIRM);
- Included the Element Level Bridge Inspection Option;
- The training course was approved by FHWA.
- Meet the continuing education training requirements specified by the ODOT.

5.1.9—ODOT Bridge Inspection Resume

The applicant will submit a Resume that contains the following information:

- Name of Applicant
- Agency Represented
- Agency Address
- Contact Information
- Education
 - Formal (College / Trade School) . . Date / Location
 - Comprehensive Br Insp Training . . Date / Location
 - Br Insp Refresher Course Date / Location
 - Fracture Critical Br Insp Training. . Date / Location
 - UW Bridge Inspection Date / Location
- Experience
 - Bridge Inspection Experience
 - Approximate number of bridges inspected each year
 - In what capacity
- License, Registration, and Certifications
 - Professional Engineer
 - Oregon Certified Bridge Inspection Team Leader No.
 - ODOT Proficiency Exam
- Other Relevant Background Information

It's up to each applicant to provide the training course attendance documentation, as well as, the confirmation documentation that the course was approved by FHWA.

5.2—INITIAL BRIDGE INSPECTOR CERTIFICATION PROCESS

The applicability of this section is for:

- Those that have never been certified as a Bridge Inspection Team Leader before, or
- Bridge Inspectors have been certified in another state and want to obtain their certification in the State of Oregon.

The National Bridge Inspection Standards (NBIS) and the Oregon Department of Transportation policy require that all bridge inspections performed for the purpose of maintaining compliance with NBIS requirements be performed by a Certified Bridge Inspection Team Leader. In addition to these minimum standards ODOT has supplemented additional business practices in an effort to insure the inspection information generated in the State of Oregon is complete, thorough, and provides an accurate condition assessment of the structures being inspected so that the bridge managers have the best and most accurate information possible with which to make programmatic decisions.

The intent of the Bridge Inspector Certification program is to insure that all individuals performing NBIS bridge inspections are:

- Thoroughly proficient in all aspects of the bridge inspection process,
- Maintain a familiarity with current recording, condition assessment reporting procedures, and the creation and use of the various supplemental reports, used in the State of Oregon.
- Understand program requirements as related to routine inspection frequency, posting requirements, elements of a fracture critical inspection, underwater inspections, load rating requirements, scour evaluation requirements, other required periodic inspections.

As the Bridge Inspection Program Manager for the State of Oregon, the ODOT Bridge Operations Engineer is responsible for the certification of bridge inspectors that perform NBIS inspections in the State of Oregon. The final determination of any individual's qualifications as a Certified Bridge Inspector in the State of Oregon is made based upon the individual's demonstrated performance and ability, which can be subject to review at any time.

Each Certified Bridge Inspection Team Leader or Trainee will be given a certification card with an assigned identification number which will be coded in the Oregon Bridge Inventory as item #120 for each bridge inspected. A bridge inspector trainee is involved in the inspection, the use of the trainee's certification number on the inspection report will allow tracking of the experience of the trainee toward that required for certification as a Certified Bridge Inspection Team Leader. The certification card will also have an expiration date which is 5 years following the certification anniversary date. All bridge inspectors in the State of Oregon will have to renew their certification at least every 5 years.

Bridge inspections performed by a single individual require that the inspector be certified as a Bridge Inspection Team Leader in accordance with the prescribed standards contained within this document. Inspections that are accomplished using additional team members, the leader of the team must be certified as a bridge inspection team leader. The team leader is the individual in charge of the work and must:

- Be on-site during the inspection,
- Assure the accuracy and adequacy of the inspection,
- Assure the completeness and accuracy of the reports, and
- Sign the completed inspection report which becomes the inspection of record.

5.2.1—Minimum Certified Bridge Inspection Team Leader Requirements

In order for a bridge inspector to be certified or maintain their certification as a Bridge Inspection Team Leader in the State of Oregon, they must meet the following minimum requirements:

- Meet Education / Registration / Experience Requirements, and
- Fulfill NBIS Bridge Inspection Training Requirements, and
- Satisfactorily complete the Proficiency Examination Requirements, and
- Satisfactorily complete the Re-certification Requirements, and
- Provide the Certification Record Requirements (Current Resume').

Examination Requirements

Each Certified Bridge Inspection Team Leader must be able to exhibit an acceptable level of proficiency by performing a number of independent bridge inspections, over a two day period, and obtain an average of 80% correct answers. The Bridge Operations Engineer will determine criteria for acceptable rating tolerances, coding errors and supporting remarks.

Bridge Inspector Proficiency Testing

Since the bridge inspectors work very independently, ODOT desires to establish an acceptable level of comfort for all bridge inspection work, statewide. Generally the proficiency testing will be administered as follows:

- The Candidate will schedule and team up with an ODOT staff person, who will accompany the candidate throughout the proficiency test. The ODOT staff person will not function as a resource to the candidate.
- The Candidate will be given a map that shows the location of all bridges that are to be inspected and it's up to the candidate to locate and drive to each bridge site.

- The Candidate will be given a blank QA Review Sheet, a copy of the SI&A sheet for each bridge on the list, and any supplemental reports for each bridge. The candidate will be instructed to not only fill out the QA Review Sheet, but to also review and update information shown on the SI&A sheet. Both sheets will be turned into ODOT at the end of each day.
- The inspection results produced by the candidate will be compared to the results produced by an ODOT Bridge Inspection QA Review Team.
- Each inspection will be graded in the following areas:
 1. NBI data used to calculate the Sufficiency Rating (Items 28, 36, 43 & 44 Including 103, 108)
 - o Acceptable threshold is expected to be exact.
 2. NBI Ratings (Items 41 & 70)
 - o Acceptable threshold is expected to be exact.
 3. NBI Condition Ratings (Items 58, 59, 60, 61, 71 & 72)
 - o Acceptable threshold is $\pm$ one rating number
 4. List of Bridge Elements and their quantities
 - o Acceptable threshold is expected to be exact.
 - o Quantities may vary (w/in 10%, Paint Systems excluded)
 5. List of Defects associated with each Element and the stratified CS Ratings
 - o Acceptable Defect threshold is expected to be exact (additional Defects listed do not count against the examinee)
 - o Acceptable CS threshold is expected to be within the designated CS
 - o For Elements 980 & 999 the acceptable threshold is expected to be within the designated CS
 6. List of Protection Systems and the stratified CS Ratings
 - o Acceptable threshold is expected to be within the designated CS
 7. Stratified Bridge Element CS Ratings
 - o Acceptable threshold is expected to be within the designated CS
 8. Adequate Condition Assessment Remarks (Y / N)
 9. Adequate Maintenance Recommendations based on assessment as specified in the ODOT Element Coding Guide.
- Proficiency is achieved when the applicant obtains a passing grade of 80% (or greater) correct answers on the ODOT Proficiency Exam.
- The candidate will be notified as to the percentage of correct answers and whether their proficiency testing was successful.
- If the candidate was successful, the proficiency testing results should be listed on the candidates resume'. If the candidate was not successful, the candidate will be given another opportunity, after a 6 month wait period.
- Each applicant must allow ODOT at least a 30 day turn-around for grading and posting the test results.

Certification Record Requirements (Required Documentation)

It is the responsibility of the applicant to provide:

- Documentation that fully supports all experience claimed for the satisfaction of the years of experience requirement,
- The results of the bridge inspection proficiency test, and
- The fulfillment of the Education Requirements, and
- Proof of successful completion of an approved Element Level Comprehensive Bridge Inspection Training Course.

The Bridge Operations Engineer will review the applicant's resume, documentation, and the results of the independent proficiency inspections, to determine the appropriate credit to be considered. This determination will:

- Take into account the number of bridges inspected each year,
- The complexity and type of bridges inspected,
- The level of responsibility and accountability assumed for the inspection,
- Demonstrated Accuracy and completeness of reports,
- Reports generated and / or updated by the applicant, and
- Such other factors as deemed appropriate by the Engineer.

5.2.2—Bridge Inspector Trainee

There is no requirement that members of a bridge inspection team other than the team leader be certified as the NBIS Bridge Inspector-of-Record. The ODOT, Bridge Operations office, however, has adopted the policy of recognizing those uncertified members of the inspection team as Bridge Inspector Trainee (CBI-T) for the purpose of documenting their experience and training as qualifying toward full certification. Experience claimed toward certification is expected to be work in a responsible capacity in bridge construction and/or safety inspection of bridges and under the supervision of a qualified team leader.

Registered Professional Engineers, in the State of Oregon, applying for certification, if otherwise meeting requirements, may be certified pending completion of the required 2 week comprehensive bridge inspection training and completion of an OJT reporting and recording procedures session. The training in reporting and recording procedures may be accomplished by attending a class sponsored by ODOT Bridge Operations section or other recognized agency training bridge inspectors to FHWA standards. Training on a personal one-on-one basis by a certified team leader may also be acceptable. Verification of such training must be submitted to the ODOT Bridge Operations Engineer by the Certified Inspector providing the training and will be reviewed for adequacy. If approved and all other requirements have been met, a Certified Bridge Inspection Team Leader certification card may be issued.

This does not apply for Non-Certified UW Bridge Inspection members (Refer to Chapter 5.6).

5.3—RENEWAL OF BRIDGE INSPECTOR CERTIFICATIONS IN THE STATE OF OREGON

In order for all Bridge Inspection Program Managers and Certified Bridge Inspection Team Leaders to retain their certifications, CFR 650.313(g) requires a “periodic field review of inspection teams, periodic bridge inspection refresher training and independent review of inspection reports and computations.” In the State of Oregon, immediately following the certification process, all bridge inspectors are issued a certification card that will expire 5 years following the date of issuance. In order for the bridge inspectors and program manager to renew their certification, they must comply with the following:

5.3.1—Minimum Bridge Inspector Re-Certification Requirements

In order for a bridge inspector to be re-certified or maintain their certification as a Bridge Inspection Team Leader in the State of Oregon, they must meet the following minimum requirements:

- Must have been initially certified as a Bridge Inspection Team Leader in the State of Oregon;
- Fulfillment of the ODOT Continuing Education requirements; and
- Must submit a current and up-to-date bridge inspection resume’.

In order to assure that each applicant has a clear understanding of what all the numbers mean and the critical features of the program, preferably, the applicant will be able to show on their resume’, that they have remained actively involved in the bridge inspection program, in some responsible capacity.

If the applicant has fulfilled the above, ODOT Bridge Section will issue a new certification card that will be good for another 5 years.

5.3.2—Continuing Education Requirements

In order for each Certified Bridge Inspection Team Leader to maintain their certification in the State of Oregon, in addition to the comprehensive bridge inspection training requirements, they must satisfactorily complete and document a certain number of Professional Development Hours (PDH) that are associated with the condition assessment of in-service bridges. In accordance with the NBIS (650.305 – Bridge Inspection Refresher Training Definition) the training must be the NHI Bridge Inspection Refresher Training Course 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. In the State of Oregon, the Professional Development Hours must meet the following criteria:

- Active participation in an ODOT QA field review (10 hours max).

- Successful completion of the NHI Bridge Inspection Refresher course within the previous 5 year period, and
- Log, at least 30 hours over the 5 previous years that fit the following:
- Aimed towards improving quality of inspections, or
- Introduction of new bridge inspection techniques, or
- Maintaining the consistency of the bridge inspection program.

Due to known training content ODOT has determined the following will be allowed as credit towards the continuing education requirement:

- Active participation in an ODOT QA field review (10 hours max).
- Attend the ODOT's Bridge Inspection conference, (10 hours max).
- Attending the ODOT Bridge Inspection Orientation session, (4 hrs max).
- Attend a Fracture Critical Bridge Inspection Class (16 hours max)
- Attend a Non-Destructive Evaluation training class. (4 hours max)
- Attend the ODOT Bridge Maintenance Conference (4 hours max)
- Attend the NHI Underwater Bridge Inspection Training (10 hrs max)
- Active participation in the ODOT Underwater Bridge Inspection training session (10 hours max).

5.3.3—Certification Renewal Record Requirements (Required Documentation)

The Bridge Operations Engineer will review the applicant's resume and documentation.

- It's up to each applicant to provide attendance documentation and a short narrative that clearly supports how the training received meets the specified criteria above.
- It is the responsibility of the applicant to provide sufficient documentation that fully supports their claim that they have stayed actively involved in the bridge inspection program as administered by ODOT in some responsible capacity, how the continuing education requirements were met.

5.3.4—ODOT Sponsored Bridge Inspection Training

- NHI Comprehensive Bridge Inspection Training (2 weeks)
 - o Obtain certification as a Bridge Inspection Team leader
 - o Every other odd year
- NBI Bridge Inspection Refresher (3 days)
 - o Meet Continuing Education Requirements
 - o Every even year
- Pacific NW Bridge Inspection Conference
 - o Obtain Continuing Education Requirements
 - o Every odd year
- Bridge Inspection Program Orientation (1 day)
 - o Update ODOT Coding Guides, Inspection Manuals and Business Rules
 - o Annual basis: every spring
- Fracture Critical Bridge Inspection Training
 - o Broaden knowledge base and area of expertise
 - o Every other even year
- Underwater Bridge Inspection Safety Training
 - o Broaden diver knowledge base and area of expertise
 - o Annual basis: every spring
- Participation in the ODOT QA Field Reviews
 - o Assess accuracy of data generated by Bridge Inspectors
 - o Monthly during summer months
- ODOT Region Bridge Inspector's Meetings
 - o Cover ODOT Business Practices
 - o Quarterly basis

5.4—MAINTAINING CERTIFICATION AS A BRIDGE INSPECTION TEAM LEADER IN THE STATE OF OREGON

5.4.1—Quality Assurance Field Reviews of Completed Work

To assure the accuracy and thoroughness of the bridge data being collected, ODOT will perform periodic QA Field Reviews on a sampling of bridges. If a Certified Bridge Inspector is found to have an average of more than 4 errors per bridge, the work performed by that individual will come under further scrutiny. The results of the QA Reviews will require the following progressive actions to be taken:

(1) Following this initial QA review, differences will be discussed with the inspector and the inspector will be given an opportunity to correct the data. Within 6 months, ODOT will perform a follow-up QA field review on work performed by that inspector following the initial QA review. The work will again be assessed for accuracy, thoroughness, and conformance with ODOT Bridge Inspection Guidelines. This will be called the 1st follow-up review.

(2) If the work performed by the inspector is still found to be unsatisfactory, within 6 months of the 1st Follow-up QA review, ODOT will perform another field review on the work performed by the bridge inspector. If the work performed by the inspector is still found to be unsatisfactory, the inspector will be required to successfully complete additional training that meets the acceptable training criteria and successfully complete an additional proficiency test. This will be referred to as the 2nd follow-up review.

(3) Within 6 months following the 2nd Field QA Review, ODOT will again perform another field review on the work performed by the bridge inspector. If the work performed by the inspector is still unsatisfactory, the individual will not be allowed to perform the Certified Bridge Inspection Team Leader duties in the State of Oregon. This will be referred to as the 3rd follow-up review.

5.5—RE-CERTIFICATION AFTER CERTIFICATION HAS EXPIRED

5.5.1—RE-CERTIFICATION Following a Prolonged Period of Inactivity

If a Certified Bridge Inspector has been inactive for a prolonged period of time (longer than 5 years), the Bridge Inspector certification will become non-current. Inactivity is defined when the previously issued ODOT Certification Card has expired and the level of inspection involvement has decreased to a point where it is no longer practical to assume that the inspector's skills and proficiency are current enough to maintain the level of accuracy required by the NBIS or ODOT.

- Participation in the ODOT QA Field Reviews
- Determination of whether or not a bridge inspector certification is current will be made based on guidelines established by the Bridge Operations Engineer and will take into account factors such as:
 - Number of bridges inspected on a routine basis,
 - Complexity of bridges inspected,
 - Types of inspections performed (Routine, Fracture Critical, Timber Boring, Movable span, etc.), and
 - The level of accountability for inspections performed (Team Member vs Team Leader).
- Successfully passed the bridge inspection proficiency test.

When a certification becomes non-current, the inspector will no longer be considered a Team Leader, but will be reclassified as a Bridge Inspector Trainee (CBI-T). As a minimum, the requirement for re-certification will normally be:

- Completion of the 2 week comprehensive Bridge Inspector's Training Course, or
- Completion of an equivalent training course, approved by FHWA, or
- Completion of On-The-Job experience approved by the Bridge Operations Engineer, and
- Successfully complete the ODOT bridge inspection proficiency test.

The Bridge Operations Engineer may include in the re-certification procedure such additional requirements as deemed appropriate, considering the individual circumstances, to insure that when certified, the individual has the necessary knowledge and skills needed to perform bridge inspection work.

5.6—CERTIFICATION AND RE-CERTIFICATION OF UNDERWATER BRIDGE INSPECTION TEAM LEADERS AND UNDERWATER DIVE TEAM MEMBERS

5.6.1—Underwater Dive Team Members

CFR 650.309(d) Qualifications of Personnel states that “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.”

However, CFR 650.309 states that all Bridge Inspection Team Leaders must have successfully completed an FHWA approved Comprehensive Bridge Inspection Training Course.

In order to maintain their UW Bridge Inspection Dive Team Member status, the applicant must fulfill the following within a 5 year period:

- Obtain their Advanced Underwater Diver Certification
- Successfully complete a FHWA approved UW diver bridge inspection course.
- Successfully complete the Bridge Inspection Refresher course.
- Annual participation in the ODOT UW Safety Training Course
- Participate in at least four weeks of UW Bridge Inspection Work
- Participate in the annual UW Bridge Inspection QA Review session.

5.6.2—Underwater Bridge Inspection Team Leader Certifications

In addition to completing the above, the applicant must:

- Successfully complete the ODOT Proficiency Exam.
- Participate in at least one of the ODOT above water Bridge Inspection QA Reviews.

CHAPTER 6: BRIDGE INSPECTOR DUTIES & BRIDGE INSPECTOR CODING GUIDES

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CHAPTER 6:**BRIDGE INSPECTOR DUTIES & BRIDGE INSPECTION CODING GUIDES****6.0—DUTIES OF THE BRIDGE INSPECTOR****6.0.1—Introduction**

CFR 650.313(a) directs that each bridge is to be inspected in accordance with the inspection procedures in the AASHTO Manual for Condition Evaluation of Bridges. In other words, each state must assure that each bridge is inspected as thoroughly as necessary to clearly establish its condition and to insure its safe operations. Since the bridge inspection team leaders work very independently, with minimal direct supervision, by filing a signed Bridge Inspection Report, they are certifying that the work was performed in accordance with the NBIS. The signed Bridge inspection report is referred to as the “Bridge Inspection-of-Record” and the bridge inspector is referred to the “Bridge Inspector-of-Record”.

The assigned bridge inspection team leader is responsible for fulfilling the following tasks:

- Identifying what type of inspections are needed for each particular structure
- What Personnel is needed on the Inspection Team,
- Mitigation of Bridge Inspector Safety Issues
- Anticipated Access Methods, Equipment, and Bridge site Itinerary
- Anticipated Inspection Methods, Procedures, Tools, and Special Instructions
- Coordinating Inspection Activities with Others like the Railroad
- Methods for Recording Bridge Inspection Field Data
- Following Bridge Element Condition Rating Guidelines
- Following Underwater Bridge Member Condition Rating Guidelines
- Channel and Channel Protection / Scour Monitoring
- Notification Expectations for Reporting Critical Findings
- Updating the Inspection Supporting Documents –
- Post Prioritized Bridge Maintenance / Repair Recommendations
- Participate in the Quality Assurance / Quality Control Process.

In order to be fully prepared to perform the work at hand, the bridge inspector must determine how each of the following is going to be addressed:

Determine the qualifications that need to be incorporated into the Bridge Inspection Team.

CFR 650.313(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. A bridge inspection team leader does not necessarily have to be on-site during a special or a bridge damage assessment inspection.

Determine whether the structure has a load restriction, the controlling member, what the posting should be, and the bridge condition when the load rating was performed.

CFR 650.313(C) Rate each bridge as to its safe load carrying capacity in accordance with the AASHTO Manual. 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.

Determine whether prior maintenance actions were required, their priority and status.

CFR 650.313(d) Prepare bridge files as described in the AASHTO Manual. 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 agency forms.

Determine whether FC or UW Inspections are required, if the bridge is Scour Critical and whether the structure has a Scour Plan of Action (POA).

CFR 650.313(e) Identify bridges with FCMs, bridge requiring underwater inspection, and bridge that are scour critical.

Determine the location of all FP and FCMs and the procedures for their inspection.

CFR 650.313(e)(1) Bridges with FCMs. In the inspection records, identify the location of FCMs and describe the FCM inspection frequency and procedures. Inspect FCMs according to these procedures. (Procedures are located in Chapter 11.1).

Determine the location of all UW element and the procedures for their inspection.

CFR 650.313(e)(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. (Procedures are located in Chapter 12.1).

Determine whether the bridge contains known or potential scour deficiencies by referring to the cross-channel profile and the scour plan of action for the bridge.

CFR 650.313(e)(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.

Determine whether the bridge contains complex details and how they should be inspected.

CFR 650.313(f) Complex Bridges. Identify specialized inspection procedures, and additional inspection training and experience required to inspect complex bridges. Inspect complex bridges according to those procedures.

Determine the status of any prior Critical Finding for the bridge.

CFR 650.313(h) Establish a statewide 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. (Critical Finding Process is located in Chapter 8).

6.0.2—Planning the Bridge Inspection

Every inspection is unique. The process can vary considerably depending on the type of bridge. The following is to simply help guide inspectors toward an appropriate process for each particular bridge. If the bridge inspector is knowledgeable in the structural behavior and design of bridges, the changing behavior of materials with age, fatigue, stress, weathering, and chemical reaction, typical construction practices, and tell-tale signs of either their proper or improper placement, will definitely help the bridge inspection process to run much smoother.

Inspection Procedures

1. Plan a General Course of Action.

When you arrive at the bridge site for the first time, it's helpful to look over the entire bridge to get a feel for what problems may exist and to focus on how to use access equipment in specific areas.

2. Developing an Eye for Potential Trouble.

The majority of inspection work is close-up visual inspection, including chipping, scraping and measuring. The bridge inspector must be familiar with the general characteristics of the structure type so that they will know where to expect to find problems: all parts that move like bearings, pins, joints, etc, or when the movable components freeze up, the movement is generally translated to other fixed members where the movement is restrained thereby increasing the stress levels on those restrained members. When problems are found the location, size, and severity of the deterioration or distress and its probable cause should be noted, particularly when repair plans or load rating calculations are to be prepared from the field notes. Throughout the inspection each inspector should be asking questions:

- Was this member really designed or constructed like this, or did something move?
- Why are these bolts here and rivets everywhere else?

- Did somebody make a change or repair?
- What's causing this deterioration?
- Will repairing the member solve the problem, or is a repair elsewhere needed to prevent further deterioration?
- Is this a basic design flaw, material flaw, normal deterioration or just bad construction?

It is clearly understood that a successful bridge inspection is dependent on proper planning, utilizing proper techniques, having access to the right equipment, and the experience and reliability of the personnel performing the work. Inspections must not be confined to only searching for defects which may exist, but must also include anticipating incipient problems. Thus, inspectors must be cognizant of both preventive, as well as, corrective maintenance programs.

3. Take Special Precautions around railroads and transit systems.

Working on or over a railroad almost always requires some special procedure to be initiated. The bridge inspection team must not foul the tracks. The railroad train window of usage is within 10 feet each side of the rails. The bridge inspector can perform these inspections and cross the tracks without notifying the railroad company. However, if the bridge inspector is required to remain within the railroad train usage window for more than a few minutes, obtaining a permit of entry, and having a railroad flagger on-site, is a must. If the railroad engineer sees a florescent orange vest next to the tracks, their instructions are to immediately stop the train. Those that cause the train stoppage could be charged or fined thousands of dollars for every minute the train is shut down. As a business rule, it's a lot more acceptable if the inspectors stay behind the adjacent bridge bent.

Schedule the Work and Work the Schedule

The type of inspections may vary over the useful life of a bridge, in order to reflect the intensity of inspection required at the time of inspection.

- Initial Inspection
- Routine Inspection
- Underwater Inspection
- Fracture Critical Inspections
- Fatigue Prone Detail Inspections
- Timber Borings
- Scour Monitoring
- Clearance Dimensions
- Inspection of Bridges that are under construction
- Drawbridge Operational Inspections

Expectations for Inspecting Bridges located within a Construction Work Zones

The bridge inventory file will remain active as long as the existing structure remains standing in-place in its present configuration. If either of the following exists, the bridge inspector will be required to inspect the structures in the construction work zone in accordance with the NBIS:

If a bridge remains in service while an adjacent replacement structure is being constructed. This will require the bridge inspector to coordinate all bridge inspection activities within the construction work zone with the construction project administrator. A normal routine inspection should be conducted.

If a temporary detour structure is constructed to carry public traffic while the existing structure is closed and is allowed to remain in-place. If the work zone is active, the bridge inspector will be required to coordinate all bridge inspection activities with the construction project administrator. If the work zone is inactive, the bridge inspector can proceed with the bridge inspection work as planned. In this case, the permanently closed structure should be considered abandoned (use element 900) and perform a cursory level inspection.

If the original configuration of the bridge is physically changed via a major rehab project or a portion of the bridge has been replaced using staged construction, the bridge construction project administration staff will be responsible

for assuring the structural integrity of the in-place structure is safe for public use, based on determination of conformance to the engineered project documents and inspection of any anomalies to the project plans.

6.0.2.1—Determining the Inspection Procedures:

Bridge inspections are conducted to determine the physical and functional condition of the bridge, form the basis for the evaluation and load rating of the bridge, analyze of overload permit applications, to initiate maintenance actions, provide a continuous record of bridge condition and rate of deterioration, and to establish priorities for repair and rehabilitation programs.

Successful bridge inspection is dependent on proper planning and techniques, adequate equipment, and the experience and reliability of the personnel performing the inspection. Inspections should not be confined to searching for defects which may exist, but should include anticipating incipient problems. Thus inspections are performed in order to develop both preventive as well as corrective maintenance programs. The inspection plan and techniques should ensure that:

- Unique structural characteristics and special problems of individual bridges are considered in developing an inspection plan.
- Current technology and practice are applied during the inspection.
- The intensity and frequency of inspection is consistent with the type of structure and details and the potential for failure.
- Inspection personnel are assigned in accordance with their qualifications as determined by the Bridge Owner.

The purpose of the routine inspection is to determine the bridge's current structural adequacy and condition, verify that previously recommended repairs have been made, monitor known deficiencies, and determine if further analysis or investigation of the structure's adequacy or condition is warranted.

No two bridges will be alike; therefore, there is no single set of procedures which can be followed in all cases. Clearly, the procedure to follow when inspecting a 50 year old steel truss will be much different than those used to inspect a 6 year old concrete box girder. In addition, certain bridge elements or design features may require another type of inspection altogether. Accomplishing any routine inspection therefore, will require the inspector to use their best engineering judgment, expertise, and common sense.

After safely parking the vehicle and placing the appropriate signing, an inspection normally begins with the approach roadway as you approach the bridge (walking towards oncoming traffic), the deck and superstructure elements located above the deck as you walk across the bridge, and then the superstructure, substructure and waterway elements as you proceed under the bridge below the deck.

6.0.2.2—Preparing for Special Inspection Requirements:

Any time the structural condition of an element cannot be determined in the course of a routine inspection, an in-depth inspection is required. The in-depth inspection is performed to obtain more sophisticated data, perform special non-destructive testing, and/or bring in other experts to assess a particular problem. In order for the special inspection to be completed, the inspector will have to coordinate the inspection, equipment, and traffic control with the experts that will be participating in the inspection.

6.0.2.3—Organizing the Field Notes:

With each bridge inspection performed, an inspection report must be completed. The inspection report is crucial as it provides the necessary details and particular insights which will allow conditions at the bridge to be evaluated accurately and objectively over the years. If the field notes are well organized, the inspector can use them as a checklist to help accomplish the inspection and to help spot particular types of problems a given bridge or bridge element will be prone to. By following these steps, a thorough and comprehensive inspection can be achieved.

6.0.2.4—Performing a Job Hazard Assessment (Jha)

Fatalities, accidents, and injuries can be reduced if we all work together and share our safety knowledge. Every job assignment can be separated into a series of relatively simple steps; the hazards associated with each step can be identified; and solutions can be developed to help control each hazard (a more detailed instructional booklet on how to perform a JSA is located in the appendix). Let's look at the basic steps of performing a very generic bridge inspection:

- Column 1: List the Sequence of Steps that are required to perform a given job (inspect a bridge).
- Column 2: List all of the Potential Hazards that are associated with performing that particular job sequence step.
- Column 3: List the Recommended Procedures or site specific decision that should be made and incorporated to remedy the potential hazards identified.

GENERIC BRIDGE INSPECTION JOB SAFETY ANALYSIS		
SEQUENCE OF JOB STEPS	POTENTIAL HAZARDS	RECOMMENDED PROCEDURES
Step #1: Working Alone - Potential for being in a position where you could not contact help	Struck by a vehicle, tripping, slipping, falling, caught on or in a hazard, confined space, exposure to toxic elements, exposure to extreme temperatures, and transients.	Don't Work Alone or Follow ODOT Working Alone Guideline * est. communication net * est. specific check-in times * acknowledge completion
Step #2: Traffic Control	Struck by a vehicle, creating traffic congestion, Presenting hazard to traffic	Match traffic plan with site conditions & work: * Provide lane closure w/signs & flaggers * Provide warning signs & est. escape routes * Traffic spotter to accompany inspector * Walk against traffic
Step #3: Doning Equipment	Not clearly visible to traffic, head injuries, slipping, falling, hand injuries, eye injuries, cuts & skin abrasions, exposure to toxic materials,	Match equipment needs to the work being performed. Review w/co-worker and follow "ODOT Personal Protective Equipment Policy"
Step #4: Planning & Implementing Access	Injuries caused by things in Motion, High Temperatures, Chemical Exposure, Harmful Atmospheres, Light Radiation (welding), Falling Objects, Sharp Objects, Rolling or Pinching, Electricity, layout of workplace and location of co-workers.	Pre-assess the work site using the ODOT Hazard Assessment Worksheet and discuss with team members before leaving the vehicle. * Devise plan to mitigate known hazards and the inspection team fully understands. * File assessment sheet for future.
Step #5: Working in a Confined Space	No air to breath, Breathing Poor quality air, Head Injuries, No lights, tripping, being locked in confined space, becoming stuck in confined space, transients.	Review and follow the "ODOT Confined Space Policy & Procedures": * est. communication net - others & team checkin/checkout * est. rescue plan * lock-out/tag-out * use appropriate equipment for conditions * notify completion * file plan for future
Step #6: Meet with Inspection Team, discuss inspection findings, document inspection and re-access areas of the bridge, if necessary.	Being struck by traffic, creating a traffic distraction, falling, slipping, tripping, off balance while taking photos and/or while taking measurements, public image.	Follow the original bridge inspection plan and make sure traffic control measures are still in place.
Step #7: Pickup Traffic Control	Same as Step #2	Same as Step #2
Step #8: Notify Others	Same as Step #1	Same as Step #1

Since every bridge type, bridge location and site conditions vary so dramatically throughout the state, this very generic bridge inspection example, must be modified on a case by case basis, to fit the local conditions encountered. JHA examples for the following bridge inspection categories along with the reference ODOT Policies and Procedures will be incorporated into the appendix as they become available:

- Culvert Inspections

- Truss Type Bridges
- Girder Type Bridges
- Bridges Over Water
- Bridges Over Other Features

In the interest of public safety, the bridge inspectors should employ proper procedures for traffic control and work zone protection during the inspection. The “Manual of Uniform Traffic Control Devices (MUTCD)” as supplemented by state and local authorities should be used as a guide for such procedures. As a supplement, ODOT produced the following references:

- A “Short Term Traffic Control Handbook”, 1996 Edition.
- In 1992, a “Traffic Control and Flagging Manual”.

6.0.2.5—Any Other Measures to Facilitate a Thorough, Safe and Complete Inspection.

- Any employee that drives a state vehicle, must have a current “Defensive Driving” training certification card.
- If two or more state employees are more than 10 minutes away from a medical facility, at least one of the employees must possess a valid “First Aid” training card w/CPR.
- When working over water, employers must provide fall protection if the distance from the walking/work surface to the water surface is 6 feet or more.
- When fall protection is provided on walking / work surfaces located above water, and no drowning hazard exists, employees do not need to wear U.S. Coast Guard approved life jackets or buoyant work vests. Section 126.106(a) states that “employees working over or near water where the danger of drowning exists, shall be provided such a floatation vest. In general, when continuous fall protection is used (without exception) to prevent employees from falling into the water, the employer has effectively removed the drowning hazard, and life jackets or buoyant work vest are not needed.

Review Available Information.

Whether the purpose of the bridge inspection is to record the bridge’s condition, or to develop repair plans, or for load rating the structure, the inspection always begins with good planning. Review available plans and previous inspection reports in the office. If it is a major or historic structure, it may help to research old engineering documents about the design and construction of the structure.

A minute of preparation can save hours in the field. A thorough review of the existing plans of a structure can identify areas of specific concern and often identify potential problems. This is particularly important when the structure has pins, fracture critical members, fatigue sensitive details, or movable spans. Field sheets and sketches should be prepared in advance, identifying each element to be inspected. The bridge inspection team leader should prepare a checklist for recording sketches and images.

If previous inspection reports exist, previously identified deficiencies should be tabulated, with space to note the current existing condition beside each for direct comparison.

Prepare a Flexible Schedule.

Start by making a tentative inspection schedule so that you can determine your equipment and personnel needs. For the most efficient use of your access equipment, it may be necessary to jump from bridge site to bridge site in order to continuously use the equipment. The schedule must be flexible in order to account for those unforeseen situations that seem to come up like: equipment breakdowns, personnel becoming unavailable, weather, or traffic restrictions. There’s nothing more frustrating than having a full complement of bridge inspector and traffic control measures in place, waiting for the equipment to be fixed so that it can be returned to use. Using access equipment requires long range plans with alternative courses of action. On a large structure, it is not unusual to have several inspection teams and access equipment, safety equipment, testing personnel on site at the same time, multiplying opportunities for something to go wrong. Always have backup plans.

Inspection Notes

Every inspection report is considered to be a signed legal document. As a result, care should be taken to write clear, accurate notes, as this will be the record of your inspection. Set up the notes, sketches, images, in accordance with

ODOT's accepted orientation practices. Having a set of plans on-site during the inspection is absolutely invaluable. Review your notes at the end of each day to make sure you did not miss something. It is very important that the inspection be complete, thorough, and accurate. As a bridge engineer, you are entrusted with the safety of the public. You have a duty to your client to report your findings truthfully. Both structural and safety concerns must be covered and the owner informed of the severity of each and the priority of corrective action needed. If a dangerous or hazardous condition is found, it should be immediately reported to the bridge owner.

6.0.3—Performing the Bridge Inspection

CFR 650.313(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.

CFR 650.313(a) directs that each bridge is to be inspected in accordance with the inspection procedures in the AASHTO Manual for Condition Evaluation of Bridges.

CFR 650.313(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.

CFR 650.313(d) Prepare bridge files as described in the AASHTO Manual. 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 agency forms.

CFR 650.313(h) Establish a statewide 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.

CFR 650.311(a)(1) Inspect each bridge at regular intervals not to exceed 24 months.

CFR 650.311(a) (2) Certain bridges require inspection at less than 24 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.

Performing the Inspection

The bridge inspector must be cognizant of the following:

- Performing the Work
 - Bridge site safety concerns (JHA)
 - Must have a mitigation plan
 - Confined Space issues
 - Fall Restraint Systems
 - Catwalks
- Accessing the Structure
 - Member Access Expectations – method, cleaning structure, and brushing vegetation
 - Level of Intensity – visual at distance vs at arms length
 - Route itinerary – walk against traffic, outside of curves, team on same side of road
- Guidelines for Condition Rating of Bridge Components
 - Perform Element Level then role-up to NBI Ratings
 - Use AASHTO Elements and Defect Flags
 - List all Defects present
 - Load Paths are Primary, Non-load Path Components are Secondary
 - Elements that affect load rating vs not
 - Items that affect sufficiency rating vs not
 - Inspection of a Critical Deficiency or Component Procedure
 - Use of Supplemental Rating Guidelines

- Substructure Business Rules
 - Abutments – defined as all end bents excluding cantilevered ends
 - Retaining Walls – approach roadway embankment or bridge component
 - Interior Bents – orientation business rules
 - Bridge Stability, Load Path translation, and Movement
- Superstructure Business Rules
 - Steel – member or connection elements
 - Concrete (Reinforced and Pre-stressed / Post-Tensioned)
 - Timber
 - Fracture Critical Members
 - Fatigue Prone Details
 - Protection Systems
 - Utilities – required labeling
- Bridge Deck / Slab – Seriousness of Crack Orientation
- Special Structural Features
 - Drawbridges,
 - Cable Suspension Bridges
 - Concrete Segmental
- Underwater Bridge Components
 - Who’s responsible for inspecting these components
 - Who’s responsible for integrating the condition of these components into the routine inspection report
- Approach Roadway Assessment
- Quality of Ride Assessment
- Channel and Channel Protection / Scour Monitoring

What Information needs to be On-site during the Inspection?

- Last Routine Inspection Report
- Last SI & A Sheet
- Bridge Plans
- A copy of the Supplemental Bridge Inspection Report for the Structure

Duties associated with the inspection include maintaining the proper structure orientation and member numbering system, developing an inspection sequence, and following proper inspection procedures.

To help accomplish this task, the State of Oregon has implemented a few basic rules:

- All bridge substructure/foundation connection points will be designated as BENTS and, if available, will be numbered consecutively in the same direction as the logged highway mileposts or city street numbers. The designated numbers will start with bent 1 as being the location of the first end bent. In the event logged highway mileposts or city street numbers are not available, the bridge inspector will orient the sequential numbering scheme either by using the numbering scheme established on the original bridge plans or numbered consecutively left to right while facing upstream, at increasing river mileposts, or in the general direction the drainage is coming from. A note should be incorporated into the report, clarifying the numbering scheme used by the bridge inspector.
- All SPANS are to be numbered consecutively in the same manner as used in item (a), starting with span 1 as being located between bents 1 and 2.
- All permanent BRIDGE MEMBERS are to be numbered consecutively from left to right, while looking ahead, on line, at increasing bent and/or span numbers.
- City/County SPAN OVERCROSSING State Highways will normally be listed from left to right, while looking ahead on line at increasing mileposts on the State Highway Route under the over-crossing. If the over crossing is another State Highway, the bent and span numbers on the structure will correspond with the increasing mileposts on the over-crossing route.
- If the bridge has INTERMEDIATE SPANS or COLUMNS that are founded on a larger arch span, the spans and support columns will be numbered consecutively, in the same direction as the designated

- bent/span numbers, alphabetically along with the larger arch span number, i.e., 5A, 5B, 5C, where columns 5A are located directly over bent 5.
- All TRUSS PANEL POINTS will be numbered consecutively in the same direction as the designated bent/span numbers, along with several designations to indicate where the panel point is located in the truss, i.e., L (left), R (right), L0 (lower chord), U1 (upper chord), and M1 (intermediate connection point), L0 is located at the truss end bent point of bearing. All TRUSS MEMBERS will carry the designation of the truss panel points that they connect, i.e., L0U1R.
 - If the structure has a Y-LEG SUBSTRUCTURE, the Y-leg SPAN directly above the Y-leg footing will carry that bent number along with an “A” designation. The next ensuing span will carry the bent number along with a “B” designation. When looking at a profile of the structure with the bent numbers increasing from left to right, the Y-LEG COLUMNS on the left will carry the bent number along with an “A” designation, and the Y-leg columns on the right will carry a “B” designation.
 - If the structure has a bent with multiple rows of piling, the piling rows will be listed in alphabetical order along with that designated bent number.

6.0.4—Reporting the Results of an Inspection

Field Data Collection Options:

- Carry laptop or iPad into the field - data enter occurring on-site
- Carry a hard copy of the last inspection report, mark-up, and data entry when back at the office
- Entering data at an ODOT facility using the Intranet (Wifi).

Reporting the Results of the Inspection

According to the Code of Federal Regulations (CFR) definition of a Routine Bridge Inspection is a regularly scheduled inspection that generally consists of visual observations and / or measurements that are needed to determine the following:

- Define the physical and functional condition of the bridge,
- Identify any changes from initial or previously recorded conditions, and
- Recommend any repairs or other services that may be needed.

Each bridge inspector is instructed to perform all assigned inspections in sufficient detail or as thorough as necessary to clearly establish its condition and to insure its continued safe operation.

ODOT considers the routine inspection report is the primary tool for reporting the condition of a structure and is a compilation summary of condition assessment data that is generated via a number of more detailed types of inspections and/or surveys. For example, the Underwater Dive Team performs an inspection on those elements that are continuously submerged, in non-wadeable water. They generate a condition assessment report for those elements and which is posted on the bridge server. Then it is the responsibility of the above water inspector to review, analyze, and incorporate the underwater condition assessment information into their routine inspection report that covers the entire structure, top-to-bottom, end-to-end. Another example is when a bridge crew bores all of the timber members in a bridge. Following the field work, they update the existing timber boring log which contains detailed measurements of the amount of decay, checks, and/or splits that were noted in each member. The routine bridge inspector reviews the changes, analyzes the reported condition of each member, and then incorporates this very detailed information into their Element and NBI condition ratings for the bridge.

The routine inspection report is a compilation of data that has been extracted from the following supporting documents:

- Bridge Clearance Diagrams
- Cross-Channel Profiles
- Underwater Inspection Report
- Fracture Critical Inspection Report
- Fatigue Prone Detail Inspection Report
- Timber Boring Report
- Deck Survey Report
- Concrete Cracking Report
- Pin & Hanger UT Report
- Structure Paint Inspection Report

- Load Rating Summary Report
- Drawbridge Electrical & Mechanical Inspection Report
- ODOT Bridge Practices and Procedures Manual (BPPM) September 2008
- Quality Assurance Field Reviews
- Expectations for Reporting Critical Findings

Significance of signing the official Bridge Inspection-of-Record

The routine inspection report that carries the original signature of the bridge inspection team leader is referred to as the Bridge Inspection Report-of-Record. As such, the routine inspection report is very static in that it is only a snapshot picture of the condition bridge at one point in time. All other supporting inspection reports are very dynamic in that they carry historical condition information that has changed over time. The intent of having the supporting inspection reports to be dynamic is to provide some sense as to the rate of decline in the condition of the bridge members, as well as, providing the reader one stop shopping for historical data on one report. Promotes data consistency, minimizes flip-flopping.

Additional Note Expectations

One of the duties assigned to the bridge inspector is to leave a sufficient paper trail to allow the reader of the report to easily interpret or follow its content. The Pontis Bridge Inspection Module provide a number of places for the bridge inspector to post a variety of notes associated with the inspection or the bridge:

- Condition Assessment Remarks
- Inspection Notes
- Bridge Notes
- Load Rating Notes
- Embankment Protection Notes

Condition Assessment Remarks

Bridge Inspection Remarks are to describe any condition or deficiency that is noteworthy or has a potential for getting worse. As a minimum, remarks are made for any deficiency that carries a NBI rating < 3 or is being reported in a condition state rating that represents the most advanced deterioration. There should also be a description of any temporary repair that may exist. Noteworthy Remarks are generally those that are associated with the load path, items that might create a traffic hazard or items that might intensify our concerns for scour at the bridge site. These condition assessment remarks are entered on the Condition Tab, by clicking on the inventoried element. The end user of the report can view these condition assessment remarks on the Routine Inspection Report.

Inspection Notes

The intent for these notes is to provide additional information about the inspection or clarify the inspection strategy. Information that includes but not limited to: what additional resources are needed for the inspection like: schedule the UBIT every other inspection, or whether freight mobility is an issue and the process for obtaining clearance from motor carriers.

Bridge Notes

Notes about the bridge itself, like: Repair History, Features to be aware of like a railroad, railroad contact information for scheduling a flagger, U.S. Coast Guard contact information, whether transient cages are located on the bridge and what keys are needed to access, etc.

Embankment Notes

Notes about the condition assessment of the approach roadway embankment and repair history.

Load Rating Notes

Notes about the bridge load rating, what members were strengthened, using what strengthening method or other structural changes that have been made to the bridge not shown on the bridge plans.

Detour Length Notes

Notes describing the detour route and how the detour length was calculated.

GPS Coordinate Information

Where the coordinates came from and how they were obtained, by whom and when.

Fulfilling Reporting Requirements Specified in the CFR:

CFR 650.313(a) directs that each bridge is to be inspected in accordance with the inspection procedures in the AASHTO Manual for Condition Evaluation of Bridges.

CFR 650.313(d) Prepare bridge files as described in the AASHTO Manual. 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 agency forms.

- Updated Structure Inventory & Appraisal Information
- Posted Inspection Remarks
- Posted additional documentation / images
- Posted Maintenance Recommendations
- Notifying the ODOT Bridge Load Raters
- Enter Actual Load Posting Information
- Update the next scheduled inspection dates

CFR 650.311(a)(1) Inspect each bridge at regular intervals not to exceed 24 months.

CFR 650.311(a)(2) Certain bridges require inspection at less than 24 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.

CFR 650.313(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.

6.0.5—Bridge Maintenance Recommendations

Identifying Items for Maintenance and Repairs

The final basic duty is to identify items needing maintenance and/or repairs. The inspector must identify such items to ensure public safety and help to maximize the longevity of the bridge. The level of bridge maintenance being performed on our bridges is not keeping pace with the rate of deterioration. Bridge deterioration can be generally contributed to the following factors:

- Exposure to the elements over time.
- Bridge Details incorporated into the Design.
- Bridge Construction Practices
- Bridge Maintenance Practices.
- Bridge Usage.
- Availability and allocation of resources.
- Special environmental problems.

It has been recognized that the requirements for bridge replacement and rehabilitation far exceed the available resources. It is also recognized that bridge maintenance managers must deal with a total system of bridges. Even though maintenance needs are identified on a bridge by bridge basis, decisions on how and where limited resources are to be spent should be made in a cost-effective manner after examining all the needs on a system wide basis.

Our primary concerns are to assure that the Structural Condition of the elements contained within the load path, items associated with potential Traffic Hazards, or items associated with Bridge Scour are adequately addressed.

- If NBI Item 58, 59, 60, 61, or 62 is rated a “5” or worse or a portion of the element / defect is in CS2 or worse: assure the appropriate defect flags and their stratified CS Ratings have been posted.
- If NBI Item 58, 59, 60, 61, or 62 is rated a “4” or worse or a portion of the element / defect flag is in CS3 or worse: in addition to the above, provide a prioritized maintenance recommendation.

- If NBI Item 58, 59, 60, 61, or 62 is rated a “3” or worse or a portion of the element / defect flag is in CS4: in addition to the above, the bridge inspector will immediately initiate the Critical Deficiency Notification Procedures.
- If a structural deficiency requires either a complete or partial bridge closure, or requires an immediate load restriction of the bridge until repairs can be accomplished, initiate the “Significant Deficiency Notification Process”.
 - Immediately contact the appropriate agency official to inform them of the situation, followed by:
 - A thorough, fully detailed narrative report, supplemented with pertinent digital images.
 - Update the bridge inspection database and submit an updated bridge inspection report of record.
 - Document notification of the ODOT Load Raters, the ODOT Bridge Hydraulics Engineer, or the ODOT Bridge Engineer.
 - Send a full report with digital images to FHWA.

CFR 650.313(d) Prepare bridge files as described in the AASHTO Manual. 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 agency forms.

CFR 650.313(h) Establish a statewide 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.

6.1—BRIDGE INSPECTION BUSINESS PRACTICES

6.1.1—Bridge Inspection Coding Guides & Reference Manuals

The State of Oregon collects bridge condition ratings using two quite different systems: FHWA Rating Codes and the AASHTO Element Rating Codes. Items included in this Guide (Items 58-Deck, 59-Superstructure, 60-Substructure, and 62-Culverts) are the FHWA Rating Codes. The American Association of Highway and Transportation Officials’ (AASHTO) Guide for Commonly Recognized (CoRe) Structural Elements, are located in the State of Oregon Element Coding Guide. CoRe element inspection ratings provide a detailed condition assessments that was designed to serve as input into a comprehensive bridge management system (BMS). Since the BMS and NBI data collection and reporting formats are quite different, the State of Oregon is collecting and recording both. To date, an automated, condition assessment, data conversion program, is not being used. The AASHTO Manual for Condition Evaluation of Bridges (called AASHTO Bridge Manual in this Guide) discusses the various items of information that are to be recorded as part of original bridge reports. That manual and the most current version of the Bridge Inspector’s Training Manual, discuss inspection procedures and the preparation of detailed reports about the structure components. These reports will be the basis for recording values for many of the 6 data elements shown in the Guide, particularly those having to do with the condition or the appraisal ratings. Further information regarding a specific bridge inspection procedure can be obtained by referencing the following publications:

Document

- FHWA Bridge Inspection Reference Manual (BIRM)
- ODOT Bridge Inspection Manual
- ODOT NBI Coding Guide
- ODOT Element Coding Guide
- Culvert Inspection Manual - FHWA-IP-86-2
- Inspection of Fracture Critical Members - FHWA-IP-82-26
- Bridge Inspector’s Manual for Movable Bridges - FHWA-IP-77-10
- ODOT Timber Boring Manual
- ODOT Underwater Bridge Inspection Manual

FHWA Recording and Coding Guide

FHWA produced this guide for the States, Federal and other agencies use in recording and coding the data elements that comprise the National Bridge Inventory data base. By having a complete and thorough inventory, an accurate

report can be made to the Congress on the number and state of the Nation's bridges. The 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 defense purposes.

The coded items in this Guide are considered to be an integral part of the data base that can be used to meet several Federal reporting requirements, as well as, as part of the States' needs. These requirements are set forth in the National Bridge Inspection Standards (23 CFR 650.3) which is included in the appendix of the manual. A complete, thorough, accurate, and compatible data base is the foundation of an effective bridge management system. Reports submitted in connection with the Highway Bridge Replacement Program and the National Bridge Inspection Program are related to this Guide.

The Structure Inventory & Appraisal Sheet (SI&A) is intended to be a tabulation of the pertinent elements of information about an individual structure. It is important to note that the SI&A is not an inspection form but merely a summary sheet of bridge data required by FHWA to effectively monitor and manage a National bridge program. When the States submit the required data to FHWA, the format will be based on the codes and instructions in this Guide. The data will also be based on the definitions, explanations, and codes supplied in this guide, the AASHTO Manual for Condition Evaluation of Bridges, and the Bridge Inspection Reference Manual (BIRM).

Oregon's NBI Coding Guide

The Oregon Bridge Inspection Coding Guide provides a definitive and explicit explanation for coding bridge inventory and inspection data, in the State of Oregon. Some of the original FHWA coding requirements have been expanded on and clarified for use by the bridge inspection community in the State of Oregon. It incorporates all changes that FHWA has made to their "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges". The goal is to:

- Provide complete, thorough, and accurate bridge inventory and condition assessment information
- Ensure that bridge managers have the latest information regarding the condition of the bridges under their jurisdiction
- Assure that the State of Oregon is in compliance with federal reporting requirements

The Guide closely follows the definitions and instructions outlined in Federal Highway Administration's Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges, December 1988. In addition, NBI Items 117 through 122 have been added for the specific use by Oregon. The descriptions and examples contained therein are for clarification purposes. The values provided in the tables or otherwise listed in this Guide are for rating purposes only. Current design standards must be used for structure design or rehabilitation. All possible combinations of actual site characteristics are not provided in this Guide. If a special situation not listed in the Guide is encountered, the evaluation criteria closest to the actual site situation should be used.

Oregon Specific NBI Items:

- NBI Item 3 & 4 - Oregon specific City / County Codes
- NBI Item 117 – Estimated Maintenance Cost
- NBI Item 118 – Culvert Length
- NBI Item 119 – Culvert inside Height
- NBI Item 120 – Inspector
- Wearing Surface Thickness

Oregon's Supplemental NBI Condition Rating Guidelines:

- ODOT Element Coding Guide
- Concrete Deck Rating Supplemental Guideline
- Timber Deck Rating Supplemental Guideline
- Steel Deck Rating Supplemental Guideline
- Concrete Deck Rating Supplemental Guideline
- Composite Deck Rating Supplemental Guideline
- Concrete Superstructure Rating Supplemental Guideline
- Prestressed Concrete Superstructure Rating Supplemental Guideline
- Timber Superstructure Rating Supplemental Guideline

- Steel Superstructure Rating Supplemental Guideline
- Concrete Substructure Rating Supplemental Guideline
- Timber Substructure Rating Supplemental Guideline
- Steel Substructure Rating Supplemental Guideline
- Channel / Channel Protection Rating Supplemental Guideline
- Corrugated Metal Culvert Rating Supplemental Guideline
- Concrete Culvert Rating Supplemental Guideline

Oregon's Element Coding Guide

ODOT elected to segregate the AASHTO Elements by their material type rather than the member type, because the associated defect thresholds were the same for each AASHTO Element. ODOT also elected to list all possible defects for each element.

Concrete Elements

(12) – Deck
 (15) – Top Flange
 (38) – Slab
 (105) – Closed Web Box Girder
 (110) – Open Girder / Beam
 (116) – Stringer (floorbeam system)
 (144) – Arch
 (155) – Floorbeam
 (205) – Column / Pile
 (227) – Submerged Pile
 (234) – Cap
 (241) – Culvert
 (321) – Approach Slab
 (331) – Bridge Railing
 (380) – Tunnel Liner
 (381) – Tunnel Portal
 (104) – P/S Closed Web Box Girder
 (109) – P/S Open Girder / Beam
 (115) – P/S Stringer (floorbeam system)
 (143) – P/S Arch
 (154) – P/S Floorbeam
 (204) – P/S Column / Pile
 (226) – Submerged P/S Pile
 (233) – P/S Pile Cap

Associated Concrete Defects

(358) - Crack Size
 (358) - Crack Density
 (411) – Reinforcement Corrosion
 (410) - Delams / Spalls / Patches
 (359) - Efflorescence
 (413) - Rutting
 (412) - Abrasion
 (361) - Scour
 (368) - Culvert Distortion
 (360) - Settlement
 (414) - Fire Damage
 (366) - Deck Incident
 (362) - Superstructure Incident
 (367) - Substructure Incident
 (369) - Bridge Rail Incident

Steel Elements

(28) – Deck, Open Grid
 (29) – Deck, Concrete Filled Grid
 (30) – Deck Corrugated / Orthotropic
 (102) – Closed Web Box Girder
 (107) – Open Girder / Beam
 (113) – Stringer (floorbeam system)
 (120) – Truss
 (141) – Arch
 (147) – Cable, primary
 (148) – Cable, secondary
 (152) – Floorbeam
 (161) – Pin and Pin & Hanger Assembly
 (162) – Gusset Plate
 (202) – Column / Pile
 (207) – Column Tower (trestle)

Associated Steel Defects

(400) - Corrosion
 (357) - Pack Rust
 (356) - Fatigue Cracking
 (401) - Connections
 (364) - Out-of-plane Bending
 (412) - Abrasion
 (361) - Scour
 (368) - Culvert Distortion
 (360) - Settlement
 (366) - Deck Incident
 (362) - Superstructure Incident
 (367) - Substructure Incident
 (369) - Bridge Railing Incident

(219) – Abutment
 (225) – Submerged Pile
 (231) – Cap
 (240) – Culvert
 (250) – Tunnel Liner
 (330) – Bridge Railing
 (390) – Bridge Paint Element
 (391) – Unpainted Bridge Element

Timber Elements

(31) - Timber Deck
 (54) - Timber Slab
 (111) - Open Girder / Beam
 (117) - Stringer (floorbeam system)
 (135) – Truss
 (146) – Arch
 (156) – Floorbeam
 (206) - Column / Pile
 (208) – Column Tower (Trestle)
 (212) – Pier Wall
 (216) – Abutment
 (228) – Submerged Pile
 (235) – Cap
 (242) – Culvert
 (252) – Tunnel Liner
 (332) – Timber Bridge Railing

Bridge Bearing Elements

(310) – Elastomeric Bearings
 (311) – Movable Bearings
 (312) – Enclosed / Concealed Bearings
 (313) – Fixed Bearings
 (314) – Pot Bearings
 (315) – Disk Bearings

Expansion Joints

(300) – Strip Seal
 (301) – Pourable Seal
 (302) – Compression / Polyfoam Seal
 (303) – Modular Joint Assembly
 (304) – Open Joint
 (305) – Joint Assembly, no seal
 (306) – Asphaltic Plug Joint Seal
 (309) – Other Deck Joint

Masonry Bridge Elements

(145) – Masonry Arch (excl conc, steel, or timber)
 (213) – Masonry Pierwall
 (217) – Masonry Abutment
 (244) – Masonry Culvert
 (383) – Masonry Tunnel Liner
 (384) – Masonry Tunnel Portal

Other Bridge Elements

(211) – Other Pierwall (excl conc, steel, timber)
 (218) – Other Abutment

Associated Timber Defects

(420) - Timber Decay
 (421) – Timber Check
 (422) – Timber Split
 (423) – Timber Crack
 (424) – Bug Infestation
 (412) - Abrasion
 (361) – Scour
 (368) – Timber Culvert
 (360) - Settlement
 (366) – Deck Incident
 (362) – Superstructure Incident
 (367) – Substructure Incident
 (369) – Bridge Rail Incident

Associated Bearing Defects

(440) - Movement
 (441) - Alignment
 (442) - Condition
 (443) – Supporting Members

Associated Exp Joint Defects

(431) – Seal Damage
 (432) – Metal Damage
 (433) – Adjacent Header Damage
 (434) – Debris Impact
 (366) – Deck Incident

Associated Masonry Defects

(450) – Mortar Breakdown
 (451) – Stone Cracks / Spalls
 (359) - Efflorescence

Associated Element Defects

(455) - Condition
 (361) - Scour

(243) – Other Culvert
(253) – Other Tunnel (mined)

(360) - Settlement
(368) – Culvert Distortion

Roadway Elements

(980) – Approach Roadway Embankment
(999) – Ride Quality

Associated Defects

(361) – Scour / Erosion
(415) – Roadway Impact

Protective Systems

(510) – Flexible / Gravel Wearing Surface
(511) – Flexible (AC) Wearing Surface
(512) – Semi-Rigid Wearing Surface
(513) – Rigid Wearing Surface
(520) – Deck / Slab Protection System
(521) – Concrete Protective Systems
(515) – Steel Paint Coating
(516) – Oxide Weathering Steel Coating
(517) – Concrete Encased Steel Coating

Associated Defects

none
rate condition / functionality
of each system
unit of measure = sq ft

Oregon's Supplemental Element Condition Rating Guidelines:

- Structure Paint Supplemental Rating Guideline
- Steel Member Supplemental Rating Guideline
- Concrete Crack Supplemental Rating Guideline
- Timber Splitting Supplemental Rating Guideline
- Timber Decay Supplemental Rating Guideline

6.1.2—ODOT Bridge Inspection Business Rules

Each bridge and inspection is unique. The process can vary quite considerably depending on the type of bridge and the terrain surrounding the bridge site. The intent of this section is to simply provide a list of things each inspector should consider when formulating an appropriate inspection and deficiency recording process for each bridge. If the bridge inspector is knowledgeable about the various load paths, how a structure is supposed to behave, the intent of the design of the bridge, the changing behavior of materials with age, fatigue, stress, weathering, chemical reaction, typical construction practices, and tell-tale signs of either their proper or improper placement, it will definitely provide a very solid foundation for the work at hand.

The maintenance / repair recommendations from the inspection reports are entered into the “ODOT Bridge Inspection Database”. A full report can be viewed or downloaded from the ODOT Bridge Inspection Web Page. This list is continuously being updated, when a routine inspection report is filed. The intent is to allow the bridge maintenance managers to review the list and schedule the work to be completed without having to screen the entire bridge inspection report of useful information. When a repair is completed, the maintenance manager is supposed to send a copy of the completed work information to the designated bridge inspector. The bridge inspector can then enter the repair date in the inspection report. This will automatically remove the repair from the printed “Bridge Repair List”. However, the repair will still appear in the Bridge Inspection history file.

During the next inspection of the bridge, the completed repairs, when verified by the inspectors, shall be noted as such on the Routine Inspection Report. The repairs that have been verified will not show up again on the Bridge Needs List.

General Business Rules

Rules Associated with Assessing and Reporting the Condition of Bridge Members:

Element Level Condition Rating Process – Since a given structure has many elements and only one NBI Condition Assessment Rating number per bridge component, the inspectors find it easier to start with the many element ratings and then roll them up into the singular NBI rating for that component.

The process is to identify and list all of the elements that are located on the bridge.
Identify and list all of the defects that are present and effecting the condition of the element.
Given the CS thresholds, provide a stratified condition assessment of each defect.
When all of the Defects have been assessed, roll the CS Ratings up into the Element CS Rating.
When all of the elements on the bridge have been assessed, roll the condition ratings up into the NBI component rating.

NBI Condition Ratings – Condition ratings are used to describe the existing, in-place bridge as compared to the as-built condition. Evaluation is for the materials related, physical condition of the deck, superstructure, and substructure components of a bridge. The condition evaluation of channels and channel protection and culverts is also included. Condition codes are properly used when they provide an overall characterization of the general condition of the entire component being rated. Conversely, they are improperly used if they attempt to describe localized or nominally occurring instances of deterioration or disrepair. Correct assignment of a condition code must, therefore, consider both the severity of the deterioration or disrepair and the extent to which it is widespread throughout the component being rated.

Rules of Orientation and Unit Labeling Conventions – The bridge inspector must be very cognizant of the user or reader of their bridge inspection report. Very few, in the field, have a complete copy of the bridge plans. And if they did, they would find that different design engineers labeled the various bridge components quite differently. There was never a definitive guide, directive, or scheme to follow. As a result, over the years, bridge maintenance forces have replaced the wrong bridge member, due to the lack of clarity and direction. Therefore, ODOT adopted the following scheme, so that the reader is lead to the specific location:

Rules of Orientation – Always, look ahead on line at increasing mileposts or increasing city street addresses. If mileposts or city street addresses are unavailable, assume that milepost “0” is located at the road connection with the higher road classification, i.e., milepost zero is probably not at the end of a dead end. If all else fails, orientate with the object under the structure – looking upstream at increasing river MP or at increasing mileposts of the route under and numbering bents / spans from left to right.

Substructure Labeling Convention – All bridge substructure / foundation connection points will be labeled as bents. Piers are called bents.

Rules for Numbering Bridge Bents – Looking ahead on line at increasing mileposts or increasing city street addresses, the bents are numbered in consecutive order starting with the number “1”. Cantilevered bridge ends are not classified as a bent, because they do not have a definable foundation connection point. To allow the location of deficiencies at those locations, the leading cantilevered bridge end is labeled bent “0” and the trailing cantilevered bridge end is labeled bent “00”.

Rules for Number Bridge Spans – Looking ahead on line, the spans are numbered in consecutive order, following the designated bent with the same number, i.e., Span 1 would follow Bent 1. Since the leading cantilevered bridge end is labeled bent “0”, the following span would be labeled Span “0”.

Rules for Number Bridge Members – Looking ahead on line at increasing mileposts or increasing city street addresses, all **permanent bridge members** are number in consecutive order, from left to right, starting with the number “1”.

Rules for Labeling Truss Panel Points - All truss panel points will be numbered consecutively in the same direction as the designated bent / span number, along with several designations to indicate where the panel point is located in the truss, i.e., L (left truss), R (right truss), L0 (leading end of the lower truss chord), U1 (leading end of upper chord), or M1 (intermediate connection point), with L0 being location over the first bearing supporting the leading end of the truss.

Rules for Labeling Arch Members – If a bridge has intermediate spans or spandrel columns that are founded on a larger arch span, the spans and support columns will be labeled in alphabetical order along with the designated arch span number that is supporting the columns, i.e., 5A, 5B, etc. where column 5A1 is located directly over bent 5, in the left arch.

Rules for Labeling Y-Leg Substructures – If the structure has a Y-leg bent, the span directly over the Y-Leg will carry that bent / span number, along with an “A” designation. The next ensuing span will carry the bent number along with a “B” designation. When looking at a profile of the structure with the bents increasing from left to right, the Y-leg columns on the left will carry the bent number along with an “A” designation, and the Y-leg columns on the right will carry a “B” designation.

Rules for Labeling Multiples Rows of Piling – If a bent contains multiple rows of piling, the piling row will be listed in alphabetical order along with that designated bent number, i.e., row 3A column 2, row 3A column 3, or row 3B column 4, etc.

Rules for Labeling Rivets in a Connection – In order to locate specific Rivets in a connection, the rivets are numbered left to right in consecutive order, without wrapping, starting from the upper left corner of the riveted connection.

Rules for Labeling Traffic Lanes – The following traffic lane label scheme comes from Motor Carriers, rather than Bridge section. Orientate looking ahead on line at increasing mileposts or increasing city street addresses, the lanes are number numerically in consecutive order from right to left.

Temporary Repairs

NBI Item 103 – Temporary Structure Designation – Temporary structure(s) or conditions are those measures that are required to facilitate traffic flow or freight mobility. This may occur either before, during a structural modification, or replacement of a bridge. The Coding Guide states that any repaired structure or replacement structure which is expected to remain in place without further project activity, other than minor maintenance, for a significant period of time will not be considered a “permanent repair”. In this case, a significant period of time shall be considered 10 years or longer. If the temporary measure does not have equal to or greater load capacity or service life of the similar non-deficient bridge components, the measure can not be considered an adequate temporary repair and would be disregarded during the condition assessment process. The temporary members that are associated with the temporary repairs are not included in the element quantity.

Portions of the bridge that’s supported or strengthened by a temporary member will be rated based on their actual condition; that is, the temporary members are not considered in the condition assessment of the item.

Business Rules Associated with Bridge Railings

Rail Element Inventory – If there is more than one railing type at a given location, inventory the type based on the most predominant crash approved material. Different rail types are inventoried when any of the following are present:

There is a separate traffic and pedestrian rail separated by a sidewalk,

There are two different rail types located at two different locations on the bridge.

A newer self supporting rail retrofit was placed at the face of the curb next to the traffic lane and the existing bridge rail that is located on the backside of the curb was not removed.

Bridge Rail Element Condition Assessment – The condition of the curbing, deck anchorage and/or railing attachment brackets should be included in the condition assessment of the railing, because they have a direct affect on the strength and / or serviceability of the element. Since the condition state language only addresses the condition of the railing, in order to report the condition of the railing posts or attachment brackets, the bridge inspector should zero in on the operative words “affect the strength and/or serviceability of the element”.

Even though the spindles in a concrete railing are only inserts, from a historical and esthetics standpoint they are considered to be an integral part of the bridge railing and therefore should be considered in the condition assessment.

Protective Screening – Do not inventory protective screening as a bridge rail. Use the Miscellaneous Element 990 to post a remark as to its condition or post maintenance / repair recommendation.

Business Rules Associated with Bridge Decks

Definition of a Bridge Deck – By definition, a bridge deck transfer loads laterally to a superstructure member. A bridge deck differs from a slab span in that the primary steel reinforcement in the deck runs transversely to the centerline of the roadway, whereas, the steel reinforcement in a slab span runs parallel to the roadway centerline.

Deck Element Inventory – A concrete deck element will not be inventoried on non-spread, pre-cast concrete superstructure elements, like voided slabs, box beams, etc. unless a deck element has been physically placed on top of the pre-cast concrete units. Since Channel beams or concrete tubs are the only exception to this rule, they will have a deck inventory. However, a deck will not be inventoried for Culverts.

Deck Joint Inventory – Deck joints are intended to accommodate structural expansion / contraction, rotation and deflection in the superstructure. Therefore, inventory a deck joint when all of the following are present:

There is a discontinuity in the deck and
There is a discontinuity in the superstructure and
The superstructure members reside on bearings.

Example 1: A timber bridge that has a timber deck and timber stringers would not have a deck joint inventoried unless the timber stringers bear on clearly identifiable bearings.

Example 2: A deck joint would be inventoried on a prestressed concrete bridge where the voided slab units bear on elastomeric bearings that are placed on top of the cap, as long as, any concrete deck that is placed on top of the slab units does not have continuous steel reinforcement over and across the bent.

Even though longitudinal joints do not fit the above criteria, they should be inventoried and rated accordingly.

Sidewalk Rules - If the sidewalk is cast monolithically with the bridge, the sidewalk is considered to be part of the deck. If the sidewalk is added to an existing bridge, the sidewalk will be inventoried using a Miscellaneous Element 990. If the sidewalk is self supporting on its own structure, the structure will be inventoried using Element 930.

Measuring AC Depth – The purpose of recording the AC depth is to correctly calculate the dead load on a structure. The number recorded may be the determining factor of whether a structure is load posted. Coming up with the most correct value takes a certain amount of judgment on the part of the bridge inspector. Here are some examples;

If the AC depth varies longitudinally on a single span, measure at the middle of the span or take an average depth.

If the AC depth varies transversely on a single span, gutter-to-gutter, locate and record the maximum depth.

If the AC depth varies from span-to-span, on a multi-span structure, record the maximum depth located on a full girder line.

Make sure to note in the remarks box what parameters controlled the AC depth. Core all wearing surface thicknesses > 5" to assure its accuracy prior to load rating.

Business Rules Associated with Bridge Superstructures:

Concrete Slabs – Slabs are similar to decks except that the main steel reinforcing bars run parallel to the roadway centerline.

Inventory of Voided Pre-stressed Concrete Slabs – These members have hollow tubes and are considered to be the same as a "closed web box girder". For the Element Condition Rating use Element #505. For the NBI 43 / 44 (Span Type) use #501 – pre-stressed concrete slabs.

Channel Beams – Instead of creating a separate element specifically for these structural members, ODOT elected to inventory these members as "concrete open girders" with a "concrete deck". However, NBI Item 43 will continue to be coded as a channel beam (122). For the quantity, count each channel beam unit as one girder. Do not count the number of stems.

Tee Beams – Since it is not clear as to whether the structure was actually designed as a Tee Beam, ODOT elected to inventory these superstructure members as “concrete open girders” with a “concrete deck”. In this case, NBI Item 43 would also be coded as concrete girders (102, 202, 502, or 602).

Arches – Measure and rate all arches in the same manner as a truss. Spandrel columns are considered to be part of the arch and therefore are not inventoried separately. The first spandrel column that is located directly over the bent is not considered a part of the arch and therefore, the columns would be inventoried and their condition assessed accordingly.

Cross Beams / Floor beams – By definition these members transfer loads laterally to another superstructure member. Bearings are considered to be a superstructure member.

Bridge Bearings – By definition a bridge bearing:

Acts as a bond breaker between the superstructure and substructure

Accommodates temperature movements in the superstructure

Allow superstructure deflection / rotation without point bearing on the superstructure

Function to spread or distribute loads to a larger area.

Sidewalk / Railing Support Systems - Sidewalks and bridge railing are very important bridge features and the condition of their superstructure support systems must be monitored. Therefore, if the structure has a small exterior sidewalk stringer which is supported by a haunch that is located on the outside of the exterior girder, these components should be inventoried and their condition assessed during every inspection.

Bridge Paint System – Primary assessment will be made by associating the paint protective coating system to the parent element and then providing a stratified condition assessment based on the CS thresholds.

However, the inspector is also directed to inventory (Element 390 / 391) assess the condition of the bridge paint system by providing a single condition rating number for the entire bridge paint system. This bridge paint system element will only be inventoried if the paint system has sufficient quantity that it could be part of a structure paint project.

Rigid Frame – If a structural rigid frame carries traffic through the barrel, the structure should be inventoried as a regular bridge, with a superstructure and a substructure. If the rigid frame has water running through the barrel, the structure should be inventoried as a culvert.

Business Rules Associated with Bridge Substructures

Abutments – ODOT decided to inventory all bridge ends as abutments rather than lumping them in with the interior bent elements because of the following:

Abutments are designed to provide two very different functions: support the roadway embankment and transfer the superstructure bearing loading down to the foundation. Interior bents are generally not designed to support lateral embankment loading.

Since the abutments have direct contact with the earthen embankment, the environment and deterioration curves differ from an interior bent.

Since a bridge end bent performs two different functions, their repair is quite different than those of an interior bent.

The only exception to this rule is when a bridge end does not provide embankment support such as a cantilevered bridge end.

Abutment Material Type Inventory Selection – Since an abutment can contain several different types of materials, the bridge inspector will need to determine which type of abutment should be inventoried. Monitoring the condition of the bridge components contained in the load path is much more critical than the embankment support function of an end bent. Therefore, the inventoried abutment type should be controlled by which material type that is contained in the load path that will deteriorate the fastest and will need to be closely monitored. If an end bent has a concrete back wall, a steel cap, and timber piling, the end bent would be inventoried as a timber abutment. If an end

bent contains a timber back wall, a steel cap, and steel piling, the end bent would be inventoried as a steel abutment because the timber back wall is not included in the vertical load path.

Caps – Caps are integral transverse beams that are supported by a substructure component, and typically transfer loads laterally. These can include sills. A cap/post/sill would have 2 caps inventoried. Caps do not include diaphragms, corbels, or stacked caps. Stacked caps are considered to be a single full-depth unit and assessed accordingly. Stacked caps differ from a cap/sill configuration by the lack of blocking or posts between the members. If a stacked cap is encountered with differing materials the material that will deteriorate the fastest will control the type of cap inventoried. A pile supported cap generally differs from a pile supported pierwall in that the primary steel reinforcement is typically transverse to the roadway.

Pier walls – Inventory as a pier wall only if the unit is greater than half the deck width as measured at the ground line. Pier walls can have a continuous footing or be supported on a pile foundation. Pier walls differ from columns in that the primary steel reinforcement is configured to accommodate a uniform vertical load path. Pier walls are considered to be all inclusive meaning that you will not inventory a cap on top of a pier wall.

Columns – Inventory only if the unit is less than half the width of the deck, as measured at the ground line. These include columns, posts, piling or pedestals. If posts / piling are only partially exposed, inventory all or none. If the posts / piling are only partially exposed, the total quantity can be obtained from the plans. Ratings on non-visible posts / piling shall be based on associated signs of distress. Since we do not have a concrete footing element, ODOT decided to lump the concrete pedestals in with the concrete piling / concrete pile extension because they perform a similar function, have a similar environment, and have a similar deterioration curve.

As a rule of thumb, the bridge inspector is to inventory what they see, i.e., the inspector would inventory all steel pipe piles as a steel column regardless of whether it is filled with concrete or not. The only exception to this rule is if it can be shown that the steel encasement only functions as a stay-in-place concrete form.

Business Rules Associated with the Channel:

As per FHWA regulations, all structures over a waterway must be monitored for scour. Providing a Cross-Channel Profile fits that purpose. If possible, the cross-channel profile should be taken at the location of maximum scour, or on the upstream side of the bridge. In order to monitor the criticality, the cross channel profile will have a measurement at each bent.

Underwater Inspections vs Cross Channel Profiles - The underwater divers perform a hands-on condition assessment of the bridge elements located below the water line, measuring local scour in the immediate vicinity of the bridge foundation, and record the amount and location of drift and debris. Whereas, the cross channel profile monitors scour and/or channel movement across the entire stream channel by overlaying multiples of cross sections and overlaying bridge substructure foundation units onto the profile so that the criticality of the scour can be more accurately monitored. Both are needed. A cross channel profile is performed on all structures that are located over a waterway and underwater dive inspections are performed on all structures that have a substructure element in a waterway that is, to deep or swift to wade.

Channel & Channel Protection Rating (NBI Item 61) – When assessing this NBI Item, the bridge inspector must consider the following:

The channel area parameters to be included in this assessment is bounded by: 4 channel widths under the bridge upstream and 4 channel widths downstream. This business rule is based on: bank debris located upstream will end up on the bridge substructure and downstream channel head-cutting or channel movements tend to move upstream. The intent of a dry overflow structure is to provide extra release area during high water events. Therefore, NBI Item 61 should be given a numerical assessment other than “N”.

If the bridge is Scour Critical, the bridge inspector can lower the NBI Item 113 (Scour Code) down to a “2” if immediate scour countermeasures are needed. However, that coding can only be raised by the ODOT Bridge Hydraulics Engineer, after an on-site assessment of the countermeasures has been made.

The channel is defined as encompassing from end bent to end bent. The approach roadway embankment is defined the bridge approach is located behind the end bent.

Business Rules Associated with Culverts:

Culverts – By definition a culvert is a drainage structure beneath an embankment. Typically, they carry water, they are surrounded by a fill or an embankment, they may or may not have a bottom, and the design / construction plans are generally standard culvert drawings. If a rigid frame carries water through an embankment they are generally inventoried as a culvert. If the rigid frame carries traffic through an embankment they are generally inventoried using various superstructure and substructure elements.

Culvert Inventory – All culvert inventories contain the following:

The total quantity (NBI Item 118) = the average of the barrel lengths.

Structure Length (NBI Item 49) = length between the inside faces of the exterior wall.

The Element Quantity = total sum of barrel lengths. The clear span between the barrels of multiple barreled culverts can not be more than $\frac{1}{2}$ the smaller diameter.

Continuity – Multi-barreled or moment carrying concrete box culverts are considered to be concrete continuous.

Culvert Deficiency Definitions - In order to define deficiencies associated with culverts, ODOT provided the following:

Distortion – deflecting in a non-symmetrical dimension, racking of the pipe.

Deflection – horizontal dimension increases and the vertical dimension decreases.

Settlement – Originally constructed on a flat grade, now has a belly. Not a Siphon.

Misalignment – Alignment differential that may have been caused by improper installation, undermining, or uneven settlement of fill.

Condition Assessment of a Culvert

Load Capacity – Culverts that are located in a fill less than 8 feet in height, need to be assessed as to its ability to carry live traffic loads. Culverts located in a fill higher than 8 feet, needs to be assessed as to its ability to carry the dead loads imparted by the fill which can be in a saturated state.

The structural strength in a rigid culvert resides in the culvert itself. The structural strength in a flexible culvert resides in the adequacy of the compacted embankment. In both cases, fill piping that can be caused by fill erosion, or rodent activity, can be a big issue. Therefore, in order to monitor the condition of a fill, the bridge inspector is directed to include Element 325 (Roadway Impact) in the condition assessment.

6.1.3—Bridge Access Methods

Each employer is responsible for protecting their workers from falling. Or-OSHA regulations contain two specific categories of activities that are covers Fall Protection: General Industry and Construction. Activities such as cleaning or maintaining equipment or structures are General Industry activities. Using a hammer and saw to build or construct, requires compliance with the Construction regulations. Bridge Inspection work, falls into the General Industry category. Bridge inspection work is continually moving, from top-to-bottom, and end-to-end, of a bridge. It is very seldom if ever static at any one location for any extended period of time. Therefore, the use of conventional methods is not very practical. As a result, the bridge inspection work generally utilizes other types of personal fall arrest systems for the duration of the work.

Oregon rules for all fall protection in general industry are as follows:

- A fall protection system is required where there is a hazard of 10 feet or more;
- A fall protection system is required if the employees are exposed to open sided floors, wall openings, or floors with hole openings that are 6 feet for more in elevation;
- Fall protection is required to be used at all elevations, when working from an articulating work platform or boom suspended bucket truck.

Or-OSHA also requires employers to:

- Give prompt rescue to workers who fall, either through self-rescue or outside rescue. Self-rescue equipment must be securely attached to the harness and be accessible to the employee in the event of a fall.
- Inspect fall protection equipment and systems for wear, damage, or deterioration prior to use, after an incident, when the system is relocated, or altered.

- Provide fall protection / self-rescue training to those employees who are exposed to fall hazards. This training will assure that the employees are thoroughly familiar with the fall protection they will be using and to properly inspect the equipment.
- Provide emergency response planning that is specific to the structure, tasks, location of work and identification of expected fall hazards and the system, components, and procedures that will minimize or eliminate them. The plan must specify what to do in the event of an emergency, identify personnel trained in first aid, personnel trained in self and aided rescue – retrieval, and be reviewed and available to all personnel involved in the work.
- Fall protection planning includes: identify all fall hazards anticipated during the course of the work at hand.

For more detailed information refer to ODOT Fall Protection Standard STD96007, a copy of which is located in the Appendix of this Section.

Bridges, by nature, are built to cross natural barriers, such as rivers and valleys, or constructed obstacles challenge the bridge inspector's ability to do a thorough and efficient inspection. Bottom-line, the bridge inspector will need to use access equipment in order to position the inspector close enough to the bridge component so that a "hands-on" inspection can be performed. Some of the more common forms of access equipment are:

- Portable Ladders
- Erection of Safeway Scaffolding
- Scaffold Board hung from Rigging Cables
- Boats or Barges
- Cable Climbers
- Bosun Chairs
- Utilizing Climbing Techniques
- Installation of Permanent Inspection Structures like walkways, ladders, handrails, or cable fall restraint systems.
- Utilizing Under Bridge Inspection Trucks (UBIT) and similar Trailer Mounted Equipment
- Utilizing Aerial Man-lifts

Although small bridges can be accessed from below using a ladder or small boat, more assistance will be needed on large major, high-level, structures. Under Bridge Inspection Truck (UBIT), aerial buckets, man-lifts, and rigging devices are some of the equipment used to properly access these structures, along with the traffic control requirements.

Use of Portable Ladders:

- Inspect the underside of the bridge superstructure and substructure units. Do not use a single ladder more than 30 feet long. Do not use two-section extension ladders more than 60 feet long and must meet the minimum overlap distance for the two sections in use. This overlap distance is specified in the Safety Standard.
- Since the bridge inspector generally carries the access ladder on the top of their vehicle due to its length, care should be taken, when retrieving the ladder, reaching and lifting heavy loads in an off balanced overhead position.
- Since the bridge inspector will be carrying the ladder from the vehicle to the inspection location, which could be down a steep vegetated embankments and loose rock riprap, the bridge inspector must not carry an object or load that could cause the person to lose balance and fall.
- Use is generally limited to areas where the ladder can be set on firm, level, non-slippery surfaces. This does not include in the water.
- Ladder must be placed at such a pitch that the horizontal distance from the top support to the foot of the ladder is about one-quarter of the working length of the ladder.
- The inspector can reach out, but the rest of the body must stay within the side rails of the ladder.
- If the ladder is used to access an upper landing, the ladder must extend at least 3 feet above the upper landing surface.
- The top 3 rungs of an extension ladder should not be used as a working position.
- Hook-ladders can be used to climb down to access elements, but will require the inspector to be tied-off to a separate safety line.

- Ladders should be inspected for visible defects on a periodic basis and after any occurrence that could affect their safe use by a trained person.
- Each bridge inspector should be trained to recognize hazards related to ladders and the procedures to be followed to recognize and minimize those hazards.
- When ascending or descending a ladder, the climber should not be carrying tools in their hands.

For more details regarding the use of ladders, please refer to the Portable and Fixed Ladder Safety Standard, #STD96026, located in the Appendix of this section.

Rigging

Rigging on a structure consists of cables and platforms that are used for:

- Gain access to floor systems
- Gain access to bottom of main load carrying members
- Where other means are not feasible – over water, busy highway, or railroads where sufficient clearance exists.
- Where special inspection procedures are required – NDE testing or pin removal
- Good choice for load posted bridge that may not be able to safely carry the weight of an inspection vehicle.
- Access is limited only to the location of the rigging. Accessing all portions of the bridge might require moving the rigging.

Scaffolds

Safeway Scaffolding system is placed up from the ground. Provide efficient access for a structure that is:

- Less than 40' high
- Over level ground
- With little or no traffic
- Can be placed on a large stable barge under the bridge.
- Access limited to the area over the scaffolding. Full bridge access might require moving the scaffolding system.

Boats or Barges

- A boat or barge may be needed for structures over water, used for:
- Underwater inspections
- Used in combination with other access equipment like a ladders, a aerial manlift, a bucket-truck vehicle, or safeway scaffolding.
- Used as a safety boat.
- When boat ramp is not available or water is swift and shallow need a light-weight low-draft boat that could be easily carried.

Climbers

Climbers are mobile inspection platforms or cages that “climb” steel cables are well suited for:

- Inspection of high piers
- Inspection of other long vertical faces of bridge members
- Common types are spiders

Floats

Floats are wood plank work platforms hung by ropes, which are used for access by painters or inspectors that will be at a particular location for a relatively long period of time.

Bosun Chairs / Rappelling

Bosun chairs are suspended with a rope and can carry only one inspector at a time. The chair can be raised and lowered with block and tackle device, and requires an independent safety line. Gas powered ascenders work well when climbers inspect the vertical members using rappelling techniques.

Truck or Trailer Mounted Under Bridge Inspection Equipment (UBIT)

If access from below is not possible, a Under Bridge Inspection Truck, will need to be used to gain arms length, hands-on access. When a UBIT is employed, the strength and geometry of the deck and framing system must be reviewed to ascertain the safe and effective use of the equipment. UBIT's are also quite heavy. The Hydra-platform is a good choice for load restricted structures.

Inspections Using Climbers

When all equipment options have been exhausted and adequate access cannot be obtained, rigging or climbing will most likely be the required method of access. Rigging can be very complicated and if not used a lot, the rigging system should only be employed by those that have the experience in doing so. Whenever using a rigging system an independent safety line should be supplied for the inspector to tie off to. Where the cost of rigging is prohibitive, bridge inspectors that have been trained in mountain climbing techniques and using specialized harnesses and climbing equipment can be brought in to do the inspection.

If other methods of access are not practical, inspectors must climb the bridge elements. There are two categories:

- Free climbing in which the inspector climbs freely
- Second category employs rappelling techniques and safety equipment

Permanent Inspection Structures

On some structures, inspection access is included in the design and construction of the bridge.

- Found on long span and more complex bridge designs
- Give access to a limited portion of the bridge
- Some examples of permanent inspection structures:
 - Catwalks - Is an inspection platform or walkway that is typically suspended from the superstructure and running parallel to the roadway from abutment-to-abutment. A catwalk is used to inspect parts of the superstructure and substructure, but the range is limited to locations between the adjacent superstructure members.
 - Handrails / Cable Restraints – Assist the inspector when free climbing and provide place to secure lanyard and safety harness. Some different location include on the main suspension cables, on top of pier caps, on top of the steel trusses, and on inside of a girder.

Types of Access Vehicles

There are many types of vehicles available to assist the inspector in gaining access to bridge elements. The most common types include the following:

- **Use of Man-lifts** – is a vehicle that has a platform or bucket attached to a hydraulic boom that is mounted on a carriage. Its limited to use on fairly level terrain and has limited reach ranging from 40' to about 150' (diagonal reach not vertical reach). Has to be delivered to the bridge site and secured after hours.
- **Bucket Truck** – similar to a manlift, except that the inspector only controls the bucket. It can be driven to the job site and taken back to the shop at night. Lift and rotating turret turning range varies with each vehicle. Outriggers are supports that are lowered from chassis to help maintain stability. Telescoping boom capable of extending and retracting. Truck movement – some vehicles offer stable operations without outriggers.
 - Walk the route prior to traveling it or lifting to look for overhead wire.
 - Keep at least 10 feet from electrical power lines.
 - Contact electrical companies / utilities in the area if there is a question about the work and / or around the electrical power lines.
 - Wind is an additional concern of any bucket truck operator. Wind will create additional force to the load weight already in the platform / boom, which could make the equipment unstable.
 - If an ODOT or other government agency employee has need to be in a manlift / bucket truck, perform an OJT covering the following:
 - Proper PPE: Hard Hat, Fall Protection Harness, Gloves, Safety Vest, and Basic instructions and emergency procedures for operating the lift.
 - Use of a Ground Person is strongly encouraged to perform the following:
 - Keeping fully aware of the work zone, at all times
 - Can use the lower controls in case of an emergency

- Check placement of the truck / lift and traffic control
 - Keep a constant eye on the traffic for high or wide loads
 - Support the up person with needed tools, parts, etc.
 - For more details refer to ODOT Manlift and Bucket Truck Safety Standard STD20071.
- **Under Bridge Inspection Truck (UBIT)**
 - Specialized bucket truck with an articulated boom designed to reach under a structure while parked on the deck. Standardized features include:
 - Rotating turret provides maximum flexibility
 - Outriggers with wheels or counterweight lock downs allow truck to be moved during operations
 - Telescoping third boom has capacity for extending and retracting.
 - Some have two or three person buckets, while others are equipped with work platforms. Telescoping second boom that can be extended and contract. Articulated third or forth booms which allow for greater vertical movement.

Access to the Underwater Portions of a Structure

Bridge members that are located underwater, and too deep to wade, can only be assessed by inspecting the members and the channel in the immediate vicinity of the underwater members by diving. The employer is also required to establish safe diving standards for ODOT employees who perform underwater diving operations. The standard operations will include:

- A Job Safety Assessment (JSA) will be performed for each diving operation and maintained to identify and address all potential job related hazards / risks, and each diver will be informed prior to the diving operation of possible hazards which might be encountered during the dive, i.e., strong currents, entanglements, and zero visibility.
- The ODOT Bridge Dive Team Manager is the designated person in charge of the underwater diving operation and assure that it is in compliance with the ODOT Commercial Diving Safety Standard STD96019.

Methods of Access and Efficiency

The employer is supposed to select a specific fall protection system that will match with the particular work situation and keep the free fall distance to a minimum. In most cases, a man-lift device will be quicker than using a ladder or rigging to inspect a structure. The time saved must offset the higher costs of operating a vehicle. The following questions should be answered:

- Can the bridge be inspected by other reasonable methods?
- What type of vehicle is available?
- How much of the bridge can be inspected using the vehicle?
- How much of the bridge can be inspected from each setup?
- How much time does it take to move from one setup to the next?
- Does the vehicle require an operator and a separate driver other than the inspector?
- Will the use of the vehicle require special traffic control?

The inspection time and vehicle costs can then be compared to costs associated with using standard access equipment.

Safety Considerations

Safety should be a primary concern on any job site, safety of not only the workers, but of the public as well. The equipment and vehicles being used also have safety considerations.

Access Equipment

- Before the bridge inspection begins, an equipment inspection must be performed.
- Inspect access equipment as per manufacturers guidelines.
- Verify that it is in good working condition.
- Check rigging and scaffolding to ensure it is installed properly and all cables and planks are secured tightly.
- When climbing, check for loose clothing or articles that can get caught.

- OSHA approved safety harnesses with shock absorbing lanyards should be worn at all times when using access equipment and vehicles.

Access Vehicles

- If the inspector is not familiar with the inspection vehicle being used, he should take the time required to become accustomed to the operation.
- Always be aware of overhead power lines or any other hazards.
- Be aware of any restrictions on the vehicle, such as weight limits for the bucket, support surface slope limits, and reach restrictions.
- Always be alert to your location and hydraulic lines being pinched
- Do not boom out into an unprotected traffic lane or near electrical lines.

Traffic Control Plan

A good traffic control plan is to provide for the safe and efficient movement of motorists, pedestrians, and the protection of the bridge inspection team in the work area. All traffic control devices used must conform to the applicable specifications of the Manual on Uniform Traffic Control Devices (MUTCD). When working with equipment on a bridge deck, or from a roadway below the bridge, where a traffic lane or shoulder is to be closed appropriate traffic control procedures must be initiated. This needed to not only route the traffic away from the inspection area, but to also keep the inspectors safe. In the State of Oregon, these traffic control measures should be employed in accordance with the “ODOT Short Term Traffic Control Manual”. Working on a route with high traffic volumes may require the limited work windows or night-time work hours. Working over or immediately adjacent to a railroad line will require the inspector to obtain, coordinate and conform to the issued permit and flagger restrictions issued by the various railroad companies.

Business Rules Associated with Working Around a Railroad:

Take Special Precautions around railroads and transit systems.

Working on or over a railroad almost always requires some special procedure to be initiated. The bridge inspection team must not foul the tracks. The railroad train window of usage is within 10 feet each side of the rails. The bridge inspector can perform these inspections and cross the tracks without notifying the railroad company. However, if the bridge inspector is required to remain within the railroad train usage window for more than a few minutes, obtaining a permit of entry, and having a railroad flagger on-site, is a must. If the railroad engineer sees a florescent orange vest next to the tracks, their instructions are to immediately stop the train. Those that cause the train stoppage could be charged or fined thousands of dollars for every minute the train is shut down.

6.1.4—Bridge Inspection Safety Practices

Safety of the bridge inspection team and the traveling public is paramount and care must be taken when choosing inspection personnel to inspect a particular bridge, particularly when climbing or working at extreme heights. Bridge inspection can be very dangerous work that may not be within the physical capacity of all structural engineers. Having technical capable people perform the work is essential, but the inspector’s safety is paramount. Assigning engineers who have been office bound for many years to perform bridge inspection work is a questionable practice. Such personnel should be teamed with engineers that may possess less overall experience, but have the field experience and the ability to perform the inspection work with ease.

When working with equipment on a bridge deck, or from a roadway below the bridge, where a traffic lane or shoulder is to be closed appropriate traffic control procedures must be initiated. This needed to not only route the traffic away from the inspection area, but to also keep the inspectors safe. In the State of Oregon, these traffic control measures should be employed in accordance with the “ODOT Short Term Traffic Control Manual”. Working a routes with high traffic volumes may require the limited work windows or night-time work hours. Working over or immediately adjacent to a railroad line will require the inspector to obtain, coordinate and conform to the issued permit and flagger restrictions issued by the various railroad companies.

Bridge Section Safety Plan

Since ODOT is committed to a safe and healthy workplace, and value the safety of their employees, Bridge Section created a safety poster, and has caused the poster to be posted on the Safety Bulletin Board of each crew. The Safety Poster contains the following information:

ODOT Occupational Safety and Health Policy

- Provide a safe and healthful environment for all employees – safety must be part of every operation.
- ODOT is committed to a safe and healthy workplace.
- Compliance with all state and federal regulations is required.
- Safety is a fundamental responsibility of every employee
- Safe practices and methods must be considered equally with other organizational objectives such as cost control, quality and productivity.

Bridge Section Management Responsibilities

- Identify safety related roles and responsibilities
- Raise the level of involvement, communication, education, and accountability.
- Proactively integrate employee safety and health into routine business meetings and business practices.
- New employee Orientation
- Provide knowledge and skill training
- Integrate into position description and expectations discussion
- Coach and counsel – performance reviews
- Acknowledge safe behaviors – positive reinforcement
- Discipline if necessary
- Raising the level of knowledge and involvement in safety and health issues by:
 - Checking in with employees on a routine basis.
 - Actively observe and act upon work unit safety and health concerns.
 - Investigate accidents and injuries ASAP and take appropriate action, do not wait.
 - If employees raise safety and health concerns, acted upon them and keep the employee engaged.
 - Review these safety measures at least annually through performance planning and/or performance appraisal.
 - Proactively think about the following: Patterns, observation of unsafe behavior, and accident history.
 - Recognize the differences in work environments, respective areas of focus and associated risk points.
 - Have each work unit develop their own list of work environment Safety indicators.
 - Set a positive example.
 - Maintain an Electronic File showing staff safety training Needs, Classes Scheduled, and Classes Completed.

Required Safety Training / Certification Checklist

Defensive Driving	One time prior to driving a State Vehicle
Performing a Job Hazard Analysis	At least once
Fall Protection / Self Rescue	Renewal: Office (2 yrs) – Field (4 yrs)
Work Zone Traffic Safety / Parking	Prior to being responsible for traffic control
Bucket Truck Certification	Certification required prior to using a man-lift
1 st Aid / CPR / Blood Pathogens	Prior to going to field – Renewal every 2 yrs
Personal Protective Equipment	At least once prior to going to field
Confined Space Awareness	At least once prior to going to field
Confined Space Entry	At least once prior to entering a Confined Space
Respirator Fit	Prior to entering a Permit Entry Confined Space
Work Platform Safety	Prior to entering construction site
Ladder Safety & OSHA Regs	Prior to entering construction site
Shoring Safety & OSHA Regs	Prior to entering construction site
Safety around Equipment	Prior to entering construction site
Hazardous Material Awareness	Prior to entering construction site
Lockout / Tagout	Prior to entering construction site
Slips / Trips / Falls	Prior to going to field is available
Violence in the Workplace	Available on line

Bridge Section Employees Responsibilities

- Follow safe work practices by performing your job in a safe manner.
- (Be familiar with and follow ODOT Working Alone Guideline)
- Stop work where hazards are not controlled or conditions change.
- Identify and report unsafe conditions – correct conditions, if appropriate
- Utilize and follow ODOT safety policies, programs, standards, and guidelines.
- Follow the Safety Indicators developed by your work unit
- Participate in safety committees / meetings
- Acknowledge the efforts of co-workers in safe behaviors
- Tailgate Party – Discuss generic and site Job Safety Analysis (JSA)
- Emphasize the complete itinerary (arriving, parking, leaving site)
- Review Accidents – Lessons Learned
- Emergency Prep / Evacuation Plan
- Recommend improvements for safety and health in the workplace – provide feedback.
- Periodically assess condition of PPE equipment; replace as needed; evaluate storage area and gear bags.
- Actively keep work space tidy.

Bridge Section Safety Indicators

- Safety discussions are included in appropriate meetings and safety reminders are periodically disseminated to staff.
- Required job related safety training is provided.
- Proactively test Confined Spaces and Disseminate currently known unsafe air quality testing report information.
- Maintain an active list of known bridges that contain unsafe air quality issues.
- Require use of Air Quality Testing Equipment in all confined spaces.
- Two person field teams are used where possible: A traffic spotter is required when working close to existing travel lanes.
- ODOT Working Alone Guideline is being followed (contacts with region TMOC's)
- Raise standard bridge rail to 42" height or provide acceptable tie-off facilities.
- Assure all utilities are properly labeled, note where they are not
- (Type of Utility, Company Name, Contact Name, Address, Phone Number)
- New Employee Orientation Plan is given to all new staff:
- (Office evacuation plan, location of 1st Aid Kits, location and operation of fire extinguishers)
- Office Safety Inspection Walk-around is periodically performed and followed up on to assure progress is being made.
- Storage areas are properly organized; construction materials, office furniture, field gear – work areas are tidy.
- Office Ergonomic Measures are available
- Workplace fatigue and stress are minimized by tempering number of hours worked.

Vehicle Safety

Ensure that employees operate all state owned vehicles as well as private vehicles used for state business in a safe manner. ODOT employees are required to operate all state owned vehicles according to Oregon Law, DAS rules, and ODOT policies.

- Employees will not operate any type of vehicle while in an impaired state.
- The use of cell phones while driving a moving vehicle is strongly discouraged. Every attempt should be made to pull off of the roadway to place or receive a call.
- Backing accidents continue to be a leading cause of vehicle accidents. Most backing accidents are avoidable. The driver must check all clearances and initiate the following:
 - Avoid backing whenever possible by looking for an alternate route that may eliminate the need to back up or back into the parking space when you arrive so that all you have to do is drive away when you leave.
 - If you must back up, use a spotter.
 - If a spotter is not available, it is important to follow these guidelines:

- Assess the backing area prior to backing and try to select an area where you can pull your vehicle to the right or back to the left, favoring your driver's mirror.
- Use drive through parking whenever possible.
- Sound your horn before backing.
- Back slowly and check both mirrors continuously.
- If you detect any movement in either mirror, stop immediately, set the parking brake, and get out and check again for clearances.

All Vehicular citations are the responsibility of the driver. ODOT will not pay nor will they reimburse the employee. This includes all payments associated with having your vehicle towed.

Personal Protective Equipment

Determine what Personal Protective Equipment is required to be work for the assigned job tasks that require the use of PPE. As a minimum, the following general clothing requirements will be followed by all ODOT employees performing work in the field:

Basic Clothing: All employees will wear the following:

- **Shirts** that are from point of shoulder and cover the entire torso.
- **Pants** are also required that cover the legs down to the ankle and should not be loose, droopy or baggy.
- A **hat** will be worn that is appropriate for the situation and potential hazards.

Footwear: All field personnel will wear the following:

- Basic boot or shoe that is appropriate for the assigned work and protection from potential hazards, like
 - Working on inclined and slippery surfaces,
 - Sharp or jagged objects like transient drug needles,
 - Unstable objects like loose riprap, etc.
- As a minimum, the work shoe or boot must be:
 - Sturdy,
 - At least 6" from the bottom of the heel to the top,
 - Completely enclosed toe and heel,
 - Upper material constructed of leather, or leather with breathable openings hat is constructed of cut resistant synthetic material.
 - The heels must be low and wide for stability, no taller than 2", and
 - Have soles and tread pattern selected for the work setting to resist slipping.

Visibility Clothing: All field personnel will wear the following:

- Retro-reflective safety vest, shirt, jacket, or rain gear is required for daytime use for all work activity on or adjacent to the roadway.
 - Adjacent to the roadway is defined as within 15 feet of the roadway, including paved shoulders.
- All ODOT purchased safety vests and hats will be identifiable as an ODOT worker by the ODOT logo and legend on their hat or garment.
- ANSI Class II t-shirts may be worn in place of the ODOT Safety vest.
- Approved soft cap, stocking cap, or hard hat of strong red, bright white, strong yellow or fluorescent versions of these colors must be worn while on or adjacent to the roadway.
 - However, if clothing purchased by employees, such as vests, shirts, or jackets or other high visibility garments acquired by employees to meet the high-visibility and reflective standards of ANSI Class II or III, will not have the ODOT logo.
- For additional protection for night or low light conditions, high visibility orange pants with retro-reflective striping is recommended for extra illumination.

Hand Protection: Regular work gloves will be worn in activities which may result in an injury. Protective gloves will be worn when hands are exposed to cuts, abrasion, electrical hazards, extreme heat, or blood-borne pathogens.

Hard Hat Requirements: Hard hats will be worn if the work site has been designated as a hard hat area, like an active construction site.

ODOT's Working Alone Policy

There are many times when ODOT employees are assigned to perform tasks where they will be working alone. Sometimes these duties will be out of sight or hearing of the public.

The ODOT Safety & Health Managers developed these guidelines to minimize the additional hazards encountered when working alone.

These guidelines are to be used by every ODOT team to develop a program / procedure for the protection of the field personnel, when required to work alone.

WORKING ALONE GUIDELINES

- To ensure that regular and emergency communication is considered and provided for the safety of employees who are required to work alone for extended periods of time. Employees will maintain a communication link by radio, telephone, or personal contact so a responsible person can monitor their safety and health at specific periodic intervals.
- An assessment will be completed to determine if hazards exist where employees are required to work alone based on the task being performed.
- If the assessment indicates special risks for the task being performed when working alone, then a communication plan shall be developed that outlines the means of communication, the employees involved, intervals of contact, and emergency procedures.
- If regular communication is deemed necessary, establish specific time lines for communication to occur. The work assignment will dictate the frequency according to the hazard assessment with a maximum of two hours between contacts.
- Establish with whom the communication will occur and activate.
- Communication may occur with employee's unit/section, adjacent section, central dispatch, or police agency personnel.
- Examples are as follows: Work occurring outside of the view of the public requires use of a fixed or portable ODOT channel, citizens band and/or police/fire/emergency band radio, telephone, or personal contact with a prearranged person. The radio or telephone device available must have a sufficient capability to reach the designated contact point or the employee may not work alone. Installation of additional repeating stations may be required. The radio or telephone must be kept with the employee. If work requires leaving a radio or telephone equipped vehicle, a proper communication device must be provided, turned on, and carried by the employee.
- At the end of the working alone assignment, acknowledge its completion with the responsible contact and what the next activity will be, i.e., another assignment working alone, working with others, going home, etc.
- Use guidelines as necessary until work shift ends.

Acceptable Working at Night Procedures

- Step 1 Working Alone
- Step 2 Traffic Control
- Step 3 Donning Equipment
- Step 4 Planning & Implementing Access
- Step 5 Identify Worksite Hazards
- Step 6 Working in a Confined Space
- Step 7 Meet with Inspection Team, discuss inspection findings and document inspection
- Step 8 Pickup Traffic Control
- Step 9 Notify Others

Working at Heights

Precautions to be taken when measuring Cross-Channel Profiles

- When continuous work is being performed on a bridge deck, always use appropriate traffic warning signs.
- Where possible always tie-off before performing any work over the side of the bridge. (Do not tie-off to a vehicle that's located on the bridge deck immediately adjacent to the travel lane - traffic collision with the vehicle could occur.)

- Where tying off is not possible, do not expose the upper torso of your body out beyond the vertical plane of the bridge railing.
- If the inspector kneels along side of the bridge parapet railing, a traffic spotter should be utilized along with making sure your feet and legs are well protected from traffic.

Bridge Fall Restraint Systems

Each employer is responsible for protecting their workers from falling. In most cases, OrOSHA suggests that each employer should use conventional fall protection such as: guard rails, safety nets, or personal fall arrest systems. Conventional systems perform the following:

- Fall restraint prevents a worker from falling.
- Fall arrest safely stops a worker who does fall.
- Guardrail system stops a worker from a fall.
- Safety net system protects a worker from fall.
- Positioning device protects a worker from a fall.

However, bridge inspection condition assessment work zone is continually moving, from top-to-bottom, and end-to-end, of a bridge. It usually is not static in any one location for any extended period of time. Therefore, the use of some conventional methods like: placing a guardrail system, safety nets, or some positioning devices, are not very practical. As a result, most of the time, bridge inspection work requires the use of personal fall arrest systems, fall restraint systems, or positioning devices for the duration of the work. It's the responsibility of the manager or crew lead person to select and initiate the most appropriate fall protection measures.

If, for some reason, these conventional measures can not be initiated, in accordance with the ODOT Fall Protection Standards STD96007, each entity must have a qualified person prepare a very thorough and site specific fall protection plan that fully explains exactly why the conventional systems are not feasible or would pose a greater safety hazard to workers, if they were to be used. In this case, a qualified person is someone who has extensive knowledge, training, and experience with fall protection systems. The qualified person must know: how to design, use, and install fall protective systems; the limitations of fall protection systems; and, fall hazards associated with work tasks and processes. Supervisory responsibility must be assigned to a competent person for implementation. A competent person is someone who can identify hazardous conditions and appropriate applications for a fall protection system and who has authority to correct hazards. A competent person must know: the site specific fall protection plan; how to perform work tasks safely, and the hazards associated with those tasks.

The plan must indicate how the competent person will supervise implementation and how accountability will be enforced. Or-OSHA requires employers to give prompt rescue to workers who fall, either through self-rescue or outside rescue. When a fall protection plan is required, it must include provisions that will assure a prompt rescue.

OR-OSHA has specific requirements that must be contained in the protection plan, covered in 29 CFR 1926.502(k), Division 3/M of the Oregon construction safety and health code. If the agency decides to use a different type of fall protection plan, the OSHA guidelines will help keep the plan in line with the requirements. An effective fall protection plan will protect workers from fall hazards and enhance the overall level of safety at each bridge site. Oregon OSHA will use the criteria in these guidelines to verify that the plan meets the intent of 29 CFR 1926.502(k).

All existing fall protection systems must be inspected for wear, damage, or deterioration prior to each use, after an incident, when the system is relocated, or altered in any way.

Where work procedures pose two or more hazards, such as working over water where both a drowning and fall hazard exists, protect against the greater hazard. For example, if the fall arrest or fall restraint system would prevent reaching the water, fall protection should be used, rather than wearing a life vest, because the fall is the greater hazard. The combination of personal protective equipment may pose additional hazards and impact the effectiveness of the fall protection system.

Inspection of Fall Protection Equipment

All fall protection components and systems must be inspected for wear, damage, or deterioration prior to each use, after an incident, when the system is relocated, or altered in any way.

Harness Inspection:

Start at one end, hold the body side of the harness toward you.
Grasp the belt with your hands 6 to 8 inches apart. Bend the belt in an inverted “U”.
The resulting surface tension makes damaged fibers or cuts easier to see.
Follow this same procedure the entire length of the belt or harness.

Lanyard Inspection: When inspecting the lanyard,

Begin at one end and work to the opposite end.
Slowly rotate the lanyard so that the entire circumference is checked.
Pay particular attention to splice areas and attachment hardware.

Cleaning Fall Protection Equipment:

Basic care of the equipment will prolong the durable life and will contribute toward the performance of its vital safety function.
Proper storage and maintenance after use is very important as is cleaning the equipment of dirt, corrosives, or contaminants.
Storage areas should be clean, dry, and free from exposure to fumes or corrosive elements.

Confined Space Requirements

A space can be classified as either a Permit-Required or a Non-Permit Entry Confined Space. The following structures are classified as having the potential for containing a Confined Space:

- Accessible box girder cells
- Culverts
- Tunnels

A space can be classified as a “Permit Required Confined Space” if it contains one or more of the following:

- Contains or has the potential of containing a hazardous atmosphere; or
- Contains materials that has the potential to engulf an entrant; or
- Has a internal configuration such that an entrant could be trapped or asphyxiated; or
- Contains any other serious safety or health hazard.

Inspection of Accessible Box Girder cells

- All entrants must have completed the “Confined Space Awareness” Training Class
- Make sure communication equipment is on-hand and operable and a communication net has been established.
- Assure air meter is fully functional and it monitors: oxygen content, hydrogen sulfide, and carbon monoxide levels.
- Before physical entry is made, test the air quality in and around the point of entry.
- Immediately upon entry, test air quality in top and bottom of the box girder section.
- Continue to monitor the air quality throughout the inspection procedure until the entry team leaves the space.
- If a prohibited condition arises or is found, the team must immediately vacate the space and treat it as a “Permit Required Space”. This will tag all points of entry as such, and inventory the space as such in the bridge inspection database.

Inspection of In-Service Culverts:

- Assess the approach to the culvert for hazards. Proceed if safe to do so.
- At the mouth of the culvert check for the following:
- Blockage inside of the culvert as indicated by the lack of light passing through or the indication of an excess of water (more than 2 ft deep).
 - Lack of air flow;
 - Presence of hazardous materials in the water or surrounding area or presence of a sheen on the water surface;

- Water depth (should be no more than 2 feet for still water and less than 1 foot for rapidly running water).
- If the inspector feels that a potential hazard that poses an immediate danger to life and health, then the inspector should address the hazard before entry. Attention should be paid to slip, trip, and drowning hazards.
- The selection of personal protective equipment will vary at each culvert and is left to the judgment of the inspector.
- If at any time during the entry of the culvert an inspector feel dizzy, nauseous, lightheaded or disoriented in any way they are to exit immediately and then proceed to treat the culvert as a permit required confined space until a thorough evaluation proves otherwise.

Inspection in a Confined Space Under-Construction

Inspectors should ensure that before performing any construction activity inside of a culvert that they perform an assessment as outlined in ODOT's Permit Required Confined Space program before proceeding with the work. Construction Activity includes: cutting with a torch, grinding with a power tool, applying a coating, epoxies or paints, flame spray applications, operation of gas power tools or generators.

Dealing with Transients within the Workplace

- Treat the individuals with respect and simply explain what you are doing.
- Take all measures necessary to be courteous and non-confrontational.
- If at all possible stay clear of all transient wastes.

Dealing with Wildlife Guano within the Workplace

- Wear appropriate protective clothing and gloves
- If the guano is dry, wear a dust mask. Try to minimize creating dust particles in the air.

Dealing with Environmental Influences

Poison Oak – Poison Oak has three pointed leaflets that can be smooth or jagged. The middle leaflet is longer than the other two. The plants are reddish in the spring, turn green in the summer, and become various shades of yellow, orange, or red in the autumn. Small greenish flowers may appear in bunches on the main stem and later in the season, white berry like clusters appear. If the bridge inspector thinks that they have come into contact with a poisonous plant, they're directed to perform the following:

- Wash exposed areas with cool water immediately and take a soapy shower as quickly as possible.
- Wash all of the clothing you were wearing and the tools you were using at the time of the exposure.
- If you get a rash, try a lukewarm bath in oatmeal or baking soda to help dry oozing blisters.

Internet Research – Diseases Given to Humans by Animals deserving additional internet research:

- Rabies
- Hanta Virus
- Contagious Ecthyma
- Brucellosis
- Tularemia
- Plague
- Pigeon Poop Fever
- Lyme Disease
- Q Fever
- Cryptosporidiosis
- Giardiasis
- Salmonellosis

Job Hazard Assessment Requirements (JHA)

Process is to divide the job into logical sequential steps. Identify all of the potential hazards that might be present while performing that particular task. Identify what procedures need to be implemented in order to mitigate those hazards. Then perform the task at hand, implementing the recommended safety measures.

<u>Job Sequence</u>	<u>Potential Hazard</u>	<u>Mitigation Measures</u>
<u>Work Planning</u>		
Br Safety Training	Not up-to-date	Keep current
<u>Inspection Timing</u>		
Day Work	Peak Traffic Windows	Advanced Planning
Night Work	Visibility / Lighting	Fully equipped
<u>Bridge Site – Egress Traffic</u>		
Vehicle Parking / Staging Area		
Protected / Un-protected	Sideswiped / rear ended	Protect
Leading end of railing	Soft shoulder/ speeding	Safe Parking
On Bridge	Getting out of vehicle	
Trailing End of bridge	Backing	Spotter
Under Bridge	same	same
<u>Bridge Inspection Team</u>		
1 Person Team	Traffic spotter	
Working Alone: Potential for not being able to contact help	Struck by a vehicle, tripping, slipping, falling, caught on or in a hazard, confined space, exposure to extreme temperatures, and transients. No follow-up No rescue plan	Don't Work Alone or follow ODOT Work Alone Guide: * setup communication net * establish check-in times * acknowledge completion
<u>Rescue Plan:</u>		
ODOT Dispatch	Radio Frequency Unknown	Incorporate into Bridge JHA
ODOT Dispatch	Radio Call sign unknown	Incorporate into Bridge JHA
ODOT Dispatch	Telephone No. unknown	Incorporate into Bridge JHA
Medical center	Telephone No. unknown	Incorporate into Bridge JHA
Fire Dept Responders	No 911 coverage	Incorporate into Bridge JHA
Coast Guard	Telephone No. unknown	Incorporate into Bridge JHA
<u>Evaluate Bridge Site Hazards</u>		
Utilities (electrical / gas)	Facility not labeled	Bridge JHA
Confined Spaces	Not properly equipped	Do not enter
Hazardous Materials	No inventory	
Non-wadeable water	No probing stick	
Fall Restraint Systems	Using wrong equipment	Do not use
	Assess condition prior to use	
Steep Slopes	Walking stick	
Bats	Guano / Urine	
Poison Oak	Rash	
Spider, Snakes, Ticks	Bite	
Tick / Mice Guano	Tick Fever, Haunta Virus	Sanitizer
Bees / Wasp Nests		
Transients	Toxic Wastes	Sanitizer, rubber gloves
<u>Advance Traffic Warnings</u>		
Vehicle Flashers	Stranded by dead battery	

Signs

Traffic Control

Struck by a vehicle, creating traffic congestion, presenting a hazard to traffic.

Match traffic plan with site conditions:

- * provide lane closure with signing
- * provide warning signs and define escape route
- * use a traffic spotter
- * walk against traffic
- * insp on same side of road

Donning Equipment

PPE

Access Equipment

Inspection Tools materials

Access keys

Not clearly visible to traffic, Head injuries, cuts & skin Abrasions, exposure to toxic

Match equipment needs to the work being performed. Review w/co-workers and follow ODOT Protective Equipment Policy.

Walking Over the Bridge

ADT

Shoulder Width

Rail Height

Working over side of br.

Restraint Tide Off's

Traffic Spotter

Hurry across

Height < 40"

No tie offs

Pre-assess the work site and discuss with team members.

- * Devise plan to mitigate known hazards.
- * File assessment for future reference.

Inspection of the far end Of bridge

Which corner of br

Vegetation

Loose Material / Riprap

Inspection of near end of bridge

Which corner of br

Vegetation

Loose Material / Riprap

Identify Worksite Hazards

Bird droppings, bat nest droppings hypodermic needles, poison oak, Poison sumac, hog weed, transient Wastes, transients, resident rodents Snakes, etc.

Pre-assess the work site and discuss with team members
* Devise a plan to mitigate known hazards
* File the assessment for Future reference.

Traffic

Wading in Water

Slippery Surfaces

Tripping Hazards

Carrying a Portable Ladder

Entering in Confined Spaces

Air Meter

Battery Charged

Calibrated

Have on site

Backup light

Batter disposal

No air to breath, breathing poor quality air, head injuries, no lights, Tripping, being locked in a Confined Space, becoming stuck

Review and follow the ODOT Confined Space Policy & Procedures:
* establish a communication

In space, Transients.

Net

*establish a rescue plan

- * lock-out / tag-out
- * use appropriate equipment
- * notify completion
- * file plan for future

Wrap-up

Meet with
Inspection Team,
Discuss inspection
Findings, document
Inspection

Being struck by traffic, creating
a traffic distraction, falling,
slipping, tripping, off balance
while taking photo and / or
measurements, public image.

Follow the original bridge
inspection plan and make
sure traffic control measures
are still in-place.

Notify Others and Ingress back into Traffic

Prep for next structure

6.1.5—Element Inventory Environment ID

Assigning the proper element environment is vital for accurate deterioration predictions and future project identification. As definition of each environment is listed as follows:

1 – BENIGN: Neither environmental factors nor operating practices are likely to significantly change the condition of the element over time or their effects have been mitigated by the presence of highly effective protective systems.

2 – LOW: Environmental factors and/or operating practices either do not adversely influence the condition of the element or their effects are substantially lessened by the application of effective protective systems.

3 – MODERATE: Any change in the condition of the element is likely to be quite normal as measured against those environmental factors and/or operating practices that are considered typical by the agency.

4 – SEVERE: Environmental factors and/or operating practices contribute to the rapid decline in the condition of the element. Protective systems are not in place or are ineffective.

The environment designation of an element can change over time; as it would if operating policies were changed, i.e., use of corrosive deicing chemicals. By definition, the environment designation can not change as a result of maintenance work or deterioration.

Factors that could increase the severity of the environment rating for various elements include: (record most predominant)

Timber Elements: High moisture content or a pest infestation.

Steel Elements: Distance from salty air or corrosive atmospheres.

Concrete Elements: Freeze-Thaw Cycles, Tire Chain/Stud Wear, Deicing Chemicals.

Joints / Bearings: High skew, Extreme Temperature Ranges, Air Pollutants.

Operating Practices: High Traffic or Truck Volumes, Sanding vs Deicing Chemicals.

6.1.6—Temporary Structure Repair Designations

Code this item to indicate situations where temporary structures or conditions exist. If no temporary structure or shoring exists, or it is not sufficient to restore the full load carrying capacity of the element, leave this item blank.

Code	Description
T	Temporary structure(s) or conditions exist.

Temporary structure(s) or conditions are those that are required to facilitate traffic flow. This may occur either before or during the modification or replacement of a structure found to be deficient. Such conditions include the following:

- Bridges shored up, including additional temporary supports.
- Temporary repairs made to keep a bridge open.
- Temporary structures, temporary runarounds or bypasses.
- Other temporary measures, such as barricaded traffic lanes to keep the bridge open.

Any repaired structure or replacement structure which is expected to remain in place without further project activity, other than maintenance, for a significant period of time shall not be considered temporary. Under such conditions, that structure, regardless of type, shall be considered the minimum adequate to remain in place and evaluated accordingly. A significant period of time shall be considered 10 years and longer.

A repaired structure element not having equal or greater load capacity or service life of a similar non-deficient element can be considered temporary.

If this item is coded T, then all data recorded for the structure shall be for the condition of the structure without temporary measures, except for the following items which shall be for the temporary structure.

ITEM

- 10 – Inventory Route, Minimum Vertical Clearance
- 41 – Structure Open, Posted, or Closed to Traffic
- 47 – Inventory Route, Total Horizontal Clearance
- 53 – Minimum Vertical Clearance Over Bridge Roadway
- 54 – Minimum Vertical Underclearance
- 55 – Minimum Lateral Underclearance on Right
- 56 – Minimum Lateral Underclearance on Left
- 70 – Bridge Posting

CHAPTER 7: BRIDGE INSPECTION QA/QC PROGRAM

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CHAPTER 7:

BRIDGE INSPECTION QA/QC PROGRAM

7.1—PURPOSE OF THE BRIDGE INSPECTION QA/QC PROGRAM

7.1.1—Introduction

23 CFR 650.313(g) Quality Control and Quality Assurance requires each state to assure that systematic Quality Control (QC) and Quality Assurance (QA) procedures are being used to maintain a high degree of accuracy and consistency in the inspection program. Accuracy and consistency of the data is important since the bridge inspection process is the foundation of the entire bridge management operation and bridge management systems. Information obtained during the inspection is used for determining needed maintenance and repairs, for prioritizing rehabilitations and replacements, for allocating resources, and for evaluating and improving design for new bridges. The accuracy and consistency of the inspection and documentation is vital because it not only impacts programming and funding appropriations, it also affects public safety. The FHWA Bridge Inspection Reference Manual (BIRM), Chapter 1.3, provides additional Quality Control / Quality Assurance information. Therefore, in recognition of the importance of this information, ODOT established the following quality control and quality assurance procedures.

To be effective, quality control / quality assurance procedures must be followed by all personnel and the procedures should be evaluated and updated regularly.

Quality Control / Quality Assurance activities occur during three separate and very distinctive phases:

- Phase 1 - includes all of those activities that are initiated prior to the bridge inspection data being collected. An example would be by training all inspectors on what exactly the correct data should be.
- Phase 2 - includes those tasks that are initiated during the data recording phase. This occurs after the bridge inspector records the data in his file, but the data has not been uploaded into the official bridge inspection database.
- Phase 3 - includes all of those tasks that are initiated to find and correct data errors that have already been uploaded into the official bridge inspection database.

7.1.2—Definitions

Quality control (QC): Implemented procedures that are intended to maintain the quality of a bridge inspection, load rating, and documentation at or above the NBIS standard. These are measures that are taken to help prevent errors from occurring before the data is recorded in the bridge inventory.

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. These are measures taken to help locate and correct errors after they have been recorded in the bridge inventory.

7.1.3—Purpose

The purpose and benefits of a QC / QA Program are:

- Assuring the Bridge Inspection Reports are Thorough and Accurate.
Assuring the information contained in the Bridge Inspection database is Accurate.
Assuring that the right projects are being selected for the STIP
- Assuring an appropriate maintenance / repair / rehabilitation / replacement strategy is being employed with the administration of the Major Bridge Maintenance Program.
- Assure the condition of the bridge is accurately reflected in the Load Rating / Load Posting and determining whether it needs to be revisited based on changes in the condition of the structure.

Assuring the Bridge Inspection Reports are Thorough and Accurate:

As with all business practices, we should be cognizant of and continually scrutinize our business practices to assure that each is as efficient and as effective as possible. The word “Efficiency” as used herein refers to “doing things

right the first time” (assuring that sufficient time and resources are allocated to each structure to ensure that the inspection was performed as thoroughly as necessary). The word “Effectiveness” as used herein refers to “doing the right things (assuring that each structure is inspected by the due date). Due to the large number of structures that are assigned to each inspector, it’s imperative that each region bridge inspector, budget their time and resources wisely. A rushed bridge inspection will quite often result in missed bridge inspection elements and inaccurate condition assessment rating information. A completely independent QA field review of the last bridge inspection will clearly point out differences and provide a measure of it’s timeliness, thoroughness and accuracy. In order to physically measure whether or not a given bridge inspection was acceptable, ODOT established 7 areas of importance with associated error thresholds:

- Accuracy of the NBI data used to calculate the Sufficiency Rating
- The NBI Condition Rating
- The list of Bridge Element and their quantities
- The Condition State Percentages assigned to each element
- The amount and clarity of the remarks describing each reportable deficiency
- The bridge maintenance recommendations for the bridge
- Thoroughness and completeness of supplemental condition reports

Overall we expect no more than 4 errors on average per bridge inspection. For more specific information refer to the ODOT Bridge Inspector Certification document.

Accuracy of the data in the bridge inspection database

The entire bridge program revolves around the bridge condition assessment information contained in the bridge inspection database. Large multi-million dollar decisions are made annually based solely on that data. Therefore, it is absolutely paramount that the data is as accurate and correct as possible. There is a lot of political embarrassment and loss of program credibility when it is shown that a program decision was made on faulty information. By performing a QA field review on the structures in the bridge program that are scheduled to receive some action, we are validating the information associated with that structure. Bottom-line, in addition to keeping the State of Oregon in compliance with the Code of Federal Regulations, initiation of such a program just makes good business sense.

STIP Projects

To assure that the right projects are getting into the State Transportation Improvement Program (STIP) every project needs a champion. By reviewing the structures in the worst condition, in each region, the QA Review Team is able to discuss, on-site, the appropriate strategy and can help develop the appropriate repair, rehabilitation, or replacement plan for every structure in question..

Major Bridge Maintenance Projects

We consider these projects to be “stopgap” measures until a full rehabilitation or replacement project can be programmed by the STIP. By reviewing the structures in the worst condition, the Review Team is able to discuss, on-site, the appropriate repair / rehabilitation / replacement strategy and/or preliminary design concepts.

Load Rating / Load Posting Issues

Implementing Load Restrictions on structures is extremely political. However, on the other hand, one of the major responsibilities we are charged with is to assure that a safe facility is available to the public. Therefore, it is absolutely imperative that all deficiencies that directly influence the load rating calculations be located during the ODOT inspection effort and addressed immediately. By reviewing the bridges in the worst conditions, the QA review team provides a second look and/or a second opinion, regarding the severity of the deficiencies and their potential implications. It’s like a person being confronted with a serious medical condition; they are encouraged to seek a second opinion.

7.2—BRIDGE INSPECTION QC MEASURES

7.2.1—Quality Control Roles and Responsibilities

In the State of Oregon, the following individuals are responsible for establishing and enforcing the bridge inspection quality control policies and procedures in accordance with CFR 650.307(c) and 650.307(e), and as contain in this manual.

ODOT Bridge Operations Engineer – as the designated Bridge Inspection Program Manager for the State, the bridge operations engineer has the overall responsibility for instituting and enforcing the Quality Control Measures contained in this manual.

The Senior Bridge Inspector – Since the senior bridge inspector provides program oversight for the state bridge inspectors, this individual also fulfills the role and responsibilities for establishing and enforcing the Quality Control Measures contained in this manual.

The Local Agency Bridge Inspection Coordinator - Since the local agency bridge inspection coordinator administers the local agency bridge inspection program, this individual also fulfills the role and responsibilities for establishing and enforcing the Quality Control Measures contained in this manual.

The Bridge Inspection Team Leader – By providing a signed bridge inspection report-of-record, each bridge inspection team leader is certifying that all work was performed in accordance with the Quality Control Measures contained in this manual.

7.2.2—Quality Control Measures

ODOT has implemented Quality Control Measures in the following areas:

Bridge Inspection Quality Control Measures:

- Require the same person that found or noted a deficiency to be the same person to enter the condition assessment information into the database, thereby minimizing transcription errors.
- Having bridge inspectors assigned to inspect the same structures. It is thought that if the bridge inspector has some ownership of the structures assigned to them, they are better equipped to measure the pulse of the structure and can develop sufficient foresight to anticipate deficiencies before they occur.
- Design the PONTIS Bridge Inspection Module so that the number of possible data entry options for a particular field is limited by using drop-down pick lists.
- Share the bridge inspection questions and answers that were brought up during a specific QA Review with the rest of the bridge inspection community by the disseminating a FAQ Sheet, in order to help keep all inspectors on the same page.
- Collect questions and clarification discussions that occur on-site during a QA Review and disseminate the information to the rest of the Bridge Inspection Community in the form of a FAQ sheet.
- Requiring a hard copy of each official bridge inspection report-of-record to be signed by the bridge inspection team leader, thereby certifying the accuracy of the information contained in that report.
- Give the bridge inspector that generated the data full ownership of that data. When a data error is found, the suggested correction is related back to that last bridge inspector of record for that report to correct, thereby minimizing repetitive errors in the future.
- Provide each bridge inspection team leader feedback as to the results of the QA Reviews of their work, so they can better gauge what specific areas that might need improvement. If the team leader exceeds the acceptable error, threshold, they will be required to obtain additional training.

Qualification & Certification Quality Control Measures:

- Since the ODOT Bridge Operations Engineer is responsible for managing the Bridge Inspection Program, they must meet the qualifications provided in CFR 650.309(a) and Section 5 of this manual.
- Since the ODOT Senior Bridge Inspector and the Local Agency Bridge Inspection Coordinator, help administer the Bridge Inspection Program, they must meet the qualifications of a Bridge Inspection Team Leader as provided in CFR 650.309(b) and Section 5 of this manual.
- Since the ODOT Bridge Program Manager is responsible for the Load Rating Program, this individual must meet the qualifications provided in CFR 650.309(c) and Section 5 of this manual.

- The ODOT Underwater Dive Team Manager must meet the qualifications of a Bridge Inspection Team Leader as provided in CFR 650.309(b), as well as, comply with the provisions contained CFR 650.309(d) and Section 5 of this manual.
- All bridge inspection work in the State of Oregon must to be performed by bridge inspectors that are certified in accordance with ODOT procedures, provided in Section 5, “Certification of Bridge Inspection Personnel”, of this manual.
- The primary responsibility of administering the Bridge Inspector Certification Program resides with the Local Agency Bridge Inspection Coordinator. The ODOT Senior Bridge Inspector functions as a secondary backup.

Element Coding Guide and Bridge Inspection Manual Quality Control Measures:

- ODOT decided to keep the condition state language the same as that provided by AASHTO, but integrating specific supplemental guidelines, to help clarify subjective terms, which provides uniformity and consistency between inspectors.
- ODOT keeps the contents of the Element Coding Guide and the Bridge Inspection Manual, current by integrating bridge inspection issues that came up during a QA Review into these guidelines and publish updated versions on an annual basis.
- Section 9 “Duties of the Bridge Inspector” of this manual clearly defines the role and responsibility expectations of each bridge inspection team leader.

Bridge Inspection Training and Continuing Education Quality Control Measures:

- Discuss bridge inspection issues and best business practices at bridge inspector meetings, the annual bridge inspection orientation session, and the bi-annual Pacific NW Bridge Inspection Conference.
- Establish and implement a continuing education requirement that must be fulfilled in order to be re-certified as a bridge inspection team leader in the State of Oregon. For more specifics refer to the ODOT Bridge Inspector Certification document.
- Monitor the results of the quality assurance field reviews to determine areas where additional training, discussion, or guidance is needed.
- Host the Comprehensive NHI Bridge Inspection Training Class every 4 years.
- Host the NHI Bridge Inspection Refresher Training Class every 4 years.
- Co-host the Pacific NW Bridge Inspection Conference every 2 years.
- Host a Fracture Critical Bridge Inspection Training Class every 4 years.
- Require active bridge inspector participation the QA Field Reviews.

Load Rating Quality Control Measures:

- Training in both the national LRFR procedures and the ODOT LRFR Manual were conducted prior to load rating contracts being issued. Examples of each major bridge type to be rated were thoroughly explained, and there was an introduction to the ODOT LRFR Manual.
- The ODOT LRFR Manual provides detailed instructions to the load rating engineers throughout the load rating process.
- Tools are used to reduce the chances of human error. An example of this is the Load Rating Summary Workbook LR.XLT which completely automates the process of extracting rating factors from BRASS output files. LL_Factors_State.xls automates the selection of live load factors for state bridges.
- Thorough examples are provided for each type of bridge to be rated before load rating contracts are issued for that bridge type. These examples can be used as templates, so that load ratings will be consistent and easily modified for changing conditions regardless of the engineer or firm that accomplished the rating.

7.3—BRIDGE INSPECTION QA/QC PROCESS

7.3.1—Quality Assurance Roles and Responsibilities

The overall responsibility for initiating Quality Assurance activities has been delegated to the Bridge Inspection Program Manager for the State, in accordance with CFR 650.307(c) and 650.307(e). In the State of Oregon, that responsibility resides with the ODOT Bridge Operations Engineer. However, these responsibilities have been further assigned to the following:

- a. The Senior Bridge Inspector has the specific responsibility for coordinating quality assurance activities on the state bridge inventory.
- b. The Local Agency Bridge Inspection Coordinator has the specific responsibility for coordinating quality assurance activities on the local agency bridge inventory.
- c. The Bridge Program Unit Manager has the specific responsibility for coordinating quality assurance activities on the load rating information.
- d. The Bridge Inventory Coordinator has the specific responsibility for performing data validation checks on submitted bridge inspection reports and data that has already been entered into the bridge inventory.
- e. The Bridge Inspection Team Leader has the specific responsibility for correcting the data after errors are found.

In the State of Oregon, the following individuals are responsible for establishing and implementing a bridge inspection quality assurance process that is in compliance with CFR 650.307(c)(1) and as contain in this manual, are as follows:

ODOT Bridge Operations Engineer – as the designated Bridge Inspection Program Manager for the State, the bridge operations engineer has the overall responsibility for establishing and implementing the Quality Assurance Activities contained in this manual.

The Senior Bridge Inspector – Since the senior bridge inspector provides program oversight of the state bridge inspectors, this individual also fulfills the role and responsibilities for establishing and implementing the Quality Assurance Activities contained in this manual.

The Local Agency Bridge Inspection Coordinator - Since the local agency bridge inspection coordinator administers the local agency bridge inspection program, this individual also fulfills the role and responsibilities for establishing and implementing the Quality Assurance Activities contained in this manual.

The Bridge Program Unit Manager – Since the ODOT bridge program unit manager is the designated responsible manager for the ODOT Bridge Load Rating Program, this individual has the specific responsibility for coordinating quality assurance activities on the load rating information.

The Bridge Inventory Coordinator – Since all bridge inspection reports-of-record are funneled through the ODOT Bridge Inventory Coordinator, this individual has the specific responsibility for performing data validation checks on submitted bridge inspection reports and data that has already been entered into the bridge inventory.

The Bridge Inspector-of-Record – Since the Bridge Inspector-of-Record is considered to be the data owner, all data errors are routed back to this individual for correction. As a result this individual has the specific responsibility for correcting the data error and re-submitting a corrected bridge inspection report-of-record.

7.3.2—Quality Assurance / Quality Check Activities

Data Validation Check of Submitted Inspection Reports

Following each bridge inspection, the assigned bridge inspection team leader is required to submit a signed bridge inspection report-of-record. Upon arrival, the ODOT Bridge Inventory Coordinator, the Senior Bridge Inspector, and the Local Agency Bridge Inspection Coordinator, will perform a cursory data validation check, on at least 10% of

the bridge inventory. The validation check will include a field review (5% of bridge inventory) to compare the accuracy of the bridge inspectors' working knowledge, and a desk audit (5% of bridge inventory) to compare the accuracy of data entered.

Field reviews will be conducted by a small group of personnel comprised of ODOT bridge inspection staff, the inspector of record (or representative), and the bridge owner(s) if applicable (Local Agency). The review group will perform an abbreviated inspection and compare the values against those recorded by the inspector to ensure consistency in understanding of coding guide requirements.

Desk audits will be reviewed by ODOT bridge inspection personnel and any data errors will be reported back to the bridge inspection team leader for correction and remitting:

- The following inter-related data fields are checked to assure that they correlate:
 - NBI Item 70 (bridge posting), 41 (structure status).
 - NBI Item 103 (temporary repair designation), 58 (deck rating), 59 (superstructure rating), 60 (substructure rating), 61 (channel protection), and 62 (culvert rating), and how they relate to the associated element condition ratings.
 - Item 108 and recorded AC Depth or recorded Wearing Surface Protective System.
 - NBI Item 43 and 44 (main and approach span types) and the recorded bridge element list.
 - Load Rating Factor values and the Inspection Frequency.
- Ensure that if a Deck (58), Superstructure (59), Substructure (60), Channel (61), or Culvert (62) rating is a 4 or less that an appropriate Remark and Maintenance Recommendation has been recorded.
- Ensure that if any bridge element condition state is in CS3 or CS4, that an appropriate Remark and Maintenance Recommendation has been recorded.
- Check that Inspection Schedule dates are correct and match the supplemental document dates.
- Assure the submitted bridge inspection-of-record contains the official signature of the assigned bridge inspection team leader.
- Runs the FHWA Edit / Update software application on a monthly basis and notify the bridge inspector of data errors.

Prior to approving payment for a bridge inspection performed by a consulting engineering firm, a data validation check is performed on the local agency bridges by the Local Agency Bridge Inspection Coordinator and the ODOT Senior Bridge Inspector checks the submitted data on the state bridges.

Late Inspections

NBIS requires inspections be performed at the required intervals. However, circumstances occasionally result in the requirement not being met. The inspector is required to document the reasons for all late inspections. This documentation will be completed as follows:

HQ Tasks:

- The Local Bridge Inspection Engineer, Senior Bridge Inspector, and/or Bridge Inventory Coordinator will run a query on BrM (Pontis) at the first of each month to verify any late inspections (Routine, Fracture Critical, and Fatigue Prone) and save the information into a monthly spreadsheet format for documentation if needed,
- The Local Bridge Inspection Engineer, Senior Bridge Inspector, and/or Bridge Inventory Coordinator will follow up with appropriate inspection staff on reasons for the late inspections and document reasons and expected completion date(s) in the monthly spreadsheet,
- Perform six month analysis of late inspections,
- Review data for submittal to FHWA,
- Submit six month summary of late inspections to FHWA,
- Roll up the reason(s) for late inspections into the MAR report.

Inspector Tasks:

- Provide documented reason(s) for late inspections

- Report on any anticipated late inspections for the next month

Data Validation Check prior to the FHWA Submittal

ODOT submits a flat file of the bridge inventory to FHWA twice a year (April and October). Prior to that submittal, the following tasks will be performed:

- One month prior to the FHWA Submittal, the ODOT Bridge Inventory Coordinator will disseminate a notice to all bridge inspectors to cease all bridge data entry until the database can be scrubbed of all correctable data errors. During this data entry interruption, the Bridge Inventory Coordinator will run the following data queries in the search for data inconsistencies and anomalies, after which the data originator is notified of the need to correct:
 - Past Due Routine Inspections
 - Past Due Fracture Critical Inspections
 - Past Due Fatigue Prone Detail Inspections
 - Bridges that require Critical Follow-up Status Report
 - Safety Related Check 8.1.1 – NBI Item 64 < 3 ton
 - Safety Related Check 8.1.2 – NBI Item 59 or 60 < 2
 - Safety Related Check 8.2.1 – NBI Item 64 between 3 ton and 23 ton
 - Safety Related Check 8.2.2 – Any bridge with NBI Item 41 = B
 - FHWA Edit / Update Application
- The Bridge Inventory Coordinator will contact the appropriate bridge inspector or load rater for updating and/or correction.
- The Senior Bridge Inspector and the Local Agency Bridge Inspection Coordinator will generate and post a copy of the Critical Follow-up Status Report on the bridge server.
- At least one week prior to submitting to FHWA, the contents of the submittal is reviewed at a Bridge Section Managers meeting. The ODOT Bridge Operations Engineer is the agenda topic leader.
- The ODOT Bridge Inventory Coordinator assures data has been scrubbed and the NBI file is ready for submission to FHWA, along with the reports identified in (a) above.

QA Field Review Process

Bridge Selection Criteria - In prep for the field review, the Bridge Inspection Program Manager, the Senior Bridge Inspector, or the Local Agency Bridge Inspection Coordinator, selects which bridges to review. Items that are considered when making the selection:

- Each state region or local agency contract area will be reviewed annually
- Strive for a sampling size of at least 5% of the assigned routine inspections performed, annually.
- Strive to review the work of all bridge inspection team leaders
- Zero in on structures that fit the following criteria:
 - Structures on the Critical Follow-up List or status of follow-up action.
 - Bridges with urgent or critical maintenance recommendations
 - Bridges with load restrictions / load posting issues /
 - Bridges that have temporary repairs in-place.
 - Bridges that are in need of bridge rehab / replacement actions
 - New structures recently opened to traffic – check initial inspection
 - Inspections that are beyond the due date
 - Bridges that contain complex or unusual structural details
 - Selecting repeat structures can be productive by determining whether the QA results are the same following a change in the QA review team dynamics, as well as, determining whether the bridge inspector amended the last report based on the results of the previous QA review.

QA Team Selection Criteria - In prep for the field review, the Bridge Inspection Program Manager, the Senior Bridge Inspector, or the Local Agency Bridge Inspection Coordinator, selects who is going to participate in each field review. Items that are considered when making the review team selections are:

- Bridge Operations Engineer, the Senior Bridge Inspector, or the Local Agency Bridge Inspection Coordinator will lead the QA Review Team.

- The region bridge inspector or the local agency contract area consultant will be the designated host inspector.
- In order to assure statewide uniformity and consistency, State Bridge Inspection staff from one of the other regions will also participate. These team members rotate on an annual basis so they are participating in a different region every year.
- For training purposes, all new bridge inspection or bridge operations staff will be required to participate on at least one QA review in each region of the state.
- For training purposes, the Region Tech Center Bridge Design, the Bridge Load Raters, or Bridge Program staff, are encouraged to participate in the QA Review process so they get a better understanding how the numbers are generated.
- Encourage the representatives of the bridge owners to participate in the process.

QA Review Preparations - In prep for the field review, in order to assure that the QA review is as thorough as possible, the team will have the following items on hand:

- A copy of the Bridge Plans,
- A copy of all appropriate supplemental reports to assure that all supplemental information has been integrated into the routine inspection report and visa versa.
- The last bridge inspection report and SI&A, which is not referred to until the QA Review is complete.

Performing the QA Field Review

- Step one: The QA Review Team will perform a totally independent inspection of each structure, zeroing in on the following specific areas:
The SI&A data used to calculate the Sufficiency Rating
 - The NBI Condition Ratings
 - The element list for the bridge and their quantities
 - The element condition rating information
 - Remarks to help clarify the condition rating information
 - Maintenance recommendations

Also in order to assure the participation of each team member, the independent inspection could be performed as a group or by each individual participant. If the group format is used the bridge inspection information is discussed and recorded on the QA review form as you go. If the individual format is used, the bridge inspection information is collected by each individual team participant and then discussed as a group upon completion of the independent inspection and recorded on the QA form according to the consensus of the group.
- Step two: Information contained in the last bridge inspection report is then placed on the QA Review form, side-by-side with the information generated by the QA Review Team so the two can easily be compared.
 - The SI&A data used to calculate the Sufficiency Rating must be exact
 - The NBI Condition Ratings must be $\pm$ one rating number
 - The element list for the bridge and their quantities, must be exact
 - The element condition rating information, $\pm$ one Condition State
 - Remarks to help clarify the condition rating, must meet expectations
 - Posting Maintenance Recommendations, must meet expectations
- Step three: Differences between the two that are beyond the prescribed acceptable thresholds are then highlighted and openly discussed so that the team can better determine which is correct and why. Each bridge inspector is given an opportunity to defend their data, if they wish.
- Step four: Copies of each QA review is given to the person that generated the last bridge inspection report-of-record, so they can determine whether the last bridge inspection report needs to be amended. The results of the QA Review are also integrated into itineraries for proficiency testing of bridge inspectors on at least 10 control bridges.

QA Review Results - The results of each QA Review is tabulated so the information can be used as follows:

- Assess whether a bridge inspector is operating within acceptable limits
- Assess the effectiveness the ODOT Bridge Inspection Program
- Assess areas where additional training or discussion is needed

CHAPTER 8: BRIDGE INSPECTION FOLLOW-UP PROCEDURES

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CHAPTER 8:

BRIDGE INSPECTION FOLLOW-UP PROCEDURES

8.1—OVERVIEW OF BRIDGE INSPECTION FOLLOW-UP PROCEDURES

Code of Federal Regulations (NBIS) 650.305 – Definition of a Critical Finding: “A structural or safety related deficiency that requires immediate follow-up inspection or action.”

ODOT classifies Critical Findings as bridges with Significant Deficiencies (as defined in Section 8.2.5).

CFR 650.313 – Follow-up on Critical Findings: Each State DOT is directed to “establish a statewide 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.”

Of primary concern during every bridge inspection is to address the structural condition of the elements that are associated with the load path and their ability to transfer those loads, address items that have created a traffic hazard, or address items that have intensified a concern for scour around the bridge foundation.

When a deficiency is determined to substantially endanger the load capacity of the bridge, deficiencies that need to be repaired as soon as possible, or to address a specific traffic safety concern, the bridge owners and ODOT Bridge Headquarters Staff, must be kept apprised of the situation.

When a bridge inspection identifies a significant structural problem requiring an emergency load restriction, lane closure, bridge closure, or if a bridge has failed, a Critical Finding Report must be completed and kept on file for future reference.

In addition to assuring that the State of Oregon is in full compliance with Chapter 650.313(h) of the Code of Federal Regulations, the purpose of these actions is to provide added visibility and attention to these repair recommendations and to ensure all recommendations are acted upon quickly and diligently. Each bridge owner is required to track these critical and significant deficiencies, showing dates, action taken, and current status of the bridge. This follow-up system provides bridge managers, with an oversight tool to aid in the resolution of all identified critical and significant deficiencies.

The Federal Highway Administration (FHWA) Division Office will periodically review the reports and the tracking system to verify the needed repairs were promptly reported and the recommended repairs were completed within a reasonable period of time. FHWA may also conduct field checks to verify that critical repair work was accomplished.

8.2—DEFICIENCY DEFINITION/PRIORITIZATION CRITERIA

ODOT established a bridge maintenance priority system to help the bridge owner to formulate their bridge maintenance work plan strategy. All bridge maintenance recommendations are prioritized in accordance with the following:

8.2.1—Monitor Deficiency

Monitor Deficiencies are “Housekeeping” type of deficiencies that are not structural in nature, but could have adverse effects on the structure or members. This priority rating indicates that there is a situation on the bridge that requires no immediate action, except for careful monitoring of affected elements, or these are deficiencies that could be addressed when the bridge maintenance crew is in the area, doing other work.

A Monitor Deficiency could change to a Routine / Schedule priority rating depending on time or conditions that allow the element’s performance to worsen. The inspection frequency will most likely not be required to be adjusted.

8.2.2—Routine/Schedule Deficiency

A Routine / Schedule Deficiency describes a minor to moderate deficiency to a primary bridge element or a major deficiency to a secondary bridge element. This type of deficiency would not cause major impact to the level of service of the bridge or compromise safety. This type of deficiency may lead to more extensive and costly structural repairs if not completed.

Routine / Schedule Deficiencies are different from Critical or Urgent Repair Deficiencies in that the Routine / Schedule deficiency does not jeopardize:

- Public Safety
- Reliable Transportation system
- Protection of Public Investments
- Maintenance of Legal Federal Mandates

A Routine / Schedule Deficiency can be similar to the Critical or Urgent Repairs, but the deterioration is not advanced enough to warrant categorizing it as urgent or critical or the load experienced by the member does not play a critical role in the bridge's performance. The bridge maintenance crews are directed to schedule these repair activities with other bridge maintenance activities.

8.2.3—Urgent Deficiency

An Urgent Deficiency describes a deficiency that needs to be addressed "As Soon Possible" or to address a specific traffic safety concern. This type of deficiency may lead to more extensive and costly structural repairs if not completed as soon as possible.

An Urgent Deficiency is different from a Critical Deficiency in that the Urgent Deficiency does not jeopardize:

- Reliable Transportation system
- Protection of Public Investments
- Maintenance of Legal Federal Mandates

An Urgent Deficiency is defined as when one or more of the NBI Items 58, 59, 60, or 61 ≤ 4 ; or a portion of the defect is in CS3. If the inspector discovers a deficiency that is determined to be a traffic hazard, the inspector will immediately perform the following:

- Immediately contact the appropriate agency officials to inform them of the situation, followed by,
- Fully written and thorough narrative documentation, supplemented with pertinent photographs.

The inspection frequency may need adjustment to ensure that inspectors verify that repairs have been done in a timely manner or that safety has not been compromised.

8.2.4—Critical Deficiency

A Critical Deficiency describes a deficiency to a primary structural bridge element that may result in the structure being load posted. This type of deficiency may lead to more extensive and costly structural repairs if not completed as soon as possible. Critical deficiencies are not classified as Critical Findings as defined by FHWA in 23 CFR 650.3113(h). Critical deficiencies are monitored by ODOT to keep them from becoming a Significant Deficiency (or Critical Finding).

A Critical Deficiency is described as a deficiency that threatens:

- Public Safety
- Reliable Transportation system
- Protection of Public Investments
- Maintenance of Legal Federal Mandates

A Critical Deficiency is defined as when one or more of NBI Items 58, 59, 60, or 61 = 3; or when NBI Item 113 = 3; or a portion of the defect is in CS4; or when the Posting Status NBI Item 41 = "B" (not posted or not posted

correctly). If the inspector discovers structural deficiencies that are determined to be substantially endangering the load carrying capacity of the bridge, the inspector will immediately perform the following:

- Immediately contact the appropriate agency officials to inform them of the situation, followed by,
- Fully written and thorough narrative documentation, supplemented with pertinent photographs.

The inspection frequency may need adjustment to ensure that inspectors verify that repairs have been done in a timely manner or that safety has not been compromised. Additionally, a Rating Review may require a reexamination of the bridge for its load carrying capability.

- Inspection Frequency
- Revise Condition Ratings
- Review Load Rating

Critical Deficiency—A Critical Deficiency or Event could also include any of the following:

- If *clearance signing* is required on a bridge, but the sign is either not present or not properly posted. (Note: Vertical clearance signs are required to be mounted on a structure that is less than 15' 0" clearance. Vertical clearance signs are required to be posted in advance of a structure that has a clearance less than 14' 0" at the point of detour or turn-around. The clearance dimension should be the exact minimum dimension for the lane.)
- If the inspector has identified some *traffic safety* deficiencies that should be addressed on an As Soon As Possible basis. These traffic safety deficiencies could include but not necessarily limited to the following: accumulation of loose material, water-ponding, wheel track rutting, edge of pavement drop-offs, exposed and loose deck reinforcement, broken modular deck joint transverse bars, protruding bridge railing members, etc.
- Local scour is within limits of the spread footing or piles, or scour is below the base of the spread footings or pile tips (but no undermining).
- When the condition of a bridge has digressed significantly from the conditions when the load rating was performed. The accepted *Load Rater Notification Threshold Criteria* is as follows:

- Load Rating Review Notification Criteria

- *NBI Condition Rating Changes – Deck (58), Superstructure (59), Substructure (60)*

<u>Load Rating Factor</u>	<u>Load Rating Condition</u>	<u>Current Condition Rating</u>
< 1.5	4 to 9	3 or less
< 1.5	any	2 or less

Note: If the bridge is closed, posted, has temporary shoring, or there is a detour structure in place, there is no need to notify the load raters. Only notify the load raters for bridges that are open to traffic and where there are concerns that the condition has changed and the issues have not been addressed already.

- *Increases in Dead Load on the Bridge*

<u>Load Rating Factor</u>	<u>Increase in Dead Load</u>
≤ 1.1	Increase Wearing Surface Thickness ≥ 2"
≥ 1.1	Increase Wearing Surface Thickness of 5" or more
≤ 1.1	Bridge Rail changed from post and rail to concrete barrier

- *Change in the Traffic Impact*

<u>Load Rating Factor</u>	<u>Load Rating Condition Rating</u>	<u>Current Condition State Rating</u>
≤ 1.1	4 to 9	CS 3

Note: Prior to the establishment of Element 980, all load ratings were based on the worse rating recorded for the "Approach Roadway Condition" or the "Wearing Surface Condition". The cross-walk conversion factors are as follows:

- 6 to 9 - - - - - CS1
- 4 to 5 - - - - - CS2
- 3 or less - - - - - CS3

- Changes in Temporary Repair Designation
 - Adequacy or Condition of Temporary Shoring is questionable
 - Temporary Shoring is changed to Permanent Repairs - - - NBI Items 103 and 41.
 - Permanent Repairs are determined to be Temporary - - - NBI Items 103 and 41.

8.2.5—Significant Deficiency

Critical Findings as defined by FHWA in 23 CFR 650.3113(h) are classified by ODOT as bridges with Significant Deficiencies (as defined in this section). A Significant Deficiency describes a structural deficiency that requires the closure of either a complete or a partial portion of the bridge, or an immediate load restriction of the bridge is required until repairs can be accomplished. This type of deficiency will usually require either a major structural rehab or a complete replacement of the bridge.

These repairs are top priority to ensure:

- Public Safety
- Reliable Transportation system
- Protection of Public Investments
- Maintenance of Legal Federal Mandates

More specifically, a Significant Deficiency or Event is when one or more of the following has occurred:

- A complete bridge failure, or
- An inspection results in temporary lane or bridge closure, due to structural problems, or a partial bridge failure, or
- An inspection results in an immediate load restriction of the bridge until repairs can be accomplished, or
- A fracture critical member is in need of immediate work in order to prevent the structure from being load restricted.
- Bridges with scour issues and Item 113 = 2 (except in the cases where a POA exists and is being monitored)
- When one or more of the NBI Items 58, 59, 60, or $61 \leq 2$; and the defect is in CS4. However, if local structural failures are possible, the NBI Rating could be a "3".
- Posting Status (item 41) = B (NBI Items 58, 59, 60 or $61 \leq 2$, and NBI 60 is not based on NBI 113). Bridge should be posted and there are condition concerns, (not just due to missing signage).

The inspection frequency may need adjustment to ensure that; inspectors verify that closure/load restrictions have been implemented, the restrictions are being adhered to by the general public, or that safety has not been compromised.

Additionally, a Rating Review may require a reexamination of the bridge for its load carrying capability.

A Significant Deficiency may affect the following:

- Inspection Frequency
- Revise Condition Ratings
- Review Load Rating

8.3—DEFICIENCY DOCUMENTATION REQUIREMENTS

Routine Deficiency Documentation – The bridge inspector will provide appropriate maintenance recommendations that fit with the condition rating criteria:

- CS2 – Bridge Preservation Activities
- CS3 – Element Repair Activities
- CS4 – Address reduced load capacity or repair failed element / system.

The primary concern is to address the structural condition of the elements that are associated with the load path and their ability to transfer those loads, items that create a traffic hazard, or items that might intensify the concern for scour around the bridge foundation. If bridge maintenance is needed, a maintenance recommendation will be provided on the “work” tab.

The expectation is the repair work would be scheduled with other bridge maintenance activities and in accordance with the annual bridge work plan strategy employed by the bridge owner. These deficiencies may evolve into a more urgent priority if repairs are not completed

Urgent Deficiency Documentation - For all deficiencies that have either a NBIS Condition Rating of “4” or worse, or a portion of an element is in CS3, in addition to providing specific remarks and/or maintenance recommendations on the routine inspection report, the inspector will also provide photographic or drawing documentation, as well, on the “Media” tab.

Critical Deficiency Documentation - When the inspector becomes aware of a critical deficiency that is determined to substantially endanger the load capacity of the bridge, the inspector will perform the following:

- Immediately contact the appropriate agency official or bridge owner, Bridge Operations Engineer, Senior Bridge Inspector or the Local Agency Bridge Inspection Engineer (for local agency bridges) and the Bridge Senior Load Rating Engineer, to inform them of the situation,
- In addition to the verbal notification, the bridge inspector is also directed to post a maintenance recommendation and prioritize the urgency.
- The Bridge Operations Staff or Bridge Load Rating Personnel will work with the appropriate agency officials to establish an acceptable plan of action to mitigate the identified deficiency.
- The bridge inspector and ODOT Bridge Operation staff will ensure the tasks described in section 8.3 are performed.

Significant Deficiency Documentation - If a significant deficiency occurs, the bridge inspector and/or ODOT Bridge Headquarters will immediately perform the following:

- Immediately (within 8 hours of discovery of the deficiency) contact the appropriate agency officials or bridge owner, the ODOT Bridge Engineer, the Bridge Operations Engineer, the Senior Bridge Inspector or the Local Agency Bridge Inspection Engineer (for local agency bridges), and the Bridge Senior Load Rating Engineer, to inform them of the situation.
- The Bridge Inspector will follow the verbal notification with a written notification (Bridge Record of Critical Findings) within 24 hours of discovery of the deficiency, supplemented with pertinent supporting documentation, and will be included in the inspection report if needed to define the deficiency, as specified below.
- If the load rating needs to be reviewed, in addition to the verbal notification, the bridge inspector is also directed to post a load rating maintenance recommendation and prioritize the urgency.
- The ODOT Bridge Operations Staff will verbally notify the FHWA Division Bridge Engineer, of the situation, followed with a copy of the Bridge Record of Critical Findings. The Senior Bridge Inspector or the Local Agency Bridge Inspection Engineer (for local agency bridges) will ensure

the tasks specified in sub-section 8.3 are performed (within 24 hours for State bridges, and 48 hours for Local Agency bridges).

The content of the Bridge Record of Critical Findings will include the following information, if needed to describe the deficiency in the inspection report:

- Describe the bridge name, ID, and location,
- Fully Describe the Deficiency or Failure Mechanism:
 - Describe the extent of the deficiency (with supporting documentation or photos),
 - The apparent probable cause (with supporting documentation or photos), and
 - Any action taken to safeguard the traveling public until the recommended repairs can be made.
- Fully Describe Suggested Countermeasures that should be taken to mitigate the Deficiency:
 - Indicate the suggested short term repairs that need to be initiated to correct the noted deficiencies.
 - Indicate a suggested long term strategy that would best address the situation.
- ODOT will also review the situation to determine whether any of the published manuals, guidelines, operational procedures, or reports needs to be updated to address these situations in the future.

An electronic copy will be placed on the bridge management server in the “Critical Finding Reports” folder. This supplemental report will be made available by a clickable link on the main Inspection Report which is located on the ODOT Bridge Inspection Report Filter. <http://rssa.odot.state.or.us/cf/Pontis/> The ODOT Bridge staff will forward a copy of the report to the FHWA Division Bridge Engineer.

8.4—CRITICAL OR SIGNIFICANT DEFICIENCY FOLLOW-UP PROCEDURES

Monitoring the status of Critical or Significant Deficiencies - Using the Critical Follow-up Report that is generated using the “Audit Reports” Application, the following ODOT Staff will monitor the bridge list, on a semi-annual basis (April 1 and October 1):

- ODOT Senior Bridge Inspector (all state and other public agency bridges)
- ODOT Local Agency Bridge Inspection Coordinator (local agency bridges)
- ODOT Bridge Senior Load Rating Engineer (all bridges)

ODOT Critical Findings are classified as bridges with Significant Deficiencies (as defined in Section 8.2.5). Critical Findings (as defined 23 CFR 650.3113(h)) will be reported in the Critical Follow-up Report and will be submitted to FHWA semi-annually on April and October 1st. ODOT will internally monitor and address bridges with Critical Deficiencies (as defined in Section 8.2.4) as part of the semi-annual audit (noted above).

In preparing the Critical Follow-up report, the Senior Bridge Inspector and the Local Agency Bridge Inspection Engineer will ensure that the following has been performed:

- a) An initial dated entry has been made regarding the Critical Finding, along with a full description of its severity, is recorded in the bridge inspection file, on the “Notes Tab, Structure Notes Box” in the BrM Bridge Inspection Module.
- b) A dated entry in the Critical Follow-up has been made noting when the Critical Finding was discovered (date inspection was performed).
- c) A dated entry in the Critical Follow-up has been made noting when the owner and/or public agency officials were notified of the Critical Finding.
- d) A Bridge Record of Critical Finding has been filed electronically.
- e) A dated entry has been made any time a follow up contact was made with the owner and/or agency officials regarding the status of the Critical Finding. Follow up contact should be made, on a semi-annual basis for submittal on April and October 1st.
- f) Describe actions taken to resolve or monitor critical finding.
- g) The Bridge Record of Critical Findings to FHWA will be followed with a semi-annual Critical Follow-up report (submitted April and October 1st) that contains the information specified in (a), (b), (c), (e), or (f) until the situation has been resolved.

8.5—POST REPAIR FOLLOW-UP REQUIREMENTS

The bridge infrastructure is continually changing. It's very dynamic. In accordance with the NBIS, the Structure Inventory & Appraisal and/or the bridge condition assessment data must be updated when the structure data has changed significantly. ODOT has defined the term "changed significantly" to mean that the condition of the bridge has changed significantly enough that it would result in a change in the sufficiency rating for the structure. This is expected to happen when the following changes occur:

- When the condition of NBI Item 58 (deck), 59 (superstructure), 60 (substructure), 61 (channel), or 62 (culvert) changed at least 2 NBI condition rating numbers; or
- When the condition of any of the load path elements changed at least 2 Element level condition state ratings, which would result in the first bullet.

Since the bridge inspector-of-record has assumed ownership of the bridge file, all changes should be routed back to that person. Then, when possible, the inspector-of-record is instructed to initiate the changes to the bridge condition file and then place a note in the remarks box as to what portion of the bridge was inspected or what condition changes occurred that required amending the original routine inspection report.

There are several other Non-Condition data changes that might result in a changed sufficiency rating that others are responsible for:

- The Load Raters are responsible for updating the Load Rating Database (NBI Items 31, 64, 66, and 70).
- The Bridge Inventory Coordinator is responsible for updating the Average Daily Traffic (NBI Item 29 and 30) and the Percent Truck Traffic (NBI Item 109)
- The Bridge Inventory Coordinator is responsible for updating any route Functional Classification (NBI Item 26) changes.
- The Bridge Inventory Coordinator is responsible for assuring that the bridge inventory contains the most accurate Longitude (NBI Item 17) and Latitude (NBI Item 16) information.

The Post Repairs Document will contain the following information:

- Describe Work Done (Describe what repair work was done to correct the problem; attach any appropriate photos.)
- Date of Completion (Date when the actual repairs were complete or restrictions were removed.)

The bridge manager who completes the document may be relying on reports and photos from those who have actually done the work. This is understandable and justified, recognizing that those who actually perform the work may not be the same person that is responsible for the bridge inspection and reporting. The purpose of the document is to provide accountability, as well as accurate, timely information, hence the requirement for submission of the document upon immediate completion of the work. However, it is still good practice to have trained bridge inspector's, to field verify that all the repairs are complete and satisfactory. If warranted, an inspection will be conducted within six months of completion of the required work.

If the deficiency was determined to be a Significant Deficiency or Event, attach a copy of the Post Repairs Document to the original report that is located in the bridge file, and send a copy to the Bridge Engineer, Bridge Operations Engineer, Bridge Load Rating Engineer, Senior Bridge Inspector, the Local Agency Bridge Inspection Engineer (for local agency bridges), and the Bridge Inventory Coordinator, and update the follow-up tracking system, in the PONTIS Bridge Inspection Module, bridge inspection file.

If a Significant Deficiency Report was filed, the ODOT Bridge Staff will forward a copy of the Post Repair Document to the FHWA Division Bridge Engineer.

ODOT will assure that the Bridge Inventory data is updated accordingly, within the timeline as specified in the NBIS.

CHAPTER 9: INITIAL BRIDGE INSPECTIONS

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CHAPTER 9:

INITIAL BRIDGE INSPECTIONS

9.0—INTRODUCTION

A good bridge inspection reporting system is absolutely essential to document bridge conditions and to protect the public's safety and investment in bridge structures. It is essential that bridge inspection data be clear, accurate, and complete, since it is an integral part of the lifelong record file of the bridge. The bridge reporting system is a valuable aid in establishing maintenance priorities and replacement priorities, and in determining structure capacity and the cost of maintaining our bridge inventory. As a result, the importance of the reporting system cannot be overemphasized. The success of any bridge program is definitely dependent upon its reporting system. The integrity of the reporting system is absolutely dependent on getting the information contained in the file correct right from the get go.

9.1—INITIAL INSPECTION OF NBI STRUCTURES

An initial inspection can occur:

- Following a planned action like construction of a new bridge,
- Following a planned action like a major rehab on the structure
- A new structure under the jurisdiction of another public agency appeared without notice. In this case the next scheduled routine inspection would become the initial inspection of the new structure.

Ideally the assigned bridge inspector would have a set of plans to refer to when sorting through the bridge inventory data. However, that's not always the case. When bridge plans are not available, the assigned bridge inspector will need to make the field measurements to fully complete the bridge inventory.

As specified in the CFR, 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 element level data and to determine baseline structural conditions is referred to as the "Initial Inspection".

As a new structure nears bid letting the ODOT Bridge Inventory Coordinator will develop an initial file for the bridge. Information contained in the file is based on the Advanced Plans for the bridge, as well as, some of the SI&A data contained in the existing file for the bridge being replaced. When either the entire bridge, or a portion thereof, is opened to traffic or public use, the assigned bridge inspector will schedule an initial inspection of the bridge, using the Initial Bridge Inventory file and the Advanced Plans as a guide to confirm the inventoried bridge elements, their quantity, and confirm the structure inventory & appraisal coding sheet (si&a) data. This bridge-site inspection is called the "initial inventory inspection". If any discrepancies are found between the planned and actual bridge configuration, dimensions, or conditions, the assigned bridge inspector is directed to correct the discrepancies so that they can be checked as the bridge ages.

This initial inspection should occur and the NBI File updated within the 90 day limitation on state bridges and 180 days on all other bridges open to the public. This timeline requirement starts when the bridge is opened for public travel. The term "open for public travel" is defined when all construction activities are substantially complete or the 2nd Notice has been issued or when the assigned bridge inspector becomes aware of the new structure. The assigned bridge inspector enters the data into the Bridge Inspection Database using Pontis, and submits a signed hard copy of the bridge inspection report to ODOT Bridge HQ, which becomes the first official Bridge Inspection-of-Record.

The Code of Federal Regulations and excerpts from the AASHTO Manual for Condition Evaluation of Bridges that pertain to this section are as follows:

CFR 650.305 – Initial Inspection Definition: The first inspection of a bridge as it becomes a part of the bridge file provides all Structure Inventory and Appraisal (SI&A) data and other relevant data and to determine baseline structural conditions. CFR 650.315(C): For existing bridge modifications that alter previously recorded data and for new bridges, enter the SI&A data into the State inventory within 90 days of the date of inspection for State bridges and within 180 days of the date of inspection for all other bridges.

9.2—INSPECTION OF NON-NBI STRUCTURES

[No data]

CHAPTER 10: ROUTINE BRIDGE INSPECTIONS, FREQUENCIES & NBI CODING

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CHAPTER 10:**ROUTINE BRIDGE INSPECTIONS, FREQUENCIES, & NBI CODING****10.1—ROUTINE BRIDGE INSPECTION****10.1.1—Routine Bridge Inspection Introduction**

The Code of Federal Regulations and excerpts from the AASHTO Manual for Bridge Element Inspection that pertain to this section are as follows:

CFR 650.313(a) - Inspection Procedures states “Inspect each bridge in accordance with the inspection procedures in the AASHTO Manual for Bridge Element Inspection.”

CFR 650.313(b) – Inspection Procedures: 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.

CFR 650.311(a)(1) - Routine Inspection Frequency: Inspect each bridge at regular intervals not to exceed twenty-four months.

CFR 650.315(C): For existing bridge modifications that alter previously recorded data and for new bridges, enter the SI&A data into the State inventory within 90 days of the date of inspection for State bridges and within 180 days of the date of inspection for all other bridges.

This is to say that the assigned bridge inspector will be required to file an amended bridge inspection report within the timeframe from becoming aware of the modifications.

CFR 650.305 – Routine Inspection definition: 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.

CFR 650.311(a)(1) Inspect each bridge at regular intervals not to exceed 24 months. This means that the routine inspection must be performed within the month that it is due.

CFR 650.311(a)(2) Certain bridges require inspection of less than 24 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.

CFR 650.311(a)(3) – Routine Inspection Frequency: Certain bridges may be inspected at greater than twenty-four month intervals, with written FHWA approval. This may be appropriate when past inspection findings and analysis justifies the increased inspection interval.

ODOT considers the routine inspection report to be the primary tool for reporting the condition of a structure. The routine inspection report is a compilation summary of condition assessment data that is generated via a number of more detailed types of inspections and/or surveys. For example, the Underwater Dive Team performs an inspection on those elements, that are located underwater which is not wadeable. They generate a condition assessment report for those elements and post the report on the bridge server. Then it is the responsibility of the above water inspector to review, analyze, and incorporate the underwater condition assessment information into their routine inspection report that covers the entire structure, top-to-bottom, end-to-end. Another example is when a bridge crew bores all of the timber members in a bridge. Following the field work, they update the existing timber boring log which contains detailed measurements of the amount of decay, checks, and/or splits that were noted in each member. The routine bridge inspector reviews the changes, analyzes the reported condition of each member, and then incorporates this information into their Element and NBI condition ratings for the bridge.

By CFR definition a Routine Bridge Inspection is a regularly scheduled inspection that generally consists of visual observations and / or measurements that are needed to determine the following:

- Define the physical and functional condition of the bridge,
- Identify any changes from initial or previously recorded conditions, and
- Recommend any repairs or other services that may be needed.
- Each bridge inspector is instructed to perform all assigned inspections in sufficient detail or as thorough as necessary to clearly establish its condition and to insure its continued safe operation.

The routine inspection report is a compilation of data that has been extracted from the following supporting documents that cover a specific area or detail:

- Bridge Clearance Diagrams
- Cross-Channel Profiles
- Underwater Inspection Report
- Fracture Critical Inspection Report
- Fatigue Prone Detail Inspection Report
- Timber Boring Report
- Deck Survey Report
- Concrete Cracking Report
- Pin & Hanger UT Report
- Structure Paint Inspection Report
- Load Rating Summary Report
- Drawbridge Electrical & Mechanical Inspection Report
- Quality Assurance Field Reviews

10.1.2—NBI Routine Bridge Inspection Frequency

Following the Initial Inspection, the CFR requires that regularly scheduled inspections be performed on each bridge at least once every two years. This is considered to be the standard routine inspection frequency which must be coded on the SI&A in NBI Items 90 (Inspection Date) and NBI Item 91 (Designated Inspection Frequency).

Any routine inspection may be performed in advance of its anniversary date, i.e., date of the last inspection, in order to fit the inspector's schedule and work load. However, a bridge must be inspected within the month that it is due. The next scheduled inspection date is recorded as the first day of the month that is 24 months out from the last inspection performed date. For example; Routine inspection performed on 9/15/2015 would give a next inspection due date of 9/1/2017. The next inspection can be performed anytime in the 9th month and still be within compliance.

The NBIS also requires inspections be performed at more frequent intervals when conditions at the bridge site warrant doing so. The following guideline is used by the ODOT for identifying bridges that require a routine inspection to be performed at least every 12 months:

- If NBI Bridge Component Ratings (NBI Item 58, 59, 60, 61, or 62 has a condition rating ≤ 3 , or if NBI Item 113 = 2, or
- A primary structural element is in condition state 4, which is affecting the load capacity of the structure, or
- The bridge has an operating load rating factor < 0.80 for any of the legal truck configurations .

The following guideline is used by the ODOT for identifying bridges that require a routine inspection to be performed at least every 6 months:

- The bridge has a load capacity issue and NBI Item 41 = B, or
- Load Rating < 3 tons and the bridge is not closed, or
-

The following guideline is used at the discretion of the inspector for identifying bridges that require a routine inspection to be performed every 6 or 12 months:

- The general condition of the bridge is considered to be poor, or
- Temporary repairs on a primary structural load path element is considered to be in a poor condition, or
- Local failures are possible, or

A serious traffic hazard is noted.

The intent of these inspections is to monitor a specific structural deficiency and not to perform a full inspection of the bridge.

10.1.3— Other Bridge Inspection Frequency Parameters

Inspection of a Bridge NOT in a designated Construction Zone:

Case 1a - The bridge is still in-service and carrying traffic.

- Perform a routine inspection at a frequency that is based on the condition of the original structure.

Case 1b - Structure has been closed utilizing permanent vehicular traffic barriers:

- Perform a routine inspection every 24 months
- Code NBI Items 112=N, 41=K, and 67, 68, 69, 71, and 72=0 (bridge closed)

Case 1c - Structure is not closed using permanent vehicular traffic barriers or if the appropriate NBI Items have not been coded accordingly:

- Perform a routine inspection at a frequency that is based on the condition of the structure as if the bridge were not closed.

Inspection of a Bridge in an active designated Construction Zone:

Case 2a - The bridge is still in-service and carrying traffic.

- Perform a routine inspection at a frequency that is based on the condition of the original structure.
- Coordinate the inspection with the construction contract administrator.

Case 2b - The original bridge is still in-place but has been permanently closed. All traffic has been shifted over onto a detour structure. Construction activity is non-existent and the detour structure is scheduled to remain in-use for a period longer than 5 years:

- Perform a routine inspection on both the original bridge and the detour bridge at a frequency based on the condition of the detour structure.
- Code NBI Item 41=E, add the detour structure elements to the existing bridge element list, code the original structure elements as having a temporary repair in-place (NBI 103=T), record NBI Items 58, 59, 60, 61, or 62 as they relate to the original structure, and code NBI Items 10, 41, 47, 53, 54, 55, 56, and 70 accordingly. Do not create a new file specifically for the detour bridge.

Case 2c - The original bridge is still in-place but has been permanently closed. All traffic has been shifted over onto a detour structure. Construction is active and the detour structure is to remain in-place only for a short duration.

- Perform a cursory routine inspection on only the original structure.
- Code NBI Item 41=E, code the original structure elements as having a temporary repair in-place (NBI 103=T), record NBI Items 58, 59, 60, 61, or 62 as they relate to the original structure, and code NBI Items 10, 41, 47, 53, 54, 55, 56, and 70 accordingly.
- The construction contract administrator is to monitor the condition of the detour structure.

Case 2d - The original structure is in the process of being modified with significant dimensional changes or alterations like widening or raising. Traffic is staged and/or restricted from using portions of the bridge.

- The construction contract administrator is responsible for monitoring the condition of the existing structure in accordance with approved project plans and specs, until the 2nd notice has been issued. When the 2nd notice is issued, the bridge inspector will perform and report on the condition of the bridge within 90 days.

Case 2e - All of the structures contained in a construction zone are substantially complete, with no significant work remaining, and are open to traffic.

- The construction contract administrator is responsible for monitoring the condition of the structure(s) in accordance with approved project plans and specs, until the 2nd notice has been issued. When the 2nd notice is issued, the bridge inspector will perform and report on the condition of the bridge within 90 days.

Case 2f - Project contains a multiple number of structures where construction on some structures may be substantially complete, or open to traffic, or have no work remaining, before issuance of the 2nd notice.

- The designated bridge inspector must coordinate the inspection with the construction contract administrator, perform and report the results of the initial inspection on the opened structures within 90 days, following becoming aware of the opening of the structure to traffic.

10.1.4—Extended Frequencies

The State of Oregon, however, has elected to keep the interval between all routine bridge inspections at the specified two year limit. The inspection interval for inspecting culverts that are smaller than the NBIS bridge definition and have a clear span of 6 feet or larger, have been increase to the four year maximum interval.

10.1.5—Inspection of Non-NBI Structures

ODOT also performs regularly scheduled inspections on structures that do not meet the NBI Bridge criteria. These are structures that are under jurisdiction of ODOT. The inspection consists 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 report the condition of these structures to the appropriate bridge manager in order to ensure that the structure continues to satisfy present service requirements.

- Culverts from 6 ft to 20 ft.
- Sign
- Support Structures
- Tunnels
- Pedestrian / Bike Structures
- Railroad Structures over a State Route
- Flume Structures over a State Route
- Abandoned / Closed Structure on a State Route
- Private Bridges over a State Route
- If the non-NBI Structure carries vehicular traffic and is a bridge type structure, the inspection frequency follows the same rules as the NBI structures. If the structure is a culvert or does not carry vehicular traffic, the inspection frequency could follow the extended inspection frequency criteria provided below:

Non-NBI Structure Inspection Frequency Guideline – During every routine inspection, the bridge inspector will fully assess the condition of the non-NBI structure. This guideline provides certain criteria that's based on the state of maintenance and/or known deficiencies that might warrant the next follow-up inspection to be performed more often than the specified 48 month inspection frequency norm.

New Structure – Perform an initial inventory and condition assessment inspection within 90 days of the official opening of the structure to traffic.

48 Month Freq: The non-NBI structure is functioning as intended. 100% of the culvert is in CS 1 or 2.

24 Month Freq: Noted deficiencies that might pose a safety concern or could potentially damage property or a portion of the non-NBI structure is in CS 3 and the NBI Condition Rating = 5.

12 Month Freq: Deficiencies could cause more extensive damage if not repaired, or a portion of the non-NBI structure is in CS 3 or the NBI Condition Rating = 3 or 4.

6 Month Freq: Signs of structural failure exist, i.e., buckling in the bottom of the CMP, etc. Inspect before and after the high runoff season (October and April). A portion of the non-NBI structure is in CS 4, or the NBI Condition Rating = 2 or less.

Tunnel Inspections - If the structure is a tunnel, the inspection frequency is specified for each specific tunnel.

<u>Tunnel Name</u>	<u>Br. No.</u>	<u>Inspection Freq.</u>
Arch Cape Tunnel	02247	2 years
Cape Creek Tunnel	03961	2 year
Elk Creek Tunnel	03437	2 years
Knowles Creek Tunnel	07139	2 years
Salt Creek Tunnel	02539	2 years
Tooth Rock Tunnel	04555	2 years
Vista Ridge EB Tunnel	09103	2 years
Vista Ridge WB Tunnel	09103B	2 years
Sunset Tunnel	02552	2 year

Each tunnel inspection team will include a Certified Bridge Inspection Team Leader and the Regional GeoTech Engineer.

10.2—ROUTINE BRIDGE INSPECTION REPORT

The routine inspection report that carries the original signature of the bridge inspection team leader is referred to as the Bridge Inspection Report-of-Record. As such, the routine inspection report is very static in that it is only a snapshot picture of the condition bridge at one point in time. All other supporting inspection reports are very dynamic in that they carry historical condition information that has changed over time. The intent of having the supporting inspection reports to be dynamic is to provide some sense as to the rate of decline in the condition of the bridge members.

10.2.1—Routine Bridge Inspection Report

The ODOT Routine Inspection Report is a compilation of a number of boxes which are listed as follows:

- Bridge Inspection Report header (ID) information
- Element Condition State Rating
- Appraisal information
- NBI Condition Rating
- Condition Remarks Box
- Bridge Inspection Notes
- Bridge Notes
- Maintenance Recommendation Box
- Load Rating Summary Box
- Load Rating Condition Comparison Table
- Inspection Schedule table for the structure
- Structure Inventory & Appraisal Sheet
- Links to supplemental reports and images
-

Bridge Inspection Report Header Information

This portion of the report lists pertinent information that is used to help identify the structure. Information such as:

- Structure Name
- Bridge ID Number (first 6 digits of the FHWA ID number)
- Facility Carried (NBI Item 7)
- Mile Point (NBI Item 11)
- Facility Crossed (NBI Item 6)
- Highway District (NBI Item 2)
- County (NBI Item 3)
- Owner (NBI Item 22)
- Wearing Surface Depth
- Bridge Length (NBI Item 49)
- Bridge Width (NBI Item 52)
- Sufficiency Rating
- Inspection Date (NBI item 90)
- Inspector 1
- Inspector 2
- Signature of the Bridge Inspector-of-Record

The inspection report that carries that original signature of the bridge inspection team leader is referred to as the Official Bridge Inspection Report-of-Record and is kept on file in the ODOT Bridge Section office.

Reporting the Condition of a Bridge

A routine inspection in the State of Oregon contains two very distinct types of condition rating schemes:

- Element Level Condition Assessments
 - AASHTO Core Elements
 - Oregon Specific Non-Core Elements
- NBI Condition Assessment Ratings
 - NBI Items
 - Oregon Specific NBI Items

Even though the existing condition rating language contained in the Element Coding Guide and the FHWA Coding Guide utilizes very general, subjective terms, ODOT decided to keep the Element Level and the NBI Condition Assessment language the same as that provided in the FHWA Bridge Inspection Reference Manual (BIRM) and the AASHTO Core Element manuals. However, in order to assure data uniformity and consistency throughout the bridge inspection community, ODOT decided to provide quite a few additional supplemental condition rating guidelines and business rules that would help guide the bridge inspectors when they are assessing the condition of a structure. These additional guidelines are called:

- Condition Rating Supplementals, and
- Commentary Business Rules

It is of utmost importance that the physical condition of all members be evaluated with due reference to the associated load path and assessing the ability of that member to carry and transfer all loads imparted onto it. This concept will have a direct impact on the quantity being reported in a given condition state. This is to say that the portion located between adjacent supports should be included in a particular condition state assessment. The only exception would be when the element requires the condition assessment to be reported in only one condition state. The condition assessment information is located in two different locations on the bridge inspection report:

- 1.) Element Condition state box
- 2.) NBI Category condition rating box

Bridge Appraisal Information

This is an area where the bridge inspector assesses whether a number of bridge features meets current design standards. This assessment is not based on the condition of the feature. One example would be to assess whether or not the bridge railing meets current design standards. If the railing does not meet current standards, considering the route classification, the bridge inspector could post and prioritize a maintenance recommendation to upgrade the bridge railing.

Remarks that Support the Condition Rating

Each bridge inspector is directed to fully describe all of the following:

- Any condition or deficiency that is noteworthy or has a potential for getting worse.

- A description of any temporary repair that may exist, or
- A description and image of any load restriction sign along with the posting date.

Noteworthy remarks are generally posted only when there is a change in the condition of the members that are associated with the load path, items that might create a traffic hazard, or items that might intensify our concerns for scour at the bridge site.

Bridge Inspection Notes

The Bridge Inspection Report Notes contains 3 separate areas where addition notes can be posted:

- **Inspection Notes** - This is where bridge personnel can log a note as to what non-condition rating bridge data was changed, when it was changed, and by whom. An example would be when the ODOT Bridge Hydraulics Engineer changes the Scour Code (NBI Item 113) following further in-depth evaluation of the bridge site. This box would also be used to provide more information regarding the amending of an inspection report due to some action.
- **Bridge Notes** - This is where bridge personnel can log a note regarding something about the bridge that is noteworthy. An example would be: For inspection planning purposes, the bridge inspector has been directed to generate a bridge specific Job Safety Analysis (JSA) that is to warn others as to what safety hazard features are located on that bridge and how they should be mitigated. Prior to start of the inspection, the JSA is to be reviewed by all parties that actively participate in the bridge inspection. This note would also describes whether a given structure contains certain features that might be of a safety concern, like: Confined Space, Fall Restraint System and it's condition, whether bat guano is present or not, etc.
- **Embankment Erosion Notes** – This is where bridge personnel can log a note regarding an appraisal of the roadway embankment and how vulnerable it is to erosion.

Maintenance Recommendations Box

The Maintenance Recommendation box contains a compilation of a variety of recommendations that have been posted by a variety of personnel. This is to say that the Routine Bridge Inspector-of-Record owns the bridge inventory and condition assessment information contained in the file for the bridge. Therefore, as a business rule, the bridge inventory and condition assessment information can only be changed by that person. However, this data ownership does not include the non-inventory or non-condition assessment data that is contained in the file, like the list of bridge maintenance recommendations. Every bridge maintenance recommendation is generally a result of someone seeing something on a bridge and thought that something needed to be done. That someone could be the underwater divers, other bridge inspectors, bridge maintenance personnel, concerned highway maintenance personnel, the bridge owner, or interested general public. An example could be when a member of the general public calls bridge headquarters about a concern. In addition to notifying others, bridge headquarters staff could post a prioritized maintenance recommendation for the bridge that would address the concern. Another example would be following an underwater bridge inspection where the divers noted that some drift needed to be removed from a bridge bent. In this case, the Underwater Bridge Inspector-of-Record would post a prioritized maintenance recommendation that would address the need.

The primary intent is to craft a prioritized bridge “work to do” list that provide a specific location of the work needing to be accomplished.

However, if during the course of processing the information associated with the above examples, if the noted deficiencies would result in a change in the condition assessment ratings for the bridge, the inspector performing that supplemental inspection must notify the last Bridge Inspector-of-Record so they can file an official Amended Routine Inspection-of-Record. The supplemental inspection person is not allowed to change the condition assessment ratings, without taking ownership of the data contained in the file. If they take ownership of that data they will be required to post and file a new official Bridge Inspection-of-Record.

Load Rating Notes

The load rating summary box was integrated into the Routine Inspection Report form for the following reasons:

- The assigned bridge inspector needs to know whether the bridge has been load rated and whether load posting is required, so NBI Items 41 and 70 can be properly coded.

- When planning an itinerary for the inspection, the assigned bridge inspector needs to know what the load rating controlling members are so they can zero in on those members with a close-up visual inspection and schedule further NDT methods where appropriate.
- Determine the criticality of any load path deficiencies by knowing what the load rating factors are for the load rating controlling members.
- Determine what the bridge is suppose to be posted for so that a comparison can be made as to it's actual posting. This also relates to NBI Item 41 and 70 as a validity check, as well as, result in the posting of a maintenance recommendation to correct.
- To assure that the load posting is enforceable, the bridge inspector needs to determine whether the configuration of the posting sign is in accordance with the Manual Uniform Traffic Control Devices (MUTCD).
- Determine whether the bridge condition has digressed sufficiently to warrant the initiation of a "Load Rating Review" recommendation.
- Determine whether a digital image of the load posting sign is needed.

ODOT initiated the following process:

- a. The load rating is calculated in accordance with the reported condition of the bridge at that point in time, for the 3 legal trucks (Type 3, 3S-2, and 3-3). When the results of the load rating calculations have been validated, the assigned load rater enters the information into the ODOT Bridge Load Rating database, including the coding of NBI Item 70 (Percent below).
- b. If the structure requires a load restriction, an official letter is send to the bridge owner, so that the load posting sign can be installed. Either the bridge owner or the assigned bridge inspector is required to post a digital image showing that the load restriction was actually posted, when it was posted, and to verify that the contents of the load posting sign is correct.
- c. The assigned bridge inspector is required to validate and/or change NBI Item 41.
- d. If the load rating information needs to be reviewed, the bridge inspector is directed to first notify the load raters verbally followed by posting a load rating needs review maintenance recommendation using "Element 990". This review could be for:
 - NBI Item 70 might not be in accordance with the load rating factors.
 - If the actual bridge posting is for a higher value than specified (NBI Item 41 = B).
 - If the condition of the bridge has digressed to warrant a review in accordance with the accepted notification thresholds.

Load Rating Condition Comparison Chart

The load rating for each structure is based on the condition of that structure at some point in time. As the structure continues to digress, at some point in the future, that original load rating will need to be updated so that it reflects the current condition of the bridge. Therefore, for that reason, this comparison table was created so the bridge inspector could easily compare the current condition of various bridge items as compared to their reported condition at the time the load rating was performed. If the differences exceed the thresholds listed in chapter 7, the bridge inspector was instructed to notify the ODOT Load Rating Engineer, so the load rating could be reviewed and updated.

Inspection Schedule for the structure

One of the over-riding responsibilities of each state is to assure that each bridge is inspected as thoroughly as necessary to clearly establish its condition and to insure its continued safe operation. To fulfill that over-riding responsibility, ODOT has initiated the following list of inspection types which will have differing frequencies. Therefore, ODOT developed this chart so that the bridge inspectors and bridge program managers could better plan and/or monitor the assigned work. The intent is to minimize the number of times that a bridge inspector has to access a given structure. It also assures that a particular inspection does not fall through the cracks and left un-completed.

As a result, this portion of the bridge inspection report provides the following:

- List what types of inspections are required to be performed on a given structure,
- The date the last inspection was performed,
- The inspection frequency, and

- The next scheduled date the inspection will be performed.
 - Routine Inspection
 - Fracture Critical Inspection
 - Fatigue Prone Detail Inspection
 - Underwater Inspection
 - Cross Channel Profile
 - Concrete Structural Cracks
 - Deck Surveys
 - Timber Boring
 - Sign Support structure
 - Snooper / UBIT Inspection
 - Load Rating Inspection
 - Drawbridge Electrical / Mechanical Inspection (Operational / In-depth)
 - Box Girder (Interior Confined Space Entry)
 - Pin & Hanger (Ultrasonic Testing)
 - Critical Follow-up and QA Field Review

Structure Inventory & Appraisal Sheet

The SI&A sheet is a tabulation of pertinent elements of information about an individual structure. It is not an inspection report form, but merely a summary sheet of bridge data that is required by FHWA so that the National Bridge Program can be effectively monitored, managed, or used for the dissemination of federal funds.

The data shown on the SI&A sheet comprises the bi-annual FHWA submittal.

Links to Associated Supplemental Reports

In order for the bridge inspection web page queries to work properly, the inspection file must adhere to the following file naming convention, where XXXXXX = bridge number, followed by the file extension .xls:

- Timber Boring – TBXXXXXX.xls
- Fracture Critical Inspection – FCXXXXXX.xls
- Fatigue Prone Detail Inspection – FPXXXXXX.xls
- Gusset Plate Inspection – GPXXXXXX.xls
- Bridge Clearance – CLXXXXXX.xls
- Underwater Inspection – UWXXXXXX.xls
- Cross Channel Profile – XCXXXXXX.xls
- Concrete Shear Cracks – CRXXXXXX.xls
- Deck Survey – DKXXXXXX.xls
- Drawbridge Inspections – DWXXXXXX.xls
- Tunnel Inspection Reports – TUXXXXXX.xls
- Sign Support Structure – SSXXXXXX.xls

All supplemental reports must be dynamic, rather than having separate reports for separate inspection dates. All sketches and images must be inserted into the document rather than simply providing a link.

Bridge Images

As a minimum the bridge inspector should post a bridge image of the following in the bridge file:

- Plan View of the Bridge
- Profile View of the Bridge
- Load Posting Signs
- Noteworthy deficiencies that have the potential for getting worse
- Bridge component deficiency that are causing a NBI rating of 4 or less
- That portion of an element that is in the most advanced state of deterioration
- Installed Temporary Repairs
- Historical Bridge Plaques

The image label should include an “IM” prefix, bridge number, and name of item being viewed.

How to generate a Routine Bridge Inspection Report

Follow directions provided in Sections 17 and 19 of this manual.

CHAPTER 11: BRIDGE DECKS, JOINTS, AND RAILINGS

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CHAPTER 11:

BRIDGE DECKS, JOINTS, AND RAILINGS

11.1—BRIDGE DECK INSPECTION OVERVIEW

11.1.1—Overview

Bridge decks perform a very simple and unique function: Distribute the traffic wheel loads to the supporting superstructure members. The path associated with the distribution of these traffic loads is called the “Load Path”. All decks must be evaluated based on their ability to perform that function. Since the deck is directly affected by traffic loads, it’s most susceptible to traffic-related problems, like:

- Traffic abrasion
- Corrosion effects of deicing chemicals,
- Live load deflections and cracking
- Impact loads that materially increase as the deck surface deteriorates.

The deck provides a riding surface for vehicles, and transmits the live loads to the supporting elements, also protects both the main superstructure and substructure system from the direct impact of the traffic and the direct effects of weathering. Maintaining the deck can often provide a major increase in the useful life of the bridge at comparatively little cost.

Concrete decks are by far the most common because:

- Popular because of the simplicity of construction and long expected service life
- Construction can be either cast-in-place or pre-cast
- Composite action can be developed with supporting elements
- Span can either be transverse or longitudinal between supporting elements
- Surfacing can either be flexible or rigid paving materials

Wood decks are more common in remote rural settings and on older structures because:

- Lightweight construction
- Materials highly accessible in less developed areas
- Planks usually placed transverse to traffic.
- Very little composite action with supporting elements
- Surface only with flexible materials (paving or gravel)

Steel decks can include:

- corrugated metal deck panels,
- steel grid deck panels (filled or unfilled),
- orthotropic steel plates

During the inspection process, a number of problems can be traced back to the deck. For example, corrosion and unexpected deflection or distortion of deck-supporting elements are clues that a deck may not be performing its protective or load distribution function.

- Corrosion of supporting elements indicates that water, and very likely salts and other corrosive roadway chemicals are passing through the deck and attacking the structure beneath. Since a healthy deck functions to protect the supporting structure, the corrosion is a sign that this function is no longer being served.
- Deflection or Distortion of supporting elements can indicate that unanticipated movements are occurring in the superstructure. These movements can be the result of joint malfunction, bearing problems, or loss of composite action.

One aspect of bridge inspection is the investigation of the condition of the deck. It is important to distinguish between problems with wearing surfaces and problems with structural elements. Although a wearing surface in poor condition will eventually affect the integrity of the underlying deck, there is usually an opportunity to restore the wearing surface before the deck is adversely affected. A normal inspection will reveal problems with wearing surfaces, which should be scheduled for early repair to provide as much protection as possible to the underlying structural elements.

Wearing surfaces perform two functions in protecting the deck:

- They provide a seal and prevent water and deicing chemicals from penetrating into the deck slab.
- They provide a smooth, skid-resistant surface for vehicular traffic, minimizing impact forces to the structure.

Each of the deck types (concrete, wood, steel grid, and steel orthotropic) has their own set of warning signals that indicate the deck may be reaching the end of its useful life.

In general, the condition of a reinforced concrete deck can be reasonably estimated by evaluating the severity of various imperfections such as corrosion of the reinforcing bars, deck cracking, delaminations, spalls, and surface scaling that is present and assessing their combined seriousness. The combined effect of these deficiencies on the concrete deck is rather difficult to assess objectively and consistently, because certain flaws may be more important than others. Therefore, the procedure for rating an existing bridge deck requires a careful evaluation of many complex and often conflicting factors. Such an evaluation is frequently based on the personal judgment, intuition, and perhaps experience of each inspector. As a result, different inspectors may assess a given bridge differently. A logical assessment procedure capable of incorporating both objective knowledge and engineering judgment systematically would be very helpful.

Determining what exactly is going on with the structure and reporting that information is the first order of business of the bridge inspector. If the bridge inspector fully understands what is causing the deficiency, we can then develop a repair strategy that will address both the cause and the effect, which should result in a good, long lasting repair. In an effort to objectively determine what, when, where, and whom should trigger a given deficiency remedial action, the following values have been determined to be the most important. The bridge inspector is responsible for determining how each portion of the bridge deck might be contributing to these categorical deficiencies:

- Quality of Ride
- Quality of Materials in the Bridge Deck
- Load Associated Deficiencies
- Corrosion Associated Deficiencies
- The Bridge Wearing Surface

The bridge deck assessment will contain the following components:

- Quality of Ride – assessing if and how the surface abrasion, scaling, spalling, traffic bump impacts, vertical bridge profile, deck joints, deck roughness, and settlement has on the bridge loading.
- Quality of Materials – assessing if and how surface scaling, abrasion resistance, reactive aggregates, rock-pockets, exposed reinforcing steel, skid resistance, or chloride intrusion has on the condition of the deck.
- Load Associated Defects – assessing if and how the deck cracks, spalls, or delaminations affect the ability of the deck to distribute the traffic wheel loads to the supporting superstructure members.
- Corrosion Associated Defects – assessing if and how corrosion is affecting the various bridge deck components, like the steel reinforcement, metal grates or corrugated metal sections.
- The Bridge Wearing Surface – assessing if and how problems associated with the wearing surface has on traffic safety. This assessment can include items like: surface abrasion like surface scaling or wheel track rutting, traffic bump impacts that can occur at bridge ends or deck joints, vertical bridge profiles like excessive camber in the superstructure, deck roughness, skid-resistance, settlement of the structure, loose sand or debris material, water-ponding or drainage.

11.2—INSPECTION OF CONCRETE DECKS

Each deck type (concrete, wood, steel grid, or steel orthotropic) has its own set of warning signals that can indicate the deck may be reaching the end of its useful life.

The most predominant bridge deck type in the State of Oregon is concrete.

The results of any evaluation, especially determining the cause and scope of the problem, are only as accurate as the understanding and effort applied to the process. A cursory review or walk-over inspection will not produce as accurate an evaluation as an in-depth, detailed investigation involving the necessary mapping, sampling, testing and exploratory efforts. However, a full in-depth detailed investigation on every concrete bridge in our inventory is not very practical, nor warranted. Therefore, our challenge here is:

- a) Provide a thorough and logical evaluation procedure that will physically measure and monitor the condition of the structure using realistic criteria,
- b) Identify the deficiency threshold values or triggers that will initiate some mitigating action,
- c) Provide a method for reporting the results of the bridge inspection, and
- d) Establish some basic criteria so that a statewide prioritization process can be implemented that will result in cost-effective repair or rehabilitative efforts.

As required by the NBIS (National Bridge Inspection Standards), a visual walk-over inspection will be performed during every routine bridge inspection that will occur at least every 24 months. When bridge conditions, so warrant, a more in-depth evaluation of the structure, destructive and non-destructive testing procedures will be initiated that will clearly determine the scope and magnitude of the problems being observed.

The condition assessment of a bridge deck will almost always start with a walk-over and a walk-under visual inspection:

11.2.1—Visual Inspection (what to look for and assess)

The performance of a visual inspection, mapping the location of problems on paper, and reviewing these along with as-built drawings and construction records can provide a pretty good understanding of the problems and possible clues as to their cause. However, assessing the condition of a bridge deck is often made more difficult by the presence of a flexible wearing surface. Asphaltic wearing surfaces are the most popular method of restoring a smooth ride surface when the original concrete surface has begun to deteriorate. When properly sealed against water intrusion, a bridge deck wearing surface can offer great benefits in extending the life of the concrete decks that have experienced minor deterioration. Our business rules do not allow the condition of the wearing surface to control the reported condition of the bridge deck. Also, if a wearing surface has been placed on the bridge deck, the bridge inspector cannot see or visually inspect the condition of the bridge deck. However, quite often, the condition of the wearing surface is a pretty good indicator as to the condition of the bridge deck. Example: cracks in the bridge deck substrate will reflect up into the wearing surface. Therefore, the condition of the wearing surface should be monitored closely and its condition reported accordingly.

During every visual inspection, the bridge inspector is charged with the responsibility to note all key indicators of structural problems. The key indicators of structural problems that will be considered, monitored and reported during every routine inspection are:

Deck Cracks

- Transverse to the primary reinforcement
- Longitudinal to the primary reinforcement
- Negative Moment cracks
- Cracks that can be contributed to construction practices
- Diagonal cracks
- Map or rebar pattern cracks

Surface Distress

- Scaling
- Surface honeycomb or rock pockets
- Concrete Delaminations
- Spalling
- Surface Abrasion
- Exposed Reinforcing Steel
- Traffic bumps and/or impacts

Structure Movements

- Deflections
- Thermal Effects
- Concrete Creep
- Settlement
- Alignment of Concrete Members

Water Leakage

- Surface dampness
- Seepage or leakage through joints or cracks
- Freeze / Thaw Action

Deck Reinforcement Corrosion

- Longitudinal cracks
- Localized areas of delaminations
- Rust Staining

Exposed reinforcing bars

- Exposed post-tension ducts or strands

Miscellaneous

- Blistering membranes and coatings (moisture vapor transmission)
- Ponding of water
- Accumulation of sanding material or traffic debris

11.2.2—Common Bridge Deck Deficiencies

A more definitive in-depth discussion of each deficiency is as follows:

The riding surface and the soffit side of every bridge deck are surveyed and the condition of the deck is judged with respect to the following deficiencies:

Spalling – the actual loss of concrete, is a general result of internal problems in the deck. Usually spalling results from expansive forces like corroded reinforcement, but may also result from forces developed as water enters voids and expands as it freezes. Both causes can be expected to be active in older concrete, since all reinforced concrete, as well as, most prestressed concrete, is subject to cracking, which will eventually lead to corrosion of reinforcement. Air entrainment added during the original placement can help by providing resistance to the freeze / thaw cycles. Most modern concrete mixes include air entrainment, but older concretes may not.

Scaling – is the flaking of surface mortar often accompanied by the loosening of surface aggregates. Scaling is believed to be caused by freezing and thawing, poor workmanship, or inadequate curing of the concrete. Freeze-thaw disintegration takes place when the following conditions are present:

- Freezing and thawing temperature cycles within the concrete.
- Porous concrete that absorbs water (water-filled pores and capillaries).

Freeze-thaw generally occurs on horizontal surfaces that are exposed to water, or on vertical surfaces that are at the water lines in submerged portions of the structures. The freezing water contained in the pore structure expands as it is converted into ice. The expansion causes localized tension forces that fracture the surrounding concrete matrix. The fracturing occurs in small pieces, working from the outer surfaces inward. The rate of freeze-thaw deterioration is a function of the following:

- Increased porosity
- Increased moisture saturation
- Increased number of freeze-thaw cycles
- Reduced amounts of air-entrainment
- Horizontal surfaces that trap standing water
- Aggregate with small capillary structure and high absorption

Since this type of deficiency occurs on the surface of the concrete member, it can be easily located, measured, assessed, and integrated into the bridge inspection report.

Cracking – is basically inevitable in non-prestressed concrete. It can be caused by shrinkage forces, as restrained concrete is subjected to tension during the curing period, shortly after placement. Another source of cracking is subsidence of the concrete around the reinforcement. Cracking is also caused by flexural stresses, as the main structural elements support the deck slab deflect under load. The deflections, and cracks, can occur shortly after the concrete has set, or during its service life. Once the concrete has cracked, a path is available for water to reach the steel reinforcement, initiating the expansive force process caused either by corrosion or ice.

Crack Orientation is also a very important item to note as they are a good indicator as to the cause of the cracks and whether they can be considered to be superficial or structural cracks. Cracks are generally oriented as follows:

- Transverse Cracks – are fairly straight and are roughly perpendicular to the centerline of the member. In a slab span, these cracks are perpendicular to the primary steel reinforcement. Whereas, on a girder type bridge, these cracks are parallel to the primary steel reinforcement. These type of cracks frequently occur over the bents in the negative moment regions of a continuous structure.
- Longitudinal Cracks – are fairly straight and generally run parallel to the centerline of the member. These cracks are generally telling the inspector that the major reinforcement is oriented perpendicular to the centerline of the bridge.
- Diagonal Cracks - typically run at an angle to the centerline of the bridge. Diagonal cracking seems to be quite prevalent on structures that have a severe skew. Near the corners of a bridge deck, the diagonal cracks seem to be perpendicular to the shorter diagonal axis and tend to turn longitudinal as you approach the center of the bridge. This configuration leads us to believe that these cracks are more associated with shrinkage or thermal effects than live loads.
- Map or Pattern Cracks – are inter-connected cracks that form a network of varying size.
- The cause and continued presence of cracks govern the future impact of cracking on the integrity of the structure and its deterioration rate. Cracks often aggravate the corrosion process by allowing easy access to chloride ions, oxygen, and moisture. In addition, certain types of cracking can significantly reduce the structural integrity of concrete members. **The causes, evaluation, and repair of cracks are covered in ACI 224.1R-93 “Causes, Evaluation, and Repair of Cracks in Concrete Structures” a copy of which is included in this section.**
- Although the depth of a crack can be an important classification parameter, it is generally neglected, because it can only be determined by coring, except in those cases in which the crack is visible on the opposite surface of the concrete member. Because coring samples are usually not taken during routine inspections, the depth of cracks is not readily available.

Efflorescence – appears on the bridge deck soffit surface. As water seeps through the concrete deck substrate, the carbonaceous products created as the water reacts with the cement in the concrete result in a white substance, known as efflorescence. The presence of this white coating indicates that water is present within the concrete, and has found a path through it.

Delaminations – are the presence of internal horizontal seams (cracks) or voids. These internal defects are the precursors of spalling, and the concrete at delaminations will eventually loosen and spall. Delaminations can be detected in several ways, from simple chain dragging or hammer tapping. When striking areas of delaminated concrete, the sound changes from a “ping” to a hollow sounding “puck”. The boundaries of the delaminations can easily be determined by sounding areas surrounding the first “puck” until a “ping” is heard. Hammer-sounding of large areas generally proves to be extremely time consuming. More productive sounding methods are available when working with horizontal flat surfaces. Chain dragging accomplishes the same result as hammer-sounding. As the chain is dragged across a concrete surface, a distinctly different sound is heard when it crosses over a delaminated area.

The boundary of the delaminated area is then marked with spray paint, for future reference. When estimating the extent of deterioration of a deck surface, areas of delamination should be combined with actual spalled and patched zones, in order to accurately assess the magnitude of the deterioration.

Surface Abrasion

In the state of Oregon, we consider surface abrasion or wheel track rutting the same as a spall or a delamination. as abrasion is the wearing away of the surface by rubbing and friction. Generally, the surface is uniformly worn away, including the cement matrix and the aggregates. Factors affecting abrasion resistance include:

Compressive strength of the concrete

Aggregate properties

Finishing methods

Use of toppings

The concrete curing

Surface abrasion is generally measured using a long straight-edge and a ruler or tape measure.

Exposed Reinforcing Steel

There are three important reasons to control the proper location of reinforcing steel in structures:

- First, reinforcing steel is placed in concrete to carry tensile loads, and if the steel is misplaced, the concrete may not be able to carry the tensile loads.
- Second, reinforcing steel requires adequate concrete cover to protect it from corrosion. The alkalinity of the concrete is a natural corrosive inhibitor. If the concrete cover is inadequate, it will not provide the necessary long-term protection.
- When the exposed rebar becomes exposed to traffic, wheel tire impacts create a steady vibration in the bar. As the bar vibrates, the bond between the reinforcing steel and the concrete is broken. As the reinforcing steel becomes more exposed, sections of the rebar will break and come loose into traffic, create a traffic hazard.

Traffic Bumps and/or Impacts

This deficiency is generally the result of a rough bridge approach, traffic abrasion or wheel track rutting. Since the deck joints are generally constructed of materials that do not rut, as the wheel tracks abrade, a traffic bump or impact is created. Even with an approach impact panel, a rough bridge approach will get the heavy truck traffic to bounce along the bridge deck, significantly increasing live loading on the deck. These areas can be easily identified by the dark stains on the bridge deck between the wheel tracks due to the accumulation of the oils falling off the trucks.

Settlement of the approach roadway embankment also creates a traffic bump or impact at each end of the bridge. If an impact panel is present and if the traffic speeds are high enough, the traffic bump can become more of a ski jump ramp.

In regards to the inspection of a bridge, a bump in the travel lanes that is greater than 1/2" is considered to be significant and a remedial action should be recommended by the bridge inspector.

The severity of traffic bumps or impacts can be monitored by watching traffic and assessing the color of the bridge deck in that the more dirt and oils that fall from the passing traffic the darker the stain on the top of the bridge deck.

Chloride Content

Chlorides can be introduced into concrete bridge decks by coming in contact with an environment containing the chlorides, such as a marine environment or various de-icing chemicals. Penetration of the chlorides start at the surface, then moves inward. Chloride intrusion in a marine environment will most likely occur on the soffit side to the deck, whereas, de-icing chemicals will most likely collect in the gutters or bridge rail splash zones. Penetration takes time, depending upon:

- The amount of chlorides coming into contact with the concrete.
- The permeability of the concrete.
- The amount of moisture present.

Eventually the concentration of chlorides in contact with the reinforcing steel will cause corrosion when moisture and oxygen are present. As the rust layer builds, tensile forces generated by expansion of the oxide cause the concrete to crack and delaminate. Spalling of the delamination occurs if the natural forces of gravity or traffic wheel loads act on the loose concrete. When cracking and delamination progress, accelerated corrosion takes place because of easy access of corrosive salts, oxygen, and moisture. Corrosion then begins to affect the rebar buried further within the concrete matrix.

Water Leakage

Aggressive chemical exposures can cause the concrete to alter its chemical makeup, resulting in changes in its mechanical properties. Depending upon the type of attack, the concrete can soften or disintegrate, in part or full depth. Certain chemicals in solution will attack various constituents of the concrete matrix. Aggressive chemicals can be categorized as follows:

- Inorganic Acids
- Organic Acids
- Salt Solutions
- Alkaline Solutions

- Miscellaneous solutions like liquid flammables

Acid attack on concrete is the reaction between the acid and the calcium hydroxide of the hydrated Portland cement. The reaction produces water soluble calcium compounds, which are leached away. When limestone or dolomite aggregates are used in the concrete mix, the acid may completely dissolve them.

Water Ponding

Slabs, such as concrete bridge decks, require drainage for proper runoff need special attention. Drains should be located at the low points on the bridge deck. Proper slope-to-pitch for quick runoff is important to prevent potential deterioration of the concrete member, leakage within the structure, and water ponding into the traffic lanes. Standing water provides concrete with the potential for saturation, the worst condition for a freeze-thaw cycle. The quicker the water runs off the structure, the less leakage can occur through the joints and cracks.

Water ponding is most notably a problem in the following areas:

- In rutted wheel tracks.
- Bridge deck was constructed with a lower grade area with no drainage
- When snow and ice is piled on top of and blocking the deck drains
- When the existing deck drains are physically blocked to keep the roadway runoff from entering into a sensitive stream below without filtration.
- On a bridge deck that has a porous AC wearing surface, if proper drainage is not provided next to the deck joint headers, surface water will collect and pond next to the deck joint headers.

11.3—INSPECTION OF TIMBER DECKS

Timber Bridge Deck Systems usually consist of any one of the following:

- Treated timber 4" x 12" transverse planks.
- Treated timber 4" x 12" transverse planks topped with longitudinal 4" x 12" timber running planks in the wheel tracks.
- Treated timber 4" x 12" transverse planks topped with a longitudinal untreated 2" x 2" cedar course and an AC wearing surface.
- Treated 2" x 6" treated members that are turned on edge and nailed together to form a nail laminated timber deck system.
- Glue laminated deck panels that are connected to the timber stringers.

Wood decks nearing the end of their useful lives exhibit a number of signals indicating problems do exist in the structure and are in dire need of further investigation:

- Excessive Deflection under load
- Shrinkage in the timber member resulting in a loose connection
- Loose nails due to traffic vibrations
- Excessive deterioration – checking, cracking, decay or crushing of the wood.
- Deck Condition indicators in AC wearing surface

Field inspection is the physical examination of a bridge for evidence of deterioration. Variations in bridge configurations and exposure conditions make this a complex task. It is therefore necessary for the inspector to be well acquainted with the agents of deterioration, the areas conducive to decay, and the fundamental of components inspection. With this knowledge as a guide, the inspector is better prepared to identify and locate deterioration and accurately define its extent.

Methods for detecting deterioration in bridges are divided into two categories: those for exterior deterioration and those for interior deterioration. Although a variety of inspection methods may be employed, in practice the inspector uses only a few tools. No equipment can replace a well-trained inspector who has a broad knowledge about timber.

11.3.1—Methods for Detecting Exterior Deterioration

Exterior deterioration is the easiest to detect because it is often readily accessible to the inspector. The three methods or tools most commonly used include visual inspection, probing, and the pick test. When areas of exterior

deterioration are located by these methods, further investigation by other methods is required in order to confirm and define the extent of damage.

Visual Inspection

The simplest method for locating deterioration is visual inspection. The inspector observes the timber bridge deck for signs of actual or potential deterioration, noting areas for further investigation.

Top of the Timber Bridge Deck

- Splitting in the timber planks
- Traffic Abrasion.
- Loose and Protruding Nails / Spikes
- Map cracking in the AC Wearing Surface. Quite often the bridge deck consists of 4" x 12" treated timber transverse planks, topped with longitudinal 2" x 2" untreated cedar, nailed together to form a timber deck system or matrix. Since the cedar tends to decay from the outside in, any areas of decay will reflect up into the AC wearing surface.

Soffit side of the Timber Bridge Deck

- Staining or discoloration indicates that members have been subjected to water and potentially high moisture contents suitable for decay.
- Insect activity is visually characterized by holes, powder posting, or other signs previously discussed. The presence of insect activity may also indicate the presence of decay.
- Plant or moss growth in splits, cracks, or soil accumulations on the structure indicate that adjacent wood has been at a relatively high moisture content suitable for decay for a sustained period of time.

11.3.2—Methods for Detecting Interior Deterioration

Detecting interior deterioration is very difficult to locate because there may be no visible signs of its presence. Numerous methods and tools have been developed to evaluate internal damage that range in complexity from sounding the surface with a hammer to sophisticated sonic or radiographic evaluation. In addition, such tools as moisture meters are used to help the inspector identify areas where conditions are suitable for development of internal decay.

- **Sounding**
Sounding the wood surface by striking it with a hammer or other object is one of the oldest and most commonly used inspection methods for detecting interior deterioration. Based on the tonal quality of the ensuing sounds, a trained inspector can interpret dull or hollow sounds that may indicate the presence of large interior voids or decay. Although sounding is widely used, it is often difficult to interpret because factors other than decay can contribute to variations in sound quality. In addition, because sounding will reveal only serious internal defects, it should never be the only method used as sounding provides only a partial picture of the extent of decay present and will not detect wood in the incipient or intermediate stages of decay. Nevertheless, sounding still has its place in inspection and can quickly identify seriously decayed structures. When suspected decay is encountered, it must be verified by other methods such as boring or coring.
- **Drilling and Coring**
Due to the thickness of the timber member matrix, drilling or coring is usually not used to assess their internal condition. Probing is a much preferred method.
- **Probing**
Probing with a moderately pointed tool, such as an awl or knife, locates decay near the wood surface by revealing excessive softness or a lack of resistant to probe penetration. Although probing is a simple inspection method, experience is required to interpret results. Care must be taken to differentiate between decay and water-softened wood that may be sound by somewhat softer than dry wood. It is also sometimes difficult to assess damage in soft-textured woods such as western red-cedar.

- Pick Test

The pick test is one of the simplest methods for detecting surface decay and is the only method available for testing the 2" x 2" longitudinal cedar deck course. The bridge inspector probes the underside of the cedar course, in between the 4" x 12" transverse deck planks on the soffit side of the bridge deck. A pointed pick, awl, or screwdriver is driven a short distance into the wood and used to pry out a sliver. The wood break is examined to determine if the break is brash (decayed) or splintered (sound). Sound wood has a fibrous structure and splinters when broken across the grain. Decayed wood breaks abruptly across the grain or crumbles into small pieces.

11.4—INSPECTION OF STEEL DECKS

Generally, a steel bridge deck will consist of one of the following systems:

- Corrugated Steel Deck Panels
- Steel Grid Decks (open and filled)
- Steel Orthotropic Decks

11.4.1—Corrugated Metal Decks

Corrugated metal bridge deck panels differ from orthotropic deck panels in that their ribs are transverse to the centerline of the bridge deck, transferring traffic loads to the supporting girders in the superstructure. More often than not, corrugated metal bridge deck panels are found in the more rural, low traffic volume, areas of the state. However, corrugated metal deck panels have exhibited good results, when incorporated into a concrete deck repair.

Characteristics of Corrugated metal deck panels include:

- Lightweight construction
- Modular elements speed installation and reduce service disruptions

The corrugated metal deck panels are connected to the superstructure members either by bolting or welding, the lower ribs are drilled for drainage, and are simply covered with either a gravel or asphalt wearing surface. Generally, these deck panels require the stringer spacing to be at least every 24 inches or less.

11.4.2—Steel Grid Decks (open and filled)

Open grids have found a number of applications due to their minimal dead loads, minimal wind resistance, and free drainage, such as on a drawbridge application.

Steel grid decks also have potential problem areas that should be examined during the inspection process:

- Reduced Skid-Resistance – both open grids and concrete-filled grids without surfacing are subject to decreased skid resistance over time. The unsurfaced filled grid can develop cupping, or wear of the concrete between the grid bars, which exposes the grid to direct wheel loads. The ride of the filled grid then becomes similar to that of an open grid, and skid resistance becomes an issue. In wet weather this is dangerous as water is held in the cups and in freezing weather the hazard increases due to ice formation. The riding surface of the grid elements, when new, presents some resistance to skidding, but as traffic wears the surface down, skid resistance becomes minimal.
- Loosening of attachment Connections – The connection of the various grid components are subject to forces caused by the interaction between the grid and its supporting elements. These forces stem from vehicle loads including those forces introduced through braking or accelerating vehicles. These connections will break down over time because of fatigue and other time-dependent effects. Traditionally, the grid deck panels are connected to the superstructure using "J" bolts. But over time, the "J" will spread due to traffic vibration. As a fix, the "J" bolts were replaced by "U" bolts, which made the connection quite rigid, which resulted in additional breakage in the steel grid members.
- Corrosion of Grid Bars – the grid bars and their supporting members are subject to the direct attack of road chemicals, including deicing chemicals which permit corrosion to develop in the steel grid deck system.
- Delamination of surfacing – surfaced grids can also be subjected to delaminations between the riding surface and the grid, which should be investigated during the inspection process.

11.4.3—Steel Orthotropic Decks

Orthotropic deck panels differ from corrugated metal deck panels in that the longitudinal ribs are welded to a top deck plate, which is designed to transfer live loads to the supporting floorbeam system.

Characteristics of Steel Orthotropic Plate stiffened with open or closed ribs, include: Lightweight construction

- Long service life of structural element
- Deck participation increases live load capacity
- Flexible surfacing materials perform better.

The main components of steel orthotropic decks have exhibited excellent longevity, but problems can arise with surfacing materials and connections. Historically, problems that appear shortly after installation have been associated with the surfacing materials. Later in the service life of the deck, problems associated with welded connections can develop.

- Shoving and rutting – are basic surfacing problems that have arisen and can easily identified during a visual inspection or through discussions with maintenance personnel. Shoving and rutting imply a breakdown in the bond between the surfacing and the steel plate that causes the surfacing to migrate across the deck, forming high and low points (wash boarding). The ridges formed create difficulties for drainage (ponding) and the resulting irregular surface increases the impacts of vehicular loads. Eventually, these problems result in a rough riding surface and chronic maintenance problems. However, these deficiencies can be minimized by resurfacing with close attention to surfacing materials and placement procedures.
- Connections – are the other major source of problems in orthotropic decks. Welds have cracked and bolts have loosened, since, as in the case of the grid decks, composite action is developed for live load between the deck and its supporting elements. These elements should be carefully examined during inspection.

11.5—INSPECTION OF FRP BRIDGE DECKS

Fiber reinforced plastic (FRP) is a composite material consisting of high strength fibers embedded in a structural matrix such as epoxy or polyester resin. The fibers most commonly used are glass, carbon or aramid (trade named Kevlar).

Even though they are brittle in solid form, materials such as glass and carbon exhibit enormous strength in fiber form. The combination of plastic matrix and fibers produces a composite material with much greater mechanical properties than in its individual components.

FRP's advantages include:

- High strength to weight ration
 - Less dead load (weighs 80% less than reinforced concrete)
 - Higher live load on rehabilitated structures due to reduced deck weight
 - Easier handling for retrofit applications
 - Less material required
- Non-corroding
- Dimensions can be customized
- Low maintenance
- Electromagnetically immune
- Excellent fatigue behavior

11.6—REPORTING THE CONDITION OF THE BRIDGE DECK

The State of Oregon, has employed a dual condition assessment / rating scheme. One condition rating scheme reports the condition of the elements or bridge parts that are located on each specific structure which is used to drive the Bridge Management System (BMS). The other, uses the rating scheme employed by the National Bridge Inspection Standards (NBIS) which assesses the condition of each major bridge component (deck, superstructure, substructure) for reporting the information to FHWA.

Before, we can report the condition of the bridge deck, we need to clearly define what portion of the bridge we're looking at. The Bridge Inventory, in the State of Oregon, contains a wide range of structural configurations. Some structures clearly have an identifiable bridge deck, whereas others do not. On a traditional concrete girder type structure the top surface where the traffic bears, clearly fits the definition of a bridge deck. On the other hand, if the bridge superstructure consists of pre-cast, pre-stressed, voided slab units, and covered with an asphalt wearing surface, it's not clear whether the structure has an identifiable bridge deck element. The deck is constructed monolithic with and functions as an integral part of the bridge superstructure.

In order to assure uniformity throughout the bridge inspection program, more direction was needed. As a result, ODOT developed and initiated the following business practices:

All bridges, that are not considered to be a culvert, will have a NBI Deck Rating.

A deck element will only be inventoried when any of the following configurations are present:

- Case 1: If a cast-in-place reinforced concrete deck has been installed on top of pre-cast or pre-fabricated superstructure units.
- Case 2: If completely separate, pre-fabricated, deck units are placed on top of pre-cast or pre-fabricated superstructure units.
- Case 3: If the superstructure consists of channel beams the stems are considered to be the same as a girder and the top of the inverted tub is considered to be the same as a deck unit. However, the quantity is based on the LF of channel beams.

The FHWA NBI Coding Guide also states: "Decks integral with the superstructure shall be rated as a deck only and not how they influence the superstructure rating (for example, rigid frame, slab, deck girder, T-beam, voided slab, box girder, etc.). Similarly, the superstructure of an integral deck-type bridge will not influence the deck rating." The bridge inspector will capture this information by using "Element 15 – Top Flange".

That is, every span, other than a culvert, will have a Deck Element and Rating, unless NBI Item 43 or 44 has been coded a 101 or a 501. If NBI Item 43 or 44 has been coded a 101 or a 501, there will be a NBI Deck Rating (Item 58) but there will be no deck element inventoried as the structural component is included in the slab rating.

11.7—GUIDELINE FOR THE INSPECTION OF DECK JOINTS

11.7.1—Overview of Deck Joints

One absolute realism: "All things move". In other words, all bridges must be designed to accommodate anticipated movements that will occur in the structure. These anticipated movements are likely to occur in the: Bridge Deck, Superstructure, Substructure, and Bridge Foundation Material. All of these structural components are inter-connected in such a way that the movement in one component will likely cause a like movement in the other components as well. As a result, the deck joint can be a very good indicator by providing some very good clues as to the structural health of the bridge.

Deck joints are among the smaller elements of a bridge, but when they fail to function properly, joints can create some very significant problems. For example,
When they leak, the underlying structural elements will likely deteriorate at an accelerated rate,
When they are unable to move, unless the other bridge components are properly designed to accommodate the movement they may experience overstress or even damage,
A joint failure can present a traffic safety hazard and increased traffic impact loading.

Since there is such a wide range of structural configurations in our bridge inventory, the State of Oregon has defined when a deck joint should be inventoried. In order for deck joint to be considered to be a deck joint, the configuration must meet the following criteria:

The deck reinforcement must not be continuous across the joint,
There must also be a discontinuity in the superstructure members, and
The superstructure members must reside on identifiable bearing elements.

11.7.2—Deck Joint Function

Each bridge designer is charged with the responsibility of providing a sufficient number of deck joints to accommodate the anticipated structural movements, but also to minimize their affect on the quality of ride on the bridge deck, the quality of the materials in the bridge deck, traffic and load associated deficiencies that can occur, corrosion associated deficiencies, and determine how compatible the deck joints will be with the wearing surface (maintainability of the bridge). Historically, on most, older concrete bridges in the State of Oregon, as a rule of thumb, you will find a deck joint was placed at every third bent in the bridge. However, we do have a few bridges that have a continuous concrete deck slab with no deck joints. All movement was designed to occur at each end of the bridge, in the approach.

The potential for developing serious structural problems from joint problems comes from their role in accommodating necessary structural movements of many types. The majority of existing bridges utilize deck joints to accommodate movements at the superstructure level without sustaining any damage to the bridge or approaches. A fairly new bridge concept utilizes a continuous deck slab that has no deck joints. These bridges accommodate the superstructure movements at the substructure level by relying on the flexibility of piles, deformation of slender substructure elements, or hinged columns.

11.7.3—Types of Deck Joints

A deck joint, depending on the type of movement it accommodates, are classified as either fixed or expansion. A fixed joint allows for only rotation in the deck / superstructure, whereas an expansion joint may accommodate all required movements (longitudinal, transverse, or superstructure deflection rotation about the support bearings).

All deck joints consist of 3 primary parts or components:

- Deck Joint Seal System
- Deck Slab Interface Seal Anchorage components
- Joint Nosing on each side of the deck joint opening

Joint Nosing

The joint nosing on each side of a deck joint can be rigid concrete, metal, or elastomeric concrete.

- Rigid Concrete consists of the existing concrete deck substrate. A separate nosing material is not present.
- Metal consists of an angle iron or metal armoring of the top edge of the concrete deck, in order to minimize spalling or chipping off of the corner of the deck joint.
- Elastomeric Concrete consists of a rubber-like elastomer component and aggregate. When these components are mixed, placed, and cured, the resulting material displays very desirable characteristics for the deck joint. Elastomeric concrete offers both flexibility and strength, forms a durable water tight bond to concrete, steel, or joint components, and does not become brittle at low temperatures. The curing time is also very short and allows imposition of vehicular traffic in a matter of hours.

Open Joints

Open joints are mostly encountered in old short-span bridges, where the movements to be accommodated are typically smaller than those in longer span bridges. They are constructed by forming a gap between deck slab and an adjoining deck slab, abutment, or approach slab.

Quite often these joints have a metal angle iron installed in the deck on each side of the joint. The intent of this joint armoring is to provide protection from traffic impacts and the joint drainage system protects surrounding bridge components from the harmful effects of infiltrating water and chemicals.

Although the initial construction cost for an open joint is relatively low, open joints are prone to the intrusion of deicing chemicals and water, creating costly repairs on surrounding bridge components in the long run. Therefore, open joints are seldom used in new bridge structures, and are often worth replacing by other types during rehabilitation of existing structures.

Sliding Plate Joints

Sliding plate joints are quite frequently encountered in medium-span bridges. Most of the sliding plate joints were constructed without any joint drainage system since the joint itself was considered to restrict the amount of infiltrating water to a minimum. The joint does not completely eliminate the intrusion of water. Therefore, if a sliding plate deck joint is rehabilitated, a tough system, or deflector is often installed to help provide long-term protection of the surrounding bridge components.

The sliding plate joint features a steel plate spanning an open joint and embedded in adjoining deck slabs. It can also be arranged to bear on the steel structure (made up of angles or other shapes that are embedded in the deck slab) at each end. At one end, the sliding plate is secured by bolts or welds to the steel substrate, and the other end rests freely on the steel element of the adjacent deck slab. Superstructure movements are accommodated by the sliding action of the plate at the free end.

Finger (Tooth) Plate joints

Finger plate joints have been successfully used in medium and long-span bridge for some time as they are able to accommodate some relatively large movements. Finger plate joints are made up of two loosely interlocking pieces of steel plates that cantilever out into the deck joint opening. The cantilevered portion of each plate is made up of rows of finger shaped protrusions that fit into the row of grooves in the opposing plate. The finger plates are anchored into the deck slab or directly attached to the underlying superstructure steel.

Whenever the bridge spans undergo a movement, the finger plates move back and forth into the opposing grooves and accommodate this movement. Properly designed finger plates remain overlapped at all times to secure a continuous riding surface and can accommodate total movements from 4 to 24 inches. Performance and service life of a finger plate joint can be enhanced by limiting the size of openings on finger plates to permit safe operation of narrow-tired vehicles or motorcycles, aligning the fingers in the direction of the longitudinal bridge axis, and adopting fatigue-resistant details. Special details can be developed if bicycles will cross the joint.

In most existing finger plate joints, the water and debris passing through the finger joint are collected and carried away by a trough system. If no trough system exists, or the existing one requires replacement, accumulation of debris and eventual clogging of the trough can be prevented by placing the new trough to a steep slope. A transverse slope of 1 inch per foot is adequate to promote a self-cleaning action by the flow of water in the trough. The trough is usually neoprene sheet while older bridges could have used copper.

Filled Joints

A filled joint is an open joint filled and sealed with a flexible and compressible material. The joint sealers, depending on the manner they are applied, can be classified as field-formed or pre-formed.

Field Formed Joints

- Polyfoam
- Pourable Joints

Pre-formed Joints

Compression Seal Joints

Compression seals are made of either preformed closed-cell hollow extruded neoprene shapes. The seals are generally installed by squeezing and inserting the seal into a preformed joint opening. Properly sized seals remain in compression under all anticipated deck joint movements. To improve the water-tightness of the joint, the contact surfaces between the gap and seal are coated with a high-solids urethane adhesive prior to the insertion of the compression seal into the joint opening.

The number of successful armored neoprene compression seal applications have made this type of seal probably the most popular one. A large variety of choices in movement ranges, water-tightness, relative ease of installation, and cost effectiveness have all contributed to the success of neoprene compression seals.

Performance and useful life of a neoprene compression seal depends primarily on the quality of the installation and the correct choice of the seal size and seal material. Compression seals that are manufactured from ozone-sensitive neoprene compositions have been known to lose their elasticity and harden after several years of service. The water-tightness of such a hardened joint will fail when bridge spans contract at low temperatures and cause the hardened seal to pull away from the sides of the joint until the adhesive debonds.

Along with the adherence to proper installation, sizing and material selection guidelines, the useful life of a neoprene compression seal joint can be improved by armoring the deck slab corners with steel angle or shapes.

Neoprene compressions seals are available in a variety of configurations and movement ratings. The largest size seal can provide for a total movement of 4 inches.

If the joint is skewed so that the seal will need to accommodate transverse as well as longitudinal movement, special care must be taken in the design.

Strip Seal Joints continue to be a popular choice in deck joints. The strip seal system performs better than a compression seal at locations in which transverse slab movements are anticipated and provides a superior seal against water leakage. Strip seal is a strip of specially shaped elastomeric material that spans a deck joint opening. The seal is mechanically locked into a pair of rolled or extruded metal shapes that are in turn anchored to the edges of the deck slabs. These metal shapes serve two important functions: they provide end restraint to the seal so that the strip seal can function in tension or compression depending on the direction of the deck slab movement and they protect the edge of the deck slab against traffic impact.

Strip seals are available in a number of configurations and a wide range of movement ratings. The largest size strip seal can provide up to 5 inches of total movement. However, most agencies limit the total movement to 4 inches.

Asphaltic Plug Joint is a field-installed low profile joint system that can be used over an existing open, filled, or compression seal joint to raise the joint profile to fit the new or existing bridge deck. Following the cleaning and preparation of the deck substrate, a metal flashing is installed over the existing joint opening and an asphaltic plug is built up in alternating layers of molten binder and heated aggregate. In the final stages of joint installation, the joint is topped with a layer of premixed binder and aggregate, compacted, and finished with a coat of binder. The resulting joint is waterproof and flexible, and can accommodate a total movement of 2 inches.

Modular Joints

Modular joints represent the state-of-the-art approach to accommodating the complex movements in long span or curved bridges. When a structure is designed to have large movements, the modular joint is usually the recommended choice. The modular joint is composed of four main components: the seals, transverse seal separator bars, longitudinal support bars, and the concrete deck anchorage / nosing that's located on each side of the deck joint.

The seals and the separator beams form a water-tight surface at the level of the riding surface and accommodate static and dynamic deformations by virtue of the deformations in the seals. Seals can be of compression, strip, or sheet type seals. The Separator beams are often extruded or rolled metal shapes, and provide for the joining of seals in series. The separator beams are supported on support bars at frequent intervals. The support bars span the joint opening, and the ends of the support bars fit into a compressible (spring-like) restraint system. This system is composed of two polyurethane or elastomeric blocks. One block (upper bar or spring) rests on top of the support bar, the second block (bearing) fits under the support bar, and both blocks are in turn attached to the deck substrate. The deformation in the spring and bearing blocks, combined with the sliding action taking place between these blocks and support bars can accommodate all possible deformations that seals normally undergo. The presence of the spring and bearing block system also helps to eliminate noisy metal-to-metal contact and dampens the traffic impact loads. Proper functioning of the modular joint depends on maintaining equal intervals. Each support location may have multiple or single bars. A multiple system provides an individual support bar to each separator beam and introduces compressible blocks between these support bars to equalize the distances between the separator beams. Alternatively each location may provide only a single support bar for all separator beams, with a system of intermediate short support bars and compressible blocks placed under the separator beams to maintain equal spacing between separator beams. In general, the multiple support type gives greater redundancy in case of failure of a bar and can better accommodate rotations and differential settlements than the single support type.

The modular joint system, because of its mechanical performance, can accommodate the complex movements of long-span bridges as well as those of horizontally curved bridges.

The water-tightness and adequate performance of a modular joint depends on good workmanship during the installation and on maintaining an equal distance between seals and providing for fatigue-resistant metal components and connections. The main points of concern with these joints are:

- The noise under live-load impact
- Water leakage at seal splice locations
- Debris accumulation in seal
- Snowplow damage
- Fatigue / Fracture of the separator beams

Longitudinal Deck Joints

All of the deck joints mentioned previously allow for longitudinal movements in a bridge. However, some bridges require the use of a longitudinal deck joint in order to accommodate transverse movements in the bridge deck. The need for such joints is related to the amount of movement induced by transverse forces as well as to the presence of large skew angles and wide deck slabs on the bridge. Although most bearing systems are designed to resist the transverse movements to a certain extent, they do not eliminate transverse movements due to temperature. Therefore, as a practice limit when a deck slab width exceeds 70 – 75 feet, it is advisable to have a longitudinal joint in the deck slab. Longitudinal joints are also used when an existing bridge deck is widened because due to concrete creep, the newly widened portion will react quite differently than the existing structure.

Construction Joints in Deck Slabs

Transverse and longitudinal construction joints are other types of joints one may encounter in existing deck slabs. Construction joints are often used to regulate the daily pours during deck slab construction or to control the deck slab deflections and associated cracking in the construction joints are usually located at the points of minimum deflection and rotation, such as girders and floorbeams, or at dead-load contraflexure points in the case of continuous spans, they usually remain as tight-butting joints between adjacent deck slab pours. However, at times, excessive shrinkage, deflection, or rotation in deck slabs may initiate separation at construction joints. In such instances, the construction joint should be sealed with a field-applied sealant to prevent deterioration. If the size of the opening at the construction joint is too small for sealant a shallow sawcut notch may be placed prior to applying the repair materials.

One of the important aspects of the general condition of the structure is the function of the deck joints. In many structural configurations, the joints are of primary importance to the long-term durability of the superstructure.

Most, older designs utilize simple-span, non-composite construction with many joints, both sealed and unsealed. These structures have exhibited many joint related problems through the years. Modern construction has attempted to limit the number of joints to reduce these problems. Maintenance records have shown that joints cause major maintenance problems, for the riding surface itself for the supporting elements in the vicinity of the joints, and for the overall behavior of the superstructure system.

Deck rehabilitation or replacement can address some of the problems associated with deck joints. Whenever deck rehabilitation or replacement is necessary, the joints need to be carefully considered. Some deck replacements have involved elimination of the deck joint entirely. By eliminating joints, many problems can be alleviated, including rough riding surface and damage to under deck elements from water leakage. When joints are eliminated, the impact on the behavior of the structure must be carefully investigated and addressed. The purpose of each joint must be established and understood, and the effects of its elimination must be traced back to the original structural system.

Determining what is going on with the structure and reporting that information is the first order of business of the bridge inspector. If the bridge inspector fully understands what is causing the deficiency, we can then develop a repair strategy that will address both the cause and the effect, which should result in a good, long lasting repair.

Concrete Paving Relief Joints – Since these features are located in the bridge approach, they are considered to be a highway feature and not inventoried as a bridge feature.

11.7.4—Inspection of Deck Joints

Deck joints, as well as the other parts of the bridge structure, require constant maintenance and repair work to offset the effects of aging and deterioration. But economic restraints and shortage of adequate equipment, staff, or time cause the agencies that own or operate bridges to devote their resources sparingly and only when remedial work is necessary. Therefore, it becomes vitally important to have an operation plan that:

- Monitors and evaluates the physical condition and level of functioning of deck joints on a periodic basis.
- Organizes and allocates necessary resources for remedial work when field conditions warrant such action.

Monitoring the condition of deck joints is achieved by means of field inspections. A field inspection often entails a condition survey of the three elements of the joint system:

- Seal

- Auxiliary components that provide functional support and protection to the seal (armored corner, hold down bar, anchor bolts, welds, water-stops, joint filler, epoxy adhesive), and
- Deck joint substrate (deck slab and underlying structural components).

Although a deck joint system is often made up of a variety of materials (concrete, steel, aluminum, copper, plastics, neoprene, epoxy, etc.) with different physical and chemical properties, they all share a common fate: aging and deterioration. Starting with the day they are installed, the deck joint components are continually exposed to natural elements (rain, snow, temperature changes, moisture) and elements that are introduced by humans (deicing chemicals, industrial pollutants, live-load impact, snow plows). The combined effect of these elements on the joint components is a steady and unavoidable deterioration process. Therefore, deck joint components should be carefully inspected to uncover the following common defects:

- Loose, torn, split, cracked, damaged, or hardened seals.
- Accumulation of debris and incompressible materials in the seals, drainage troughs, downspouts, and silting basins.
- Loose, rusted, cracked, missing, or damaged steel plates, shapes, anchorages, bolts, nuts, and other metal components.
- Cracked and spalled concrete, and rusted or exposed reinforcement steel or structural steel in the deck joint substrate.
- Evidence of water leakage on the underside of the deck.
- Evidence of noise during the passage of vehicles over the joint.
- Restriction on freedom of joint movement.
- Evidence of rotation, tilting, or settlement.
- Incorrect joint opening, or improper joint clearance and alignment.

Evaluate the deck joint as to its functionality: movement capacity, water-tightness, or riding surface.

11.8—INSPECTION AND REPORTING OF BRIDGE RAIL CONDITIONS

The primary function of the bridge railing is to keep errant vehicles from driving off the edge of the bridge. Bridge railings must also smoothly redirect the vehicle in such a manner that the vehicle does not overturn and the railing does not fail.

Bridge railings have changed substantially since they were first used on bridges. The evolution of bridge railing can be seen by examining older structures:

- The earliest existing stone bridges had bridge rail constructed of cut stone with mortared joints.
- The earliest existing steel and timber bridges had bridge rails consisting of timber planks nailed together in a picket fence-like arrangement.
- Railings made of steel angles and bars were popular on many turn-of-the-century structures.
- Solid concrete parapets were used on concrete slabs and encased I-beam bridges. Although they appeared to be strong, vertical reinforcement of ½ inch diameter bars at 18 inch spacing suggest otherwise. In some cases, the parapets were actually the top portion of a reinforced concrete girder.
- Reinforced concrete tee beam bridges of the 1930's introduced the pigeonhole or dog-house parapet. Bars ½ inch in diameter at 1-foot spacing were the only vertical reinforcement.
- Bridge rails consisting of welded steel tubing was often used on smaller, locally owned structures.
- Today, galvanized W-shaped rail supported by wide flange post are frequently used to replace damaged rail on older timber and concrete decks.
- Steel and aluminum railings using multiple pipes were usually used only if the bridge had a sidewalk and curb.
- Concrete parapets with a steel or aluminum railing tube attached to the top were also common.
- If a bridge passed over another roadway, a parapet with fencing attached to the top was often used. Sometimes the fencing was curved near the top to make it more difficult for objects to be thrown onto traffic below.

While all of these bridge railings were popular in their day, most have one thing in common: they do not conform to the current minimum criteria set by the American Association of State Highway and Transportation Officials (AASHTO) and the Federal Highway Administration (FHWA) for crashworthiness of bridge railing.

AASHTO sets minimum criteria for acceptable bridge and bridge approach railings. These criteria include the height, material, strength, and geometric features of the railing. In addition, many state agencies have developed guidelines for bridge railings in their state. In order to determine whether these railing meet current standards and to properly assess their condition, the bridge inspector must be familiar with these criteria and guidelines.

To meet the minimum criteria, a barrier must pass the following tests:

- It must withstand two vehicular hits at 60 mph; one from a 4,500 pound vehicle hitting the barrier at a 25 degree angle, and the other from a 2,250 pound vehicle at a 15 degree angle.
- It must redirect the vehicle away from the barrier.
- It must not cause the vehicle to abruptly decelerate.
- It must not cause the vehicle to roll over
- It must be designed such that the vehicle shall remain upright during and after the impact.

11.8.1—Bridge Rail Types

Bridge Rails - The most common barrier to pass all of these tests is the New Jersey type concrete barrier.

Median Barriers - are used to separate opposing traffic lanes when the average daily traffic (ADT) on the road exceeds a specified amount. They are usually found on high speed, limited access highways. The most commonly used median barrier on bridges is the concrete median barrier. This is a double sided parapet, and it should meet the current criteria for the crash testing of bridge railing. The only acceptable end treatment for a concrete median barrier is an impact attenuator.

Pedestrian Railings - are a fence-like barrier constructed of wood, brick, stone, metal, or concrete. It is built on structures at the outermost edge of sidewalks and is used to guard or guide the movement of pedestrian traffic. They must be at least 42' high and not have an opening more than 6" wide.

11.8.2—Inspection of Bridge Railings

In order for the bridge inspector to properly assess the condition of a bridge rail they need to zero in on three critical areas:

- The condition of the bridge railing
- The condition of the bridge railing anchorage or post/deck connection
- The deck over-hang and support haunches.

More often than not, concrete bridge rails are pre-cast concrete sections which are anchored to the deck. Inspect for deterioration and spalling and check the attachment of any additional railing.

Steel bridge barriers should be firmly attached to the deck, and they should be functional. Investigate for corrosion and collision damage.

Median barriers should be firmly attached to the deck, and they should be functional. Inspect for collision damage and attachment to any additional safety features. Check for deterioration and spalling on concrete median barriers, and examine for corrosion on steel railings and posts.

Bridge railings should be evaluated for condition and adequacy of geometry and structural capacity. The inspector must be familiar with the requirements of the bridge owner. Inspect reinforced concrete parapets and curbline barriers for evidence of traffic impact or rotation. Check precast barriers for evidence of anchorage failures. If the anchor bolt is exposed, sound with a hammer. Check for separation between precast barrier and deck and any associated water leakage. Some states are replacing precast parapets because of anchorage problems.

11.8.3—Reporting the Condition of the Bridge Railing

Quite often a bridge rail will consist of a number of different types of material types like a concrete parapet with a singly metal tube on top. In this case, the bridge inspector will use the most predominant crash tested and approved feature. In this case, since the concrete parapet is the most predominant crash tested feature, the concrete bridge railing will be used.

As previously noted in this manual, the State of Oregon is using a Bridge Management System in order to program future bridge projects. In order for the management system to work properly, ODOT has developed a deterioration model that will predict the condition of the bridge element at some time in the future, given the environmental conditions. As a result, when the bridge inspector is performing their condition assessment, it is imperative that they segregate the deterioration driven deficiencies from the incident driven deficiencies. A good example of an incident driven deficiency is: traffic collision damage or a construction defect. A good example of a deterioration driven deficiency is corrosion of the steel components in a bridge rail. The magnitude of the incident driven deficiencies are reported using the incident smart flags, whereas, the condition of the bridge railing components are reported using the appropriate bridge rail elements.

The State of Oregon also operates using the following logic: A section of bridge rail is only as good as the condition of the support post, anchorage, or support haunch. That's to say, they bridge rail might be in pristine condition, but the post attachment to the bridge deck was broken and fractured. In this case, the bridge inspector would report at least two sections of bridge railing in one of the worse condition states, if the deficiency was deterioration driven. If the deficiency was determined to be caused by a previous traffic collision, the bridge inspector would use Element 369 – Rail Incident Smartflag. This weak link element portion logic does not follow the linear foot unit of measure logic.

11.9—BRIDGE DECK TREATMENTS

Almost all deficiencies that are noted by the bridge inspector can be contributed to a wide range of factors working together in concert. However, one of the roles and responsibilities of the bridge inspector is to provide prioritized bridge maintenance recommendations. The following is a list of items that should be considered when proposing a viable solution to a deficiency:

Treatments that will improve the Mechanical Properties of the bridge deck

- Compressive Strength
- Quality of Concrete
- Tensile Strength (negative moment regions)
- Flexural Strength
- Abrasion Resistance
- Bond Strength of the overlay

Treatments that will help protect the bridge deck from exterior attack.

- Chloride Content,
- Depth of Carbonation,
- Alkali-Aggregate Reactions
- Fires / Extreme heat

Treatments that will either protect or improve the Physical Condition of the bridge deck

- Thin deck vs standard depth of a bridge deck
- Class 1, 2 or 3 Spalls or Delaminations
- Location / Condition of the Embedded Steel Reinforcement
- Water permeability
- Air permeability
- Water absorption
- Frost & Freeze-thaw resistance
- Resistance to deicing chemicals

Treatments that will protect the bridge deck from External Forces

- Cracks/spalls
- Deflections from Service Loads
- Movements of Service / Exposure Conditions
- Leakage
- Temperature / Moisture Conditions
- External Geometry

CHAPTER 12: INSPECTION OF CONCRETE BRIDGES

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CHAPTER 12:**INSPECTION OF CONCRETE BRIDGES****12.1—OVERVIEW**

Methods used to construct concrete structures are different from methods used in other types of construction. Concrete is one of the few materials in which raw ingredients are brought together at, or near, the construction site, where they are mixed, placed and molded into a final form. There are so many variables affecting the production of concrete that there is always a potential for something to go wrong. The construction of every concrete structure includes a sequence of necessary step-by-step operations – from conceptual plan to finished structure. Some of the factors that influence the behavior of a concrete structure or element, one way or the other are:

- The Original Design of the member,
- Strength of the Materials Used,
- Construction Practices,
- Applied Service Loads, and
- Environmental Conditions the member is exposed to.

In an effort to objectively determine what, when, where, and whom should trigger some remedial action, the following values have been determined to be most important. The bridge inspector is responsible for determining how each structural member might be contributing to these categorical deficiencies:

- Quality of Ride – surface abrasion, bump impacts or roughness, skid-resistance, settlement, water-ponding.
- Quality of Materials – surface scaling, reactive aggregates, rock-pockets, exposed reinforcing steel, or fire damage.
- Load Associated Defects – structural cracks, spalls, or delaminations.
- Corrosion Associated Defects – salt intrusion or carbonation into the concrete substrates corroding the reinforcing steel.
- Bridges with Protective Wearing Surfaces – problems associated with a wearing surface rather than the deck substrate.

Almost all deficiencies that are noted by the bridge inspector can be contributed to a combination of these factors working together. The application, of these factors can result in structural deficiencies that can be categorized as follows:

- Mechanical Properties
 - Quality of Concrete
 - Compressive Strength
 - Tensile Strength
 - Flexural Strength
 - Abrasion Resistance
 - Bond Strength
- Chemical Make-up
 - Chloride Content,
 - Depth of Carbonation,
 - Alkali-Silica Reactivity
- Physical Condition
 - Mix Uniformity
 - Air-Entrainment
 - Delaminations / Voids / Rock Pockets
 - Location / Condition of the Embedded Steel Reinforcement
 - Water permeability
 - Air permeability
 - Water absorption
 - Frost & Freeze-thaw resistance
 - Resistance to deicing chemicals
- External Forces

- Cracks / Spalls / Delaminations
- Deflections from Service Loads
- Movements / Impacts from Service Loads
- Leakage
- Temperature / Moisture Conditions
- External Geometry

In general, the condition of a reinforced concrete member can be reasonably estimated by evaluating the severity of various imperfections that are present such as corrosion of the reinforcing bars, cracking, delaminations, spalls, or scaling so that their combined seriousness can be assessed. The combined effect of these deficiencies on the concrete member is rather difficult to assess objectively and consistently, because certain flaws may be more important than others. Therefore, the procedure for rating an existing bridge structure requires a careful evaluation of many complex and often conflicting factors. Such an evaluation is frequently based on the personal judgement, intuition, and perhaps experience of each inspector. As a result, different inspectors may assess a given bridge differently. A logical assessment procedure capable of incorporating both objective knowledge and engineering judgement systematically would be very helpful.

Determining what is going on with the structure and reporting that information is the first order of business of the bridge inspector. If the bridge inspector fully understands what is causing the deficiency, we can then develop a repair strategy that will address both the cause and the effect, which should result in a good, long lasting repair.

12.2—CONDITION ASSESSMENT PROCEDURE

The results of any evaluation, especially determining the cause and scope of the problem, are only as accurate as the understanding and effort applied to the process. A cursory review or walk-over inspection will not produce as accurate an evaluation as an in-depth, detailed investigation involving the necessary mapping, sampling, testing and exploratory efforts. However, a full in-depth detailed investigation on every concrete bridge in our inventory is not very practical, nor warranted. Therefore, our challenge here is:

Provide a thorough and logical evaluation procedure that will physically measure and monitor the condition of the structure using realistic criteria,
Identify the deficiency threshold values or triggers that will initiate some mitigating action,
Provide a method for reporting the results of the bridge inspection, and
Establish some basic criteria so that a statewide prioritization process can be implemented that will result in cost-effective repair or rehabilitative efforts.

As required by the NBIS (National Bridge Inspection Standards), a visual walk-over inspection will be performed during every 2 year routine bridge inspection. When bridge conditions, so warrant, the bridge a more in-depth evaluation of the structure, destructive and non-destructive testing procedures will be initiated that will clearly determine the scope and magnitude of the problems being observed.

The performance of a visual inspection, mapping the location of problems on paper, and reviewing these along with as-built drawings and construction records can provide a general scope of the problems and possible clues as to their cause.

During every visual inspection, the bridge inspector is charged with the responsibility to note all key indicators of structure problems. The key indicators of structural problems that will be considered, monitored and reported during every routine inspection are:

- Concrete Cracks
 - Transverse
 - Longitudinal
 - Diagonal
 - Map
- Surface Distress
 - Scaling
 - Surface honeycomb or rock pockets

- Concrete Delaminations
 - Spalling
 - Surface Abrasion
 - Exposed Reinforcing Steel
 - Traffic bumps and/or impacts
- Structure Movements
 - Deflections
 - Thermal Effects
 - Concrete Creep
 - Settlement
 - Alignment of Concrete Members
- Water Leakage
 - Surface dampness
 - Seepage or leakage through joints or cracks
- Metal Corrosion
 - Longitudinal cracks
 - Localized areas of delaminations
 - Rust Staining
 - Exposed reinforcing bars
 - Exposed post-tension cable strands
- Miscellaneous
 - Blistering membranes and coatings (moisture vapor transmission)
 - Ponding of water

12.3—CONCRETE CRACKS

12.3.1—Overview

Cracking is defined as a separation of the concrete into two or more parts due to localized tensile failure. Cracking is very common as the tensile strength of concrete is quite low. The directional orientation, depth, and width of a crack determines whether or not it is significant. Generally, the directional orientation is labeled longitudinal, transverse, diagonal or random. For a structural member the orientation is to the major axis of that particular member. If a crack extends through a concrete member it is easy to determine its depth. Non-destructive test methods such as ultrasonic pulse velocity and destructive techniques such as coring can be used to estimate the depth of cracks, which do not extend through the entire concrete member. Crack widths can be measured using simple gages placed directly over the crack.

There are two basic types of cracks: Structural and Non-structural. Structural Cracks are more serious than non-structural cracks because they affect the load carrying capacity of the member.

Structural cracks, are generally caused by dead load and live load forces. These types of cracks can also be the result of an earthquake, support settlement, or accidents during hauling, erection, or vehicular collisions.

There are two types of structural cracks:

Flexure Cracks – start in the maximum tension zone or the maximum moment region and proceed toward the compression zone.

Shear Cracks – are diagonal cracks, are inclined towards the supports that are a result of diagonal tension.

Non-structural Cracks are minor problems themselves and do not affect the load carrying capacity of the member. They can, however, provide openings for water and contaminants, which can lead to serious problems, such as corrosion.

There are at least seven different types of non-structural cracks:

- Temperature differences within a structure may be caused by heating one portion of the structure to a different degree or at a different rate than another portion of the structure. These temperature differences result in differential volume changes. When the tensile stresses due to the differential volume changes exceed the tensile stress capacity, the concrete member will crack. Typically, the coefficient of thermal expansion for hardened concrete is 0.0000055. The amount of unrestricted dimensional change is approximately 5/8" per 100 degrees F temperature change for each 100 feet of length. Bridge designers are supposed to give special consideration to structure in which some portions are exposed to temperature changes, while other portions of the structure are either partially or completely protected.
- Plastic shrinkage cracks occurs when freshly placed concrete is subjected to a very rapid loss of moisture caused by a combination of factors which include air and concrete temperatures, relative humidity, and wind velocity at the surface of the concrete. When the moisture evaporates faster than it is replaced by bleed water, the surface concrete shrinks, resulting in shallow cracks of varying depth which may be a random form. A 100 foot section allowed to air dry at 70 degrees F for 3 years would shrink about 3/4". The majority of the shrinkage would occur during the first year.
- Concrete creep – Pre-stressing and post-tensioning of concrete members is an effective method of producing durable, efficient structures. The member is compressed with high tensile steel strands. The strands are jacked from one end of the member, and slippage of the strand through the concrete is allowed with grease and sheathing. The stretching of the strands compresses the concrete to offset any tension stress from future service loads. The lack of tension in the concrete reduces the potential for tension cracks. Upon stressing, the concrete shortens. This is known as elastic shortening. The amount of elastic shortening depends upon the modulus of elasticity (E) and the unit stress to which the concrete is compressed. After stressing, long-term shortening, known as creep, will take place. It may take over 1500 days to reach ultimate creep.
- Weathering – The weathering processes that can cause cracking include freezing and thawing. Cracking of concrete due to natural weathering is usually very conspicuous, and it may give the impression that the concrete is on the verge of disintegration, even though the deterioration may not have progressed much below the concrete surface. Damage in hardened concrete is caused by the hydraulic pressure generated by the growth of ice crystals. Concrete is best protected against freezing and thawing through the use of the lowest practical water-cement ratio and the total water content, durable aggregate, and adequate air entrainment. Adequate curing prior to exposure to freezing conditions is also important.
- Post-tensioning cable drap cracks – Correct placement of post-tension cable is critical to achieve the designed structural load-carrying capacity. Improper placement may result in tension stress, causing the concrete to crack along the drap line.
- Alkali-Aggregate Reactivity: Concrete may crack with time as the result of slowly developing expansive reactions between the aggregate that contains active silica and the alkalis that are derived from the cement hydration, admixtures, or external sources. As these reactive forms of silica, react with the potassium, sodium, and calcium hydroxide from the cement, forms a swelling gel around the reacting aggregates. When the gel around the aggregate is exposed to moisture, it expands, creating forces than cause tension cracks to form around the aggregate. The moisture content of the concrete must be approximately 80 percent: relative humidity at 70 degrees F. Control measures includes the proper selection of aggregates, use of low alkali cement, and the use of pozzolans, which themselves contain very fine, highly active silica. Unconfined concrete undergoing this type of reaction exhibits tell-tale signs of surface map cracking on exposed surfaces. Once the cracking has formed, more moisture penetrates the concrete, accelerating the reaction and allowing additional freeze-thaw damage.
- Corrosion of the Steel Reinforcement – Reinforcing steel usually does not corrode in concrete because a tightly adhering protective oxide coating forms in the highly alkaline concrete environment. This is known as passive protection. However, the steel reinforcement can corrode, if the alkalinity of the concrete is reduced through carbonation or if the passivity of the steel is destroyed by aggressive ion oxides, such as chloride ions. Corrosion of the steel produces an iron oxide, which has a volume that is much greater than the volume of the original steel. This increase in volume causes high radial stresses to be imparted onto the surrounding concrete from the steel reinforcing bars, results in local cracks which results in the formation of longitudinal cracks, delaminations, or spalls that are parallel to the steel reinforcement. Even minor cracks provide easier access for oxygen, moisture, and chlorides, and thus creates a condition in which

If there are identical girder span configurations in the same condition only one needs to be marked.

Keep works well for tracing the cracks. A fat permanent ink marker works the best for marking crack widths, dates, and ends.

Crack Mapping

There is no need to do a detailed map of the cracks for the inspection report. Marking the cracks, taking photos and adding notes about the extent of cracking, average crack width, and the largest crack size in the inspection report should be adequate record keeping.

If cracking is not consistent throughout the spans, a hand sketch noting the cracked regions may be required.

12.3.3—Concrete Crack Inspection Frequency

Initially, when at least one shear crack measures $\geq 0.040"$, the crack inspection should be conducted during every routine inspection.

If at least one crack measures $\geq 0.040"$ and has a lateral offset $> 0.030"$, or at least one crack measures $\geq 0.040"$ and the length of the crack has grown more than 6" from the last inspection, the crack inspection should be conducted annually.

12.3.4—Reporting Concrete Crack Condition Assessment

Historically, ODOT assessed concrete cracks differently, based on their cause:

- Superficial Cracks were considered to be non-structural and generally caused by non-live load induced shrinkage, temperature, or construction practices. As a result, the assessment was not as harsh as a structural crack.
- Structural Cracks, on the other hand, were considered to be caused by live loads or other environmental loading such as settlement or structure movement. As a result, the assessment was much more severe.

However, the new AASHTO Guide Manual for Bridge Element Inspection treats all concrete cracks in the same vain, in that all cracks essentially expose the steel reinforcement to the environment forces, like deicing chemicals. The condition assessment narrative in the new manual follows the Good, Fair, Poor, Serious/Critical identifiers:

- NBI 59 or 60 rated a 7 or 8
- Concrete Crack Defect – Condition State 1 - (Pristine Condition).
- NBI 59 or 60 rating of a 6.
- Concrete Crack Defect – CS 2 – (Fair Condition – warrants Preservation activities)
- NBI Item 59 or 60 rating of 5 or 4.
- Concrete Crack Defect – CS3 – (Poor Condition – warrants repair activities)
- NBI Item 59 or 60 rating of 3 or worse.
- Concrete Crack Defect – CS4 – (Serious / Critical Condition – Initiate Critical Finding actions, warrants a structural analysis.

A note of caution is warranted when associating NBI and Element Ratings. NBI Ratings are an overall condition assessment for that bridge component. Element ratings, on the other hand, are specific to the unit of measure for that element.

12.4—OTHER SURFACE DISTRESS – CONCRETE SCALING, HONEYCOMBING, DELAMINATIONS, SPALLS, EXPOSED REBAR, AND SURFACE BUMPS OR IMPACTS

12.4.1—Concrete Scaling

Concrete Scaling is the flaking of surface mortar often accompanied by the loosening of surface aggregates. Scaling is believed to be caused by freezing and thawing, poor workmanship, or inadequate curing of the concrete. Freeze-thaw disintegration takes place when the following conditions are present:

- Freezing and thawing temperature cycles within the concrete.
- Porous concrete that absorbs water (water-filled pores and capillaries).

Freeze-thaw generally occurs on horizontal surfaces that are exposed to water, or on vertical surfaces that are at the water lines in submerged portions of the structures. The freezing water contained in the pore structure expands as it is converted into ice. The expansion causes localized tension forces that fracture the surrounding concrete matrix. The fracturing occurs in small pieces, working from the outer surfaces inward. The rate of freeze-thaw deterioration is a function of the following:

- Increased porosity
- Increased moisture saturation
- Increased number of freeze-thaw cycles
- Reduced amounts of air-entrainment
- Horizontal surfaces that trap standing water
- Aggregate with small capillary structure and high absorption

Scaling is generally described in terms of its depth. A classification of scaling as a function of its depth, which was reported in a cooperative study by the Bureau of Public Roads and the Portland Cement Association is as follows:

<u>Description</u>	<u>Depth</u>	<u>Structural Condition</u>
Light	0.0 to 0.25 in.	Good
Medium	0.25 to 0.50 in.	Fair
Heavy	0.50 to 1.0 in.	Poor
Severe	More than 1.0 in.	Very Poor

Since this type of deficiency occurs on the surface of the concrete member, it can be easily located, measured, assessed, and integrated into the bridge inspection report.

12.4.2—Honeycomb or Rock Pockets

A honeycomb is a void left in concrete due to failure of the mortar to effectively fill the spaces among coarse aggregate particles. Rock pockets are generally severe conditions of honeycomb where an excessive volume of aggregate is found.

Primary Causes of a honeycomb are:

- Design of the members:
 - Highly congested reinforcement
 - Narrow sections
 - Internal interference
 - Reinforcement Splices
- Forms
 - Leaking at joints
 - Severe grout loss
- Construction Conditions
 - Reinforcement too close to forms
 - High temperature
 - Accessibility
- Properties of fresh concrete
 - Insufficient fines

- Low workability
- Early stiffening
- Excessive mixing
- Aggregate that is too large
- Placement
 - Excessive free-fall
 - Excessive travel in forms
 - Lift that is too high
 - Improper tremie or drop chute
 - Segregation
- Consolidation
 - Vibrator too small
 - Frequency too low
 - Amplitude too small
 - Short immersion time
 - Excessive spacing between insertion
 - Inadequate penetration

A honeycomb or rock pocket can be easily seen when it's located on the surface of the concrete member. When it has been covered by a surface finish, they can be located by sounding the surface of the concrete member with a hammer. Otherwise, if the bridge inspector strongly suspects that a rock pocket exists in the interior portion of a concrete member, the inspector might employ one of the accepted non-destructive testing procedures.

12.4.3—Delaminations or Spalls

Sounding of concrete with a hammer provides a low-cost, accurate method for identifying delaminated areas. When striking areas of delaminated concrete, the sound changes from a “ping” to a hollow sounding “puck”. The boundaries of the delaminations can easily be determined by sounding areas surrounding the first “puck” until a “ping” is heard. The boundary of the delaminated area is then marked with spray paint, for future reference.

Hammer-sounding of large areas generally proves to be extremely time consuming. More productive sounding methods are available when working with horizontal flat surfaces. Chain dragging accomplishes the same result as hammer-sounding. As the chain is dragged across a concrete surface, a distinctly different sound is heard when it crosses over a delaminated area.

Concrete Spalls

Spalling is the breaking loose of pieces of concrete, and often occurs initially near the top reinforcing steel. Spalling results from large tensile stresses within the concrete that are usually caused by corrosion of the reinforcing bars and freezing of the concrete member. The products of corrosion exert stresses within the concrete that cannot be supported by the limited plastic deformation of the concrete, thereby causing the concrete to disintegrate.

The US Army Corp of Engineers bridge inspection brochure classifies spalling as follows:

<u>Size</u>	<u>Shape</u>	<u>Diameter</u>	<u>Depth</u>	<u>Structural Condition</u>
Small	circular	< 2 1/2 in.	< 1 in.	Very Good
Small	circular	< 4 1/2 in.	< 1 in.	Good
Small	circular	< 7 1/2 in.	< 1 in.	Fair
Large	circular	< 9 1/2 in.	> 1 in.	Poor
Large	circular	> 9 1/2 in.	> 1 in.	Very Poor

12.4.4—Surface Abrasion

Abrasion is the wearing away of the surface by rubbing and friction. Generally, the surface is uniformly worn away, including the cement matrix and the aggregates. Factors affecting abrasion resistance include:

- Compressive strength of the concrete

- Aggregate properties
- Finishing methods
- Use of toppings
- The concrete curing

Surface abrasion is generally measured using a long straight-edge and a ruler or tape measure. ODOT rates abrasion as follows:

Element has little or no deterioration - Roughening is limited to a loss of fines – CS 1

Minor structural issues - The large aggregate popping off – CS 2

Spalls / Delaminations - Loss of the concrete cover, exposure of steel reinforcement – CS 3.

Advanced Deterioration - Loss of the concrete core, below the depth of the steel reinforcement – CS 4.

12.4.5—Exposed Steel Reinforcement

There are three important reasons to control the proper location of reinforcing steel in structures. First, reinforcing steel is placed in concrete to carry tensile loads, and if the steel is misplaced, the concrete may not be able to carry the tensile loads. Second, reinforcing steel requires adequate concrete cover to protect it from corrosion and traffic abrasion. The alkalinity of the concrete is a natural corrosive inhibitor. If the concrete cover is inadequate, it will not provide the necessary long-term protection. The shifting of the reinforcing steel during the placement of the concrete will also cause the loss of proper cover.

When the exposed rebar becomes exposed to traffic, wheel tire impacts create a steady vibration in the bar. As the bar vibrates, the bond between the reinforcing steel and the concrete is broken. As the reinforcing steel become more exposed, sections of the rebar will break and come loose in traffic.

12.4.6—Traffic Impacts

This deficiency is generally the result of traffic abrasion or wheel track rutting. Since the deck joints are generally constructed of materials that do not rut, a traffic bump or impact is created.

Settlement of the approach roadway embankment also creates a traffic bump or impact at each end of the bridge. If an impact panel is present, the traffic bump can become more of a ski jump or vehicular launching ramp. As a result, the heavy trucks tend to bounce as they use the bridge deck

In regards to the inspection of a bridge, a bump in the travel lanes that is greater than 1/2" is considered to be significant and a remedial action should be recommended by the bridge inspector. These areas can also be located by the darker discoloration of the top of the bridge deck between the wheel tracks, which is caused by oily debris coming from the vehicles as they impact the deck.

12.5—STRUCTURE MOVEMENT

12.5.1—Deflections

Deflection produced by live loading should not be excessive because of aesthetics, user discomfort, and possible damage to the whole structure. Limitations are generally expressed as a deflection-to-span ratio. AASHTO generally limits live load bridge deflection to 1/800, i.e. 1 inch vertical movement per 800 inches (66.67') of span length. For bridges with sidewalks, live load bridge deflection is limited to 1/1000.

Rotational movement in bridges is a direct result of live load deflection and occurs with the greatest magnitude at the bridge supports. This movement can be accommodated using bearing devices which are round or spherical in shape. Rotational movement is generally not a concern until a structure or span is over 50 feet.

12.5.2—Thermal Effects

The effect of temperature on concrete structures and members is one of volume change. The volume relationship to temperature is expressed by the coefficient of thermal expansion / contraction. Volume changes create stress when

the concrete is restrained. The resulting stress can be of any type: tension, compression, shear, etc. The stressed conditions may result in concrete cracking, spalling, and excessive deflections. The coefficient = 0.000005 in/in/degree F. The change of 100 degrees F in a 100 foot length will change the overall length by 5/8".

Structural Restraint. If a structural member is free to deform as a result of changes in temperature, moisture, or loads, there is no build-up of internal stress. If the structural member is restrained, stress build-up occurs and can be very significant. When stress build-up is relieved, it will occur in the weakest portion of the structural member or its connection to other parts of the structure. The stress may result in tension cracks, shear cracks, spalling and buckling.

Example:

(1) Elastic modulus of concrete =	4,000,000 psi
(2) Length of concrete member =	100 feet
(3) Temperature Change =	100 degrees F
(4) Thermal Coefficient =	0.000005 in / in / degree F
(5) Unit Strain =	0.005 (2) x (3) x (4)
(6) Unit Stress (if restrained) =	2,000 psi (1) x (5)
(7) Force per square foot =	288,000 psf ((6) / 144 sq in / sq ft)

Uneven Thermal Loads – Temperature gradient exist in many structures. The temperature on the surface of a deck slab exposed to direct sunlight may reach 118 degrees F while the underside of the deck may be only 78 degrees F. This causes the top surface to have a tendency to expand more than the bottom surface. This results in an upward movement during heating, and a downward movement during cooling. A precast double-T shaped structural member with a 60 foot span can move ¾" upward at midspan, causing the ends to rotate. Simple span structures deflect up and down and are free to rotate at end supports. Continuous structures may behave differently because they are not free to rotate at the supports. If enough thermal gradient exists, together with insufficient tensile capacity in the bottom of the member, a hinge will form. Hinges may occur randomly in newly formed cracks, or may form in construction joints near the columns. Hinges open and close with daily temperature changes.

12.5.3—Fire Damage

Fire affects concrete in extreme ways, some of which are listed below:

- Uneven volume changes in affected members, resulting in distortion, buckling, and cracking. The temperature gradients are extreme: from ambient 70 degrees F to higher than 1500 degrees F at the source of the fire and near the surface.
- Spalling of rapidly expanding concrete surfaces from extreme heat near the source of the fire. Some aggregates expand in bursts, spalling the adjacent matrix. Moisture rapidly changes to steam, causing localized bursting of small pieces of concrete and aggregate.
- The cement mortar converts to quicklime at temperatures of 750 degrees F, thereby causing disintegration of the concrete.
- Reinforcing steel loses tensile capacity as the temperature rises.
- Once the reinforcing steel is exposed by the spalling action, the steel expands more rapidly than the surrounding concrete, causing buckling and loss of bond to adjacent concrete where the reinforcement is fully encased.

12.5.4—Concrete Creep

Concrete columns are designed to carry vertical loads. Concrete, like all materials stretches (lengthens) under tension, and compresses (shortens) under compression. When concrete is compress, the member shortens (vertical strain) and bulges (horizontal strain). Horizontal strain is equal to the vertical strain times the "Poisson's Ratio" (0.1 – 0.2). The bulge generates tension forces that are restrained by steel reinforcement (column ties). Shortening of the columns consists of three components:

Elastic Shortening – **occur** Concrete columns are designed to carry vertical loads. Concrete, like all materials stretches (lengthens) under tension, and compresses (shortens) under compression. When concrete is compress, the member shortens (vertical strain) and bulges (horizontal strain). Horizontal strain is equal to the vertical strain times the “Poisson’s Ratio” (0.1 – 0.2). The bulge generates tension forces that are restrained by steel reinforcement (column ties). Shortening of the columns consists of three components:

- Elastic Shortening – occurs as soon as loads are applied, and is equal to the stress (psi) divided by the elastic modulus (E).
- Creep Shortening – occurs over time and is affected by constant stress and long-term loss of moisture (concrete maturity).
- Drying Shrinkage – occurs over time with loss of moisture and is time dependent process.

An example: A reinforced concrete column in a 500 foot tall building under constant sustained service stress of 1500 psi will shorten 8 inches (2.5” elastic, 2.5” creep, 2.5” drying shrinkage, and 0.5” other).

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12.5.5—Settlement

Bridges move because of many factors – some are anticipated, others are not. Unanticipated movements generally result from settlement, sliding, and rotation of foundations. The reason why monitoring settlement is so important, is because its one of the primary tell-tale indicators that a major deficiency has either already occurred or is about to occur.

Example: Quite often the loss of foundation bearing occurs as a result of local scour during a high water event. Since the scour can not be seen, any settlement in the structure will be reflected in the vertical and horizontal profile of the bridge, the plumbness of the bridge bents, or cracking in the superstructure or substructure.

12.5.6—Alignment of Concrete Members

Structural members that are cast out of tolerance pose aesthetic and structural problems. Members cast out of tolerance may have improper concrete cover and cross-section, which may produce eccentric loading.

The accepted tolerances, refer to the ODOT Standard Specification for Highway Construction, 1996.

12.6—METAL CORROSION

Concrete is a high alkalinity material. The pH of newly produced concrete is usually between 12 and 13. In this range of alkalinity, embedded steel is protected from corrosion by a passivating film bonded to the reinforcing bar surface. However, when the passivating film is disrupted, corrosion may take place.

Corrosion is an electrochemical process requiring an anode, a cathode, and an electrolyte. A moist concrete matrix forms an acceptable electrolyte, and the steel reinforcement provides the anode and cathode. Electrical current flows between the cathode and anode, and the reaction results in an increase in metal volume as the iron base materials is oxidized and rust is precipitated. Water and oxygen must be present for the reaction to take place. In good quality concrete the corrosion rate will be very low. Accelerated corrosion will take place if the pH (alkalinity) is lowered (carbonation) or if aggressive chemicals or dissimilar metals are introduced into the concrete. Other causes include stray electrical currents and concentration cells caused by an uneven chemical environment.

The structural capacity of a concrete member is affected by bar corrosion and cracking of surrounding concrete. The research conducted on flexural beams found that in steel with more than 1.5 percent corrosion, the ultimate load

capacity began to fall, and at 4.5 percent corrosion, the ultimate load was reduced by 12 percent as a result of reduced diameter of the reinforcing steel. It can be surmised that, in compressive members, cracking and spalling of the concrete matrix reduces the effective cross-section of the concrete, thereby reducing the ultimate compressive load capacity.

12.6.1—Chloride Content

Chlorides can be introduced into concrete by coming in contact with an environment containing the chlorides, such as a marine environment or various de-icing chemicals. Penetration of the chlorides start at the surface, then moves inward. Penetration takes time, depending upon:

- The amount of chlorides coming into contact with the concrete.
- The permeability of the concrete.
- The amount of moisture present.

Eventually the concentration of chlorides in contact with the reinforcing steel will cause corrosion when moisture and oxygen are present. As the rust layer builds, tensile forces generated by expansion of the oxide cause the concrete to crack and delaminate. Spalling of the delamination occurs if the natural forces of gravity or traffic wheel loads act on the loose concrete. When cracking and delamination progress, accelerated corrosion takes place because of easy access of corrosive salts, oxygen, and moisture. Corrosion then begins to affect the rebar buried further within the concrete matrix.

The concentration of chlorides necessary to promote corrosion, among other factors is greatly affected by the concrete's pH. It was demonstrated that a threshold level of 8,000 ppm of chloride ions was required to initiate corrosion when the pH was 13.2. As the pH was lowered to 11.6, corrosion was initiated with only 71 ppm of chloride ions.

12.6.2—Carbonation

Carbonation of concrete is a reaction between acidic gases in the atmosphere and the products on cement hydration. Normal air contains carbon dioxide in relatively low concentrations (0.03%). The level of carbon dioxide in industrial atmospheres is, as a rule higher. Carbon dioxide penetrates into the pores of concrete by diffusion and reacts with the calcium hydroxide dissolved in the pore water. As a result of this reaction, the alkalinity of the concrete is reduced to a pH value of about 10, and consequently, concrete protection of the reinforcing steel is lost. The passivity of the protective layer on the steel is destroyed. When steel is depassivated and the environment is acidic or mildly alkaline, corrosion begins if moisture and oxygen gain access into the concrete.

In good quality concrete, the carbonation process is very slow. It has been estimated that the process will proceed at a rate of up to 0.04 in per year. The process requires constant change in moisture levels from dry to damp to dry. Carbonation will not occur when concrete is constantly under water.

12.7—WATER LEAKAGE

12.7.1—Exposure to Aggressive Chemicals

Aggressive chemical exposures can cause the concrete to alter its chemical makeup, resulting in changes in its mechanical properties. Depending upon the type of attack, the concrete can soften or disintegrate, in part or in whole. Certain chemicals in solution will attack various constituents of the concrete matrix. Aggressive chemicals can be categorized as follows:

- Inorganic Acids
- Organic Acids
- Salt Solutions
- Alkaline Solutions
- Miscellaneous

Acid attack on concrete is the reaction between the acid and the calcium hydroxide of the hydrated Portland cement. The reaction produces water soluble calcium compounds, which are leached away. When limestone or dolomitic aggregates are used in the concrete mix, the acid may completely dissolve them.

12.8—MISCELLANEOUS CONSIDERATIONS

12.8.1—Poor Construction Practices

A wide variety of poor construction practices can result in cracking in concrete structures. Foremost among these is the common practice of adding water to concrete to improve workability. Added water has the effect of reducing strength, increasing settlement, and increasing shrinkage while drying. When a higher cement content to help offset the decrease in strength, and increase in water content will also mean an increase in the temperature differential between the interior and exterior portions of the structure, resulting in increased thermal stresses and possible cracking. By adding cement, even if the water-cement ratio remains constant, more shrinkage will occur since the relative paste volume is increased.

Lack of curing will increase the degree of cracking within a concrete structure. The early termination of curing will allow for increased shrinkage at a time when the concrete has low strength. The lack of hydration of the cement due to drying, will result not only in decreased long-term strength, but also in the reduced durability of the structure.

12.8.2—Construction Overloads

Loads induced during construction can often be far more severe than those experienced in service. Unfortunately, these conditions may occur at early ages when the concrete is most susceptible to damage and they often result in permanent cracks.

Pre-cast members, such as pre-stressed beams, columns, hollow core slabs, and double tees, are most frequently subject to this abuse during fabrication and shipment, but cast-in-place concrete can also be affected. A common error occurs when pre-cast members are not properly supported during transport and erection. A large beam or slab lowered to fast, and stopped suddenly, results in an impact load that may be several times the dead weight of the member. Another common construction error is prying up on one corner to lift it off its casting bed or “break it loose”. Some examples that occur during shipment of large pre-cast members via tractor and trailer are jumping curbs or tight highway corners, torsion due to differing roadway super-elevations between the trailer and the tractor, and differential acceleration of the trailer and the tractor.

12.8.3—Water Ponding

Slabs, such as concrete bridge decks, require drainage for proper runoff need special attention. Drains should be located at the low points on the bridge deck. Proper slope-to-pitch for quick runoff is important to prevent potential deterioration of the concrete member, leakage within the structure, and water ponding into the traffic lanes. Standing water provides concrete with the potential for saturation, the worst condition for a freeze-thaw cycle. The quicker the water runs off the structure, the less leakage can occur through the joints and cracks.

12.9—IN-DEPTH TESTING AND EVALUATIONS

12.9.1—Overview

Visual examination often results in many questions regarding the extent and details of deterioration/distress. A useful way to answer these questions is to initiate a more in-depth evaluation of the structure. The bridge inspector may employ either non-destructive testing techniques or exploratory removal of concrete to expose hidden elements, which is considered to be destructive testing. Chipping, drilling and core drilling are the most common in-depth exploratory methods, because of the technical expertise that is required to interpret the non-destructive testing techniques, in the field.

However, the steps in a typical in-depth evaluation of a concrete structure are:

- Visual Inspection (walk over) with the last bridge inspection report in-hand.
- Review of Engineering data
- Design and construction documentation
- Operation and maintenance records

- Concrete (including materials used) records
- Periodic Inspection Reports
- Condition Survey
- Mapping of the various deficiencies
- Monitoring
- Joint survey
- Sampling and testing
- Non-destructive testing
- Structural analysis
- Final Evaluation
- In-depth Condition Assessment Report

The existing test techniques and procedures identified below are used to conduct concrete and corrosion condition assessments on conventionally reinforced structures. Many of these techniques and procedures are not applicable on prestressed or post-tensioned concrete structures. Also some of the methods are not applicable for epoxy-coated and galvanized reinforcing steel. The number and type of tests that can be performed on a given structure also depends on the type of protective system present.

- Non-Destructive Evaluations (when conditions warrant)
- Depth of Cover Measurements
- Sounding or Chain-drag
- Electrical Continuity Tests
- Corrosion Potential Mapping
- Corrosion Rate Measurements
- Determination of Cross Section Loss on Reinforcing Steel
- Pulse Velocity and Impact-echo Tests
- Neutron Test and Relative Humidity Test
- Rebound Number and Penetration Resistance Tests
- Destructive Testing (when conditions warrant)
- Determination of Chloride Content in Concrete
- Depth of Carbonation Testing
- Petrographic Analysis

Which type of in-depth testing procedure that is employed depends entirely on the type and quantity of the deficiency that is to be investigated.

12.9.2—Non-Destructive Testing Procedures

12.9.2.1 - Depth of Cover Measurements

The thickness of the concrete cover over reinforcing steel has a great bearing on corrosion. Shallow cover obviously leads to more rapid corrosion and subsequent deterioration of the structure if other environmental conditions are conducive. Concrete cover information is valuable in assessing the corrosion susceptibility of reinforcing steel and deviations from original construction specifications.

The steel location and depth of cover can be determined non-destructively using a device called a pachometer. This device measures variations in magnetic flux caused by the presence of steel. If the size of reinforcement is known, the amount of concrete cover can be determined. In general, these devices can measure cover to within ¼" at 0 to 3" from the surface. The accuracy of the devices is dependent on the amount of reinforcing steel that is present in the concrete. The more congested the reinforcing, including multiple layers, the less accurate the device becomes. In some cases, when other bars interfere, the device cannot identify either location or depth of cover.

Calibration of the pachometer is recommended in cases where there is possible magnetic interference from metallic particles or additives, such as fly ash, in the concrete. Calibration can be done by excavating the concrete, measuring the actual cover, and adjusting the pachometer to the actual measurement.

Pachometers are also reliable in locating post-tension strands when the strands are 0 to 3" from the surface.

Other devices, such as ground-penetrating radar or x-ray, can be used for locating embedded metals when the pachometer fails to provide the necessary information. Ground-penetrating radar can be used for locating reinforcing steel bars or other non-magnetic metals; however, x-ray is the most accurate method. An x-ray works by photographing the inside of the concrete in question, showing all embedded objects. X-ray exposure at each location will take 30 minutes or more to penetrate the concrete element. The thicker the member, the longer the exposure time.

12.9.2.2 - Corrosion Activity Measurement

Corrosion of reinforcement is the electrochemical degradation of steel in concrete. It occurs when the passivity of the steel is destroyed by carbonation or by chloride ions and electrochemical cells develop. When steel corrodes in concrete, a potential difference exists between the anodic half-cell areas and the cathodic half-cell areas of the steel. This difference can be detected by placing a copper-copper sulfate half-cell on the surface of the concrete and measuring the potential differences between the reinforcing steel and a wet sponge on the concrete surface. The reference cell connects the concrete surface to a high-impedence voltmeter, which is also connected electrically to the reinforcing steel mat. The voltmeter then reads the potential difference at the test location. These readings are taken on a grid basis and converted into potential gradient mapping.

It's generally agreed that the half-cell potential measurements can be interpreted as follows:

- Less negative than -0.20 volts indicates a 90 percent probability of no corrosion.
- Between -0.20 and -0.35 volts, corrosion activity is uncertain.
- More negative than -0.35 volts is indicative of a greater than 90 percent probability that corrosion is occurring.

If positive readings are obtained, it usually means that insufficient moisture is available in the concrete and the readings are not valid. These tests do not indicate the rate of corrosion: the measurements only indicate the potential for corrosion at the time of measurement.

These half-cell methods cannot detect corrosion in post-tensioned strands, nor can they detect corrosion when reinforcing steel is discontinuous from the voltmeter. However, half-cell measurements are often useful because they are easy to perform and results can be delivered quickly at relatively low costs.

A full description of the above test procedure and equipment is detailed in ASTM C 876, Half Cell Potentials of Reinforcing Steel in Concrete.

12.9.3—Destructive In-Depth Testing Procedures

12.9.3.1—Chloride Content

Chloride ions are the major cause of reinforcing steel corrosion. The primary sources of chloride ions on reinforced concrete structures are:

- Chloride containing admixtures used at the time of construction.
- Chloride contaminated concrete constituents, such as sea dredged sand.
- Deicing Salt.
- Air-borne chlorides in marine environments and direct exposure to salt water.

It is well established that corrosion of reinforcing steel is directly related to a threshold value of chloride ion content adjacent to the steel. This threshold is approximately 0.025 to 0.033% by weight of concrete or 2 lbs of chloride / cu yd of concrete. Hence, it is important to determine the chloride ion content in the structure being inspected. Chloride profiles (i.e. chloride concentration versus depth of concrete) are also important for assessing the future corrosion susceptibility of reinforcing steel and in determining the primary source of chlorides.

The chloride content in concrete is determined through analysis of powdered concrete samples. It's done by taking a sample of concrete from the structure, either by drawing pulverized concrete using a rotary-percussion hammer (preferably electric), or by taking cores and then pulverizing the concrete in the lab. Field pulverization samples are generally taken at various locations and depth of the suspect member under investigation.

At each level of sampling, the pulverized material is collected and stored in a clean container, the hole is vacuum cleaned, and the next sample is drawn at the next desired depth. When deep holes are to be drilled, care must be taken to prevent contamination of the sample from the abrasion of the rotary drill bit against the side of the hole. Using a drill bit with a stepped-down bit diameter will reduce the chance of contamination. Powdered samples are analyzed using a wet chemical method.

Separating cast-in chlorides from chlorides that have entered the structure from the surface can be done by comparing the chloride content at various levels in the suspect member. Cast-in chlorides will generally have similar chloride contents throughout the member, whereas chlorides that have entered the concrete after casting will have higher concentrations at the surface and lower levels further into the member.

Chloride content results are reported in percent chloride by weight of concrete, parts per million (ppm) chloride, percent chloride by weight of cement, or pounds of chloride per cubic yard of concrete. Values may be converted from one to another as follows:

Percent Cl by weight of concrete. Result of test method
Parts per million Cl by weight of concrete. . . . Multiply (1) by 10,000
Percent Cl by weight of cement. Multiply (1) by weight of concrete and divide by cement content
Pound Cl per cu yd of concrete. Multiply (1) by weight of concrete and divide by 100.
ASSUME: Cement content (658 lb/cu yd) and concrete unit weight (3915 lb/cu yd)

12.9.3.2 Depth of Carbonation

Carbonation of concrete results from reaction of carbon dioxide in the air (which forms a weak acid in solution) and the alkaline constituents of cement paste. As a result, the alkalinity of the concrete is reduced and the steel is no longer protected against corrosion. The depth of carbonation increases with age but is a very slow reaction, typically no more than about 0.04 inches per year.

To determine the depth of carbonation, a fresh concrete surface must be exposed. This can be done by core sampling the suspect surface and splitting the core with a hammer and chisel. The position of the carbonation front is measured by spraying the concrete surface with an acid-based indicator which changes the colors at the pH of about 10, indicating the interface between carbonated and un-carbonated zones. The most commonly used indicator for this purpose is the solution of phenophtalein, which colors the concrete an intense red (pink) at pH values greater than 10 and is colorless at pH values less than 10. The pH-indicators are not supposed to give the exact pH value of the concrete, but merely to measure the depth of the layer altered by carbonation.

12.9.3.3 Compressive Concrete Strength

Core Testing. Concrete is cored and samples are taken to establish compressive strength, to examine physical make-up (size and distribution of aggregates, hairline cracks), and to perform petrographic testing. Core samples can vary from 2 to 6 inches in diameter, depending on the difficulty of access and coring. The larger cores usually provide a better indication of the physical make-up of the concrete material.

12.9.3.4 Petrographic Analysis

Petrographic analysis is a detailed examination of concrete to determine the formation and composition of the concrete and to classify its type, condition, and serviceability. The petrographic examination attempts to answer two questions: "What is the composition?" and "How is it put together?" Together with various other concrete tests, the petrographic examination helps to determine why this concrete member is functioning in the way it is, and how it may function in the future.

To perform this type of analysis, concrete specimens are taken from the structure and are prepared by either polishing or etching a surface of the specimen. Petrographic examinations include identification of mineral aggregates, aggregate-paste interface, assessment of the structure, and integrity of the cement paste. Petrographic examination helps determine some of the following mechanisms:

- Freeze-Thaw Resistance
- Sulfate Attack
- Alkali-aggregate reactivity
- Aggregate durability
- Carbonation

Petrographic examination is a highly specialized practice requiring skilled technicians.

CHAPTER 13: POST TENSION STRUCTURES IN THE STATE OF OREGON

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CHAPTER 13:

POST TENSION STRUCTURES IN THE STATE OF OREGON

13.1—INTRODUCTION

All post-tensioning tendons are important. They are installed for a specific purpose – to provide the necessary pre-stress forces to counter the effects of dead and live loads. Post-tensioning strands are added for live load and continuity requirements for the concrete structure.

Pre-stressed concrete construction is the technique of pre-compressing concrete members to offset anticipated tensile stresses resulting from subsequently applied loads. Pre-stressing forces are applied to hardened concrete by transferring tensile forces that have been introduced into high strength steel wires or strands. Pre-stressing is typically achieved by one of two methods, pre-tensioning and post-tensioning, or a combination of the two.

In pre-tensioned concrete members, the high strength tensile elements (typically pre-stressing strands) are stressed through the forms before the concrete is cast. The strands are released after the concrete has been cast and allowed to gain sufficient strength, transferring through bond an equal and opposite compression into the member.

In post-tensioned concrete construction, the high strength elements (post-tensioning tendons) are stressed against the hardened concrete by means of hydraulic jacks. The ends of each tendon are anchored, in order to lock the force in the tendons and induce an equal and opposite compressive force in the concrete.

Post-tensioning tendons are typically made of a high strength steel bar or a number of high strength steel, 7-wire pre-stressing strands (six small diameter wires helically wound around the seventh central “king” wire). Post-tensioning tendons may be installed through voids formed by ducts cast into the concrete – in which case, they are “internal” tendons – or they may be installed outside the concrete itself – in which case they are “external” tendons. Ducts for internal tendons are usually made of corrugated metal or plastic. External tendons are most often used in span-by-span segmental construction. The tendons anchor in diaphragms at each end of each span and drape through deviators at intermediate points in the span. At the diaphragms and deviators, external tendons are housed in rigid steel pipes pre-bent, to a specified radii and cast into the concrete. Between these points, where the tendon is external to the concrete, the tendons are inside high-density polyethylene (HDPE) smooth pipes. Some tendons have been detailed to be internal over a portion of their length and external over the remainder of the tendon.

The annular area between the pre-stressing steel and duct of the post-tensioning tendon is grouted after stressing. The two primary functions of the grout are bond development and corrosion protection. The effectiveness of the grout in relation to these two primary functions is tied to several parameters such as the type of construction (cast-in-place vs pre-cast segmental), the type of tendon (internal vs external), the quality of the grout, and the grouting procedures.

13.2—ITEMS TO CONSIDER WHEN EVALUATING POTENTIAL RISK

When comparing the relative durability of different post-tensioned bridge types, or when planning the effective deployment of inspection and maintenance resources, we started by identifying a hierarchy of the types of post-tensioning techniques used in the State of Oregon.

In order to evaluate the corrosion potential, we considered the following items:

- Corrosion protection offered by the tendon system
- Bridge Type and Type of Construction
- Structural Redundancy
- Tendon Bond

In developing this hierarchy, or relative importance of tendons, it is important to consider the wide range of influencing factors. For example, some tendons are provided to facilitate a particular type of construction or carry construction loads that may be greater than the final structural condition. As a result, their relative importance in the completed bridge may not be as critical as other more significant tendons.

Structural configuration also bears on the relative importance of the tendons. Continuous structures are redundant and are capable of redistributing forces internally at post-elastic load levels, creating a mechanism in which certain tendons may be more significant in providing resistance than others. Continuous post-tensioned structures with multiple girder lines provide additional levels of redundancy, further affecting the relative importance of the tendons.

The corrosion protection system provided by a particular bridge type has an impact on the resulting relative importance of the tendons in that bridge. It may be more important to review the condition of tendons of a pre-cast segmental balanced cantilever bridge more so than the same bridge built with cast-in-place balanced cantilever construction. In cast-in-place structures, the ducts are easily made continuous and duct splices can be offset from construction joints and buried in subsequent concrete pours, thus providing more protection from contaminants. However, duct splices in a pre-cast structure are located at the construction joint. As a result, they would naturally carry a higher potential for exposure to moisture and/or other contaminants.

13.3—CORROSION PROTECTION OFFERED BY THE TENDON SYSTEM

The main tensile elements of post-tensioning tendons in our bridges are typically protected against corrosion by a combination of concrete cover, ducts, and grout. The extent to which these three function effectively depends on the quality of the individual materials, workmanship, inspection during construction, and the type of construction as well.

13.3.1—Concrete Cover

Tendons of cast-in-place concrete bridge with infrequent, or no construction joints provide a near ideal barrier to free water and contaminants. When the concrete properties are enhanced by use of fly ash, micro-silica and similar admixtures that act to slow migration of chloride ions, or when the concrete is coated with penetrating sealants, the protection of the tendons is further improved. However, we have been finding quite a few post-tensioned structures, in the State of Oregon, with cracks on the external face of the post-tensioned members, that tend to follow the drape of the ducts. We believe, these cracks were most likely caused during the original construction by stressing and releasing the post-tensioning tendons before the concrete had gained its design strength. As a result, these cracks have compromised the concrete cover protection.

Bridges with more frequently occurring construction joints, such as, cast-in-place balanced cantilever bridges, could provide access for water and contaminants to the post-tensioning. Continuity of mild reinforcing across the construction joints helps to maintain the corrosion protection provided by the concrete cover. Bridges built using pre-cast segmental methods introduce joints that interrupt the protection offered by the concrete cover. Therefore, these joints need to be properly sealed with epoxy during construction. Breach of the seal can allow contaminants to enter and attack the tendons. External tendons receive corrosion protection from embedment in the superstructure concrete only at diaphragms and deviators. In other locations, these tendons are outside of the concrete but inside the interior of box girders, with protection principally supplied by duct and grout alone.

13.3.2—Ducts

Different types of ducts offer varying degrees of corrosion protection. The Oregon State DOT Standard Specifications for Highway Construction specifies that the tendon duct be rigid galvanized steel, mortar-tight ducts, with waterproof tape at the connections. Helical wound, galvanized steel ducts do not provide a physical barrier to the migration of chloride ions through the concrete and grout. However, they offer sacrificial protection of the galvanized coating. Plastic ducts provide a physical barrier to the migration of corrosive elements, but they can suffer local damage or sustain holes as strands rub against the duct wall during installation and stressing. As originally used, the purpose of the ducts was to create the hole through which the tendons would pass. The porosity of helical wound duct that is often used in cast-in-place construction was seen in research by CALTRANS as an advantage, permitting the migration of excess water in grout that could then be absorbed by the surrounding concrete. Ducts play a significantly different role with regard to external tendons. These ducts are made of solid extruded, high-density polyethylene and are connected to embedded steel pipes at diaphragms and deviators by

elastomeric boots and clamps. All water introduced into the duct through the grouting process is either consumed in the hydration of the grout, bleeds through the anchor heads, or is locked inside the tendon.

13.3.3—Grout

Portland cement grout injected into post-tensioning tendons has the well as providing corrosion protection to the pre-stressing steel. The duct and the grout are typically the last line of defense protecting the pre-stressing steel against contaminants such as chlorides. Since the tendons are obscured from view in the structure, the effectiveness of the grout is rarely observed. Quite often the effort was never made to observe the proper filling of the ducts. Voids can form in the post-tensioning duct from incomplete grouting, trapped air pockets, bleed water absorption, plastic grout settlement, or a combination of these factors. Quality grout is of little benefit if poor grouting procedures result in significant voids, providing space for oxygen, moisture and contaminants to collect in the duct and anchorages. Proper venting of the post-tensioning duct is critical for complete grouting. The spaces between the pre-stressing steel and duct and in the anchorage are usually geometrically complex, providing an ideal condition for entrapment of air or bleed water if the system is not properly ported and vented. For instance, a draped duct with a tensioned tendon will have a number of small spaces of varying shapes and sizes along the length of the profile. The interstitial spaces within the strand's individual twisted wires and between strands (or wires) in a tendon are large enough to easily allow passage of water but not cement. This creates a filtering effect in which the cement particles are separated from the grout, leaving the bleed water to move upward along the tendon. Segregation of the cement and water can lead to bleed water collection at the high points in the tendon profile while the grout is plastic. As the grout sets, bleed water may also collect at intermediate points in tall grout columns, or at the top of the horizontal pre-stressing steel. Bleed resistance is a key property for grouts used in filling post-tensioning ducts

To ensure more complete filling of the duct, historically, admixtures were occasionally used that caused grout expansion, during the plastic stage. If expansion is not adequate or properly timed, voids could still occur. Therefore, expansion admixtures are not considered as a complete solution.

13.3.4—Tendon System

After proper consideration for protection offered by concrete whole. Anchor heads can be a point for entry of water or contaminants if the grouting is incomplete. This can be worse at anchors exposed to leaking expansion joints. Anchors embedded in or under a deck slab can be susceptible to water ingress through cracks in the concrete deck. Anchors in blisters or at interior diaphragms on the interior of a box section are relatively well protected, providing they are completely grouted and are not directly under a leak or where water can pond. Voids in anchors not tightly sealed can be recharged with humid air that is possibly laden with salt. As temperatures change the humid air can condense inside the anchor and aggravate corrosion.

In the free lengths of external tendons the principal role of the grout is to provide a chemically based environment inside the polyethylene duct.

13.4—CRITICALITY OF CORROSION OFFERED BY TYPE OF CONSTRUCTION

When a concrete segmental superstructure is built in balanced cantilever, the maximum load is often that from the weight of the cantilever itself and other loads during construction. Consequently, cantilever post-tensioning is usually conservative and more than sufficient to sustain the self-weight alone. Under long-term service conditions, redistribution of internal forces from dead load and pre-stress occurs. Along with live loads, the redistribution of internal forces necessitates continuity tendons to connect cantilevers and end span portions. After installation, these induce further internal force redistribution making the final internal state of stress complex but redundant. Subsequent removal or loss of a continuity tendon would make the structure revert toward acting in the manner it was built. In the case of balanced cantilever construction, this would mean relying more on the cantilever tendons. On the other hand, removal or loss of a cantilever tendon would induce different internal force redistribution placing greater reliance on the mid-span continuity tendons. In general, a continuous cantilever structure has significant ability to redistribute internal forces – taking advantage of its structural redundancy and large number of negative moment tendons over the pier.

In a similar fashion, the corrosion of a longitudinal post-tensioning tendon in a continuous concrete girder bridge could cause the girder to move toward the simple span condition under which it was erected. As the girder attempted to behave in this fashion the benefits of lateral redundancy would appear, carrying load to adjacent girders through the deck slab, diaphragms and/or cross-beams.

13.5—CRITICALITY OF CORROSION AS INFLUENCED BY THE TENDON BOND

Although tendons are initially tensioned and anchored at their ends, grouted internal tendons can develop bond to the concrete through the grout along their length. So, if corrosion of strands occurs in the anchor, capacity of the entire tendon is not lost and may remain sufficient at critical sections. External tendons, on the other hand, are anchored at their ends and develop little or no bond in the length through a diaphragm or deviator. Corrosion of these tendons can lead to dramatic failure.

13.6—CRITICALITY OF CORROSION AS INFLUENCED BY REDUNDANCY

Redundancy provides a measure of confidence that a structure will exhibit noticeable warning (such as excessive deflection or local structural cracking) without failure. Even when some internal parts may have failed locally (due to corrosion or other reasons) – thus affording time and opportunity for routine inspection to notice potential problems and take the necessary corrective action.

Most post-tensioned superstructures are made structurally continuous over one or more interior piers, providing longitudinal redundancy. In concrete open girder bridges, multiple (more than two) lines of girders provide lateral redundancy through the multiple load paths. Hollow box section superstructures develop redundancy through their high, tension capacity and behavior that distributes loads around the section and along to different spans.

In addition to overall structural redundancy, there is sometimes benefit from having several small capacity tendons, rather than a few large capacity tendons, through the structure. In the event that one is lost due to corrosion, it represents a smaller portion of the whole.

13.7—POTENTIAL CORROSION IN CAST-IN PLACE BRIDGES AS FALSEWORK

Bridges of this type have a superstructure cross-section of solid or cellular construction. They are built on-site using form-work supported by temporary false-work. Forms are used to create the shape of the concrete section and any internal voids or diaphragms. All reinforcement and ducts for post-tensioning are installed in the forms and then the concrete is poured, consolidated and cured. When the concrete attains sufficient strength, post-tensioning is installed and stressed to the required forces.

Longitudinal post-tensioning usually comprises multi-strand tendons smoothly draped to a specific vertical profile. In continuous spans, the tendon profile drapes to the bottom of the section in the mid-span region and rises to the top of the section over interior supports. In simple spans and at the expansion ends of continuous spans, the post-tensioning anchors are arranged vertically so that the resultant of the tendon anchor force passes close to the centroid of the section. A draped profile of this type provides the most effective distribution of internal pre-stressing.

The cement grout and concrete section are chemically basic and provides a passive environment around the post-tensioning strands. In cast-in-place construction, where concrete cover offers the majority of the anticipated corrosion protection, the grout primarily serves to bond the tendon to the structure.

13.8—POTENTIAL CORROSION IN PRE-CAST CONCRETE SEGMENTAL BRIDGE

The only pre-cast segmental balanced cantilever bridge in Oregon, was built in 1982, carries I-205 over the main channel of the Columbia River between the Portland Metro Area and Vancouver, Washington. The total bridge length is 7,434 feet and has span lengths reaching 600 feet. The bridge has a horizontal clearance of 68' in both directions, carries three lanes of traffic with shoulders, and a central bicycle lane. All segments were pre-cast off-site, trucked and barged to the bridge site and erected using a barge mounted crane. The deck to stream dimension is 144 feet. Since the bridge is such a major piece of the Interstate traffic flow, the structure is considered to carry a higher risk than most other post-tensioned structures in the State of Oregon.

Pre-cast segmental balanced cantilever construction involves the symmetrical placement of segments about a supporting pier table. Each segment is lifted into position and joining faces are coated with epoxy. Temporary post-tensioning bars are then stressed attaching the segment to the cantilever. When both balancing segments are in place, post-tensioning tendons are stressed across the cantilever. In this way, as segments are added to the cantilever, more top cantilever tendons are added. The number of cantilever tendons is a maximum at the segment over the pier and reduces along the length of the cantilever. Once all of the segments of adjacent cantilevers are erected and tendons stressed, a closure joint is poured and continuity post-tensioning tendons stressed. These operations repeat until all spans of the bridge are assembled. The finished bridge is a continuous varying depth trapezoidal box.

For cantilever erection, post-tensioning tendons are contained within the top slab of the segments and are usually placed in a single layer grouped over each web. Occasionally, when the span lengths warrant, there might be a second, lower layer of just a few tendons, with sufficient concrete thickness provided in the top slab. The tendons counteract the bending effect from the self-weight of the cantilever under construction. This bending induces a longitudinal tension stress in the top, reaching a maximum over a pier. The top cantilever post-tensioning counters these effects by inducing a compression stress of equal or greater magnitude at each cross section along the cantilever.

Quite often the cantilever tendons are anchored on the face of the pre-cast segments. This detail, unfortunately, does not allow for the later inspection of the anchor head following tendon grouting if additional segments are placed in cantilever after stressing. An alternative approach is to anchor the cantilever tendons in blisters cast with the segments at the intersection of the top slab and web. Anchorages of these tendons can be inspected at any time.

To complete a span, the ends of two adjacent cantilevers are connected by a cast-in-place closure pour at or near mid-span of interior spans, but usually nearer to the end of the end spans. The length of the closure (of the complete cross section of the superstructure box) may be a few inches to several feet. In order to align and hold the cantilever tips while making the closure, a special device, known as a “closure beam or strong-back”, is fastened across the tips of the cantilevers. Form-work is secured around the closure, reinforcement and transverse post-tensioning is installed if required, and the closure concrete is poured. When the closure concrete attains sufficient strength, additional post-tensioning (continuity) tendons are installed, tensioned and grouted. When the closure is several feet long, and the closure segment weighs more than one half as much as a typical pre-cast segment, it’s necessary to pour the closure concrete in a very specific sequence in order to prevent the closure joints opening or cracking as the cantilevers deflect. Occasionally it’s necessary to apply a small amount of post-tensioning (10% - 20% of two continuity tendons) through the closure just as soon as the bottom slab concrete has taken an initial set (i.e., within about 2 – 4 hours of casting). This will then keep the closure joints tight, even as the weight of more concrete is added to the closure. Mid-span bottom continuity tendons produce tensile stresses in the top slab at the closure joint that need to be counteracted with top continuity tendons. Subsequent application of the barrier railing and possible wearing surface will produce top compression at this location and minimize the need for the top continuity tendons. However, live loads in adjacent spans could again produce a stress that would cause tension in the closure joint and again require the top continuity tendons. Ultimately, redistribution due to the creep of the concrete will induce compression in the top, again reducing the need for top continuity tendons. It is considered good practice, to provide at least two top continuity tendons, one over each web, in the top of the section.

In segmental structures with tendons passing through the joints, the concrete and duct are interrupted and the grout and epoxy at the joint provides the corrosion protection.

13.9—SPLICED AND POST-TENSIONED CONCRETE GIRDERS

Pre-cast, post-tensioned girders are usually pre-tensioned sufficiently at the pre-cast plant to carry their own self-weight for transportation and erection. The girders are erected as simple spans between piers and cast-in-place joints that are a part of the transverse diaphragms are poured. Longitudinal post-tensioning tendons are threaded through ducts already cast into the webs and stressed, establishing continuous behavior. Good examples of these types of structures are located over I-5 between Salem and Woodburn. Generally, these structures do not carry large percentages of truck traffic.

The simplest form of a continuous, post-tensioned concrete girder bridge has ducts that follow a smoothly curved, draped profile running continuously through multiple beams in line and are spliced at the cast-in-place joints at the beam ends. Tendons rise to the top of the girder over the interior piers of a typical unit and drape in the web into the bottom flange of the girder in the mid-span regions. Tendons can be anchored in a variety of configurations at the ends of each continuous unit.

The construction sequence begins by erecting simple span girders on their bearings at the piers. Tendon ducts are then spliced and closure joints are poured at the interior piers and a first stage of post-tensioning is stressed, making the girders continuous. Next the slab is cast and allowed to cure. The unit is complete when a second stage longitudinal post-tensioning is applied to the composite section. A good example of a staged post-tensioned structure in our inventory is the recently completed Crooked River Gorge Bridge (#18211) in central Oregon on highway 4, at milepost 112.63..

13.10—TRANSVERSE TOP SLAB POST-TENSIONING

The top slab of the Crooked River Gorge Bridge also has transverse post-tensioning installed to support the large outside overhang. The transverse tendons are spaced _____ feet along the structure. The tendons were anchored in the edge of the top slabs in cantilever wings in blockouts. The blockouts were subsequently filled with concrete and covered with a traffic barrier.

13.11—INSPECTION OF TENDONS BASED ON STRUCTURAL DETAILS HIERARCHY

Based on the factors presented above, post-tensioning tendons may be prioritized for inspection purposes in accordance with the following hierarchy. Care should be taken to remember that all tendons are important to a bridge. This hierarchy is based on how likely the post-tensioned tendons will be exposed to a corrosive environment. In this case, (1) has the highest probability and (7) being the lowest:

- **Internal Tendons with Suspended Spans** – Internal draped tendons in concrete girders cantilevering over piers that anchor in dapped hinges and support suspended spans. Longitudinally these are statically determinate structures with no redundancy. Loss of support to any dapped hinge on any girder could be serious even though there are multiple girder lines. In addition, the embedded anchors at expansion joints are not readily accessible, nor visible.
- **Bottom Internal Continuity Tendons at Expansion Joints** – There is risk of exposure and possible recharge of any incompletely grouted ducts at end anchors near any leaky expansion joints. If the tendons are anchored in blisters and diaphragms, the tendons are accessible for inspection. Otherwise, they are not accessible.
- **Continuous Drop-In Spliced Girder Tendons** – Integrity of the structure can be susceptible to shrinkage of cast-in-place concrete, flexure cracks in the slab, or any local concrete honeycombing of the cast-in-place concrete at the duct splices. Which, in turn, can lead to pathways for ingress of contaminants to the ducts and concrete surrounding the duct splices – both must be good for corrosion protection. Corrosion and loss of any internal tendons would lead to an internal redistribution of forces inducing higher shear at piers and higher flexure in the spans. The structure would then tend toward behavior similar to that of a suspended span bridge. These effects can be overcome by staged application of the post-tensioning to both the non-composite and composite cross sections.
- **Pre-cast Cantilever Tendons Anchored on Segment Face** – Internal cantilever tendons of segmental box section superstructures that anchor on the joint faces of the pre-cast segments are not readily accessible and require invasive inspection and maintenance procedures.
- **Pre-cast Cantilever Tendons Anchored in Blisters** – Cantilever tendons of segmental box section superstructures that anchor in blisters on the inside of the box superstructure can be inspected at the anchors for adequate grouting or evidence of possible corrosion. These bridges rely on the epoxy at pre-cast joints for corrosion protection. Leaking epoxy joints between pre-cast segments may allow water to enter the interior of the box. If this is not drained but collects against anchor blisters and diaphragms, it may then seep into tendons that were not fully grouted or tendon anchors. Corrosion damage of a tendon is then possible.

- **Cast-in-Place Cantilever Tendons Anchored on Segment Face** – Cantilever tendons of cast-in-place bridges where tendons anchor on faces of construction joints are not readily accessible for inspection. However, ducts can be made continuous and can be offset from the construction joint. Also, there is typically a continuity of mild reinforcing across the joints.
- **Mid-Span Bottom Internal Continuity Tendons** -

13.12—RESULTS OF THE SPECIFICATIONS REVIEW

The ODOT Specifications for Highway Construction, Section 00555, provides a full description of the specifications used by the State of Oregon. However, there are several areas of concern that need to be more explicitly explored:

- 00555.42 Bonding and Grouting (b) Trial Batch. This, sub-section calls, for one trial batch be tested per structure. The test method calls for a freshly mixed grout sample to be placed into a flow cone and allowed to sit undisturbed for a period of time. After that time the plug is pulled and the grout sample is allowed to run out of the flow cone and the time is recorded. This test procedure doesn't really subject the grout sample to column pressure nor the filtering effect of the pre-stressing stand. As a result, the called for test procedure might not be very representative of field conditions. There could be some room for adopting a more rigorous test method for grouting conditions that require enhanced anti-bleeding properties. One alternative, needing explored, was developed by M. Schupack in the early 1970's. The Schupack test method combines the filtering effect and higher pressure to test grouts for use in pre-stressing tendons.
- Another area of concern is the specification for the actual grouting procedure – 00555.42 Bonding and Grouting (c) Grouting Procedure: The existing specification, as written, does not direct the contractor to notify the Engineer when the grouting process is going to occur. Due to the criticality of the work being performed, the Engineer, or their field representative, should observe the grouting procedure.
- Section 00555.41 Stressing (c) Timing: specifies the conditions that must be met prior to stressing and releasing the post-tensioning tendons. From our review of the longitudinal duct drape cracks in the face of the member, shows that maybe this item needs more review.

13.13—POST-TENSIONED BRIDGE INSPECTION PROCEDURES

The following structure types require an immediate walk through inspection:

- All segmentally constructed concrete box superstructures.
- All segmentally constructed substructures
- Post Tensioned girders with anchorage pockets in the deck slab that might be exposed due to deck cracking.
- Post tensioned structures with longitudinal duct drape cracks in the face of the existing post-tensioned members.

More specifically, structures that fit the above criteria are the Columbia River (Glen Jackson) Bridge, I-205, and the I-5 over crossing structures north of Woodburn.

The inspectors should conduct a walk through inspection observing the following items and note any deficiencies found. If possible this inspection should be conducted during or shortly after a heavy rain. This may help find possible access paths for moisture.

The inspectors performing the walk through inspection should observe the following items and note any deficiencies found.

- Look for and note signs of water leaking, efflorescence and/or rust staining, especially at joints between segments.
- Look for cracks near anchorages that are leaking.
- Physically map all cracks along the stem (box wall) with a keel so that crack growth can be actively monitored. Physically measure the width of all cracks. Put measurements on the stem wall for future reference.

- Sound the concrete stems in the vicinity of the duct high points, with the intent of locating possible voids in the grout. If suspicious areas are found, drill into the duct to determine for sure and have the void filled.
- Look for porous or cracked anchorage pour-backs where water may enter and recharge the tendon voids.
- Look for and note signs of poor drainage. This may include the identification of areas where water ponds after periods of heavy rains.
- Identify types of expansion joints and assess their condition.
- Note any cracks that are discovered in the outside of the box. Especially note cracks in tension areas.
- Look for any signs of misalignment of the box or girder line. If this is found, the inspector should immediately contact the ODOT Bridge Operations Engineer for an immediate evaluation of the situation.
- Listen for any unusual sounds while inside the box. Depending on the traffic level on the structure this may not always be possible. Popping or cracking sounds may be an indication of post-tensioning wires breaking or cracking of the ducts.
- Discuss significant deficiencies found including location and orientation. If there is a deficiency that is found repetitively throughout the bridge give the number of locations where this is found and the total number of locations where it is possible for this deficiency to be found. Ex. 9 of 56 anchor blocks have severe rust staining around the pour-back. Include photographs and sketches of typical deficiencies.

13.14—IN-DEPTH EVALUATION OF POST-TENSIONED STRUCTURES IN OREGON

Due to recent post-tensioned structure failures, nationwide, Oregon Department of Transportation (ODOT) initiated the following actions:

- Obtain an inventory of all post-tensioned structures on the state and local agency highway systems.
- Review the existing bridge inspection reports to determine if any deficiencies have been reported on the post-tensioned elements in condition states less than 1, which includes the existence of cracks in the concrete members.
- Investigate into what might have caused the cracking in the post-tensioned members to have occurred (early release, use of expansive grouts, structural loading or corrosion).
- Review the design details, to determine how potentially vulnerable the post-tensioning strands might be to corrosion. Identify specific design details that present the highest potential exposure to a corrosive environment.
- Identify which bridges contain design details that are determined to present a higher risk and/or highest potential for corrosion.
- Perform a hands-on, close-up, inspection of those bridges, to determine if a problem exists, in the State of Oregon and/or to determine if the cracks are static or growing.
- Review the existing construction specifications and construction practices to determine if any changes are warranted.

CHAPTER 14: INSPECTION OF STEEL BRIDGES

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CHAPTER 14:

INSPECTION OF STEEL BRIDGES

14.1—INTRODUCTION

The major advantage of steel is its high strength relative to the strengths of the other common structural materials: wood, masonry, and concrete. Unlike masonry and concrete, which are weak in tension, steel is strong in both tension and compression. Because of its high strength, structural steel is widely used in construction. The tallest and longest-span structures are predominantly steel.

Steel bridges have proven their functional durability with such examples as the 100 year old Brooklyn Bridge in New York City. However, durability for any bridge material comes at a price. And that price is regular maintenance, which involves inspections, repair, rehabilitation, strengthening, and painting. Steel also tends to require a much higher level of maintenance than say concrete. Steel is also a lot more expensive to maintain due to the historical use of toxic materials in the paint system such as red lead, or zinc chromate. The removal and disposal of these toxic materials must be done in accordance with accepted DEQ procedures.

The principal components of a steel bridge are beams, girders, trusses, or suspension cable systems. The simplest form of a steel bridge consists of a steel beam configuration in a simple span arrangement. When the spans exceed a certain length limit, built-up plate girders are used and the structure is referred to as a plate girder bridge. For still longer spans, steel truss bridges are more economical. For very long spans, the suspension bridge is probably the only available solution, with high-strength cables carrying the main loads. As the span requirements for a bridge get longer the most economical structure can become a multi-span continuous bridge where the girders are made composite with the concrete deck. Selection of the appropriate design for a particular set of conditions is governed by several considerations such as span lengths, deflection limitations, construction time, and overall cost. Members in simple or continuous spans should be designed so that the deflection due to service live load plus impact does not exceed 1/800 of the span, except on bridges in urban areas used partly by pedestrians where this ratio should not exceed 1/1000.

Steel Bridge Types are classified as follows:

- Girders – straight, curved or skewed
 - Rolled Beam
 - Built-up Girder
 - Welded Plate Girder
 - Box Girder
 - Simple span – cantilevered – continuous
- Trusses
 - Pony Truss
 - Thru Truss
 - Deck Truss
 - Simple span – cantilevered – continuous
- Arches:
 - Plate arches – thru or deck – fixed or pinned members
 - Truss arches – thru or deck – fixed or pinned members
 - Tied arches – trussed or box members
- Suspension Bridges:
 - Cable Support System
 - Stiffener Truss
 - Cable Stayed Bridges
- Movable Bridge:
 - Bascule Span – Single and Double Leaf
 - Vertical Lift Span
 - Swing Span

- Roll-Out Span

14.1.1—Steel Rolled Beam Bridges

On these structures, the steel rolled beams are the primary structural member. Although there is a wide variation in: the number of spans, the span lengths, the structure depth, and the width of superstructure. Where the bridge length is sufficiently long to warrant multiple spans, the selection usually focuses on simple or continuous units. A rolled-beam simple-span highway bridge is likely to be economical for spans up to 60 feet. Composite construction, have been found to be attractive and economical for spans up to 100 feet.

14.1.2—Plate Girder Bridges

The principal difference between the design of a rolled beam and a plate girder is in that it offers greater freedom and flexibility in proportioning the member cross section by choosing the flange and web plates. This allows a much deeper web member with a much thicker flange dimension to be constructed. However, as the web dimension increases, to guard against lateral web deflections or buckling, web stiffeners are required to be incorporated into the designed section, both in a vertical and longitudinal direction. In general, simple spans 70 to 150 feet long have traditionally been the domain of a plate girder. Several three-span continuous, plate girder bridges have been built with a center span exceeding 400 feet. The larger depth usually selected for a plate girder often results in relatively thin webs making web-buckling problems more relevant to the design. Box girders are made of two flange plates and two web plates which have high torsional strength and rigidity. The end reactions of continuous girder bridges should be checked for possible uplift.

14.1.3—Box Girder Bridges

Box girders are particularly effective in resisting bending stresses because of the wide bottom flanges. The closed shape of the section provides considerable rigidity in resisting torsional effects on the bridge. Additionally, the box is not as susceptible to corrosion as ordinary steel members because half of the steel surface is contained with the section. A box girder bridge is considered as esthetically pleasing structure. Long-span composite box girder bridges usually average about 200 feet, but can span up to approximately 400 feet in length. A single box girder is considered to be fracture critical. Multiples of box girders are considered to have redundant load paths, as long as the open space between the box girders does not exceed 14 feet.

14.1.4—Steel Truss Bridges

A truss is essentially a triangulated assembly of straight members. A planar truss may be regarded as a deep girder, where the girder flanges are replaced by the truss chords and the web plate is formed by an open system of web members. A planar truss can support loads only in its own plane. In a truss the applied loads are considered to be resisted primarily by axial forces induced onto the truss members. Most bending moments are generally quite small and can be neglected, with the following exceptions: Eccentricities in member connections, torsional moments introduced by members not acting in the truss plane like floor beams, transverse loads on a member such as the weight of the member itself, and truss distortion and rigidity of the truss joints resulting in bending like restraints caused by frozen bearings, traffic impact loads, or foundation settlement, can induce a bending moment and transient loading into the surrounding truss members. A truss can be configured as a

- Deck truss
- Pony truss
- Thru truss

A truss bridge of conventional design consists of the following elements:

- A deck or slab
- Longitudinal stringers that directly supports the deck
- Cross beams at panel points accepting the load from the longitudinal stringers.
- The two main truss systems on each side of the roadway,
- Diagonal lateral bracing provided in the planes of the upper and lower chords,
- End sway frames (end portals) receiving the horizontal transverse forced from the lateral bracing and transferring these forces to the piers, and

- Additional over-roadway intermediate sway frames distributing the transverse loads to the lateral truss system and keeping the system stable during erection.

Truss members generally consist of: H sections, either rolled or built-up; Channel sections; Single or Double Box sections that are usually made with side channels, beams, angles, or flat plates, connected together using batten plates.

Where the truss members meet, these are called panel points. At each panel point the truss members are connected using a gusset plate. The connections can be made by riveting, bolting or welding. The thickness of the gusset plates is determined by several factors. A minimum plate thickness is necessary to develop the full strength of the bolts, depending on a single or double shear action. Experience shows that a usual gusset plate thickness is 3/8 to 1/2 in for light trusses and 5/8 to 7/8 in for heavier trusses. Stress transmission through the gusset at a truss joint may be achieved in two ways. If the chord member is continuous through the gusset, the main portion of the stress is transmitted directly within the chord, and only the difference of the chord stresses is carried through the gusset. This arrangement is often used to relieve the gusset plate of any excessive load. If chord splices are necessary, they can be made outside of the joint in the lesser-stressed member. If the chord members are spliced at a joint, the gusset at this location will be subjected to heavy stress because it transmits the entire amount of the chord stresses. Gusset plates are designed for shear, bending, and axial load using the method-of-section approach as in service load design.

14.1.5—Steel Arch Bridges

Arch bridges are considered the most successful of all bridge types in esthetic terms, and the curved shape is invariably pleasing. As a structural unit, an arch is defined as a member shaped in a curved form and supported in such a manner that intermediate transverse loads are transmitted to the supports primarily by axial compressive thrusts in the arch. In a tied arch the horizontal reactions to the arch rib are provided by a tie at deck level. Due to the lack of redundancy, the tie in this case would be considered fracture critical.

14.1.6—Movable Bridges

When topography of a bridge site makes it desirable to have the roadway closed to the surface of the body of water crossed by the bridge, the vertical under-clearance requirements of the navigation passing beneath the bridge may dictate a movable bridge. A movable bridge is a structure that may be moved to permit the passage of navigational traffic. The most important types of movable bridges are: bascule span bridges (single or double leaf); vertical lift bridges, and horizontal swing span bridges. The type used depends largely on the horizontal and vertical clearance requirements. Whether a low-level movable bridge or a high-level fixed bridge should be used at a given site can usually be determined by an economic analysis.

Bascule Span Drawbridges: A bascule bridge may prove economical where horizontal navigation requirements do not necessitate too long of a span where a high vertical clearance is required. A single leaf bascule bridge is where the draw-span rotates about one of the supporting piers so the other end of the drawbridge is in a vertical plane directly over that supporting pier. A double leaf bascule bridge is where the draw-span is split at mid-span and both leaves rotate around their supporting pier so that they are in a vertical plane directly over that supporting pier. The dead load stresses in a bascule span changes as the bridge is opened or lowered, and it is possible that the dead load stresses in certain members during this operation may exceed the total stresses with the bridge down and subjected to traffic.

Vertical Lift Drawbridges: When the horizontal clearance requirements exceed the vertical clearance requirements for navigation, a vertical lift bridge is likely to be more economical. The central span is raised or lowered vertically by cables running over sheaves that are located at the tops of the lift towers.

Horizontal Swing Drawbridges: These structures accommodate unlimited vertical clearance, but the center pier constitutes an obstruction to navigation traffic and the horizontal swing creates a conflict with immediately adjacent suspended power and telephone lines. Horizontal swing bridges generally are of two types: a center-bearing type, or a rim-bearing type. In both cases the bridge is opened by horizontal rotation about a vertical line. When the bridge is open, the two spans cantilever from the center pier. Movable bridges are provided with a mechanism to surface and align the bridge and roadway and to fasten them securely in position so that

horizontal and vertical displacement is prevented under traffic. End lifting devices are used for swing bridges and span locks for bascule types.

Horizontal Roll-out / Lift-out Drawbridges: These structures have a steel span that can either be lifted out with a crane or pulled out using a set of rollers. The State of Oregon has three of these structures in the inventory:

Hwy 102, MP 4.58, Br No 02320A, Willuski River Bridge
Hwy 244, MP 16.78, Br No 00598D, Coquille River Bridge
Smith River – Douglas County Bridge

14.2—STEEL PROTECTIVE COATING SYSTEMS

14.2.1—Introduction

For most steel bridges, a paint coating system is required to provide corrosion protection and to enhance the aesthetic appearance. Matters of color, shading, gloss, texture, and general appearance are left to the owners. The coating system, however, may be the responsibility of the engineer. The cost, method of application, and durability of the system all must be carefully examined and presented to the owner along with the engineer's recommendation. This paint system can be as important as design repairs since in the long run it often determines the useful life of the structure.

Many coating systems are available and each must be judged for its durability and dependability for that given geographical area. For compatibility, it is always good practice to require all coats to be supplied by the same manufacturer and applied strictly in accordance with the manufacturer's recommendation. The coating systems employed in the State of Oregon are:

- Painted Coating System
- Hot-dipped Galvanized Coating System, or
- Use of Weathering Steel

14.2.2—Painted Coating Systems

The paint system consists of surface preparation, prime coat, and finish coat. For an in-depth review of current painting practices, reference should be made to the latest AISI and SSPC publications.

The most important part of evaluating the effectiveness of a steel coating system is the thickness. Coating thickness determines if the amount of coating is equal to or greater than the amount that was originally specified. There are several methods of determining the thickness of a coating. Because it is non-destructive, magnetic thickness measurements are the most common method of evaluating coating thickness. ASTM Recommended Practice E 376 and CSA Standard G 164 provide guidance on the use of magnetic thickness measurement instruments and their accuracy. Sampling procedures outlined in ASTM A 123, ASTM Standard Method B 602 and CSA Standard Z 90 provide assistance with the number of specimens needed to represent the inspection lot.

The following are indicators of a failure in the paint system:

- Chalking, erosion, checking, cracking, and wrinkling.
- Blisters are caused by painting over oil, grease, water, salt, or by solvent retention.
- Undercutting is the rusting, blistering, or peeling of paint over corroding steel. It commonly occurs along scratches that expose the steel or along sharp edges. The corrosion undermines intact paint, causing it to blister and peel.
- Pinpoint rusting, which are tiny, deep holes in the paint exposing the steel, which is caused by thin paint coverage.

In order to standardize the field assessment of the amount of corrosion present on the bridge structures, five categories of corrosion have been developed. The categories range from little or none, some corrosion present, heavy corrosion, rust scale, and pitting. The first three categories address the amount present, and the last two categories address the severity of the corrosion. ASTM D610 provides a "Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces".

14.2.3—Weathering Steels

When exposed to the atmosphere, weathering steel develops a protective oxide film on the surface of the member which seals the surface of the member which helps to prevent further corrosion. The frequency of surface wetting and drying cycles determines the oxide film's texture and protective nature.

The performance of weathering steel in highway bridges has shown that the majority of these bridges are in good condition. Although there have been some localized areas of corrosion on many structures and some have experienced excessive attack by deicing or marine environment salts. The general conclusion is that weathering steel can provide a satisfactory service life with limited maintenance, if the structural details are designed so as to prevent accelerated attack. Vulnerable areas should be painted and contamination which chlorides should be inhibited. The principal factors that determine the ultimate performance of weathering steel bridges are location and design. Environmental differences may exist from one bridge site to the other with respect to amount and type of atmosphere pollution, extent of rainfall, variations in humidity, temperature and the prevailing winds, and the amount of airborne salinity in marine environments. Because of these factors the corrosion performance of weathering steel can differ in degree from site to site. Environmental locations to be avoided are:

- Those exposed to highly corrosive chemical and industrial fumes;
- Those subject to high rainfall and humidity or where there is constant wetness;
- Depressed roadway that create tunnel-like conditions;
- Those that are low level water crossings that can lead to highly humid or frequently wet conditions;
- Those subject to salt spray or significant salt-laden fogs at coastal areas; and
- Those where steel may be continuously submerged in water, buried in soil, or covered by vegetation.

Proper attention to the design details can contribute markedly to the satisfactory long-term performance of weathering steel. Bridges items that need to be considered include expansion joints, leakage and drainage, painting below joints, integral abutments, connection, handling and storage of weathering steels, the welding process, and future inspections (difficulty in locating fatigue cracks on a rough textured rusty surface).

14.2.4—Hot Dipped Galvanized Coatings

Thanks to the nature of the galvanized coating, the inspection is relatively simple – either the steel is coated or it isn't.

There are two primary aspects: visual appearance and coating thickness.

Appearance

Often the phrase “if it looks good, it is good” is used to describe the coating's appearance. Unfortunately, “good” is such a subjective term that what looks like a good coating to one inspector may be different than what looks “good” to another inspector.

Frequently, spec writers and inspectors hold idealized perceptions that a hot dip galvanized coating should be a bright, shiny coating with a clearly visible spangled appearance. In reality, this image is more often the exception rather than the rule for after-fabrication hot dip galvanized steel. An acceptable galvanized coating runs the full spectrum of appearance from shiny silver to a dull gray and from a clearly visible spangle to no discernible spangle.

Coating appearance is determined by a number of variables including steel chemistry, the cleaning process, zinc bath temperature and chemistry, and the rate of withdrawal from the bath. As there are so many influencing factors, it is very difficult for galvanizers to predict or control the final look of a galvanized coating. Although, good communication between the spec writers, fabricator and galvanizer can help eliminate surprises and provide a more aesthetically pleasing coating.

Because the primary objective of a galvanized coating is to provide corrosion protection, aesthetics are not reason for rejection. If the coating is relatively smooth, continuous, free from gross surface imperfections, and meets the requirements for thickness, it is acceptable.

Generally variations in appearance do not affect the corrosion protection the steel is afforded. In fact, duller coatings are typically thicker and provide longer corrosion protection than bright coatings. In any case, all visual variations of the galvanized coating will weather to become the same dull, medium gray, over time.

Many things can affect the appearance of a galvanized coating, but the most common culprit of darker, dull coatings is steel chemistry. Steel with high levels of silicon or phosphorus are very reactive during galvanizing and form excessively thick, rough coatings. Steel containing silicon at levels between 0.03 and 0.15 percent or greater than 0.25 percent are considered reactive. Steel with phosphorus content in excess of 0.04 percent is also highly reactive.

During the galvanizing process, reactive steels force a very rapid, difficult to control, growth of the zinc-iron alloy layers. These thick alloy layers are responsible for the darker, rougher coating. The photomicrographs of a typical galvanized coating and a reactive galvanized coating show an obvious difference in the alloy layer thickness.

While specifying steel of the proper chemistry can alleviate this problem, it cannot always eliminate it. Occasionally, a non-reactive steel produces “spots” of dark, rough areas on an otherwise typical galvanized coating. This is a result of a non-homogeneous steel composition. When the steel is tested for composition certification at the steel mill, the samples reflect the content of each specific location and can statistically imply the make-up of the entire piece. However, it is possible for the mill certifications of the steel composition to be within the non-reactive range, but the steel may still have isolated pockets of silicon or phosphorus that fall in the reactive range, causing areas of darker coatings.

Very rarely do reactive galvanized coatings need to be re-galvanized. Because reactive coatings form thicker zinc-iron alloy layers, the galvanized coating is thicker, translating into a longer service life. As long as the coating meets the specification for coating thickness, the galvanized items are not rejected.

Unfortunately, the galvanizer has little control over the coating thickness or reactive steels, and the coating may become too thick. When this happens, the coating can become brittle and flake off. If the flaking areas fall below the minimum thickness specified, then the area must be repaired (if small enough) or re-galvanized (if the area is quite large).

Remember, just because a coating is a dull gray does not mean it is a bad coating.

Coating Thickness

The thickness of the galvanized coating is the primary factor used to determine the service life of galvanized structure. The thicker the coating, the better the corrosion protection it offers.

14.3—STEEL BRIDGE DESIGN FEATURES

14.3.1—Introduction

Public confidence in highway safety is a top priority and must be maintained; by all transportation agencies. Accidents cost money and sometimes a person’s life or livelihood. Bridges deteriorate due to a variety of factors. When the right combination of factors occurs at a bridge site, it can and will fail. Most bridge failures are due to a limited number of problems such as overstress, fatigue, scour, undermining, and settlement.

Therefore, understanding the causes of the common failure modes is extremely important. It permits the inspector to spend more time evaluating the problematic areas of a bridge and perform a cursory inspection on the others. This procedure allows the inspector to feel more confident that the entire bridge site is safe and it will greatly reduce any chance of failure.

14.3.2—Steel Properties

Some of the properties of steel include:

- Strength – steel is isotropic and possesses tremendous compressive and tensile strength, which varies widely with type of steel.

- Elasticity – the modulus of elasticity is nearly independent of steel type and is commonly assigned as 29,000,000 psi.
- Ductility – both the low carbon and low alloy steels normally used in bridge construction are quite ductile. However, brittleness may occur because of heat treatment, welding, or metal fatigue.
- Fire resistance – steel is subject to a loss of strength when exposed to high temperatures such as those resulting from fire.
- Corrosion resistance – unprotected carbon steel corrodes (rusts) readily. However, steel can be readily protected.
- Weldability – steel is weldable, but it is necessary to select a suitable welding procedure based on the chemistry of the steel.
- Fatigue – fatigue problems in steel members and connections can occur in bridges due to numerous live load stress cycles combined with poor welded or connection details.

There's a whole wide variety of different types of structural steels that have been approved for use. The yield stresses of these steels range from 36 ksi for common A36 steel up to 100 ksi for A514 steel. The yield stress of a given grade of steel is not a constant. It varies with plate thickness; very thick structural shapes and plates have reduced yield stresses. A particular type of steel is generally selected based on their material properties such as corrosion resistance, abrasion resistance, toughness, and price which can vary considerably.

A structural member can be a rolled shape or can be built up from two or more rolled shapes or plates, connected by welds or bolts. The more economical rolled shapes are utilized whenever possible. However, special conditions (such as the need for heavier members or particular cross-sectional geometries) may dictate the use of built-up members. Available rolled shapes and their section properties are cataloged in the AISC Manual. The most commonly used sections include wide flange beams, angles, channels, and tee sections.

The yield strength is of prime importance because it is the property that determines working unit stresses. The ratio of yield to tensile strength for structural carbon steel is about 0.60, but for high-strength steels this ratio is in the range of 0.70 to 0.80. AASHTO defines the Charpy V-notch impact requirements for main load-carrying members subjected to tensile stresses. These impact requirements vary depending on the type of steel, type of construction, whether welded or mechanically fastened, and the average minimum service temperature.

A steel bridge member may react to a stress three different ways: (a) deform elastically, (b) deform plastically, or (c) break. The amount of elastic or plastic deformation (strain) that occurs before fracture depends mainly on the magnitude of the applied loads, how they are combined, their cyclic and repetitive nature, and the residual stresses. Fracture-critical members are tension components of a bridge whose failure would be expected to result in a total or partial collapse of a bridge.

14.3.3—Connections

There are several basic methods used to connect steel bridge members: pinning, riveting, bolting, or welding.

Riveted Connections

For many years, riveted or pinned connections were the only ones found in structural steel erection. The rivet must be driven through a well-aligned hole, and comes with a head on one end, and is driven while hot. Actually, the rivet fits exactly through the rivet hole, and the driving represents the forming of a new head on the shank end, with the riveter driving against the buckler on the head side. Riveting does not result in a clamping action, so the members must be firmly held together while the riveting is in progress. Any loosening of the fit will result in loose rivets. Even when the members are held tightly together with clamps or shop bolts, poor driving can result in loose rivets. Field riveting is a very unwieldy process.

Bolted Connections

The development of high-strength bolted connections revolutionized the structural steel erection process. The high-strength bolt is identified by three radial marks on the head and three long indented marks on the nut. The bolt is used with a washer on the side of the element that is turned, and all of the elements are made of high carbon steel – ordinary washers and nuts must not be used, and must be closely scrutinized. The highest tensile bolt is driven with

an air-driven impact wrench which is pre-calibrated to drive to the right point of refusal. The high-strength bolt is torqued, actually stretching the bolt. The result is not only the resistance to shear which the rivet offered, but also a clamping action which provides movement resistance as well as simple shear and tension. Even though high-tension bolts have the ability to clamp, contact surfaces should be clean of mill scale, burns, pits, dirt, oil, and any other foreign materials which would prevent solid seating of the parts. Since the high-strength bolts are physically stretched, they should not be reused because they will not be able to develop the designed strength. Usually, the threaded length of the bolt is kept as short as possible so that the full shank is available to resist shear between the members being connected. Where the high-tensile bolt is to be subjected to vibration or dynamic loading, locking devices may be specified.

Welded Connections

Some of the readily available structural steels are more suited to welding than others. Usually, welding procedures are based on steel's chemistry instead of the maximum alloy content. Beginning in about 1955, the fabrication of structural steel underwent some very great changes. Welding took over and almost completely replaced the long-serving rivet. It was difficult to find riveting equipment in fabrication shops by the early 1970's. Welding has many recognized advantages in saving weight, labor, and simplifying details – resulting in much more economical steel structures. Welded connections are widely used and accepted by the structural steel industry. Welding requires careful procedural workmanship, and therefore, careful inspection. Therefore, welders are to be tested and certified in accordance to an approved welding procedure. Mistakes and errors in welding are often not readily apparent. Welding in the field under difficult conditions may produce less certain results than high strength bolting. Weld location is important and placing welds in the wrong location can be just as serious as omitting them altogether. The finished weld size, length and standards of workmanship, using appearance of the surface, surface defects, craters, undercutting, cracks, etc., as methods of evaluation. Another common deficiency is where defects may develop due to porosity and lack of penetration or fusion.

A butt joint is used mainly to join the ends of flat plates of the same or nearly the same thickness. The principal advantage is in the elimination of the eccentricity developed in single lap joints. The principal disadvantage is in the preparation (beveling, grinding flat) necessary for the members to be connected. Because only little adjustment is possible, the pieces must be carefully aligned, detailed, and fabricated. As a result, most butt joints are made in the shop where the welding process can be better controlled. Irregularities affect the stress distribution according to the stress paths. Stress concentrations will occur at sharp reentrant corners of butt welds connecting bars of different cross section, thereby reducing the strength of the connection considerably. To minimize stress concentration, a gradual transition from one section to the other must be provided. Tension results of butt-welded specimens indicate that their average tensile strength is nearly the same as the average tensile strength of the base metal, but strength variation is greater for the welded than for the un-welded specimen because of imperfections and non-homogeneity. Butt welds are much preferable to fillet welds on the basis of strength, including fatigue.

Unlike the full continuity attained with butt welds, fillet welds introduce eccentricities of force transmission and discontinuity of shape in the connected parts. Consequently, the actual stress distribution is extremely complex. Within the elastic limits the strains at the end of the fillet welds are considerably greater than at the center. The flange plate-to-web weld connection should be checked at critical locations based on fatigue considerations. Such critical locations are at supports. The nominal resistance of fillet welds is determined from the effective throat area, whereas the strength of the connected parts is governed by their respective thickness.

Two other factors to be considered in the choice of weld size are the minimum weld size necessary to prevent quick cooling resulting in weld brittleness, and the maximum weld size as determined by practical restrictions in obtaining the proper shape. The minimum practical weld size is 1/16 in.; the most economical size is 5/16 in, which is generally the maximum weld manually obtainable in one pass.

14.3.4—Simple Spans vs. Continuous

Simple spans consist of a superstructure span having a single unrestrained bearing at each end. The supports must be such that they allow rotation as the span flexes under load. Ordinarily, at least one support is attached in a way that keeps the span from moving longitudinally.

Spans are considered continuous when one continuous piece crosses or bears on three or more supports. Since the member is continuous over the center support the magnitude of the member rotation, or deflection, is restricted by the loads associated on the adjacent spans. This is like the teeter-totter effect. Continuity in bridges is exhibited essentially in two forms: continuous spans and rigid frames.

14.3.5—Composite Construction vs. Non-Composite Construction

A considerable economy may be attained in a bridge if the beam and deck are made to be composite in order to resist subsequent superimposed loads. With this type of design, a mechanical lock between the girders and the concrete deck is integrated into the design. Mechanical devices of sufficient shear capacity is attached to the top of the steel beams and embedded in the concrete deck so that the steel and concrete act as an integral unit. Composite construction results in a longer span with the same cross section as non-composite construction. This elastic design method provided the basis of the 1957 AASHTO specifications. Since that date, composite bridges have become standard practice. This is say, if bridge plans are not available and if the date built was prior to 1957, the steel beams are probably not composite, and NBI Item 43 / 44 should be coded accordingly.

14.3.6—Bridge Bearings

Since there is so much movement in a steel structure than concrete or timber, addressing the bearing types that are designed to accommodate the movement is very important. Bearings are classified as either fixed or expansion. Fixed bearings allow rotation but provide reaction for longitudinal load. Expansion bearings allow for longitudinal movement by providing only limited longitudinal restraint. Usually both fixed and expansion bearings provide restraint for transverse loads. The more commonly bearings used on a steel structure are:

- Rocker bearings,
- Roller bearings,
- Sliding plate,
- Pot Bearings,
- Disc Bearings, or
- Elastomeric Bearings

Of these, rocker, roller, and sliding plate bearings are found on older bridges, while the remaining types are found on newer designs, especially in higher seismic zones.

14.4—INSPECTION OF STEEL STRUCTURES

14.4.1—Introduction

In the State of Oregon, the bridge inspectors are assigned a specific inventory of structures within a geographical area. It is our belief that through repeated inspection the bridge inspector will gain an intimate knowledge of each structure, and would be in a better position to evaluate and anticipate deficiencies before they appear. They would be in a better position to properly evaluate the symptoms in order to identify and zero in on the root cause of the deficiency. This is especially true when inspecting a steel structure. Fatigue cracks are not always readily apparent. But if the inspector knows where to look, what to look for, and how to look, they will be in an excellent position to locate these deficiencies before they become critical. On steel structures, response time is of the essence, due to the rate of deterioration that is associated with some structural deficiencies. Crack growth from small to major can be quite sudden.

By definition, to inspect is to view closely or scrutinize. In most organizations, the bridge inspector is more than an observer or reporter. The job entails evaluating defects, as the defect that is observed is often only a symptom. The appropriate response to the defect must then be recommended. Inspection personnel must fully understand the severity of the potential consequences if a bridge inspection is not properly conducted. The inspection team must realize the importance of recognizing which bridges contain critical structural details and know where those critical details are on the bridge.

Due to the structural complexities associated with most, larger steel structures, it is absolutely imperative to allocate an adequate amount of time for the inspection. An adequate inspection of a steel structure will most likely take a lot

longer time to perform than say a concrete bridge inspection. The following will help minimize the time requirements:

- Know the structures assigned
- Formulate an inspection plan to ensure that each critical feature receives a proper evaluation.
- Assure the right tools and equipment are on hand, the right inspection techniques employed, and the inspection team has the right expertise.
- Initiate a tailgate party to ensure the entire team fully understands the complexity of the structure being inspected.

The most common defects encountered in steel superstructures include:

- Corrosion,
- Fatigue cracking due to out-of-plane distortion,
- Collision damage,
- Overload damage,
- Heat damage, or
- Previously repaired steel sections,
- Unauthorized Welds,
- Utility Installation Connections.

14.4.2—Corrosion

The most recognizable type of steel deterioration is corrosion, or rust. Bridge inspectors should be familiar with corrosion since it can lead to a substantial reduction in member capacity. If the interface between two members is not properly sealed, moisture collection will result in rust to be packed into the interface. As the interface continues to rust, the rust expands or swells, putting addition tension on the connection fasteners (bolts / rivets). If the tension imparted into the bolts or rivets exceed their capacity, they will fracture and fall off of the structure. One of the primary methods to mitigate corrosion is painting with an acceptable coating and sealing the joints with an acceptable sealer.

14.4.3—Fatigue Damage

The most recognizable type of steel deterioration is corrosion, or rust. Bridge inspectors should be familiar with corrosion since it can lead to a substantial reduction in member capacity. If the interface between two members is not properly sealed, moisture collection will result in rust to be packed into the interface. As the interface continues to rust, the rust expands or swells, putting addition tension on the connection fasteners (bolts / rivets). If the tension imparted into the bolts or rivets exceed their capacity, they will fracture and fall off of the structure. One of the primary methods to mitigate corrosion is painting with an acceptable coating and sealing the joints with an acceptable sealer.

14.4.4—Collision Damage

Physical damage from impact of a vehicle or shipping vessel, or from natural occurrences such as floods, fires, or earthquakes also take their toll on steel and other structure bridge materials.

Nicks and gouges need to be clearly described and digital images integrated into the routine inspection report. Superficial nicks and gouges can be repaired simply by grinding them smooth, thereby removing the stress riser. More serious damage to weldable steel can be repaired by welding. More serious damages of non-weldable steel can usually be repaired by adding bolted splices. Requiring partial replacement due to nicks and gouges are rare.

14.4.5—Overload Damage

Steel is elastic (i.e., it returns to its original shape when a load is removed) up to a certain point, known as the yield point. After this point is reached, steel will deform or elongate and remain in this condition even after the load has been removed. This type of deformation is called plastic deformation. Plastic deformations due to overload conditions may be encountered in both tension and compression members. The symptoms in tension members are: Elongation, and Decrease in cross-section, commonly called “necking down”. The symptoms in compression

members are: Buckling in the form of a single bow, Buckling in the form of a double bow or “S” type, usually occurring where the section under compression is pinned or braced at the center point.

14.4.6—Heat Damage

Temperature change, especially for members on the sunny side, and wind loads also can have a deleterious effect on steel structures. High temperatures (> 120 degrees F) that might be the result of vehicular or transient fires will also most like have a huge effect on the structural capacity of the structural steel members.

Even though flame straightening is an acceptable repair method, it should not be employed on fracture-critical or primary tension members unless the flame-straightened area is fully supplemented by bolted splicing. Previously damaged / repaired areas should be inspected closely.

14.4.7—Common Definitions

Some common signs of distress include:

Bent or damaged members – determine the type of damage (e.g. collision, overload, or fire); measure the variance from proper alignment, check for cracks, tears, and gouges near the damaged location.

Corrosion – since rust continually flakes off a member, the severity of corrosion can not always be determined based simply on the amount of rust. Therefore, corroded members must be examined by physical as well as visual means.

Fatigue cracks – fatigue cracks are common at certain locations on the bridge and certain inspection procedures should be followed when fatigue cracks are observed.

Other stress related cracks such as those associated with Tri-axial shear or brittle fracture. Since these are so severe and occur so suddenly, they will require the inspector to immediately close the bridge. Then determine and document the length, size, and location of the crack.

As part of the field inspection and rating effort, construction plans, past inspection reports, and possibly design calculations and rehabilitation reports are usually available.

14.4.8—Guidelines for Assessing Corrosion Damage of Riveted Connections on Steel Super Structures

The purpose of this guideline is to provide the construction project inspector , bridge inspector and bridge maintenance personnel with guidance for determining the severity of section loss due to corrosion of riveted connections on steel bridge super structures. This information will assist the inspector in deciding whether or not particular rivets need to be replaced.

Two steps are generally required for the assessment:

- identification of connection type
- identification of damage to the rivet.

Some typical riveted connections are listed below:

- Truss member connections
- Built up girders , i.e. web to flange and stiffener connections
- Floor beam to girder or truss connections
- Stringer to floor beam connections
- Wind bracing connections
- Bearing member connections

These connection types can be categorized as either critical or non-critical but important depending on the loads at the connection and the availability of alternate load paths. The following list generalizes critical and non-critical connection types.

Critical Connections

Truss connections- Almost any connection of one truss member to another can be considered critical, irregardless of whether the connection is in tension or compression. Gusset plates are exceedingly complex in that the portion surrounding a tension member is in tension and the portion surrounding a compression member is in compression. To add to the complexity, some gusset plates have intermediate stiffeners installed as well. This makes each gusset plate extremely difficult to model in order to analyze the stresses contained in the steel gusset plates.

Built up girders connections- For riveted girders the connection of the web to flange, flange cover plates, flange and web splice plates are critical connections.

Floor beam to girder or truss connections- Typically floor beams are connected to truss or girder elements with angles. Many designs only attach web and others attach both the web and flange of the floor beam. This type of connection is critical.

Stringer to floor beam connections – Stringers are typically attached to floor beams with angles on the web only. Many times either the rivets break or the angles crack due to fatigue and are generally protected from the weather and hence corrosion.. These are critical connections.

Non-critical but important connections

Stiffeners on girders – The webs of built up girders typically have vertical and sometimes horizontal stiffeners that are riveted to the web. If there are no floor beams attached to these stiffeners they are important but non-critical.

Wind bracing – The connections wind bracing to either truss or girder elements is sometimes used in design. Under high winds these connections are very important but many times have alternate load paths available. These connections are generally important but non-critical.

Truss connections for stability members - Some truss designs employ “dummy” members that are used to prevent compression members from buckling. The connections of this type of member would likely be important but non-critical.

Bearing member connections – The riveted connections of bearing devices to either girder or truss elements is important but generally non-critical because failure of the rivets many times will not cause extreme problems unless the span over the bearing tends to lift during live load or the structure is a movable bridge. Many times this area is subject to corrosion due to the failing expansion joint over it.

14.4.8.1—Rivet Damage Identification

Rivets are generally designed as shear type connections as opposed to clamping type connections. In other words the members that are connected by rivets generally load the rivets in shear. Clamping type connections are generally reserved for threaded fasteners. Thus , in theory as long as the shank or body of the rivet is not damaged it can provide the shear strength it was designed for. In reality the heads on the rivets provide two important functions. First they keep the shank properly located in the holes of the parts being connected and second they will provide some clamping force if they were installed properly. Even though riveted connections are not designed to be slip critical it is not desirable to have relative displacement between connected parts.

Head damage- The two heads of a rivet are the easiest parts to examine visually. Below are some guide lines for rivet rejection based on section loss due to corrosion.

If 50% or more of either head on the rivet is gone reject the rivet.

If 25% or more of either head on the rivet is gone at the base of the head, i.e. where the rivet head bares on the plate, the rivet is rejected.

Shank damage-

If 10% or more of the rivet shank is gone the rivet is rejected. This is very hard to identify without removing a few rivets for examination. If pack or bleeding rust indicates that section loss of the shank is occurring it may be worthwhile to remove a few for inspection.

Replace or Leave as is?

In most cases the decision as replace damaged rivet or not is a judgment call that involves structural, environmental and economical perspectives. Many times damaged rivets are not discovered until a project is already let. This can complicate the later perspective. At a minimum it is prudent to stop or slow the corrosion on damaged areas. Other times replacement is absolutely necessary for public safety. The following will give guidance to the structural aspect of this decision.

If 10 to 20% or more of the rivets in a critical connection are rejectable then replacement of the damaged rivets is very important and should be strongly considered even if the project funding and schedule are intolerant of this extra work.

If 20 to 40% or more of the rivets on a non-critical connection are rejectable then replacement of the damaged rivets is very important and should be strongly considered even if the project funding and schedule are intolerant of this extra work.

In cases less severe than the above replacement can be postponed provided the corrosion activity has been greatly reduced. If there is any question as to replace or not seek advice from a structural engineer that is experienced in steel design.

Rivets should be removed by knocking one of the heads off with a pneumatic hammer with an bit that minimizes damage to the connection plates. After the one head is removed a second bit that resembles a punch is used to drive out the rivet. **The use of a cutting torch or plasma cutter should not be allowed.** After removal the affected area should be sandblasted and protected with an approved coating system. Replace removed rivets with threaded fasteners such as ASTM A-325. Tension fasteners in accordance with standard specifications section 560.

14.5—STEEL BRIDGE FATIGUE

14.5.1—Introduction

One of the most important aspects of steel bridge inspection is the determination of the bridge's potential for fatigue and/or fracture. Fatigue and fracture can lead to premature and possibly sudden failure of a portion of the bridge or of the entire bridge. Therefore, it is essential that fatigue and fracture inspections be performed to identify these potential failures before they occur. It also cannot be emphasized enough that the bridge inspector must be able to identify, visualize, and properly assesses those members that play an integral part of the load paths.

Fatigue failure of a material is the initiation and propagation of cracks due to repeated application of loads. Fatigue failures develop at stresses well below the material's yield point stress. Three factors are needed for fatigue to occur in metal:

- Tensile stresses
- Repetitive load, and
- Poor details that create high tensile stress concentrations.

It is absolutely imperative that a fatigue crack is not allowed to go unchecked because it may propagate to a size that would trigger a fracture of the structure in a very short period of time.

A steel bridge member may react to stresses in three ways: (a) deform elastically, (b) deform plastically, or (c) break. The amount of elastic or plastic deformation (strain) that occurs before fracture depends mainly on the magnitude of the applied loads, how they are combined, their cyclic and repetitive nature, and the residual stresses. When a bar specimen is subjected to bending, it elongates in the tension direction and contracts in all lateral directions an amount proportional to its width. This is called "necking down". The physical process of fatigue involves two basic phases: (a) crack initiation and (b) crack propagation or sub-critical crack growth. Crack initiation usually refers to the formation of cracks that are easily detectable. Thus, the crack initiation period may

extend for a substantial portion of the usable fatigue life where stress fluctuations are low. On the other hand, where stress fluctuations are high, or in the presence of cracks, notches, or other stress risers like areas of section loss, fatigue cracks will initiate quite early. When welds and other structural details are present, or where defects are unavoidable in the fabrication process, micro-cracks can propagate almost immediately with the first load application.

14.5.2—Fatigue Prone Detail Inspection Procedures

The bridge inspector is directed to periodically perform a close-up, hands-on, In-Depth (Fatigue Prone Detail) Inspection on all steel members that have a Fatigue Category E, E', or D detail, so their propensity to produce fatigue cracks can be documented and closely monitored. The specific procedure is to initiate the appropriate NDE Method(s) in order to locate, identify, assess, and document the presence of a fatigue crack in the steel members.

If an E, E', or some D category Fatigue Sensitive Details are located on a FC Member, their condition is reported on the FC Inspection Report. If the Fatigue Sensitive Details are located on a Non-FC Member, its condition is reported on the FP Inspection Report. The FC Inspection Report relates to the condition of the member, whereas, the FP Inspection Report relates to the condition of the fatigue detail.

In order to establish some organization, uniformity, consistency and to provide the report reader a clear picture of the details encountered, the bridge inspector is directed to obtain the following information:

- Location of the detail
- Identifying which FP Detail is present
- Assess the Condition of each detail, and
- Provide the associated Documentation

The inspector must plan to have a hands-on level of access in order to reach the details to be inspected. In addition, the inspector should have a magnifying glass and dye-penetrant kits on site, at a minimum, as they will be most helpful in the initial investigation. Lighting to ensure details are visible may also be critical on some bridges. Factors that need to be considered include the criticality of the detail, tension stress level, the over-all condition of the member, the estimated remaining fatigue life, ADTT, installed retrofits, and the inspection frequency.

If an inspector discovers a fatigue prone detail deficiency on a load path structural member, and assesses it to be critical, it should be immediately follow the “Bridge Inspection Follow-up Procedures” provide in Chapter 8 of this ODOT Bridge Inspection Manual. The action taken at this point may vary, and can involve closing the bridge to traffic, load posting, additional and special inspection with NDT equipment or repairs.

It is therefore, very important that the inspector communicates the findings in a timely manner. Ordinarily, the inspector would prepare and post the report on the Bridge Section Server (S7000b) in the Fatigue Prone Detail Folder.

When problems are identified, it is a good idea to go back and look at similar details throughout the bridge. Often inspectors have found cracks at other locations that had already been inspected. This demonstrates that it helps to know exactly where to look and what to look for on the other details.

14.5.3—Fatigue Prone Details

ODOT found a high number of steel fatigue cracks that were located on steel members throughout the State. As a result, ODOT decided to start performing an In-Depth Inspection entitled “Fatigue Prone Detail Inspections”, so their condition could be documented and closely monitored. For the most part, these details have been classified as having a Fatigue Category of E, E', or select D details:

- Groove Welds – (a) In longitudinal stiffeners, or (b) between longitudinal stiffeners and intersecting members.
- Ends of Welded Cover Plates on Tension Flanges – (a) At the toe weld or in the weld throat at mid-width of the flange on cover plates with end welds; or (b) at the end of longitudinal welds on cover plates without end welds.

- Ends of Attachment Plates Welded to Flange or Web – (a) Welded splices between adjacent parts, such as gusset plates; (b) repaired flanges or webs with doubler plates; (c) repaired webs using fish plates; (d) attachments for signs, railings, utility supports, etc., with attachment plate parallel to the girders; (e) welded attachment plates perpendicular to the girder.
- Diaphragm Connections – (a) Ends of welded diaphragm connection plates on girder webs where the plate is not connected to the flange (cracks may occur at the top or bottom of the connection plate when positive attachments are not made to the flange); (b) Ends of riveted connection plates on girder webs when the angles are not connected to the flange (web cracks are most likely when connection angles do not overlap the flange angles).
- End Connections of Floor Beams – (a) Copes and blocked flanges at ends of floor beams (cracks may occur at the reentrant angle of the cope or the blocked flange); (b) connection plates and angles as in diaphragm connections.
- Floor Beam Brackets – (a) Bracket connection to girder webs, as in diaphragm connections; (b) tie plates connected between top flanges of outside brackets and the floor beam.
- Top and Bottom Lateral Bracing Connections – (a) Gusset plate bracing connections to girders (web or flange) (when the gusset plate is attached to the web but not to the diaphragm connection plate, cracks may occur in the web gap at the toe of the weld); (b) gusset plate to diaphragm connection plate welds (displacement – induced forces develop in the diaphragms because of differential girder deflections).
- Tack Welds – (a) At tack welds used for attaching bridge components during erection (fatigue cracking often originates at these locations); (b) tack welds often occur between gussets and main members, bearing plates and beam flanges, and bolted connection angles and webs.
- Plug Welds – At any plug weld (made to correct a misplaced drilled hole, or in the field during repairs).
- Burn Holes – At any hole that was burned through the member rather than being drilled. These holes exhibit very rough edges which act as a stress riser.
- Attachments – with a welded connection that creates out-of-plane bending.

14.5.3.1---Groove Welds

Flange Groove Welds:

Relatively older structures with groove welds in flanges made prior to adequate nondestructive inspection.

Web Groove Welds:

Same comments as above.

Groove Welds in Longitudinal Stiffeners:

Longitudinal stiffeners on girder webs are structural components and the welds should be treated as structural welds. Older bridges seldom had these connections inspected.

Groove Welds Between Longitudinal Stiffeners and Intersecting Members:

Often lack of fusion exists in the transverse weld connection. This is particularly acute when no cope exists at the web.

14.5.3.2—Ends of Welded Cover Plates

Cover Plates with End Welds:

Crack develops at toe of weld or in throat of weld most likely at mid-width of flange.

Cover Plates Without End Welds

Cracks develop at end of longitudinal weld at the end of cover plate (and near flange tip).

14.5.3.3—Ends of Various Reinforcement or Attachment Plates Welded on Girder Flange or Web or on Truss Members

Welded Splices between Adjacent Parts; Lateral Gusset Plates:

These are equivalent to cover plates.

Repairs Using Welded Doubler Plates:

These are equivalent to cover plates if more than 8" long.

Attachments for Sign, Railings, Light Fixtures and Other Fittings with the Attachment Plate Parallel to the Bridge Members:

These are equivalent to cover plates if more than 8" long.

Welded Attachment Plates Perpendicular to the Direction of the Bridge Member:

These have higher resistance to fatigue than details described above.

14.5.3.4—Diaphragm Connections in Girder Bridge

Ends of Welded Diaphragm Connection Plates on Girder Webs where the Connection Plate is not Welded to the Flange:

Cracks may occur at the gap (cope), either horizontal along the web-to-flange weld, or at the top of web-to-connection plate weld. These cracks can occur at the upper and lower end of the connection plate when no positive attachment is made to the flange.

Ends of Riveted Diaphragm Connection Angles on Girder Webs where the Angles are not Connected to the Flange:

Cracks may occur in the web horizontal along the flange, or in the angles vertically, or in the first (highest or lowest) rivets. The web cracks are most likely when connections angles do not overlap the flange angles. Also, rivet heads or bolts may crack from prying.

14.5.3.5—End Connections of Floor Beams or Diaphragms

Copes and Blocked Flanges at Ends of Floor Beams:

Cracks may occur at the re-entrant angle of the cope or the blocked flange, particularly when the re-entrant angle is flame cut, with re-entrant notches.

Connection Plates and Angles may have cracks, similar to those described in 14.5.3.4.

14.5.3.6—Floor Beam Brackets

Bracket Connections to Girder Webs:

These are similar to diaphragm connections described in 14.5.3.4.

Tie Plates between top flange of Outrigger Brackets and the Floor Beams:

Cracks may develop from edge of rivet holes of these plates if connected to top flange of longitudinal girder. Relative movement also results in web cracks in the floor beam and bracket webs.

14.5.3.7—Stringer to Floor Beam Connections

Crack in Cope (14.5.3.5.1).

Crack in Connections (14.5.3.4).

14.5.3.8—Lateral (Wind) Bracing Connections to Girders

Gusset Plates Welded to Girder Web or Flange:

These plates are welded attachments (14.5.3.3). These gussets are also force-transmitting connection plates. When the gusset plate is attached to the web, but not connected to the diaphragm connection plate, cracks may occur in the web gap, at the toe of the weld.

Gusset Plate to Diaphragm Connection Plate Welds:

These welds are often groove welds similar to those described in 14.5.3.1, but are subjected to more forces. If the welds, joining the gusset to the web and the welds joining the gusset to the diaphragm connection plate intersect, high restraint develops in the region. The probability of defects in the high restraint region increases the possibility of fatigue crack growth. Special attention should be given to these types of details.

14.5.3.9—Traverse Stiffness

These intermediate stiffeners are not connection plates for diaphragms or floor beams. These stiffener plates are transverse attachments normally with adequate fatigue strength (14.5.3.3).

Occasionally, cracks may occur at the ends of cut-short intermediate stiffeners, due to handling or transportation during fabrication and construction. Excessive web plate vibration may also result in cracking. At fitted stiffeners, movement can be revealed by the paint film.

14.5.3.10—Box Girder Diaphragms and Connections

Connection Plates for X or K Type Interior and Exterior Diaphragms:

These connection plates are load-carrying members. Cracks may occur at the ends of the connection plates in the web gaps, as described in 14.5.3.4.

Interior Plate Diaphragms which are not Connected to the Tension Flange:

Cracks may develop in the web at the gap between the diaphragms and the flange.

Floor Beam Connections to Box Girder Webs:

Cracks may occur at copes or at connection plate or angel (14.5.3.4 and 14.5.3.5).

Girder Connection to the Pier Cap Box Girder:

Same comment as above, (14.5.3.4 and 14.5.3.5).

14.5.3.11—Truss Bridge Floor Beams

Connection of Floor Beam to Verticals:

Cracks may develop in connection angles, at rivet or bolt heads (14.5.3.4) or at copes (14.5.3.5).

Connection of Lateral (Wind) Bracing to Floor Beams:

Cracks may occur in horizontal gussets connecting the laterals to the floor beam flanges, or in the flange or web of the floor beam, often near bridge bearings.

14.5.3.12—Truss Bridge Verticals and Diagonals

Verticals near Bridge Ends:

Cracks may occur in the first vertical member, at the top near the gusset plate or in the gusset plate usually starting from a rivet hole. Cracks may also occur near the floor beam connection.

Verticals and Diagonals which are Eye-bars:

These flat eye-bars with enlarged heads may develop cracks at the pin holes when a forge lap exists. Cracks may also occur at the transition from the shank to the head when the bar edge is flame cut.

14.5.3.13—Pin-Connected Links or Hangers of Multi-Span Bridges

Eye-bar Links:

Cracks may occur at the ends of pin holes, at the width transition, or at the edge of bar (14.5.3.12).

Hanger Plates:

These plates are similar to eye-bar links, but without reduction of width. Cracks may occur at the pin holes or at the edge of the plate.

Most pin-connected links and hanger plates are subjected to in-plane bending, because the pins are not frictionless. Extra attention should be given to these links if corrosion and fixity is apparent.

14.5.3.14—Tack Welds

Tack welds which were used for attaching bridge components during construction and erection are often sources of fatigue cracks.

Tack welds between gussets and main members between bearing plates and beam flanges, between floor beam top flanges and outrigger bracket tie plates, between riveted and bolted connection angles and webs, etc. are examples.

14.5.4—Fatigue Prone Detail Inspection Frequency

Once located, all members that contain a fatigue prone detail will have an initial, hands-on, condition assessment that will be used as a base line. All follow-up NDE and In-Depth Inspections are to be performed at a frequency that is based on the condition of the member. Each FP Detail Inspection will be performed at, and based on, the lesser frequency of:

- Condition State Assessment – All FP Details will be given a hands-on initial Visual Inspection. The inspector will record information on the FP Inspection Form, post the report on the ODOT Bridge Server, and establish the inspection frequency of the next inspection. If the elements inspected are in

CS1 then the inspector should assign an inspection frequency of 120 months. Once the elements exhibit a change in condition state, then the inspector should use the following guide for scheduling future inspection dates:

- Inspect every 96 months if the Corrosion or Connection defect is in CS2 for that member.
 - Inspect every 48 months years if the Corrosion or Connection defect is in CS3 for that member.
 - Inspect every 24 months if the Corrosion or Connection defect is in CS4 for that member, or if the member has a previous NDE indication of the existence of an internal fatigue crack
- ADTT Detail Assessment – Frequency (Months) is based on the Fatigue Category of the Detail and considers the associated ADTT:

<u>Fatigue Category</u>	<u>D</u>	<u>E</u>	<u>E'</u>
ADTT <500	120	120	96
500 ≤ ADTT < 1500	120	96	48
1500 ≤ ADTT < 5000	96	48	24
5000 ≤ ADTT	48	24	24

Note: If there are two directions of traffic, use only half of the structures' ADTT (use one direction) to determine the frequency.

The Fatigue Prone inspection dates and frequencies should be entered into the Fatigue Prone fields on the ODOT Inspection tab of BrM (Pontis). Any Ultrasonic Testing associated with the Fatigue Prone inspections should be recorded in the Bridge Inspection Notes section and the Fatigue Prone supplemental report. UT information should include a description and date of what was tested.

- For redundant Pin & Hangers:
 - Conduct an initial baseline Ultrasonic Test (UT) of the hanger at the Pin locations using approved operator, equipment and procedures. Record the UT date under the Bridge Inspection Schedule for Pin & Hanger Inspection. Conduct an additional UT if the hanger element condition state enters CS4.
- For Non-Redundant Pin & Hangers – See Section 14.7.5.1

14.6—REDUNDANT FATIGUE PRONE DETAIL INSPECTION REPORT

In order to provide uniformity and consistency in the report form, ODOT decided that these supplemental inspection reports need to contain the following information:

- Location
 - Bridge Location – report header information
 - Bridge Schematic – Plan and Profile Views (Identify Members w/FP Details)
 - List of specific members
 - Identify
 - Member description
 - FP Structure Type
 - FP Member Type
 - Member description
 - Dated Condition Assessment, Associated Remarks, Maintenance Recommendations
- Element Condition States
- Defect Flags: Pack Rust, Steel Corrosion, Fatigue Cracks
- Images / Sketches

Location – Bridge Location / Report Header

Bridge Name
Bridge Number
Location (Hwy / MP)
Owner
Year Built
Date of the Inspection
Last Inspector
Inspection Agency / Firm

Location – Bridge Schematic

- a. Sufficient detail that anyone can locate the members that have FP details.
- b. Narrative description of any fatigue prone detail(s) that are located on a FP member and accompanied with a typical photo or sketch.

Location – Specific Members

Structure Type
Span
List each member that have E, E' or some D fatigue prone details.

Member Description

FP Member Type
(Measure of Internal Redundancy & Propensity for crack migration)
All Hanger Assemblies
Welded, Direct Tension
Welding – Bending
Riveted / Bolted, Tack Weld
Riveted / Bolted, No Welding
Rolled Section

Condition Assessment and Associated Remarks

- Note the condition of each FP member
- Note type and location of any fatigue sensitive details on the member

Images / Sketches

- Note whether a digital image is and where it's located

Summary

- The total number of FP members on the structure
- Overall condition assessment summary
- Method of Access
- Note whether traffic control was required
- Time to Inspect

14.7—FRACTURE CRITICAL BRIDGE INSPECTIONS**14.7.1—Introduction**

Using the recent Minnesota bridge collapse as an example, bridges are normally taken for granted by the public and are crossed without notice or concern. Only when problems occur is there a reaction. A road that was closed because of an unsafe structure brings a predictable reaction and the closed bridge quickly becomes the most important bridge in the area. Questions are then asked such as: Why was the condition permitted to deteriorate? Who's responsible?

Unless the inspector and/or their supervisor fully understand where to look and what to look for during the inspection, they will be ineffective. To evaluate the way in which a deficiency affects safety often require an appraisal of its significance on the structural stability of the bridge. The following questions should be considered:

- Is the deficiency located on a critical member of the bridge?
- Is the deficiency located at a critical point on the member?
- If the member fails, will it cause the bridge to collapse?
- Will other load-carrying members provide adequate resistance to support the bridge?
- Should the bridge be closed to traffic to prevent any possible catastrophe?

The bridge inspection team should realize the importance of recognizing which bridges contain fracture critical members and know where those fracture critical members are within the bridge. Having established this, the inspection team can then proceed with planning the inspection work.

The purpose of the inspection plan is to identify unique requirements of a specific bridge. If the bridge is small and not complex, the inspection plan may consist of only routine procedures except that the FC members are given special attention to reflect their criticality. Large complex structures often require considerable preparation and coordination to accomplish the FC inspection.

One of the big differences between a Fracture Critical Bridge Inspection and a Fatigue Prone Detail Inspection is as follows:

- A FC Inspection is associated with the non-redundant configuration of the bridge and the member connections, whereas,
- A Fatigue Prone Detail is associated with how sensitive a particular detail is to fatigue cracking or the difficulty to adequately assess the condition of a redundant structural detail.

A fracture critical bridge may have numerous fatigue prone details. Certain design details have proven to be more susceptible to fatigue cracking. Fewer number of tensile stress cycles on these details are needed to cause cracks to initiate and propagate. These fatigue prone details can lead to the collapse of a fracture critical bridge.

Even though a FC Inspection zero's in on specific members that have been determined to be fracture critical, the assigned inspector must also be very cognizant of and pay particular attention to the Fatigue Prone Details that are located on a FC Member. For the most part, steel cracks are frequently a result of fatigue or cyclic loading that is occurring near, a weld, a material flaw, or a change in the cross section of the member. Also the following list of Category E or E' details tend to be very sensitive to fatigue cracking and must be closely inspected. Therefore, each inspector is directed to note the specific locations of these details and provide a narrative description of their condition:

- Coped Corners
- Built-up member using a welded cover plate
- Detail attached with a groove weld that is subject to longitudinal loading
- Intermittent fillet weld connections
- Rough burn holes in the member
- Nicks and gouges, deeper than 1/4"
- Corroded areas with more than 20% section loss of cross-sectional area
- Unauthorized field attachments, welded to a tension member
- Rough welds in a tension zone – start / stop defects or undercuts

A list of supplemental reports and documents outlining the general design and inspection processes can be found in Chapter 28.

14.7.2—Fracture Critical Members

The definition of a Fracture Critical Member provided in CFR 650.305 is a steel member in tension, or with a tension element, whose failure would probably cause a portion of or the entire bridge to collapse. This is to say that after the crack occurs, failure of the member could be quite sudden. For that reason a steel bridge with any of the following structural configurations or components should be closely observed during every inspection so their physical condition can be properly assessed. CFR 650.305 also states that the inspection of these structures must be "Hands-on", or within arm's length of the component:

- One or two-girder systems,
- Multiple Girder system where girder spacing is greater than 12' and Floor-beams.
- Double or single welded box girders
- Steel pier caps and cross girders
- Two truss systems
- Suspended spans
- Tied arches
- Pin and hanger connections on two girder systems.
- Pin and hanger systems where girder spacing is greater than 12'.

Redundancy is the ability of the other members to help carry the load when a member becomes weak or fails. A two-girder bridge or a truss is considered non-redundant since the other members are unable to help share the load, and therefore these bridges are fracture critical.

A fracture critical member is a member in **tension**. This causes cracks to grow and a fracture to occur. A member in axial tension is stressed the same throughout the cross section for the total length between connections. Hangers, suspension cables and some truss members normally are stressed in axial tension. Direct tension members, even though they may have no welding associated with them are the most critical because they are usually used in situations where virtually no redundancy exists, and defects can initiate and grow to possibly critical flaw size without being detected. Eye-bars and hangers that have been repaired by field welding become highly susceptible to fatigue cracking.

Members in bending have variable stresses throughout. On a simple beam, the maximum tension is in the bottom flange at mid-span. An equally important location on a continuous span is the top flange over the support. High stress may also be concentrated at locations along a member when the cross section changes or where there is a discontinuity.

Many of the problems being discovered in in-service bridges are associated with **weld terminations** or defects which are inherent to the welding process. Welding of structures generally started in the 1950's. The state-of-the-art at that time, both from a welding procedure standpoint, as well as shop inspection techniques that were available, makes it very likely that defects are present, and the bridge inspector now has to find them before they reach the critical flaw size. Welds made in the field are especially susceptible to fatigue cracking. Even tack welds could initiate cracking under certain conditions.

A FCM is endangered by corrosion which can lead to loss of section, pack rust and shortened fatigue life. Proper maintenance and painting can reduce this problem. Rust can build up between plates and add additional stresses to members

EXAMPLES OF FRACTURE CRITICAL BRIDGES

The following is a partial list of examples of bridges which are fracture critical (See Report No. FHWA-IP-86-26, Inspection of Fracture Critical Bridge Members):

1. **Suspend Spans with Two Girders;**
Links and hangers and the connecting pins are susceptible to fatigue cracking; pack rust can push hangers off pins.
2. **Bar-Chain Suspension Bridge with Two Eye Bars Per Panel;**
Fracture critical condition depends on the ability of a single eye bar and the joint at panel point to resist loads if one eye bar is fractured.
3. **Welded Tied Arches with Tie Girder;**
Partial length cover plates, diaphragm and floor beam connections, or details with low fatigue strength (e.g., AASHTO Stress Category D, E, E') may initiate fatigue crack growth in the tie and subsequent brittle fracture.

4. **Simple Span Trusses with Two Eye Bars Between Panel Points;**
If the floor system is rigidly connected to the verticals (hangers), redistribution of forces can take place in the event of eye bar fracture, but bridge deflection would be excessive. If not connected, same as #2 above.
5. **Simple Span Single Welded Box Girders;**
Fatigue cracks could develop at fatigue sensitive details, such as at termination of longitudinal stiffeners, diaphragms, or gusset plates, leading to fracture of the box. Such fatigue crack growth would normally propagate at moderate rate, hopefully allowing time for inspections and discovery before fracture.
6. **Simple Span Two Girder Bridges;**
Where the floor system, including the deck and the lateral bracing members, provides alternative load paths and redundancy, fracture of one girder would not cause collapse of the bridge but could lead to excessive deck deflection. If alternative load paths do not exist, it is fracture critical.

Where the lateral bracing connected to horizontal gusset plates which are attached to webs; differential forces in laterals could cause fatigue cracks in girder web at the ends of the gusset plates, particularly when the gusset plates are not attached to the floor beam or diaphragm connection plate. The vertical crack could grow toward the tension flange and may cause brittle fracture.
7. **Continuous Span Two Girder System with Cantilever and Suspension Link**
Arrangement or Welded Partial Length Cover Plates;
Fracture of a girder will render the unit a system with simple spans. The end spans and suspended spans are fracture critical as in #6 above.
8. **Single Welded I-Girder or Box Girder Pier Cap Supporting Bridge Girders or**
Stringers;
Continuous multi-girders or stringers with bridge deck may permit redistribution of forces providing alternative load paths. If simply supported, the cap is fracture critical.

14.7.3—FC Bridge Inventory

A fracture critical member (FCM) is a member in tension or reversal (or with tension element) whose failure would cause the bridge (or a portion of the bridge) to collapse. Tension elements of a bridge member consist of those portions of a flexural (bending) member that are subjected to tension or reversal stress. Fatigue is the primary cause of failure in fracture critical members. Therefore, fatigue and fracture inspections are especially critical for bridges with FCM's (FCM Bridges).

The purpose of a fatigue and fracture inspection is to identify and record the location of fatigue sensitive details and any problems or potential problems at these locations in order to determine the safety of the structure. For bridges with fatigue-prone details, these inspections provide a history of cracking (time of initiation, rate of growth, etc.) that can greatly assist the engineer in determining the need and priority of repairs and in estimating the remaining life of the bridge.

Bridges with fatigue sensitive details can be classified into two groups according to the degree of redundancy. There are three types of redundancy related to the basic structural makeup of the bridge. The first type of redundancy, Load Path redundancy, determines whether a bridge is fracture critical or not. Fracture critical bridges have no load path redundancy and if the load path fails, the bridge, or a portion thereof, have a potential of collapse. State differently, fracture critical bridges are Non-Redundant Structures. The other types of redundancy, Structural Redundancy and Internal Redundancy, help to determine the criticality of non-redundancy fracture critical structures.

Of the 6,500 public bridges in the State of Oregon, 359 (state & local bridges) are fracture critical. While developing and implementing the fracture critical bridge inspection program for the State of Oregon, ODOT

submitted a proposal to FHWA requesting that in-depth, hands on, fracture critical inspections be performed at a frequency based on a fatigue analysis that is calculated for each bridge in-lieu-of the 24 month frequency specified above. On an interim basis, until the fatigue analysis could be completed, the inspection frequency was to be determined using a flowchart developed by ODOT. The frequencies obtained from both of these processes were consistently longer than the 24 month FHWA requirement. In response, FHWA was in agreement with the approach proposed by ODOT, but they still wanted the NBI file to reflect that routine fracture critical inspection be performed at the 24 month maximum frequency. FHWA's extended frequency approved lasted until 2005 at which time it was rescinded. ODOT is currently performing all FC Inspections on a 24 month frequency.

As per FHWA requirements, working with and through the 5 ODOT Region Bridge Inspectors, the Assistant Bridge Inspectors and the Local Agency Bridge Inspection Coordinator, the ODOT Bridge Operations Engineer, prepared and is maintaining an inventory of bridges which contain fracture critical members, the location and description of such members on the bridge and the inspection frequency and procedures for inspection of such members. All of which has received concurrence from FHWA.

14.7.4—Fracture Critical Inspections

CFR 650.305 specifies that the Fracture Critical Member Inspection must be a hands-on inspection that may include visual and other nondestructive evaluation. Therefore, ODOT decided to establish two specific types of FC inspections, both of which require a close-up, hands-on level of inspection. The first type is a visual inspection using standard, readily available tools. The second type dictates that an additional level of effort is employed by bringing in a higher level of expertise or employing a more sophisticated non-destructive testing method that might require specialized training. Each type of inspection is appropriate for a given circumstance.

A. Preparation

FC Inspections

The level of access for a FC inspection is close-up and hands-on. In accordance with CFR 650.311(c)(1) this inspection is generally a visual inspection and occurs at least every 24 months, unless conditions dictate a more frequent inspection is warranted. All fracture critical bridges will receive at least a FC Inspection. The date of the inspection and frequency is coded in the Bridge Structure Inventory (SI & A) file in NBI Items 92A and 93A.

Ideally the FC Inspection will coincide at the same time as the routine inspection of the bridge. However, if any of the following conditions exist, the FC Inspection could occur at a frequency more often than the specified 24 months:

- If the base metal is A7, A8, A94, A242, A440, A5, A14, or A517steel, or
- If the Fatigue, Section Loss, or Pack Rust SF is on for the FC member and is in CS 3 or 4.

A fracture critical bridge inspection begins before the bridge inspection crew arrives at the bridge. The crew should study the maintenance file carefully while still in the office. It is important for each inspector to understand which members are fracture critical and where the fracture critical zones are located. Fatigue prone details should also be identified. A copy of the plans with the fracture critical areas marked on them should be taken along. Records of damage to the structure due to collision or corrosion and repairs are also important. In addition, to access equipment, such as ladders and snooters, the crew may need special tools such as magnifying glasses, spotlights, or dye penetrant testing kits. Pre-made forms listing the locations to be inspected and the data to be collected would be helpful.

When more than one person is making the inspection, it is important to coordinate the activities. It is the team leader's responsibility to insure that duplications and omissions in inspection of FCM's are minimized. Data collection should also be coordinated so that it can be easily put into a report.

B. Inspections

The inspection should begin with a general evaluation of the structure and fracture critical members. Look for things such as misalignment of spans either horizontally or vertically. Unusual movement or noise might also

indicate serious problems. During the overall evaluation, inspectors should also look for distortions or damage created by traffic, flooding, etc.

After the overall evaluation, each member and each fracture critical detail should be checked closely. The inspector should focus on tension zones of fracture critical members and fracture critical connections.

The inspector's eye should be within 24" of the surface. The member should be viewed from all sides and all angles. The inspector should use additional light and magnification to evaluate the member if necessary.

C. Inspection Reports

By definition, fracture critical bridges are prone to failure which may result in a catastrophe. It is important that the inspection of a fracture critical bridge be documented thoroughly and accurately. This should include a narrative description of all FCM's whether there are problems or not. Photographs and sketches should be included. Where there are many details and findings, tables and charts are also necessary. The data should be organized efficiently for ease in interpreting the report. The data should provide information on why problems occurred (out-of-plane bending, poor weld, corrosion, etc.). Repairs are only effective when the cause of problem is known. The report should also include conclusions, a summary of the findings, and repair or rehabilitation recommendations.

D. What do you do if a Defect is found.

Identification of a defect should initiate appropriate follow-up action to prevent a failure. It is therefore, very important that the inspector communicates the findings in a timely manner. Ordinarily, the inspector would prepare and post the report on the Bridge Section Server (S7000b) in the Fracture Critical Folder. This procedure is adequate for problems assessed as not requiring immediate attention.

If an inspector discovers a defect on a FC member, and assesses it to be critical, it should be immediately follow the provision provide in Section 8.4 of the ODOT Bridge Inspection Manual. The action taken at this point may vary, and can involve closing the bridge to traffic, load posting, additional and special inspection with NDT equipment or repairs. In either case, the procedure "Follow-up Action On Critical Bridge Repair Recommendations" shall be implemented.

When problems are identified, it is a good idea to go back and look at similar details throughout the bridge. Often inspectors have found cracks at other locations that had already been inspected. This demonstrates that it helps to know exactly where to look and what to look for on the other details.

Follow-up Action on Critical Bridge Repair Recommendations

The following procedure shall be followed when a FC bridge member has a NBI condition rated "3" or less, or an Element Rating of CS4. These rating are indicating that the "member has major defects, is failing, and is inadequate to support truck traffic":

The Bridge Inspector will initiate the process and two report forms:

Immediately notify and appraise the bridge owner as to the severity of the condition and suggest load restrictions be implemented.

Recommended repairs shall be completed within two months of an initial report. If the deficiency endangers the load-carrying ability of the bridge, immediate action will be taken. This may entail emergency repair and/or load restrictions.

When the repair is made, a note indicating the action taken shall be placed on the inspection report by repair personnel in charge and sent to the RBI. The RBI shall amend the bridge inspection report and forward a copy to Bridge Operations to show the condition rating of the bridge element with the repairs, and an Oregon Bridge Inventory sheet with revisions and repairs noted under "Maintenance Notes".

If no repair action is implemented within three weeks for deficiencies other than maintenance, since the deficiency is considered a critical finding, the recommendation will be reviewed with the bridge owner inquiring as to the status of the work and why corrective action has not been taken.

Bridges requiring load posting will be load rated by either the bridge owner or ODOT Bridge HQ. If the load rating is performed by the bridge owner, ODOT Bridge HQ will review the calculations. Signing reflecting the load restrictions will be installed. Paperwork including the bridge inspection report and Oregon Bridge Inventory sheet with the posting items coded and photographs showing the bridge with the signing shall be placed in the bridge inspection file.

14.7.5—Fracture Critical Inspection Procedures

14.7.5.1—Pin and Hanger Connection Inspection Procedures

Hanger Plates:

1. Try to determine whether the hanger-pin connection is frozen. Check under live load movement of the hanger relative to the pin.
2. Check hanger plates for cracks.
 - a. Visual inspection.
 - b. Dye penetrant test to verify visual suspects.
3. Observe the amount of corrosion build-up between the webs of the girders and the back faces of the plates.
4. Check the hanger plate for bowing or out-of-plane movement from the webs of the girders. If the plate is bowed, check carefully at the point of maximum bow for cracks.
5. Check the hangers for welds. Check welds for cracks.
6. Measure the distance from the girder web to the hanger plate at top and bottom.
7. Check the deck joint for signs of leakage on hanger assemblies.
8. Conduct an initial baseline Ultrasonic Test (UT) of the hanger at the Pin locations using approved operator, equipment and procedures. Record the UT date under the Bridge Inspection Schedule for Pin & Hanger Inspection. Conduct an additional UT if the hanger element condition state enters CS3 and CS4 (test for each change in CS).

Pins

1. Check pin retaining devices for tightness and positioning; pin nuts, pin caps, pin cap retaining bolt. Check the pin caps for warpage or bowing.
2. Check wear on pin and hanger.
 - a. Measure the vertical misalignment of the deck expansion joint over the hanger connection.
 - b. Measure the clearance between the pin and the pin holes with wire gauges.
 - c. Measure dimensions on the hanger assembly.
 - 1) Locate the center of the pin.
 - 2) For pin and hanger assembly, measure the distance between the center of the pin and the end of the hanger.
3. Compare dimensions to plan dimensions. If plans are not available, compare to previous measurements to determine section loss.
4. Conduct an initial baseline Ultrasonic Test (UT) of the Pin using approved operator, equipment and procedures. Record the UT date under the Bridge Inspection Schedule for Pin & Hanger Inspection. Conduct an additional UT if the hanger element condition state enters CS3 and CS4 (test for each change in CS).

14.7.5.2—Two-Girder System Inspection Procedures

Welded Members:

1. Check all transverse groove welds for cracks, especially near backup bars.

2. Check all transverse stiffeners and connection plates at the connection to the web, particularly at floor beams and lateral bracing where out-of-plane bending is introduced.
3. If longitudinal stiffeners have been used, check any butt weld splices in the longitudinal stiffeners. The web at the termination of longitudinal stiffeners should also be checked.
4. If cover plates are present, check at the end of each cover plate.
5. Observe any area of heavy corrosion for pitting section loss or crack formulation.
6. If girders have been haunched by use of insert plates, check the transverse groove welding between the web and insert plate.
7. Check longitudinal fillet welds for possible poor quality or irregularities that may cause cracking to initiate.
8. Check for cracks at any intersecting fillet welds. If triaxial intersecting welds are found on a fracture critical member, they should be reported and carefully examined in future inspections.
9. Check any plug welds.
10. Check bolted splices for any sign of cracks in girders or splice plates and look for missing or cracked bolts.
11. Check the entire length of the tension flanges and web for cracking which may have originated from corrosion, pitting or section loss, or defects in fabrication (e.g., nicks and gouges).
12. Check entire length for temporary erection welds, tack welds, or welded connections not shown on the design drawings.

Riveted or Bolted Members:

1. Check all rivets and bolts to determine that they are tight and that the individual components are operating as one. Check for cracked or missing bolts, rivets and rivet heads.
2. Check the member for misplaced holes or repaired holes that have been filled with weld metal.
3. Check the area around the floor beam and lateral bracing connections for cracking in the web due to out-of-plane bending.
4. Check the entire length of the tension flanges and web for cracking which may have originated from corrosion, pitting or section loss, or defects in fabrication (e.g., nicks and gouges).
5. Check entire length for temporary erection welds, tack welds, or welded connections not shown on the design drawings.

14.7.5.3—Truss Tension Members Inspection Procedures

Riveted or Bolted Members:

(Chords, diagonals or verticals)

1. Check each component to see that loads are being evenly distributed between them by attempting to vibrate members by hand and that batten plates and lacing are tight. Check for loose components. Strike with hammer and check ring.
2. Check carefully along the first row of bolts or rivets for cracking. The first row is the row closest to the edge of the gusset plate and perpendicular to the axis of the member.
3. Check for nicks, gouges and tears due to impact from passing vehicular traffic.
4. Observe carefully for cracks any tack welding used either in construction or repairs. Any tack welds shall be recorded.
5. Check for other repair welds and plug welded holes. Check for fatigue cracks at welded locations. Record welds.

Welded Members:

(Chords, diagonals or verticals)

1. Check all longitudinal welds the full length of each member.
2. Check all joints at the ends of members including gussets.
3. Check all transverse welding including internal diaphragms in box members.
4. If connections are welded at gusset plates, check welds.
5. Check for nicks, gouges and tears due to impact damage and for repairs made using tack welding.
6. Box sections or other sections welded with back up bars should be checked for discontinuity in the back up bars.

7. Portions of members which are difficult to access must be checked for corrosion.
8. Examine members for any sites of arc strikes.
9. Check for other repair welds and plug welded holes. Check for fatigue cracks.

Eyebar Members:**(Chords, diagonals, or verticals)**

1. Inspect the area around the eye and shank for cracks. Dye penetrant test suspect areas.
2. Examine the spacers on the pins to be sure they are holding the eye-bars in their proper position.
3. Check pin retaining devices for tightness and positioning; pin nuts, pin caps, pin cap retaining bolt.
4. Examine closely spaced eye-bars at the pin for corrosion build up (pack rust).
5. Check for wear or cracks where a member rests on another member.
6. Evaluate and record weld repairs and unauthorized welds.
7. Check to determine if any eye-bars are loose (unequal load distribution) or if they are frozen at the ends (no rotation).
8. Ultrasonic Test the pins using approved operator, equipment and procedures. See the Bridge Inventory for frequency of test.

Counters:

1. Check the looped rod for cracks where the loop is formed.
2. Observe the counters under live load for abnormal rubbing where the counters cross, and check this area for wear.
3. Examine the threaded rods in the area of the turnbuckle for corrosion and wear.
4. Test the tension in each rod to be sure they are not over-tightened or under-tightened. The relative tension can be checked by pulling transversely by hand.

14.7.5.4—Cross Girder at Pier Inspection Procedure**Riveted Members:**

1. Check all rivets and bolts to determine that they are tight and that the individual components are operating as one. Check for cracked or missing bolts, rivets, and rivet heads.
2. Check the member for misplaced holes or repaired holes that have been filled with weld metal.
3. Check the area around girder and lateral bracing connections for cracking in the web due to out-of-plane bending.
4. Check the entire length of the tension flanges and web for cracking which may have originated from corrosion, pitting or section loss, or defects in fabrication (e.g., nicks and gouges).
5. Check entire length for temporary erection welds, tack welds, or welded connections not shown on the design drawings.

Welded Members:

1. Check all transverse groove welds for indication of cracks.
2. Check all transverse stiffeners and connection plates at the connection to the web, particularly at girders and lateral bracing where out-of-plane bending is introduced.
3. If longitudinal stiffeners have been used, check any butt weld splices in the longitudinal stiffeners. The web at the termination of longitudinal stiffeners should be checked.
4. If cover plates are present, check at the ends of each cover plate.
5. Check areas of heavy corrosion for pitting section loss or crack formation.
6. If girders have been haunched by use of insert plates, check the transverse groove welding between the web and insert plate.
7. Check longitudinal fillet welds for possible poor quality or irregularities that may cause cracking to initiate.
8. Check for cracks at any intersecting fillet welds. If tri-axial intersecting welds are found on a fracture critical member, they should be reported and examined in future inspections.
9. Check any plug welds.

10. Check bolted splices for any sign of cracks in girders or splice plates and look for missing or cracked bolts.
11. Check the entire length of the tension flanges and web for cracking which may have originated from corrosion, pitting or section loss, or defects in fabrication (e.g., nicks and gouges).
12. Check entire length for temporary erection welds, tack welds, or weld connections not shown on the design drawings.
13. Portions of members which are difficult to access must be checked for corrosion.

14.7.5.5—Tied Arches Inspection Procedure

Riveted or Bolted Members:

1. Observe built-up members to assure that the load is being evenly distributed to all components and that batten plates, lacing and ties are right. Check for loose components. Strike with hammer and check ring.
2. Check the bolts or rivets at all connections (hangers, floor beams, and end reactions) for cracks.
3. Check if any repairs or construction techniques have made use of tack welding and check for cracks.
4. Check the area around the floor beam connections for cracks due to out-of-plane bending of the floor beam and for cracks in rivet and bolt heads due to prying action.
5. Check for corrosion areas with potential loss of section. Check inside of box-shaped members.
6. If pins are used, check retaining devices for tightness and positioning; pin nuts, pin-caps, pin-cap retaining bolt.
7. Ultrasonic Test the pins using approved operator, equipment and procedures. See the Bridge Inventory for frequency of test.
8. Check the members under live load for areas of rubbing, and check the area for wear.

Welded Members:

1. Check all welds for the entire length of the member.
 - a. Corner welds where the web and flange plates are jointed.
 - b. All fillet welds inside the girder.
 - c. Check for tri-axial intersecting welds, irregular weld profiles and possible intermittent fillet welds along the back up bars.
2. Locate and inspect all the internal diaphragms and transverse butt welds.

Check transverse connections at floor beams. The usual location of a crack is near the corners, particularly if there is any gap between the floor beam diaphragm and the web plates. Clean and use a dye penetrant test.

14.7.5.6—Cable

(Check List for Assessment of Corrosion Damage to Suspension Bridge Main Cables)

Exterior Cable Survey:

1. Review drawings of the bridge, including major components such as bands and anchor assemblies.
2. Inspect cables externally by performing the following tasks:
 - a. Walk the cables to check condition of paint, locate any gaps in the wrapping, and inspect the band packing.
 - b. Inspect the underside of the cables with binoculars to check for rust stains, water leakage from the cables, chipped paint, and band packing pop-outs.
 - c. Check for presence of drains in the packing on the underside of the banks.
3. Note all wrapping disturbances or signs of possible corrosion problems in the cables on sketches of the bridge.

Cable Interior Wire Corrosion Assessment:

(Do not perform without Engineer's prior review and approval)

1. Review exterior cable survey sketches to select portions of the main cables to be subject to interior inspection. Rank severity of indications as follows:
 - a. Rust stains,
 - b. Water leakage from the cables,
 - c. Chipped paint on undersides of the cables,
 - d. Bank pop-outs,
 - e. Paint or wrapping failures on topside of cable (those can be the most important indication if the failures are severe).
2. Select at least four locations per cable for interior wire corrosion assessment (the locations should vary along each cable – select at least one location near mid-span of the bridge for each cable).
3. Install cable inspection port or alternatively strip all wrapping from the cable along a panel (band-to-band) at each designated inspection location.
4. Visually inspect the interior wires and strands.
5. Note and record the progression of corrosion on the wires.
 - a. If Stage 3 or 4 corrosion exists, inspect the lowest outer strands for corrosion cracking in the wires.
 - b. If Stage 4 corrosion is detected, consider stripping the remaining wrapping from the panel, if the inspection report is employed, and also consider stripping the wrapping from adjacent panels.
 - c. If Stage 4 corrosion is detected, consider inspecting interior strands by wedging the lower strands apart.
 - d. If cracked wires are detected, unwrap the adjacent panels and inspect them for broken wires.
6. Reseal the cables.
7. Review the inspection results and determine the need for more extensive inspections or remedial work.

14.7.5.7—Anchor House Inspections

1. Review drawings of the anchorages and details.
2. Inspect exterior of anchor house including cable entrance (usually the splay saddle).
3. Inspect the interior of the anchor chamber for signs of excessive moisture.
4. Examine the splay saddle for signs of washing of debris or rust from the cables.
5. Determine the corrosion condition of the wire in the anchor chamber:
 - a. If Stage 3 or 4 corrosion is detected, closely inspect the wires for corrosion cracking.
 - b. Inspect the strand socket openings for signs of wire corrosion (if pre-stranded wire is employed)
 - c. Inspect wires along the looped ends, including tangent points at the strand shoes (if spun wire is employed).
 - d. Record corrosion damage found on the wires and signs of excessive moisture in the anchorage chambers.
6. Review the inspection results to determine the need for further inspection and remedial work.

NOTE:

Deterioration of galvanized helical strand was observed to occur in four stages. In stage 1, the strand wires were shiny with random signs of zinc corrosion. During stage 2, the zinc would be partially corroded revealing a white corrosion product, but no ferrous rust would be present. In stage 3, the zinc would be depleted with occasional spots of ferrous rust. During stage four, the zinc corrosion product would be largely displaced by ferrous rust. Cracking was possible during stage three and could be expected during stage four.

14.7.6—Fracture Critical Inspection Documentation

1. Take photographs and use sketches to record defects and condition.
2. Annotate photographs and sketches to provide:

- a. Date
- b. Identification of member
- c. Measurements
- d. Location and type of defect
- e. Cross reference photos to sketches and sketches to photos
3. Record:
 - a. Identify member
 - b. Condition:
 - 1) Type of deterioration
 - 2) Type of defect
 - 3) Type of damage
 - 4) Description if no notable problems
 - c. Location of problems
 - d. Dimensions of problems
 - e. Loss of material or section
 - f. Cause, if known
4. Summary and conclusions.
5. Recommendations:
 - a. List of repairs required:
 - 1) Urgent
 - 2) Programmed
 - b. Rehabilitation
 - c. Maintenance
 - d. Special inspections
 - e. Other

14.8—FRACTURE CRITICAL BRIDGE INSPECTION REPORT

Good reporting is the key to any successful inspection program. Before any repair tasks on the structure are undertaken, the inspection Report should be reviewed to assess the impact on the structure. The important questions of what, where, why, when, and how must be answered. The goal of the inspection report is to provide a detailed verification of the inspection. The report must be comprehensive and should be developed with the thought that it may be used in a liability issue to substantiate the thoroughness of the inspection effort and the validity of the findings resulting from the inspection. The report provides a record of the present condition and a history of the structure's performance.

FC Report Format - ODOT's normal procedure is for the assigned bridge inspector to find and report the condition of each structural member on a bridge in such detail that the load rating engineers can adequately evaluate the structural integrity of each member. All supplemental condition assessment reports are dynamic in that they contain an ongoing historical condition of each member. Well documented reports, over many years, provides a historical sense as to the rate of deterioration. The importance of this history may not be readily apparent, but many defects become more obvious as time passes. Viewing these deficiencies over the course of several inspection cycles, may show a pattern indicating a problem which needs to be addressed.

Elements of the ODOT FC Inspection Report

- **Pertinent Bridge ID Information**
- **Bridge Inspection Notes**
 - Bridge Notes
 - Inspection Notes
- **System that clearly identifies which members are FC**
- **Condition description of each FC member**
- **Supporting Remarks**

Pertinent Bridge ID Information – Information about the bridge:

Bridge Name,
 Bridge Number,
 Highway Number,
 Milepost,
 Owner,
 Year Built,
 Highway District,
 County,
 FC Structure Type,
 FC Member Type,
 FC Inspection Level and Frequency,

FC Bridge Inspection Procedure Cross Reference – The appropriate FC Bridge Inspection Procedures, contained in Section 14 of the ODOT Bridge Inspection Manual, are categorized by the type of steel superstructure and member type.

Bridge Inspection Notes

Date of each Inspection, Name of the FC Inspector-of-record, Inspectors Signature.
 Method used to gain access to each portion of the bridge
 Whether confined spaces are located on the bridge and how they were mitigated
 Fall restraint systems located on the bridge, manufacture, usage notes, and condition.
 NDE Methods that were employed on which members during the inspection

Identification of FC Bridge Members -The report needs to clearly identify all FC members so the bridge inspectors and bridge maintenance personnel know exactly which bridge members are FC and which are not. Since ODOT believes that a picture or sketch serves a thousand words, ODOT decided to integrate a profile sketch / diagram into each report using Excel Drawing Tools. Each FC member is highlighted by making the line weight in heavy bold print. The truss panel point notes are also placed on the sketch in accordance with increasing highway mileposts, which might be counter to the bridge plans.

CFR 650.313(e)(1) – Inspection Procedures for 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.

Condition Description of each FC Member - This helps the inspector by providing a list of specific bridge members that need to receive a hands-on inspection to assure that no deficiency is missed and documentation that the bridge was inspected in a satisfactory manner. In order to address this requirement, every FC report contains a profile view of the structure which has the FC members located in a bold heavy line weight.

Specific list of all FC Members
 Dimensional description of each member
 Identification and location of any E or E' details on each FC member
 NDE Method employed during the inspection
 Narrative description of all deficiencies noted on that specific member
 Note whether an image is available of that member or deficiency

Remarks that Support the Condition Rating - Each bridge inspector is directed to fully describe all of the following:

- Any condition or deficiency that is noteworthy or has a potential for getting worse, or
- The specific location and description of each E or E' detail, or
- A description of any temporary repair that may exist, or
- A description and image of any load restriction sign along with the posting date.

Noteworthy remarks are generally posted only when there is a change in the condition of the members that are associated with the load path, items that might create a traffic hazard, or items that might intensify our concerns for scour at the bridge site.

Maintenance Recommendations and Notification Requirements – The FC inspection might occur at the same time as the routine or it might be completed at a different time. The FC inspection might be performed by the same

inspector as the routine bridge inspector-of-record, or might be performed by somebody else. Therefore, we must post some business rules that would help govern who's responsible for doing what, when and how. If during the course of the FC inspection, a structural deficiency is located that warrants the posting of a bridge maintenance / repair recommendation, we need to know exactly who's responsible for entering the maintenance recommendation into the system, when, and how should it be done.

Therefore, since ODOT performs a wide variety of different kinds of supplemental inspections and reports, the business rule is as follows: **The bridge inspector that performed the inspection is responsible for entering and posting the appropriate bridge maintenance recommendation in the system.** Due to the potential critical nature of some FC deficiencies, the bridge maintenance recommendation should be posted as-soon-as the FC inspection is completed. This is to say that the routine bridge inspector-of-record owns the bridge inventory and condition rating data, which can only be changed by them. They do not own the bridge maintenance recommendations, or their prioritization, that can be posted by others.

If during the course of performing the FC bridge inspection a deficiency was located that would affectively change the NBI condition rating for the bridge more than 2 ratings, the FC bridge inspector must notify the routine bridge inspector-of-record. The routine bridge inspector-of-record will be responsible for amending the official routine bridge inspection-of-record.

Also if the inspector locates a **deficiency that can be defined as being "Critical, Urgent, or Significant"**, the inspector is directed to immediately initiate the actions as specified in Chapter 8 of this manual (Bridge Inspection Follow-up Procedures).

Bridge Specific Inspection Information – Useful information that can be used to plan the next FC Inspection:

- Total Number of FC Members Inspected
- Total linear feet of FC Members Inspected
- NDE Procedures employed to perform the inspection
- Total Time, required to perform the FC Inspection
- Link to other inspection reports completed by others

CHAPTER 15: TIMBER BRIDGE INSPECTIONS

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CHAPTER 15:

TIMBER BRIDGE INSPECTIONS

15.1 INTRODUCTION

Damage ranges from relatively minor discolorations caused by fungi or chemicals to more serious decay and insect attack. Wood outperforms most other materials when used in a properly designed and maintained structure. However, when used in adverse environments, it must be protected to ensure adequate performance. Although the use of pressure-treated wood has significantly extended the life of timber, decay is still the primary cause of bridge deterioration.

Like any investment, a timber bridge must be inspected and maintained on a regular basis to maximize the investment. Timber structures can not be installed and then simply walk away, hoping that all will be well. The fact is that a poor design, poor construction and poor management practices can be major factors in the degradation of a timber structure. Over the life of a timber bridge, deterioration can be minimized, by identifying and recording information on the condition and performance of the structure. With such information, timely maintenance operations can be undertaken to correct situations that could otherwise lead to extensive repair or even replacement.

Bridge inspectors have the difficult task of accurately assessing the condition of an existing timber structure. They must understand the biotic and physical factors associated with wood deterioration, as well as, the relative rate at which these processes occur in a given environment. Timber inspection is a learned process that requires some knowledge of wood pathology, wood technology and timber engineering. This guideline covers the fundamentals of timber bridge inspection for decay and deterioration and outlines inspection methods.

Biotic agents require certain conditions for survival. These requirements include moisture, available oxygen, suitable temperatures, and an adequate source of food, which is generally the wood. Although the degree of dependency on these requirements varies among different organisms, each must be present for deterioration to occur. When any one is removed, the wood is safe from biotic attack.

Moisture

Although many wood users speak of *dry rot*, the term is misleading since wood must contain water for most biological attacks to occur. Wood moisture content is a major determinant of the types of organisms present and the rate at which they degrade the wood. Generally, wood low the fiber saturation point will not decay, although some specialized fungi and insects can attack wood at much lower moisture levels. While keeping wood dry makes sense, it is sometimes difficult to implement, particularly in exposed timber bridges.

Moisture in wood serves several purposes in the deterioration process. For fungi and insects, it is required for many metabolic processes. For fungi, it also provides a diffusion medium for enzymes that degrade the wood structures. When water enters wood, the microstructure swells until the fiber saturation point is reached (about 30 percent wood moisture content). At this point, free water collects in the wood cell cavities, and many fungi can begin to degrade the wood. The swelling associated with water is believed to make the cellulose more accessible to fungi enzymes, enhancing the rate of decay. Additionally, repeated wetting and drying or continuous exposure to moisture can result in leaching of toxic heartwood extractive and some preservatives, reducing decay resistance.

Oxygen

With the exception of anaerobic bacteria, all organisms require oxygen for respiration. While depriving them of oxygen may seem a logical decay control strategy, it is generally impractical in bridge applications since most fungi can survive at very low oxygen levels. An exception is piling that is totally submerged or placed below the water table. In marine environments, piling may be wrapped in plastic or concrete so that marine borers are unable to exchange nutrients and oxygen with the surrounding seawater. In many cases, untreated piling in fresh water will decay to the water line, but remain sound underwater where oxygen is absent.

Temperature

Most organisms thrive in a optimum temperature range of 70 to 85 degrees F, however, they are capable of surviving over a considerably wider range. At temperatures below 32 degrees F, the metabolism of most organisms slows, or they produce resistant survival structures to carry them through the unfavorable period. As temperatures rise above freezing, they once again begin to attack wood, but activity slows rapidly as the temperature approaches 90 degrees F. At temperatures above 90 degrees F, the growth of most organisms declines, although some extreme tolerant species continue to thrive up to 104 degrees F. Most organisms succumb at prolonged exposure above this level, and it is generally accepted that 75 minutes of exposure to 150 degrees F will eliminate all decay fungi established in wood.

In the context of timber bridges, temperature is not controllable, but the inspector should realize that decay will be much more serious in warm environments where the rate of biological activity is higher. This factor has been used, in combination with rainfall, to develop a climate index that expresses temperature and rainfall for an area to formulate a decay hazard index. Although this index cannot account for small variations in regional weather patterns, it does provide a relative guide to decay hazard.

Food

Most biotic agents that attack wood use it as a food source. When wood is treated with preservatives, the food source is poisoned, and infestation can occur only where the preservative treatment envelope is inadequate, or has been broken. If the exposed wood is from a naturally durable species it will initially have some degree of resistance to attack, but this resistance will be reduced rapidly by weathering and leaching. Maintaining an effective preservative treatment is essential for preventing biotic attack.

The Timber Bridge Inspection can be divided into three major steps: pre-inspection planning, field inspection and preparation of reports and records. Although the specific procedures in each step may vary among bridges, the basic process is the same –

- locate,
- assess the condition of the member, and
- document the amount of deterioration in each timber member.

15.2 PLANNING THE TIMBER INSPECTION

One of the most important aspects of an inspection is the sequence and coordination of inspection efforts. To ensure that all critical areas are covered, a systematic, well-defined plan must be developed. When more than one inspector is involved, the responsibilities of each must be clearly defined to avoid either missing areas or excessive duplication.

Suggested Equipment:

Resistograph		
1/2" Electric Drill (w/reverse)		
Gas Powered Drill (optional)		
Increment Borer (optional)		
3/8" x 12" ship augers and 3/8" x 18" ship augers (1/2" bits optional)		
25% Chlorine-Water or Boric Acid Solution in Squirt Bottle		
Cleaning Rags		
Treated Plugs (1/8" larger than bit size)		
Generator	Hammers	Keel
Extension Ladder	Measuring Tapes	Ropes
3-wire Extension Cords	Bit File	Shovel
Paper and Pencils	Clipboard	Straight Edge
Harness	Lanyard	Goggles

Variations in bridge configurations and exposure conditions make the field inspection process a very complex task. It is therefore necessary for the inspector to be well acquainted with the agents of deterioration, the areas conducive

to decay, and the fundamentals of the inspection process. With this knowledge as a guide, the inspector is better prepared to identify and locate deterioration and accurately define its extent.

Methods for detecting deterioration in bridges are divided into two categories: those for exterior deterioration and those for interior deterioration. Although a variety of inspection methods may be employed, in practice the inspector uses only a few tools. No equipment can replace a well-trained inspector who has a broad knowledge of wood systems.

15.2.1 Methods for Detecting Exterior Deterioration

Exterior deterioration is the easiest to detect because it is often readily accessible to the inspector. The three methods or tools most commonly used include visual inspection, probing, and the pick test. When areas of exterior deterioration are located by these methods, further investigation by other methods is required in order to confirm and define the extent of damage.

15.2.1.1 Visual Inspection

The simplest method for locating deterioration is visual inspection. The inspector observes the structure for signs of actual or potential deterioration, noting areas for further investigation.

Fruiting bodies provide positive indication of fungal attack, but do not indicate the amount or extent of decay. Some fungi produce fruiting bodies after small amounts of decay have occurred, while others develop only after decay is extensive.

Sunken faces or localized surface depressions can indicate underlying decay. Decay voids or pockets may develop close to the surface of the member, leaving a thin, depressed layer of intact, or partially intact, wood at the surface.

Bulging faces or localized surface raisings in the immediate area of load carrying bearing points, most likely, are the result of underlying decay. A decayed member generally, can no longer carry the loads the original member was designed for. As a result, the cross-section of the timber member will begin to crush. As the timber member crushes, the outer shell will start to bulge outward, creating a localized surface raising.

Staining or discoloration indicates that members have been subjected to water and potentially high moisture contents suitable for decay.

Insect activity is visually characterized by holes, powder posting, or other signs previously discussed. The presence of insect activity may also indicate the presence of decay.

Plant or moss growth in splits, cracks, or soil accumulations on the structure indicate that adjacent wood has been at a relatively high moisture content suitable for decay for a sustained period of time.

15.2.1.2 Probing

Probing with a moderately pointed tool, such as an awl or knife, locates decay near the wood surface by revealing excessive softness or a lack of resistance to probe penetration. Although probing is a simple inspection method, experience is required to interpret results. Care must be taken to differentiate between decay and water-softened wood that may be sound by somewhat softer than dry wood. It is also sometimes difficult to assess damage in soft-textured woods such as western red-cedar.

15.2.1.3 Pick Test

The pick test is one of the simplest methods for detecting surface decay. A pointed pick, awl, or screwdriver is driven a short distance into the wood and used to pry out a sliver. The wood break is examined to determine if the break is brash (decayed) or splintered (sound). Sound wood has a fibrous structure and splinters when broken across the grain. Decayed wood breaks abruptly across the grain or crumbles into small pieces. Since this method basically destroys the outside layer of the timber member, we do not support using this method to inspect timber bridges in the State of Oregon.

15.2.2 Methods for Detecting Interior Deterioration

Detecting interior deterioration is very difficult to locate because there may be no visible signs of its presence. Numerous methods and tools have been developed to evaluate internal damage that range in complexity from sounding the surface with a hammer to sophisticated sonic or radiographic evaluation. In addition, such tools as

moisture meters are used to help the inspector identify areas where conditions are suitable for development of internal decay.

15.2.2.1 Sounding

Sounding the wood surface by striking it with a hammer or other object is one of the oldest and most commonly used inspection methods for detecting interior deterioration. Based on the tonal quality of the ensuing sounds, a trained inspector can interpret dull or hollow sounds that may indicate the presence of large interior voids or decay (a hammer head weight of 3lbs is recommended). Although sounding is widely used, it is often difficult to interpret because factors other than decay can contribute to variations in sound quality. In addition, because sounding will reveal only serious internal defects, it should never be the only method used. Sounding provides only a partial picture of the extent of decay present and will not detect wood in the incipient or intermediate stages of decay. Nevertheless, sounding still has its place in inspection and can quickly identify seriously decayed structures. When suspected decay is encountered, it must be verified by other methods such as boring or coring.

15.2.2.2 Drilling and Coring

Drilling and coring are the most common methods for detecting internal deterioration in bridges. Both techniques are used to detect the presence of voids and to determine the thickness of the residual shell when voids are present.

Drilling is usually done with a power drill or hand-crank drill equipped with a 3/8" to 3/4" diameter bit. Power drilling is faster, but hand drilling allows the inspector a better feel and may be more beneficial in detecting pockets of deterioration. Generally, the inspector drills into the structure, noting zones where the drilling becomes easier (torque releases), and observes the drill shavings for evidence of decay. The presence of common wood defects such as knots, resin pockets, and abnormal grain must be anticipated while drilling and must not be confused with decay. If decay is detected, the inspection hole can also be used to add remedial treatments to the wood.

An alternate NDT method to drilling is the use of the "Resistograph".

The "Resistograph" uses a 1/16" flexible drill bit and measures the resistance, or lack of resistance, as steady pressure is applied while drilling into the timber member. When bad areas are encountered the bit will slip forward in "jumps" as the bit experiences a lessening of resistance across the rot or decayed material. This method will not work well when it is desired to observe the coloration of the drill shavings as the resistograph shavings are too small. The use of the "Resistograph" is fast becoming the preferred method of drilling due to the small amount of intrusion into the timber members, speed of drilling, number of drillings per battery, weight of equipment, and obtaining a permanent record of the condition of the timber.

Coring with increment borers also provides information on the presence of decay pockets and other voids, and coring produces a solid wood core that can be carefully examined for evidence of decay. Where appropriate, the core also can be used to obtain an accurate measure of the depth of preservative penetration and retention. When structures are not yet showing signs of decay, cores can be cultured to detect the presence of decay fungi. The presence of such fungi usually indicates that the wood is in the early or incipient stage of decay and should be remedially treated. Culturing provides a simple method for assessing the potential decay hazard and many laboratories provide routine culturing services. Because of the wide variety of fungi near the surface, culturing is not practical for assessing the hazard of external decay.

Drilling and coring are generally used to confirm suspected areas of decay identified by the use of other methods. When decay is detected, drilling and coring are also used to further define the decay's extent and limits. Inspectors may find drilling best for initial inspection until some evidence of decay is found. When decay is detected, coring may be preferred for defining the limits of the infection and extracting samples for further examination and analysis. It is important to use sharp tools for both drilling and coring and the inspector should always carry extra bits or increment borers. Dull tools tend to crush or break wood fibers and cause excessive core or shaving breakage that may be confused with decay.

To ensure that bridge inspectors are not spreading decay fungi, throughout a structure, while boring, drill bits should be sterilized after every hole is drilled. Because of the variety of organisms that use wood as a food source or a place to live, most approved wood preservatives are necessarily toxic to other organisms and must be applied and used professionally to avoid potential impact on the environment and human health. However, several inorganic boron compounds, such as borax and boric acid, provide wood with effective protection against decay fungi and insects. These systems have several advantages over other wood preservatives. Borates have low toxicity to man and other non-target organism and are in fact important components of fertilizers. They are very mobile in water, and so will diffuse into wet wood, providing deeper preservative protection than achievable by pressure treatment in difficult to treat species. An experience timber boring bridge inspector can develop a good feel from the drill when boring a hole. Before starting a drill hole, the inspector will measure from the tip of the drill bit to the drill chucks. If a good sharp drill bit is used, lateral pressure is only needed to get the drill bit started into the timber member. After the bit is started, as long as it's in good sound wood, the bit should pull itself into the timber member. As long as the drill bit is in good sound wood, there is also a considerable amount of torque being transmitted to the drill operator. When a decay pocket is encountered, there is a noticeable torque release (becomes easier) and the drill bit will stop pulling itself into the timber member. At this point the inspector should make it a point to check out the drill shavings for evidence of decay or a discoloration in the wood fibers. If it is determined that decay is present, the inspector will measure the distance from the drill chuck to the face of the timber member and subtract the original length of the drill bit. The difference between the two measurements is the depth of the timber shell. At this point the inspector should continue to drill by pushing the drill into the timber member. When a noticeable torque is again being transmitted, the inspector will again measure the distance from the drill chuck to the face of the timber member. The difference between this measurement and the measurement at the start of the decay pocket is the extent of decay at that cross-section location. To determine the extent of decay longitudinally along the centerline of a member, the inspector must drill additional holes into the timber member.

15.2.2.3 Sonic Evaluation

Sophisticated sonic tests for evaluating wood condition have been developed in recent years. Several of these methods, including sonic wave velocity, acoustic emission, and stress wave analysis have been investigated. The simplest of the sonic techniques uses an instrument to measure the velocity changes of a sound wave moving across the wood. The earliest versions of these tools were used with mixed results on utility poles. More recent efforts have concentrated on measuring how the sonic wave is altered by wood defects. The altered sonic wave or fingerprint can be used to determine the exact size and nature of a defect. Several sonic methods are nearing commercialization and offer a significant advancement in decay detection capabilities; however, where defects are detected, other methods must still be used to determine the cause.

Areas Most Susceptible to Decay

Wood decay can occur only when proper conditions exist for fungal growth. Although timber bridges differ in many respects, there are several common areas where decay is most likely to occur. These areas involve situation where the wood moisture is high and where breaks exist in the preservative envelope (or insufficient preservative penetration) providing an entry point for decay organisms.

Why does wood check or split? By definition, a check is a horizontal separation that generally follows the wood grain. A split on the other hand is considered to be a through check that migrated completely through the timber member. Checks and splits are generally caused by differential shrinkage. Differential shrinkage occurs because the outer fibers in the shell dry first and begin to shrink. However, the core has not yet begun to dry and shrink, and consequently the shell is restrained from shrinking by the core. Thus the shell goes into tension and the core into compression. With the stresses from the shell and core pulling in opposite directions the wood fibers separate in the form of a check or split. The larger the wood member, the more stress is exerted in the wooden member. This is the reason why wood materials should be properly dried before using them where their final moisture content will be 15% or less.

The substructure is the portion of a bridge that is probably most susceptible to deterioration. Soil-contacting members such as posts, piling, abutments, bracing and wing walls are exposed in varying degrees to nearly constant

wetting, resulting in wood moisture contents suitable for decay. Surrounding soil frequently contains large numbers of fungal spores and woody plant material in which decay fungi can live and spread to infect bridge members.

The superstructure is the portion of a bridge that also has a high potential for deterioration due to the high incidence of field fabrication (cutting and drilling) and the large number of penetrating fasteners.

SUBSTRUCTURE

The initial inspection of the substructure should begin with a visual examination of abutments for signs of deterioration and settlement of the approach roadway embankment. The most probable locations for decay are in the vicinity of the ground line, at connections between the cap and piling, and at framing connections for bracing and backwall or wingwall planks.

Timber Piling at Ground Line

Soil should be removed from around a representative number of members in order to inspect for indications of decay or insect attack. When soil is very wet or covered by water, decay is generally limited to areas close to ground level, because of the lack of oxygen below the surface limits the growth of most fungi. As soil moisture content decreases, condition below ground become more favorable, and decay may occur at depths of 2 feet or more in moderately dry soils. Surface decay and insect damage can be revealed by visual observation and probing. When evidence of decay is found, its extent is further defined by drilling or coring.

Timber Piling Tops

Many of the connections between the cap and columns are made with drift pins or bolts that extend deep into the column end grain. Water from the cap flows into these connections and can result in substantial internal decay with little evidence of exterior damage. Exposed end grain on pile or post tops in the wingwalls should also be inspected for decay. Many tops are intentionally cut at an angle in the belief that water will run off. However, the angled cuts expose more untreated end grain, increasing the decay potential. When tops are provided with a protective cap, the condition of the cap should be checked for holes or tears in the surface.

Timber Caps

Above the supporting piles or posts, the cap supporting the superstructure provides a horizontal surface that traps debris and water runoff from the deck. Connections into the cap and horizontal checks that trap water and debris are critical zones. Timber stringers are generally toe-nailed into the top of the timber cap. The ends of the cap generally extend out beyond the superstructure covering. This flat surface provides an excellent location for moist debris to accumulate to the point where vegetation will take root and grow. The inspector should also check for crushed zones at bearing points along the cap that trap water and damage the treated wood shell. Crushing can also indicate overloads or load redistribution from settlement and should be further investigated in other components of the structure.

Inter-Tidal Zone

For substructures located in seawater, low tides present the best opportunity to inspect for marine borer damage. A scraper and probe will need to be used to remove fouling organisms from the pile surface and thus permit better examination around bolt holes and adjoining wood members. Signs of a *Limnoria* attack include an hourglass shape of piles, bore holes, and a general softening of the wood in the attack areas. Detecting damage by shipworms is much more difficult due to the very small entrance hole on the wood surface. To assess the presence of shipworms, a common practice is to immerse sacrificial blocks of untreated wood at various depths around the substructure. These blocks are then periodically removed and examined for evidence of marine borer activity.

SUPERSTRUCTURE

Although most elements of the superstructure are out of ground contact, decay potential can be quite high in areas where water passes from the deck and collects at member interfaces, connections, checks, and crevices where air circulation and drying are inhibited. Most of the time this decay occurs with little or no surface evidence, even though, the member may be severely decayed inside.

Deck-Stringer Interface

The deck-stringer interface is one of the most frequent decay areas. This is because most timber decks are attached with nails that penetrate the top of the stringers. Water passing through the deck enters the top of the stringer through the nail hole and is trapped. Severe decay will be noticed visually by a flaring of the top of the timber stringer outward, by the deck attachment nails becoming loose and by excessive deflections in the deck.

Stringer-Cap Bearing Points

Generally, the stringers are toe nailed to the top of the cap with a #10 spike. The spike allows water to run the length of the spike into the bearing area between the timber stringer and the cap. Severe decay will be noticed visually by a flaring or the bottom edge of the timber stringer outward or a cross grain crushing action either in the stringer or the cap.

Field Fabricated - Dapped Stringers

Quite often the inspector will find dapped timber stringers. This is where the bottom side of the stringer is removed so the stringer will fit into the space between the top of the cap and the bottom of the deck. Sometimes the notching material is permanently removed and occasionally it is used to shim the stringer back tight against the bottom of the deck.

In either case, the field fabrication, is exposing the untreated timber material to the environment.

End of Exterior Stringer Cuts

The interior stringers are almost always lapped over the caps. However, the exterior stringers are generally cut to form an end to end fit, bearing on top of the cap. This field fabrication removes the pressure treated shell from the end of the stringer, exposing the end grain to the environment. Severe decay will be noted by a bulging the stringer cross section.

Exterior Stringer Bridge Rail and Felloe-guard Bolts

Bridge rails and felloe-guards are some of the most exposed elements of the bridge superstructure, yet are often ignored during a bridge inspection. The accepted construction practice is mount a timber felloe-guard to each side of the bridge deck with a long bolt extending from the top of the felloe-guard to the bottom of the timber stringer. Each bridge railing support post is then bolted to the outside edges of the timber felloe-guard and to the exterior timber stringer. These bolts, allow water to run through the treated timber shell to the untreated portion of the timber members. Severe decay will most likely result in a loose, wobbly bridge railing.

Exterior Stringer Scupper/Drains Fabrication Cuts

In an effort to provide drainage from the gutter line, occasionally the bottom of the fellow-guard, the ends of the timber deck planking and the top edge of the timber stringers are notched or removed to form a scupper drainage cutout. This field fabrication process removes the pressure treated shell, exposing the untreated portion of the timber member to the environment.

Timber Deck

At the same time the timber stringers are being inspected, the underside of the deck should also be examined for signs of deterioration and conditions conducive to decay. Signs to observe include abnormal deflections and loose joints or fasteners. Severe decay may result in a cross grain crushing action between the bottom of the timber planks and the top of the timber stringers. When the inspection of the underside is complete, efforts are next directed to the roadway portion of the deck. The highest decay potential will occur at the fasteners or zones of mechanical damage and is influenced by the degree of protection provided by the wearing surface. Severe decay in a timber deck will most likely be noted by localized alligator cracking in the asphalt wearing surface.

15.3 DRILLING PROCEDURES

Inspection procedures for timber bridges depend on such variables as the age and type of bridge and the environment in which the bridge is located. Therefore, detailed recommendations for specific procedures are somewhat impractical. In general, the inspector must thoroughly examine the bridge for decay and other deterioration and record findings in sufficient detail for an engineering appraisal. The specific procedures and methods, however, will vary substantially from bridge to bridge.

To ensure that bridge inspectors are not spreading decay fungi, throughout a structure, while boring, drill bits should be sterilized after every hole is drilled. Because of the variety of organisms that use wood as a food source or a place to live, most approved wood preservatives are necessarily toxic to other organisms and must be applied and used professionally to avoid potential impact on the environment and human health. However, several inorganic boron compounds, such as borax and boric acid, provide wood with effective protection against decay fungi and insects. These systems have several advantages over other wood preservatives. Borates have low toxicity to man and other non-target organism and are in fact important components of fertilizers. They are very mobile in water, and so will diffuse into wet wood, providing deeper preservative protection than achievable by pressure treatment in difficult to treat species.

Boring Procedure:

1. Sterilize drill bit with disinfectant before drilling each hole.
(25% chlorine or boric acid solution)
2. Get base reading; measure the exposed bit in the drill chuck.
3. Drill and record findings on face of timber in consecutive order.
4. In some instances, another boring may be useful to get both a horizontal and vertical dimension of a rotten member.
5. Plug the drill hole with a treated wooden plug.

Reasons Why a Bit will not Feed:

1. Decay
2. Drilling with the grain of wood.
3. Season checks and splits.

An experience timber boring bridge inspector can develop a good feel from the drill when boring a hole. Before starting a drill hole, the inspector will measure from the tip of the drill bit to the drill chucks. If a good sharp drill bit is used, lateral pressure is only needed to get the drill bit started into the timber member. After the bit is started, as long as it's in good sound wood, the bit should pull itself into the timber member. As long as the drill bit is in good sound wood, there is also a considerable amount of torque being transmitted to the drill operator. When a decay pocket is encountered, there is a noticeable torque release (becomes easier) and the drill bit will stop pulling itself into the timber member. At this point the inspector should make it a point to check out the drill shavings for evidence of decay or a discoloration in the wood fibers. If it is determined that decay is present, the inspector will measure the distance from the drill chuck to the face of the timber member and subtract the original length of the drill bit. The difference between the two measurements is the depth of the timber shell. At this point the inspector should continue to drill by pushing the drill into the timber member. When a noticeable torque is again being transmitted, the inspector will again measure the distance from the drill chuck to the face of the timber member. The difference between this measurement and the measurement at the start of the decay pocket is the extent of decay at that cross-section location. To determine the extent of decay longitudinally along the centerline of a member, the inspector must drill additional holes into the timber member.

For the less experience inspector and/or for checking the result of a timber boring, the inspector may incorporate the use of another tool that is useful as a shell-depth indicator. This tool is basically a heavy gauge wire or a small metal bar, notched at the end and inscribed in inches. The tool is inserted into the inspection hole and pulled back along the sides. As it moves along the wood, the hook will catch on the edges of voids. In this way the inspector can note the depth of the solid wood shell.

Inspection methods or techniques that destroy or remove a portion of the wood, splinters, probe holes, and borings may become avenues for decay entry if not properly treated at the conclusion of the inspection. All surface damage should be treated with liquid or paste wood preservative. For bore holes, liquid wood preservative should be squirted into the hole, which then should be plugged with a preservative-treated dowel slightly larger in diameter than the inspection hole. Treatment with creosote or copper naphthenate is generally sufficient for most bridge inspections, but other treatments should be used for additional protection in areas of marine borer hazard. When wood is subject to attack by *Limnoria*, surfaces and plugs should be treated with waterborne salts. In areas where pholads may attack, treatment with both creosote and waterborne salts is advisable. Failure to follow these procedures may result in accelerated decay development or deterioration in the structure.

15.3.1 HOW and WHERE to DRILL:

1. Sills, approximately 2" from edges.
 - a. under all posts.
 - b. over all concrete pedestals.
2. Posts, approximately 4" from
 - a. top of all posts.
 - b. bottom of all posts.
3. Piling
 - a. approximately 4" from the top of all piles.
 - b. at low water line or ground line, on all piling.
 - c. at average high-water mark in tidal zones, on all piling.
 - d. near bracing bolts, on tall (20'+) piles.
4. Cap, approximately 2" from edges.
 - a. under exterior stringers.
 - b. over each support (pile, post, etc.).
5. Stringers
 - a. bottom at end of all stringers
 - * drill at 45 degree angle over cap.
 - * drill approximately 6", if no decay is found.
 - * if decay is found, drill as far as required to determine extent
 - b. top near midspan of each stringer.
 - * drill toward the top middle of the stringer from 6" to 8" down the side.
 - * drill to within 1" of the top of the stringer.
6. Decking
 - a. 4 x 12's, in the bottom at center of member next to a stringer, angling slightly over the stringer, bore full 4".
 - * include around drains.
 - * bore any other suspect areas.
 - b. Cedar 2x2's, rot from the outside and do not need to be bored.
 - * probe and look for decay between the deck planks.
 - * look for failure (alligator cracking) in the AC wearing surface.
7. Bulkhead, bracing, felloe guard, rail and rail posts.
 - a. boring normally not necessary, sounding can be used.
 - b. look for loose attachment bolts.
 - c. bore as necessary, if questionable or to determine extent.
8. Bore and note any questionable area.
 - a. stained and discolored areas.
 - b. fungus growth on the surface of the member.
 - c. vermin activity
 - d. timbers covered with dirt.
 - e. Any member that is in contact with another decayed member.

15.4 TIMBER MEMBER INSPECTION FREQUENCY**15.4.1 Base-Line Assessment**

All timber members will have an initial base line condition assessment that is based on a hands-on visual assessment, sounding, and / or boring, and documented on a timber boring report. In order to minimize the number of holes in the timber member, it is highly recommended the inspector drills the timber member using a "Resistograph".

15.4.2—Sounding

The expectation is that all timber bridge members will be sounded during every routine inspection (at least every two years). Recommend using a 3lb hammer in order to accentuate the sound plus being able to feel the hammer rebound.

15.4.3—Timber Boring

All timber members are to be sounded as per Section 15.4.2 and depending on the condition of the member decay defect, the inspector will determine whether drilling the member is necessary and establish what future frequency should be followed in order to ensure that a complete and thorough condition assessment is being recorded.

15.4.3.1—Individual Member Timber Boring

A timber boring on individual members will occur at a frequency that is based on the condition of each particular member:

- Rebore every 10 years if the member Decay Defect is being reported in CS2.
- Rebore every 6 years if that member Decay Defect is being reported in CS3.
- Rebore every 2 years if that member Decay Defect is being reported in CS4.

Individual member boring information will be updated in the element remarks and in the Timber Boring Supplemental Report. Dates for future individual timber borings on members will be recorded and tracked in the Timber Boring Supplemental Report.

15.4.3.2—Full Timber Boring

A full timber boring report will be updated or rebored at the following intervals:

- Structure is located West of the Coast Range, **and**;
 - Has been in service < 20 years.
 - Updated Full Timber Boring not required
 - Has been in service ≥ 20 years.
 - Bore at least every 8 years.
- Structure is located within the Western Oregon region, **and**;
 - Has been in service < 25 years.
 - Updated Full Timber Boring not required
 - Has been in service ≥ 25 years.
 - Bore at least every 10 years.
- Structure is located East of the Cascades, **and**;
 - Has been in service < 30 years.
 - Updated Full Timber Boring not required
 - Has been in service ≥ 30 years.
 - Bore at least every 12 years.

Dates for Full Timber Borings will be recorded and tracked under the Timber Boring Schedule date located on the ODOT Inspection tab in BrM (Pontis).

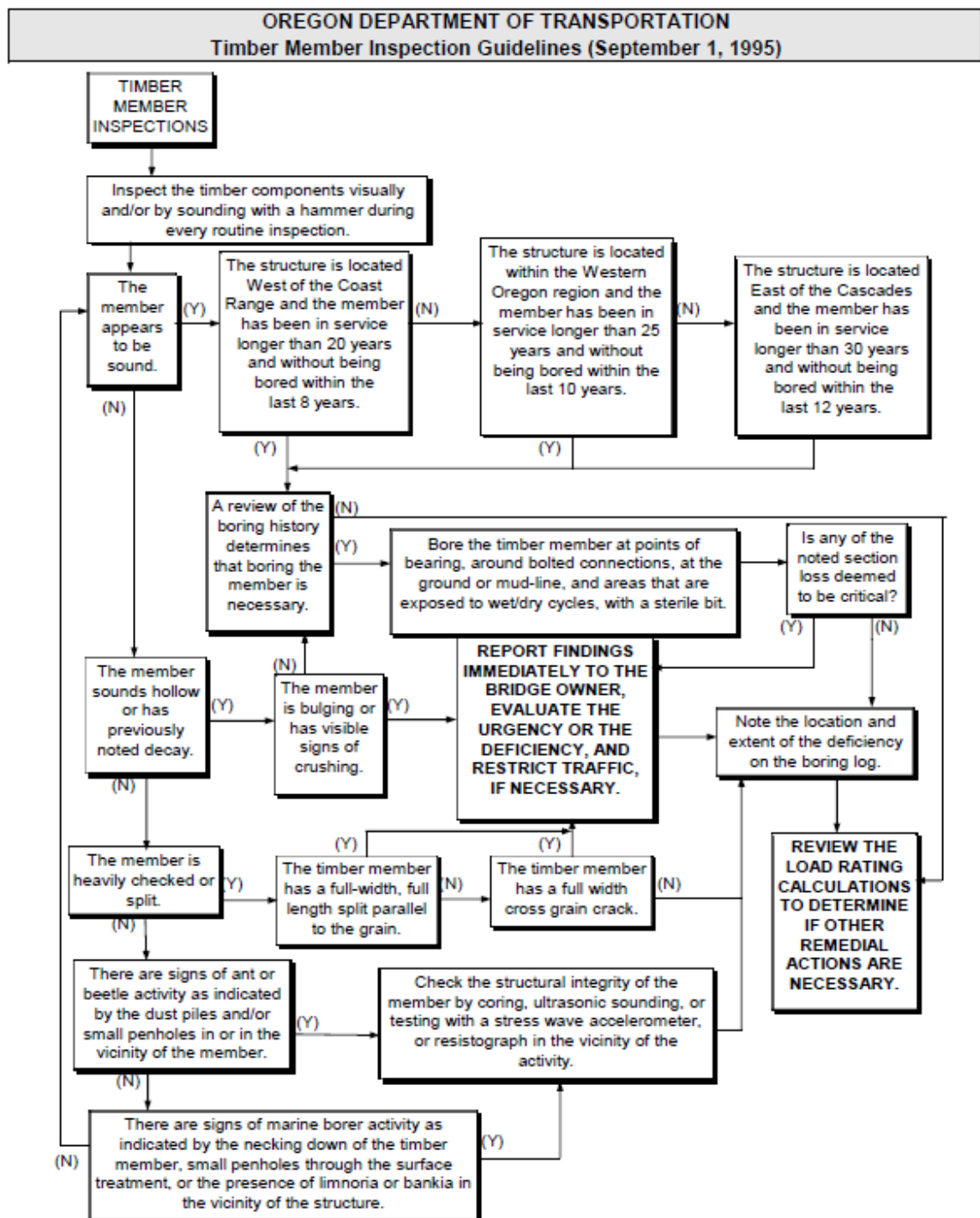
15.4.3.3—2 Year Frequency

A specific timber member will be immediately rebored every 2 years if any of the following defects are found:

- The member sounds hollow or previously noted decay information has not been updated within the last 4 years.
- The member is bulging or as visible signs of crushing.
- The member is heavily split or cracked (CS4).
- The member has a full-width, full length, cross grain crack in the member.

- Signs of ant or beetle activity as indicated by the dust piles and / or small pinholes in or in the vicinity of the member.
- There are signs of marine borer activity as indicated by necking down of the timber member, small pen holes through the surface treatment, or the presence of limnoria or bankia in the vicinity of the member.
- The member has a full-width, full length split parallel to the grain of the wood.

Bore the timber member at points of bearing, around bolted connections, at the ground or mud line, and areas that are directly exposed to wet / dry cycles.



15.5—TIMBER BRIDGE INSPECTION REPORT

15.5.1—Introduction

While detecting decay or other wood damage is the major goal of bridge inspections, it is important to ensure that all pertinent inspection information is accurately recorded and documented. The report prepared by the inspector provides the only means of communicating information about the structure and serves to:

1. Identify total quantity of conditions that may limit the capacity of the structure, which is to say that enough borings will be performed to provide the clear 3 dimension volume of any timber decay. The goal is to provide sufficient information that the load rating could be calculated.
2. Develop a chronological record of structural condition and provide the information necessary to complete a structural analysis when conditions change,
3. Provide a basis for identifying current and future maintenance needs through the detection of early structural defects or deficiencies, and
4. Provide a reference source for future inspections and comparative analysis.

When properly completed, the bridge inspection report is an important document and plays a critical role in ensuring the safety of users and in allocating funds for maintenance and replacement. In an effort to provide a well organized, clear and concise report, ODOT has adopted the timber boring log standard located in the appendix of this guideline.

15.5.2—Timber Boring Supplemental Report

The timber boring supplemental report is based on the premise that a simple sketch or picture provides a thousand words. As a result, ODOT decided to use Microsoft Excel as the report format due to its availability, and the ease of creating a sketch in an electronic format. The timber boring supplemental report should be updated whenever there is a change in;

1. Individual member condition states,
2. Full timber boring findings,
3. Timber member design or configuration.

The ODOT Timber Boring Supplemental Report contains the following information:

1. Report Heading
2. Member Dimension and Spacing information
3. Summary of Deterioration encounter on that structure
4. Schematic layout of the deck and timber stringers
5. Schematic layout of each individual bent

15.5.3—Timber Boring Condition Assessment Scheme

Recording Boring Results

1. "X" represents good, sound wood.
 - a. "X" alone means completely sound wood.
 - b. "X2R8X2-98" means 2" good, 8" decay, 2" good wood.
 - c. "-98" means the boring results were obtained in 1998.
2. "R" represents rotted, decayed wood.
 - a. "R" alone means decay was noted at this location.
 - b. "R4X10R2-96" means 4" rot, 10" good wood, 2" rot.
 - c. "-96" means the boring results were obtained in 1996.
3. "STD" represents an area that is "Starting To Decay" and may sound punky when hammered on.
4. Mark on the diagram, the location the timber member was bored. If all good wood was noted, mark the member with an "X". If any decay was noted, place an "R" on the member and place a text box with an arrow, showing the results of the timber boring.
5. If the timber member was previously bored and the results of that inspection were previously recorded, simply enlarge the existing text box and add the current measurements. Don't forget to include the year the timber boring occurred. This will allow the reader to obtain an estimate as to the rate of deterioration.

6. In order to clearly define the condition of each timber member, the bridge inspector will label each member with its condition state rating, so that the information can be used to numerically stratify the ratings.
7. Each inspection report should include a summary of inspection findings and the recommendations of the inspector. The summary should outline the general condition of the structure and significant deficiencies encountered during the inspection. It may also include information and recommendations that the inspector believes are necessary to emphasize important inspection findings.

CHAPTER 16: UNDERWATER BRIDGE INSPECTIONS

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CHAPTER 16:

UNDERWATER BRIDGE INSPECTION

16.1—EXECUTIVE SUMMARY

This chapter contains only an executive summary of the ODOT Underwater Bridge Inspection Program. More specific / detailed information is located in the ODOT Underwater Bridge Inspection Manual, which is located in the Chapter 16 Appendix.

Historically speaking, there have been more bridge failures as a result of an underwater deficiency than any other reason. Therefore, every underwater inspection must fulfill two tasks:

- The physical condition of each underwater member must be inspected to the extent necessary to determine with certainty that their physical condition has not been compromised to the point where the structural safety of the bridge becomes an issue, **and**
- The stream bottom or bridge foundation in the immediate vicinity of the bridge bents must be inspected in order to monitor for scour.

Underwater Bridge Inspection Definition – By CFR definition, if the underwater portion of a bridge substructure and the surrounding stream channel cannot be inspected visually at low water by wading or probing, it will require an underwater inspection using divers or other appropriate techniques to accomplish these tasks. In the State of Oregon, wadeable is defined as flow is < 2 feet deep and having a velocity of < 2 cubic feet per second. The ODOT Underwater Dive Team performs these inspections on both the State and Local Agency Bridges.

If the bridge substructure and the surrounding channel can be inspected visually at low water by wading or probing, these actions will be initiated by the above water Routine Bridge Inspector during every routine inspection and an underwater inspection using divers will not be required.

Since the above water bridge inspector is required to perform a routine inspection on every bridge, it's their responsibility to assess the conditions and notify the ODOT Underwater Dive Team Manager that an Underwater Bridge Inspection is needed.

In addition to the underwater bridge inspection requirements contained in the CFR, supplemental inspections occasionally become necessary for the following reasons:

- Following a major flooding event or observed channel change,
- Apparent bridge substructure damage from navigational traffic
- Before alterations or reconstruction of the superstructure or substructure, and
- For pre-acceptance evaluation of contracted construction work.

Considering the above, ODOT decided to staff an in-house dive team due to the following considerations:

- Offers the advantages of low cost,
- Can be mobilized quickly for priority or emergency assessments,
- Is used on quality control work by performing pre-acceptance underwater inspections for contracted construction and maintenance projects.

However, as a result of that decision, the agency had to accept the following:

- The agency must assume liability for the employees safety, and
- Necessitates having a supervisor knowledgeable in underwater procedures, bridge condition assessments, and hazard mitigation, and
- Provide dive training and
- Maintain a boat, trailer, tow vehicle, and a complement of equipment in a condition to assure that it is reliable and continued safe operational use for the given working conditions.

Due to the minimum number of positions that are available, ODOT decided to only have two full time divers. One position is the ODOT Dive Team Manager, and the other position is the ODOT Sounding Coordinator. The other dive team members are assigned to other full time positions within ODOT and dive on a part-time basis. This allows ODOT to foster the multi-disciplinary expertise that is needed on the team:

- bridge condition assessment expertise
- bridge maintenance expertise
- bridge construction inspection expertise
- bridge materials expertise
- bridge foundation expertise
- bridge hydraulics / scour expertise

As associated with other types of inspections, the term “Procedures” as contained herein refers to:

- Locate all underwater elements
- Provide a description of each member
- Procedures used to assess or monitor the condition of each member type
- Criteria used to establishment the inspection frequency
- Identifying what information must be documented and to what level
- Disseminating maintenance recommendations and critical finding notifications.

Additional Resource Materials

ODOT Underwater Bridge Inspection Manual, and

Transportation Research Board Circular No. 330 “Underwater Bridge Inspection Programs, together with references, outlines the state-of-the-art of underwater inspections.

AASHTO Bridge Inspection Reference Manual (BIRM)

16.2—UNDERWATER BRIDGE INSPECTION PROCEDURES

16.2.1—Underwater Bridge Inspection Procedures Overview

This chapter contains only an executive summary of the Underwater Bridge Inspection Procedures. More specific / detailed information is located in Chapter 8 of the ODOT Underwater Bridge Inspection Manual, which is located in the Chapter 16 Appendix.

In accordance with CFR 650.313(e)(2) – The agency is required to provide the following:

- Identify the location of all underwater elements,
- Provide a description of the underwater elements,
- Provide the underwater bridge inspection frequency,
- Provide the underwater bridge inspection procedures, and
- Inspect the underwater bridge elements in accordance with those procedures.

Also CFR 650.313(e)(3) state that for bridges that are scour critical, the agency is required to:

- Prepare a plan of action to monitor known and potential deficiencies,
- Address Critical Findings, and
- Monitor the bridge in accordance with the “Plan of Action”.

To comply with the CFR mandate, the ODOT Underwater Bridge Inspection Report contains the following

- Identification and location of all Underwater Elements
 - Schematically locate of all Underwater Elements using Excel drawing tools
 - Provide a description of each member
 - Location of Scour Countermeasures
- A detailed condition assessment of each member
- Describe the methods used to complete the Inspection
- Identify the major equipment needed / used to perform the inspection
- Identify Scour / Undermining Risk Factors
 - Debris Accumulation
 - Rapid stream flows / waterway constrictions

- o Direction of flow as they relate to the bridge substructure units
 - o Unstable Streambeds
 - o Volatility of the Thalweg Movement (vertically or horizontally)
- Inspectability Risk Factors
 - o Brackish Water
 - o Visibility
- Bridge Element Deterioration Risk Factors
 - o Corrosive Water
 - o Unprotected steel members
 - o Timber Piling in presence of teredos or limnoria
- Identify the Underwater Bridge Inspection Frequency (CFR 650.311(b)(1) and (2))
 - o ODOT criteria is based on:
 - the scour code,
 - the condition of the NBI bridge component, or
 - the condition of the element.
- Posting Maintenance Recommendations or describing what critical finding notifications were made.

16.2.2—Underwater Bridge Inspection Procedures

Concrete, wood, or steel members are prone to different types of failure mechanisms and therefore require quite different underwater inspection strategies:

- Wooden structures contain a great number of substructure components, including numerous piles and cross bracing members that require considerable time for inspection. The life of wooden structures depends heavily on the environment. Those in salt water are prone to attack by marine borers that can cause rapid deterioration from the inside out. For this reason, wooden bridges are difficult to assess without coring. Bolt replacement at the cross members is a common maintenance requirement, but undermining is rare with driven wooden piling.
- The durability of steel structures is also heavily dependent on the water conditions. UT NDE methods might be necessary on steel bridges that are particularly sensitive to a corrosive water environment or susceptible to drift collision damage.
- Concrete bridges are susceptible to spalling, scour, or concrete cracking. Because of the possibility of scour patterns with uneven undermining on one or more sides, the entire circumference of the footing must be examined. Adequate concrete cover over the rebar is necessary to slow corrosion, although there is some evidence that water may penetrate to the steel reinforcement under certain conditions. Stress cracks can be an important indicator of: load damage, navigational collision damage, structure settlement of the structure, improper handling and overdriving of the pre-cast piling, or corrosion and swelling of the corroding steel reinforcement. Freeze-thaw cycles can cause cracking and surface spalling of concrete. The length, location and density of cracks should be noted on inspections, and an attempt should be made to identify the cause.
- The water environment has a significant effect on bridges. Heavy currents and ice flows are especially destructive. Rapid tidal currents lead to surface spalling and necking (severe spalling of a pile at the waterline with considerable loss of cross-sectional area. Bottom currents cause scour around the piles. The scour most often occurs around mid-channel piles, but not always. Floods cause damage from rapidly moving water as well as from impact of the large debris carried by the flood waters. The debris accumulations in the stream channel tend to focus the flow of water, thus increasing the potential for scour. Damage, including scour of bridge piers, fracture of piles, broken lateral and longitudinal bracing, undermining and collapse of retaining walls and scour protection systems, can show up immediately following a moderate to major flooding event. Quite often the extent of the damage is not readily evident from the surface due to scour hole in-filling as the flow velocities slow.

Underwater Bridge Inspector-of-Record – In the State of Oregon, the underwater bridge inspection team leader is expected to make engineering judgments as to the integrity, safety, and load carrying capacity of both individual elements and the collective elements of individual bridges acting as a unit, during the course of their day-to-day inspections. Therefore, it is essential that underwater bridge inspection team

leader is well trained and experienced in bridge performance and inspection techniques. Also some bridges require a great deal of specialized experience and knowledge which can only be provided by an experienced professional bridge engineer. This is especially true for evaluation of the safe load capacity of a bridge which may have any uncommon features of design or may have deteriorated to the point that specialized analysis is appropriate.

- CFR 650.309(b) ODOT requires a certified bridge inspection team leader must be on-site and actively participating in every underwater bridge inspection.
- In accordance with CFR 650.309(d) all dive team members must successfully complete either the NHI Comprehensive Bridge Inspection Training Course or the NHI Underwater Bridge Inspection Training Class.
- CFR 650.309(b), states that all Bridge Inspection Team Leaders must successfully completed the NHI Comprehensive Bridge Inspection Training Course.

16.3—UNDERWATER BRIDGE INSPECTION FREQUENCIES

Also by CFR directive, 650.311(b) specifies that if an underwater inspection is required, the underwater bridge elements must be inspected at least every 5 years and the dates and frequencies of these inspections are to be coded in the NBI File under 92B and 93B.

The 5 year frequency specified above is the maximum interval permitted between underwater inspections for a bridge that has underwater components that are in excellent condition and is located in a very passive, non-threatening stream channel. Many bridges may require more frequent inspections and absolutely necessary for the more critical structures in the inventory. In order to better define when these underwater inspections are to occur, ODOT has initiated the following guidelines:

16.3.1—5 Year Frequency

The Underwater Inspection will be performed at least every 5 years if the following conditions exist:

- NBI Item 113 (Scour Code) is coded ≥ 4 , **and**
- No Scour Defect exists, or is in CS1, **and**
- NBI Item 60, Substructure Condition Assessment ≥ 6 , **and**
- NBI Item 61 (Channel and Channel Protection) ≥ 7 .

16.3.2—4 Year Frequency or Less

CFR 650.311(b)(2) dictates that some underwater structural elements must be inspected at less than sixty-month intervals and that the agency must 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. Therefore ODOT established the following guideline:

The Underwater Inspection will be performed at least every 3 years if the following conditions exist:

- NBI Item 113 (Scour Code) is coded ≤ 3 or "U", **and**
- Scour Defect is in CS2, **and**
- NBI Item 60, Substructure Condition Assessment = 5 or 6, **and**
- NBI Rating 61 (Channel and Channel Protection) = 6, **and**
- Element 223 (Submerged Seal Footing) is exposed

16.3.3—2 Year Frequency

The Underwater Inspection will be performed at least every 2 years if the following condition exists:

- NBI Item 113 (Scour Code) is coded ≤ 2 , **and**
- Scour Defect is in CS3 or CS4, **and**
- NBI Item 60, Substructure Condition Assessment ≤ 5 , **and**
- NBI Rating 61 (Channel and Channel Protection) ≤ 5 , **and**
- Element 223 (Submerged Seal Footing) is exposed, **or**

- Combination of age, environment, history, importance, etc.

16.3.4—Annual Inspections

The Underwater Inspection will be performed at least on an annual basis if the following condition exists:

- NBI Item 113 (Scour Code) is coded = 2, **and**
- Scour Defect is in CS4, **and**
- NBI Item 60, Substructure Condition Assessment ≤ 4 , **and**
- NBI Rating 61 (Channel and Channel Protection) ≤ 4 .
- Element 223 (Submerged Seal Footing) is exposed, **and**
- Combination of age, environment, history, importance, etc.

These operational underwater inspection frequencies are only guidelines, which can be modified by considering any of the following factors:

- The volatility of the stream channel movement (horizontally / vertically) as noted on the Cross-Channel Profiles, or
- The stream channel flow angle at low flow vs high flow, or
- The type of bridge footing (spread footing vs Pile foundation), or
- Whether the structure has a history of being a drift catcher, or
- Channel known to carry abrasive type debris such as ice, trees, or boulders, or
- Channel known to support commercial shipping / navigation traffic, or
- Whether approved scour countermeasures have been installed, or
- The importance of the route: Interstate vs local rural road.
- The bridge foundation material type as follows:

16.3.5—Inspections Scheduled at Frequency >60 months

Even though CFR 650.311(b)(3) allows certain underwater structural elements to be inspected at greater than sixty-month intervals, not to exceed seventy-two months, with written FHWA approval, ODOT elected to not pursue this option.

16.4—UNDERWATER BRIDGE INSPECTION REPORT

By definition this is a regularly scheduled inspection consisting of sufficient observations and/or measurements to determine the physical and functional condition of the bridge, to identify any developing problems and/or change from the previously recorded conditions and to ensure that the structure continues to satisfy present service requirements. Careful documentation of inspection findings is absolutely mandatory, and our entire Bridge Program hinges on the adequacy and thoroughness of that documentation. The documented findings are used for:

- Planning appropriate inspection cycles,
- Evaluating the amount of deterioration that has occurred between inspections, and
- Determining appropriate maintenance recommendations.

If a bridge site contains a notable deficiency or finding, it must be carefully documented so that the divers can return to the same location for further assessment. Documentation can take the form of detailed written notes, sketches, and measurements. Underwater digital images can also be used to document the deficiencies. Standardization of the overall reporting procedure is important to limit subjectivity and to facilitate comparisons with subsequent inspections to determine the deterioration rates and contributing factors. Consistency among reports assists in bridge prioritization and administrative recognition of conditions requiring repairs. It's the responsibility of the Underwater Dive Team Manager to generate the Underwater Bridge Inspection Report. Then, it's the responsibility of the above water Routine Bridge Inspector to incorporate the Underwater Inspection findings into the overall end-to-end, top-to-bottom condition assessment report for the bridge.

As stated earlier, each Underwater Bridge Inspection Report must fulfill the following objectives:

- Accurately record the present condition of all underwater bridge components; and

- Since during the course of the underwater inspection the dive team is much closer to some of the bridge components than the above water routine inspector. Therefore, the dive team is directed to suggest what other Element and NBI condition ratings should be. This includes post remarks or maintenance recommendations in the routine inspection file; and
- Identify conditions that are indicative of potential problems with scour and stream stability so that they can be further reviewed and evaluation by others.

Most underwater inspections will be performed separately from the above water routine bridge inspections. The integration of information from underwater inspections is a very important final step for the full assessment of a bridge.

16.4.1—Underwater Bridge Inspection Report Format

Since everybody has a copy of the Microsoft Office products on their computer, ODOT elected to require all Bridge Inspection Supplemental Reports to utilize Excel so that the drawing tools can be easily used to incorporate drawings, sketches, and place specific measurement notes, within the body of the condition assessment report or image.

ODOT also decided that all supplemental bridge inspection reports will be dynamic, in that they will contain all historical information on only one report rather than utilizing a separate report for every inspection. This business rule allows the reader to zero in on a specific bridge component, find a full history of its condition so that the rate of deterioration can be easily assessed, without going from report, to report, to report, to report.

16.4.2—Elements of the Underwater Bridge Inspection Report

Pertinent Bridge ID Information

Bridge Name
 Bridge Number
 Highway
 Milepost
 Owner of the Bridge
 Date of the Underwater Bridge Inspection
 UW Inspection Frequency
 Highway District
 County
 Signature of the Underwater Certified Bridge Inspector-of-Record
 List of Underwater Divers that were involved in the inspection

Required Underwater Bridge Inspection Information

CFR 650.313(e)(2) indicates that the DOT must document the following:

- Identify the location of underwater elements that are to be inspected, and
- Provide a description of the underwater elements, and
- Establish the appropriate inspection frequency, and
- Document the underwater inspection procedures for each bridge, and
- Document that the underwater elements were inspected in accordance with those procedures.

Required Condition Assessment Information

The Underwater Bridge Inspection Report must provide the following Condition Rating Information, in such detail that the information can be integrated into the Routine Inspection Report:

- List of bridge elements located below the water level and their condition state rating
- NBI Item 60 (Based on underwater components inspected)
- NBI Item 61 (Channel / Channel Protection)
- Validation check, best guestimate of what Scour Code (NBI Item 113) should be.

Suggested Condition Assessment Information

During the course of performing the underwater bridge inspection, the dive team has the opportunity to view the underside of the structure in much closer detail than the above water routine bridge inspector. As a result, the desire is that the underwater dive team would offer up additional condition assessment information that might help assess other above water level elements. Suggested elements are:

- Deck Soffit Cracking SF (Element 359)
- Condition of the paint system on a steel structure
- The condition of the navigational lighting,
- Etc.

Remarks

Detailed Condition Assessment Information (Historical Remarks)

Condition Assessment notes regarding specific members located below water level

Condition Assessment notes regarding specific bridge members located above water level

Notes associated with the channel, channel protection, and local scour

References to the Cross-Channel Profile (Location of Thalweg to bridge footings)

References to the Scour Plan of Action for the bridge

Inspection Notes

Access Plan for the inspection

Inspection Plan for the bridge

List of Divers that participated in the inspection

Water depth

Estimated Visibility during dive

Estimated water velocity

Bridge Notes

Benchmark Elevation location used for measurements

Type of Bridge Foundation

Maintenance Recommendations and Notification Requirements – The Underwater Bridge Inspection will most likely occur at a different time than the routine and definitely will be performed by a different inspector than the routine bridge inspector-of-record. Therefore, we must post some business rules that would help govern who's responsible for doing what, when and how. If during the course of the Underwater Bridge Inspection, a structural deficiency is located that warrants the posting of a bridge maintenance / repair recommendation, we need to know exactly who's responsible for entering the maintenance recommendation into the system, when, and how should it be done.

Therefore, since ODOT performs a wide variety of different kinds of supplemental inspections and reports, the business rule is as follows: **The bridge inspector that performed the inspection is responsible for entering and posting the appropriate bridge maintenance recommendation in the system.** Due to the potential critical nature of some scour deficiencies, the bridge maintenance recommendation should be posted as-soon-as the Underwater Inspection is completed. This is to say that the routine bridge inspector-of-record owns the bridge inventory and condition rating data, which can only be changed by them. They do not own the bridge maintenance recommendations or their prioritization.

If during the course of performing the Underwater Bridge Inspection a deficiency was located that would affectively change the NBI condition rating for the bridge more than 2 ratings, the Underwater Bridge Inspector must notify the routine bridge inspector-of-record. The routine bridge inspector-of-record will be responsible for amending the official routine bridge inspection-of-record.

Also if the inspector locates a **deficiency that can be defined as being "Critical, Urgent, or Significant"**, the inspector is directed to immediately initiate the actions as specified in "Follow-up Bridge Inspection Procedures" (Chapter 8 of this manual).

Underwater Sketch / Diagram (use excel drawing tools)

Underwater elements
Scour location and dimensions
Location of Maintenance Recommendations
Drift location and size

CHAPTER 17: IN-DEPTH BRIDGE INSPECTIONS

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CHAPTER 17:

IN-DEPTH BRIDGE INSPECTIONS

17.1—INTRODUCTION

Perhaps the most important NBIS requirement is that **detailed and comprehensive inspections of each bridge must be performed**. As no two structures are alike, the particular items to look for on a given inspection will vary from bridge to bridge. The depth and degree of inspection will depend upon the type of structure, its design features, age, condition, and other factors. The primary stipulation is simply that each bridge must be inspected as thoroughly as necessary to clearly establish its condition and to insure its continued safe operation.

The Code of Federal Regulations and the AASHTO Manual for Condition Evaluations of Bridges provides guidance on seven different types of bridge inspections that may be required over the useful life of a bridge, in order to reflect an appropriate level of inspection intensity. The above references refer to:

1. Initial Inspections
2. Routine Inspections
3. Underwater Inspections
4. Fracture Critical Inspections
5. **In-Depth Inspections**
6. Special Inspections
7. Damage to Structure Inspections

The individual in charge of the bridge inspection program for the State of Oregon is responsible for determining how the inspections performed by ODOT might fit into these inspection types, establish appropriate inspection procedures, and set inspection frequencies that are consistent with the intent of the federal directives specified in CFR 650.311. To meet that mandate, the State of Oregon, in-turn, initiated the following:

CFR 650.313 states that there must be at least one bridge inspection team leader at the bridge at all times during each initial, routine, in-depth, fracture critical, and underwater bridge inspections. This is to say that the special and damage to structure inspections can be performed by others that might not be certified bridge inspection team leaders. CFR 650.315(b) says that the inspection date and frequency of the routine, in-depth, fracture critical, underwater, damage, and special inspections are to be entered into the SI&A. However, there are not enough slots to record the inspection date and frequency for all of those inspections. The routine, fracture critical and the underwater bridge inspections have required data entry slots that must be used for recording those specific inspections. That leaves the in-depth, special, and damage inspections with only one slot for recording their date and frequency (92C / 93C). Also the inspection frequency is limited to only two digits. As a result, ODOT can not accurately data enter the inspection frequency because many of the inspection frequencies are three digits (120 months). Therefore, in response to CFR 650.311(3)(d), ODOT decided to not show 92C/93C on the SI& A Sheet. However, the 92C / 93C fields are populated in the database.

CFR 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 deficiencies not readily detectable using routine inspection procedures, but may require a hands-on inspection at some locations. Since by definition, these inspections either require the use of NDE Methods or employing a higher level of expertise, these inspection types carry a high level of importance. ODOT determined that the following inspections fit this definition:

- Fatigue Prone Details Inspections, or
- Redundant Pin & Hanger Inspections, or
- Cross Channel Profile Measurements (Scour Monitoring), or
- Timber Boring, or
- Cable Suspension Bridge Inspections.

17.2—FATIGUE PRONE DETAIL INSPECTIONS

Please refer to Chapter 14.5 of this manual.

17.3—REDUNDANT PIN AND HANGAR ASSEMBLY INSPECTION

Refer to Chapter 14.5 of this manual.

17.4—TIMBER BORING

Refer to Chapter 15 of this manual.

17.5—CROSS-CHANNEL PROFILES

As per FHWA Technical Advisory T 5140.21, “Evaluating Scour at Bridges”, if the structure is located over a waterway, a cross-channel profile is taken. The State of Oregon has decided to collect this data in the form of x,y coordinates, as measured along the upstream bridge rail and down to the existing ground line / streambed. The x,y coordinates are then placed on cross-sectional plot, so that plots over a period of time can be overlaid. By overlaying multiples of years of profiles, channel movements, horizontal and vertical, can be easily monitored and any channel changes become clearly apparent. The bridge foundation information is also plotted onto these profiles so that the criticality of the movement can also be assessed. If the channel thalweg was found to be below and next to the bridge footing the deficiency would definitely warrant an immediate structural analysis and the implementation of countermeasures. ODOT uses Excel charting tools contained in a computer application call “BrEase” to perform these plotting tasks.

17.6—CABLE SUSPENDED BRIDGE INSPECTIONS

Cable suspended structures contain fracture critical members and fatigue prone details and the inspection of those components are specifically covered in those types of inspections. However, we need to clearly define why a Cable Suspended Special Inspection is also necessary. The intent of these inspections is to zero in on the structural geometry and the very different load paths, in order to assure that the structure is functioning, as originally designed. The two distinct load paths consist of the cable suspension system back to the cable anchorages and along the stiffener truss and down the interior piers. The original design called for a balanced system so that the cable suspender ropes, the stiffener truss, and the bearings would not be overloaded. However, over time, the cable suspension system will relax or the interior bents can settle, transferring more of the load into these components. Therefore, this inspection is to assess whether that load transfer is still within tolerable limits. Since there are only 3 cable suspended bridges in the State, these inspections are contracted out to a consulting engineering firm with notable expertise in cable suspended bridges. The contracts for these inspections are administered by ODOT, Bridge Operations. The date and frequency of these inspections are coded in the NBI File under 92C and 93C. The cable suspended bridges in the State of Oregon are:

Willamette River (St Johns) Bridge
Lake Billy Chinook Bridge
Deschutes River Bridge
Willamette River (Tilikum) Bridge

ODOT only has one suspension bridge in the ODOT bridge inventory:

Willamette River (St Johns) Bridge

There are two more suspension bridges in the state that are owned by Jefferson County:

Lake Billy Chinook
Deschutes River

There is one cable-stayed bridge in the state that is owned by Tri-Met:

Willamette River (Tilikum) Bridge

Suspension Bridges: During routine inspections, the main cable wrap system will be inspected for signs of distress, signs of leakage at drain holes, and rust staining at drain holes, in addition to condition assessment of the suspender cables. It would be counterproductive to breach the main cable wrap if the wrap is in good condition and there is no sign of the wrap failing to protect the main cable.

Cable-Stayed Bridges: During routine inspections, the cable protection system will be inspected for signs of distress or failure and for signs of cable corrosion.

Since ODOT does not maintain a cadre of staff expertise for only one structure, any in-depth inspection is typically outsourced to a consultant that specializes in these types of structures.

An in-depth inspection will be scheduled when any of the main cable elements or cable support elements exhibit section loss or degradation.

The bridge inspection procedures are contained in the Scope of Work for the Engineering Consultant firm and the project deliverable for the investigation.

With each bridge inspection performed, an inspection report must be completed and the results incorporated into the routine inspection report, along with any noted maintenance or repairs activities which would have an effect on the assigned NBI or Element Condition Ratings. Any of these additional inspections may be performed concurrently or separately with the routine bridge inspection or other types of inspections.

Furthermore, as a part of every inspection cycle, bridge load ratings should be reviewed and updated to reflect any relevant changes in condition or dead load noted during the inspection. The safe load capacity of a bridge is based on existing structural conditions. To maintain this capacity, it is assumed that the structures are subject to competent inspections, as often as the existing conditions of the structure require, and that sound judgment will be exercised in determining an appropriate factor of safety.

Depending on the information obtained from this inspection type could require the inspector to file an “Amended Routine Inspection Report”. The term “amended” is used here with the intent to keep the bridge inspection database as current as possible without changing the next scheduled routine inspection date. All filed amended inspections require an official signature of new bridge inspector-of-record.

17.7—MAINTENANCE RECOMMENDATIONS AND NOTIFICATION REQUIREMENTS

By definition, the In-depth, Inspections will most likely occur at a different time than the routine inspection. There is also a good chance that any of the In-depth, Special, or Damage to Structure inspections will be performed by a different inspector than the routine bridge inspector-of-record. Therefore, we must post some business rules that would help govern who’s responsible for doing what, when and how. If during the course of the FC inspection, a structural deficiency is located that warrants the posting of a bridge maintenance / repair recommendation, we need to know exactly who’s responsible for entering the maintenance recommendation into the system, when, and how should it be done.

Since ODOT performs a wide variety of different kinds of supplemental inspections and reports, the business rule is as follows: **If the person that performed the inspection has access to the bridge inspection database, they are responsible for entering and posting the appropriate bridge maintenance recommendation. If the person that performed the inspection does not have access to the bridge inspection database, they will need to provide the information to others so that the data entry can be performed.** Due to the potential critical nature of some deficiencies, the bridge maintenance recommendation should be posted as-soon-as the inspection is completed. This is to say that the routine bridge inspector-of-record owns the bridge inventory and condition rating data, which can only be changed by them. They do not own the bridge maintenance recommendations, or their prioritization, that can be posted by others.

If during the course of performing the in-depth, special, or damage to structure inspection, a deficiency was located that would affectively change the NBI condition rating for the bridge more than 2 ratings, the bridge

inspector must notify the routine bridge inspector-of-record. The routine bridge inspector-of-record will be responsible for scheduling an inspection and amending the official routine bridge inspection-of-record.

Also if the inspector locates a **deficiency that can be defined as being “Critical, Urgent, or Significant”**, the inspector is directed to immediately initiate the actions as specified in Section 8 of this manual.

CHAPTER 18: SPECIAL BRIDGE INSPECTIONS

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CHAPTER 18:

SPECIAL BRIDGE INSPECTIONS

18.1—INTRODUCTION

CFR 650.313(f) Complex Bridges directs the transportation agencies to identify specialized inspection procedures, and additional inspector training and experience required to inspect complex bridges. Inspect complex bridges according to those procedures. **CFR 650.305 defines a Complex Bridge as:** Movable, Suspension, cable stayed, and other bridges with unusual characteristics.

CFR 650.313 Inspection Procedures – A certified bridge inspection team leader does not necessarily have to be on-site during the inspection of a complex bridge. However, if the inspection is defined as an In-Depth Inspection, a team leader must be on-site during the inspection. As a result, ODOT elected to separate the bridge features so that more clarity existed as to whether a team leader was required or not. If the investigation only covered the operational features like Drawbridge Electrical / Mechanical, it would be classified as a Special Inspection. If the intent of the investigation was to determine the condition of a primary load path member such as the Suspension System on a bridge, it would be classified as an In-depth Bridge Inspection and a team leader would be required to be on site and actively participate throughout the investigation.

Required Inspector Training / Experience

No NHI training for movable bridges exists. ODOT requires the following professional certifications:

- Drawbridge Mechanical Component Inspections
 - Licensed Mechanical Engineer in the State of Oregon
- Drawbridge Electrical Component Inspections
 - Licensed Electrical Engineer in the State of Oregon
- Suspension Bridge Inspections
 - Licensed Civil / Structural Engineer in the State of Oregon
 - History of performing Suspension Bridge Inspections

The CFR 650.305 goes on to defines a “Special” inspection as an inspection that is scheduled at the discretion of the bridge owner, and is used to monitor a particular known or suspected deficiency. By definition these inspections do not appear to carry as high a level of criticality. ODOT decided that the inspection types that best fit this definition are:

- Deck Surveys in order to measure the quantity of spalls and delaminations
- Interior Box Girder Inspections, due to the presence of Permit-Entry Confined Spaces
- Concrete Segmental Bridge Inspection due to the complexity of the structure
- Movable Drawbridge Electrical / Mechanical Inspection due to the complexity of these components and the expertise required to assess their condition.
- Concrete Bridge Chloride Content Surveys
- Bridge Clearance Measurements for the routing of over-size vehicles

Since Special inspections are scheduled at the discretion of the bridge owner, and is used to monitor a particular known or suspected deficiency, ODOT performs these inspections on the bridge inventory that is under ODOT jurisdiction only. The other public agencies are responsible for performing these inspections on their own bridge inventory.

18.2—DECK SURVEYS

If the structure has a concrete deck, the deck is surveyed periodically to help monitor its condition with due reference to the following

- The Quality of Ride,
- The Quality of the Materials in the deck,
- Load Associated Defects,
- Corrosion Associated Defects, and/or

- The condition of any Wearing Surfaces.

These bridge deck deficiencies are generally located using the chain drag method and monitoring traffic as it traverses the bridge deck. The result of the survey is plotted onto a plan view of the bridge deck using Excel drawing tools.

18.3—INSPECTION OF ACCESSIBLE INTERIOR BOX GIRDER STRUCTURES

All accessible Box girders contain confined spaces. As such, in order to be in compliance with OrOSHA regulations, these spaces can only be entered if the assigned inspectors follow very specific precautionary procedures. Each entry fouls the air quality due to the amount of pigeon guano, etc. Therefore, in order to provide an acceptable level of workplace safety, access to these spaces should be minimized and only after the required safety measures are in-place. These inspections will almost always coincide with the routine inspection and the reason why they are considered a Special Inspection is the extra effort, equipment, and safety documentation that is required to be performed before, during and after each entry.

The interior of a box girder section will be inspected at the specified intervals, if the following criteria is encountered:

- The interior of all box girder sections will be inspected at least every 10 years.
- Visual indications on the exterior of the box shows that something out of the ordinary is occurring inside, i.e., water from a utility pipe, asphalt from the wearing surface, etc – inspect ASAP.
- The structure has structural elements that can only be viewed from inside of the box section, such as, pin and hanger assemblies, bearings, modular deck joint assemblies, or integral cross-beams – inspect during every routine inspection.
- Areas inside of the box section where water occasionally puddles are noted – inspect at least every 4 years.
- The box section shows signs of active corrosion: If areas of pack rust or section loss are noted, inspect during every routine inspection. Otherwise inspect at least every 6 years.
- The box girder sections was constructed on a curve where distortion induced or out-of-plane bending problems might exist – inspect at least every 6 years.
- Fatigue Cracking has been noted in a steel member – inspect during every routine inspection.
- The steel box section is considered to be Fracture Critical – inspect during every FC Inspection.
- The exterior of a concrete box girder section has shear cracks that are $> 0.040"$ – inspect at the frequency indicated by Concrete Crack guideline.

18.4—CONCRETE CORROSION/CATHODIC PROTECTION SYSTEM INSPECTION

If the structure is a concrete bridge, located in a coastal marine or corrosive type of an environment, a thorough investigation is performed periodically in order to assess the amount of corrosion that is occurring on the reinforcing steel in our bridges. Several of the higher priority bridges along the coast have had Cathodic Systems installed to counter that corrosive environment thereby protecting the steel reinforcement. However, since these Cathodic Protection Systems are sacrificial, in nature, periodic monitoring and maintaining the system is required. These inspections are being performed by the ODOT, Bridge Preservation Work Unit.

18.5—CONCRETE SEGMENTAL BRIDGE INSPECTIONS

Concrete segmental bridges are still considered to deserve special attention. The appearance of a distress crack in a post-tensioned structure is evidence of an unfavorable condition. Concrete cracking may occur for a number of reasons, but more often than not, is the result of the interaction of several factors. These factors taken individually may be minor, but when superimposed can result in a deficiency that is serious enough to cause concern for the structural integrity of the bridge. For more information, refer to Walt Podolny's "Guide Manual on Inspection of Segmental Bridges." The concrete segmental bridge in the State of Oregon is:

Columbia River (Glenn Jackson / I-205) Bridge

18.6—MOVABLE/DRAWBRIDGE INSPECTIONS

The Code of Federal Regulations (CFR), Title 33, Chapter 1, Part 117, “Drawbridge Operation Regulations”, prescribes that the state will operate all drawbridges that are over navigable streams, in accordance with U. S. Coast Guard Regulations. As a result, ODOT performs an inspection every 2 years on all electrical and/or mechanical operational systems under its jurisdiction in order to meet U.S. Coast Guard requirements. The technical support, for these inspections is provided by the Bridge Preservation Unit, as they have Mechanical and/or Electrical Engineering expertise on staff. The drawbridges inspection performed on the bridges under the Local Agency jurisdiction are performed by the local agency and/or personnel who have the responsibility for their operation. The drawbridges under ODOT jurisdiction is as follows:

New Young’s Bay (Astoria)
Old Young’s Bay (Astoria)
Lewis & Clark River (Astoria)
Walluski River Bridge
Columbia River (Interstate / I-5 NB) Bridge
Columbia River (Interstate / I-5 SB) Bridge
Umpqua River (Reedsport) Bridge

Coquille River (Coquille) Bridge
Coquille River (Bullards) Bridge*
Isthmus Slough (East Side) Bridge
Coos River (Chandler) Bridge
South Slough (Charleston) Bridge

*Coast Guard decommissioned this movable bridge – only inspect prior to bridge painting projects as bridge will only be operated to gain access to otherwise hidden surfaces such as end floor beams.

Inspection procedures will follow the guidelines of the AASHTO Movable Bridge Inspection, Evaluation, and Maintenance Manual, Chapter 2 (all components listed in Figure 2.1.2.3-1 will be inspected every 2 years).

18.7—BRIDGE CLEARANCES

In response to a Congressional Directive, in 1972 Federal Highway Administration (FHWA) crafted the Structure Inventory and Appraisal (SI&A Sheet) of the Nation’s Bridges. Each state was required to capture and record specific data elements that comprise the National Bridge Inventory Database. In addition to providing a complete and thorough inventory as to the number and condition of the Nation’s bridges, the collected data was necessary for FHWA and the Military Traffic Management Command to identify and classify the Strategic Highway Corridor Network and it’s connectors for defense purposes. These requirements are set forth in the National Bridge Inspection Standards (23 CFR 650.3). It’s important to note that the SI&A Sheet is not an inspection form but merely a summary sheet of the bridge data required by the FHWA to effectively monitor and manage a National bridge program.

If the structure is located over a roadway, clearance measurements are obtained in such a form so that they can be used to code the appropriate code NBI Items. This information is also used by Motor Carriers for the routing of oversize trucks throughout the state. The information is obtained using a vehicle mounted laser measurement device (VCMS), which can safely take the measurements at highway speeds. The field results are plotted onto a digital image of the bridge profile at each skip and fog line. These measurements are validated during every routine inspection using a hand held laser distance measuring device, as well as, assuring that the bridge is properly signed.

Program Definition

Why were these tasks assigned to Bridge Operations

- In charge of the Bridge Inspection Program for the State of Oregon
- Performs condition assessment on every bridge in the inventory at least every 2 years.
- Original task was to collect this type of data for reporting to FHWA on a bi-annual basis.

- Made sense to share information with Motor Carriers.

History of how the data was collected

- 1970's and 80's, - Collected By hand using a telescoping clearance rod
- 1990's - Used handheld Accoustic distance measuring devices
- 2006 - Handheld and Vehicle mounted Laser distance measuring device

Documents that use bridge clearance data:

- FHWA Structure Inventory & Appraisal Database
- Motor Carriers Over-height / Over-width Permit Manual
- ODOT Bridge Operations Clearance Diagrams
- ODOT Bridge Log

Note: Each document is used quite differently and should not be used for a purpose not intended.

Define Data Users, Source, and how they differ

Document: FHWA Structure Inventory & Appraisal Information

How Data is Used: For FHWA to Manage the National Bridge Program

Where is Data Stored: ODOT Bridge Inspection Database

Who collects the data: Bridge Operations

What basic information is collected / reported:

Bridge Location (Hwy / Milepost and Longitude / Latitude)

Inventory Route, Minimum Vertical Clearance (Item 10)

Bypass, Detour Length (Item 19)

Functional Classification of Inventory Route (Item 26)

Owner / Maintenance Responsibility (Item 21 / 22)

Lanes On / Lanes Under (Item 28)

Design Load (Item 31)

Approach Roadway Width (Item 32)

Navigation Vertical Clearance (Item 39)

Navigation Horizontal Clearance (Item 40)

Inventory Route, Total Horizontal Clearance (Item 47)

Curb or Sidewalk Widths (Item 50)

Bridge Roadway Width, Curb-to-curb (Item 51)

Minimum Vertical Clearance over Bridge Roadway (Item 53)

Minimum Vertical Underclearance (Item 54)

Minimum Lateral Underclearance on right (Item 55)

Minimum Lateral Underclearance on left (Item 56)

Deck Geometry (Item 68) - Calculated field by comparing the minimum vertical clearance over bridge roadway (Item 53) and Functional Classification (Item 26)

Underclearances, Vertical and Horizontal (Item 69) - Calculated field by comparing the minimum vertical underclearance (Item 54) and Functional Classification of Underpassing Route (Item 26).

NOTE: NBI Items 10 and 54 are obtained by VCMS Team, Bridge inspectors obtain all others

Accuracy Required: $\pm 1"$

QA / QC Data: Bridge Operations Reviews

How this information differs: Contains information on state and local agency structures. The Vertical Clearance information contained herein is not tied to a specific lane. Clearances are either maximum or minimum dimensions under a structure only. This information is used to calculate a sufficiency rating that is used to appropriate federal Bridge Program Funds and potential routing of civil defense vehicles.

Access to information: SI&A Sheet associated with each bridge can be accessed via Internet and Intranet connection to the ODOT Bridge Inspection Reports Web Page.

Document: Motor Carriers Over-height / Over-width Permit Manual

How is Data Used: Routing of over-height and over-width vehicles

Where is Data Stored: Motor Carriers Database

Who collects the data: Br Ops – lane info (VCMS Team), shoulder info (RBI)

What information is collected / reported:

Tabular clearance dimensions on a given route – motor carrier incl. buffer
 Vertical Clearance over each traffic lane and shoulder
 Horizontal Clearance across each traffic lane and shoulder
 Total Horizontal Clearance between face of restrictions
 Clearance information on state highway system only.

Accuracy Required: strive for $\pm 1/2"$. VCMS vehicle measures perpendicular to the roadway surface.

Handheld lasers measure plumb dimensions. Depending on grade of overhead restriction, the difference between these two could exceed tolerance. Bridge Operations provides actual dimension, Motor Carriers logs dimension minus 4" buffer.

QA / QC of Data: Data is scrubbed by Bridge Operations Staff during download and upload process to Motor Carriers Database. The Region Bridge Inspectors check the exterior fog-line measurements during their routine bridge inspection.

How this information differs: This data is collected using lasers, and is tied to each specific traffic lane or shoulder, under an overhead restriction.

Access to Information: Tabulated lane dimensions from Motor Carriers

Document: ODOT Bridge Log

Anticipated Users: Bridge Community, Primary resource for ODOT Personnel, when on the road.

How data is used: Quick bridge identifier and location reference document, sorted by highway / milepoint, and contains bridge number, along with horizontal and vertical clearance information.

Where is Data Stored: Database resides on Dick Groff's computer.

Accuracy: Dick Groff updates database manually as changes are provided. As a result, accuracy or timeliness of data can not be guaranteed.

Who collects / provides the data: Region bridge inspectors

What information is collected:

Highway / Milepost, Bridge Number, Structure Configuration, Vertical / Horizontal Clearance, Deck-to-stream dimension.

QA / QC of the Data: The region bridge inspectors check the data

How does this information differ: Quick reference to state highway system only. The vertical clearance information is the minimum dimension - not lane specific. The information is updated occasionally – timeliness or accuracy can not be guaranteed.

Access to Information: ODOT Bridge Log can be accessed via Internet and Intranet connection to the ODOT Bridge Section Home Page.

Document: ODOT Clearance Diagrams

Anticipated User: Highway Construction and Highway Maintenance Staff

How data is used: Traffic Control during construction project or incident management

Where is Data Stored: Clearance Diagram Folders on bridge server 'S7000B'

Accuracy: Dimensions using laser measurement devices - $\pm 1/2"$.

Who collects / provides the data: VCMS Team and Region bridge inspectors

What information is collected:

Lane specific vertical and horizontal dimensions

QA / QC of the Data: The region bridge inspectors check the diagrams during each routine inspection.

How does this information differ: Clearance dimensions overlaid onto a digital image of profile view of the structure, using Excel.

Access to Information: Clearance Diagrams can be viewed via Internet or Intranet connection to the ODOT Bridge Inspection Reports Web Page.

Define Databases where clearance information is stored:

ODOT Bridge Inspection Database: "\\S-SALEMREV-63\PROD_M1"

Motor Carriers Database: "\\EXSQL7P2\DATABASE\HTDR1"

Bridge Log Database: "brdgshar(scddata)\bridge\BRLOG\BRLOG.dbf"

Long-Term Program Issues

- Bridge Operations:
 - Establishment of follow-up frequency based on the following criteria:
 - Number of Under Crossings = 657 bridges
 - Frequency based on number of changes in clearance info
 - Base frequency on functional class of the route
 - Base frequency on Freight Route designation
 - Base frequency on production and available weather
 - Tasks: Create data set for itinerary (5 min/br)
 - Perform field work (40 min / br)
 - Process data (10 min / br)
 - Create Motor Carriers text file (10 min/br)
 - Update Clearance Diagrams (10 min/br)
 - Production Rate: Use 1.5 crew hr / bridge
 - Full inventory = 6.57 months
 - 3 yr turn around = 219 brs in 8 weeks which equates to a ± 1 wk /month commitment.
 - Planned work schedule: April thru Sept. = 6 mo
 - Yr 1: I-5 = 244 Under Crossings
 - Yr 2: I-84 + I-205 + I-105 = 216 Under Crossings
 - Yr 3: Remainder of Inv. = 197 Under Crossings
 - VCMS Team – one driver + one laptop operator
 - Use of Bridge Inventory Coordinator
 - Use of temps (driver)
 - Use of Region Bridge Inspectors
 - QA / QC of Data (Measurements)
 - VCMS team cleans & calibrates lasers daily
 - Itinerary is kept short due to potential error.
 - VCMS Teams compares with previous measurements when updating diagrams
 - RBI's validates info fogline-out during insp.

Construction Section

- Construction Manual Instructions to provide during and post construction clearances

Highway Maintenance

- Maintenance Manual instructions to provide during and post maintenance operations clearances

Special requests

- Project planning requests – provide EA ?????

CHAPTER 19: DAMAGE TO STRUCTURE INSPECTIONS

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CHAPTER 19:

DAMAGE TO STRUCTURE INSPECTIONS

19.1—INTRODUCTION

Even though they cannot be **anticipated**, these inspections at times can certainly be warranted during the life of the bridge and can be performed by personnel that might not necessarily be certified as a bridge inspection team leader (like a licensed engineer or the bridge maintenance crew staff). The intent of these inspections is to assess whether structural damage has occurred as a result of some environmental or human factor. The scope of these inspections is to obtain sufficient detail to clearly define a course of action: placement of emergency load restrictions, closure of the bridge to traffic, and/or to assess the level of effort necessary to affect a repair. The amount of effort expended on this type of inspection may vary significantly depending on the extent of the damage. If major damage has occurred, inspectors must evaluate fractured members, determine the extent of section loss, make measurements for misalignment of members, and check for proper support. For program support in notifying, scheduling and reporting the results of these interim inspections, contact the ODOT Bridge Operations Engineer: (503) 986-3402. Inspections that fit this category are as follows:

- Traffic Collision Damage
- Navigational Traffic Collision Damage
- Rockfall Damage
- Fire Damage
- Structural damage caused by drift or ice
- Post High Water Event Surveys
- Post Seismic Event Surveys
 - Any time the bridge has been struck and sustained major structural damaged due to a collision from a vehicle or a vessel, a damage to structure inspection should be performed to assess the extent of the damage and to determine the appropriate action(s) to take.
 - Any time a high water event reaches the bottom of the superstructure, or if an inordinate amount of drift has accumulated upstream from an existing structure, a flood inspection should be conducted both during and immediately after the event to assess what effects the increased water flow and/or drift is having, or had, on the bridge.
 - If the bridge has been jostled by an earthquake of a magnitude where it is vibrations are physically felt by people in the area, an inspection may be warranted.
 - If a structural members has been touched by a fire that is intense enough to blister the surface paint on a steel bridge, char the outside surface of a timber bridge, or pop-off surface cover on a concrete bridge.

With each bridge inspection performed, an inspection report must be completed and the results incorporated into the routine inspection report, along with any noted maintenance or repairs activities which would have an effect on the assigned NBI or Element Condition Ratings.

Any of these additional inspections may be performed concurrently or separately with the routine bridge inspection or other types of inspections.

Furthermore, as a part of every inspection cycle, bridge load ratings should be reviewed and updated to reflect any relevant changes in condition or dead load noted during the inspection. The safe load capacity of a bridge is based on existing structural conditions. To maintain this capacity, it is assumed that the structures are subject to competent inspections, as often as the existing conditions of the structure require, and that sound judgment will be exercised in determining an appropriate factor of safety.

Depending on the information obtained from this inspection type could require the inspector to file an “Amended Routine Inspection Report”. The term “amended” is used here with the intent to keep the bridge inspection database as current as possible without changing the next scheduled routine inspection date. All filed amended inspections require an official signature of new bridge inspector-of-record.

19.2—MAINTENANCE RECOMMENDATIONS AND NOTIFICATION REQUIREMENTS

By definition, the In-depth, Special, or Damage to Structure inspections will most likely occur at a different time than the routine inspection. There is also a good chance that any of the In-depth, Special, or Damage to Structure inspections will be performed by a different inspector than the routine bridge inspector-of-record. Therefore, we must post some business rules that would help govern who's responsible for doing what, when and how. If during the course of the FC inspection, a structural deficiency is located that warrants the posting of a bridge maintenance / repair recommendation, we need to know exactly who's responsible for entering the maintenance recommendation into the system, when, and how should it be done.

Since ODOT performs a wide variety of different kinds of supplemental inspections and reports, the business rule is as follows: **If the person that performed the inspection has access to the bridge inspection database, they are responsible for entering and posting the appropriate bridge maintenance recommendation. If the person that performed the inspection does not have access to the bridge inspection database, they will need to provide the information to others so that the data entry can be performed.** Due to the potential critical nature of some deficiencies, the bridge maintenance recommendation should be posted as-soon-as the inspection is completed. This is to say that the routine bridge inspector-of-record owns the bridge inventory and condition rating data, which can only be changed by them. They do not own the bridge maintenance recommendations, or their prioritization, that can be posted by others.

If during the course of performing the in-depth, special, or damage to structure inspection, a deficiency was located that would affectively change the NBI condition rating for the bridge more than 2 ratings, the bridge inspector must notify the routine bridge inspector-of-record. The routine bridge inspector-of-record will be responsible for scheduling an inspection and amending the official routine bridge inspection-of-record.

Also if the inspector locates a **deficiency that can be defined as being “Critical, Urgent, or Significant”**, the inspector is directed to immediately initiate the actions as specified in Section 8 of this manual.

The same CFR defined a “Damage” Inspection as an inspection that is unscheduled, to assess structural damage resulting from an environmental factor or human actions. An Environmental Factors or Human Actions that would fit this definition are:

- Damage caused by High Load Traffic Collisions
- Damage caused by Collision with large commercial shipping vessels
- Rock falls onto the structure
- Damage caused by stream flow actions, like: Scour, Erosion, Drift, or Ice

The reason ODOT believes this categorical inspection carries a fairly high priority is because of the following:

- Damage imparted onto a bridge component quite often, results in a major project to repair or prevent reoccurrence in the future, and
- This is an indicator that a significant traffic hazard exists at this bridge site.

CHAPTER 20: SCOUR MONITORING PROCEDURES

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CHAPTER 20:

SCOUR MONITORING PROCEDURES

20.1—INTRODUCTION

CFR 650.313(e) directs each agency to “Identify bridges that are scour critical”. CFR 650.313(e)(3) – For bridges that are scour critical, the agency is directed to “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.” In accordance with this provision, ODOT evaluated each bridge over a waterway as to its scour potential in accordance with the “FHWA Technical Advisory - 5140.23 **“Evaluating Scour at Bridges”** - dated October 28, 1991”. This evaluation included its vulnerability to scour in order to determine the prudent measures to be taken for its protection.

In 1996, the ODOT Hydraulics Unit performed an extensive evaluation of all bridges located over a waterway, in the State and assigned the initial scour code for NBI Item 113. Since that time, the bridge condition assessment inspectors have been responsible for making a reasonableness validation check when they are performing their on-site routine inspections. In order to retain some consistency in the scour database, ODOT restricted access to the database. Updates can only be initiated by the ODOT Bridge Hydraulics Engineer. If the bridge inspector believes a change to the existing code is warranted, they submit a request to the ODOT Bridge Hydraulics Engineer for a review of the scour evaluation along with sufficient field data, pictures, and a narrative description that supports their conclusion. We believe this method provides the desired checks and balance measures between the field and bridge headquarters.

ODOT actively monitors scour by performing cross-channel profiles. This allows multiples of profiles to be overlaid onto a profile view of the bridge foundation elements, which provides a measure of channel movement over time and helps assess the criticality of the channel movement, by referencing the stream thalweg with the elevation and location of the bridge footings. The cross-channel profiles are checked during every routine inspection and updated if the following conditions exist:

- NBI Item 113 has been coded as being scour critical or has an unknown foundation, and
- NBI Item 61 – Channel Protection has major damage, or
- The scour defect is in condition state 2 or less.

In addition to the evaluation requirement, a plan of action was developed for each existing bridge that has been determined to be scour critical. (See HEC 18, Chapter 5).

- a. The plan of action includes instructions regarding the type and frequency of inspections to be made at the bridge, particularly in regard to monitoring the performance and closing of the bridge, if necessary, during and after flood events. (See HEC 18, Chapter 7).
- b. The plan of action includes a schedule for the timely design and construction of scour countermeasures determined to be needed for the protection of the bridge. (See HEC 18, Chapter 7).

Bridge Inspectors have received appropriate training and instruction in inspecting bridges for scour. (See HEC 18, Chapter 6). It is anticipated that the assigned bridge inspector will provide the following:

- a. Accurately record the present condition of the bridge and the stream. At least one cross section at each bridge should be documented and compared with previously recorded cross section(s) at the site. Pier locations and footing elevations should be included.
- b. Identify conditions that are indicative of potential problems with scour and stream stability.
- c. Effective notification procedures should be available to permit the inspector to promptly communicate findings of actual or potential scour problems to others for further review and evaluation.

- d. Special attention should be focused on the routine inspection of scour critical bridges on the monitoring and closing as necessary of scour critical or other bridges during and after flooding events.

FHWA endorses the guidance contained in the 1987 AASHTO Manual for Bridge Maintenance. Particular attention is directed to the following statement:

“Determining an effective solution to a stream bed or river problem is difficult. Settlement of foundations, local scour, bank erosion, and channel degradation are complex problems and cannot be solved by one or two prescribed methods. Hydraulic, geotechnical, and structural engineers are all needed for consultation prior to undertaking the solution of a serious maintenance problem. In some cases, some remedial action could actually be detrimental to the structure.”

Any or all of the following factors can lead to significant scour around the bridge foundation:

- Poor choice of bridge location
- Meandering river bed
- Inadequate flow area or restrictions imposed by the substructure of the bridge
- Inaccurate estimation of flood levels and its velocity
- Excessive storm (super-flood)
- Poor orientation of substructure elements with respect to water flow
- Fine-grained riverbed material can become water-bourn with just a small increase in velocity
- Foundations that are above the scour depth or the bridge has an unknown foundation
- Unpredicted increase in the flow velocity caused by debris
- Lack of scour preventive measures
- Improperly designed riprap where stronger measures should have been used.
- Dramatic change in the run-off characteristics upstream from the structure.

Periodic inspection of the bridge foundation or overlaying historical cross-channel measurements are the only methods by which a potentially scour-induced failure can be detected or prevented. A lasting repair of an undermined foundation depends on understanding the streambed dynamics and what factors contributed to the scour and also what hydraulic impact the proposed corrective measures would have on the remaining parts of the river. Sometimes, adding riprap or constructing a cofferdam around a scoured bridge bent can induce more scour and undermining on a bridge bent with no scour history.

There are two main objectives to be accomplished in inspecting bridges for scour:

- Accurately record the present condition of the bridge and the stream; and
- Identify conditions that are indicative of potential problems with scour and stream stability for further review and evaluation by others.

In order to accomplish these objectives, the inspector needs to recognize and understand the inter-relationship between the bridge, the stream, and the floodplain. Typically, a bridge spans the main channel of a stream and perhaps a portion of the floodplain. The road approaches to the bridge are typically on embankments which obstruct flow on the floodplain. This over-bank or floodplain flow must, therefore, return to the stream at the bridge and/or overtop the approach roadways. Where over-bank flow is forced to return to the main channel at the bridges, zones of turbulence are established and scour is likely to occur at the bridge abutments. Further, piers and abutments may present obstacles to flood flows in the main channel, creating conditions for local scour because of the turbulence around the foundations. After flowing through the bridge, the floodwater will expand back to the floodplain, creating additional zones of turbulence and scour.

This section is to present guidance for the bridge inspector's use in developing a comprehension of the overall flood flow patterns at each bridge inspected; and the use of this information for rating the present condition of the bridge and the potential for damage from scour. When an actual or potential scour problem is identified by a bridge inspector, the bridge should be further evaluated by the bridge hydraulics and bridge foundations engineers. The results of this evaluation should be recorded in the bridge inventory under NBI Item 113 – Scour Code.

If the bridge is determined to be scour critical, a plan of action should be developed for installing scour countermeasures. In this case, the rating of the bridge substructure (NBI Item 60) should be revised to reflect the effect of the scour on the substructure.

20.1.1—Office Review

It's desirable to make an office review of the bridge plans and previous inspection reports prior to making the bridge inspection. Information obtained from the office review provides a better basis for inspecting the bridge and the stream. Items for consideration in the office review include:

- Has an engineering scour evaluation been completed? If so, is the bridge scour critical?
- If the bridge is scour critical, has a plan of action been made for monitoring the bridge and/or installing scour countermeasures?
- What do comparisons of streambed cross sections taken during successive inspections reveal about the streambed? Is it stable? Degrading? Aggrading? Moving laterally? Are there scour holes around the piers and abutments?
- What equipment is needed (rods, poles, sounding lines, sonar, etc.) to obtain streambed cross sections?
- Are there sketches and aerial photographs to indicate the plan location of the stream and whether the main channel is changing direction at the bridge?
- What type of bridge foundation was constructed? (Spread footing, piles, drilled shafts, etc.) Do the foundations appear to be vulnerable to scour?
- Do special conditions exist requiring particular methods and equipment (divers, boats, electronic gear for measuring stream bottom, etc.) for underwater inspections?
- Are there special items that should be looked at? (Examples might include damaged riprap, stream channel at adverse angle flow, problems with debris, etc.)

20.1.2—Bridge Inspection

During the bridge inspection, the condition of the bridge waterway opening substructure, channel protection, and scour countermeasures should be evaluated, along with the condition of the stream.

1. NBI Item 60: Substructure, and
2. NBI Item 61: Channel and Channel Protection, and
3. NBI Item 71: Waterway Adequacy.

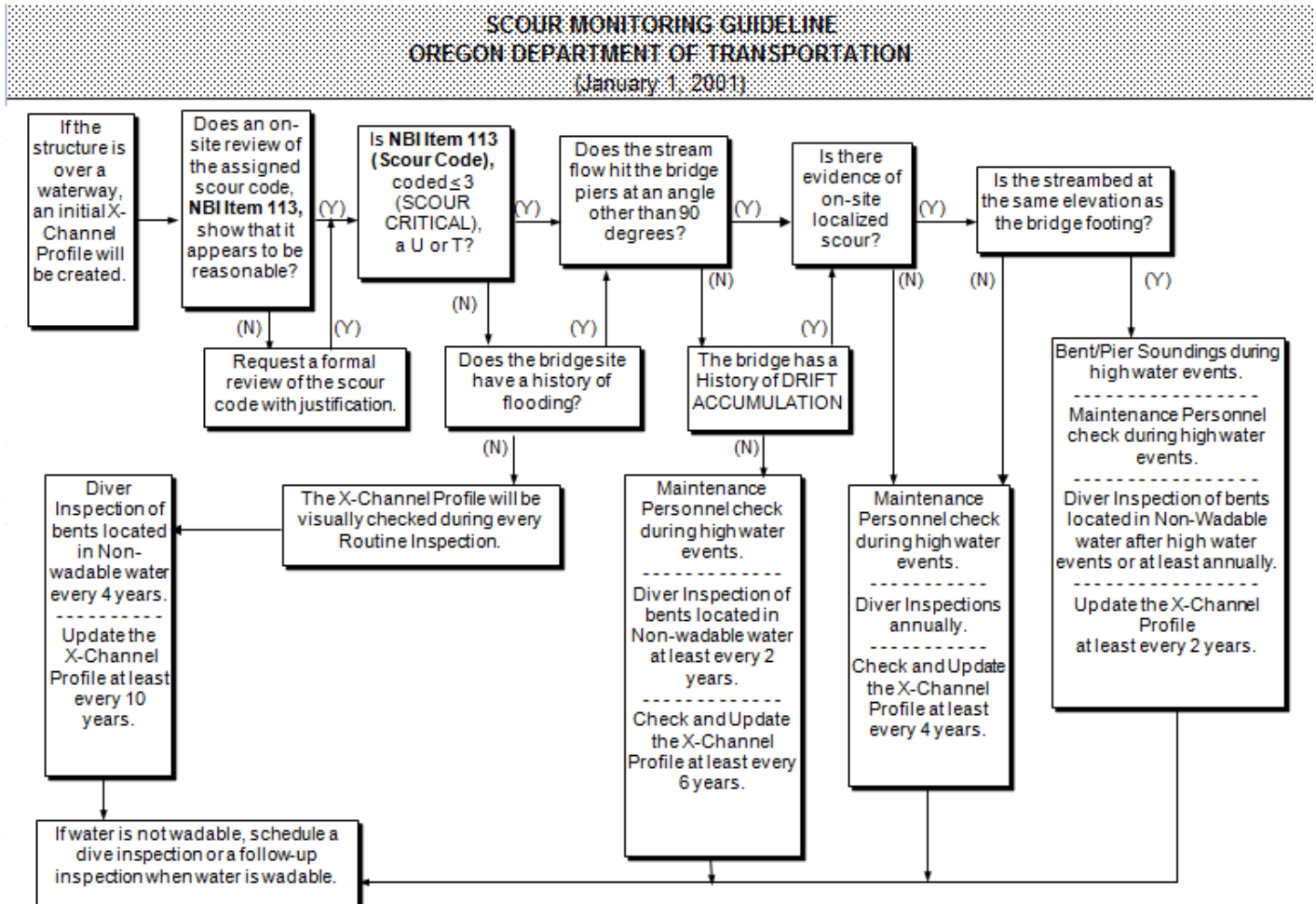
20.1.3—Assessing the Condition of the Bridge Substructure

NBI Item 60, Substructure, is the key item for rating the bridge foundations for vulnerability to scour damage. When a bridge inspector finds that a scour problem has already occurred, it should be considered in the rating of Item 60. Both existing and potential problems with scour should be reported so that a scour evaluation can be made by others. The scour evaluation is reported in NBI Item 113 – Scour Code. If the bridge is determined to be scour critical, the rating of NBI Item 60 should be evaluated to ensure that existing scour problems have been considered. The following items are recommended for consideration in inspecting the present condition of the bridge foundations:

1. Evidence of movement of piers and abutments:
 - a. Rotational movement (check for plumb line),
 - b. Settlement (check lines of substructure and superstructure, bridge railing, etc, for discontinuities; check for structural cracking of spalling),
 - c. Check bridge bearing for excessive movement.
 - d. Check the deck joints for differential movements.
2. Damage to scour countermeasures protecting the foundations (riprap, guide banks, sheet piling, sills, etc.
3. Changes in streambed elevation at foundations (undermining of footings, exposure of piles), and
4. Changes in streambed cross section at the bridge, including location and depth of scour holes.

In order to evaluate the conditions of the foundations, the inspector should take cross sections of the stream, noting location and condition of streambanks. Careful measurements should be made of scour holes at piers and abutments,

probing soft material in scour holes to determine the location of a firm bottom. If equipment or conditions do not permit measurement of the stream bottom, this condition should be noted for further action.



NOTE: An acceptable scour countermeasure are those features that are Engineered in accordance with HEC-18 and 20. Such features include Rock Riprap, Guide Banks, Channel Improvements, Structural Scour Countermeasures, Overflow spans and/or structures, or Monitoring and Instrumentation.

20.2—SCOUR MONITORING GUIDELINE

20.2.1—Cross Channel Profile Frequency

A Cross Channel Profile will be performed on all structures located over a waterway. If the structure is scour critical, the Profile will be performed during the next routine inspection. If the structure is not scour critical, the Profile will be performed as the work load permits.

Check and Update the X - Channel Profile at least every 10 years if the following conditions exist:

- NBI Item 113 (Scour Code) is coded as not being scour critical (coding ≥ 4), **or**
- NBI Rating 61 (Channel and Channel Protection) has been rated ≥ 7 (minor debris present), **or**
- One or more scour defects $\leq$ CS2 exist on the structure.

Check and Update the X - Channel Profile at least every 4 years if the following conditions exist

- NBI 113 (Scour Code) is coded as being scour critical (coding ≤ 3 , has an Unknown foundation (U), or founded on a spread footing), **or**
- NBI Rating 61 (Channel and Channel Protection) has been rated = 6 (protection has minor damage), **or**
- One or more scour defects = CS3 exist on the structure, **or**
- There is a measurable difference in the channel profile due to degradation, aggradation or migration, **or**
- The thalweg has migrated laterally and is below the top of the footing.

Check and Update the X - Channel Profile at least every 2 years if the following conditions exist

- NBI Item 113 (Scour Code) is coded as being scour critical (coding < 3 or a U), **and**
- NBI Rating 61 (Channel and Channel Protection) has been rated ≤ 5 (protection has major damage), **or**
- One or more scour defects in CS4 exist on the structure, **or**
- There is a measurable difference in the channel profile due to degradation, aggradation or migration, **or**
- The thalweg has migrated laterally and is below the top of the footing.

20.3—EXPLANATION OF PROPOSED STATE BRIDGE SCOUR DATABASE

OREGON DEPARTMENT OF TRANSPORTATION Incident Report (Flood Inspection)												
INSTRUCTIONS												
1.) Indications of X-Section Settlement are: misalignments in the railing, curb or bridge profile; cracking or distortions in the stringer/girders and/or concrete deck; or out of plumbness of the substructure.												
2.) Safety concerns can be: Loss of Approach shoulder, embankment erosion, loss of stringer/girder bearing.												
3.) Amount of drift is approximately how many trees and their Size is the diameter of the trees.												
4.) Locate the high water mark on the bridge, Upstream and Downstream. Approximately how deep was the water over the bridge or approaches.												
5.) Flow Angle in reference to the centerline of the travel lane on the bridge with 0 degree being in line with the centerline and 90 degrees being perpendicular to the travel lane.												
DATE	HWY	MP	BR. NO.	BRIDGE NAME	STREAM X-SECTION		DRIFT		HIGH WATER MARK		COUNTERMEASURES	
					SETTLEMENT	SAFETY CONCERN	AMOUNT	SIZE	LOCATION	ANGLE OF FLOW	TYPE	DAMAGED

20.3—EXPLANATION OF PROPOSED STATE BRIDGE SCOUR DATABASE

This database has been created using some of the data fields from Pontius combined with the scour database developed by the scour program several years ago. At the time that the scour program was collecting data the two databases were not reconciled for differences, so inconsistencies are present in this new database.

The purpose of this database is to provide a Plan of Action (POA) for each ODOT owned scour critical bridge. The goal of the POA is to provide guidance for inspectors and engineers that can be implemented before, during and after flood events to protect the traveling public. Each POA is divided into five elements; management strategies, inspection strategies, closure instructions, countermeasure alternative and schedule, and any other information. The basic POA form was developed to follow these elements closely.

It was determined that all scour critical bridges will be placed into four categories; A, B, C, or D as defined below:

Category A - Bridges that are rated in the NBIS as scour critical (3, 2, 1, 0, U, or T) that have spread footing foundations on erodible material and have a history of scour or the history is unknown. Bridges with NBIS code ratings of U or T are included in this category if other databases have data on foundation type and /or scour history.

Category B - Bridges that are rated in the NBIS as scour critical (3, 2, 1, 0, U, or T) that have spread footing foundations on non-erodible material or are pile supported, and have a history of scour or the history is unknown. Bridges with NBIS code ratings of U or T are included in this category if other databases have data on foundation type and /or scour history.

Category C - Bridges that are rated in the NBIS as scour critical (3, 2, 1, 0, U, or T) that have been calculated as being scour critical but have no history of observed scour. All foundation types are included in this category. Bridges with NBIS code ratings of U or T are included in this category if other databases have data on scour history.

Category D - Bridges that are rated in the NBIS as scour critical (U or T) that are not yet evaluated as the foundation has not been determined. These bridges are included in the other categories if other databases have data on foundation and/or history. For this reason some of the Category D bridges will be found in the other three categories.

The Bridge scour category type determines the procedures and methods used in the inspection, monitoring, closure, and countermeasures for each bridge.

The POA database is a first attempt to gather existing data from different databases and combine the information into a set of policies, procedure, and methods that will provide guidance on protecting bridges for failure due to scour. The database is at the stage of being a draft that needs input from all parties involved.

CHAPTER 21: ANCILLARY INVESTIGATIONS

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CHAPTER 21:**ANCILLARY INVESTIGATIONS****21.1—ANCILLARY INVESTIGATIONS**

In essence, the CFR recitals state that each State Transportation Department is responsible for assuring that each structure in the inventory is inspected as thoroughly as necessary to clearly establish its condition, inspected at the appropriate interval or frequency, and insure their continued safe operation. In accordance with the CFR recitals, ODOT Bridge Section performs a variety of ancillary investigations which are listed as follows:

21.1.1—Investigations to Obtain or Monitor Specific Information

- Critical Finding Investigations,
- Bridge Clearances for freight mobility routing,
- Post Structural Failure Forensic Investigations,
- Bridge Health Monitoring / Load Testing,
- Seismic Baseline Monitoring,
- Scour Monitoring.

ODOT initiated these investigations for the following reasons:

21.1.2—Special Types of Structures**21.1.2.1—Sign Support Structures**

Though not mandated by the NBIS, FHWA highly encourages each state to periodically inspect these structures because they are:

- a. Generally, located immediately adjacent to high ADT interstate routes
- b. A structural failure would likely present a significant traffic hazard, and
- c. Winds tend to induce harmonic movements and fatigue into in these structural members

21.1.2.2—Tunnel Inspections

The modern highway tunnel may be defined as an underground passageway used by vehicular traffic under or through a geographical mass. Tunnels are employed for two distinct reasons: (a) alignment restraints, and (b) environmental considerations. The design of a tunnel must consider the following components: (1) the elements required to withstand temporary or permanent ground pressure, and (2) the elements required to support traffic, (3) provide elements for the removal of ground water from behind the tunnel, liner, system, and (4) Lighting and illumination. Since many of these structural items are not visible during the routine inspection, to properly assess their condition requires a high level of geotechnical expertise.

Covered Bridges – Even though these structures are extremely picturesque, they are almost always constructed of timber members. As a result, a thorough condition assessment must include a hands-on level of access so that each member can be bored to determine the presence of decay. Therein lies the problem: the timber house encapsulating the timber superstructure, make it almost impossible to easily access all parts of the bridge.

21.1.2.3—Non-NBI Structure Inspections

Regularly scheduled condition assessments of structures shorter than 20 feet. Structures that fit this category are:

- Bridges longer than 6 feet up to 20 feet or less,
- Culverts larger than 6 feet up to 20 feet or less,
- Tunnels that carry highway traffic,
- Stand alone Pedestrian Structures,
- Sign Support Structures,

- Railroad and Private Structures located over a State Highway route.

21.1.2.4—Critical Finding

ODOT has established a statewide procedure to assure critical findings are addressed in a timely manner while keeping FHWA apprised in accordance with the NBIS. A critical finding is a structural or safety related deficiency that requires immediate follow-up inspection or action. ODOT has interpreted this to mean that if the bridge deck, superstructure, substructure or channel has a condition rating of 3 or less, triggers a critical finding follow-up.

21.1.2.5—Scour Monitoring

Scour is an erosion of the streambed or bank material due to flowing water; which is often considered as being localized around the bridge piers or abutments. A scour critical bridge is defined as a bridge with a foundation element that has been determined to be unstable for the observed or evaluated scour condition. ODOT scour monitoring program consists of the following:

- Every bridge over a waterway has been evaluated as to its vulnerability to scour in order to determine the prudent measures for its protection.
- A cross-channel profile has been collected on every bridge over a waterway which is measured longitudinally along the length of the bridge, generally on the upstream side. ODOT overlays multiples of channel profiles that were taken over a period of years with a profile view of the bridge. This process provides a clear picture of any vertical or horizontal movement of the channel, as well as, it's criticality by comparing the channel thalweg with the bridge footing information.
- ODOT performs an underwater dive inspection on any bridge that has substructure elements located in non-wadable water. The dive team physically monitors any localized channel scour in relation to the bridge substructure information.
- ODOT has prepared a plan of action for the scour critical bridges in the inventory.
- Bridge Inspectors have received appropriate training and instruction in inspecting bridges for scour.

21.1.2.6—Quality Assurance / Quality Control Reviews

Each state must develop and provide a QA / QC program of the bridge inspections performed in the state. The QA review must provide procedures to verify or measure the quality level of the entire bridge inspection and load rating program. The QC procedures are to maintain the quality of the bridge inspection and load rating at or above a specified level.

21.1.2.7—Sign Support Structure Inspections

In a 1995, FHWA conducted a Quality Improvement Project in the State of Oregon. The program review concentrated on the Overhead, Cantilevered, or Butterfly Sign Support Structures, the High Mast Light Towers and Large Traffic Signal Structures. Following the review, ODOT was encouraged to incorporate these structures in the bridge inspection program. ODOT decided not to include the large traffic signals or the high mast light towers in the program.

21.1.2.8—Emergency Bridge Operations

The emergency event can be isolated to only one structure or widespread over a much larger geographical area. No one can predict the occurrence or nature of a major event. These events could include Earthquakes, Tsunamis, Forest or Transient Fires, Landslides and Mudflows, Winter Storms and Blizzards, Severe Thunderstorms, Floods and Flash Floods, Hurricanes, Tornadoes, and Volcanic Eruptions. It is important that personnel be familiar with the emergency procedures, so the plans can be quickly changed and implemented as the need arises. It is also imperative that the ODOT response procedures are designed so they can be easily modified to fit any major event.

21.2—GUIDELINES FOR INVENTORY AND INSPECTION OF STATE OF OREGON OVERHEAD SIGN SUPPORTS

21.2.1—Purpose

The purpose of this inspection program is to inventory each sign support structure (location and configuration), and to determine its physical condition, maintenance needs, and maintenance history, so the information can be recorded in the appropriate database. These guidelines are to provide methodology and procedures for those inspections.

21.2.2—Safety, Traffic Control, and Access

- Established safety procedures of the Oregon Department of Transportation and Oregon Occupational Safety and Health Code shall be followed.
- Traffic control shall be provided during the inspection as needed, in compliance with *the ODOT Short Term Traffic Control Handbook, 1996* manual. Disruption of traffic shall be minimized whenever possible. Traffic control and lane closures shall be coordinated with the District Manager.
- Means of Access for the inspection and maintenance of sign structure must be determined:
 1. Standing on the shoulder of the road, outside of the fog line, behind the protective guardrail.
 2. Portable ladder.
 3. Fixed staging on a vehicle.
 4. Mobile man-lift.

21.2.3—Inspector Qualifications

- Each inspection team shall include at least one Certified Bridge Inspection Team Leader or a Licensed Professional Engineer, registered in the State of Oregon.
- When required, a certified technician will perform all non-destructive testing. Ultrasonic testing shall be performed by a ASNT Level II or a Level III technician. In addition, technicians performing ultrasonic testing of anchor rods shall first demonstrate proficiency in the use of ODOT's Procedure for Ultrasonic Testing of Anchor Rods (See Appendix A).

21.2.4—Types of Structures

Overhead sign support structures are typically constructed of either galvanized steel or aluminum. There are also some painted and unpainted weathering steel structures. The three basic types of overhead sign support structures in Oregon are described below:

21.2.4.1—Sign Bridge

Consisting of one or more horizontal members supported at each end. Overhead structures may be multi-span. Subtypes include: planar trusses, 3 or 4 chord trusses, mono-tube, and rigid frame structures. These structures are used to support large signs or variable message signs, usually over the interstate highway system.

21.2.4.2—Cantilever

Consisting of one or more horizontal members supported at one end. The cantilevered section can be either on one side of the support post or on both sides to form a butterfly configuration.

21.2.4.3—Structure-Mounted

A sign attachment permanently mounted to the fascia and/or parapet to be visible to traffic beneath the bridge. Typically inspected during the bridge's NBIS inspections.

21.2.5—Sign Support Structure Inspection Priorities

The following priority shall be used to determine the order of work:

1. Cantilever Variable Message Sign Support Structures
2. Cantilever Sign Support Structures
3. Butterfly Sign Support Structures
4. Sign Bridges
5. Others as yet to be determined (Major Signal Arms, etc.). High Mast Luminares are addressed in a separate document.

21.2.6—Inspection Reporting Requirements

- Inspection reporting requirements include completion of the Sign Support Structure Inspection Report form (See Appendix C) and updating the appropriate database.
- The information to be reported or verified will depend upon the type of inspection being performed and the inspection tasks which correspond to the inspection type (see Section VII – Types of Inspections, and Appendix C – Sign Support Structure Inspection Form).
- The inspector will report the condition of all sign support structures on the ODOT Bridge Inspection Database, which currently resides on server S0442E. Use element # 920 in accordance with the ODOT Element Coding Guide. Use the inspection data entry guidelines provided in the National Bridge Inspection Standard, as established by FHWA. The over-all condition of each sign support structure will be reported in one of the 3 condition states for the element: (1) Good, (2) Fair, or (3) Poor. These 3 element condition states translates to the accepted NBI ratings as follows:

Condition State 1 (Good) -	NBI Rating 7 thru 9
Condition State 2 (Fair) -	NBI Rating 4 thru 6
Condition State 3 (Poor) -	NBI Rating of 3 or less

21.2.7—Types of Inspections

There are 4 types of inspections, three of which include close visual and hands-on examination of the sign structures. The scope of each type of inspection is discussed below:

21.2.7.1—Level 1 Inspection

Collecting the structure's inventory data and entering it into appropriate database, will be required during the Level 1 inspection.

21.2.7.2—Level 2 Inspection

Close visual and hands-on examination of all portions of the sign structure which can be accessed without traffic control or climbing. Those portions which can not be accessed safely from beyond the edge of pavement and outside of arms reach, are viewed using binoculars. Ultrasonic testing of anchor rods will be performed. Existing inventory data is to be updated.

21.2.7.3—Level 3 Inspection

A close visual, hands-on examination will be performed on each component, member, fastener, and weld on the structure. All Non-destructive Testing Methods determined to be applicable will be utilized. Lane closures are anticipated to permit access to all portions of the structure. Existing inventory data is to be updated.

21.2.4.1—Level 4 Inspection

When significant structural deficiencies, severe section loss, collision damage, or corrosion have been noted, in addition to assigning a "Poor" condition rating, the inspector will schedule a Level 4 Inspection. The intent of this

inspection is to determine if the serviceability of the structure has been compromised and what feasible action(s) should be initiated. Existing inventory data is to be updated.

21.2.8—Inspection Frequencies

- Within 90 days of installation, an initial routine inspection (level 1) shall be performed.
- A Level 2 Inspection will be performed on all sign support structures in “Good” condition, at least every 6 years.
- If the condition of the sign support structure is reported to be in a “Fair” condition, the Level 2 Inspection will be performed at least every 4 years.
- A Level 3 Inspection will be scheduled and performed on every sign support structure at least every 10 years.
- When the condition assessment shows that the sign support structure is in a “Poor” condition, a Level 4 Inspection will be initiated immediately.

21.2.9—Field Inspection Procedures

21.2.9.1—General Instructions

- See Appendix D – Definitions and Conventions
- See Appendix E – Equipment List.
- Based upon the type of inspection being performed and access to various parts of the structure, determine which tasks will be performed. The Sign Support Structure Report Form (Appendix C) lists the Inspection Levels associated with each task.
- Collect or verify identity and location data as required.
- Collect or verify structure type data as required.
- Collect or verify dimension and clearance data as required.
- Collect or verify structural condition data as required.
- Complete the sign structure inspection report.
- List and prioritize needed maintenance needs.
- Update database as appropriate.

21.2.9.2—Establish the Sign Support Structure Location by Collecting and/or Verifying the following information:

- Gather plans and shop drawings when possible.
- Verify existing structure number if identification tag is present.
- The ODOT Bridge Inventory Administrator will assign a unique interim identification number to each structure. This interim identification number will be recorded on the pole in the field, using paint, crayon, stainless steel band, barcode sticker, or other method (to be determined). Should the sticker become illegible due to weathering, vandalism, etc., other unique identifiers, such as GPS location will be used to re-establish the pole identity.
- The ODOT Region Number
- The name of the County
- The State Highway Inventory Number
- The Milepost location of the structure
- The State Highway direction of the sign support structure
- Global Positioning Satellite (GPS) location.
- Additional text, as required, to describe the specific location.

21.2.9.3—Establish the Structure Type by Collecting and/or Verify the Following Information:

- Take digital photos of front, back, both ends, base, span to post connection(s), and sign legends. Additional digital photos shall be taken as required to show important information.

- Post Type (single member, truss, rigid frame)
- Arm Type (single member, truss, rigid frame)
- Material (steel, aluminum, concrete, fiberglass, wood, etc.)
- Section Type (pipe, square tube, wide flange, etc.)
- Coating (galvanized, painted, none).
- Leveling nuts / No leveling nuts
- Grout Pad / No grout pad
- Number, diameter, and bolt circle of anchor bolts
- Number, diameter of bolt washers (DTI's or flat washers)
- Type of sign being supported (standard sign panel, VMS, signals, etc.)
- Structure Type comments

21.2.9.4—Determine and/or Verify the Following Structure Measurements:

- Post total height (above top of base plate).
- Post member size and dimensions between chord centerlines and panel points (if trussed).
- Number of posts (one for cantilever, two for sign bridges).
- Number of vertical members per post
- Grout Pad thickness.
- Anchor bolt configuration (number of bolts, bolt diameter, bolt pattern dimensions).
- Base plate dimensions (length, width, thickness).
- Length of the arm or bridge (centerline post near end to centerline post far end).
- Arm or bridge to post connection configuration (number of bolts, diameter of bolts, bolt pattern dimensions).
- Vertical clearance from roadway to bridge or arm (minimum) and horizontal distance from post to point of minimum clearance.
- Bridge or arm Camber (loaded).
- Bridge or arm member sizes and dimension between chord centerlines and panel points (if trussed).
- Number of bridge or arm chords (if trussed).
- Number of signs and sign sizes.
- Provide a clearance diagram of sign structure, showing all roadway features and clearances (roadway centerline, lane widths, shoulders, guardrails, vertical clearances over the roadway pavement, and shoulder breaks). This data is to be field verified at each inspection. See Appendix F – Sample Clearance Diagram.

21.2.9.5—Structural Condition Assessment

- Structural Members
 - Structural members include arms and posts, truss members, and member of structural frames. Sign support members, lighting support members, and platforms are also considered to be structural members.
 - Check for missing members.
 - Check for sag, or excessive deflection.
 - Using a magnet, verify whether the metal is steel or aluminum
 - Inspect for dents, cracks, rust, and overall condition of galvanizing
 - Visually inspect all welds for cracks, especially where galvanizing is peeling, cracked or where rust bleeding is present.
 - Use Dye-Penetrant testing (ASTM E165-92) as the primary method to investigate suspected cracks. Other non-destructive testing, including Ultra-Sonic and Mag-Particle are to be used at the discretion of the Inspector.
 - Repair portions of galvanizing damaged during testing, according to ASTM A 780.
 - Visually inspect all members for cracks, straightness, and buckling.
 - Visually inspect all members and connections for signs of corrosion.
 - Check thickness of galvanizing where rust colored stains are observed.

- Check for loss of section thickness at the base of posts, base of arms, and at any suspect location, using ultrasonic testing.
- Check member connection plate and bolts/nuts for rusting, cracks, and condition of galvanizing.
- Visually inspect the arm to column connection on cantilever structures, and the truss to column connections on sign bridges. This includes connection plate(s) and all welds.
- Structural Member Connections
 - Includes the assessment of the bolted or welded structural connections between two adjacent structural members.
 - Visually inspect all bolted connections for missing bolts, adequate thread projection beyond the nut, and proper washer configuration. Report any bolts needing replacement and any missing bolts, nuts, or washers as maintenance recommendation items. Select maintenance priority carefully as this can be a critical deficiency, depending upon location and redundancy. Bolts in tapped holes must be correct length to avoid thread stripping and to permit proper tightening. Removal of inspection plates or Ultrasonic Testing can be used to determine bolt length.
 - Inspect all bolts for tightness.
 - Verify bolt and nut grade for high strength bolts by observing markings. See Appendix G for guidance on identification of bolts and nuts.
 - Because high strength bolts are plastically deformed during installation, subsequent re-tightening will produce further strain in the bolt that may result in fracture.
 - For A325 bolts: If the nut can be removed and turned by hand up to shank end of threads, it can be safely re-tightened using normal installation procedures. If A325 bolts fail this test or cannot be checked, the nuts may be re-tightened ONLY as a temporary measure. Paint such temporary bolts red/orange to identify them for replacement.
 - For A490 bolts: Do not re-tighten. Replace bolt and nut.
 - To install/tighten bolts, use a method that is consistent with the design. Turn-of-the-Nut method and Direct Tension Indicator method (for sign supports) are described Section 930 Standard Specifications for Highway Construction
 - Determine and record how far bolt projects beyond nut. All bolts should at least be flush with the outer surface of the nut. The preferred projection is at least $\frac{1}{4}$ " or 2 threads protruding above the nut.
 - Determine the length of all bolts that are installed in tapped holes by utilizing ultrasonic testing procedures.
 - Inspect all structural bolts and anchor bolts for fracture, using ultrasonic testing procedures for rods and visual inspection for bolts (the bolt heads prevent ultrasonic testing).
 - Visually inspect all welds.
 - Note visible gaps between connection plates (no gap should exist between connection plates).
 - Inspect 10% of U-bolts (in place) for cracks, using dye-penetrant testing procedures.
 - Since many fabrication bolt-holes are oversize to facilitate structure installation, it is common practice for high strength bolts to have 3 washers under each nut (1 to cover the bolt hole, 1 direct-tension indicator washer, and 1 washer to prevent contact between the turning nut and the direct-tension indicator washer).
- Base Connections
 - Includes the assessment of connection between the vertical column members and the concrete foundation.
 - Inspect for adequate clearance from the surrounding brush, vegetation and/or soil.
 - Inspect for adequate site drainage.
 - Inspect for adequate drainage path from inside of the vertical post.
 - Inspect condition of the grout pad, if present. Where the base plate is elevated on leveling nuts and grout is not present, a "rat band" should be used to prevent vermin from chewing wires and hiding in the pole base. Animal bites are a concern.
 - Visually inspect the base connection for missing bolts/nuts, adequate beyond nut thread projection, and proper washer configuration.
 - Inspect all anchor bolts for fracture, using ultrasonic testing procedures (see Appendix A for Anchor Rod UT Procedure).

- Inspect for gaps under the base plate (for base plates without leveling nuts), and gaps between base plate and leveling nuts (for base plates with leveling nuts and without grout pads).
- Inspect the base plate, gussets and tubing - outside (and inside where possible) for rust, ponded water, welds for cracks, and condition of galvanizing.
- Inspect the anchor bolts for size, rust, tightness of nuts, washers, section loss at threads, and condition of galvanizing. Use 24-ounce ball-peen hammer when checking bolt tightness. Hit both sides of top nut and top of bolt to check for loose nuts and/or cracked or broken bolts. Tight nuts give sharp ringing sound, loose equates to dull sound. Determine and record bolt pattern, record missing bolts, damage, etc.
- Loose or missing anchor bolts or nuts on cantilevers should be considered a critical deficiency. Establish priority for maintenance item accordingly.
- Foundation
 - Includes the condition assessment of the concrete foundation, which includes the concrete column/pedestal.
 - Check for spalls, cracks, or deterioration in the concrete footing.
 - Check for soil erosion and note any encroaching vegetation.
 - Inspect the foundation for signs of rotation, sliding, undermining, misalignment, and settlement.
 - Conduct a soundness test of the concrete foundation by listening to the sound made when lightly tapped with a hammer. Any areas of the foundation which exhibit a hollow ringing sound are to be noted further evaluation and/or testing.
- Sign Mounts
 - This includes the structural condition of the sign board and its accessories/attachments, NOT the legibility or visibility of the message.
 - Visually inspect sign mounts and mounting hardware.
 - Visually inspect U-bolts for cracks, using dye-penetrant testing procedures to investigate suspected cracks.
 - Visually inspect Aluminum or Stainless Steel sign attachment clip nuts.
 - Report missing and/or broken nuts, or bolts on the extruded sheet aluminum panels as a maintenance recommendation.
 - Tighten loose or replace missing panel clip assemblies of either stainless steel or aluminum composition with a torque wrench. Apply 225 inch-pounds of torque to each nut with threads clean, dry, and non-lubricated.

CHAPTER 22: EMERGENCY RESPONSE PLAN

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CHAPTER 22: EMERGENCY RESPONSE PLAN

22.1—BRIDGE OWNER RESPONSIBILITIES EMERGENCY RESPONSE FIRST RESPONDER

If a Bridge Owner establishes an Incident Command Center, they will need to contact the other public agencies so that a coordinated effort can be deployed. If additional assistance is needed, District Bridge Maintenance, Construction, Region Tech Center, or Bridge Section Personnel will be immediately dispatched, to help coordinate bridge inspection, shoring, repair, or recovery activities. Bridge Operations can provide the bridge owner with a complete inventory check-off spreadsheet of all the structures within the apparent effected area. The local agency coordinator should maintain a multi-jurisdictional information file on all bridges inspected, recording information regarding their operational status, extent of the damage and a general description of any damage repair activity. All measures will be taken to assure the general public is being properly protected and as a way of establishing an acceptable level of confidence.

The bridge owner is responsible for:

- First Look – Establish facility to Field emergency calls from the public, assess magnitude of the event, coordination with other public entities, interface with media.
- Level 1 Inspections – Perform these inspection with assigned staff
- Level 2 Inspections – Team bridge owner staff with bridge inspector and engineers.
- Level 3 Inspections – Coordinate traffic control, access equipment, shoring
- Event Recovery Phase – Traffic Routing / Control, Structural Shoring or Repairs, Contract vs Force Account decision, contract administration.

For more details: following a major event, the bridge owner must take ownership and determine the level of the response which could include any or all of the following:

1. To determine how widespread the damage might be and gauge the level of the response, the bridge owner must conduct an initial Rapid Survey (***FIRST LOOK***) of all bridges within the affected area. Since the source of this initial information would most likely come from the recorded, magnitude of the event, or from non-transportation personnel such as 911 calls from the general public, various police agencies, fire departments, and rescue personnel, this inspection is basically an initial assessment of the usability of a bridge by an untrained observer. The assessment results are whether or not the bridge (and approaches) collapsed or not. Recording a first look status provides the ability to log and track initial reports, coming in following a major event. These reports will be taken at face value, will likely be the best initial damage assessment available.
The Bridge Owners (District Maintenance and Local Agency Office Staff) will immediately tabulate the results of the survey so the information can be forwarded to other Agency Incident Command Centers as needed. The Region Tech Center Bridge Managers will help interpret the identification and location of the bridges being reported as being damaged. Names and bridge locations used by the general public does not always coincide with ODOT identifiers.
2. Upon notification that a major event has or is occurring, the Bridge Owners will assure that all bridges within the affected area(s) are being assessed for damage by trained agency personnel. This assessment is called a ***Level 1 Inspection***. Even though, all structures within the affected area(s) will be inspected, the inspection teams will use the following as a guideline to help prioritize their inspection order:
 - a. Life-Line Routes
 - b. Life-line Alternate Routes
 - c. Interstate Routes
 - d. Major Arterial Routes
 - e. Secondary Highways

A Life-Line Route is defined as a route that is used to provide essential services during the first 72 hours following an event.

It is expected that the bridge owner will perform a Level 1 Inspection on all bridges within a 50 mile radius around the epicenter within the first 24 hours following a magnitude 5.0 seismic event. These inspections will identify all damaged structures and record the nature and extent of the damage on each. For emergency response purposes, this level revolves around questions regarding the bridges' serviceability: Is it damaged? If yes how badly? Is it usable? If so, how many lanes? Under what conditions, or limitations? This level of inspection will only assess whether the structure should remain open or closed. The guideline used by the personnel performing this level of inspection is whether they would feel safe driving over the bridge with a loaded truck. The personnel will take whatever action is deemed necessary, at the moment, to help protect the general public. They will notify their designated Bridge Inspection Coordinator as to the status of the bridge based on their appraisal and mark the right hand approaches to the bridge ends in accordance with the standard procedures.

In order to facilitate the following, it's suggested that the bridge owner use the ODOT Emergency Bridge Inspection Report Form to:

- Identify which specific bridges are assigned to that inspector for a condition assessment.
 - Provide pictorial bridge closure threshold guidelines.
 - Provide pictorial diagrams of structural damage that the inspector will likely encounter so that it can be used as a communication tool, to help convey structural damage information by using sketches.
 - Help document actions taken by date & time.
3. Following a magnitude 6.0 or greater seismic event or on all bridges that have reported damage, the bridge owner will coordinate a **Level II Inspection** on all bridges within 50 miles radius around the epicenter within 72 hours of the event. Level II Inspections are performed by a certified bridge inspection team leader or a licensed engineer. The results of these inspections will be used for evaluating the load carrying capacity of the existing structure, help design temporary shoring and an information gathering mission, so that the bridge owner can start developing plans and specifications for more long-term, permanent repairs. The decisions to close only a portion of a bridge or re-open a bridge, to traffic, after it had been closed, should only be made by a Licensed Engineer.

As a safety precaution, it is anticipated that the bridge owner will team and deploy the Bridge Inspection or Engineering personnel with Bridge Owner Personnel. The objective of this teaming is to maximize the expertise of the personnel, familiarity of the affected area for potential detour routes, and to exercise the delegated authority for closing a structure.

Upon completion of this inspection, these inspection team will take the following actions:

- Notify the Bridge Inspection Coordinator as to the status of the bridge,
 - Mark the bridge ends in accordance with the standard procedure,
 - Complete an Emergency Bridge Inspection Report Form on each structure inspected,
 - Forward a copy of the bridge inspection report to the Bridge Operations Engineer.
4. After all bridges within the affected area(s) have been inspected and actions have been taken to ensure their safety, a more detailed inspection (**Level III**) or investigation should be undertaken, by a structural forensic team, assigned by the Bridge Engineer. It is anticipated that a Level III Inspection will only occur on selected structures that warrant a detailed inspection. If the inspection teams are not familiar with the area, or they plan to employ access equipment, or need traffic control, the team will coordinate all work activities with the bridge owner, so they can help guide the team through alternate routes, if heavy damage has occurred.

The purpose of the Level III, in-depth inspection, is to analyze the damaged portion of the bridge and study the failure mechanisms so that the ODOT Bridge Design Standards & Practices can be updated and/or modified on future bridge designs. The analysis will also determine whether other structural retrofits or modifications are warranted. This field analysis could include NDE testing of the primary structural members.

Specialists may be consulted to analyze failure modes, so the information can be incorporated into future design practices. Upon completion of their inspection, these inspectors will again notify the Bridge Inspection Coordinator as to the status of the bridge, based on their appraisal, mark the bridge ends in accordance with the standard procedure, fill out and forward a bridge inspection report to the Bridge Operations Engine

22.2—ODOT BRIDGE ENGINEERING SECTION EMERGENCY RESPONSE PLAN PROCEDURES

22.2.1—Purpose

The purpose of this document is to provide a list of personnel expectations and actions, when a major event involves bridges in the State of Oregon. The event can be isolated to only one structure or widespread, over a much larger geographical area. No one can predict the occurrence or nature of a major event. These events could include Earthquakes, Tsunamis, Forest or Transient Fires, Landslides and Mudflows, Winter Storms and Blizzards, Severe Thunderstorms, Floods and Flash Floods, Hurricanes, Tornadoes, and Volcanic Eruptions. It is important that personnel be familiar with the emergency procedures, so the plans can be quickly changed and implemented as the need arises. These procedures are designed so they can be easily modified to fit any major event.

The first responders are: ODOT District Bridge Maintenance personnel and the Region Tech Center and Bridge Inspection Personnel. The first responders will be called upon to perform the initial inspection of all bridges within their geographical area. Bridge Engineering Section is committed to assisting as needed, by making technical expertise, bridge inspectors, and underwater diver resources available, for providing on-site assistance. The technical assistance, could include, but not limited to, the following:

- Evaluate the safety of a damaged structure, and/or
- Provide temporary or permanent repair details, during the 1st Response Phase.
- Provide plans for temporary or replacement structures, and/or
- Provide construction assistance, throughout the event recovery phase.

After a major event, one of the first items to be determined is the level of the response. Depending on the magnitude of the event, the response level could include any or all of the following (**Note: The magnitudes shown herein are only guidelines and not threshold values for the actions to take place**):

1. **Magnitude 4.0 to 5.0 with an epicenter within the State of Oregon, or within 50 miles of the Oregon Coast or State Border** – District logs observations and information from, the police, public, and media. Primary task – make sure the notification, communication, and response plans are working. Structural damage – unlikely.
2. **Magnitude 5.0 to 6.0 with an epicenter within the State of Oregon, or within 50 miles of the Oregon Coast or State Border** – Bridge Maintenance Crews will perform a condition assessment on all structures within 50 miles of the epicenter within the first 24 hours.
3. If the magnitude of the event is relatively small (one or two bridges), it is anticipated that technical support will be provided by the Region Tech Center Bridge Design personnel assigned to that geographical area.
4. **Magnitude 6.0 to 8.0 with an epicenter within the State of Oregon or within 100 miles of the Oregon Coast or State Border** – Bridge Maintenance Crews will perform a condition assessment on all structures within 100 miles of the epicenter within the first 24 hours. All damaged structures will receive a follow-up condition assessment performed by engineering personnel within the first 72 hours.
 - The bridge maintenance crews will either close or leave the structure open to traffic. The intent of having the engineering personnel to make a follow-up assessment is to:
 - Partially open
 - Load Restrict traffic
 - Design shoring
 - Retrofit bridge details
 - Design repairs
5. **Magnitude greater than 8.0 with an epicenter within the State of Oregon, or within 300 miles of the Oregon Coast or State Border** – Bridge Maintenance Crews will perform a condition assessment on all structures

within 300 miles of the epicenter. A time frame cannot be established due to the magnitude of the damage and the uncertainty of being able to navigate the terrain.

22.2.2—Employee Safety

ODOT is committed to a safe and healthy workplace through prevention, equipment maintenance, education, training and compliance with all state and federal regulations.

Before any Bridge Engineering Section employee is sent on a field assignment, they should be very familiar with the following:

22.2.1.1—Job Safety Analysis

Safety in the field is a fundamental responsibility of each employee. Safe practices and methods must be considered equally with other organizational objectives, such as cost control, quality and productivity. Before Bridge Engineering Section personnel are assigned to a field assignment, they must become familiar with this subsection and properly equipped.

Every job assignment can be separated into a series of relatively simple steps; the hazards associated with each step can be identified and solutions can be developed to help control each hazard. Every bridge type, location and site conditions vary quite drastically throughout the state. Therefore, any hazard analysis must be modified on a case by case basis to fit the local conditions encountered. A very generic example is as follows:

Step 1: Working Alone. Being in a position where the employee can not contact help. Solution: Don't work alone or Follow the ODOT Working Alone Guidelines by establishing a communication net with specific check-in times and acknowledge completion.

Step 2: Traffic Control. Match traffic plan with site conditions and work: Walk against traffic, have a traffic spotter accompany the inspector, always have an escape route, provide warning signs or vehicular strobe light or provide a lane closure.

Step 3: Doning Equipment. Match equipment needs to the work being performed. Review and follow the "ODOT Personal Protective Equipment Policy".

Step 4: Planning and Implementing Access. Devise a plan to mitigate all know hazards and assure that all team members fully understand the plan.

Step 5: Working in a Confined Space. Review and follow the "ODOT Confined Space Policy & Procedures".

22.2.1.2—Emergency Bridge Inspection Equipment

To assure the safety of Bridge Engineering Section Personnel, each employee assigned to field duties must be properly equipped. A suggested list of personal protective equipment and supplies is as follows:

Clothing

• Hard Hat w/chin strap	• Safety Glasses	• Work Gloves
• Work Boots	• Soft Cap	• Coveralls
• Extra Sweatshirt	• Rubber Boots	• Rubber Gloves
• Safety Vest	• Rain Gear	• Extra Socks
• Ear Plugs	• Stocking Cap	

Inspection Equipment

• Clipboard	• Flashlight	• 25' Pocket Tape
• 100' Measuring Tape	• Notepad	• Red Paint Marker

- Pens & Pencils
- Hammer
- Green Paint Marker
- Safety Harness
- 2 Lanyards
- Keel/Crayon
- Binoculars
- Cellular Phone
- Portable Strobe (yellow)
- Flagging Tape
- Machete
- Life Vest
- Duct Tape
- 50' of 1/2" rope
- Safety Rope Slide
- Portable Ladder
- Sounding Weight
- Camera w/Film
- Wire Cutters
- Crescent Wrench
- Pliers
- Micrometer
- Metal File
- Wire Brush

Personal Supplies

- First Aid Kit
- Fresh Water
- Toilet Paper
- Food / Munchies
- Drinking Cup

22.2.1.3—ODOT Identification Cards

In possession of an acceptable Building Access or DMV Identification Card with photo ID, to substantiate that the employee is on official business.

22.2.3—Emergency Response Notification

Actions taken will depend on the distance from the epicenter, duration and magnitude of the shaking, and other factors. It is anticipated that structural damage could occur as follows:

Magnitude 3: Damage is not anticipated
 Magnitude 4: Possible structural damage
 Magnitude 5: Might have damage – finding it is the problem
 Magnitude 6: Structural damage clearly apparent

It is anticipated that the following procedures will be put into play immediately following all seismic events with a magnitude of 3.0 or greater that occur either within the State of Oregon or within 100 miles of the border thereof. Each notification will provide the location of the epicenter and the recorded magnitude of the earthquake:

- a. The University of Washington's earthquake monitoring center, notifies the Oregon Emergency Response System (OERS) following all earthquakes that are 3.0 or greater, via LEDS (Law Enforcement Data System).
- b. Following that notification, the Oregon Emergency Response System will immediately notify the ODOT Dispatch Centers located throughout the state, also via LEDS.
- c. Pursuant to that notification, the ODOT Dispatch Centers will immediately notify the ODOT Bridge Maintenance Crews, the Region Bridge Inspector (RBI) located in each region, via assigned pagers. The ODOT Bridge Engineer and the ODOT Bridge Operations Engineer will be notified by the Region 2 Dispatch Center (Station 2), also via their pager.
 - Each Bridge Engineering Section Team Leader will periodically hold a pre-event planning session with the personnel assigned to them, to discuss these ODOT seismic event expectations. Each employee will be directed to follow the instructions on the back of their "pocket phone directory cards".

An earthquake can be measured by the amount of energy released. The Richter Scale uses Arabic numerals to rate the amount of energy or its magnitude. The size or strength of an earthquake may also be measured by the intensity that is felt or the kind of damage that occurs. Intensity depends on your distance from the epicenter and the geologic area. The Modified Mercalli scale measures the earthquake's effect on people, property, and ground damage. An earthquake may have a different intensity rating at different locations from the epicenter. Damage is usually lessened with the distance from the earthquake's epicenter. However, damage may depend on the type of structure, the construction, the type of soil the structure was built on, or the geometric location of the structure as referenced

by the location of the epicenter. For example, a bridge on bedrock experiences less movement than a bridge on loose sediments, or the longitudinal axis is perpendicular vs. transverse to the seismic stress waves. The Modified Mercalli Intensity Scale is as follows:

1. Not felt by most people, only instruments detect the earthquake.
2. People lying down might feel the earthquake.
3. People on upper floors of buildings will feel it, but may not know it is an earthquake. Hanging objects swing.
4. People indoors will probably feel it, but those outside, may not. Houses may creak.
5. Nearly everyone feels it. Sleepers are awakened. Doors swing, pictures move, things tip over.
6. Everyone feels the earthquake. It's hard to walk. Windows and dishes broken. Books fall from shelf.
7. It's hard to stand. Plaster, bricks, and tiles fall from buildings. Small land slides.
8. People will not be able to drive cars. Poorly built buildings may collapse. Chimneys may fall.
9. Most foundations are damaged. Masonry heavily damaged. Pipes are broken. The ground cracks.
10. Most buildings are destroyed. Water is thrown out of rivers and lakes. Large landslides.
11. Fencing and/or Guardrails are bent. Bridge and underground pipelines unusable.
12. Most things are leveled. Large objects may be thrown into the air. Large rock masses are displaced.

The magnitudes reported by the news agencies are based on the Richter Scale at the epicenter of the earthquake. As a result, the magnitude of the event at each specific bridge site is unknown. Therefore, to quickly assess how widespread the potential damage might be, and gauge the level of response effort, we need to use the Modified Mercalli Scale above. By interviewing people at various locations as to what they felt, the size of the affected area and the scope of the response effort can be determined. It is anticipated that a level 1 and 2 bridge inspection effort will be dispatched throughout all areas that experienced a magnitude (V) or greater as defined on the Modified Mercalli Scale.

22.2.4—First Response

The Region Bridge Inspectors (RBI's) are located geographically throughout the state. Therefore, when a major event occurs, the RBI staff is directed to report to the closest ODOT District Maintenance Office to the effected area(s) and function as the initial Bridge Inspection Coordinator, until the Bridge Engineering Section Incident Command Center has been determined to be operational. As the Bridge Inspection Coordinator, the RBI will also be the initial contact with the Local City/County Agencies and assure that a rapid survey of all bridges within the affected area(s) is being conducted. The RBI will make the initial determination of whether they need additional inspection personnel. The RBI will continue to function as the Bridge Inspection Coordinator, until relieved by other Bridge Engineering Section personnel.

If a Local Agency establishes an Incident Command Center with-in the affected area(s), Bridge Engineering Section will make contact and offer resource assistance. If assistance is requested, Bridge Engineering Section Personnel will be immediately dispatched, to help coordinate bridge inspection, shoring and/or repair activities. Bridge Operations will provide the local agency coordinator with a complete inventory check-off spreadsheet of all structures within the apparent effected area. The local agency coordinator will maintain a multi-jurisdictional information file on all bridges inspected, recording information regarding their operational status, extent of the damage and a general description of any damage repair activity.

All measures will be taken to assure the general public is being properly protected and as a way of establishing an acceptable level of confidence. The level of the inspection that has been performed on each structure will be tracked by Bridge Engineering Section. The level of inspection is described as follows:

22.2.4.1—First Look

Since the source of the initial information would most likely come from non-transportation personnel such as 911 calls from the general public, various police agencies, fire departments, and rescue personnel, the initial survey would be recorded as a FIRST LOOK Status Report. This inspection is basically an initial assessment of the usability of a bridge by an untrained observer, such as police, fire, motorist, or news media reports. The results of

this level is, whether or not the bridge (and approaches) have collapsed or not. Recording a first look status provides the ability to log and track initial reports, and by whom, coming in following a major event. These reports will be taken at face value, but will likely be the best initial damage assessment available.

The Region Bridge Inspector will immediately report the results of the survey to Bridge Engineering Section Incident Command Center. The Region Bridge Inspector will help interpret the identification and location of the bridges being reported as being damaged. Names and bridge locations used by the general populous does not always coincide with ODOT identifiers.

If the event can be classified as widespread or when the Bridge Engineer or designee determines it is needed an inspector will be directed to either accompany an initial reconnaissance flight or interact with the local agency personnel. The intent is to assess the magnitude of the event, get an inventory of all collapsed bridges, and readily determine the status of available bypass routes. If the Oregon Emergency Coordination Center (ECC) is activated and the State and Regional Disaster Aviation Plan (SARDA) is in effect, ODOT will be competing with other agencies for these air resources. As a result, ODOT may need to request air support through the SARDA Coordinator at the Oregon ECC:

SARDA: (503) 378-2911 or (503) 452-0311
ODOT Airplane: (503) 378-4882
Buswell Aviation: (503) 362-9328
Civil Air Patrol: (503) 581-2125
US Coast Guard: (503) 756-4141
939th Air Rescue Wing (503) 335-4718
304 Air Rescue Squadron 1-800-452-0311
Aerial Photographic Service (503) 678-2704

22.2.4.2—Level I Inspection

Upon notification that a major event has or is occurring, the Bridge Inspection Coordinator (RBI) will assure that all bridges within the affected area(s) is being assessed for damage by trained bridge maintenance personnel. Even though all structures within the affected area(s) will be inspected, the inspection teams will use the following as a guideline to help prioritize their inspection order:

1. Life-Line Routes
2. Life-line Alternate Routes
3. Interstate Routes
4. Major Arterial Routes
5. Secondary Highways

Life-Line Route is defined as a route that is used to provide essential services during the first 72 hours following an event.

It is anticipated that all bridges with the affected area(s) will have had a level I inspection within the first 24 hours. These inspections will identify all damaged structures and record the nature and extent of the damage on each. For emergency response purposes, this level revolves around questions regarding the bridges' serviceability: Is it damaged? If yes how badly? Is it usable? If so, how many lanes? Under what conditions, or limitations? This level of inspection will only assess whether the structure should remain open or closed. The guideline used by the personnel performing this level of inspection is whether they would feel safe driving over the bridge with a loaded truck. The personnel performing this level of inspection will take whatever action is deemed necessary, at the moment, to help protect the general public. The personnel performing this level of inspection will notify their designated Bridge Inspection Coordinator as to the status of the bridge based on their appraisal and mark the right hand approaches to the bridge ends in accordance with the standard procedures.

Bridge Engineering Section developed an Emergency Bridge Inspection Report Form, in order to facilitate the following:

- Identify which bridges are assigned to the inspector for a condition assessment.

- Provide the inspector with guidelines that would warrant closing a bridge.
- A document that can be used as a communication tool, to help convey structural damage information by using sketches that contain critical dimensions.
- Help document actions taken by date & time.

22.2.4.3—Level II Inspection

A Level II Inspection will be performed on all bridges within 50 miles of the epicenter following a seismic event with a magnitude of 5.0 or greater, or on all bridges that have reported damage, within 72 hours of the event. If the Local Bridge Inspection Coordinator determines that additional inspection assistance is needed, Bridge Engineering Section will direct additional inspection resources to report to either the ODOT District Maintenance Office or the Local Agency Incident Command Center for further deployment.

As a safety precaution, it is anticipated that Bridge Engineering Section personnel will be teamed and deployed with District Bridge Maintenance Personnel. The objective of this teaming is to maximize the expertise of the personnel, familiarity of the affected area for potential detour routes, and to exercise the delegated authority for closing a structure.

Preliminary data from the Level I Inspection Reports will begin to define the scope of the event. The purpose of this inspection level is to assure that a more in-depth damage assessment is conducted by Certified Bridge Inspection Team Leader or a Licensed Civil/Structural Engineer.

Upon completion of the inspection, these inspectors will take the following actions:

- Notify the Bridge Inspection Coordinator as to the status of the bridge,
- Mark the bridge ends in accordance with the standard procedure,
- Complete an Emergency Bridge Inspection Report Form on each structure inspected,
- Forward a copy of the bridge inspection report to the Bridge Operations Engineer.

Personnel performing this level of inspection will also make temporary repair/shoring recommendations and/or if necessary, request a Level III Inspection be made by Bridge Engineering Section Personnel. The decision whether to keep a portion of a bridge open to traffic should only be made by a Licensed Professional Engineer. It is anticipated that every bridge within the affected area(s), would receive a level II inspection, within 72 hours of the major event.

22.2.4.4—Level III Inspection

After all bridges within the affected area(s) have been initially inspected and actions have been taken to ensure their safety, a more detailed inspection or investigation should be undertaken, by forensic investigation teams assigned by the Bridge Engineering Section. If the inspection teams are not familiar with the area, they should be assisted by at least one district maintenance staff member, to help guide the team through alternate routes, if heavy damage has occurred. If warranted, the purpose of this in-depth inspection, is to perform an on-site, analysis of the damaged portion of the bridge, which could include NDE testing of the primary structural members. The analysis will be used for evaluating the load carrying capacity of the existing structure, help design temporary shoring and an information gathering mission, so that Bridge Engineering Section can start developing plans and specifications for more long-term, permanent repairs. Specialists may be consulted to analyze failure modes, so the information can be incorporated into future design practices. Upon completion of their inspection, these inspectors will again notify the Bridge Inspection Coordinator as to the status of the bridge, based on their appraisal, mark the bridge ends in accordance with the standard procedure, fill-out and forward a bridge inspection report to the Bridge Operations Engineer. It is anticipated that a Level III Inspection will only occur on selected structures that warrant a detailed inspection.

22.2.4—Standard Bridge Tagging Procedure

It has been our experience, that during a major event, there are a multitude of people, from a multitude of public agencies, running around the affected area(s), with very little coordination, or without a plan in hand of what to do. Therefore, a plan was developed, in an effort to maximize the use of available personnel, minimize duplication, minimize conflicting reports, and provide the most up-to-date information due to after-shocks. Upon completion of each inspection, each structure will be tagged in such a manner that the condition of each structure can be easily determined and the date and time that inspection was performed. The right bridge end, of each approach, will be tagged, so that it is clearly visible to approaching traffic. The tags should be painted on fixed vertical surfaces, such as the inside face of the concrete parapet wall, wingwall, inside face of the approach guardrail, or attached to a bridge approach sight marker. The tag will be coded as follows:

agency	_____ ODOT	RMS _____	initials of inspector
level	_____ I		
date	_____ 2/17	1430 _____	time

Translated: "A level 1 inspection was made by an ODOT bridge maintenance person whose initials are R.M.S., at 2:30 PM local time on February 17th."

If the tag is **GREEN**, the bridge appears to have little or no damage. The bridge maintenance person performing the inspection would feel quite comfortable crossing the bridge in a loaded truck and feels that it should remain open, with no restrictions.

If the tag is **RED**, the inspector feels the bridge appears unsafe for any traffic and should be closed immediately, due to visible structural distress, partial failure, or collapse. In this case, physically close the bridge with whatever means that are available, Mark the bridge end tag in red, call the local incident command center to arrange for barricades and for someone to man the barricades, at all times. A good example for physically closing a bridge, would be to park vehicles across both road approaches and have someone standby at both ends of the bridge, until other policing personnel arrive on-site to take charge of the situation. The local incident commander will notify the policing agencies and the general public, via public safety announcements on commercial radio and television stations. The ODOT Regional Dispatch Centers and the ODOT representative at the Oregon ECC also must be notified of all bridge closures. The ODOT Regional Dispatch Centers will thereby notify the Ports of Entry and the Oregon Trucking Association, who can promptly notify truckers and trucking companies, as well as, updating the information on the ODOT toll-free Road and Weather Information Hot line. The ODOT Representative at the Oregon ECC must be notified so that current information is available to state emergency response agencies concurrent with its release to the public.

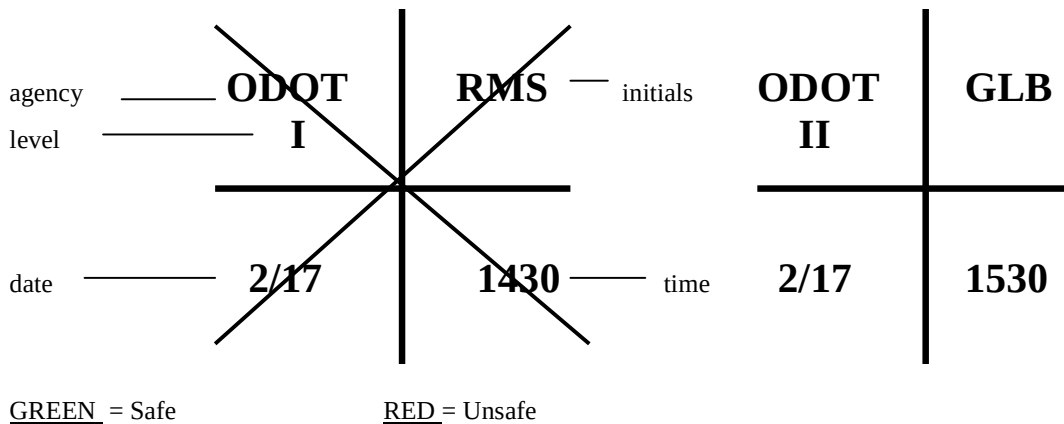
Oregon ECC Phone numbers are:

(503) 378-4429 (direct line)

(503) 378-2911 or (503) 452-0311 (alternate)

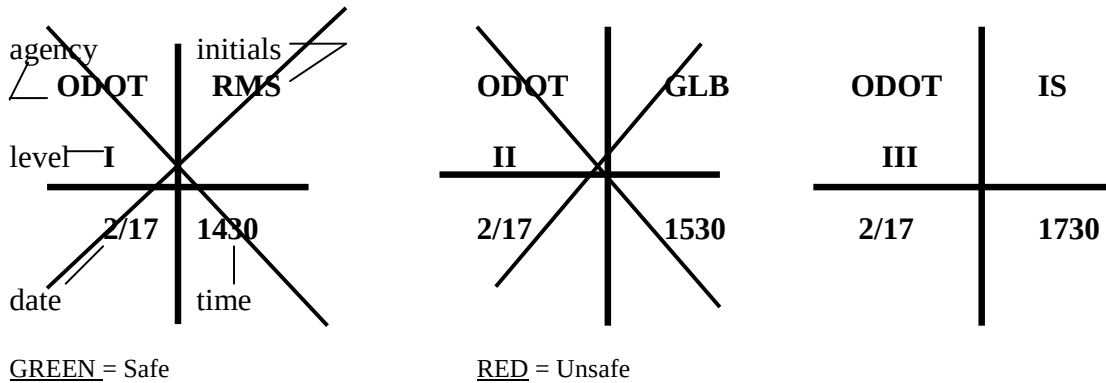
(503) 588-1378 FAX

NOTE: After the inspector is assured that the bridge has been physically closed, they should proceed on their pre-designated inspection route, to the next structure.



This figure indicates that another inspector made a subsequent inspection. The tag reads: "An ODOT Certified Bridge Inspector, with the initials of G.L.B., made a level II bridge inspection on February 17th, at 3:30 PM." The follow-up inspection could agree with the level I inspection and remedial action, in which case, the tag would be painted with the same color. Or the inspector could change the status of the bridge by changing the color of the tag. In either case, the inspector will X out the first inspection marking and place another tag beside it, using the appropriate color of paint. The inspector will then notify the local inspection coordinator and fill out an emergency bridge assessment form for the bridge.

Finally, a third, more detailed inspection was made, at the direction of the local bridge inspection coordinator:



In this case, "A bridge inspection team, from ODOT Bridge Engineering Section, with the initials I.S. performed a detailed forensic inspection of the bridge, on February 17th, at 5:30 PM." If the inspector placed a green tag on the bridge end, the bridge is considered safe and no further action is required. Red would mean the bridge is unsafe and needs extensive repairs or rehabilitation. When tagging with red, keep the bridge barricaded or post load limit signs, depending on the situation.

If closing the bridge appears warranted, the designated Bridge Inspection Coordinator will also report what actions are being taken to protect the general public. If a bridge has been closed, it should not be re-opened to traffic, until it has been thoroughly inspected by a Level III Inspection Team.

22.2.5—Bridge Engineering Section Incident Command Center (ICC)

If the apparent structural damage is not wide spread, the Bridge Engineer, may direct the Bridge Operations Engineer, to coordinate the field activities simply as business-as-usual. However, depending on the magnitude of the event, the Bridge Engineer may establish an Incident Command Center (ICC) to help coordinate the initial bridge inspection activities and/or function as a resource, by providing the following:

22.2.5.1—Bridge Data

ODOT Bridge Engineering Section maintains a complete file on all bridges in the State of Oregon that are 20 feet and longer. The files include the latest bridge, condition assessment information, bridge plans and digital images. This type of information is generally very essential either during or immediately after such an event.

22.2.5.2—Design and Inspection Staff

Bridge Engineering Section maintains a complement of trained Licensed Civil Engineers, and Certified Bridge Inspectors, that can be used to supplement bridge inspection efforts and governmental office building condition assessments, in the field. These Engineers and Certified Bridge Inspectors are either on staff or as Consultants under contract to ODOT to provide professional services. Most of the Engineers are familiar with bridge design, building design, the load rating process and the operation of computer software.

22.2.5.3—Structural Analysis

Bridge Engineering Section Personnel can be sent into the field on information gathering missions that would include performing an in-depth, on-site, full-scale analysis of a damaged structure. The full-scale analysis would be used for evaluating the load carrying capacity of the existing structure, help design temporary shoring and expedite the development of plans and specifications for more long-term, permanent repairs. Bridge Engineering Section has a wide variety of bridge design and load rating computer software and the trained personnel for using the applications.

22.2.5.4—Advance Forensic Investigation and Analysis

After all the bridges within the affected area(s) have been initially inspected and actions have been taken to ensure their safety, a more detailed inspection or investigation should be undertaken, by forensic investigation teams. The forensic investigation team should consist of multi-disciplinary specialists that can be consulted to analyze failure modes, so the information can be incorporated into future design practices.

As a result, Bridge Engineering Section maintains a valuable resource of information and technical expertise that could be tapped into, by transportation personnel in the field.

The ODOT Bridge Engineer, or his designee, will determine whether the establishment of an Incident Command Center is warranted. If warranted, the following actions will be immediately put into action:

1. Upon notification of a major event (earthquakes that have a magnitude > 6.0), a Technical Services Incident Command Center may be activated in Room 301 of the Transportation Building. Telephone numbers at this location are: (503) 986-4200. FAX number: (503) 986-3407. If the Transportation Building is not useable, the Incident Command Center will be activated in the ODOT East Salem Highway Complex Sign Shop Conference Room, located at 800 Airport Road SE, Salem.
2. Upon activation, an Acting Bridge Engineering Section Incident Commander will be designated by the ODOT Bridge Engineer and will be directed to function on his behalf. The Acting Bridge Engineer will be

one of the Bridge Engineering Section Team Leaders. The designated commander will immediately establish an Incident Chain of Command and shift staffing levels that will undertake the following tasks:

- a. Contact the ODOT Agency Operations Center (AOC) to inform them of the bridge section activities, notify them of the available resources, and/or request any additional communication needs, such as, radios, cellular phones, battery packs, additional phone lines, etc. Determine if a bridge person needs to be sitting in the AOC and whether any local agency incident command centers have been established within the affected area(s) and their location(s).

ODOT Agency Operations Center (AOC):
(503) 986-3000

Region 1 Traffic Management Operations Center (TMOC):
Region 1 Headquarters Bldg, 123 NW Flanders, Portland
(503) 283-5259 ODOT Radio: Station 1

Region 2 Communication Dispatch Center:
OSP Western Regional Dispatch Center, Portland Rd, Salem
378-2299, 378-2948, 378-8990, 1-800-776-7718 (emergency use)
FAX (503) 371-5924, ODOT Radio: Station 2

Region 3 Communication Dispatch Center:
OSP Southern Regional Dispatch Center, Medford
(541) 858-3103 ODOT Radio: Station 3

Region 4 / 5 Communication Dispatch Center:
OSP Eastern Regional Dispatch Center, Bend
(541) 388-6232 ODOT Radio: Station 4

- b. Conduct a rapid survey of all bridges in the area(s) affected by the event to identify the failed and/or unsafe bridges. Since the source of the information would most likely come from the Emergency Management Centers, i.e. (non-transportation personnel such as 911 calls from the general public, various police agencies, fire departments, and rescue personnel), the inspection would be recorded as a FIRST LOOK Status Report. Assign a staff member to interpret the identification and location of the bridge. Names and bridge locations used by the general populous doesn't always coincide with ODOT identifiers. Assure all necessary actions are being taken to protect the general public, if closing the bridge appears to be warranted. If a bridge has been closed, it should not be re-opened to traffic, until it has been thoroughly inspected by a Level III Inspection Team.
 - For a listing of local agency contacts, please refer to the Local Agency City / County Directory
- c. Follow-up the First Look reports, by assuring that at least a Level I Inspection (performed by transportation department bridge maintenance personnel) is conducted on all bridges in the affected area, identifying all damaged structures and recording the nature and extent of damage on each structure. Inspections performed by Certified Bridge Inspectors or Licensed Civil/Structural Engineers, can be recorded as Level II Inspections.

For Bridge Personnel contacts in the field, please refer to the following directories:

- Bridge Operations Directory
- Bridge Maintenance Directory
- Local City/County Directory
- Border State Directory

If the event can be classified as major, the Incident Command Center Commander will assign an Inspector to:

- accompany a site reconnaissance flight or interact with the news media flights, to assess the magnitude of the event, get an inventory of all collapsed bridges, and readily determine the status of available bypass routes:

SARDA Coordinator: (503) 378-2911 or (503) 452-0311
 ODOT Airplane: (503) 378-4882
 Buswell Aviation: (503) 362-9328
 Civil Air Patrol: (503) 581-2125
 US Coast Guard: (503) 756-4141
 939th Air Rescue Wing (503) 335-4718
 304 Air Rescue Squadron 1-800-452-0311
 Aerial Photographic Service (503) 678-2704

- d. Immediately dispatch an Inspection Coordinator to the local incident command center located with-in the affected area(s) to help coordinate bridge inspection activities.

The Bridge Engineering Section incident commander will identify personnel available for inspection teams or other tasks.

- e. If warranted, establish a 24-hour staffing schedule for the Bridge Engineering Section Incident Command Center. Assign critical tasks:

- Bridge Engineering Section Incident Commanders (3 - 8 hour shifts)
- Bridge Inspection Coordinators @ local incident command centers
- Dispatcher/Data Collector,
- Inventory/Status Map Producer
- Bridge Maintenance/Repair Coordinators (multi-disciplinary team)
- Communications Coordinator,
- Couriers (runners),
- Lodging Coordinator,
- FEMA Coordinator, etc.

Coordinate all Bridge Engineering Section activities with all of the local agencies in the affected area(s).

- f. Locate and Inventory: available vehicles, equipment, tools and supplies:

DAS Motor Pool: 378-4377
 Rob Cameron, Motor Pool Manager: hm 390-4357, cell 559-1939

If vehicles are unavailable from the DAS Motor Pool contact:

Enterprise Rent-a-Car
 808 12th St, SE, Salem
 (503) 364-1911

Each person on the assigned inspection team should be equipped with the appropriate personal protective equipment.

- g. Based on the results of the Level I or Level II Inspection, assign a member of Bridge Engineering Section to coordinate forensic investigation teams to investigate bridge failures and/or determine the load carrying capacity of a bridge that might still be able to carry vehicular traffic. This in-

depth forensic investigation will involve utilizing Non-destructive Testing methods to determine the structural integrity of the bridge, and will be recorded as a Level III Inspection. If additional bridge section personnel are needed to assist the inspection and/or maintenance effort, assure that the assigned person is accompanied by and is working directly with the field forces.

- h. There may be a large number of damaged structures, and numerous emergency repair projects in motion. To avoid confusion, duplication of assignments, false starts, etc., a staff member (maintenance coordinator) will be designated to collect and record damage information and help coordinate all repair activities. The maintenance coordinator should be the central source and clearing house for information regarding bridge repairs. This person should be the Bridge Engineering Section resource person, to interact with the bridge repair forces, locating materials (i.e., steel girders, Bailey Bridge, Acrow Bridge, railroad car sections, etc.) that can be used as a temporary structure or shoring, until permanent repairs can be made.

The maintenance coordinator will form multi-disciplinary design teams, as needed. The multi-disciplinary design teams will provide technical guidance to ODOT and City/County Agencies. The technical guidance can include any of the following:

- Emergency actions that must be taken to ensure public safety,
- To prevent additional damage to the bridge,
- Recommend and provide structural details (sketches) and material specifications for performing repair work on a damaged bridge. The repairs can be performed by: agency maintenance forces, emergency contracts, regular contracts, or by change orders for bridges within the limits of ongoing construction contracts.

Temporary Detour Structures:

- ODOT Bridge Operations Engineer or Senior Bridge Inspector
- Western Direct Federal, Richard Wasill, (360) 696-7717
- WashDOT Preservation Engr, Harvey L. Coffman, (360) 753-4739
- USFS, Kathy Van Hecke, (503) 326-2829
- CalTRANS Temp. RR Bridges, Tom Harrington (916) 227-8843
- Versa Steel, 1618 NE First Ave., Portland, Oregon 97232
- Bernie Mares, 1-800-678-0814
- (long steel beams & modular Bridge Engineering Sections)

- i. Post maps of the damaged area(s).
- j. Conduct daily staff meetings to provide a brief summary of important events, decisions, agreements, and assignments. Prepare and distribute a daily summary report identifying the status of the bridges in the affected area(s). The summary should consist of short remarks to keep those involved informed.
- k. Assign a staff member to receive and redirect non-critical phone calls to minimize key manager involvement. Calls from the media should be directed to the ODOT Public Affairs Section: (503) 986-3455.
 - Region 1 (Portland Metro Area) - Kathy Conrad (503) 731-8264
 - Region 2 (Willamette Valley) - Dave Davies (503) 986-3426
 - Region 3 (Southern Oregon) – Jerrod Castle (541) 957-3656
 - Region 4 (Central Oregon) - Laurie Gould (541) 388-6224
 - Region 5 (Eastern Oregon) - Crindalyn Lyster (541) 963-3177
- l. Assign a staff member to coordinate lodging requirements for all out-of-town personnel involved in the disaster-related activities.

- m. Initiate and coordinate assignments of ODOT team members with the FEMA Damage Assessment Teams.
- n. Develop periodic summaries and reports for upper management and emergency operations centers. The ODOT District office within the affected area will be responsible for directing the initial Level I Inspection efforts, including maintenance of the bridge status reports. Bridge Engineering Section, located in the Transportation Bldg, will be responsible for developing and issuing status report results from the Level II or III Inspections, preparing capacity calculations for damaged bridges, and preparing plans for temporary shoring until more permanent repairs can be instigated. Bridge Engineering Section will also coordinate the design effort for major repairs and any necessary coordination with FEMA.
- o. In any unexpected situation, the Bridge Engineering Section Incident Commander will make decisions based on the objectives of ensuring the safety of the traveling public and protection of public property, and contact the ODOT Agency Operations Center ASAP.
- p. When finished with their shift, each person involved with the event must provide the relieving Incident Commander with instructions on how to contact them, if the need arises. On many occasions, questions arise regarding an action that was undertaken or a decision that was made by personnel assigned to the preceding shift.

CHAPTER 23: LOAD RATING PROCEDURES

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CHAPTER 23:**LOAD RATING PROCEDURES****23.1—LOAD RATING REQUIREMENTS**

CFR 650.313(c): Rate each bridge as to its safe load-carrying capacity in accordance with the AASHTO Manual. By FHWA letter of agreement from George Romack, the original bridge design calculations that utilized the load and resistance factor design (LRFD) method can be the load rating calculations.

Bridge Engineers have recognized that for the same bridge conditions a wide range of ratings may arise, depending on the rating method selected. In an effort to provide more uniform safety margins for structures in terms of a reliability index, the State of Oregon is currently specifying that all load rating calculations follow the AASHTO Load and Resistance Factor Design (LRFD) method. The LRFD method provides a flexible selection of dead and live load factors and material resistance factors that appears to be more representative of the types of structures being rated, in the State of Oregon.

Normally, the determining of the load-carrying capacity of a structure requires a comprehensive analysis, not limited to simply a check at maximum moment and shear points, but also to insure long-term serviceability and durability by controlling permanent deformations under overloads and fatigue characteristics under service loads.

The load rating of a bridge should be completely documented in writing, including all background information such as field inspection reports, material and load test data, all supporting computations, and a clear statement of all assumptions used in calculating the load rating. If a computer model was used, the input data file should be retained for future use.

Furthermore, as a part of every inspection cycle, bridge load ratings should be reviewed and updated to reflect any relevant changes in condition or dead load noted during the inspection. The safe load capacity of a bridge is based on existing structural conditions. To maintain this capacity, it is assumed that the structures are subject to competent inspections, as often as the existing conditions of the structure require, and that sound judgment will be exercised in determining an appropriate factor of safety.

23.1.1—Loading Posting Requirements

CFR 650.313(c): Also directs each to 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. However, there are some cases where judgment must be exercised, when making a load capacity evaluation of a structure. Safety factors can be adjusted, based on site conditions such as the type of vehicles that routinely use the bridge, the volume of traffic on the bridge and/or the condition of the existing structure, as recorded in the most recent inspection report. If the jurisdictional owner elects to not load post a bridge based on their engineering judgment, all data used in the determination should be fully documented.

Also, anytime a primary structural member has an element condition state representing the most advanced deterioration and the condition is determined to affect the load capacity of the element or the structure, the bridge inspector must immediately take additional action. That action should include the following:

- a. Immediately notify the jurisdictional bridge owner of the conditions.
- b. If conditions warrant an immediate closure of the bridge, the inspector is expected to place flagging across both ends of the bridge, stop and notify traffic that they should not cross the bridge. Commandeer the help of the general public for traffic control, until other forces can arrive on site.
- c. If, in the best judgment of the bridge inspector, conditions only warrant restricting traffic, the bridge inspector should immediately inform the jurisdictional owner of the bridge, that an interim load restriction should be placed on both approaches to the bridge, until such time that a formal load analysis can be made. The jurisdictional owner of the bridge has the option of seeking the authority to place the recommended load restriction or immediately initiate the placement of structural shoring capable of carrying legal loads.

The structural shoring must be designed by a Professional Engineer in the State of Oregon. All load restrictions on a State Highway, must be authorized by the Deputy Director of the Oregon Department of Transportation.

- d. CFR 650.315(d) For changes in load restriction or closure status, enter the SI&A data into the State inventory with 90 days after the change in status of the structure for State agency bridges and within 180 days after the change in status of the structure for all other bridges.

Regulatory signing must conform to the requirements of the “Manual of Uniform Traffic Control Devices” (MUTCD), and should be established in accordance with the requirements of the agency having authority over the highway. All load restrictions placed on a State Highway must be authorized by the Deputy Director of the Oregon Department of Transportation.

23.1.2—Overload Enforcement Requirements

ODOT Bridge Section is in the process of implementing the Load and Resistance Factor Rating (LRFR) method, based on the 2003 AASHTO Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges. This method is referred to as the Tier-2 Load Rating Procedures. LRFR is a statistically-based, more accurate and defensible load rating than the previous method, that is now referred to as the Tier-1 Load Rating Procedures.

Normally, determining the load-carrying capacity of a structure requires a comprehensive analysis, not limited to simply a check at maximum moment and shear points, but also to insure long-term serviceability and durability by controlling permanent deformations under overloads and fatigue characteristics under service loads.

The load rating of a bridge should be completely documented in writing, including all background information such as field inspection reports, material and load test data, all supporting computations, and a clear statement of all assumptions used in calculating the load rating. If a computer model was used, the input data file should be retained for future use.

23.2—LOAD RATING AND BRIDGE POST REGULATIONS

CFR 650.313(c): requires that each bridge in the inventory is rated as to its safe load-carrying capacity in accordance with the AASHTO Manual. Load ratings are performed for the following reasons:

- To protect both the safety of traffic and the significant investment in the state’s bridge infrastructure.
- Knowledge of the capacity of each bridge to carry loads is critical for each function.
- A Load rating that reflects the current condition of each bridge provides a valuable tool that is used in identifying the need for load posting or bridge strengthening and in making overweight vehicle permit decisions.
- Load Ratings are also used in the bridge management system to prioritize bridge repairs and replacements.

Bridge Engineers have recognized that for the same bridge conditions a wide range of ratings may arise, depending on the rating method selected. In an effort to provide more uniform safety margins for structures in terms of a reliability index, the State of Oregon is currently specifying that all load rating calculations follow the AASHTO Load and Resistance Factor Design (LRFD) method. The LRFD method provides a flexible selection of dead and live load factors and material resistance factors that appears to be more representative of the types of structures being rated, in the State of Oregon.

Furthermore, as a part of every inspection cycle, bridge load ratings should be reviewed and updated to reflect any relevant changes in condition or dead load noted during the inspection. The safe load capacity of a bridge is based on existing structural conditions. To maintain this capacity, it is assumed that the structures are subject to competent inspections, as often as the existing conditions of the structure require, and that sound judgment will be exercised in determining an appropriate factor of safety.

23.2.1—Load Rating

In accordance with CFR all structures must have a load rating. The structure may have been designed for a lighter loading than is used today, a different design code, or a stress range that is no longer applicable, or it may have lost live-load capacity as a result of aging, deterioration, damage to members, or added weight such as a new deck, or wearing surface. In the State of Oregon ODOT uses the Load Resistance & Factor Rating (LRFR) method. Individual members should first be rated for their full design section based on today's rating criteria. This will determine the maximum capacity of the bridge if it is rehabilitated to the original design conditions. Members should then be rated for current loss to determine their present load-carrying capacity.

Bridges can be rated at two levels, inventory rating and operating rating. Inventory rating determines the load capacity of the bridge for normal service conditions that is unrestricted traffic. The inventory rating for a steel bridge is 55% of the yield stress in a flexure member. The operating rating computes the flexural load capacity of a steel bridge at 75% of the yield stress.

Bridge posting should not be confused with bridge evaluation and rating. Evaluation and rating are engineering-related activities whereas bridge posting is a policy decision made by the bridge owner. That's to say that although the engineer may recommend posting the bridge based on either the inventory or operating rating, it's the bridge owner, not the engineer, who ultimately must make the decision on whether a bridge will be posted. Many times a bridge may be posted for reasons other than ratings, such as restricting truck traffic in a local neighborhood.

23.2.2—Load Posting Requirements

CFR 650.313(c): Also directs each bridge owner to 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. However, there are some cases where judgment must be exercised, when making a load capacity evaluation of a structure.

Also, anytime a primary structural member has an element condition state representing the most advanced deterioration and the condition is determined to affect the load capacity of the element or the structure, the bridge inspector must immediately take additional action. That action should include the following:

- a. Immediately notify the jurisdictional bridge owner of the conditions.
- b. If conditions warrant an immediate closure of the bridge, the inspector is expected to place flagging across both ends of the bridge, stop and notify traffic that they should not cross the bridge. Commandeer the help of the general public for traffic control, until other forces can arrive on site.
- c. If, in the best judgment of the bridge inspector, conditions only warrant restricting traffic, the bridge inspector should immediately inform the jurisdictional owner of the bridge, that an interim load restriction should be placed on both approaches to the bridge, until such time that a formal load analysis can be made. The jurisdictional owner of the bridge has the option of seeking the authority to place the recommended load restriction or immediately initiate the placement of structural shoring capable of carrying legal loads. The structural shoring must be designed by a Professional Engineer in the State of Oregon. All load restrictions on a State Highway, must be authorized by the Deputy Director of the Oregon Department of Transportation.
- d. CFR 650.315(d) For changes in load restriction or closure status, enter the SI&A data into the State inventory with 90 days after the change in status of the structure for State agency bridges and within 180 days after the change in status of the structure for all other bridges.

23.2.2.1—Regulatory Signs

Regulatory signing must conform to the requirements of the "Manual of Uniform Traffic Control Devices" (MUTCD), and should be established in accordance with the requirements of the agency having authority over the highway. All load restrictions placed on a State Highway must be authorized by the Deputy Director of the Oregon Department of Transportation.

CHAPTER 24: DATA ENTRY PROCEDURES

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(This chapter is under development)

CHAPTER 24:**DATA ENTRY PROCEDURES**

(This chapter is under development.)

CHAPTER 25: SOURCES AND LOCATION OF BRIDGE INSPECTION DATA AND REPORTS

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CHAPTER 25:**SOURCES AND LOCATION OF BRIDGE INSPECTION DATA AND REPORTS****25.1—SOURCES OF INFORMATION****25.1.1—Bridge Section Files**

The Bridge Engineering Section has five major file categories. They are:

1. Bridge Inspection Reports (State, City & Local)
2. Bridge Maintenance Files
3. Bridge Plan Files
4. Bridge Contract Files
5. Bridge Housekeeping Files

All filing of these materials is handled by the Bridge Section Front Office Staff.

25.1.2—Bridge Inspection Reports

According to the Code of Federal Regulations (CFR) definition of a Routine Bridge Inspection is: a regularly scheduled inspection that generally consists of visual Observations, and / or measurements that are needed to determine the following:

- Define the physical and functional condition of the bridge,
- Identify any changes from initial or previously recorded conditions, and
- Recommend any repairs or other services that may be needed.

Each bridge inspector is instructed to perform all assigned inspections in sufficient detail or as thorough as necessary to clearly establish its condition and to insure its continued safe operation. To define just exactly what thorough means, the following file folders are available on the ODOT bridge server S7000b:

- Routine Inspection Report
- SI & A Report
- Fracture Critical Report
- Underwater Bridge Inspection Report
- Scour Plans of Action
- Bridge Clearances
- Bridge Images
- Cross Channel Profiles
- Deck Surveys
- Fatigue Prone Detail Report
- Timber Boring Diagrams
- Sign Support Structure Inspection Reports
- Bridge Specific Job Hazard Assessments

25.1.3—Web Page Access

The primary tool for providing access to various bridge files is the Bridge Inspection Web Page. The idea was to place the supplemental bridge inspection reports on a central server (BridgeMgmt on S7000b), and then use a web page to provide read only access to a set of standard reports that describe the condition and status of bridges and bridge structures in the State of Oregon. The bridge inspection web page is located at the following address:

<http://rssa.odot.state.or.us/cf/Pontis>

An access password is required for those that reside outside of the ODOT System. The password can be setup by contacting the ODOT Bridge Inventory Coordinator.

Bridge server S7000b contains the electronic file folders and the bridge inspection web page provides access to the following standard reports:

- Bridge Inspection Reports
- Inspection Schedule
- Maintenance Recommendations
- Load Rating Summary
- Sufficiency Rating Report

Each standard report has an associated database query screen that can be used to narrow or refine the search for information. If the user selects all of the supplemental reports their links will be located at the bottom of the SI&A report.

25.2—STANDARD BRIDGE INSPECTION REPORTS

ODOT maintains standard reports for the various types of inspections, reviews and survey associated with the bridge inspection program. These reports include:

25.2.1—Level 2 Fracture Critical Bridge Inspection Report

This is an Excel Spreadsheet that identifies which structural members are considered to be fracture critical and provides a condition description of each member inspected. **NOTE:** The State of Oregon has decided to save all previous fracture critical inspection reports. In order to keep the various reports as separate files, the last two digits of the year the fracture critical inspection was performed is placed at the end of the 6 digit bridge number. The depository of these reports is the bridge server in the following directory:

N://Brdgshar on 's7000b'/bridge/FC/Region Number/Bridge Number

25.2.2—Underwater Inspection Report

This report is currently a word document in a narrative format. However, sketches may be attached. **NOTE:** As a Business Rule, the format of the attached sketches will always be stored in the database as either a Word or Excel document. If the sketches were developed using a CAD program such as Microstation, the developer will save the sketch into a Bitmap Format and import into either of the Microsoft products specified above. These reports will reside in the following directory:

N://Brdgshar on 's7000b'/bridge/Uwinsp/Region Number/Bridge Number

25.2.3—Fatigue Prone Detail Inspection Report

Since the inspection of these details will generally occur at the same time as the fracture critical inspection is being performed, this report is usually sheet two of the Fracture Critical Inspection Report. It also is an Excel Spreadsheet. The State of Oregon elected to keep the two inspection reports separate, because of the difference in criticality of the members and the details being inspected. These reports will be stored in the same file path specified for the fracture critical inspection reports.

N://Brdgshar on 's7000b'/bridge/FC/Region Number/Bridge Number

25.2.4—Timber Boring Report

This report is currently a graphical representation using Excel drawing toolbar to show the amount of decay and good wood in each timber member. In order to provide a single dynamic report, the last two digits of the year the member was bored is added at the end of every boring result. **NOTE:** As a Business Rule, the format of the timber boring sketches will always be stored in the database as an Excel document. If the sketches were developed using a

CAD program such as Microstation, the developer will save the sketch into a Bitmap Format and imported into Excel as a spreadsheet. These reports will reside in the following directory:

N://Brdgshar on 's7000b'/bridge/Borings/Region Number/Bridge Number

25.2.5—Movable Drawbridge Inspection Report

ODOT currently performs an annual cursory inspection on all electrical and mechanical drawbridge operational systems, under the State's jurisdiction. This annual operational inspection is followed by a more in-depth inspection, at least every six years. These inspections generate an annual report that is currently a word document in a narrative format. However, photos and/or sketches may be attached. **NOTE:** As a Business Rule, the format of attached sketches will always be stored in the database as either a Word or Excel document. If the sketches were developed using a CAD program such as Microstation, the developer will save the sketch into a Bitmap Format and import into either of the Microsoft products specified above. **NOTE:** The State of Oregon has decided to save all previous drawbridge inspection reports. In order to keep the various reports as separate files, the last two digits of the year the drawbridge inspection was performed is placed at the end of the 6 digit bridge number. These reports will reside in the following directory:

N://Brdgshar on 's7000b'/bridge/Drawbridge Insp/Region Number/Bridge Number

25.2.6—Pin & Hanger Inspection Report

The goal is to have every redundant pin and hanger assembly to have a baseline ultra-sonic test performed to assure the homogeneity of the material contained in the detail. Follow-up inspections will be performed, on a case-by-case basis, as conditions and/or indications dictate by the designated bridge inspector. These reports are currently in a word document narrative format. However, UT printouts, photos and/or sketches may be attached. **NOTE:** As a Business Rule, the format of attached sketches will always be stored in the database as either a Word or Excel document. If the sketches were developed using a CAD program such as Microstation, the developer will save the sketch into a Bitmap Format and import into either of the Microsoft products specified above. These reports will reside in the following directory:

N://Brdgshar on 's7000b'/bridge/Pin & Hanger/Region Number/Bridge Number

25.2.7—Special Equipment Report

Using this file, the bridge inspector can budget for, plan and schedule special equipment that is periodically needed in which to perform a thorough inspection on a particular bridge. The special access equipment might be:

- Snooper Crane
- Boat
- Special Traffic Control Requirements

These reports will reside on the bridge server in the following directory:

N://Brdgshar on 's7000b'/bridge/Special Equipment/Region Number/Bridge Number

25.2.8—Deck Survey

This report provides a graphical representation, using Excel drawing toolbar, to show the amount of spalls and/or delaminations that have been located in a concrete bridge deck. The graphical representation may be the results of a manual chain drag or that of a ground penetrating radar investigation. **NOTE:** As a Business Rule, the format of the deck survey sketches will always be stored in the database as an Excel document. If the sketches were developed using a CAD program such as Microstation, the developer will save the sketch into a Bitmap Format and import into Excel as a spreadsheet. These reports will reside in the following directory:

N://Brdgshar on 's7000b'/bridge/Decks/Region Number/Bridge Number

25.2.9—Cross Channel Profile

If a structure is located over a waterway, a cross-channel profile will be taken and periodically updated as per FHWA Technical Advisory T5140.21, “Evaluating Scour at Bridges”. A cross-channel profile of the streambed parallel to the bridge is generated from measured X,Y coordinates taken during the routine inspection process. Cross-channel profiles taken at multiple year intervals can then be overlayed with bridge specific geometric information, so that scour can be physically monitored. The State of Oregon is using an application developed by Kevin Flora, CalTrans Hydraulic Section, that graphically overlays multiple year profiles with the specific bridge information. These profiles will reside in the following directory:

N://Brdgshar on ‘s7000b’/bridge/X-Chan/Region Number/Bridge Number

25.2.10—Clearance Diagrams

The desire is to have a clearance diagram for every structure that is located over another roadway or railway. The bridge clearance diagrams were created using an Excel charting application called “BrEase”. The profile is generated from X,Y coordinates as measured in the field by the bridge inspector and profile view bridge information from the plans. Kevin Flora, CalTrans Hydraulic Section, developed the application. The clearance diagrams will reside in the following directory:

N://Brdgshar on ‘s7000b’/bridge/BrClearance/Region Number/Bridge Number

25.2.11—Coastal Concrete Inspection Report

These reports provide a graphical representation and/or tabular results of a concrete corrosion survey. The reports show the size, quantity and location of concrete spalls and/or delaminations that have occurred due to salt intrusion. The report will also show the amount of chloride present at the rebar level at a specific location on the bridge. When chloride is found to be present, the last two digits of the year the chloride samples were obtained will accompany the survey results. NOTE: As a Business Rule, the format of the coastal concrete survey sketches will always be stored in the database as an Excel document. If the sketches were developed using a CAD program such as Microstation, the developer will save the sketch into a Bitmap Format and import into Excel as a spreadsheet. These reports will reside in the following directory:

N://Brdgshar on ‘s7000b’/bridge/Concrete Corrosion/Region Number/Bridge Number

25.2.12—Electro-Slag Inspection Report

Despite the many advantages of utilizing electro-slag welding process to construct a steel bridge, there are certain problems associated with the process. A national study of electroslag welds on highway bridges revealed that a high percentage of these welds contain unacceptable weld imperfections and some were judged to be structurally unsafe. As a result, the State of Oregon, has taken the initiative to perform periodic in-depth inspections of these weldments, using Non-Destructive Testing methods. These electro-slag weld inspection reports will reside in the following directory:

N://Brdgshar on ‘s7000b’/bridge/Electroslag/Bridge Number

25.2.13—Suspension Bridge Inspection Report

A thorough inspection and evaluation of a cable suspended bridge requires special expertise generally not found on a standard routine inspection team. Therefore, these types of structural evaluations are contracted out to consultants specializing in this area. A copy of the executive summary report produced by the consultants will reside in the following directory:

N://Brdgshar on ‘s7000b’/bridge/Suspension Bridges/Bridge Number

25.2.14—Concrete Segmental Inspection Report

Concrete segmental bridges are still considered to be an experimental design, deserving of special attention. The appearance of a distress crack in the post-tensioned structure may occur for a number of reasons, but more often than not, it's a result of the interaction of several factors. These factors taken individually may be minor, but when superimposed can result in a deficiency that is serious enough to cause concern for the structural integrity of the bridge. Therefore, the State of Oregon, has elected to periodically perform a more in depth inspection of the Columbia River (Glen Jackson) and South Channel Bridges on I-205. The results of the inspection will reside in the following directory:

N://Brdgshar on 's7000b'/bridge/Concrete Segmental/Bridge Number

25.2.15—Collision Damage Report

A damage to structure inspection is an unscheduled event to assess structural damage resulting from environmental factors or human factors. This inspection is usually of sufficient detail to determine the need for emergency load restrictions, bridge closure, and/or assess the level of effort necessary to effect repairs. These reports will only be generated if and when a structure sustained sufficient damage to warrant a structural analysis to be performed. The report is currently in an Excel Spreadsheet format that identifies which structural members were damaged and to what extent. Photos, drawings or sketches may be attached to the report. **NOTE:** As a Business Rule, the format of these attachments will always be stored in the database as either an Excel document. If the sketches were developed using a CAD program such as Microstation, the developer will save the sketch into a Bitmap Format and import into Excel. **NOTE:** The State of Oregon has decided to save all previous damage to structure reports. In order to keep the various reports as separate files, the last two digits of the year the damage to structure inspection was performed is placed at the end of the 6 digit bridge number. The depository of these reports is the bridge server in the following directory:

N://Brdgshar on 's7000b'/bridge/Collision Damage/Region Number/Bridge Number

25.2.16—High Water Inspection Report

A high water inspection is an unscheduled event to assess scour damage resulting from a major high water event. This inspection is usually of sufficient detail to determine the need for emergency load restrictions, bridge closure, and/or assess the level of effort necessary to effect repairs. These reports will only be generated if and when high water reaches the bottom of the superstructure and/or when an extraordinary amount of drift is lodged against the superstructure of the bridge. The report is currently in an Excel Spreadsheet format and provides cross channel X,Y coordinate field measurements during maximum flow, of the streambed and the water surface elevation. Photos, drawings or sketches may be attached to the report. **NOTE:** As a Business Rule, the format of these attachments will always be stored in the database as either an Excel document. If the sketches were developed using a CAD program such as Microstation, the developer will save the sketch into a Bitmap Format and import into Excel. **NOTE:** The State of Oregon has decided to save all previous high water inspection reports. In order to keep the various reports as separate files, place the numerical designation for the month and year of the occurrence at the end of the 6 digit bridge number. The depository of these reports is the bridge server in the following directory:

N://Brdgshar on 's7000b'/bridge/High Water/Region Number/Bridge Number

25.2.17—Earthquake Damage Inspection Report

A earthquake damage inspection is an unscheduled event to assess structural damage resulting from an earthquake. This inspection is usually of sufficient detail to determine the need for emergency load restrictions, bridge closure, and/or assess the level of effort necessary to effect repairs. These reports will only be generated if and when a structure sustained sufficient damage to warrant a structural analysis to be performed. The report is currently in an Excel Spreadsheet format and identifies which structural members were damaged and to what extent. Photos, drawings or sketches may be attached to the report. **NOTE:** As a Business Rule, the format of these attachments will always be stored in the database as either an Excel document. If the sketches were developed using a CAD

program such as Microstation, the developer will save the sketch into a Bitmap Format and import into Excel.

NOTE: The State of Oregon has decided to save all previous earthquake damage inspection reports. In order to keep the various reports as separate files, place the numerical designation for the month and year of the occurrence at the end of the 6 digit bridge number. The depository of these reports is the bridge server in the following directory:

N://Brdgshar on 's7000b'/bridge/Earthquake Damage/Region Number/Bridge Number

25.2.18—Quality Assurance Review Report

Federal Code of Regulations as administered by FHWA, directs each highway department to include a bridge inspection organization that is capable of performing inspections, prepare reports, and determine ratings in accordance with the provisions of the AASHTO Manual and the National Bridge Inspection Standards (NBIS). To assure that the bridge inspection program in the State of Oregon is meeting these federal regulations, an independent inspection is performed and the results are compared to the actual bridge inspection as reported by the designated bridge inspector. This comparison is referred to as a QA Review. The goal is to perform a QA review on 10 % of the total bridge inventory located in each region. Each individual report resides in the following directory:

N://Brdgshar on 's7000b'/Bridge/QA Reports/Region Number/Bridge Number

25.2.19—Job Safety Analysis Report

These reports are currently Excel spreadsheets that basically detail the step-by-step process of inspecting each individual bridge, identifying all apparent safety hazards that are associated with each step and provide a suggested plan as to how to mitigate those hazards. It is anticipated that each inspector, on the crew, will review and become familiar with the JSA prior to starting an inspection of each structure. These reports will reside in the following directory:

N://Brdgshar on 's7000b'/Bridge/JSA/Region Number/Bridge Number

25.3—BRIDGE DATA

25.3.1—Load Rating Database

Load rating information for each bridge is summarized on a Load Summary Sheet. The load raters store the information from each load rating into a load rating database. Information from the load rating databases is downloaded into the bridge inventory, maintained in Pontis, at least twice a year so that the National Bridge Inventory (NBI) submittals will have current data.

The Load Rating Summary Report plus supporting calculations and data for Local Agency bridges is filed by bridge numbers in the Load Rating Team Room.

25.3.2—Scour Database

The purpose of a Plan of Action (POA) is to clearly furnish important information to interested parties on who is responsible for the monitoring, maintenance, and emergency procedures for each scour critical bridge.

The purpose of the scour database is to provide an easily accessible Plan of Action for every scour critical bridge. Data from many sources are used to furnish as much information as possible. The goal of the POA is to provide guidance for inspectors and engineers that can be implemented before, during and after flood events to protect the traveling public. Each POA is divided into five elements; management strategies, inspection strategies, closure instructions, countermeasure alternative and schedule, and any other information. The POA'S are developed to follow these elements closely. When the user's manual is completed instructions will be included on how to install and use the database. It is presently scheduled for release in May 2009.

State Bridges Folders with scour study data for bridges on the State Highway System are filed by bridge number in the Senior Hydraulics Engineer's work area.

25.3.3—Vertical Clearance Data

Bridge vertical clearance data is stored in 3 locations depending on the format of the data.

Here is a summary:

1. Basic line data (clearances over each outside shoulder line, inside shoulder line, and each skip line) is stored in a spreadsheet on server S7000B. This data is used to prepare clearance diagrams that show actual clearances over each line. The clearance diagrams are available on the Web through the Bridge Inspection data web application. Both the spreadsheets and diagrams are maintained by the Bridge Operations Unit.
2. NBI vertical clearance data is maintained in Pontis, data fields 53 and 54. The 3 digit fields contain the minimum clearance in meters across all travel lanes for either above the bridge roadway surface (field 53) or below the bridge (field 54). The minimum clearance is taken as the minimum value of either the inside shoulder lines or skip lines from the spreadsheets on server S7000B.
3. We propose that the vertical clearance over a given lane be stored in ITIS, or its replacement. We are unsure whether ITIS is planned to remain in its current form on the mainframe or be transferred to a SQL application. The lane vertical clearance data is taken from the minimum of either the inside shoulder lines or skip line from the spreadsheet on server S7000B for that given lane. This data will be the actual clearance given in inches, without a buffer, in a spreadsheet and transmitted to Transportation Data Unit for uploading in ITIS. Following the upload, Bridge Operations Unit will verify the data by comparison to the original spreadsheet.

Most ODOT business users will only need access to the ITIS lane data. It will be the one location where vertical clearance lane data is stored. If any users need line data, it will be provided by Bridge Operations Unit in bulk form from the spreadsheets or for individual bridges it will be available through the Bridge Inspection Report Web Page.

25.3.4—Drawing Files

A major component of all construction and maintenance projects is documentation, and one of the most important categories comprises the drawings produced by drafters and contractors. In a perfect world, we have available CAD files, the signed Mylar or paper prints of them, and scanned image files through which we share the drawings. Drawings are assigned standard all-numeric serial numbers by the BDS, associated with a work project on one or more specific structures. These numbers may be obtained by any ODOT or partner entity with appropriate security rights, or by request from the Bridge Section.

CAD files are created by drafters and contractors, as required. Formats for various classes of drawings are standardized in the BDDM. CAD files are archived at the Bridge Section in Salem. For archival purposes, CAD files should be named per the process outlined in the BDDM. Whenever possible, the CAD file name should be also entered into the BDS in the individual records for all contained drawings. Scanned images of drawings are restricted to black and white TIFF format, at 400- or 600-dpi resolution, and with Group IV compression. Images in other formats will be rejected by the BDS. Drawing image files are named as drawing#.tif, e.g., 78501.tif.

25.3.5—As-Constructed Bridge Plans

After construction on a project is completed, all of the project drawings are reviewed and revised to reflect as-constructed conditions of every component, including those components that have been excluded from the project. Drawings lacking these revisions are considered "design drawings" only. As soon as possible, Bridge Section scans the revised drawings and uploads them into the BDS, and then archives the hard-copies. See Section 2.7.11.1 As-Constructed Drawings in the BDDM for current as-constructed procedures.

Also, see Technical Bulletin TSB08-01(B), "As Constructed Plans" at the following link:
http://www.oregon.gov/ODOT/HWY/TECHSERV/docs/tech_bulletins/TSB08-01b.pdf

25.3.6—Bridge Foundation and Pile Record Books

A pile record book is usually produced for every structure supported on permanent foundation piles. These record books contain the as-constructed pile foundation information for the project. They are used to document contract pay items for the furnishing, driving and splicing of permanent foundation piles. They are also used when a bridge project involving foundation construction is proposed at the same site. As-constructed pile driving information can be very useful in characterizing the subsurface and pile driving conditions at the site for these future projects.

25.3.7—Contents of a Pile Record Book

Information contained in pile record books typically includes the following:

- Project Name, Bridge No., Contract No.,
- Plan view of bent, pile layout and numbering sequence
- Pile hammer used
- Type and size of pile
- Driven pile lengths
- Pile tip elevations
- Pile cutoff elevations
- Final pile resistance (or set)
- Final pile bearing
- Other pile information such as observed damage, pile set periods (freeze) and splicing information.
- Blank pile record books (Item 734-3485(5-93)) are available from the ODOT storeroom under stock number 203215. Guidance for the proper completion of pile record books can be found in the course notebook for the Bridge Construction Inspection Certification course.

25.3.8—Location and Access

Pile record books are initially completed at the project field office and forwarded to the HQ Bridge Office in Salem after the project is completed. The original hard copies of the record books are stored in the Bridge Section File Room, filed by bridge number. All record books are scanned into a pile record book electronic database. Requests for pile record book information should be through the Bridge Section front office. If the record books are available in the database the files can be easily obtained by clicking on the following link:

[\\Sc-salemrev-12\brdgpilebks](#)

(Individuals working outside of ODOT will have to send a request for pile book records to: bridge@odot.state.or.us; if the record is available it will be sent to you within 5 business days)

25.3.9—Bridge Hydraulic Files

Hydraulic files located in the headquarters office can be accessed using the following link:
http://www.oregon.gov/ODOT/HWY/GEOENVIRONMENTAL/hyd_data_resources.shtml

Hydraulics reports produced in other offices are not yet available. The Geo- Environmental unit is developing the file access to the hydraulic data.

25.3.10—Calc Books

Bridge Calculation Books are to be turned in to the Front Office Staff when a project has been completed. The Front Office Staff will have the Calculation Book scanned and then bound by the DAS Copy Center. When the book returns it will be archived by Front Office Staff and sent to the State Records Center. The Calculation Books are available for checkout by sending your request to:

bridge@odot.state.or.us

However, for most cases we do not let the books leave the Transportation Building. Individuals making requests can come to the Transportation Building to view the book and make any copies they may need. By not sending the books out it helps prevent us from losing them. This will not be an issue once all of the Calculation Books have been scanned and made available electronically.

25.3.11—Bridge Maintenance Files

At one time you would go to the Bridge Maintenance Files with a State bridge number in hand to research the history and condition of a bridge. The file folder might include:

- Correspondence
- Set of reduced plans
- Bridge Inspection Reports
- Scour data
- History of maintenance and repairs

Now however, certain items such as the more recent Bridge Inspection Reports, Load Rating Summary Reports, and scour data are found in other files in other areas. The hard copy Maintenance Files are located in the Bridge File Room (Room 321). Bridge Inspection Report Files, State and Local Agency Bridges (Bridge File Room, Room 321) the more recent Bridge Inspection Reports, generally 1980s and later, for bridges on the State Highway System are filed by bridge number. Please note that Structure Inventory and Appraisal Reports (SI&A), which include the sufficiency rating, are now included in all Routine Bridge Inspection Reports and can be located by looking up the Bridge Inspection Report.

Agency Bridge Management and Maintenance Files (Bridge File Room 321) these files of management and maintenance data for agency bridges include:

- Bridge Plans
- Bridge Inspection Reports
- Structure Inventory and Appraisal
- Load Ratings
- Scour Data

The files are organized by county or city and then by bridge number within each county or city and are located at the ODOT TLC Bldg.

25.3.12—Bridge Log

The Bridge Log has been published since 1924 and is perhaps the most readily available source of bridge information for ODOT personnel. Hard copies can be found under the front seat of many vehicles, and a searchable electronic copy of the Bridge Log can be found at:
<http://www.oregon.gov/ODOT/HWY/BRIDGE/docs/brlog.pdf>.

The Bridge Log is organized by highway and mile point, and contains basic inventory information including bridge number, bridge name, year built, structure type, and a brief description of the structure. The Bridge Log also contains information that is helpful when trying to locate a bridge, such as city limits and highway junctions.

25.3.13—Qualified Products List

A list of products that have met ODOT standards can be found at the following link:
<http://www.oregon.gov/ODOT/HWY/CONSTRUCTION/QPL/QPIndex.shtml>

25.4—ARCHIVES

25.4.1—State Archive and Records Center

The Bridge Section stores its inactive records and documents at the State Archives

Record Center (4298 22nd Ave NE Salem, OR 97301)

What does the Bridge Section store in the ODOT records area?

- Boxes of project contract files, and calc books stored on open shelving. Box numbers are referenced in the Bridge Section Archives Database. Requests are researched by the Bridge Section Front Office staff.

Outside agency customers can request material by emailing bridge@odot.state.or.us.

Early contract material has been microfilmed.

- Bridge Mylar's are located in three areas.
 - Drawings 00001-49800 and 57801- 63800 are located at the State Archives Records Center.
 - Drawings 49801-57800 are located in a storage vault at 985 Broadway NE Salem, OR 97301.
 - Drawings 63801 and above are located in the Bridge Section file room (Rm. 321).

Once a request is received the Bridge Section staff will research the Archives Database for the requested material to locate the box assigned to the material. The AS1 will then forward the box number and accession number to the Records and Forms Analyst via email. The Records and Forms Analyst will contact the State Archives Record Center to request the box and have it sent to the requesting AS1. The box will be sent by the State Archives Record Center through the shuttle within three days of receiving the request. The Bridge Section office staff will track and distribute the material to the requestor. To request bridge drawings or Mylar's you must send a written request to bridge@odot.state.or.us. The email address is monitored by the Bridge Section Administration Office; requests will be honored within three business days.

25.4.2—Bridge Cost Data Files

The unit cost for various bridge types and for ODOT standard bid items are summarized each year. The data is published electronically in the Bridge Cost Data Book. The data is also used as a source for the Transport Cost Estimating program. See Section 2.5.1. Click on the following link to access the Bridge Cost Data Guide: http://ftp.odot.state.or.us/Bridge/BPPM/Sec_1_Br_Admin/Sources_of_Info/Cost_Data/2008costdata_manual.pdf

25.4.3—Bridge Data System (BDS)

The Bridge Data System (BDS) is a program developed by the Information Systems, Transportation Application Development Unit (TAD) to manage and display structure design related information.

Designed to be extensible, the system can assign structure and drawing numbers and display scanned images of contract drawings. The system was written to be accessed through the internet giving select consultants and others outside of ODOT the ability to use the program.

Functionality is controlled with the use of access groups. Users will not be able to see or access functions that are not associated with the access group(s) they are assigned to. The basic access can view our scanned images. This type of access is granted to any employee of ODOT who has a need to see the data. Additional access can be granted to a user depending on their job requirements.

Additional information that will be available through BDS will be the assigning and viewing of calculation books, pile record books, foundation and hydraulic data and eventually pictures.

To have the BDS installed, send an e-mail request to bridge@odot.state.or.us and include your login id. The administration staff will submit a request to the ODOT Computer Security Unit to add your login id to the appropriate access groups. Once completed, the administrative staff will send you a responding e-mail with a shortcut which will allow you to install the application on your machine. Once installed, the program can be started by pressing the selecting the Start button and navigating to – Programs – Bridge Data System – Start BDS.

25.4.4—Bridge Servers

Four dedicated server locations have been created to share information. Access and privileges to these locations are provided by virtue of the crew a user is assigned to.

The first is [\\scdata\brdgshar\bridge](#) and is commonly known as “bridge share”. It is only accessible to users who are assigned to crews that start with 74xx, people who are assigned to the “Bridge Section” groups. Users within those groups have read and write privileges and can easily create and store data in this location.

Because Bridge Section Data needs to be shared among the Region Tech Centers, a second storage location was created. This location, [\\scdata\brdgdata](#) gives users in both the Bridge Section and the Region Tech Centers a location to read and write common files.

The third location, [\\scdata\brdgpup](#) was created to allow Bridge Section to publish information that can be read by everyone in ODOT but access to write or change the data is limited to a few people within the Bridge Section.

A fourth location is used by the Bridge Operations & Standards Unit, and the Bridge Program Unit. This location [\\s7000b\BridgeMgmt](#) stores data related to inspections, load rating and several other sensitive data. Access to this location is limited and granted only by the Manager of the Bridge Operations & Standards Unit. The Department has one server dedicated to transferring files outside of the ODOT network. The File Transfer Protocol (FTP) Server is a storage location that is accessible through the internet. People outside the agency can deposit/retrieve files for/from ODOT employees. This is usually used for those files that can’t be easily sent over the e-mail system.

Two main folders are used to transfer files outside of ODOT. The first is called “Outgoing” and is where you can create subfolders into which you can copy your files to be retrieved from someone outside the Agency. The second is the “Incoming” folder where you can create a subfolder to have people outside the Agency deposit files for you to retrieve. Storage space is limited on this server and the files in these folders will be automatically erased 10 days from the last time they were accessed. The Bridge Section also has a dedicated folder that is not automatically cleaned out. This folder is labeled “Bridge” and is where items are placed that will be accessed over longer periods. For example, this location is used to distribute the Inspection Coding Guide to consultants. Because of the limited server space, you should talk with your supervisor before using this location.

The FTP server can be access from within the Department by pressing the Start button on the task bar and selecting the Run option. In the Run window, type [\\s0442c\ftp](#) and press the Enter key. You can also map a drive to this server location. This is how you will create subfolders and copy files between your computer and the FTP server. Outside ODOT, users can access our ftp server by typing <ftp.odot.state.or.us> in Windows Explorer address field or the Internet Explorer address field. They can transfer files by dragging them from or to a folder on their computer. If they can’t transfer files by “drag and drop”, set the following option:

1. Open Internet Explorer and select the Tools menu item.
2. Click on the “Internet Options” item.
3. Select the Advanced tab and make sure the box labeled “Enable folder view for FTP sites” is checked.

25.5—PROJECT FILES

25.5.1—General Description

A Project Contract File is setup by the Front Office Staff after the contract for a project has been awarded. Filed by contract number, each Project Contract File covers all the structures in the project and generally includes the following material:

- Contract Booklet
- Correspondence and Miscellaneous folders which can include, among the letters and transmittals, such things as copies of the Bridge Project Prospectus Estimate, Hydraulics Report, Bridge Project Discussion Memos, agreements, etc.
- Copies of working drawings (shop drawings and temporary construction drawings and calculations)
- Foundation Report

- Original Job Record Sheet and approved TS&L submittal package
- Set of bidding documents – reduced plans and special provision booklet
- After the contract is completed and the project accepted, the file is archived by the Front Office Staff and then sent to the State Archives and Record Center for storage.

25.5.2—How to Get Information In/Out of System

A Project Contract File is setup by the Front Office Staff after the contract for a project has been awarded. Filed by contract number, each Project Contract File covers all the structures in the project and generally includes the following material:

- Contract Booklet
- Correspondence and Miscellaneous folders which can include, among the letters and transmittals, such things as copies of the Bridge Project Prospectus Estimate, Hydraulics Report, Bridge Project Discussion Memos, agreements, etc.
- Copies of working drawings (shop drawings and temporary construction drawings and calculations)
- Foundation Report
- Original Job Record Sheet and approved TS&L submittal package
- Set of bidding documents – reduced plans and special provision booklet After the contract is completed and the project accepted, the file is archived by the Front Office Staff and then sent to the State Archives and Record Center for storage.

25.5.3—Construction Narratives

- All Narratives that come in to the Bridge Section are scanned and placed into the bridge share drive by the front office staff member responsible for opening mail, usually the Office Specialist 2. The link where the scanned narratives are stored (ftp://ftp.odot.state.or.us/Bridge/BPPM/Sec_1_Br_Admin/Sources_of_Info/Project_Narratives) is sent to section managers and standards engineers via email.

25.5.4—Design and Inspection Support Documents and Reports

Supplemental reports are listed in Chapter 28 of this manual.

CHAPTER 26: STANDARD BRIDGE INSPECTION REPORTS

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Chapter 26:**Standard Bridge Inspection Reports****26.1-STANDARD BRIDGE INSPECTION REPORTS**

This chapter contains standardized reports and example reports used by the Oregon DOT to document the results of the various inspection activities including;

- Initial Inspection Report
- Routine Inspection Report
- SI & A Report
- Fracture Critical Report
- Underwater Bridge Inspection Report
- Scour Plans of Action
- Bridge Clearances
- Cross Channel Profiles
- Deck Surveys
- Fatigue Prone Detail Report
- Timber Boring Diagrams
- Sign Support Structure Inspection Reports
- Bridge Specific Job Hazard Assessments
- Movable Drawbridge Inspection Report
- Pin & Hanger Inspection Report
- Corrosion Inspection Report
- Concrete Shear Crack Diagrams
- High Water Inspection Report
- Earthquake Damage Inspection Report
- Quality Assurance Review Report
- Collision Damage Report
- Bridge Record of Critical Finding
- Coastal Concrete Inspection Report (under development)
- Concrete Segmental Inspection Report (under development)

26.1.1-Initial Inspection Report

OREGON DEPT. OF TRANSPORTATION BRIDGE INSPECTION REPORT

DISTRICT
BR. NAME:
LOCAL NAME:
LOCAL ID:

AC DEPTH:

OWNER
COUNTY:
RECORD TYPE:
INSP. FREQ.
INSP. DATE:
BRIDGE LENGTH

BR. NO.
FACILITY CARRIED:
MILEPOST:
INSPECTOR 1 NO.
INSPECTOR 2 NO.
BRIDGE WIDTH:

ELEMENT CONDITION STATE RATINGS

ELEM.	ELEMENT DESCRIPTION	ENV.	QTY.	UNITS	Element Condition States					TEMP.
					1	2	3	4	5	

APPRAISAL ITEMS

Appraisal Item	#	Coding
Scour	113	
Bridge Rail	36A	
Transition	36B	
Approach Rail	36C	
Rail Ends	36D	
Main Span Type	43	
Appr Span Type	44	
Recomm. Level of Access & Frequency:		

NBI RATINGS

NBI Item	#	Rating
Approach Condition		
Deck Wearing Surface		
Deck	58	
Superstructure	59	
Substructure	60	
Channel	61	
Culvert	62	

REMARKS

Elem.	Bent/Span	Member	Deficiency Description

MAINTENANCE RECOMMENDATIONS

Crew	Order #	Priority	Elem.	Bent/Span	Member	Work Description	Est. Cost	Comp

JSA

26.1.2-Routine Inspection Report

PONTIS Reporting

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Oregon Department of Transportation

Bridge Inspection Report

District	04	Structure	Marys River, Hwy 1W NB	Bridge ID	00706
Fac Crossed	MARYS RIVER	Owner	State Highway Agency	Fac Carried	OR 99W (HWY 1W) NB
Suff Rating	55.4	County	Benton	Mile Point	84.14mi
AC Depth	1.00	Record Type	1	Insp Date	06/14/2011
Bridge Length	307.80ft	Insp Freq	24	Inspector 1	Robert Burns (S0033)
		Bridge Width	40.50ft	Inspector 2	Orren Vann (02019)

Signature: _____

Element Condition States

Elem	Description	Env	Qty	Units	1	2	3	4	5	status
12	Concrete Deck - Bare	Mod.	10692.00sqft	(SF)	0%	100%	0%	0%	0%	
26	Concrete Deck - Protected w/ Coated Bars	Mod.	705.00sqft	(SF)	100%	0%	0%	0%	0%	
104	P/S Conc Closed Web/Box Girder	Mod.	256.00ft	(LF)	100%	0%	0%	0%	0%	
110	Reinforced Conc Open Girder/Beam	Mod.	172.00ft	(LF)	0%	100%	0%	0%	0%	
111	Timber Open Girder/Beam	Mod.	1368.00ft	(LF)	75%	25%	0%	0%	0%	
113	Painted Steel Stringer	Mod.	1050.00ft	(LF)	30%	30%	20%	20%	0%	
121	Painted Steel Bottom Chord Thru Truss	Mod.	300.00ft	(LF)	25%	35%	25%	15%	0%	
126	Painted Steel Thru Truss (excl. bottom chord)	Mod.	300.00ft	(LF)	25%	30%	30%	15%	0%	
152	Painted Steel Floor Beam	Mod.	192.00ft	(LF)	15%	45%	25%	15%	0%	
201	Unpainted Steel Column or Pile Extension	Mod.	4	(EA)	0%	100%	0%	0%	0%	
202	Painted Steel Column or Pile Extension	Mod.	4	(EA)	0%	100%	0%	0%	0%	
205	Reinforced Conc Column or Pile Extension	Mod.	4	(EA)	70%	25%	5%	0%	0%	
206	Timber Column or Pile Extension	Mod.	27	(EA)	40%	60%	0%	0%	0%	
216	Timber Abutment	Mod.	1	(EA)	0%	100%	0%	0%	0%	
218	Painted Steel Abutment	Mod.	1	(EA)	0%	100%	0%	0%	0%	
231	Painted Steel Cap	Mod.	5	(EA)	0%	100%	0%	0%	0%	
234	Reinforced Conc Cap	Mod.	2	(EA)	90%	0%	10%	0%	0%	
235	Timber Cap	Mod.	3	(EA)	0%	65%	0%	35%	0%	
301	Pourable Joint Seal	Mod.	42.00ft	(LF)	0%	100%	0%	0%	0%	
309	Other Joint	Mod.	110.00ft	(LF)	0%	100%	0%	0%	0%	
310	Elastomeric Bearing	Mod.	10	(EA)	100%	0%	0%	0%	0%	
311	Moveable Bearing (roller, sliding, etc.)	Mod.	2	(EA)	0%	100%	0%	0%	0%	
313	Fixed Bearing	Mod.	2	(EA)	0%	100%	0%	0%	0%	
325	Traffic Impact Condition	Mod.	1	(EA)	0%	100%	0%	0%	0%	
326	Deck Wearing Surface	Mod.	1	(EA)	0%	100%	0%	0%	0%	
331	Reinforced Conc Bridge Railing	Mod.	616.00ft	(LF)	80%	20%	0%	0%	0%	
334	Metal Bridge Railing - Coated	Mod.	300.00ft	(LF)	60%	20%	20%	0%	0%	
357	Pack Rust	Mod.	1	(EA)	0%	100%	0%	0%	0%	
358	Deck Cracking	Mod.	1	(EA)	20%	20%	30%	30%	0%	
359	Soffit of Concrete Deck or Slab	Mod.	1	(EA)	40%	40%	0%	20%	0%	
361	Scour	Mod.	1	(EA)	100%	0%	0%	0%	0%	

26.1.2-Routine Inspection Report (continued)

PONTIS Reporting

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362	Traffic Impact	Mod.	1	(EA)	100%	0%	0%	0%	0%
363	Section Loss	Mod.	1	(EA)	0%	100%	0%	0%	0%
390	Paint, Alkyd (incl red lead)	Mod.	17850.00sqft	(SF)	30%	35%	20%	15%	0%
990	Miscellaneous Items	Mod.	1	(EA)	100%	0%	0%	0%	0%

Appraisal			NBI Category		
Appraisal	NBI #	Rating	Category	NBI #	Rating
Scour	113	3 SC - Unstable	Deck Condition	58	5 Fair
Bridge Rail	36A	0 Substandard	Superstructure	59	6 Satisfactory
Transitions	36B	0 Substandard	Substructure	60	5 Fair
Approach Rail	36C	0 Substandard	Channel	61	5 Bank Prot Eroded
Rail Ends	36D	0 Substandard	Culvert/Retaining Walls	62	N N/A (NBI)
Structural	67	5 Above Min Tolerable			
Deck	68	2 Intolerable - Replace			
Clearance	69	N Not applicable (NBI)			
Waterway	71	8 Equal Desirable			
Approach Alignment	72	8 Equal Desirable Crit			

Remarks

Bare Concrete Deck (12)

SPAN 2: SPALL IN DECK SURFACE, LEFT LANE. SPALLS WITH EXPOSED REBAR IN BOTH OVERHANG SOFFITS; SPALL WITH EXPOSED REBAR IN THE DECK SOFFIT; SPALL UNDER THE CURB WITH EXPOSED 5-FOOT LONG LONGITUDINAL REBAR, RIGHT SIDE NEAR BENT 3.. SPAN 3: SPALLS WITH EXPOSED REBAR IN THE LEFT OVERHANG SOFFIT.

Conc Deck/Coatd Bars (26)

INVENTORY FOR DECK ON PRECAST SIDEWALK SECTIONS (TUBS).

P/S Conc Box Girder (104)

INVENTORY FOR P/S SLABS IN SPAN 1. EVIDENCE OF WATER LEAKAGE BETWEEN THE SLABS.

R/Conc Open Girder (110)

SEVERAL SMALL CRACKS IN EVERY PRECAST, SIDEWALK SECTION GIRDER IN SPAN 1.

Timber Open Girder (111)

SPANS 7 & 8: FIRE DAMAGE (SURFACE ONLY) TO SPAN 7 & 8 GIRDERS, CAPS AND PILES. ALSO SOME DELAMINATIONS ON THE UNDERSIDE OF THE DECK DUE TO THE FIRE. FERNS GROWING ON GIRDER 11 IN SPAN 3.

Paint Stl Stringer (113)

MODERATE TO HEAVY RUST AND SOME PAINT SYSTEM FAILURE ON THE TOP FLANGES OF THE STRINGERS, ESPECIALLY THE EXTERIOR ONES. SMALL BEND IN THE BOTTOM FLANGE OF STRINGER 1 NEAR L1 LEFT.

P/Stl Thru Truss/Bot (121)

SOME CORROSION ON A FEW RIVETS. MODERATE TO HEAVY SURFACE RUST AND SOME PAINT SYSTEM FAILURE; PITTING AND MINOR SECTION LOSS ON THE CONNECTION PLATES AND BOTTOM CHORD CHANNEL MEMBERS. SOME MEASUREABLE SECTION LOSS IN THE BOTTOM FLANGES OF THE BOTTOM CHORD CHANNEL SECTIONS AT THE CONNECTION PLATES (2011). ALSO SEE COMMENTS ON THE LATEST FRACTURE CRITICAL REPORT.

P/Stl Thru Truss/Top (126)

MODERATE RUST ON BACK-TO-BACK ANGLES. PEELING PAINT ON TRUSS MEMBERS. MINOR TO MODERATE RUST AT CONNECTIONS. SOME AREAS WITH PAINT SYSTEM FAILURE. U4-L4 (VERTICAL) ON RIGHT SIDE WAS REPLACED DUE TO COLLISION DAMAGE, THE PORTION BELOW THE DECK WAS NOT PAINTED. BOTH U3-L3 ON RIGHT SIDE AND U5-L5 ON LEFT SIDE LOOK SLIGHTLY TWISTED DUE TO PREVIOUS COLLISION DAMAGE IN 2006. DEBRIS ON THE LOWER PORTIONS OF THE DIAGONALS

Paint Stl Floor Beam (152)

CHALKING PAINT; SOME MODERATE TO HEAVY RUST AND PAINT SYSTEM FAILURE ON THE TOP FLANGES.

Paint Stl Column (202)

CHALKING PAINT ON COLUMNS.

R/Conc Column (205)

SMALL SPALL WITH EXPOSED REBAR IN COLUMN 2 AT BENT 3. UNDERWATER INSPECTORS RATED

26.1.2-Routine Inspection Report (continued)**PONTIS Reporting**

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COLUMN 1 AT BENT 2 IN CONDITION STATE 2 (ABRASION).

Timber Column (206)

BENT 4, PILE 3: SURFACE DECAY AND LARGE SPLITS, CHECK BORED 6/04 BY ABC - OK, HOWEVER THE PILE SHOULD BE BANDED; REPLACED WITH STEEL 8/07. BENT 4, PILE 7: PILE MARKED 4X-2R-4X AT BOTTOM, SOUNDED OK (6/05). BENT 5, PILE 3: PILE HAS LARGE SPLIT AND SURFACE DECAY, SOUNDS ROTTEN (BORED 6/04 BY ABC). BENT 5 CORBEL OVER PILE 4: CORBLE HAS SPLIT THROUGH BOTTOM. BENT 5, PILE 6: SURFACE DECAY NEAR BOTTOM. BENT 5, PILE 7: PILE IS MARKED 4X-2R-4X; SOUNDED OK (6/05). BENT 6, PILE 3: PILE SOUNDED DECAYED AT BOTTOM (6/05), CHECK BORE. BENT 6, PILE 7: PILE HAS DEEP SPLIT AND IS MARKED 5X-2R-5X (6/04). BENT 7, PILE 3: PILE HAS ONLY 1/2 BEARING UNDER CAP. BENT 7, PILE 5: PILE HAS SURFACE DECAY, MARKED AS BORED 6/04. BENT 7, PILE 6: PILE HAS SURFACE DECAY. BENT 8, PILE 3: PILE HAS LARGE SPLIT AND IS MARKED 4X-4R-4X.

Timber Abutment (216)

RATING BASED ON CONDITION OF THE TIMBER CAP AND PILES AT BENT 9.

Paint Stl Abutment (218)

PAINTED STEEL CAP AT BENT 1.

Paint Stl Cap (231)

CHALKING PAINT.

R/Conc Cap (234)

SPALLS WITH EXPOSED REBAR IN THE STEMWALL ABOVE THE CAP AT BENT 3. SPALLS WITH EXPOSED REBAR IN THE BENT 3 CAP ON THE SPAN 2 SIDE.

Timber Cap (235)

BENT 4 CAP REPLACED WITH STEEL CAP IN AUGUST 2007. COMMENTS PRIOR TO THE CAP REPLACEMENT: THE RIGHT SIDE OF THE BENT 4 CAP OVER PILES 6 & 7 IS HOLLOW AND HAS "TERMINATOR-SIZED" CARPENTER ANTS; ABOUT 1-INCH OF CRUSH IN THE CAP OVER PILE 6. ROT SOUNDED ON THE BOTTOMS OF THE SPLIT CAPS AT BENT 3; THE SPLIT CAP ON THE LEFT SIDE SOUNDS HOLLOW BETWEEN THE UTILITY PIPE AND GIRDER 2 (2011). ALSO DECAY IN THE NAILING STRIP AND MINOR TO MODERATE CRUSH UNDER THE CENTER GIRDERS ON THE SPAN 3 SIDE OF BENT 3; NOW ABOUT 1/4" CRUSH UNDER GIRDERS 5 AND 6 (2011).

Pourable Joint Seal (301)

THE OPEN JOINTS IN THE SIDEWALK AREAS WERE FILLED WITH POURABLE SEALER.

Other Joint (309)

COPPER WATER STOPS IN THE DECK JOINTS. FILLED JOINTS IN THE SIDEWALK NEAR THE NORTH END OF THE BRIDGE.

Moveable Bearing (311)

BEARINGS HAVE DIRT AND DEBRIS AROUND THEM; THE ROLLER BEARINGS AT BENT 3 ARE FULL OF DEBRIS, BUT APPEAR TO BE FUNCTIONING (2011). CORRODED NUTS AND BOLTS ON THE BEARING ASSEMBLIES.

Fixed Bearing (313)

FIXED BEARINGS AT BENT 2. DEBRIS AND RUST ON THE BEARINGS.

Traffic Impact Cond (325)

SOUTH END APPROACH: AC IS BREAKING UP WITH POT HOLES CAUSING HEAVY IMPACTS ON THE STRUCTURE.

Conc Bridge Railing (331)

SOME ROTTEN WOODEN BALUSTERS IN THE CONCRETE RAILING.

Metal Rail Coated (334)

RUST ON THE BACK SIDES OF THE RAILING; OTHER AREAS HAVE MODERATE TO HEAVY RUST. A PREVIOUS COLLISION CAUSED A CRACK IN THE END OF THE RAIL AT BENT 2, RIGHT SIDE.

Pack Rust Smart Flag (357)

PACK RUST BETWEEN BOTTOM CHORDS AND CONNECTION PLATES. THE PACK RUST IS STARTING TO SWELL SOME VERTICAL CONNECTIONS SIMILAR TO THAT OBSERVED BEHIND THE VERTICAL PLATES AT L1, RIGHT SIDE.

Deck Cracking SmFlag (358)

MODERATE SIZED, DENSE CRACKS AND SEVERE SIZED CRACKS IN THE DECK SURFACE.

Soffit Smart Flag (359)

TRANSVERSE CRACKING WITH EFFLORESCENCE AND RUST STAINING. SEVERE CRACKING AND CRACKS WITH HEAVY RUST STAINING IN THE TRUSS SPAN SOFFIT. SPAN 2: SPALLS WITH EXPOSED REBAR IN THE DECK SOFFIT WHERE THE DIAGONAL TRUSS MEMBERS EXTEND THROUGH THE DECK AND SOME SPALLS WHERE THE RAILING POSTS GO THROUGH THE DECK.

Scour Smart Flag (361)

26.1.2-Routine Inspection Report (continued)

PONTIS Reporting

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WATER FLOWING BEHIND BENT 2 AND OLD ABUTMENT CAUSING SCOUR ALONG BANK AND EXPOSING FORMWORK. EROSION HAS CAUSED TREES TO FALL INTO THE RIVER; PART OF THE PAVED BIKE PATH HAS ALSO SLID DOWN THE SLOPE (6/05) CAUSING A HAZARD; REPAIRED IN SEPTEMBER 2007.

Traf Impact SmFlag (362)

COLLISION DAMAGE TO PORTALS AND SWAY STRUTS WAS REPAIRED, BUT SOME STRUTS ARE STILL SLIGHTLY BENT OR TWISTED. 2006 COLLISION DAMAGE TO VERTICAL MEMBER WAS REPAIRED, BUT ADJACENT VERTICAL MEMBERS LOOK SLIGHTLY TWISTED.

Section Loss SmFlag (363)

SECTION LOSS (PITTING AND FLAKING) ON THE BOTTOM CHORD CONNECTION PLATES. PAINTED OVER PITTED AREAS ON SOME CONNECTION PLATES. SOME PITTING ON THE WEBS OF BOTTOM CHORD CHANNEL MEMBERS; MEASURABLE SECTION LOSS ON THE FLANGES OF THE CHANNEL MEMBERS NEAR THE CONNECTION PLATES (2011).

Paint, Alkyd (390)

SEE COMMENTS FOR PAINTED STEEL MEMBERS.

Misc (990)

ABANDONED 1" UTILITY PIPE ADJACENT TO BOTTOM CHORD, LEFT SIDE. ABANDONED 3" UTILITY PIPE ADJACENT TO BOTTOM CHORD, RIGHT SIDE. DAMAGED LIGHTING FIXTURE BELOW SPAN 1 AND OVER THE BIKE PATH MAY NOT WORK PROPERLY.

Notes**Inspection Notes****Bridge Notes****Embankment Erosion Notes****Maintenance Recommendations**

<u>Region</u>	<u>District</u>	<u>Highway</u>	<u>Mile Point</u>	<u>Bridge ID</u>	<u>Bridge Name</u>	<u>County</u>	<u>Custodian</u>		
2	04	091	-84.14mi-	00706	Marys River, Hwy 1W NB	Benton	State Highway Agency		
<u>Priority</u>	<u>Crew</u>	<u>Element</u>	<u>Notes</u>		<u>Est. Cost</u>	<u>Status</u>	<u>Action</u>	<u>Rec Date</u>	
Routine/Schedule	Albany Bridge Crew	(126) P/Stl Thru Truss/Top	THE UPPER TRUSS MEMBERS SHOULD BE POWER WASHED.		2500	Unknown	Pr Maint	5/30/03	
Routine/Schedule	Albany Bridge Crew	(206) Timber Column	BENT 6, PILE 7: CHECK BORE PILE.		150	Unknown	Other EL	5/30/03	
Routine/Schedule	Albany Bridge Crew	(235) Timber Cap	REPLACE THE DECAYING NAILER STRIP ON THE SPAN 3 SIDE OF BENT 3. IT WILL PROBABLY BE NECESSARY TO ALSO REPLACE THE SPLIT TIMBER CAPS SUPPORTING THE SIDEWALKS AT BENT 3. 2011 - CRUSH IN NAILING STRIP UNDER GIRDERS 5 AND 6; HOLLOW SOUNDING HALF CAP AT BENT 3, LEFT SIDE.		2500	Unknown	Repl Elem	5/26/09	
Routine/Schedule	Albany Bridge Crew	(311) Moveable Bearing	CLEAN AND REPAIR THE ROLLER BEARINGS AT BENT 3 AND REPLACE ANY CORRODED BOLTS AND NUTS.		500	Unknown	Rehab Elem	6/19/07	
	Albany		REPAIR OR REPLACE THE						

26.1.2-Routine Inspection Report (continued)

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Routine/Schedule	Bridge Crew	(990) Misc	DAMAGED LIGHTING FIXTURE FOR THE BIKE PATH UNDER SPAN 1.	500	Unknown	Other EL	5/30/03
Routine/Schedule	Albany Bridge Crew	(990) Misc	REMOVE ANY ABANDONED UTILITY PIPES ADJACENT TO THE BOTTOM CHORDS.	500	Unknown	Other EL	6/19/07

*Completed items not included on default search

*Red dates are overdue items.

Load Rating

Rating Date	08/21/1991	Posting Req	5 At/Above Legal Loads
Design Load	2 M 13.5 (H 15)	Posting Status.	A Open, no restriction
Operating Load	46.00ton	OR Method	1 LF Load Factor
Inventory Rating	34.00ton	IR Method	1 LF Load Factor

<u>truck</u>	<u>Rating Factor</u>	<u>% Below</u>	<u>Posting Required</u>	<u>Controlling Member</u>	<u>Actual Posting</u>	<u>Posting Date</u>
Type 3	1.50	5	No	Moment in Steel Stringers		
Type 3S-2	2.00	5	No	Moment in Steel Stringers		
Type 3-3	1.55	5	No	Moment in Steel Stringers		

Load Rating Notes

Load Rating Condition Comparison Chart

<u>Category</u>	<u>NB#</u>	<u>Rating Condition</u>	<u>Current Condition</u>
Traffic Impact		0	CS2
Deck Wearing Surface		0	CS2
Deck Condition	58	7	5
Superstructure	59	7	6
Substructure	60	6	5
Temporary Repairs	103		
Wearing Surface Thickness	293	0.00	1.00

Inspection Schedule

<u>Activity</u>	<u>Conducted On</u>	<u>Frequency</u>	<u>Next Inspection</u>
Routine Inspection	06/14/2011	24	06/01/2013
Underwater	02/15/2012	48	02/15/2016
Fracture Critical 1 Inspection	06/14/2011	24	06/01/2013
Fracture Critical 2 Inspection	06/14/2011	24	06/01/2013
Fatigue Prone Inspection	06/14/2011	72	06/01/2017
Timber Boring	08/07/2001	96	08/01/2009
X-Channel Profile	05/26/2009	48	06/01/2013
Snooper Inspection	06/14/2011	24	06/01/2013

26.1.2-Routine Inspection Report (continued)

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55.4 **Suff Rating**
Functionally ObsoleteOregon Department of Transportation
Structure and Inventory Appraisal ReportBridge NO: 00706
InspDate: 6/14/11

(122) Highway/CO RD	091	(43) Struct Main	3 Steel	(65) Inv Rating Method	1
(2) Highway District	District 4		10 Truss-Thru	(92) Critical Feat Insp	(93) Date
(3) County	Benton	(44) Struct Appr	7 Wood or Timber	(A)Fracture Crit	Y 24 Jun 14
(4) City	15800		02 Stringer/Girder	(B)Underwater Insp	2011 12: Y 48 Feb 15
(5) Inventory Route	131000994	(45) Number Main Spans	1	(94) Cost of Improvement	2012 12: 985606
(6) Feature INT	MARYS RIVER	(46) Number Appr Spans	7	(95) Roadway Improvement	98561
(7) Facility Carried	OR 99W (HWY 1W) NB	(47) Horizontal Clearance	24.00ft	(96) Project Improvement	1576970
(8) Structure Number	00706 01W 08414	(48) Maximum Span Length	150.00ft	(97) Year of Improvement	2011
(9) Location	IN CORVALLIS	(49) Structure Length	307.80ft	(98) Border BRST-Code	
(10) Vert Clearance	14.75ft	(50) Sidewalk Width LT	7.00ft	(100) Defense Highway	0
(11) Mile Post	84.14mi	(50) Sidewalk Width RT	7.00ft	(101) Parallel Structure	L
(16) Latitude	443323.67	(51) Bridge Roadway Width	24.00ft	(102) Direction of Traffic	1
(17) Longitude	1231552.65	(52) Deck Width	40.50ft	(103) Temporary Structure	
(19) Bypass Detour	4.41mi	(53) Vert Clear Over Deck	14.75ft	(104) Highway System	0
(20) TOLL	3 On free road	(54) Vert Clear Under Deck	N 0.00ft	(106) Year Reconstructed	1997
(21) Custodian	State Highway Agency	(55) Min Lat Underclear CD	N 0.00ft	(107) Deck Structure	1
(22) Owner	State Highway Agency	(56) Min Lat Underclear	L 0.00ft	(108) Wearing Surface	100
(26) Func Class	14 Urban Other Princ	*** CONDITION ***		(109) Truck ADT	3
(27) Year Built	1933	(58) Deck	5	(110) Designated National Network	1
(28) Lanes	on: 2 / under: 0	(59) SuperStructure	6	(111) Pier Protection	
(29) Average Daily Traffic	9300	(60) SubStructure	5	(112) NBIS Bridge Length	Y
(30) Year of ADT	2010	(61) Channel	5	(113) Scour Critical Bridge	3
(31) Design Load	2 M 13.5 (H 15)	(62) Culvert	N	(114) Future ADT	17100
(32) Approach Roadway	24.00ft	(64) Operating Rating	46.00ton	(115) Year of Future ADT	2030
(33) Bridge Median	0 No median	(66) Inventory Rating	34.00ton	(116) Vert-Lift Clearance	
(34) Skew	0°	***APPRAISAL***		***State Information***	
(35) Structure Flared	0 No flare	(67) Structure Condition	5	(117) Est Maint Cost	
(36) Traffic Safety Feature	0000	(68) Deck Geometry	2	(118) Culvert Length	
(37) Historical Significance	2	(69) Underclearance	N	(119) Culvert Inside Height	
(38) Navigation Control	0	(70) Posting	5	(120) Inspector	Robert Burns (S0033)
(39) Navigation Vert Clear	0.00ft	(71) Waterway Adequacy	8	(125) Embankment Erosion	4
(40) Navigation Horz Clear	0.00ft	(72) APPR RDWY Alignment	8		
(41) Open Status	A	(75) Type of Work	8		
(42) Type Service On	1	(76) Improvement Length	308.40ft		
(42) Type Service Under	5	(90) Inspection Date	06/14/2011		
(12) Base Highway Network	1	(90) Inspection Frequency	24		
(13) LRS Inventory Route	009100100S00	(63) Oper Rating Method	1		
(105) Federal Lands HWY	0				

26.1.2-Routine Inspection Report (continued)

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☐ **Documents for Bridge # 00706***Bridge Clearance documents:* [CL00706.PDF](#),*Bridge Images:* [IM00706_A0.JPG](#), [IM00706_A10.JPG](#),
[IM00706_A11.JPG](#), [IM00706_A12.JPG](#), [IM00706_A13.JPG](#),
[IM00706_A14.JPG](#), [IM00706_A15.JPG](#), [IM00706_A2.JPG](#),
[IM00706_A3.JPG](#), [IM00706_A4.JPG](#), [IM00706_A5.JPG](#),
[IM00706_A6.JPG](#), [IM00706_A7.JPG](#), [IM00706_A8.JPG](#),
[IM00706_A9.JPG](#),*Job Hazard Assessment:* [JHA00706_.PDF](#),*Cross Channel Documents:* [XC00706_.PDF](#),*Gusset Plate Documents:* *Unavailable**Fracture Critical Inspection Documents:* [FC00706_.PDF](#),*Fatigue Prone Detail Documents:* [FP00706_.PDF](#),*Sign Structures Documents:* *Unavailable**Timber Boring Documents:* [TB00706_.PDF](#),*Underwater Documents:* [UW00706_.pdf](#),*Bridge Scour Plan:* [00706.pdf](#),

26.1.3-SI & A Report

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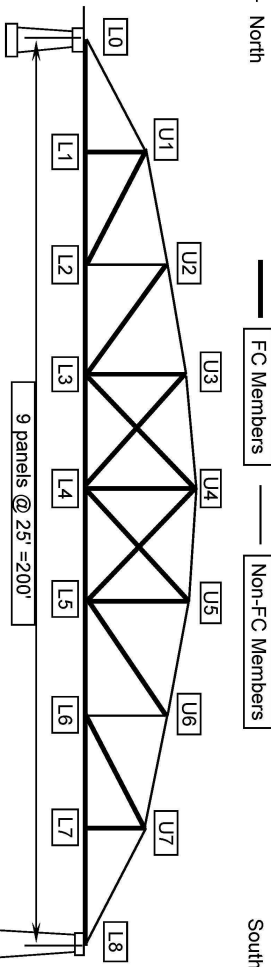
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55.4 **Suff Rating**
Functionally ObsoleteOregon Department of Transportation
Structure and Inventory Appraisal ReportBridge NO: 00706
InspDate: 6/14/11

(122) Highway/CO RD	091	(43) Struct Main	3 Steel	(65) Inv Rating Method	1
(2) Highway District	District 4		10 Truss-Thru	(92) Critical Feat Insp	(93) Date
(3) County	Benton	(44) Struct Appr	7 Wood or Timber	(A)Fracture Crit	Y 24 Jun 14 2011 12:
(4) City	15800		02 Stringer/Girder	(B)Underwater Insp	Y 48 Feb 15 2012 12:
(5) Inventory Route	131000994	(45) Number Main Spans	1	(94) Cost of Improvement	985606
(6) Feature INT	MARYS RIVER	(46) Number Appr Spans	7	(95) Roadway Improvement	98561
(7) Facility Carried	OR 99W (HWY 1W) NB	(47) Horizontal Clearance	24.00ft	(96) Project Improvement	1576970
(8) Structure Number	00706 01W 084 14	(48) Maximum Span Length	150.00ft	(97) Year of Improvement	2011
(9) Location	IN CORVALLIS	(49) Structure Length	307.80ft	(98) Border BRST-Code	
(10) Vert Clearance	14.75ft	(50) Sidewalk Width LT	7.00ft	(100) Defense Highway	0
(11) Mile Post	84.14mi	(50) Sidewalk Width RT	7.00ft	(101) Parallel Structure	L
(16) Latitude	443323.67	(51) Bridge Roadway Width	24.00ft	(102) Direction of Traffic	1
(17) Longitude	1231552.65	(52) Deck Width	40.50ft	(103) Temporary Structure	
(19) Bypass Detour	4.41mi	(53) Vert Clear Over Deck	14.75ft	(104) Highway System	0
(20) TOLL	3 On free road	(54) Vert Clear Under Deck	N 0.00ft	(106) Year Reconstructed	1997
(21) Custodian	State Highway Agency	(55) Min Lat Underclear CD	N 0.00ft	(107) Deck Structure	1
(22) Owner	State Highway Agency	(56) Min Lat Underclear	L 0.00ft	(108) Wearing Surface	100
(26) Func Class	14 Urban Other Princ	*** CONDITION ***		(109) Truck ADT	3
(27) Year Built	1933	(58) Deck	5	(110) Designated National Network	1
(28) Lanes	on: 2 / under: 0	(59) SuperStructure	6	(111) Pier Protection	
(29) Average Daily Traffic	9300	(60) SubStructure	5	(112) NBIS Bridge Length	Y
(30) Year of ADT	2010	(61) Channel	5	(113) Scour Critical Bridge	3
(31) Design Load	2 M 13.5 (H 15)	(62) Culvert	N	(114) Future ADT	17100
(32) Approach Roadway	24.00ft	(64) Operating Rating	46.00ton	(115) Year of Future ADT	2030
(33) Bridge Median	0 No median	(66) Inventory Rating	34.00ton	(116) Vert-Lift Clearance	
(34) Skew	0°	*** APPRAISAL ***		***State Information***	
(35) Structure Flared	0 No flare	(67) Structure Condition	5	(117) Est Maint Cost	
(36) Traffic Safety Feature	0000	(68) Deck Geometry	2	(118) Culvert Length	
(37) Historical Significance	2	(69) Underclearance	N	(119) Culvert Inside Height	
(38) Navigation Control	0	(70) Posting	5	(120) Inspector	Robert Burns (S0033)
(39) Navigation Vert Clear	0.00ft	(71) Waterway Adequacy	8	(125) Embankment Erosion	4
(40) Navigation Horz Clear	0.00ft	(72) APPR RDWY Alignment	8		
(41) Open Status	A	(75) Type of Work	8		
(42) Type Service On	1	(76) Improvement Length	308.40ft		
(42) Type Service Under	5	(90) Inspection Date	06/14/2011		
(12) Base Highway Network	1	(90) Inspection Frequency	24		
(13) LRS Inventory Route	009100100S00	(63) Oper Rating Method	1		
(105) Federal Lands HWY	0				

26.1.4-Fracture Critical Report

		OREGON DEPARTMENT OF TRANSPORTATION FRACTURE CRITICAL INSPECTION REPORT	
Bridge Name : <u>Rogue River</u>		Owner : <u>Jackson County - 029</u>	
Bridge No. : <u>06970</u>		Year Built : <u>1950</u>	
Highway : <u>508</u>		Insp Freq: <u>2</u> years	
Inspection Agency/Firm: <u>HW Lochner</u>		Inspector Name & Number:	

← North FC Members Non-FC Members South →	
	
Panel 1 Bottom Chord Stringers Bottom Chord Span 2 Panel 8	
Note: This bridge contains a bottom chord with built-up c-channels and batten plates; The fracture critical diagonal and vertical members are a combination of built up members with angles and plates Truss members are numbered from North to South and trusses are numbered East to West with increasing milepoint	
	
	

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26.1.4-Fracture Critical Report (continued)

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SPAN	Type of Member	Location	Type of Detail	Condition assessment & associated remarks	SKETCH/ PHOTO
	Riveted Built-up 3 girder	Gir 1, Bent 3-4	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	No defects noted	
	Riveted Built-up 3 girder	Gir 1, Bent 4-5	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	At floor beam 9, 2" long horizontal crack in girder web caused by out-of-plane bending	Yes
	Riveted Built-up 3 girder	Gir 1, Bent 5-6	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	No defects noted	
	Riveted Built-up 4 girder	Gir 1, Bent 3-4	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	No defects noted	
	Riveted Built-up 4 girder	Gir 1, Bent 4-5	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	No defects noted	
	Riveted Built-up 4 girder	Gir 1, Bent 5-6	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	No defects noted	
	Riveted Built-up 5 girder	Gir 1, Bent 3-4	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	No defects noted	
	Riveted Built-up 5 girder	Gir 1, Bent 4-5	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	Cracked tack weld in top of vertical stiffener and top flange	Yes
	Riveted Built-up 5 girder	Gir 1, Bent 5-6	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	No defects noted	
	Riveted Built-up 3 girder	Gir 2, Bent 3-4	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	No defects noted	
	Riveted Built-up 3 girder	Gir 2, Bent 4-5	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	No defects noted	
	Riveted Built-up 3 girder	Gir 2, Bent 5-6	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	Severe pack rust between btm chord angle and East side of web (near FB 15)	Yes
	Riveted Built-up 4 girder	Gir 2, Bent 3-4	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	No defects noted	
	Riveted Built-up 4 girder	Gir 2, Bent 4-5	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	No defects noted	

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26.1.4-Fracture Critical Report (continued)

SPAN	Type of Member	Location	Type of Detail	Condition assessment & associated remarks	SKETCH/ PHOTO
4	Riveted Built-up girder	Gir 2, Bent 5-6	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	No defects noted	
5	Riveted Built-up girder	Gir 2, Bent 3-4	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	No defects noted	
5	Riveted Built-up girder	Gir 2, Bent 4-5	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	No defects noted	
5	Riveted Built-up girder	Gir 2, Bent 5-6	Riveted top & btm flange angles, web plate, horiz. & vertical stiffeners	No defects noted	
Total number of fracture critical members inspected = 2					
Total number of girder floor beam connections inspected = 42					

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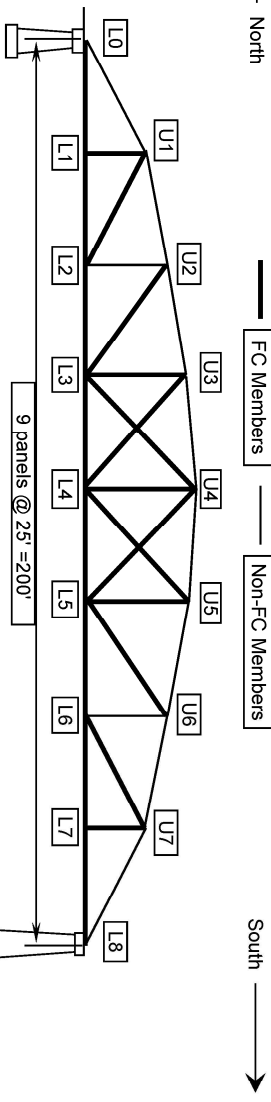
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26.1.4-Fracture Critical Report (continued)

OREGON DEPARTMENT OF TRANSPORTATION FRACTURE CRITICAL INSPECTION REPORT			
			
Bridge Name : Rogue River		Owner : Jackson County - 029	
Bridge No : 06970		Year Built : 1950	
Highway : 508		MP : 30.33	
Inspection Agency/Firm: HW Lochner		Insp Freq: 2 years	
		Date of Inspection : 9/4/04	
		Inspector Name & Number:	

← North

FC Members Non-FC Members



South →

Bottom Chord	Stringers	Bottom Chord
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6

Panel 1

Span 2

Panel 8

FB 0

FB 2

FB 6

FB 8

Note: This bridge contains a bottom chord with built-up c-channels and batten plates. The fracture critical diagonal and vertical members are a combination of built up members with angles and plates. Truss members are numbered from North to South and trusses are numbered East to West with increasing milepoint

Bottom Chord



Truss members



26.1.4-Fracture Critical Report (continued)

SPAN	Type of Member	Location	Type OF Detail	Condition Assessment and associated remarks	Sketch/ Photo
2	Riveted built-up	Truss 1	L0-L1	Btm chord riveted c-channel, Floor beam truss & Btm chord truss connections	No defects noted.
2	Riveted built-up	Truss 1	L1-L2	Btm chord riveted c-channel, Floor beam truss & Btm chord truss connections	Pack rust between batten plates and c-channels
2	Riveted built-up	Truss 1	L2-L3	Btm chord riveted c-channel, Floor beam truss & Btm chord truss connections	No defects noted.
2	Riveted built-up	Truss 1	L3-L4	Btm chord riveted c-channel, Floor beam truss & Btm chord truss connections	Pack rust between vertical gusset and c-channel @ L3 connection
2	Riveted built-up	Truss 1	L4-L5	Btm chord riveted c-channel, Floor beam truss & Btm chord truss connections	No defects noted.
2	Riveted built-up	Truss 1	L5-L6	Btm chord riveted c-channel, Floor beam truss & Btm chord truss connections	Burn hole in c-channel 4 ft. from L6 connection
2	Riveted built-up	Truss 1	L6-L7	Btm chord riveted c-channel, Floor beam truss & Btm chord truss connections	No defects noted.
2	Riveted built-up	Truss 1	L7-L8	Btm chord riveted c-channel, Floor beam truss & Btm chord truss connections	No defects noted.
2	Riveted built-up	Truss 2	L0-L1	Btm chord riveted c-channel, Floor beam truss & Btm chord truss connections	No defects noted.
2	Riveted built-up	Truss 2	L1-L2	Btm chord riveted c-channel, Floor beam truss & Btm chord truss connections	No defects noted.
2	Riveted built-up	Truss 2	L2-L3	Btm chord riveted c-channel, Floor beam truss & Btm chord truss connections	No defects noted.
2	Riveted built-up	Truss 2	L3-L4	Btm chord riveted c-channel, Floor beam truss & Btm chord truss connections	No defects noted.
2	Riveted built-up	Truss 2	L4-L5	Btm chord riveted c-channel, Floor beam truss & Btm chord truss connections	No defects noted.
2	Riveted built-up	Truss 2	L5-L6	Btm chord riveted c-channel, Floor beam truss & Btm chord truss connections	No defects noted.

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SPAN	Type of Member	Location	Type OF Detail	Condition Assessment and associated remarks	Sketch/ Photo
2	Riveted built-up	Truss 2	Btm chord riveted c-channel, Floor beam truss & Btm chord truss	No defects noted.	
2	Riveted built-up	Truss 2	Btm chord riveted c-channel, Floor beam truss & Btm chord truss	No defects noted	
2	Riveted built-up	Truss 1	L1-U1 Riveted angles, top & btm chord connection areas	No defects noted.	
2	Riveted built-up	Truss 1	U1-L2 Riveted angles, top & btm chord connection areas	Burn hole in angle 6 ft. from btm chord connection area	Yes
2	Riveted built-up	Truss 1	U2-L3 Riveted angles, top & btm chord connection areas	No defects noted.	
2	Riveted built-up	Truss 1	U3-L4 Riveted angles, top & btm chord connection areas	No defects noted.	
2	Riveted built-up	Truss 1	L3-U4 Riveted angles, top & btm chord connection areas	No defects noted.	
2	Riveted built-up	Truss 1	U4-L4 Riveted angles, top & btm chord connection areas	No defects noted.	
2	Riveted built-up	Truss 1	U4-L5 Riveted angles, top & btm chord connection areas	No defects noted.	
2	Riveted built-up	Truss 1	U4-L5 Riveted angles, top & btm chord connection areas	No defects noted.	
2	Riveted built-up	Truss 1	L4-U5 Riveted angles, top & btm chord connection areas	Notch in angle 3 ft. from top chord connection area	Yes
2	Riveted built-up	Truss 1	U5-L5 Riveted angles, top & btm chord connection areas	No defects noted.	
2	Riveted built-up	Truss 1	L5-U6 Riveted angles, top & btm chord connection areas	No defects noted.	
2	Riveted built-up	Truss 1	L6-U7 Riveted angles, top & btm chord connection areas	No defects noted.	
2	Riveted built-up	Truss 1	U7-L7 Riveted angles, top & btm chord connection areas	No defects noted.	
2	Riveted built-up	Truss 2	L1-U1 Riveted angles, top & btm chord connection areas	Severe pack rust between angles full length of member	Yes
2	Riveted built-up	Truss 2	U1-L2 Riveted angles, top & btm chord connection areas	No defects noted.	
2	Riveted built-up	Truss 2	U2-L3 Riveted angles, top & btm chord connection areas	No defects noted.	
2	Riveted built-up	Truss 2	U3-L4 Riveted angles, top & btm chord connection areas	No defects noted	
2	Riveted built-up	Truss 2	L3-U4 Riveted angles, top & btm chord connection areas	No defects noted.	

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[illegible]

26.1.5-Underwater Bridge Inspection Report

UNDERWATER INSPECTION REPORT								
BRIDGE NAME:	Mary's River			REGION:	2	BRIDGE NUMBER:	00706	
RIVER NAME:	Mary's River		OWNER:	State	DISTRICT:	4	INSPECTION DATE:	2/15/2012
STATE HWY #:	1W	ROUTE NUMBER:	OR 99W (NB)		MILE POINT:	84.14	CURRENT:	Low
COUNTY:	Benton	ROAD NAME:				VISIBILITY (Ft.):	1	
FOUNDATION TYPE:	Spread Footing				ACCESS:	3	WATER TEMP:	40
DIVERS:	Shorb, J.Ottosen, Lonie				INS. INTERVAL:	4	MAXIMUM DEPTH:	12-ft
Water Elevation	Pier #2 from bottom of cofferdam window = El. 194.8 - 0.4-ft. = El. 194.4-ft.						Constructed In	1933

The element description provided in the general notes will be used to establish the appropriate underwater bridge inspection procedures, as provided in Section 8 of the ODOT Underwater Bridge Inspection Manual.

GENERAL NOTES:

This is a Steel Through Truss, with one main pier at each edge of the river. Which is supported on two concrete columns on concrete spread footings.

UNDERWATER ELEMENT CONDITION STATES:					CONDITION STATES					
Elem.	Description:	Environment	Qty	Units	1	2	3	4	5	Temp
205	Concrete Column/Pile Extn.	Moderate	2	each	1	1	0	0	0	N

2 columns were inspected Underwater. 1 interior bent was in the water at the time of this inspection.

ELEMENT REMARKS:

Elem. Description:

205 Pier 2(North End): The form work is still in place around the channel side of this pier. At the SW corner of the form work, there is 1.5' exposed. At the SE Corner there is approximately 10' of form work exposed that extends down to the main channel bottom. The streambed is consolidated sand and gravel. The downstream column has some abrasion and is in Condition State 2.

NBI Ratings

Item	Description:	Current Condition Rating	Underwater Portion Condition Rating
60	Substructure Condition Assessment	5	7
61	Channel and Channel Protection Condition Assessment	5	6
71	Waterway Adequacy	8	8
113	Scour	3	3

NBI Item 60, No footing is exposed, columns are good.

NBI Item 61, Channel has some bank erosion.

NBI Item 71,

NBI Item 113, Calculated to be a 3 by Hydraulics.

Maintenance Recommendations:

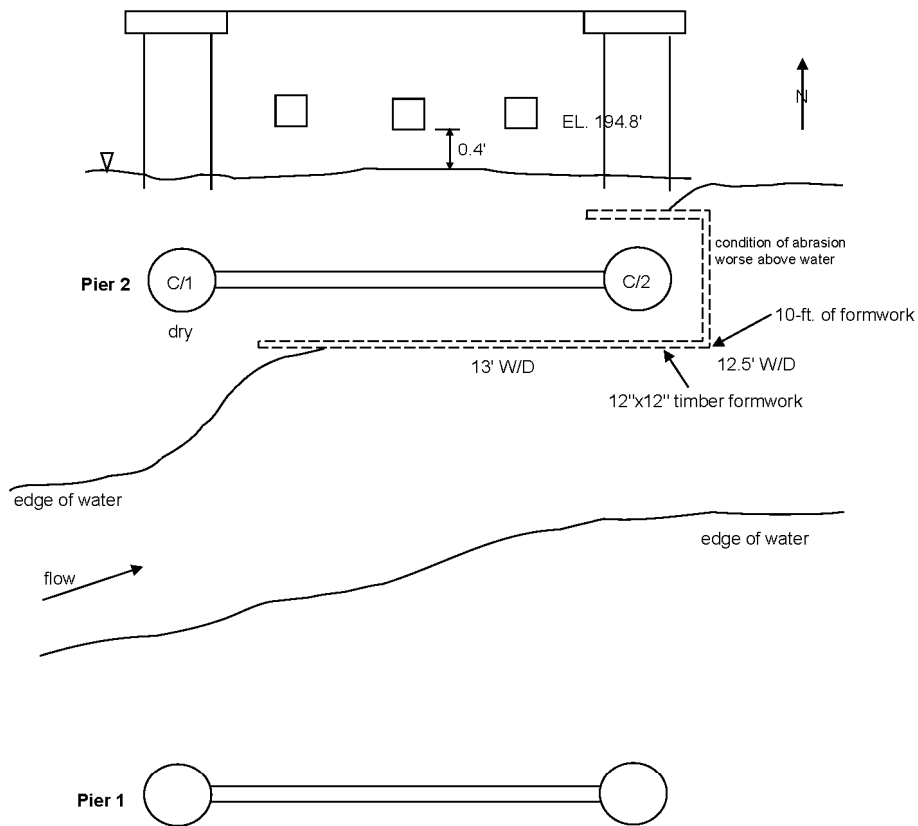
Elem. Description:

No underwater maintenance is recommended at this time.

Rick Shorb, P.E.
Underwater Operations Engineer
(503) 986-2979

cc: District 4 (Salem-Newport BMM)
Region 2 Bridge Inspector
Bridge Operations

26.1.5-Underwater Bridge Inspection Report (continued)

BR. #00706 Marys River Bridge, OR 99W NB - STATE

26.1.6-Scour Plans of Action

SCOUR CRITICAL BRIDGE - PLAN OF ACTION			
1. GENERAL INFORMATION			
Structure number: 27C35 605 00352	City, County, State: Hood River County, Oregon		Waterway: GORTON CREEK
Structure name: Gorton Creek, Wyeth Rd #605	State highway or facility carried: WYETH RD #605		Owner: County Hwy Agency
Year built: 1919	Year rebuilt: _____	Bridge replacement plans (if scheduled): _____ Anticipated opening date: _____	
Structure type: ☒ Bridge ☐ Culvert			
Structure size and description: 50 ft., 01 Slab, 1 Concrete			
Foundations: ☐ Known, type: _____ Depth: _____ ☒ Unknown			
Subsurface soil information (<i>check all that apply</i>): ☐ Non-cohesive ☐ Cohesive ☐ Rock			
Bridge ADT: 65	Year/ADT: 2006	% Trucks: _____	
Does the bridge provide service to emergency facilities and/or an evacuation route (Y/N)? N If so, describe: _____			
2. RESPONSIBILITY FOR POA			
Author(s) of POA (name, title, agency/organization, telephone, pager, email): N/A Date: _____			
Concurrences on POA (name, title, agency/organization, telephone, pager, email): N/A			
POA updated by (name, title, agency, organization): N/A Date of update: _____ Items update: _____			
POA to be updated every 24 months by (name, title, agency/organization): N/A Date of next update: 8/1/2008			
3. SCOUR VULNERABILITY			
a. Current Item 113 Code: ☐ 3 ☒ 2 ☐ 1 Other: _____			
b. Source of Scour Critical Code: ☒ Observed ☐ Assessment ☐ Calculated Other: _____			
c. Scour Evaluation Summary: INSPECTION: < none >			
d. Scour History: _____			

26.1.6-Scour Plans of Action (continued)

4. RECOMMENDED ACTION(S) (see Sections 6 and 7)				
	<u>Recommended</u>		<u>Implemented</u>	
a. Increased Inspection Frequency	☐ Yes	☒ No	☐ Yes	☒ No
b. Fixed Monitoring Device(s)	☐ Yes	☒ No	☐ Yes	☒ No
c. Flood Monitoring Program	☒ Yes	☐ No	☐ Yes	☒ No
d. Hydraulic/Structural Countermeasures	☐ Yes	☒ No	☐ Yes	☒ No

5. NBI CODING INFORMATION		
	Current	Previous
Inspection date	2/24/2009	8/22/2006
Item 113 Scour Critical	2 SC - Extensive Scour	2 SC - Extensive Scour
Item 60 Substructure	2 Critical	5 Fair
Item 61 Channel & Channel Protection	6 Bank Slumping	6 Bank Slumping
Item 71 Waterway Adequacy	6 Equal Minimum	6 Equal Minimum
Comments: (drift, scour holes, etc. – depict in sketches in Section 10)	BRIDGE: ORIENTED WEST TO EAST W/ U/S ON RIGHT. INSPECTION: <none>	INSPECTION: ORIENTED WEST TO EAST W/ U/S ON RIGHT.

6. MONITORING PROGRAM
☒ Regular Inspection Program ☐ w/surveyed cross sections Items to Watch: _____
☐ Increased Inspection Frequency of ___ mo. ☐ w/surveyed cross sections Items to Watch: _____
☐ Underwater Inspection Required Items to Watch: _____
☐ Increased Underwater Inspection Frequency of ___ mo. Items to Watch: _____
☐ Fixed Monitoring Device(s) Type of Instrument: _____ Installation location(s): _____ Sample Interval: ☐ 30 min. ☐ 1 hr. ☐ 6 hrs. ☐ 12 hrs. ☐ Other: _____ Frequency of data download and review: ☐ Daily ☐ Weekly ☐ Monthly ☐ Other _____ Scour alert criteria for each pier/abutment: _____ Scour critical criteria for each pier/abutment: _____ Survey ties: _____ Criteria of termination for fixed monitoring: _____

26.1.6-Scour Plans of Action (continued)

☒ **Flood Monitoring Program**

Type: ☒ Visual inspection
☐ Instrument (check all that apply):
☐ Portable ☐ Geophysical ☐ Sonar ☒ Other: Soundings at piers and abutments

Flood monitoring required: ☒ Yes ☐ No

Flood monitoring event defined by (check all that apply):
☐ Discharge _____ ☒ Stage At or above bank full discharge
☐ Elev. measured from _____ ☐ Rainfall _____ (in) per _____ (hour)
☐ Flood forecasting information: _____
☐ Flood warning system: _____

Frequency of flood monitoring: ☐ 1 hr. ☐ 3 hrs. ☐ 6 hrs. ☐ Other: _____

Post-flood monitoring required: ☐ No ☐ Yes, within _____ days

Frequency of post-flood monitoring: ☐ Daily ☐ Weekly ☐ Monthly ☐ Other: _____

Criteria for termination of flood monitoring: Active scouring no longer measured

Criteria for termination of post-flood monitoring: _____

Scour alert criteria for each pier/abutment: _____

Scour critical criteria for each pier/abutment: _____

Note: Additional details for action(s) required may be included in Section 8.

Action(s) required if scour alert criteria detected (include notification and closure procedures): _____

Action(s) required if scour critical criteria detected (include notification and closure): _____

Contact person (include name, title, agency/organization, telephone, pager, e-mail): N/A

7. COUNTERMEASURE RECOMMENDATIONS

Prioritize alternatives below. Include information on any hydraulic, structural or monitoring countermeasures.

☒ **Monitoring Countermeasure (see Section 6 and Section 10 – Attachment F)**
Estimated cost \$5,000.00

☐ **Structural/hydraulic countermeasures considered (see Section 10, Attachment F):**

Priority Ranking	Estimated cost
(1) monitoring	\$ 5,000.00
(2) riprap placement	\$ 50,000.00
(3) increased monitoring and riprap placement	\$ 55,000.00
(4) _____	\$ _____
(5) _____	\$ _____

Basis for the selection of the preferred scour countermeasure: _____

Countermeasure implementation project type:
☐ Proposed Construction Project ☐ Maintenance Project
☐ Programmed Construction - Project Lead Agency:
☐ Bridge Bureau ☐ Road Design ☐ Other _____

Contact person (include name, title, agency/organization, telephone, pager, e-mail):
N/A

Target design completion date: riprap placement before next large event

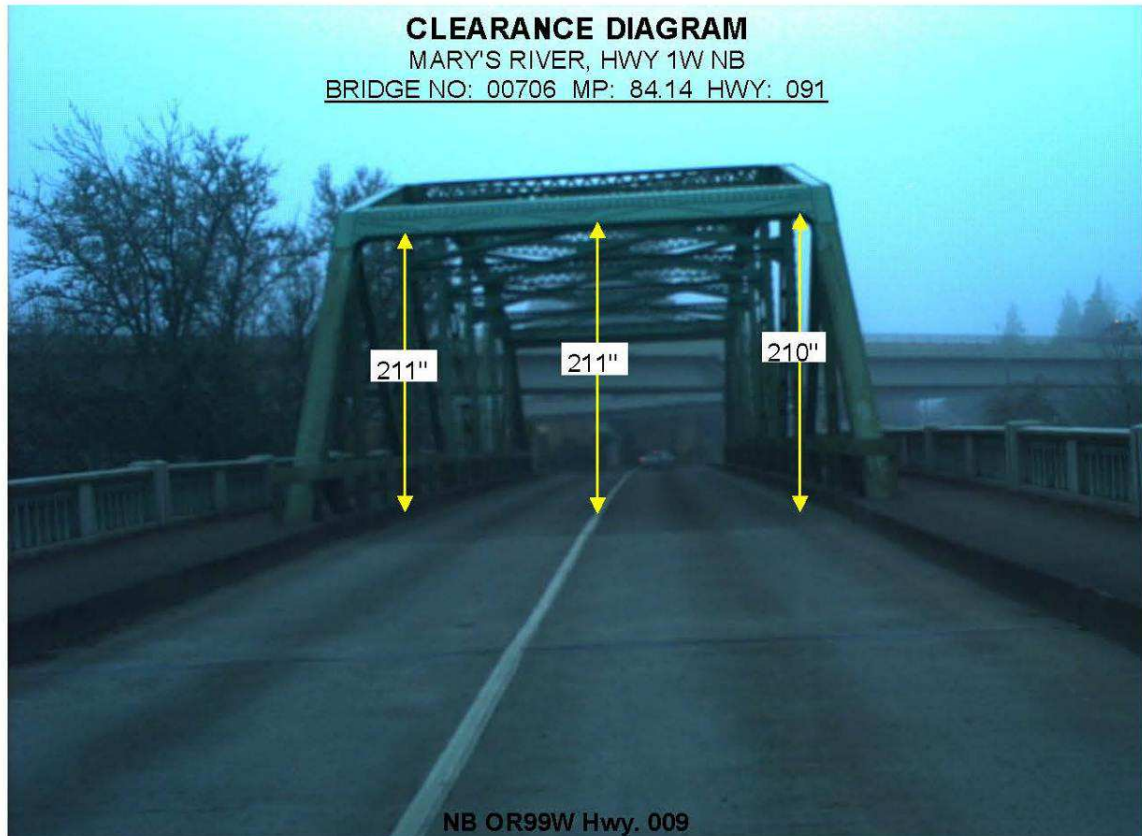
Target construction completion date:

26.1.6-Scour Plans of Action (continued)

Countermeasures already completed:			
8. BRIDGE CLOSURE PLAN			
Scour monitoring criteria for consideration of bridge closure: ☐ Water surface elevation reaches ____ at ____ ☐ Overtopping road or structure ☒ Scour measurement results / Monitoring device (See Section 6) ☐ Observed structure movement / Settlement ☐ Discharge: ____ cfs ☐ Flood forecast: ____ ☐ Other: ☐ Debris accumulation ☐ Movement of riprap/other armor protection ☐ Loss of road embankment			
Emergency repair plans (include source(s), contact(s), cost, installation directions): ____			
Contact persons (name, title, agency/organization, telephone, pager, email): N/A			
Criteria for re-opening the bridge: When determined safe by DM			
Agency and person responsible for re-opening the bridge after inspection: N/A			
9. DETOUR ROUTE			
Detour route description (route number, from/to, distance from bridge, etc.) - Include map in Section 10, Attachment E.			
Bridges on Detour Route:			
Bridge Number	Waterway	Sufficiency Rating/ Load Limitations	Item 113 Code
Traffic control equipment (detour signing and barriers) and location(s): Signs posted with flagging on site			
Additional considerations or critical issues (susceptibility to overtopping, limited waterway adequacy, lane restrictions, etc.): ____			
News release, other public notice: Authorized person(s): N/A Information to be provided, and Limitations: Signs posted with flagging on site			
10. ATTACHMENTS		To VIEW, ADD, or REMOVE attachments, click in the Text Box beneath the attachment's Check Box.	
Please indicate which materials are being submitted with this POA:			
☐ Attachment A: Boring logs and/or other subsurface information			

26.1.6-Scour Plans of Action (continued)

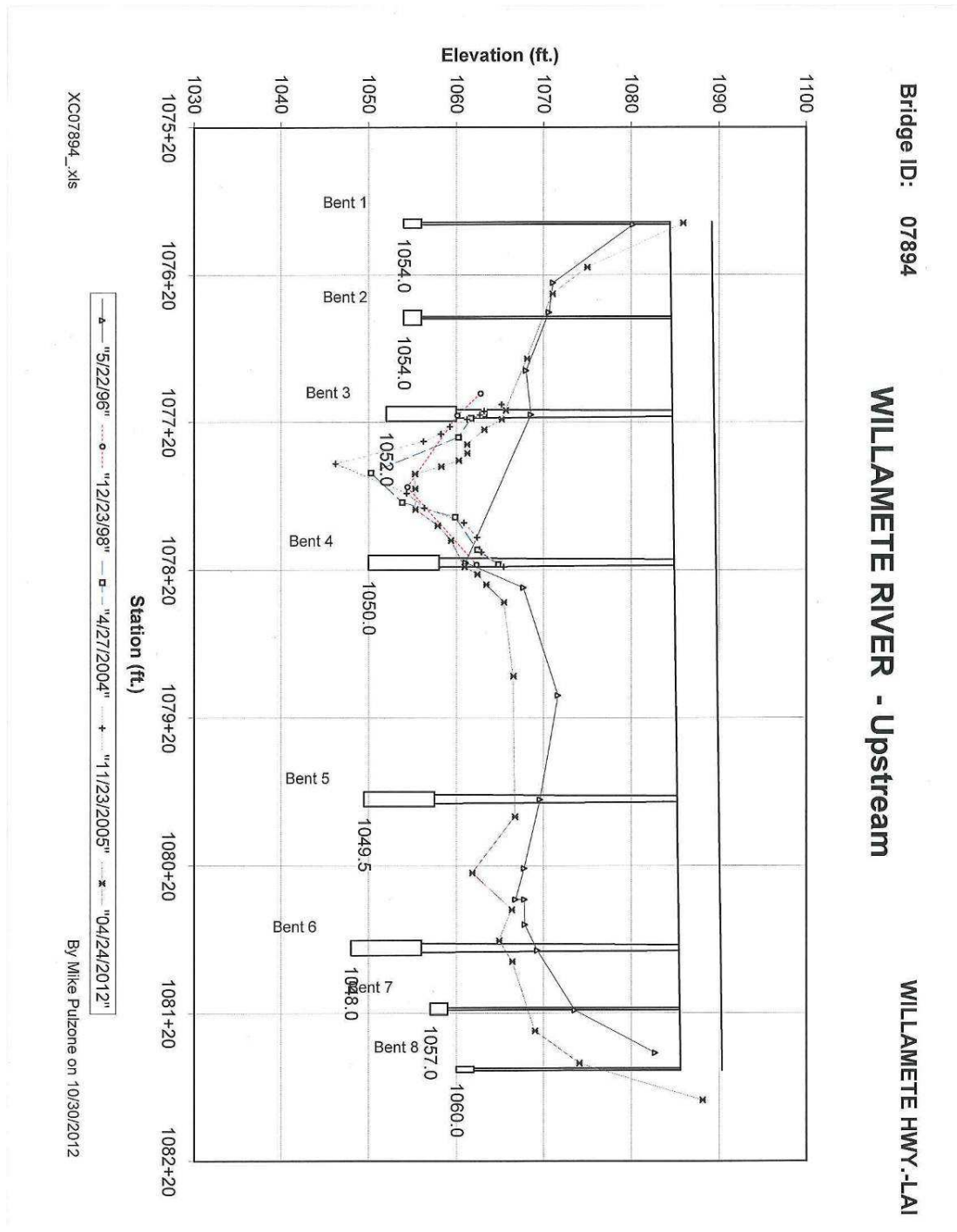
☒ Attachment B: Cross sections from current and previous inspection reports \\Scdata\BridgeMgmt\X-Channel\Region1\PDF\P27C35.PDF \\Scdata\BridgeMgmt\X-Channel\Region1\PDF\XC27C35_.PDF ☐ Attachment C: Bridge elevation showing existing streambed, foundation depth(s) and observed and/or calculated scour depths ☐ Attachment D: Plan view showing location of scour holes, debris, etc. ☐ Attachment E: Map showing detour route(s) ☐ Attachment F: Supporting documentation, calculations, estimates and conceptual designs for scour countermeasures. ☐ Attachment G: Photos ☐ Attachment H: Other information:
11. ADDITIONAL COMMENTS
This section is primarily for you to amplify and explain any other entries. Please note also any discrepancies in the pre-printed data in Sections 1 (General Information), 5 (NBI Coding Information), and 9 (Detour Route).
a.
b.
c.
d.
e.
f.
g.
h.

26.1.7-Bridge Clearances**NB OR99W IN THE NON ADD MILEAGE DIRECTION ON ROADWAY 2**

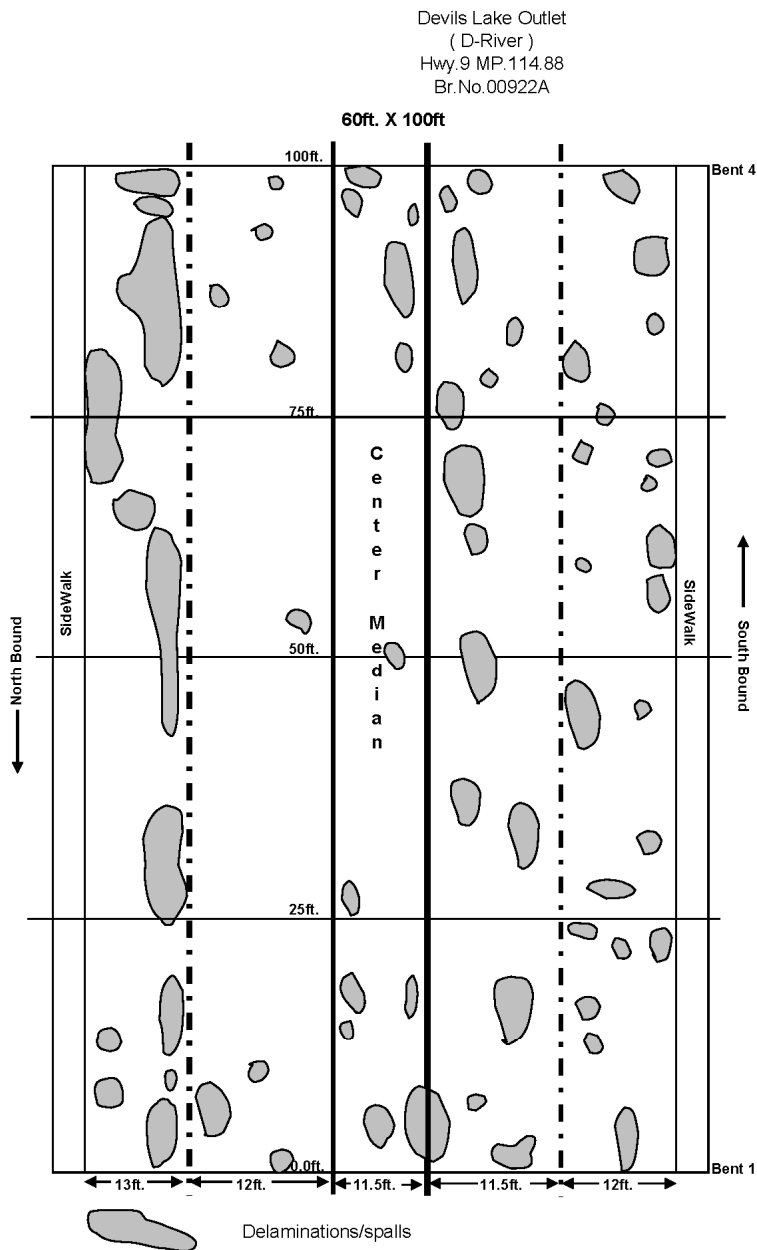
MEASUREMENTS BY ERICK CAIN AND KATIE PRICHARD ON 12/6/2011 WITH MANDLI VERTICAL CLEARANCE MEASUREMENTS SYSTEM. DIAGRAM MADE 12/7/2011 BY KATIE PRICHARD, ODOT 503-986-3505.

CLEARANCE DIMENSIONS ARE VERTICAL, UNBUFFERED, ACTUAL MEASUREMENTS. QUESTIONS? CALL VERTICAL CLEARANCE COORDINATOR 503-986-3537.

26.1.8-Cross Channel Profiles



26.1.9-Deck Surveys



26.1.10-Fatigue Prone Detail Report

OREGON DEPARTMENT OF TRANSPORTATION

FATIGUE PRONE DETAIL INSPECTION REPORT

Bridge Name: S. Umpqua River (Missouri Bottom Br)

District: 06 County: Douglas

Bridge No. 07931S

Highway: 001 MP: 105.41

Inspection Agency/Firm: ODOT

Owner: State

Year Built: 1968

Frequency: 6 years

Date of Inspection:

Name and No:

To Grants Pass South North To Roseburg

Note: Bents are numbered from South to North as with increasing MP and bridge locations where wind bracing is welded to girder web

26.1.10-Fatigue Prone Detail Report (continued)

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SPAN	Type of Member	Location	Type of Detail	Condition assessment & associated remarks	SKETCH/ PHOTO
3	Rolled	Panel 1, Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 1, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 1, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 1 FB 0, Gir 1, 2	Floor beam girder connection	No defects found	
3	Rolled	Panel 1 FB 1, Gir 1, 2	Floor beam girder connection	No defects found	
3	Rolled	Diagonal 1	Diagonal bracing, welded gusset to girder web	Crack at toe of weld end of horizontal gusset	Yes
3	Rolled	Panel 1 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found	
3	Rolled	Panel 2, Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 2, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 2, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 2 FB 0, Gir 1, 2	Floor beam girder connection	No defects found	
3	Rolled	Panel 2 FB 1, Gir 1, 2	Floor beam girder connection	No defects found	
3	Rolled	Panel 2 Diagonal 1	Diagonal bracing, welded gusset to girder web	Crack at toe of weld end of horizontal gusset	Yes
3	Rolled	Panel 2 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found	
3	Rolled	Panel 3, Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 3, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 3, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 3 FB 0, Gir 1, 2	Floor beam girder connection	No defects found	

26.1.10-Fatigue Prone Detail Report (continued)

FPD 04-30-08

SPAN	Type of Member	Location	Type of Detail	Condition assessment & associated remarks	SKETCH/ PHOTO
3	Rolled	Panel 3 FB 1, Gir 1,2	Floor beam girder connection	No defects found	
3	Rolled	Panel 3 Diagonal 1 Panel 3	Diagonal bracing, welded gusset to girder web Diagonal bracing, welded gusset to girder web	Crack at toe of weld end of horizontal gusset	Yes
3	Rolled	Diagonal 2		No defects found	
3	Rolled	Panel 4 , Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 4, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 4, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 4 FB 0, Gir 1,2	Floor beam girder connection	No defects found	
3	Rolled	Panel 4 FB 1, Gir 1,2	Floor beam girder connection	No defects found	
3	Rolled	Panel 4 Diagonal 1	Diagonal bracing, welded gusset to girder web	Crack at toe of weld end of horizontal gusset	Yes
3	Rolled	Panel 4 Diagonal 2	Diagonal bracing, welded gusset to girder web Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 5 , Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 5, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 5, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 5 FB 0, Gir 1,2	Floor beam girder connection	No defects found	
3	Rolled	Panel 5 FB 1, Gir 1,2	Floor beam girder connection	No defects found	
3	Rolled	Panel 5 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found	
3	Rolled	Panel 5 Diagonal 2	Diagonal bracing, welded gusset to girder web Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
3	Rolled	Panel 6 , Strg 1		No defects found	

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FPD 04-30-08

26.1.10-Fatigue Prone Detail Report (continued)

SPAN	Type of Member	Location	Type of Detail	Condition assessment & associated remarks	SKETCH/ PHOTO
4	Rolled	Panel 8 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found	
4	Rolled	Panel 8 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found	
4	Rolled	Panel 9 , Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 9, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 9, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 9 FB 0, Gir 1,2	Floor beam girder connection	No defects found	
4	Rolled	Panel 9 FB 1, Gir 1,2	Floor beam girder connection	No defects found	
4	Rolled	Panel 9 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found	
4	Rolled	Panel 9 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found	
4	Rolled	Panel 10 , Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 10, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 10, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 10 FB 0, Gir 1,2	Floor beam girder connection	No defects found	
4	Rolled	Panel 10 FB 1, Gir 1,2	Floor beam girder connection	No defects found	
4	Rolled	Panel 10 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found	
4	Rolled	Panel 10 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found	
4	Rolled	Panel 11 , Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 11, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	

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26.1.10-Fatigue Prone Detail Report (continued)

SPAN	Type of Member	Location	Type of Detail	Condition assessment & associated remarks	SKETCH/ PHOTO
4	Rolled	Panel 11, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 11 FB 0, Gir 1,2	Floor beam girder connection	No defects found	
4	Rolled	Panel 11 FB 1, Gir 1,2	Floor beam girder connection	No defects found	
4	Rolled	Panel 11 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found	
4	Rolled	Panel 11 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found	
4	Rolled	Panel 12 , Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 12, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 12, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 12 FB 0, Gir 1,2	Floor beam girder connection	No defects found	
4	Rolled	Panel 12 FB 1, Gir 1,2	Floor beam girder connection	No defects found	
4	Rolled	Panel 12 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found	
4	Rolled	Panel 12 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found	
4	Rolled	Panel 13 , Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 13, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 13, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 13 FB 0, Gir 1,2	Floor beam girder connection	No defects found	
4	Rolled	Panel 13 FB 1, Gir 1,2	Floor beam girder connection	No defects found	
4	Rolled	Panel 13 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found	

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26.1.10-Fatigue Prone Detail Report (continued)

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SPAN	Type of Member	Location	Type of Detail	Condition assessment & associated remarks	SKETCH/ PHOTO
4	Rolled	Panel 13 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found	
4	Rolled	Panel 14 , Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 14, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 14, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
4	Rolled	Panel 14 FB 0, Gir 1,2	Floor beam girder connection	No defects found	
4	Rolled	Panel 14 FB 1, Gir 1,2	Floor beam girder connection	No defects found	
4	Rolled	Panel 14 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found	
4	Rolled	Panel 14 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found	
5	Rolled	Panel 15 , Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 15, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 15, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 15 FB 0, Gir 1,2	Floor beam girder connection	No defects found	
5	Rolled	Panel 15 FB 1, Gir 1,2	Floor beam girder connection	No defects found	
5	Rolled	Panel 15 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found	
5	Rolled	Panel 15 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found	
5	Rolled	Panel 16 , Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 16, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 16, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	

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26.1.10-Fatigue Prone Detail Report (continued)

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SPAN	Type of Member	Location	Type of Detail	Condition assessment & associated remarks	SKETCH/ PHOTO
5	Rolled	Panel 16 FB 0, Gir 1,2	Floor beam girder connection	No defects found	
5	Rolled	Panel 16 FB 1, Gir 1,2	Floor beam girder connection	No defects found	
5	Rolled	Panel 16 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found	
5	Rolled	Panel 16 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found	
5	Rolled	Panel 17 , Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 17, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 17, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 17 FB 0, Gir 1,2	Floor beam girder connection	No defects found	
5	Rolled	Panel 17 FB 1, Gir 1,2	Floor beam girder connection	No defects found	
5	Rolled	Panel 17 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found	
5	Rolled	Panel 17 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found	
5	Rolled	Panel 18 , Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 18, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 18, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 18 FB 0, Gir 1,2	Floor beam girder connection	No defects found	
5	Rolled	Panel 18 FB 1, Gir 1,2	Floor beam girder connection	No defects found	
5	Rolled	Panel 18 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found	
5	Rolled	Panel 18 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found	

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26.1.10-Fatigue Prone Detail Report (continued)

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SPAN	Type of Member	Location	Type of Detail	Condition assessment & associated remarks	SKETCH/ PHOTO
5	Rolled	Panel 16 FB 0, Gir 1,2	Floor beam girder connection	No defects found	
5	Rolled	Panel 16 FB 1, Gir 1,2	Floor beam girder connection	No defects found	
5	Rolled	Panel 16 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found	
5	Rolled	Panel 16 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found	
5	Rolled	Panel 17 , Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 17, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 17, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 17 FB 0, Gir 1,2	Floor beam girder connection	No defects found	
5	Rolled	Panel 17 FB 1, Gir 1,2	Floor beam girder connection	No defects found	
5	Rolled	Panel 17 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found	
5	Rolled	Panel 17 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found	
5	Rolled	Panel 18 , Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 18, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 18, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found	
5	Rolled	Panel 18 FB 0, Gir 1,2	Floor beam girder connection	No defects found	
5	Rolled	Panel 18 FB 1, Gir 1,2	Floor beam girder connection	No defects found	
5	Rolled	Panel 18 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found	
5	Rolled	Panel 18 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found	

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26.1.10-Fatigue Prone Detail Report (continued)

SPAN	Type of Member	Location	Type of Detail	Condition assessment & associated remarks		SKETCH/ PHOTO
5	Rolled	Panel 19, Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found		
5	Rolled	Panel 19, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found		
5	Rolled	Panel 19, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found		
5	Rolled	Panel 19 FB 0, Gir 1,2	Floor beam girder connection	No defects found		
5	Rolled	Panel 19 FB 1, Gir 1,2	Floor beam girder connection	No defects found		
5	Rolled	Panel 19 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found		
5	Rolled	Panel 19 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found		
5	Rolled	Panel 20, Strg 1	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found		
5	Rolled	Panel 20, Strg 2	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found		
5	Rolled	Panel 20, Strg 3	Riveted stringer floor beam conn. (stringers bearing on floor beam)	No defects found		
5	Rolled	Panel 20 FB 0, Gir 1,2	Floor beam girder connection	No defects found		
5	Rolled	Panel 20 FB 1, Gir 1,2	Floor beam girder connection	No defects found		
5	Rolled	Panel 20 Diagonal 1	Diagonal bracing, welded gusset to girder web	No defects found		
5	Rolled	Panel 20 Diagonal 2	Diagonal bracing, welded gusset to girder web	No defects found		
Total floor beam stringer connections inspected = 120						
Total floor beam girder connections inspected = 42						
Total diagonal bracing gusset connections inspected=80						

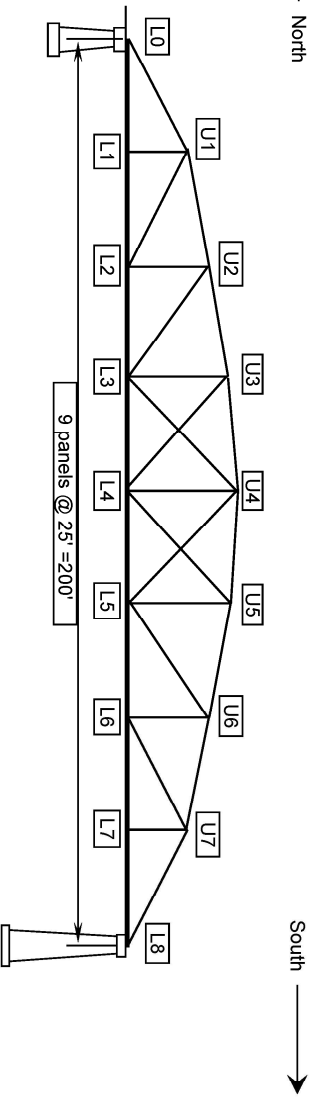
26.1.10-Fatigue Prone Detail Report (continued)



OREGON DEPARTMENT OF TRANSPORTATION
FRACTURE CRITICAL INSPECTION REPORT

Bridge Name : Rogue River		Owner : Jackson County - 029		Date of Inspection : 9/4/04	
Bridge No. : 06970		Year Built : 1950		Inspector Name & Number:	
Highway : 508		MP : 30.33		Insp Freq: 6 years	
Inspection Agency/Firm: HW Lochner					

← North



South →

Bottom Chord

Left

Stringers

Bottom Chord

Right

Panel 1

Stringer-Floor Beam Connections are FPD

Panel 8

Span 2

FB 0

FB 2

FB 6

FB 8

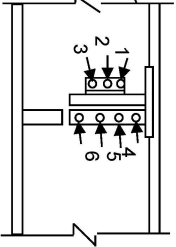
Note: This bridge contains a total of 192 riveted angle clip locations and 96 stringer coped corners. All FPD locations were inspected and the inspection findings are listed by member below. Access requires a snooper crane. Estimated time to inspect each FPD is 3 min. = 288 FPD x 3 min. = 12 hours



Stringer Coped Corner and angle clip



Stringer/floor beam conn



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26.1.10-Fatigue Prone Detail Report (continued)

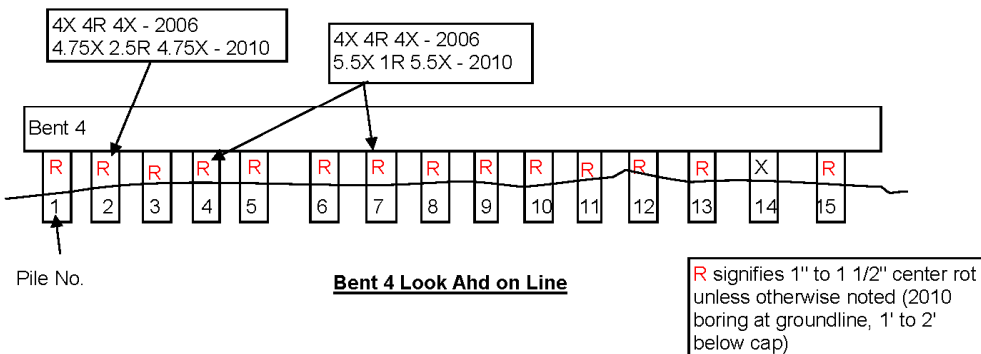
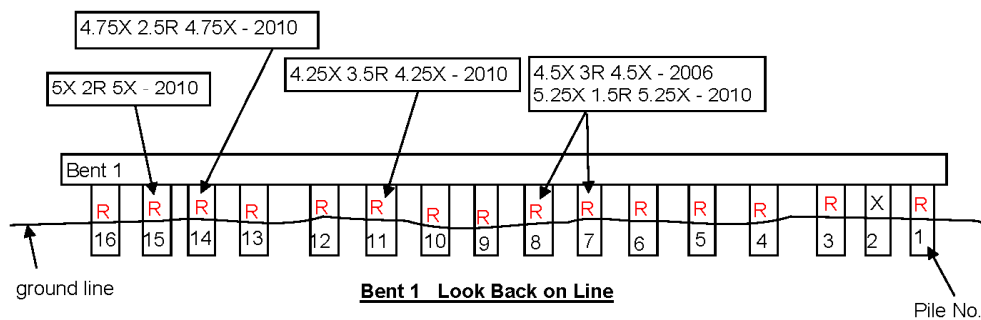
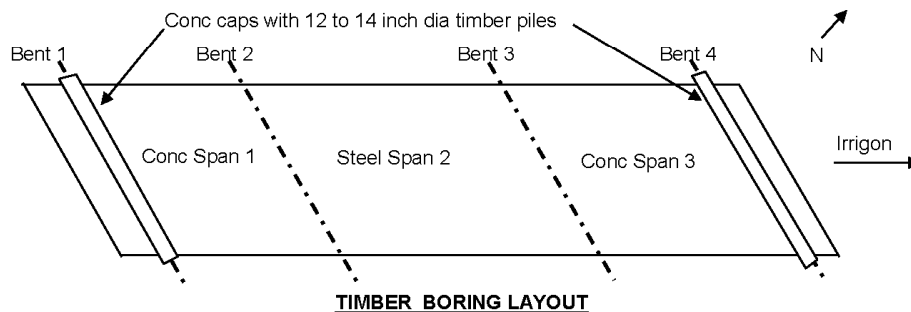
2	Rolled	Panel 3	Strg 6	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 4	Strg 1	Stringer floor beam connection, Angle clip, coped corner	Rivet 6 broken and 1 5/8" long crack in left angle clip @ FB 0 connection (9/2006)	Yes
					Rivet 4 & 5 broken in right angle clip angle, 1" long crack in left angle clip @ FB 0 connection (9/2000); No change (9/2006)	Yes
					1" long crack in left angle clip @ FB 1 connection (9/2000); No change (9/2006)	Yes
					No defects noted in other angle clips or coped corners @ FB 0 & 1 connections (9/2004). No change (9/2006)	
2	Rolled	Panel 4	FB 0 Strg 2	Stringer floor beam connection, Angle clip, coped corner	1 broken rivet in left angle clip (stop here)	Yes
2	Rolled	Panel 4	FB 1 Strg 2	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 4	Strg 3	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 4	Strg 4	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 4	Strg 5	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 4	Strg 6	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 5	Strg 1	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 5	Strg 2	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 5	Strg 3	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 5	Strg 4	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 5	Strg 5	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 5	Strg 6	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 6	Strg 1	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 6	Strg 2	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 6	Strg 3	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 6	Strg 4	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	

26.1.10-Fatigue Prone Detail Report (continued)

2	Rolled	Panel 6	Strg 5	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 6	Strg 6	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 7	Strg 1	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 7	Strg 2	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 7	Strg 3	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 7	Strg 4	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 7	Strg 5	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 7	Strg 6	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 8	Strg 1	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 8	Strg 2	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 8	Strg 3	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 8	Strg 4	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 8	Strg 5	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
2	Rolled	Panel 8	Strg 6	Stringer floor beam connection, Angle clip, coped corner	No defects noted in angle clips or coped corners.	
Total Number of Angle clips inspected =192						
Total Number of coped corners inspected =96						
Total Number of floor beam stringer connections inspected =96						

26.1.11-Timber Boring Diagrams

TIMBER BORING REPORT		Page 1 of 1	
Br# 08884 Hwy 2 over UPRR (Clarke) Hwy 2 MP 168.77			
Bridge Inspector:	K. McAlister	Dates of Timber Boring:	12/3/2003 6/21/2006 2/16/2010
Boring Crew:	Dist 12 Bridge Crew 12/3/2003 12/4/2003 K. McAlister (Resistograph) 2/16/2010	Report Date:	12/17/2003 Craig Sipp 11/29/2006 K. McAlister 1/25/2012 K. McAlister

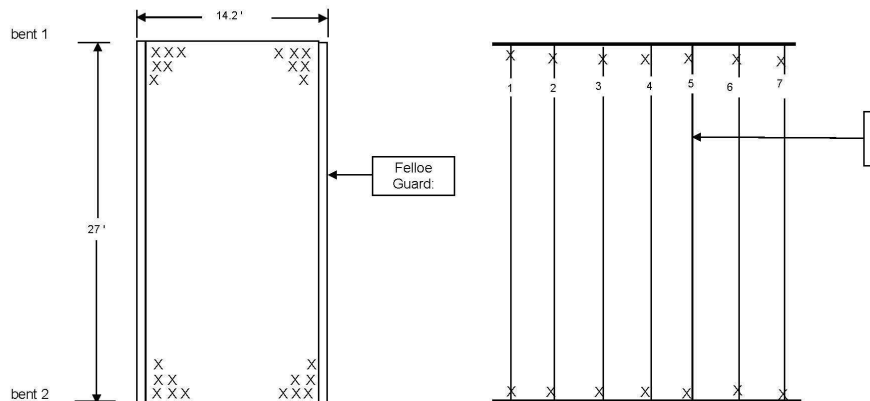


26.1.11-Timber Boring Diagrams (continued)

Timber Bore Report					
Beech Creek Bridge					
Br. # 0M041					
Hwy 28 MP 109.07					
Bridge Inspector:	Craig Sipp	Inspector #	S0029	Dates of Timber Boring:	4/6/1996
Boring Crew:	Ontario Bridge Crew				
Bridge Inspector:	Kelley McAlister	S0035		Dates of Timber Boring:	8/20/2007
				Electronic (Excel) Report:	Craig Sipp 8/16/01 K McAlister 1/8/08
MEMBER DIMENSIONS					
Caps: 2					
Bent	Material	Width	Depth	Length	(43) Main Span Type: Concrete
1	Timber	12"	12"	14'	(46) No. of Approach Spans: 0
2	Timber	12"	12"	14'	(49) Structure length: 27 Ft
					(48) Max. span length: 27 Ft
					(51) Bridge roadway width: 12.0 Ft
Piles: 14					
Bent	Material	Number	Size	Length	(52) Deck width,(o - o): 14.2 Ft
	On 4" X 12" X 2' Transverse Sills				(107) Deck structure type: Timber
					(108A) Deck surface type: 4" X 12" Planks
General Notes:					

X - 1996 BORING X or R - 2007 BORING USED RESISTOGRAPH TOOL FOR 2007 BORING

BRIDGE CLOSED IN SEPT 2007 BY DIST 14 DUE TO ROT AT BENT CAPS.



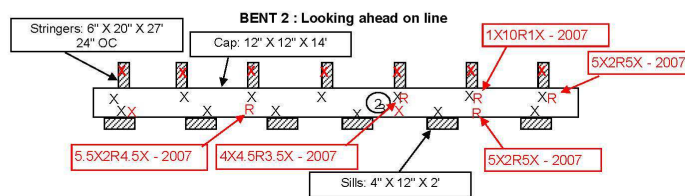
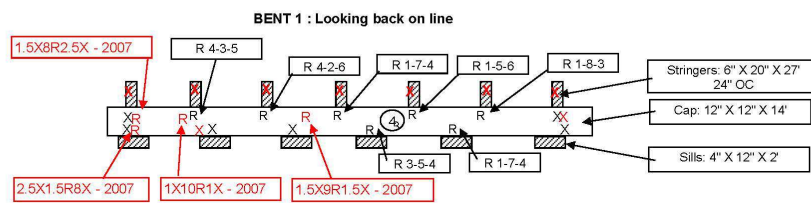
DECK

8/20/07 - Deck planks weathered and worn with many cracks and splits. One deck plank heavily split and rotted, debris between all planks. Felloe guard timbers split and rotted.

STRINGERS



26.1.11-Timber Boring Diagrams (continued)



26.1.12-Sign Support Structure Inspection Reports

OREGON DEPARTMENT OF TRANSPORTATION

Sign Support Structure Inspection Form

Structure Type:
Inspection Type:
Inspector:

Structure Name:
GPS Location:
Location Description:

Hwy
MP
Structure No.

FOUNDATION		SUBSTRUCTURE	
Footings Dimensions: Number of Anchor Bolts: Anchor Bolts Dia: Anchor Bolt Pattern: Bolt Circle Dimensions: Condition: (photo)	Base Plate Dimensions: Grout Pad (Y / N): Grout Pad Thickness: Leveling Nuts (Y / N) Washer # & Configuration:	Post Type: Post Section Type: Material Type: Number of Posts: Number of Verticals / Post: Condition: (photo)	Coating and Thickness: Post Member Sizes: Post Dimensions: Post Height: Rake (loaded):
Arm Type: Material Type: Section Type: Coating and Thickness: Length of Arm: Type of Arm to Post Connection: Arm to Post Connection Pattern: Arm / Bridge Member Sizes: Number of Arm / Bridge Chords (truss): Arm / Bridge Chord spacing (truss): Arm / Bridge Camber (loaded): Number of Signs: Minimum Vertical Roadway Clearance:		Size Legend(s) of Signs: (photo)	
TRAFFIC SAFETY		MAINTENANCE RECOMMENDATIONS	

26.1.13-Bridge Specific Job Hazard Assessments

Job/Jobsite Hazard Assessment Worksheet

Date of Assessment 06 / 01 / 2011				Assessment Conducted by: Bill Burns (503) 986-2659				Manager/ Supervisor: Gary Bowling (503) 986-3402			
Structure Name Mary's River				Employee(s) Performing Work Bill Burns , O.R.Vann							
Bridge Number 00706				Date of Work 06/ 14 / 2011							
Hwy 1-W NB		MP 84.14		Emergency Contact Station 2 by Radio or by Phone (503) 362-0457							
Type of Work: Bridge Inspection Fracture Critical				Emergency Dial 911							
INVENTORY: Mark each hazard YES or NO as a potential risk for the site and work defined above.											
YES	NO	## Equipment Hazards	YES	NO	## Utility Hazards	YES	NO	## Personal Hazards (Cont.)	YES	NO	## Environmental Hazards (Cont.)
X		11 Nearby Vehicular Traffic		X	23 Overhead Utility Contact	X		34 Slip/Trip/Fall Hazard		X	45 Open Trench /Entrapment
X		12 Heavy Equip. Operation		X	24 Underground Utility Contact.	X		35 Working near Traffic	X		46 Falling or Flying Debris
X		13 Heavy Equip. Back/Run-over		X	25 Exposed Utility Lines	X		36 Ladders/Elevated Platforms		X	47 Confined Space
	X	14 Heavy Equip. Tip-over /Roll-over		X	26 Panel/Breaker/ Riser Exposure	X		37 Fall Hazard/ Working at Heights		X	48 High Noise Level
X		15 Heavy Equip. Pinch Points		X	27 Exposed Electrical Wires	X		38 Working Over Water	X		49 Weather (Snow/Ice, cold, or heat)
	X	16 Equip. Contact with Overhead Wires		X	28 Bottled gasses			39 Other	X		50 Lighting (Darkness, Glare, Flash)
	X	17 Transport/ Launch Boat/ATV/Etc.			29 Other			40 Other	X		51 Vegetation Hazards (Poison/Thorns/Etc.
	X	18 Boat/Watercraft Operation			30 Other	YES	NO	## Environmental Hazards	X		52 Livestock, Wildlife, or Pet Hazards
	X	19 ATV/Snow-Cat/Etc. Operation	YES	NO	## Personal Hazards		X	41 Chemical Exposure	X		53 Other Transients
	X	20 Saw/Drill/Router/ Etc. Operation	X		31 Twisting/Bending/ Awkward Positions		X	42 Flammable Gasses	X		54 Other Bats, Rats
X		21 Other	X		32 Lifting and Carrying		X	43 Flammable Liquids			Insects
		22 Other	X		33 Loose or Unstable footing		X	44 Flammable Solids			
MITIGATIONS: For each hazard marked "YES", list the hazard # from above table in the left column and then describe the risk(s) identified. Across from each risk, list in the right column the steps taken/planned to mitigate that risk or safeguard the employee(s). Use additional sheets as needed.											
Identified Hazard						Mitigation/Safeguard					
# 11 : Vehicular Traffic						# 11 : Always wear PPE , Walk against traffic , Set signs as needed , use Roto Beams and flashers. Park where safe away from traffic.					
# 12 : Heavy Equipment Operation						# 12 : Use a spotter , Have communication , Stay clear.					
# 13 : Heavy Equip. Backing/ Run over						# 13 : Use a spotter , Have communication , Stay clear.					
15 : Heavy Equip. Pinch Points						# 15 : Stay clear of pinch points such as Booms , Never get between fixed objects and equipment , stay alert.					
# 21 : Hand Held Tools						# 21 : Keep all hand tools and reports in a safe location while in the bucket. Avoid dropping.					
# 31: Bending & Twisting						# 31 : Avoid over head hazards (Bumping head on underside of structure) Wear proper PPE . Avoid Over twisting and bending.					
# 32 : Carrying						# 32 : Keep your hands free of tools , Wear gloves. Share the load.					
# 33 : Loose or Unstable Footing						# 33 : Always watch your step , loose rock , Mud , Vines , Moss.					
# 34 : Slip Trip Fall Hazard						# 34 : Always watch your step , Limbs , Loose rock , Vines , Moss , Mud.					
# 35 : Working Near Traffic						# 35 : Always wear proper PPE , Have spotter , Set signs , Flashers , Roto Beams.					
# 37 : Fall Hazards Working at heights						# 36 : Wear proper Fall protection PPE , Always be tied off , Have rescue plan , Check equipment.					
# 38 : Working over water						# 37 : Wear proper Fall protection PPE , Always be tied off , Have rescue plan , Check Equipment.					
# 46 : Falling or Flying Debris						# 38 : Use proper Floatation devices , Have rescue plan.					
# 49 : Working in adverse weather Rain , snow , wind Ect.						# 46 : Be aware of traffic debris falling from structure , Loose limbs , Ect.					
# 50 : Lighting (Darkness, Glare , Flash)						# 49 : Wear proper clothing , Rain gear , warm clothing , Gloves , Head gear.					
# 51 : Vegetation Hazards (Poison Oak , Berry Vines , Ect.)						# 50 : Use flash lights when needed.					
# 52 : Livestock , Wildlife , or Pet Hazards						# 51 : Using hand tools to cut brush avoid cuts and scratches , Avoid Poison Oak. (Wash hands with Tech new to clean areas of exposure from poison oak)					
# 53 : Transients						# 52 : Watch out for Livestock , Wildlife or Pets (Report to proper personnel , Station 2).					
# 54 : Bats , Rats , Insects						# 53 : Watch out for Transient waste , litter, needles , Ect. (Call Station 2)					
						# 54 : Watch out for Bat droppings or dust , Pigeon waste , Biting Insects. Use proper PPE.					

26.1.13-Bridge Specific Job Hazard Assessments (continued)

Job/Jobsite Hazard Assessment Worksheet

Date of Assessment 10 / 01 / 2011				Assessment Conducted by: Bill Burns (503) 986-2659				Manager/ Supervisor Gary Bowling (503) 986-3402			
Structure Name Yaquina Bay Bridge				Employee(s) Performing Work Bill Burns , O.R.Vann							
Bridge Number 01820				Date of Work 10 / 20 / 2011							
Hwy 9 MP 141.68				Emergency Contact Station 2 by Radio or by Phone (503) 362-0457							
Type of Work Bridge Inspection				Emergency Dial 911							
INVENTORY: Mark each hazard YES or NO as a potential risk for the site and work defined above.											
YES	NO	## Equipment Hazards	YES	NO	## Utility Hazards	YES	NO	## Personal Hazards (Cont.)	YES	NO	## Environmental Hazards (Cont.)
X		11 Nearby Vehicular Traffic		X	23 Overhead Utility Contact	X		34 Slip/Trip/Fall Hazard		X	45 Open Trench /Entrapment
	X	12 Heavy Equip. Operation		X	24 Underground Utility Contact	X		35 Working near Traffic		X	46 Falling or Flying Debris
	X	13 Heavy Equip. Back/Run-over		X	25 Exposed Utility Lines		X	36 Ladders/Elevated Platforms		X	47 Confined Space
	X	14 Heavy Equip. Tip-over /Roll-over		X	26 Panel/Breaker/ Riser Exposure		X	37 Fall Hazard/ Working at Heights		X	48 High Noise Level
	X	15 Heavy Equip. Pinch Points		X	27 Exposed Electrical Wires		X	38 Working Over Water	X		49 Weather (Snow/Ice, cold, or heat)
	X	16 Equip. Contact with Overhead Wires		X	28 Bottled gasses	X		39 Other Wading	X		50 Lighting (Darkness, Glare, Flash)
	X	17 Transport/ Launch Boat/ATV/Etc.			29 Other			40 Other	X		51 Vegetation Hazards (Poison/Thorns/Etc.)
	X	18 Boat/Watercraft Operation			30 Other	YES	NO	## Environmental Hazards	X		52 Livestock, Wildlife, or Pet Hazards
	X	19 ATV/Snow-Cat/Etc. Operation	YES	NO	## Personal Hazards		X	41 Chemical Exposure			53 Other
	X	20 Saw/Drill/Router/ Etc. Operation	X		31 Twisting/Bending/ Awkward Positions		X	42 Flammable Gasses			54 Other
X		21 Other (Flash Lights		X	32 Lifting and Carrying		X	43 Flammable Liquids			
		22 Other	X		33 Loose or Unstable footing		X	44 Flammable Solids			
MITIGATIONS: For each hazard marked "YES", list the hazard # from above table in the left column and then describe the risk(s) identified. Across from each risk, list in the right column the steps taken/planned to mitigate that risk or safeguard the employee(s). Use additional sheets as needed.											
Identified Hazard						Mitigation/Safeguard					
# 11 : Vehicular Traffic # 21 : Flash Lights # 31 : Twisting / Bending / Awkward Positions # 33 : Loose or Unstable Footing # 34 : Slip , Trip , Fall Hazard # 35 : Working Near Traffic # 39 : Wading in Water # 49 : Weather Cold or Heat # 50 : Lighting (Darkness , Glare , Flash) # 51 : Vegetation Hazards (Poison Oak , Berry Vines , Etc # 52 : Livestock , Wildlife , Pet Hazards # 54 : Bats , Rats , Insects						# 11 : Always wear proper PPE , Walk against traffic , Set proper signing as needed , Use Roto beams and flashers. # 21 : Use caution While holding Flash lights , Take extra Batteries. # 31 : Avoid over head hazards (Bumping head on underside of structure) Wear proper PPE. Avoid over twisting and bending. # 33 : Always watch your step , Loose rock , Mud , Vines . # 34 : Always watch your step , slippery slopes ,Loose rock , Fallen Limbs , Mud , Vines. # 35 : Always wear proper PPE , Have spotter , Set Signs , Flashers and Roto Beams. # 39 : Wear proper rubber boots , Use walking stick , Gloves , Flash light. # 49 : Wear proper clothing. # 50 : Use Flash light as needed. # 51 : Use hand tools to cut brush avoid cuts and scratches , Avoid Poison Oak . (Wash hands with Technew and clean areas of exposure) . # 52 : Watch out for Livestock , Wildlife or Pets (Report to Station 2 by radio) # 54 : Watch out for Bat droppings or dust , Pigeon waste, Biting Insects.					

26.1.13-Bridge Specific Job Hazard Assessments (continued)

Job/Jobsite Hazard Assessment Worksheet

Date of Assessment: 9/15/2008		Assessment Conducted by: Jeff Swanstrom		Manager/ Supervisor: Gary Bowling							
Structure Name: Yaquina Bay Bridge		Employee(s): Jeff Swanstrom, Ivan Silbernagel, James Garrard, Mike Pulzone, Bill Burns, ONA Beach bridge crew personnel, bridge painting contractor Performing Work									
Bridge Number: 01820		Date of Work: 9/17, 9/18/2008									
Hwy: 009	MP: 141.68										
Type of Work: FC & FP inspection via climbing system											
INVENTORY: Mark each hazard YES or NO as a potential risk for the site and work defined above.											
YES	NO	## Equipment	YES	NO	## Utility Hazards	YES	NO	## Personal Hazards	YES	NO	## Environmental
X		11 Nearby		X	23 Overhead	X		34 Slip/Trip/Fall	X		45 Open manhole
X		12 Injury from		X	24 Gas lines	X		35 Working near Traffic		X	46 Falling or Flying
X		13 Faulty fall		X	25 Exposed Utility	X		36 Ladders/Elevated		X	47 Confined Space
X		14 Faulty climb gear			26 Panel/Breaker/	X		37 Fall Hazard/		X	48 High Noise Level
X		15 loose or damaged		X	27 Exposed Electrical	X		38 Working Over	X		49 Weather (Snow/Ice,
X		16 Faulty climbing			28 Other	X		39 communication loud		X	50 Lighting (Darkness,
X		17 Secure bridge			29 Other	X		40 Have adequate		X	51 Vegetation Hazards
X		18 Radio			30 Other	YES	NO	## Environmental		X	52 Livestock, Wildlife,
X		19 Rescue Equip.	YES	NO	## Personal		X	41 Chemical Exposure	X		53 Agreed weather
X		20 All personnel with	X		31 Twisting/Bending/		X	42 Flammable Gasses		X	54 Other
X		21 Workers needing		X	32 Lifting and Carrying		X	43 Flammable Liquids			
X		22 Fall Protect.& use	X		33 Loose or Unstable		X	44 Flammable Solids			
MITIGATIONS: For each hazard marked "YES", list the hazard # from above table in the left column and then describe the risk(s) identified. Across from each risk, list in the right column the steps taken/planned to mitigate that risk or safeguard the employee(s). Use additional sheets as needed.											
Identified Hazard						Mitigation/Safeguard					
11 Nearby Vehicular Traffic						11 bridge has sidewalks but watch for traffic at each end of the bridge and under each approach					
12 Injury from dropped tools						12 Make sure to wear hardhat and secure tools					
13 Faulty Fall Protection system						13 check fall protection system (anchorage, cable, supports, etc.)					
14 Faulty climbing gear, harness, lanyard						14 inspect harness, lanyard, d-ring straps before climbing					
15 Loose, damaged cleats on arch						15 look for signs of loose cleats by inspecting fasteners, misalignment of cleat members					
16 Faulty climbing apparatus						16 Check proper function of climbing apparatus before climbing					
17 Secure bridge ladders & platforms						17 Inspect permanent ladders and platforms for safety (fasteners, ladder rungs, etc.)					
18 Radio communication						18 Check to make sure radios operating properly					
19 Rescue Equipment						19 Make sure that proper rescue equipment is on hand and functioning properly					
20 All personnel with proper PPE						20 Make sure all inspectors/climbers have hardhats, gloves, boots with good grip, proper climbing gear, safety glasses, etc					
21 Workers needing rescue						21 Make sure inspectors aware of rescue plan, alert Coast Guard of presence on bridge					
22 Fall protection & use of climbing system						22 All workers should be trained in the use of the ariana climbing system					
31 Twisting/bending/awkward positions						31 Avoid excessive twisting or bending of body.					
33 Loose or unstable footing						33 When climbing on bridge surface or cleats be sure have stable footing before taking next step					
34 Slip/trip/fall/hazard & wet surface						34 Do not climb steel when excessively wet and be careful around wet bird dropping which can increase slip hazard					
35 Working near traffic						35 See hazard mitigation no. 11					
36 Ladders elevated platforms						36 make sure meet OSHA requirements when climbing ladders or on platforms					
37 Fall Hazard/ working at heights						37 Make certain all inspectors are connected to climbing system and tied off at all times when above OSHA regulation heights					
38 Working over water						38 Life vest not necessary if worker 100% tied off					
39 Communication in loud environment						39 Use radios or hand signals					
40 Have adequate water on site						40 have water at ends of climbing system or worker carries own water					
45 Open manhole						45 make sure any open manholes at deck surface are coned, sidewalk closed to pedestrians or manhole closed when not used					
49 Weather (snow, rain, heat, wind)						49 Avoid climbing when weather conditions harmful to good solid footing or balance					
50 Agreed weather related stop work						50 Discuss with group when weather conditions ie wet surface, wind will cause suspension of inspection work (either predetermined or via radio communication)					

26.1.14-Movable Drawbridge Inspection Report

**Movable Bridge Electrical / Mechanical Inspection Report
Oregon Department of Transportation
Bridge Engineering Section**

Bridge Type _____ Single Leaf Bascule _____ Bridge # _____ 0711 _____

Bridge Name _____ Lewis and Clark _____ Highway # _____ 105 _____

District _____ 1 _____ Date _____ 8-16-11 _____ M.P. _____ 4.78 _____

Inspectors _____ S.Lovejoy, N. Lung _____

Purpose of Inspection _____ Biannual Cursory Mechanical _____

Component Identification Coding

Group (M) Machinery	Group (S) Support Components	Group (E) Electrical Components
1. Open gears	1. Bearing plates and load shoes	1. Motors
2. Shafts	2. Span locks/ end jacks	2. Generators
3. Bearings	3. wedges	3. Transformers
4. Enclosed gear boxes	4. Trunnions	4. Circuit breakers
5. Couplings	5. Buffers	5. Brakes
6. Sheaves / operating drums	6. Counterweights	6. Motor controllers
7. Hydraulics	7. Wire ropes	7. Limit switches
8. Lubrication	8. Balance wheels	8. Conductors
9. Auxiliary power	9. FRP deck and wear surface	9. Lighting
10. Brakes		10. PLC
11. Drive performance testing		11. Instrumentation

Remarks (reference group and component number).

M1: Open gears were rehabbed in 2002 with the exception of the outer reduction bull gears and racks. Racks are very worn and will need to be rehabbed in the next 5 to 10 years. Bull gears show several large casting cracks that do not appear to be growing but

26.1.14-Movable Drawbridge Inspection Report (continued)

should be replaced with rack in time. All other open gears are in good condition, running smooth and quiet and are well lubricated.

M2: Shafts were aligned in 2002 rehab and appear to be running true.

M3: All bearing were rehabbed and align bored in the 2002 contract. They appear well lubricated.

M5: The upstream main drive shaft coupling was replaced several times while trying to time the two main drive pinions during the 2002 rehab.

M7: The hydraulic power unit for the end barriers is in good condition. The hydraulic cylinders need to be painted ASAP before the main tension rods loose section or suffer stress corrosion cracking. No leaks noted.

M8: Lubrication on all machinery is excellent.

M10: The drum brakes were replaced with disk brakes and appear to be in good adjustment with minor wear on disks and pads.

M11: The span balance was checked using both % full load torque on the motors and a drift test at mid-open position. The span requires 20% full load torque to open and close and the drift test at mid-open remained stationary with the brakes released indicating neutral balance.

S1: The front live load shoes are in uniform contact.

S2: The end jacks are equally engaged supporting the counterweight against live load.

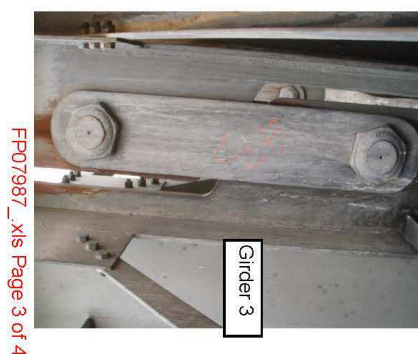
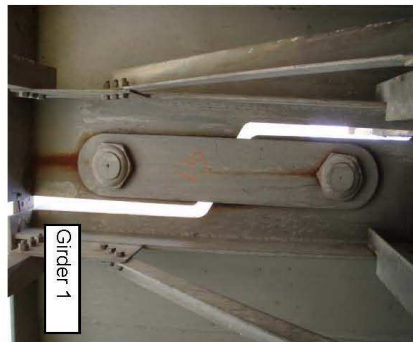
S4: Trunnions were UT checked circa 2004 with no defect indications noted.

S9: WJE Inc. was contracted to inspect and assess the remaining life of the FRP deck and wear surface which replaced the timber asphalt deck in 2002. The final report has yet to be issued but it was the general consensus that the FRP deck is in good condition with only minor signs of degradation. The wearing surface is at the end of its service life and will need to be replaced with a year to two maximum time.

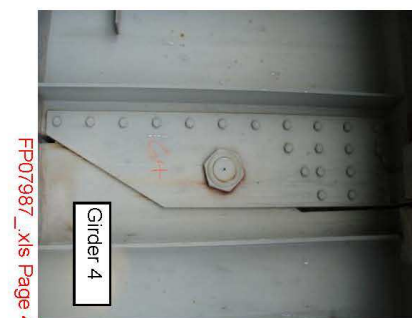
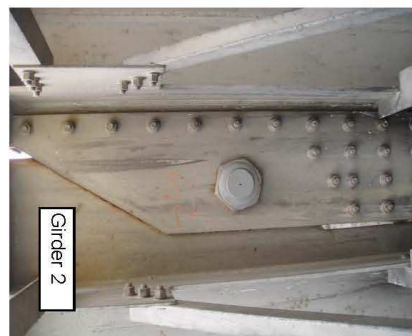
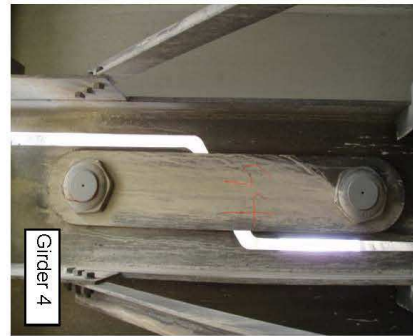
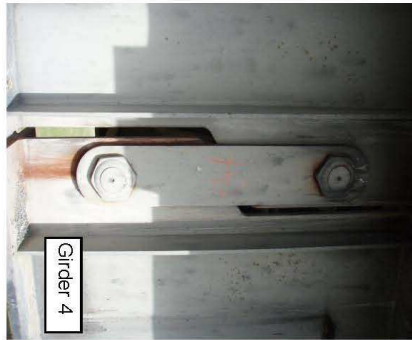
26.1.15-Pin & Hanger Inspection Report

OREGON DEPARTMENT OF TRANSPORTATION FATIGUE PRONE INSPECTION REPORT			
Bridge Name: Pritchard Creek and UPRR, Hwy 6 WB	Owner: State	Bridge No. 07987	
District: 13	Year Built: 1966	Highway: 6 WB	
Bridge Type: Steel Multi-Girder	MP: 325.31	Freq. 6 yrs.	
Agency Inspected By: ODOT	Date of Inspection: 4/12/11	Report Date: 12/8/11	
FP07987.xls Page 1 of 4	Insp Name and No.: Kelley McAlister S0035		
Fatigue Prone Details - Pins and Pin and Hanger Assemblies (Cat. E)			

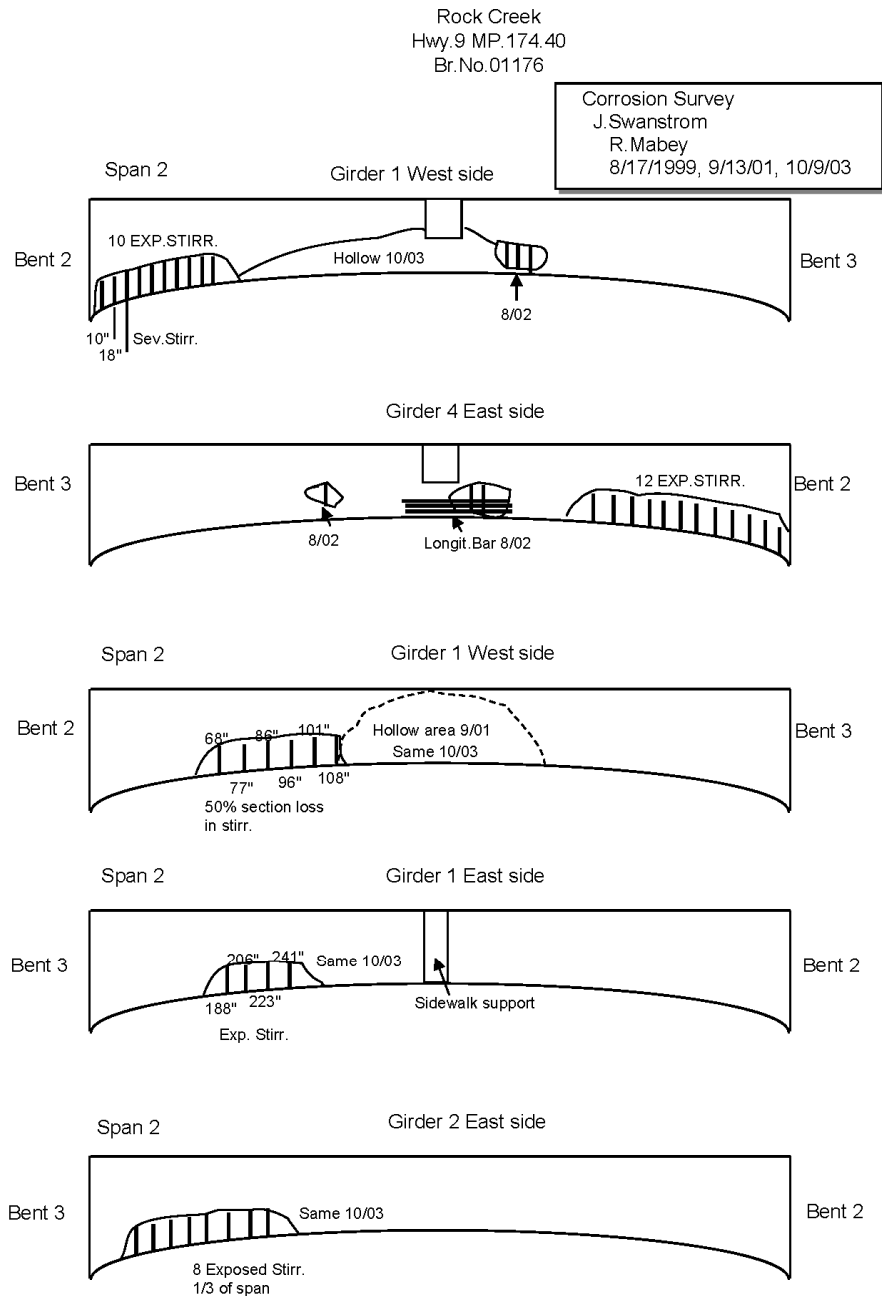
26.1.15-Pin & Hanger Inspection Report (continued)



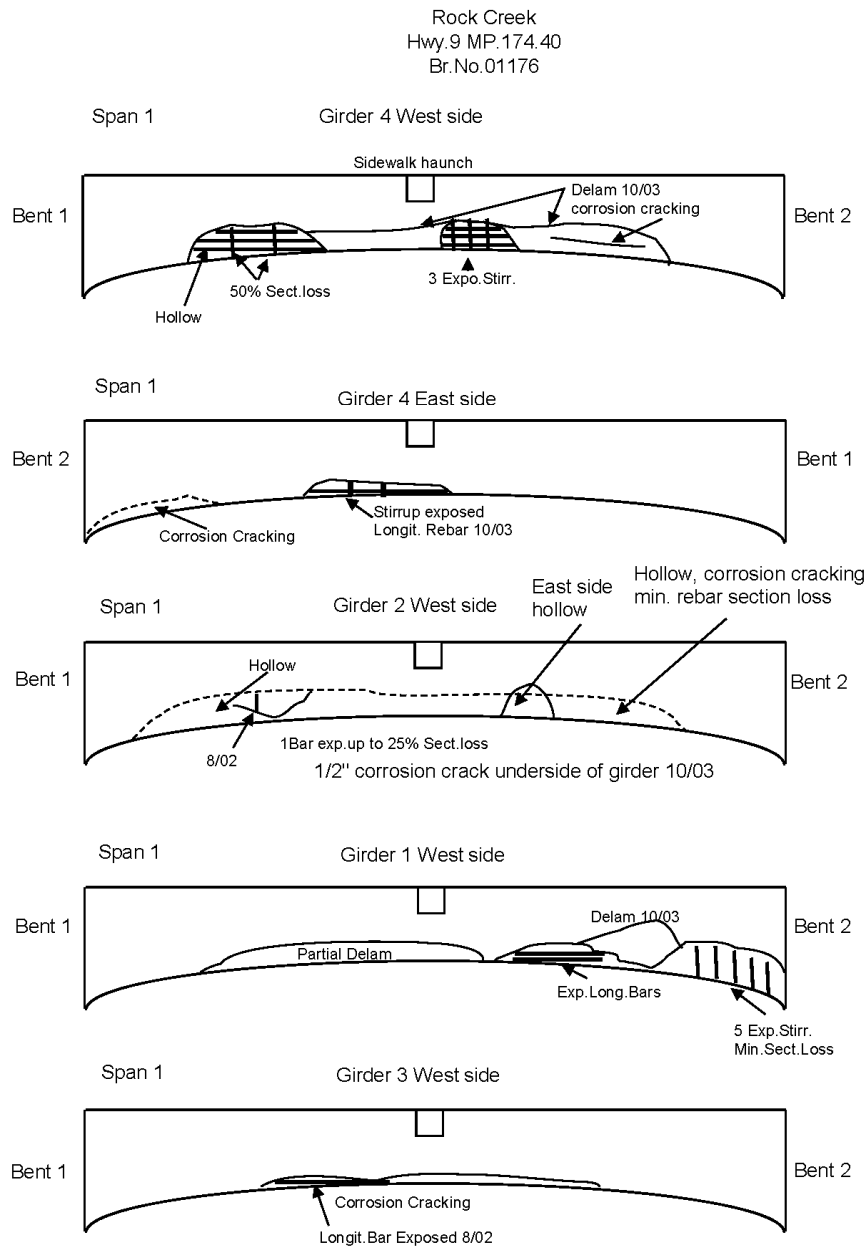
26.1.15-Pin & Hanger Inspection Report (continued)



26.1.16-Corrosion Inspection Report

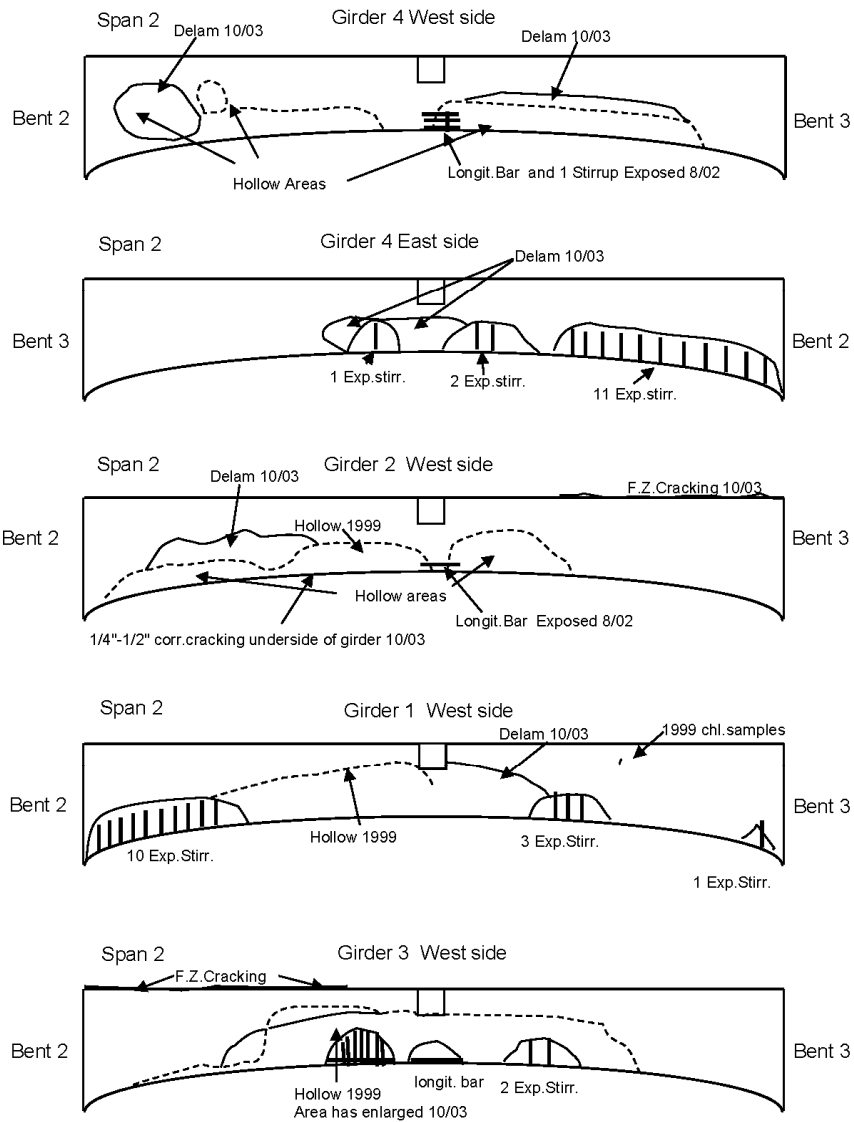


26.1.16-Corrosion Inspection Report (continued)



26.1.16-Corrosion Inspection Report (continued)

Rock Creek
Hwy.9 MP.174.40
Br.No.01176



26.1.17-Concrete Shear Crack Diagrams

Bridge Name: Marys River (Fourth St.) Bridge

Inspector 1: Jeff Swanson

Inspector 2: Tim Good

No. of Crack Gauges Installed:

Gauge Location

Date Installed

Initial Gauge Reading

Br. No.

Hwy No.

MP

Date:

07019

01W

84.21

1/9/02

1/9/02

0.020"

(see sketch 5/30/03)

Concrete Shear Cracks

SUMMARY:

- Bent 1 Crossbeam - 0.025" shear crack

Bent 2 Crossbeam - 0.040" shear crack

Bent 3 Crossbeam - 0.025" shear crack

Bent 4 Crossbeam - 0.060" shear crack

Bent 5 Crossbeam - 0.060" shear crack

Bent 6 Crossbeam - 0.030" shear crack

Bent 7 Crossbeam - 0.040" shear crack

Bent 8 Crossbeam - 0.030" shear crack

Bent 9 Crossbeam - 0.030" shear crack
- Span 4, Girder 3 - 0.020"

Span 4, Girder 4 - 0.020"

Span 4, Girder 5 - 0.016"

Span 4, Girder 6 - 0.020"

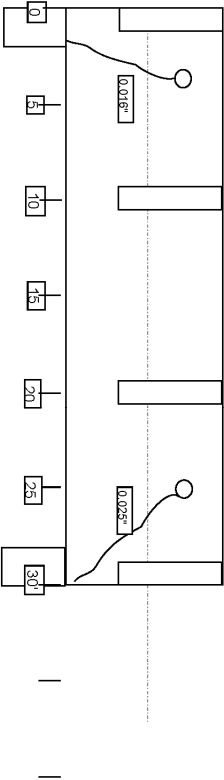
Span 5, Girder 1 - 0.016"

Span 5, Girder 2 - 0.016"

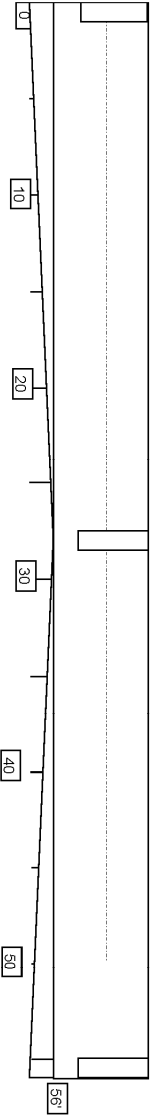
Span 5, Girder 3 - 0.025"

Span 5, Girder 4 - 0.016"

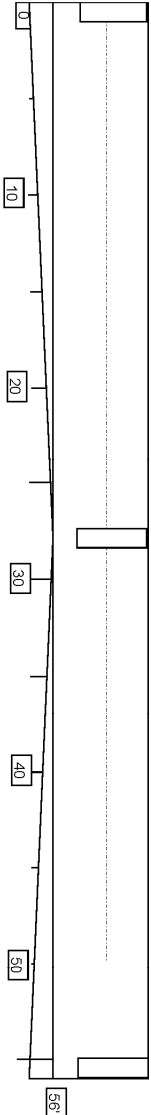
Bent 1, Cap, Side, Span 1



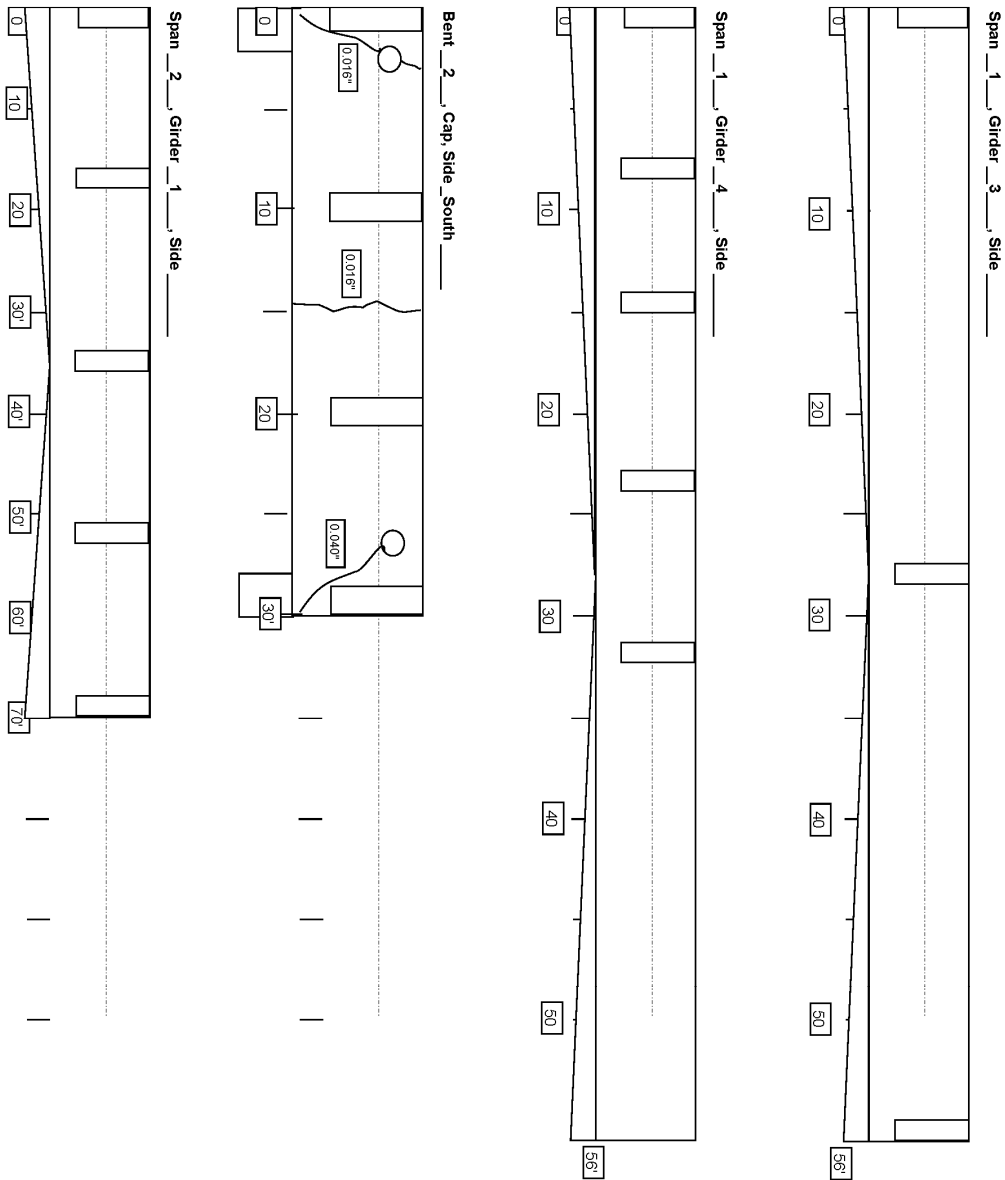
Span 1, Girder 1, Side



Span 1, Girder 2, Side



26.1.17-Concrete Shear Crack Diagrams (continued)



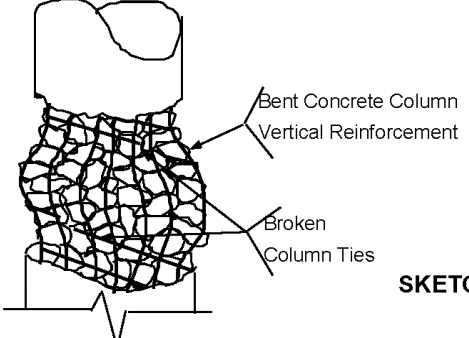
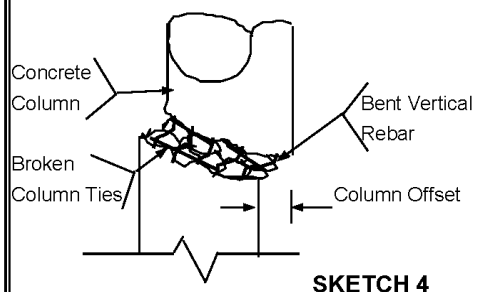
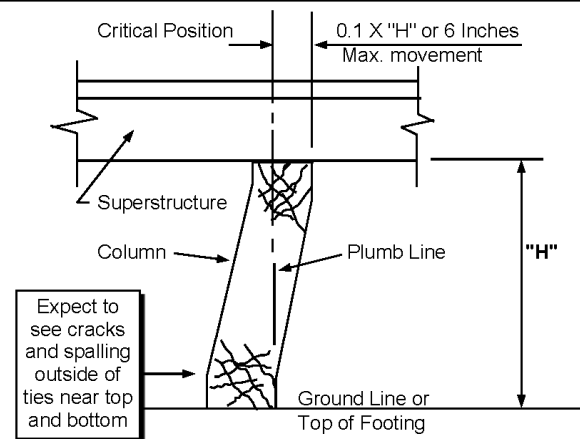
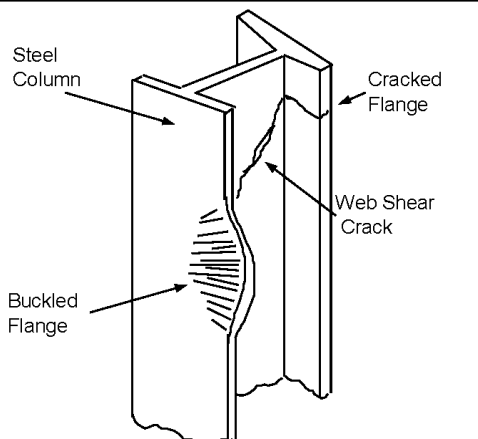
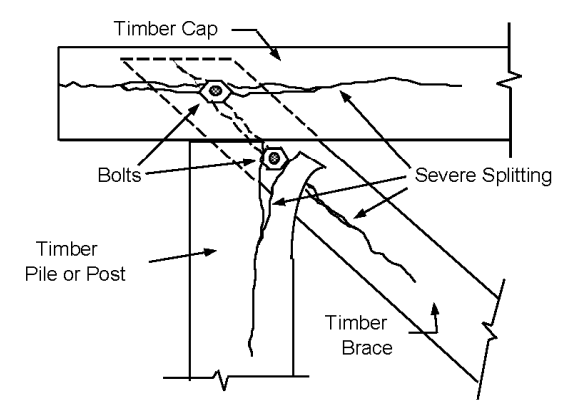
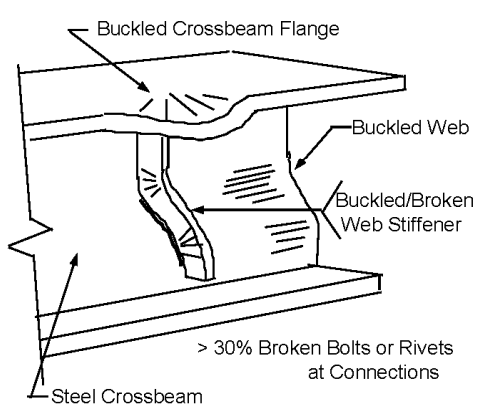
26.1.18-High Water Inspection Report

OREGON DEPARTMENT OF TRANSPORTATION Incident Report (Flood Inspection) (Date: _____)	
Agency: _____ Bridge Owner: _____ Bridge Name: _____ Signature of Inspector(s): _____	Bridge No: _____ Hwy No: _____ MP: _____
Stream Cross Section	
<u>Settlement?</u> - Railing - Curb - Member Cracking? <u>Safety Concerns?</u> - Approach Shoulder - Embankment Erosion - Other	(sketch deficiencies)
Drift	
Amount on Bridge: Type and Size: Photos Taken?	(sketch)
High Water Mark	
<u>Location on Bridge</u> - Upstream - Downstream Water Depth overtop Br: Water Depth overtop Appr:	(sketch)
Angle of Flow	
(sketch)	
Installed Scour Countermeasures	
Type Present: Sustain Damage? Photos Taken?	(sketch)
Maintenance Recommendations	

26.1.19-Earthquake Damage Inspection Report

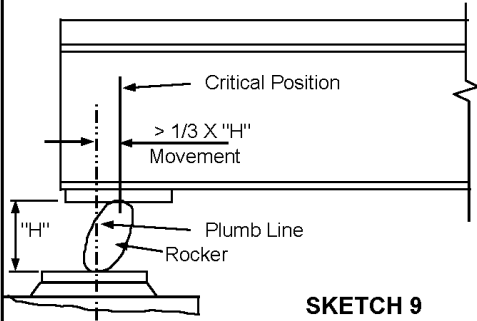
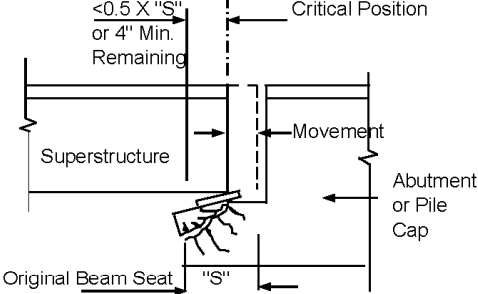
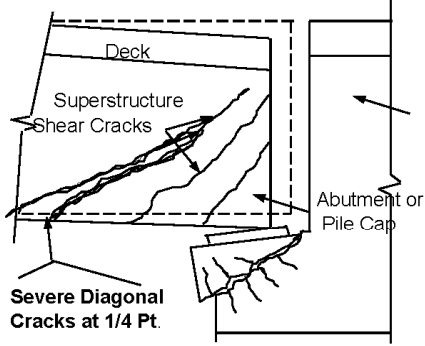
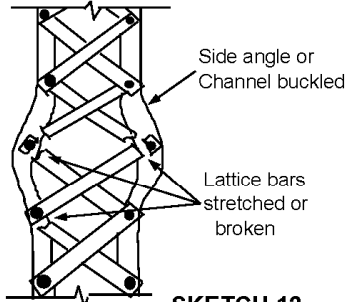
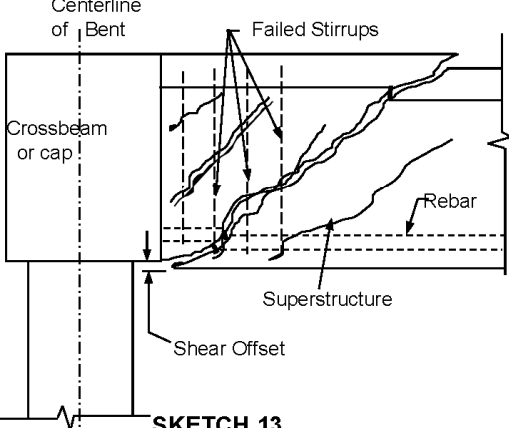
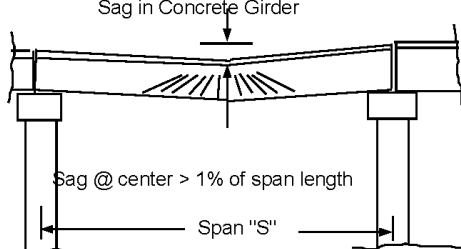
OREGON DEPARTMENT OF TRANSPORTATION Earthquake Damage Assessment Report Form (Date: _____ Time: _____)		
Agency: _____	Bridge Owner: _____	Bridge No. _____
Bridge Name: _____	Hwy No. _____	
Name of Inspector(s) _____	MP _____	
Contact # (radio, cell, pager): _____	Utilities ? _____	Inspection Level: _____
INSTRUCTIONS:		
1.) If ANY of the following deficiencies would possibly warrant an immediate closing of the bridge. 2.) Notify the incident command center or field office of the bridge condition and the actions taken. (Report: Inspection level; Action taken; Deficiency Sketch #; deficiency meas., damage location, and contact #) 3.) Mark the bridge parapet or approach guardrail accordingly. 4.) Fill out the Report Heading and Circle the action and the deficiencies found on the bridge. 5.) Continue on with your assigned damage assessment itinerary. 6.) Upon returning to your office, forward all report forms to the designated bridge inspector and/or ODOT Bridge Section.		
<i>Note 1: If the bridge appears hazardous and over another roadway, the roadway below should be closed.</i> <i>Note 2: Do not open a drawbridge until it has been thoroughly inspected by a qualified bridge inspector.</i>		
1. CLOSE. SHORING NOT FEASIBLE ----- Bridge is collapsed or impassible. Close to all traffic.	2. CLOSE. SHORE TO OPEN OR PARTIAL OPEN ----- Damage is serious. Possible partial opening or Shoring might allow full re-opening.	3. OPEN ----- Based on inspection, the bridge should remain open.
HORIZONTAL & VERTICAL ALIGNMENT		
Seal Width Edm Version (5/1/97) SKETCH 1	SKETCH 2	

26.1.19-Earthquake Damage Inspection Report (continued)

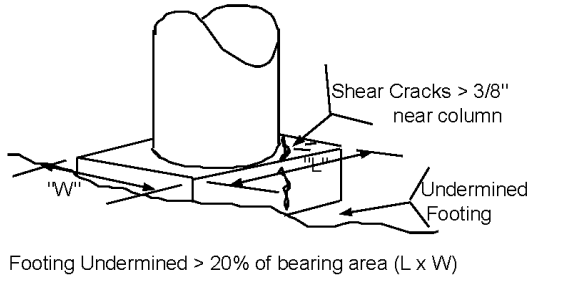
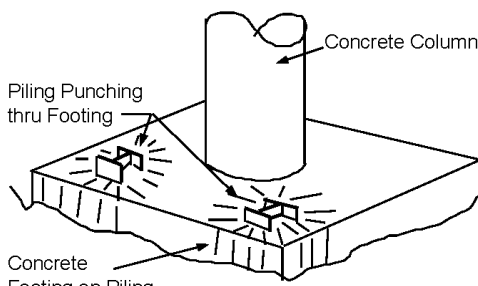
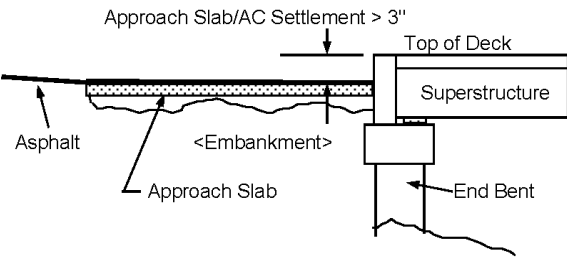
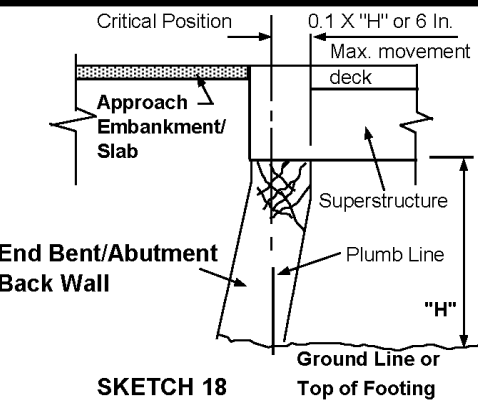
COLUMNS	
 SKETCH 3	 SKETCH 4
 SKETCH 5	 SKETCH 6
CROSSBEAMS	
 SKETCH 7	 SKETCH 8

Form Version (5/1/97)

26.1.19-Earthquake Damage Inspection Report (continued)

BEARINGS	
 SKETCH 9	 SKETCH 10
SUPERSTRUCTURE	
 SKETCH 11	 SKETCH 12
 SKETCH 13	 SKETCH 14

26.1.19-Earthquake Damage Inspection Report (continued)

FOOTINGS	
 SKETCH 15	 SKETCH 16
APPROACHES	
 SKETCH 17	 SKETCH 18
OTHER DEFICIENCIES (sketch)	

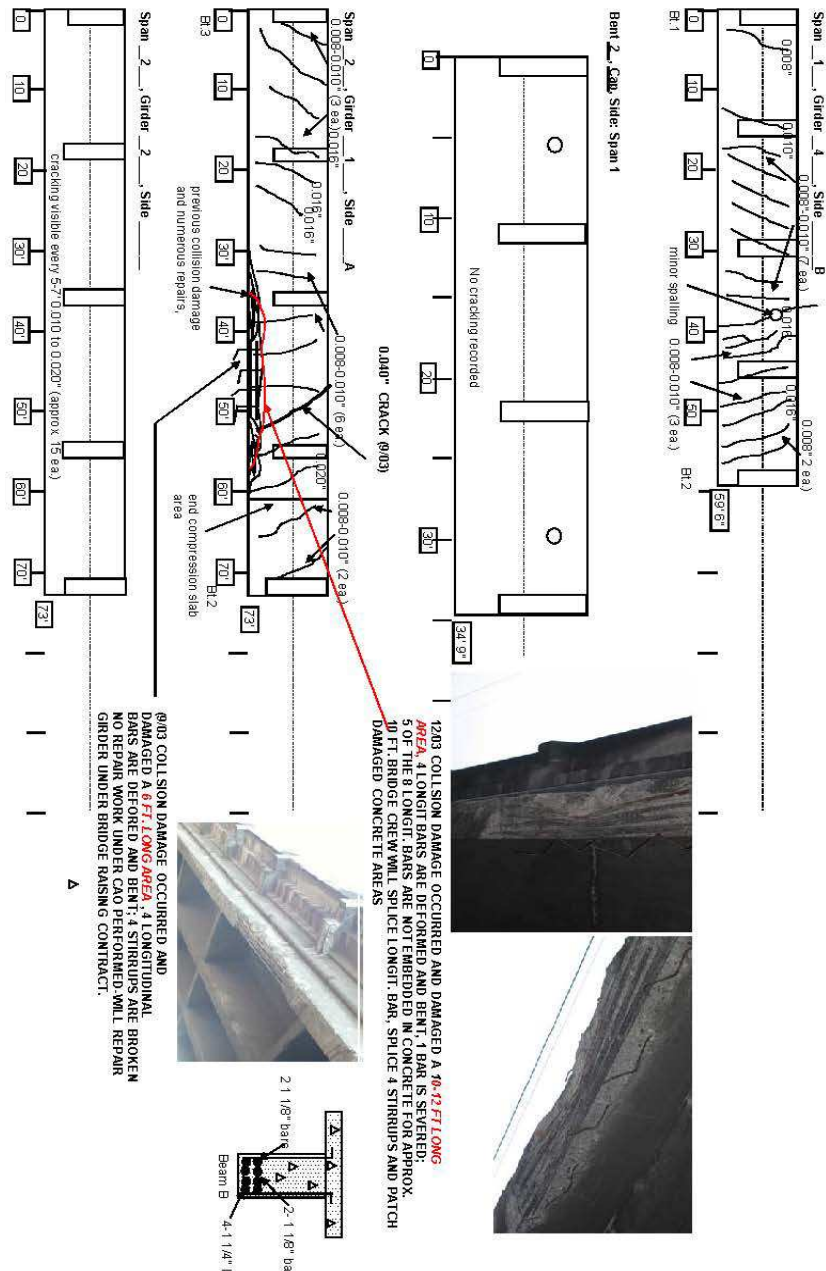
26.1.19-Earthquake Damage Inspection Report (continued)

[illegible]

26.1.20-Quality Assurance Review Report

ODOT Bridge Inspection QA Review							
Bridge Name	Insp Area		Bridge Owner		Br. No.	Hwy No.	MP
Agency / Consultant	Last Routine Insp Date	Prev Insp Date	Last FC Insp Date	Prev Insp Date	Last UW Insp Date	Prev Insp Date	Date
Last Routine Insp Date	Reviewers	Inspector	Deck Condition (58)	Reviewers	Inspector	Deficiency Status:	
WS Depth			Superstructure Condition (59)				
Latitude (16)			Substructure Condition (60)				
Longitude (17)			Channel & Channel Condition (61)				
Lanes On / Under (28)			Culvert Condition (62)				
Appr Roadway Width (32):			Temporary Repair (103)				
Safety Features (36)			Wearing Surface Type (108)				
Structure Status (41)			Scour Code (113)				
Main Span Type (43)			FC Insp (92a)				
Appr Span Type (44)			UW Insp (92b)				
Bridge Roadway Width (51):			Special Insp (92c)				
Vertical Clear over Deck (53):			Load Rating Needs Review?				
Bridge Posting (70)			Remarks / Maint. Recomm Adequate?				
Waterway Adequacy (71)			Supplemental Report Info?				
Appr Roadway Alignment (72):			JHA?				
On / Off System (104)							

26.1.21-Collision Damage Report



26.1.22-Bridge Record of Critical Finding

Bridge Record of Critical Findings

Bridge Name: Santiam River, Hwy 164		Bridge Owner: ODOT																									
Bridge Number: 1582		Location: Hwy 164 MP 6.27																									
Date:	Contacted (Name):	Business Phone:	Cell Phone: Email Address:																								
5/18/2012	Orren Vann	503-986-5760	Orren.R.VANN@odot.state.or.us																								
5/18/2012	Al Heyn	503-986-2774	Al.H.HEYN@odot.state.or.us																								
5/18/2012	Joe Squire	541-757-4211	Joe.SQUIRE@odot.state.or.us																								
5/18/2012	Bruce Johnson	503-986-3344	Bruce.V.JOHNSON@odot.state.or.us																								
5/18/2012	Bernie Kleutsch	503-986-2646	Bernard.D.KLEUTSCH@odot.state.or.us																								
Problem (Brief Statement): On May 18, 2012, Region 2 Dispatch was notified that the West end deck span no. 4 (Arch span no. 3) of the Jefferson historic bridge had settled 2 to 4 inches. District 4 Maintenance crews responded and closed the bridge. The Assistant Region 2 Bridge Inspector along with the Albany bridge crew, Region 2 Tech Center, District 4 Manager, and State Bridge Engineer responded to inspect the damage. Their assessment indicated that some of the Arch hanger steel (4-1 1/8" sq. bars & 2-1" sq. bars) supporting floor beam no. 9 (West end Arch span no. 3) had section loss or were severed in four locations causing the floor beam and deck to settle. They determined that the bridge was not capable of sustaining traffic without shoring.																											
Action Recommended: Provide shoring to support floor beam no.9 (West end of Arch span no. 3); remove concrete to check condition of remaining hanger steel at each end of the Arch spans. Load rate the bridge based upon the condition of the hanger steel;																											
Action Taken (By Bridge Owner): Hamilton Construction Co. was hired and erected shoring to support the deck and floor beam no. 9 (West end of Arch span no. 3); Concrete was removed at the ends of the Arch spans to inspect the hanger steel. At the East end of Arch span no. 1 Inspectors found one severed hanger bar and up to 50% section loss in the remaining bars.																											
Implemented Operational Restrictions: ODOT Load Raters determined that until the bridge is repaired or additional shoring is provided the bridge should be restricted to 20 tons for Type 3 vehicles, 31 tons for Type 3S2 vehicles and 34 tons for Type 3-3 vehicles. The bridge should be restricted for all Continuous Trip Permit loads and for Single Trip Permit loads.																											
Name: Jon Rooper, Load Rating Engr.		Signature: Date:																									
Follow-up Action / Inspection: Monitor the condition of the remaining hanger bars at each end of the Arch spans (especially East end of Arch Span no. 1) and the shoring at the West end of Arch span no. 3, until a permanent repair is completed over the next few months.																											
Name: Bill Burns, Reg 2 Bridge Insp		Signature: Date:																									
Name: Orren Vann, Asst. Reg 2 Br Insp		Signature: Date:																									
Routing: <table border="0"> <tr> <td>Name:</td> <td>Title:</td> <td>Signature:</td> <td>Follow-up Signature (if required)</td> </tr> <tr> <td>1.)</td> <td>Orren Vann</td> <td></td> <td></td> </tr> <tr> <td>2.)</td> <td>Al Heyn</td> <td></td> <td></td> </tr> <tr> <td>3.)</td> <td>Joe Squire</td> <td></td> <td></td> </tr> <tr> <td>4.)</td> <td>Bruce Johnson</td> <td></td> <td></td> </tr> <tr> <td>5.)</td> <td>Bernie Kleutsch</td> <td></td> <td></td> </tr> </table>				Name:	Title:	Signature:	Follow-up Signature (if required)	1.)	Orren Vann			2.)	Al Heyn			3.)	Joe Squire			4.)	Bruce Johnson			5.)	Bernie Kleutsch		
Name:	Title:	Signature:	Follow-up Signature (if required)																								
1.)	Orren Vann																										
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CHAPTER 27: BRIDGE MANAGEMENT SYSTEM

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Chapter 27:

Bridge Management

27.1—BRIDGE MANAGEMENT

State DOT's generally have a mission statement or other document that sets the direction to be followed in establishing and accomplishing their objectives. This mission statement may include planning, developing, operating, and maintaining a safe, cost-effective, and efficient statewide system of transportation facilities, or simply the goal to protecting the public's investment in transportation.

Bridges are an important part of the transportation system and investment because of their cost and potential impact on facility use. The management decisions necessary for the bridge portion of the system are unique and require some special considerations. These considerations generally relate to managing the bridge inventory so that its condition remains the same or improves with time while the minimum needs of the public are met or exceeded. To this end, it is necessary to allocate dedicated budget and personnel resources and establish minimum performance criteria to ensure uninterrupted use of these critical transportation facilities for the mobility of people and goods. The established performance criteria will have effects in several areas, including budget activities, design, construction, and maintenance.

Transportation program needs at all levels of government generally exceed the available funding by a large margin. Management must therefore review critically all actions necessary to achieve its minimum objectives and allocate the available funds cost-effectively. The bridge program must compete with all other funding needs. The shortfall of fund reinforces the requirement for management to base its funding allocation decisions on accurate and current information. This requirement is compounded by the increasing trend to incorporate participation of local citizens in project development, which can result in additional costs.

To help management in its decision making and allocation of resources, a good database with continuous updating is necessary. The compilation of such a database and the identification of needed bridge work begin with bridge inspection. Today's bridge inspection programs are large in scope, well organized, and professionally managed. The data collected can consist of more than 400 data items per bridge. These data provide critical information for decisions that result in a mix of preventive maintenance, repair, rehabilitation, replacement, and other actions over the life of the bridge. Bridges can be identified as functionally obsolete or structurally deficient so that appropriate actions can be planned to reduce the deficiencies and their impact on the usefulness of the transportation system, especially for critical facilities. Some states have established policies that limit the time allowed to mitigate a structurally deficient bridge once it has been classified.

Most states have in place or are developing a bridge management program to provide a means of evaluating bridge data and reporting critical trends. Because the databases are so large, it has been necessary to develop automation tools to help in sorting, compiling, reporting, and analyzing the data. The more widely used tools are the PONTIS and BRIDGIT software programs. Various specific state programs have been developed as well. With such automation tools, numerous combinations of parameters can be used for comparison and evaluation of the bridge data.

One type of information that can and should be obtained from the data is performance information relative to bridge types, component types, materials, and construction practices. This information can be used to make better choices in design, materials, and construction methods that will give structures longer service lives and the lowest life-cycle costs. The strategy of management should be to leverage advances in material science, design practices, and construction methods, along with an aggressive maintenance program, to extend the useful bridge service life, this minimizing the need to replace many bridges within a short time. There is also a trend today toward developing major bridge projects for a longer service life by using advanced design and construction practices and high performance materials.

Other issues that are becoming critical in bridge type selection are construction time and impact on the public during construction. Although these are short-term issues with respect to the bridge service life, they can have a significant impact on costs. The public is demanding reduced construction times and fewer impacts on businesses, adjacent landowners, and motorists. Meeting these demands requires evaluating bridge concepts that involve quick construction with minimum impact on the motoring public, such as off-site prefabrication and quick field erection. As a result, the desire to use other structural concepts based on long-term performance may be overridden.

Maintenance of bridges is a major concern for management because of the long-term impact on the budget and operation of the facilities. The overall objective of bridge maintenance is the safety and preservation of existing bridges. Maintenance and timely repair activities keep bridges in good condition, avoid more expensive repair or replacement costs in the future, and ensure that the bridges are safe for use by the public. However, the conduct of maintenance activity according to past practices will not keep pace with growing needs. The average age and number of bridges are increasing, resulting in more maintenance demand and cost. Accordingly, management must identify new means of making better use of the available resources.

In summary, the issues raised above reflect the complexity of the bridge program and its continuing challenges for management. The bridge program involves several disciplines within a transportation department that must work as a team so that decisions will be made with the objective of ensuring that all bridges will serve the needs of the public at the lowest possible cost.

The “National Highway System” (NHS) bill of 1995, required each state to **manage the bridges on all NHS Highways, with a comprehensive Bridge Management System (BMS)**, which was required to be fully implemented by October 1998. However, this requirement was tempered to strongly encouraged to implement.

NCHRP Report 300, on Bridge Management Systems, defines the basic concepts of such a system. “A BMS is a rational and systematic approach to organizing and carrying out the activities related to planning, designing, constructing, maintaining, rehabilitating, and replacing bridges vital to the transportation infrastructure. The BMS should assist decision-makers to select optimum cost-effective alternatives needed to achieve desired levels of service within the allocated funds and to identify future funding requirements. The concepts can be implemented in many ways, but should include, in some format, the following: a data base; network level maintenance, rehabilitation, and replacement selection procedures; maintenance scheduling; capability to analyze historical data; and a system for generating standard and customized reports.”

To comply with this stipulation, in 1992, ODOT, decided to adopt the “PONTIS” Bridge Management System (“PONTIS” being the Latin word for “bridge”). This program was adopted because it was being supported by AASHTO, and our neighboring states also selected this management system. Usage of the PONTIS program required that we implement a quantified element level 1-5 condition rating scheme in addition to the NBI 9 - 0 rating scheme. To accurately inspect a bridge using the ELEMENT LEVEL condition rating criteria, the inspector must:

- identify all of the elements present on the bridge
- estimate the total quantity of each element
- provide the correct units for each element
- put the appropriate quantity for each element in each condition state

The new element level coding criteria typically follows these basic points:

- Condition codes are based on condition at which actions are required.
- Elements can be split up, if portions are in different conditions. This means that both severity and extent of deterioration can be recorded. By recording both severity and extent of deterioration, we can identify proper actions to recommend for each element, and refine the deterioration rates that are used by the PONTIS BMS to determine the best actions to take.
- An element has 4 different condition codes, where 1 is always the best and 4 being the worst.
- Defect flags were established to assist the inspector better determine the condition of the bridge by providing more detailed information when there are multiple distresses possible on an element and to point to potential problems that are not identified in the element condition code language. These noted deficiencies do not fit the standard deterioration model used by PONTIS.

27.1.1—Software Programs

Bridge Management decisions are currently made using priority ranking procedures or rating formulas. For example, federal funding eligibility for bridges is determined on the basis of the sufficiency rating, which is calculated using information from the National Bridge Inventory (NBI). This rating combines information reflecting the structural adequacy of the bridge and the associated effect on public safety; the serviceability of the bridge, and whether the structure adequately services user demands or is functionally obsolete; and how essential or important the bridge is to the traveling public.

The ratings are determined by means of a point deduction system. A new bridge would receive a sufficiency rating of 100, given that the structure met or exceeded all level-of-service criteria. A failed structure would receive a rating of 0. Bridges with sufficiency ratings of 50 or lower are eligible for federal replacement funds, while bridges with ratings between 50 and 80 are eligible for rehabilitation funds. Sufficiency ratings often provide a basis for state bridge management activities.

This form of bridge management is responsive to specific conditions and is intended to address the worst first concept. Future conditions and future traffic demand are not considered in calculating the sufficiency rating. Given that static and potentially shrinking funds, it has been widely recognized that a new form of bridge management is required. In response to the need for more effective and efficient bridge management, Congress, through the Intermodal Surface Transportation Efficiency Act (ISTEA), required the implementation of bridge management systems by State DOT's and Metropolitan Planning Organizations (MPO's).

The National Highway System Designation Act of 1995 officially repealed the legislative mandate for bridge management system implementation by state highway agencies. Nevertheless, DOT's continue to pursue use of these systems.

The Federal Highway Administration (FHWA) encourages states to use bridge management software programs to optimize transportation resources by providing information in support of (1) network-level bridge planning, (2) network-level bridge maintenance planning, and (3) project-level bridge planning. BMS software that is currently available, utilize element-level inspections, predict the future condition of the elements in the network using sophisticated deterioration modeling techniques, and optimize long-term expenditures for preservation and improvement of the highway bridge network. Since both agency costs and user costs are taken into account, decisions can then be made on the basis of economics and structural safety. User costs are those costs incurred by the bridge user for detours, load postings, clearance limitations, and accidents due to poor geometrics or clearances on the bridge. The deterioration rates of various bridge elements and the costs of actions to fix or replace those elements are critical to calculating accurate benefit/cost ratios.

The focus of the preservation optimization model is on finding the long-term steady-state policy, for each bridge element in each environment that will minimize maintenance funding requirements while ensuring that the element will not fail. The optimization model incorporates changes in condition, the effectiveness of agency or owner actions such as widening, raising, and strengthening bridges to minimize user costs. The BMS program then combines the results of the preservation and improvement models to determine overall maintenance, rehabilitation, and replacement needs.

BMS outputs can be used for three main purposes: (1) to provide defensible data for network-level target funding levels; (2) to identify and describe bridge maintenance needs; and (3) to provide information needed for the development of cost-effective programs for bridge maintenance, improvement, and replacement. The outputs provided include historical conditions and funding levels; anticipated deterioration rates of bridge systems; costs for various maintenance, improvement, and replacement activities; present conditions of the system; and a ranking of proposed bridge activity.

Two of the most difficult questions asked of any bridge agency professional are how much money should be invested in the bridge network during the next 20 years and which bridges should receive funding for capital improvements, for rehabilitation, for repair, and for preventative maintenance in the next 2 years.

The answer to these questions lie in one simple performance measure that most bridge management engineers use as a guiding principle: minimizing life-cycle costs for bridges in the network. The life-cycle cost is the sum of three unique costs that occur over the life of a bridge: (1) design and construction costs, (2) traffic disruption and public costs, and (3) operations and maintenance costs. Over the long run, a bridge properly maintained in the early stages of deterioration is less costly. The goal is to minimize all taxpayer investments in bridge building, travel time, travel costs, and bridge operational costs. Authority for long-term planning, preventative maintenance, capital improvement, inspection, posting, and bridge closing generally resides in ODOT Bridge Section. All major decision in each bridge's life is influenced by a team comprising Bridge Maintenance, Bridge Design, and Bridge Management personnel.

27.1.2—Element-Level Inspections

In the past, bridges were categorized into various components, and each component was rated according to its condition. Under the element-level inspection system, bridge elements are defined and rated according to the type, severity, and extent of deterioration. That's to say during the first step of the process, the bridge inspector lists all of the bridge elements. Second step: list all of the deterioration modes or defect flags that are associated with each element. Third step: Since the defect quantity always equals one unit of measure, the inspector assesses how wide spread the defect is on the element using percent only. Fourth step: the inspector allows all of the defect condition assessment ratings to influence the element condition rating. This is to say, the defects will influence the element condition rating but will not control nor roll-up numerically into the element rating.

A condition rating scale of 1 to 4 is used, with 1 being the best rating and 4 being the worst. Element-level reporting requires that data on each element be recorded to show the total quantity of each and the quantity in various condition states. These data items are then used to develop detailed maintenance programs such as deck overlays, deck crack sealing, spot painting, and expansion joint repair.

27.2—BRIDGE MAINTENANCE PROGRAM

Bridge Maintenance Personnel often question the importance and urgency of reporting work accomplishments. After all, the work is done and that's what counts. Maintenance personnel must fully understand the importance of reporting as a means of building an information base in order to help do things better and more efficiently, in the future. The following list includes some of the benefits of reporting that might be of interest to maintenance personnel:

- Having a historical record of maintenance and repair on each bridge can be an excellent source of information as to who did what, how, when and where;
- More in-depth assessment of continual problems with a structure;
- Assess the adequacy of the materials used to make the repair;
- Assess the adequacy of a bridge detail design or repair design;
- Assess the quality and adequacy of the work being performed;
- Assess the best time of year to plan future work on structure;
- Maintains a record of regular, periodic and special expenditures as a basis for developing and justifying future budgets;
- Maintains a current record to establish cost-to-performance relationships;
- Provides a source of information to enable maintenance managers to develop maintenance trends;
- Develop a source of information for public relations;
- Resource of generating accomplishment reports;
- Provides a cost record to compare and update budget estimates;
- The resource that can be incorporated into a defense of a tort liability claim.

Each agency has their own specific reporting requirements. However, in general, the following five general classifications are used to describe the types of information any reporting system should include:

Who – Indicate who performed the work.

What – Report the specific type and amount of work performed. The report of “what” and “how much” is used to evaluate crew performance, the suitability of standards, and work progress and is also used for budget comparisons.

When – Given the date the work was performed is helpful in determining when work should be scheduled in future years. Certain times of the year have much more impact on work production than others.

Where – A given bridge maintenance / repair activity might not address all of the maintenance / repair needs to a given element. Therefore, are fully accounting must be kept on each structure.

How – Report the resources that were used and the process used to get the job done. The hours of labor, types of equipment, and type and amount of materials used are included. This permits computing the cost of performing the work and provides resource utilization data. This information also permits managers to determine the monthly resource needs for use in future scheduling.

27.2.1—Tort Liability

Lawsuits seem to be inevitable in U.S. public agencies. U.S. society is well known as being prone to sue rather than settle disagreements through mediation and reconciliation. Thus maintenance managers should be prepared to participate in a process intended to “manage” litigation. **The successful defense of lawsuits arising from claims of maintenance negligence are significantly aided by good documentation of the actual condition at the time of an accident.**

One excellent source of literature that will provide an understanding of liability issues is the National Cooperative Highway Research Program (NCHRP) legal research digest series. For example:

Number 38: Risk Management for Transportation Programs Employing Written Guidelines as Design and Performance Standards, August 1997. The principals discussed here also apply to written and publicly available maintenance standards.

Number 26: Supplement to Legal Implications of Highway department’s failure to comply with design, safety, or maintenance guidelines, 1992.

The maintenance / repair recommendations from the inspection reports are entered into the “ODOT Bridge Inspection Database”. A full report can be viewed or downloaded from the ODOT Bridge Inspection Web Page. This list is continuously being updated, when a routine inspection report is filed. The intent is of allow the bridge maintenance managers to review the list and schedule the work to be completed without having to screen the entire bridge inspection report of useful information. When a repair is completed, the maintenance manager is supposed to send a copy of the completed work information to the designated bridge inspector. The bridge inspector can then enter the repair date in the inspection report. This will automatically remove the repair from the printed “Bridge Repair List”. However, the repair will still appear in the Bridge Inspection history file.

During the next inspection of the bridge, the completed repairs, when verified by the inspectors, shall be noted as such on the Routine Inspection Report. The repairs that have been verified will not show up again on the Bridge Needs List.

27.2.2—Bridge Scour

Appropriate training has been made available to the various Bridge Owners in the State of Oregon in inspecting bridges for scour. (See HEC 18, Chapter 6). FHWA endorses the guidance contained in the 1987 AASHTO Manual for Bridge Maintenance. Particular attention is directed to the following statement:

Determining an effective solution to a stream bed or river problem is difficult. Settlement of foundations, local scour, bank erosion, and channel degradation are Complex problems and cannot be solved by one or two prescribed methods. Hydraulic, geotechnical, and structural engineers are all needed for consultation prior to undertaking the solution of a serious maintenance problem. In some cases, some remedial action could actually be detrimental to the structure.”

27.3—ODOT BRIDGE MAINTENANCE PROGRAM

During the interstate construction era of the sixties, highway agencies were placed in an enormous building mode. Agencies were managed almost exclusively by engineers and project level engineering dominated the decision making process.

During the seventies and eighties, as interstate construction leveled off, the organizational structure and decision making process in the highway agencies began to change. Additional concerns such as limited resources, ongoing maintenance needs as well as environmental issues, traffic management and community awareness placed new constraints on project level decisions. A new breed of policy makers began to emerge from the ranks.

Now, in the nineties, dollars are being spent on the maintenance of existing facilities at an ever increasing pace. Agencies are being forced to choose between ongoing maintenance activities and the construction of new facilities. To make this choice, agencies are recognizing the need to have better infrastructure management procedures in place. Pure project level engineering decision making, the mainstay of the sixties, is influenced by other constraints. Decision makers must recognize the impact of these constraints so they can be properly weighed against traditional engineering solutions. Engineers must be provided the skills to quantify the components of the decision process so that solutions to complex problems can be methodically formulated. Advanced technology allows innovative computer modeling to aid in these decisions. The age of infrastructure management systems is here.

To manage the complex and aging bridge inventory of today, bridge managers must know where to spend precious resources. They need to weigh maintenance needs against improvement needs. To do this, they need information about user costs as well as the agency costs in performing the required work or the costs that are incurred by deferring it. These costs need to be appropriately weighed so that a decision that best benefits the entire network of bridge can be made.

Bridge managers today, more so than their predecessors, have an increased sensitivity to issues such as budget constraints, environmental issues, user impacts, tort liability and the consequences of work deferral. Most have obtained this sensitivity through years of experience.

The purpose of this document is to simply put forth some guidelines, recommendations, and/or insights to those that might be contemplating issues as to how their organization (Region, District, City, County, etc.) would best be structured. Since you asked, we would like to share our comments regarding four areas:

1. Why a vigorous bridge maintenance organization is needed.
2. The development of a Bridge Maintenance Strategy.
3. The development of a Bridge Maintenance Business Plan.
4. Organizational Structure that is flexible.

27.3.1—The Need for a Bridge Maintenance Organization

There is one absolute fact of life: “All things deteriorate”. Bridges represent the highest unit investment of all elements of the highway system and deficiencies in that structure represents a reduction in the original investment. Additionally, and even more importantly, deficiencies in a structure can present the greatest danger of all potential highway failures for disruption of community welfare and loss of life. Therefore, providing a systematic approach to the development of a complete bridge maintenance program that addresses the Who, What, When, Where, Why and How things are to be accomplished, is very worthwhile and can pay big dividends to the organization.

All maintenance organizational decisions must start with some kind of a visionary objective. Our visionary objectives for establishing a Bridge Maintenance Organization is to:

- a. Protect the original capital investment,
- b. Ensure that a safe facility is available to the public, and
- c. Maintain a desired level of service.

ODOT has an excellent full cycle checks and balance system in place. A certified, bridge inspector routinely inspects the structures and copies of the condition assessments are sent to the responsible organization. The responsible organization then prioritizes the inspectors’ bridge maintenance recommendations and assigns the work

to a dedicated bridge maintenance crew. Upon completion of the bridge maintenance work, the crew supervisor keeps the bridge inspector abreast of work accomplishments and provides worthwhile feedback on the quality of the original inspection. This full cycle checks and balance system seems fit into the above objective quite well and we think it should be preserved.

27.3.1.1—Protection of the Original Capital Investment

Completed studies by the American Public Works Association (APWA) and the Pennsylvania Department of Transportation, have shown, convincingly, that appropriate bridge maintenance activities, performed at the proper time, are cost effective. These studies also showed that it costs less to maintain a bridge in a good condition than to maintain them in a poor condition. Therefore, preventive bridge maintenance is cost effective and deferring maintenance results in increased costs over the life of the structure. As a result, bridge maintenance activities that are well managed so that there is a good match between structural repairs, preventive maintenance, and available resources, is very cost effective.

27.3.1.2—Ensure a Safe Facility is Available to the Public

Bottom line, bridge maintenance managers must assure that the most important problems on the most critical bridges get the highest priority and are addressed in the most cost-effective manner. At the same time, the bridge maintenance managers should also assure that preventive maintenance activities, which have a significant effect on providing an adequate level of safety and minimizing future maintenance problems, are also given high priority. Therefore, we would recommend that each organization develop a bridge maintenance plan or strategy for each structure under their jurisdiction. The plan or strategy should be updated at least annually and specifically address: the expected life of the structure, the rate of deterioration, the effect maintenance has on extending the life, the inspection frequency, scheduled repairs, materials that are to be used, monitoring systems, and user costs.

27.3.1.2—Maintain a Desired Level of Service

To help the organization to better assess where their bridges are and where they should be, a network level of service reference is provided at the end of this document, for your use. The purpose of this attachment is to help each organization identify the appropriate level of service for on a given section of highway and better determine what level of service deficiencies exist on each structure in the inventory.

The opinion that bridges have a high degree of vulnerability concept is reflected in stringent FHWA guidelines that basically dictates that each state is responsible for imparting quality bridge inspection and load rating programs that exhibit thoroughness and good judgement. To assure that ODOT is adhering to the National Bridge Inspection Standards (NBIS), FHWA audits our programs annually. Therefore, in this case, the objective is to assure that the State of Oregon is adhering to FHWA guidelines.

The National Bridge Inspection Standards (NBIS) stipulates that each state will determine the load-carrying capacity of each structure in their inventory in accordance with AASHTO guidelines. The AASHTO guidelines, in turn, directs the Engineer to exercise sound judgment in determining the load capacity of a given structure, by taking into consideration the impacts of three major factors:

- Quality of the Bridge Inspections being performed on the structure,
- Whether bridge maintenance is being performed vigorously or intermittently,
- Whether the overload enforcement is reasonable or non-existent.

Therefore, in this case, the organizational structure should take into account whether the bridge maintenance activities can be termed to be vigorous or intermittent. In the State of Oregon, we have taken the position that if the organization had a dedicated crew to specifically address identified bridge deficiencies, the activities would be termed vigorous and additional load carrying capacity allowances could be made accordingly. If the organization reduces their ability to vigorously perform bridge maintenance activities, the calculated load capacities of the bridges in their inventory could like wise be reduced and possibly require load posting. Since one of the ODOT goals is to not have any load posted structures in our inventory, we would hope that the organization maintains a

crew that is specifically dedicated, skilled and trained to vigorously address structural deficiencies that are identified during the bridge inspection process.

27.3.2—Development of a Bridge Maintenance Strategy

Personnel in the organization that are directly involved in the bridge maintenance decision making process, should first start with the development of a bridge maintenance strategy or game plan. Looking at the amount of work that actually gets into the STIP verses the number of identified needs, it becomes quite obvious that the total available resources are simply not sufficient to keep pace with the rate of deterioration of the bridges in our inventory. Therefore, bridge maintenance managers are required to make serious trade-offs. They must ensure that existing facilities are properly maintained to protect the original capital investment and to ensure that a safe facility is available to the public. Since this cannot be accomplished totally with a bridge replacement and rehabilitation program, it must be accomplished by directing considerable attention to preserving the structures in our inventory through the use of good management practices.

The bridge manager needs to develop a balanced program that spends enough on maintenance at the right time in the life of a bridge so that rehabilitation or replacement is not needed prematurely. Some preventive maintenance activities, if performed routinely, would prolong the life of the bridge and reduce the need for other, more costly, maintenance activities. Therefore, someone, somewhere along the line must develop a long term maintenance strategy and decide where we're going, and provide that direction.

Using bridge inspection data, the organization can identify the current condition of each bridge. The current condition of the bridge should be the starting point for any maintenance action. Obviously the strategy should consider the performance desired for the specific bridge in terms of maintaining the current condition, improving it, or allowing the condition to degrade to a lower level. Matching the bridge's condition with the most appropriate strategy must be accomplished through an evaluation of the bridge deficiencies and the causes of the deficiencies. Deficiencies in different elements do not have an equal effect on the service life of the bridge, the safety of the general public, and the cost of maintenance, repair, or rehabilitation. Determination of an appropriate strategy involves a detailed evaluation of all of these factors, requires engineering judgment, and should be performed by personnel with bridge experience.

27.3.3—Development of a Bridge Maintenance Business Plan

During each routine bridge inspection, the bridge inspector creates a list of bridge maintenance recommendations that they feel would adequately address each deficiency that is found on a given structure. Given that list of maintenance recommendations, it is the bridge maintenance managers' responsibility to produce a game plan that adequately addresses each recommendation. In essence, this equates to the effectiveness, efficiency, and the value of the services that the bridge maintenance personnel are providing. In other words, this means that the bridge maintenance managers must be responsible for doing the right things, at the right time, and for doing them correctly.

In order to achieve a well-balanced, cost-effective bridge program, on a network basis, the following four bridge maintenance categories must be incorporated into the business plan:

- Preventive Maintenance. This includes those maintenance activities that protect the original capital investment, prevent deterioration, or allow the bridge components to function as designed. For bridges in good condition, preventive maintenance is generally the most cost-effective use of funds. If at all possible, preventive maintenance needs should be funded each year.
- Minor Repair. These are performed to arrest and correct deterioration before it becomes a serious problem. Depending on the extent of the deterioration, minor repair may be a more expensive action than preventive maintenance.
- Major Repairs. These provide for the correction of extensive deterioration and minor betterment to the bridge. The cost effectiveness of this strategy will depend on the additional service life expected. Initial costs will usually be less than rehabilitation.
- Deferred Action. This strategy is reserved for those bridges with maintenance needs, which are beyond the point where preventive maintenance and minor repair will be effective and have not deteriorated to the point of needing major repair or rehabilitation. Selecting this strategy is deferring maintenance, so the

bridge maintenance office must be prepared to fund major repairs or rehabilitation when it becomes necessary. Emergency repairs must be performed to keep the bridge in service or eliminate unsafe conditions. Deferred action should never be considered for fracture critical bridges or members. The deferred category would also include emergency work resulting from an act of man or God, such as damage from a vehicle accident or severe storm.

Depending on the condition of the structures in your inventory, we would suggest that the bridge maintenance funds might be allocated in the following proportions:

- Preventive Maintenance 10 to 25 %
- Minor Repairs 15 to 25 %
- Deferred Maintenance 10 to 20 %
- Major Repairs 30 to 65 %

In the State of Oregon, depending on the scope and complexities of the work, we have three different business plans:

1. The first plan is at the district level. Given the list of bridge deficiencies on each structure, the district manager decides, whether the work should be assigned to the bridge maintenance crew, or whether submitted for inclusion in one of the other two programs. Work activities that generally fall into this business plan are Preventative Maintenance and Minor Repairs. For the most part, this business plan is rather predictable and routine. However, occasionally, unforeseen deficiencies do occur and a decision must be made as to how they will be addressed.
2. In about 1990, the State of Oregon established a \$10 million biennial Bridge Contract Maintenance or Major Maintenance Budget, to specifically address Major Repairs. This type of work is generally determined to be: beyond the scope of work normally performed by an ODOT Bridge Maintenance Crew, with respect to equipment, materials, required time to complete, or the project requires specialized skills or levels of expertise generally not found on a bridge maintenance crew. The proposed work was not inclusion in the entities' original budget, it addresses unforeseen repair activities not anticipated, or requires immediate action to correct. This would include projects that were removed from the finalized STIP that may require implementing additional stopgap measures in order to keep the structure at an acceptable level of service. This type of work generally is not categorized as modernization and therefore is not included in the STIP. The Bridge Contract Maintenance program is formulated every two years and tends to be the catchall of projects that do not fit the districts business plans and projects that did not make the finalized STIP.
3. The 3rd Business Plan is the Statewide Transportation Improvement Plan (STIP). Projects that fit into this category are extremely large Major Repairs, such as, structure painting, cathodic protection projects, structural overlays, bridge modernization projects such as widening, raising and bridge replacements. This is a six year plan that is updated every two years. When established, the business plan becomes very rigid and extremely hard to change.

27.3.4—Organizational Structure that is Flexible

To help guide decisions regarding the structure of a bridge maintenance organization, we would hope that the following operational goals and objectives be adopted and/or incorporated into the operations:

- a. Plan, authorize, and coordinate the structure maintenance and repair activities under the guidance of a bridge maintenance strategy to assure that the most critical repairs are being addressed, in a cost effective and timely manner, that exhibits good workmanship.

Emergency repairs may be required, but where possible, bridge repairs must be planned, authorized, and coordinated under the guidance of a prioritized bridge maintenance work list to assure that the most critical repairs are being addressed. An action plan could be established within the following guidelines:

- NBI Items rated a "6" will be addressed within 24 months,
- NBI Items rated a "5" will be addressed within 12 months,
- NBI Items rated a "4" will be addressed within 6 months, and
- NBI Items rated a "3" or less will be addressed immediately.

The prioritized bridge maintenance work list should be updated at least twice a year, and coordinated with the results of the ODOT bridge inspection program.

- b. Develop a responsive, flexible, and efficient organization that provides quality management and quality performance by sharing or re-assigning employees, crews, equipment, tools, purchased materials, ideas, tricks of the trade, and budgets, in order to provide a good match between structural repairs, preventative maintenance, and the available resources.

It's recognized that the boundaries of a given ODOT district are basically created around the capabilities of a highway section crew to adequately maintain a given stretch of highway. However, it is also recognized that bridge maintenance needs are not necessarily evenly distributed within a given geographical district boundary. Therefore, there is considerable merit to establishing a bridge maintenance organization that is structured in such a manner that the resources can easily be shifted and/or directed to address specific bridge maintenance recommendations, without being tied to some geographical boundary. We think there's considerable merit and efficiencies gained by organizing the work force by the type of work that needs to be accomplished, rather than having a more generalized work force. We also believe the implementation of a more generalized work force would most likely, in the long run, result in the following:

- ODOT would lose the skilled bridge maintenance labor force that now exists,
- Be less prepared to respond effectively to emergency needs, and
- More of the bridge maintenance activities would be contracted out, resulting in higher expenditures and less work performed.

If a given bridge maintenance crew is jacking up structures, placing temporary shoring and working on structural members under traffic, I would sincerely hope that the crew members are well skilled and have a considerable amount of experience performing such tasks. There is a considerable amount of risks, that can be minimized simply by having the best and most experienced employees possible to perform the work that needs to be accomplished. There is also merit in having a bridge maintenance organization that can be mustered together into a large skilled and trained work force to take care of larger projects or emergencies. Likewise, we would also like to be able to disseminate the work force out to smaller work units, so as not to be over staffed while undertaking preventive maintenance and minor bridge repair chores.

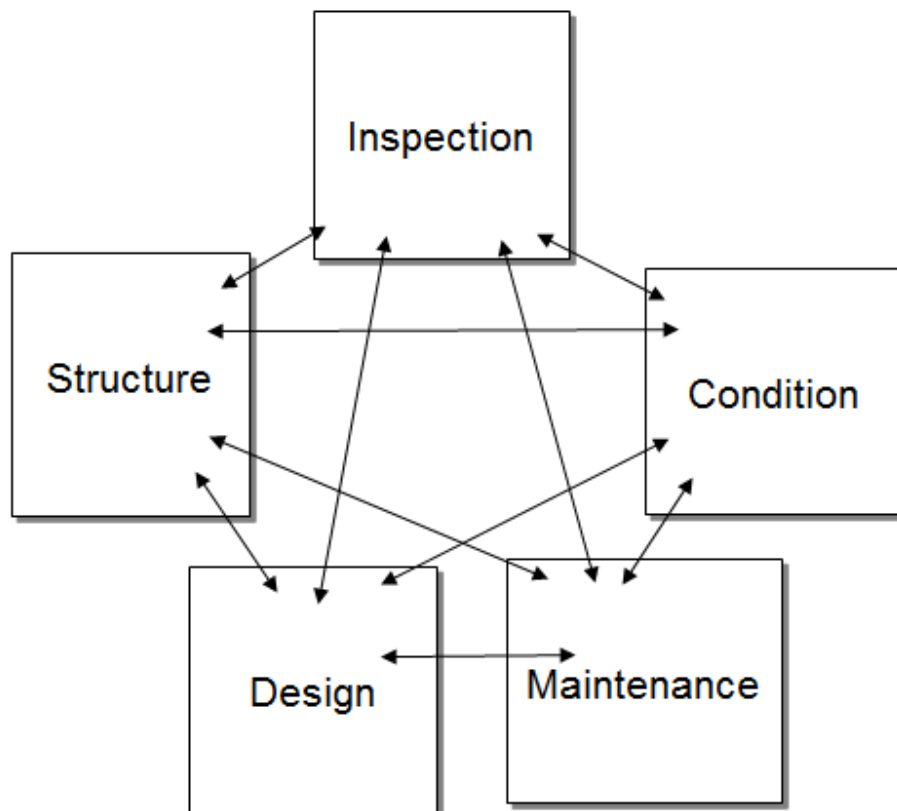
- c. Since the employees are our most important resource, actively seek and value their ideas and contributions, fostering and recognizing innovation, creativity, teamwork, and building an organization that fully utilizes their abilities.

Historically speaking, ODOT bridge maintenance employees have always been considered to be an elite group that were jacks of all trades (carpenters, woodworkers, steelworkers, welders, concrete finishers, equipment operators, and skilled riggers working at heights). ODOT bridge maintenance personnel have always prided themselves to be able to easily perform tasks assigned to highway section maintenance personnel, but the reverse was not easily accomplished. Therefore, as value to the organization, we do not think that there is merit in assigning bridge maintenance personnel tasks that do not utilize their skills and/or expertise to the fullest.

Grouping bridge maintenance together with highway maintenance would most likely result in competing activities. Activities that are generally assigned to highway maintenance such as, mowing, paving, signing, landscaping, etc. are much more visible to the public. Whereas activities that are generally assigned to bridge maintenance crews occur to a greater extent under a bridge in a much less visible location. Therefore, we believe that such a grouping would greatly reduce the focus of the bridge maintenance program and result in a much higher degree of deferred maintenance. This generalized type of grouping could also result in reduced load rating allowances for the structures in the organizations' bridge inventory.

- d. Promote a work ethic and training that insists upon safe working conditions, equipment, tools, safe work practices, and a clean, pleasant, orderly, and well- maintained work area so that the safety of the employees and general public is maximized.

Tasks that are generally assigned to a given bridge maintenance crew are very labor intensive, requiring heavy loads to be manhandled into very tight quarters. We believe that the size of an average bridge crew, statewide, should be at least 6 people (1 supervisor/coordinator; 1 equipment operator; 2 on the boom line; and 2 employees performing traffic control). Traffic control duties were included in the proposed bridge maintenance crew staffing levels, because many crews use the two positions to rotate throughout the crew, in order to provide each member a break from the heavy physical labor. Therefore, is there any merit, assigning highway maintenance personnel from another crew to fill-in on a bridge maintenance crew? Before the employee is assigned such tasks, we would recommend that they have received an adequate amount of training to mitigate all known workplace hazards.



CHAPTER 28: SUPPORTING DOCUMENTS AND REPORTS

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CHAPTER 28:

SUPPORTING DOCUMENTS AND REPORTS

28.1—SAFETY MANAGEMENT SYSTEM FOR BRIDGES W/ FRACTURE CRITICAL MEMEBERS

Purpose

The purpose of this Guide is to identify Oregon' best practices regarding the safety management of bridges with fracture critical members (FCMs).

Goal

The Oregon Department of Transportation's (ODOT's) primary goal is the safety of those using, building, and maintaining Oregon's transportation system. The ODOT Bridge Section of Technical Services Branch is specifically tasked with ensuring the safety of our bridges. Toward that end, this safety management system for bridges with FCMs has been adopted to facilitate cost- effective decision making and to assure the safety and performance of its transportation network.

General Background

A number of steel structures failed in the 1950s and 1960s due to various causes, but the failure of the Silver Bridge at Point Pleasant in West Virginia in 1967 got national attention. This truss collapsed suddenly due to the brittle fracture of an eyebar link, resulting in the loss of 46 lives and closure of a major route. As a result of this terrible tragedy, the National Bridge Inspection Standards (NBIS) were developed as part of the Federal-Aid Highway Act of 1968. In addition, significant additional research efforts were initiated in fracture mechanics. As a result, the effects of multiple stresses at less than yield of the materials were understood more thoroughly.

Redundant and non-redundant members were first recognized in the twelfth edition of the AASHTO Bridge Specifications in 1977. The first guide specifications for FCMs were issued by AASHTO in 1978.

After design engineers began to recognize the problems associated with stress cycles at less than allowable values, further information was developed to assist in the design process and in evaluation of existing structures. After notable failures, it was recognized that many existing bridges may be nearing failure due to fatigue. FCMs were recognized and defined as a steel member or component in tension whose failure would result in the total or partial collapse of a bridge. These are commonly referred to as non-redundant members. Methods were developed to help determine which structures must be further evaluated by designers for susceptibility to fatigue problems. Designers began to include Fracture Control Plans in bridge design details.

The most common types of FCMs are tension flanges and parts of webs of flexural members such as beams and girders. Tension members of trusses, particularly the lower chords, can also be fracture critical (FC). Other tension members of trusses, such as diagonals, can also be FC. Concrete members are not often used in pure tension. The design of flexural concrete members with multiple reinforcing bars precludes the possibility of abrupt failure due to their ductile failure mode.

The ODOT Safety Management System for Bridges with Fracture Critical Members

Overview

A Safety Management System (SMS) for bridges with FCMs requires the interaction of good policy and practices regarding design and detailing, quality construction to assure durability, inspectability, maintainability and replaceability. ODOT has documented its policies, definitions, descriptions and inspection procedures for the safety management of fracture critical bridges in its collection of policy manuals available online and in accordance with "Preferred Practices for Steel Bridge Design, Fabrication and Erection," a 2009 collaboration of the Oregon Steel

Quality Council and ODOT. ODOT also has created a listing of all FCMs and/or fatigue prone details used to organize the critical components to be evaluated during field inspections and to ensure that each FCM is inspected.

Design.

Design procedures for FCMs start by evaluating the need for an FCM. FCMs are ideally eliminated at the planning and design stage. FCMs are used if no appropriate or acceptable alternative to their use is found. When FCMs are incorporated into a bridge, design methods, practices, and polices to mitigate the risk associated with their use include:

- Designing for fatigue and fracture limit state in the AASHTO LRFD Bridge Design Specifications, which requires the design details to provide a minimum acceptable level of resistance to fatigue and fracture. These design specifications include the latest research in the area of fatigue and fracture in steel bridge elements, along with prescribing design loading and load factors that specifically address the unique aspects of fatigue in steel bridges.
- Avoiding welded details more prone to fatigue crack initiation unless appropriate or acceptable alternatives to their use are found. Fatigue cracks usually originate at a weld in a steel member. Commonly encountered welded steel details are categorized by the susceptibility to fatigue crack initiation.
- Using modern steels in the design with high levels of resistance to fracture, such as High Performance Steel which was specifically developed for high fracture toughness.
- Incorporating a robust QA/QC of the bridge design to identify and remove any errors and mistakes in the design and design details.
- Training bridge designers on the features of FC bridge elements and expected outcomes of design decisions with FCMs.
- Incorporating features into the design details that facilitate in-service inspection of FCMs. These include such items as providing access doors to the inside of tub girders and box caps along with openings in diaphragms inside of tub girders and box caps that are adequately sized for inspection personnel and equipment to pass through. Also, the insides of FC tub girders and box caps are required to be painted white in the bridge plans and specifications which assist in finding fatigue-related cracks by highlighting cracking when coating flakes and making limited lighting more effective due to the lightened surface. Electrical outlets are also called for in design plans for tub girders to provide lighting during inspection of the interiors.
- Providing bridge design plans that identify all FCMs in the bridge and requiring the bridge fabricator to adhere to the Fracture Control Plan outlined in the AWS/AASHTO Bridge Welding Code, D1.5.
- Providing plans that prohibit welds to FCMs during field erection.

Construction.

The governing specifications for steel bridge fabrication are found in Oregon Standard Specifications, 00560, “Steel Structures” and 02530, “Structural Steel” and 02560, “Fasteners”. These specifications can be found at: http://www.oregon.gov/ODOT/HWY/SPECS/Pages/standard_specifications.aspx, as modified by Special Provision at http://www.oregon.gov/ODOT/HWY/SPECS/Pages/2008_special_provisions.aspx#Part_00500.

In general, 00560 requires the fabricator to perform fabrication in accordance with AASHTO/NSBA Steel Bridge Collaborations S2.1. This document is a national standard for bridge fabricators and requires them to establish a Fracture Control Plan. The fabricators are also required to identify on the shop drawings the FCMs and include the Charpy V-Notch (CVN, a measure of steel toughness) and fracture control requirements for the member. Shop drawing reviewers verify that fracture critical elements are properly identified and that shop drawings and material lists conform to the Fracture Control Plan. Fabricators are required to identify the different materials by the CVNs to insure that the correct material is used to fabricate FCMs. 00560 defaults to a CVN for Zone 2 (cold climate) but some regions of the state use Zone 3 (for colder climates). This information is put in the plans based on guidance to designers from the BDDM.

Before welding any primary bridge member, including fracture critical elements, a welder must pass the AWS/AASHTO Bridge Welding Code, D1.5 qualification test for groove and fillet welds in the vertical and overhead positions. The Bridge Division issues Department certification papers if the test results are approved.

00560 requires that the fabricator perform Nondestructive Examination (NDE) in accordance with the AWS/AASHTO Bridge Welding Code, D1.5. In addition to the NDE requirements set forth for all steel bridge members, fabricators must also perform radiographic and ultrasonic testing on all splice joints in tension zones of fracture critical members. The Department maintains a staff of AWS Certified Welding Inspectors to perform visual inspection of all welds, as well as Level II NDE technicians to perform ultrasonic testing and check radiographic film.

In-Service Bridge Inspection.

ODOT not only requires all fracture critical inspection team leaders to meet all qualifications called for in the Code of Federal Regulations, it also encourages that they complete the National Highway Institutes' Course # 130078, Fracture Critical Inspection Techniques for Steel Bridges. Inspection procedures begin with proper advanced planning. Important planning aspects usually based on an office review of the structural plans, fracture critical inspection records, and aerial views of the location, include:

- Identify all fracture critical members on both the superstructure and substructure including all primary gusset plate locations.
- Note the particular members in the structure that may require special field attention, such as built-up tension members composed of few individual pieces.
- Determine equipment necessary to access the fracture critical members, such as a UBIT, ladders, bucket truck, boom lift, boat, ventilation equipment, or climbing gear.
- Determine whether or not a confined space entry permit is required to perform a hands-on inspection of the fatigue details located inside box caps and tub girders.
- Identify all personal protective equipment necessary to inspect the structure such as air monitor, hard hat, vest, steel toed boots, flashlight, respirator, or eye protection.
- Many structures designed for urban situations with necessary complex alignment geometries result in FCMs. Proper inspection of these bridges may require closing a traffic lane or require a night time inspection due to high average daily traffic. Coordinate safe traffic control in advance with the local District and Area offices and their Safety Review Team.
- Coordinate with the proper railroad company for a railroad flagger if inspection operations are within 25 ft. proximity of a railroad track. Every individual entering a railroad must have a right-of-way entry permit with appropriate safety measures in place.
- Identify and make available any necessary special tools and equipment that may be required in addition to the normal inspection gear.
 - Tools for cleaning
 - Shop-vac to remove loose debris
 - Brushes – both wire and synthetic
 - Needle scaler
 - Chipping hammer
 - Compressed air
 - Non-destructive test equipment:
 - Penetrant Testing - Used for crack verification and crack tip location.
 - Magnetic Particle Testing – Used for crack verification and crack tip location
 - Ultrasonic Testing – Used to detect subsurface cracks and evaluate remaining thickness at locations that have experienced section loss. All pin-and-hanger connections are evaluated using this method.

The actual field inspection of all FCMs consists of a hands-on visual inspection where the inspector gets within 24 inches of all fracture critical members. The inspector notes any:

- Visual cracks and records the crack length, direction, and location, describing what member the crack is in and where on the member the crack is located. Marks are made on the member documenting crack limits

and the date crack observations were made. A picture is taken of each crack and placed in the picture report.

- Corrosion resulting in section loss of the fracture critical member, or resulting in pack rust between built-up members. At least one picture showing the worst location of this type of deficiency is placed in the picture report.
- Weld terminations, plug welds, or intersecting welds in a tension area.
- Interrupted back-up bars used for built-up-member fabrication.
- Arc strikes, scars from assembly cables or chains, or other physical damage.
- Cross-section changes which may cause a sudden increase in the stress pattern.
- Each type of AASHTO defined fatigue detail and all known problematic details that exists on the member. A picture of each is taken and placed in the picture report.

After the field inspection has been performed, a report is written to document the inspection plan and the current condition of the FCMs. This written report is supplemented by a picture report. The picture report contains an example of each type of fatigue detail, the overall layout of the structure, a picture of every crack, and the location of moderate to severe section loss. The format of the report is as follows:

Methods:

- The equipment used to get within 24" of all FCMs, including required safety equipment.
- Who performed the inspection?
- How long was required to perform the inspection?
- When the inspection was performed (night/day – date).
- Site specific details requiring special attention (fatigue details, problematic details, primary gusset plates, dangerous conditions).
- List special equipment necessary to clean and verify cracks and quantify section loss, including non-destructive evaluation techniques used.
- Equipment setup and access points

Traffic Control:

- The agency or contract firm that provided the traffic control.
- Identify whether a railroad flagger is necessary.
- Lane closure information.
- Advanced notification time required to obtain ROW access

Structure Description:

- Year Built, Structure Type, Length of Structure
- Structure Orientation.
- Identification of each FCM which are then grouped by the appropriate AASHTO fatigue category.
- List of fatigue details and problematic welded detail.

Inspection Summary:

- Describe the general condition of the structure.
- List all cracks, on the structure, in a table showing length, location, and direction.
- List all section loss dimension and locations. This value should be recorded as remaining thickness.
- List all pack rust locations that are causing bowing of the built-up members or causing bolts or rivet to shear.

Recommendations:

- Repair and/or preventative maintenance recommendations based on the information shown in the inspection summary.
- Items to be updated on the NBI as a result of the fracture critical inspection.
 - o Item 59 - Superstructure Rating (0-9)
 - o Item 60 - Substructure Rating (0-9)
 - o Item 92A - Fracture Critical Inspection Frequency (0-24)

- o Item 93A - Fracture Critical Inspection Date (Month/Year)
- Items to be undated on the Element Level report as a result of the fracture critical inspection.
 - o Elements 102, 107, 113, 120, 121, 125, 126, 141, 151, 152, 147, 161, and 162.

Section 14.8 of the ODOT Bridge Inspection Manual includes an outline of the elements of a typical fracture critical inspection report used by ODOT describing items that are documented in the inspection.

Maintenance and Preservation

Although rare, routine FC inspections occasionally reveal defects or deterioration in fracture critical elements. In those cases, the inspectors who observe and document the defects work closely with the engineers in the Bridge Maintenance group, located in ODOT's Bridge Section, to develop appropriate repair procedures and details.

When damage is limited to a few isolated locations, ODOT personnel often perform repair work themselves. There are several Certified Bridge Welders on staff in the Bridge Maintenance Unit who are capable of performing a variety of routine repairs to steel structures. When damage is more substantial or widespread, ODOT engineers develop repair procedures and details for use by a qualified steel repair contractor.

Repairing damage to fracture critical elements is given a high priority, particularly when the deterioration appears to be rapidly advancing or when it could potentially lead to failure of the element and consequently to the bridge itself. Routine maintenance is also an important aspect of preserving fracture critical elements. Repairs are typically far more effective and less expensive when a problem is addressed before it advances to the point that the load-carrying capacity of the structure is compromised. For example, cleaning and coating steel that exhibits minor surface corrosion can prevent deterioration from worsening to the point that more substantial structural repairs are necessary.

Summary

ODOT's primary focus is on safety. Part of this focus is evidenced in Oregon's bridge safety management system for bridges with FCMs. Through the implementation of this system, ODOT ensures the safety of our bridges through prudent design and construction, thorough inspections and consistent maintenance. Each component is critical to the system as a whole as they work together to improve safety and reduce risks and costs.